Planning Proposal

Proposed re-zoning of R5 land and amendments to the minimum lot size within the South East urban release area at Southlakes Estate, Dubbo

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Executive Summary

The intention of this Planning Proposal (PP) is to continue a planning regime that supports the development of land in consistent manner to that of the existing Southlake's Estate. This PP would provide greater flexibility and choice across residential land and housing product and provide for the location for the future southern distributor within the south east Urban Release Area of Dubbo, currently planned under the *Dubbo Local Environmental Plan 2011* (DLEP). The subject land of this PP includes one land holding (Lot 2 DP 880413) within the south east of Dubbo bounded by Boundary Road to the north, Henessy Road to the south and Sheraton Road to the east. This PP has been prepared in accordance with the NSW Department of Planning and Environment's (DPE) advisory documents *'A Guide to Preparing Local Environmental Plans'* and *'A Guide to Preparing Planning Proposals'.*

The proposed rezoning and subsequent changes to the minimum allotment size within the DLEP would facilitate a Master Planned Neighbourhood that would provide:

- Greater flexibility and choice in residential land and housing product within the south east urban release area and the greater residential market of Dubbo consistent with Southlakes Estate.

It is anticipated that this PP would facilitate:

- A combination of low and medium density residential development of varied scale, height and design;
- Direct pedestrian and road links to public recreation land and the local road network;
- Varied infrastructure designed to provide stormwater management integrated into the design of proposed landscaped recreation areas;
- Reservation of land within the flood plain for the future southern distributor.

This PP affects the *Land Zoning Map – Sheet LZN_008B* and the *Minimum Lot Size Map – Sheet LSZ_008B* of the *Dubbo Local Environmental Plan 2011* (DLEP) by:

Rezoning:

- part of the existing R5 residential land to R1 - General Residential land
- part of the existing R5 residential land to R2 – Low Density Residential land
- part of the existing R5 residential land to RU2 – Rural Landscape land

Amending the minimum lot sizes for:

- The R5 zoned land to comprise a minimum lot size range of 0m^2 to 2,000m^2
- The Ru2 zoned land to comprise a minimum lot size of 100ha

The R1 land has been chosen to facilitate higher density residential and private recreation land options. It is envisioned that this PP would assist in continuing to provide a more flexible development suite and potential subdivision layout than that currently achievable under the existing R2 zoned land. Whilst the Ru2 zoned land has been chosen to facilitate the extension of adjoining Rural landscape land to the future Southern Distributor.

Approval of the proposed planning amendments is sought from the Director-General of the DPE. Details of the proposal's compliance with all applicable strategic, regional, and local planning instruments, State environmental planning policies, and ministerial directions are contained in the body of this report.

Background

1.1 INTRODUCTION

Maas Group Family Properties Pty Ltd have prepared this PP to support a proposed amendment to the DLEP. This PP affects the *Land Zoning Map – Sheet LZN_008B* and the *Minimum Lot Size Map – Sheet LSZ_008B* of the *Dubbo Local Environmental Plan 2011* (DLEP). In particular, this PP affects one land holding (Lot 2 DP 880413) within the south east of Dubbo bounded by Boundary Road to the north, Henessy Road to the south and Sheraton Road to the east.

This land is nearing readiness for development as the existing residential estate of Southlakes progress east towards the property boundary.

The proposed rezoning and subsequent changes to the minimum allotment size within the DLEP would facilitate a Master Planned Neighbourhood that would provide:

- Greater flexibility and choice in residential land and housing product within the south east Urban Release Area and the greater residential market of Dubbo

It is anticipated that this PP would facilitate:

- A combination of low and medium density residential development of varied scale, height and design;
- Direct pedestrian and road links to public recreation land and the local road network;
- Varied infrastructure designed to provide stormwater management integrated into the design of proposed landscaped recreation areas;
- Reservation of land within the flood plain for the future southern distributor.

This PP affects the *Land Zoning Map – Sheet LZN_008B* and the *Minimum Lot Size Map – Sheet LSZ_008B* of the *Dubbo Local Environmental Plan 2011* (LEP).

Details of the proposal's compliance with relevant strategic, regional, and local planning instruments, state environmental planning policies, and ministerial directions are contained in the following sections.

1.2 SCOPE OF REPORT

This PP has been prepared in accordance with the NSW Department of Planning's advisory documents '*A Guide to Preparing Local Environmental Plans*' and '*A Guide to Preparing Planning Proposals*'. The latter document requires the PP to be provided in five (5) parts, those being;

- *Part 1* – A statement of the objectives or intended outcomes of the proposed LEP;
- *Part 2* – An explanation of the provisions that are to be included in the proposed LEP;
- *Part 3* – The justification for those objectives, outcomes, and provisions and the process for their implementation;
- *Part 4* – Mapping; and
- *Part 5* – Details of the community consultation that is to be undertaken on the Planning Proposal.

It is noted that Part 4 would be confirmed following a Gateway Determination of this Planning Proposal by the NSW Department of Planning and Environment.

1.3 STRUCTURE

This PP is provided in the following structure;

- **Section 2** provides an overview of the subject site; the development intent; and development constraints;
- **Section 3** provides a statement of the objective and explanation of provisions of the PP;
- **Section 4** provides justification regarding the need for the PP; outlines its relationship to strategic planning strategies; and overviews the environmental, economic, and social impacts of the proposal;
- **Section 5** provides the proposed mapping amendments relating to the Planning Proposal area; and
- **Section 6** details how community consultation is to be undertaken with respect to the PP.

Overview

2.1 THE SUBJECT SITE

2.1.1 SITE DESCRIPTION AND LOCATION

This Planning Proposal (PP) affects a portion of land known as Lot 2 in DP 880413 within the south east Urban Release Area of Dubbo bounded by the future extension of Boundary Road to the north, Henessy Road and its future extension to the south, and Sheraton Road to the east.

This land is nearing readiness for development as the existing residential estate development of Southlakes progress east. This land is located within visible transition and eastern edge of Dubbo's South Eastern Urban Development Precinct, being the Sheraton Road and Hennessy Road corridors.

Plate 1 provides an aerial view of the land relative to the city of Dubbo and surrounding development which is the subject of this PP.

Plate 1: Aerial view of the subject land, Dubbo City and surrounding development (source: www.maps.six.nsw.gov.au)

2.2 DEVELOPMENT INTENT

The intention of this Planning Proposal (PP) is to provide;

- Greater flexibility and choice in residential land and housing product within the south east Urban Release Area and the greater residential market of Dubbo.

It is anticipated that the PP would facilitate:

- A combination of low and medium density residential development of varied scale, height and design;
- Direct pedestrian and road links to public recreation land and the local road network;
- Varied infrastructure designed to provide stormwater management integrated into the design of proposed landscaped recreation areas;
- Reservation of land within the flood plain for the future southern distributor.

2.2.1 EXISTING ZONE REGIME AND PERMISSIBILITY

The existing DLEP *Land Zoning Map – Sheet LZN_008B* describes the land use zone for the site of R5 residential land. The current zoning application across the south east precinct results in a large expanse of land area with a predominantly homogenous residential development potential and without a broad choice of allotment and subsequent housing types.

Plate 2 below details the current land zoning regime within the south east Precinct.

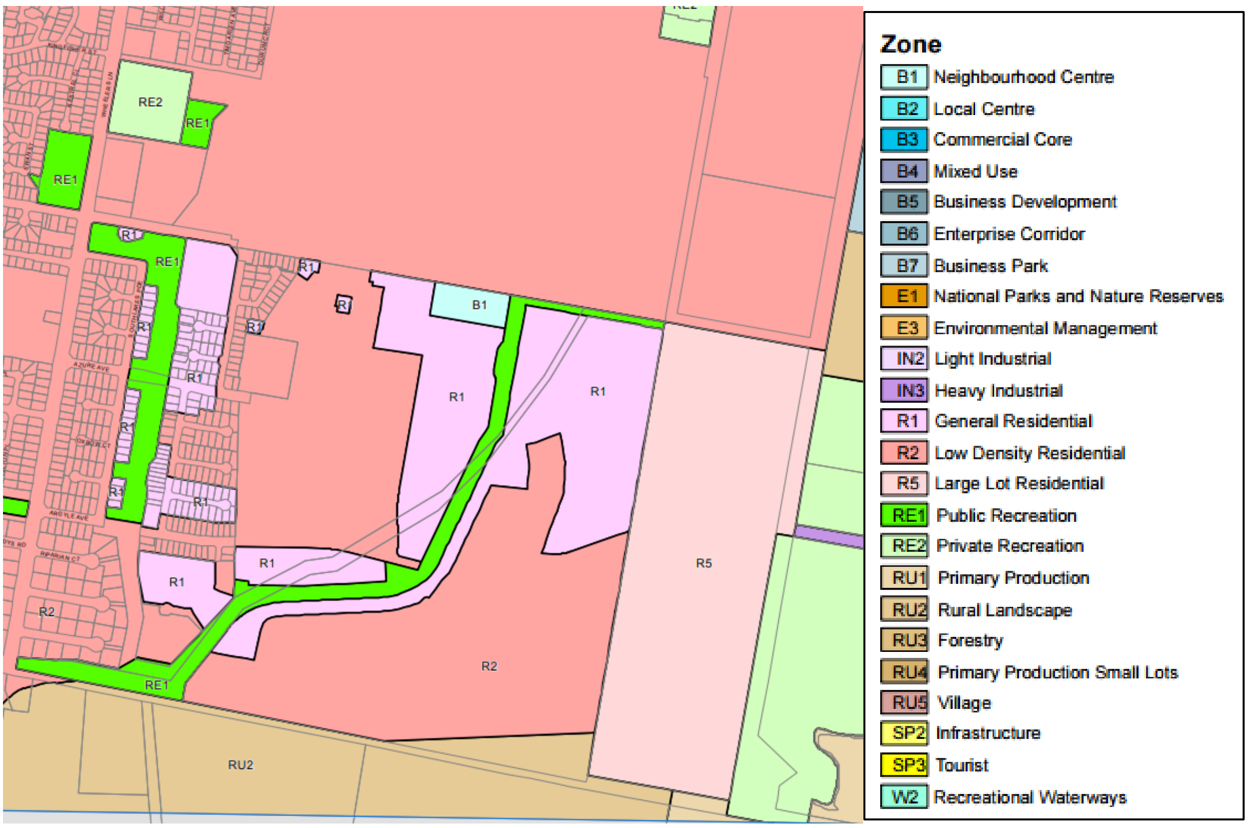


Plate 2: DLEP 2011 Zoning Map LZN_008B extract (Source: www.legislation.nsw.gov.au)

2.2.2 EXISTING MINIMUM LOT SIZE RESTRICTIONS

Upon viewing the DLEP *Minimum Lot Size Map – Sheet LSZ_008B* the predominant minimum lot size for the majority of R5 zoned land upon the site is 1.5ha.

Southlakes Estate

The existing residential land within the developed Southlakes Estate is comprised of:

- R1 zoned Land adjoining the stormwater 'lakes' system with no minimum lot size;
- R1 zoned land adjoining the stormwater 'lakes' system with a minimum lot size of $300m^2$;
- R2 zoned land adjoining the creek lake system and the majority of the site with a minimum lot size of $600m^2$;
- R2 zoned land in the southern portion of the site, north of Hennesy Road with a minimum lot size of $2,000m^2$.
- R5 zoned land in the eastern portion of the site adjoining Sheraton Road with a minimum lot size of 1.5ha.

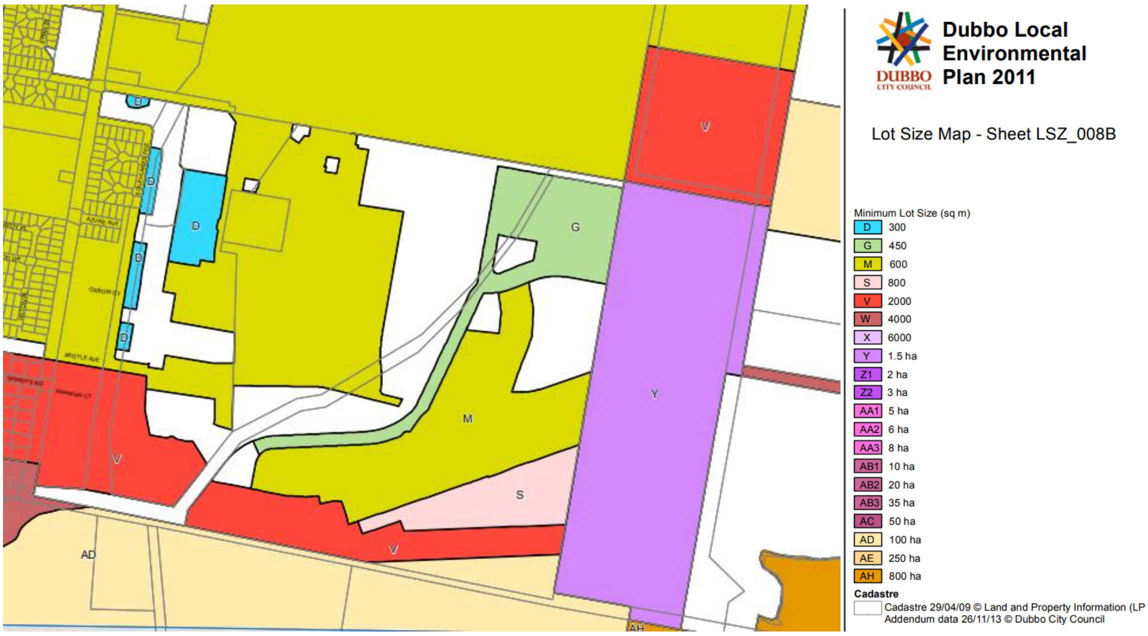


Plate 3: DLEP 2011 Minimum Lot Size Map LSZ_008B extract (Source: www.legislation.nsw.gov.au)

2.2.3 PROPOSED ZONE REGIME

The intention of the rezoning is to provide:

- A combination of low and medium density residential development of varied scale, height and design;
- Varied infrastructure integrated with the future road and landscaped recreation areas;
- Rural Landscape land through the flood prone land of the Eulomogo Creek that enhances the amenity and natural qualities of the water course and adjoining agricultural grazing land.

Plate 4 below shows the proposed zoning amendments within the South East Precinct.

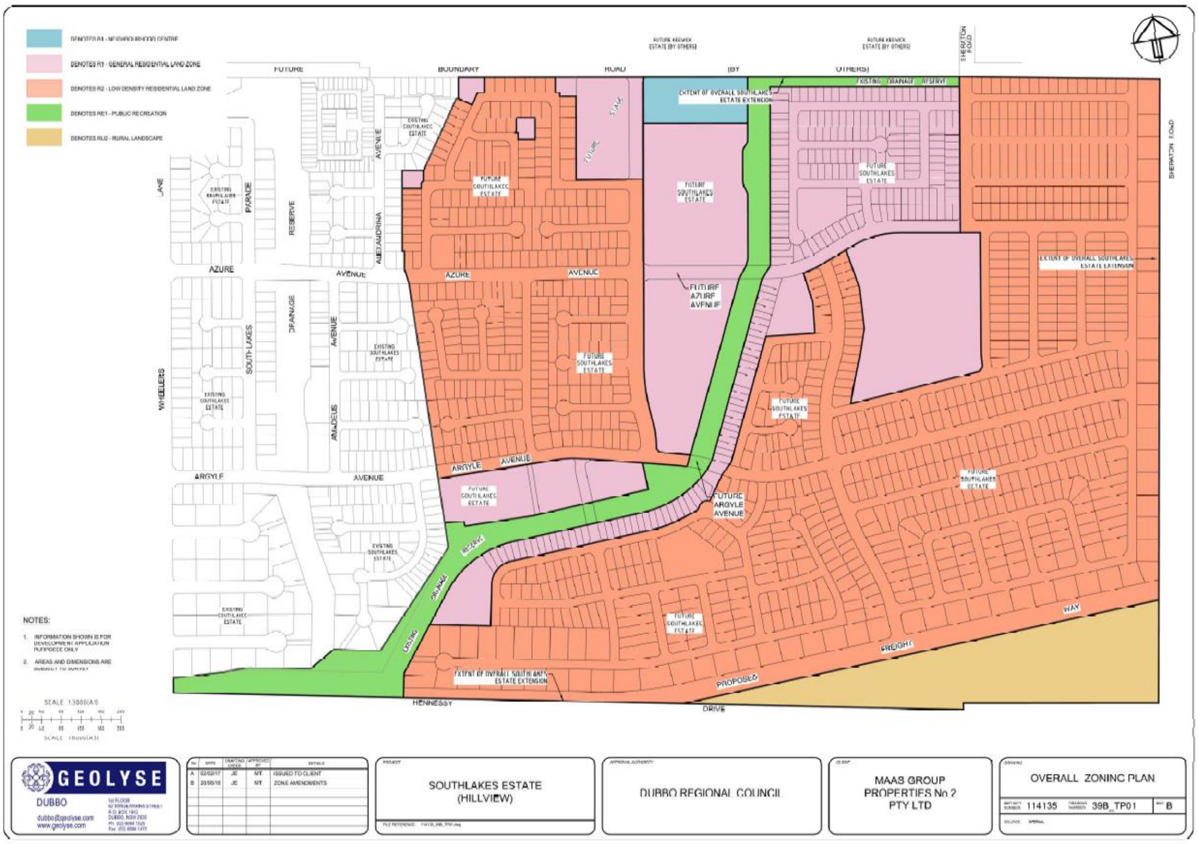


Plate 4: Proposed zoning plan extract (Source: Geolyse Pty Ltd)

The proposed zoning regime has been developed to:

- Provide a for a variety of housing types and densities;
- Provide higher density residential living within proximity to neighbourhood shops, public recreation land, cycle ways, walkways, and drainage reserves;
- Provide low density housing within a landscaped setting on the fringe of the Dubbo urban area;
- Provide land for infrastructure and related uses;
- Provide land to be used for Rural Landscape purposes; and

2.2.4 PROPOSED MINIMUM LOTS SIZE REQUIREMENTS

In accordance with the DLEP *Land Zoning Map LZN_008B* and *Lot Size Map LSZ_008B*, the following Minimum Lot Sizes are proposed:

- Selected R1 General Residential land - no minimum lot size
- Selected R2 Low Density Residential land - 600m^2
- Selected R2 Low Density Residential land - 800m^2
- Selected R2 Low Density Residential land - 2,000m^2
- Selected RU2 Rural Landscape land – 100 Ha

Plate 5 below shows the proposed minimum lot size amendments within the south east Precinct.

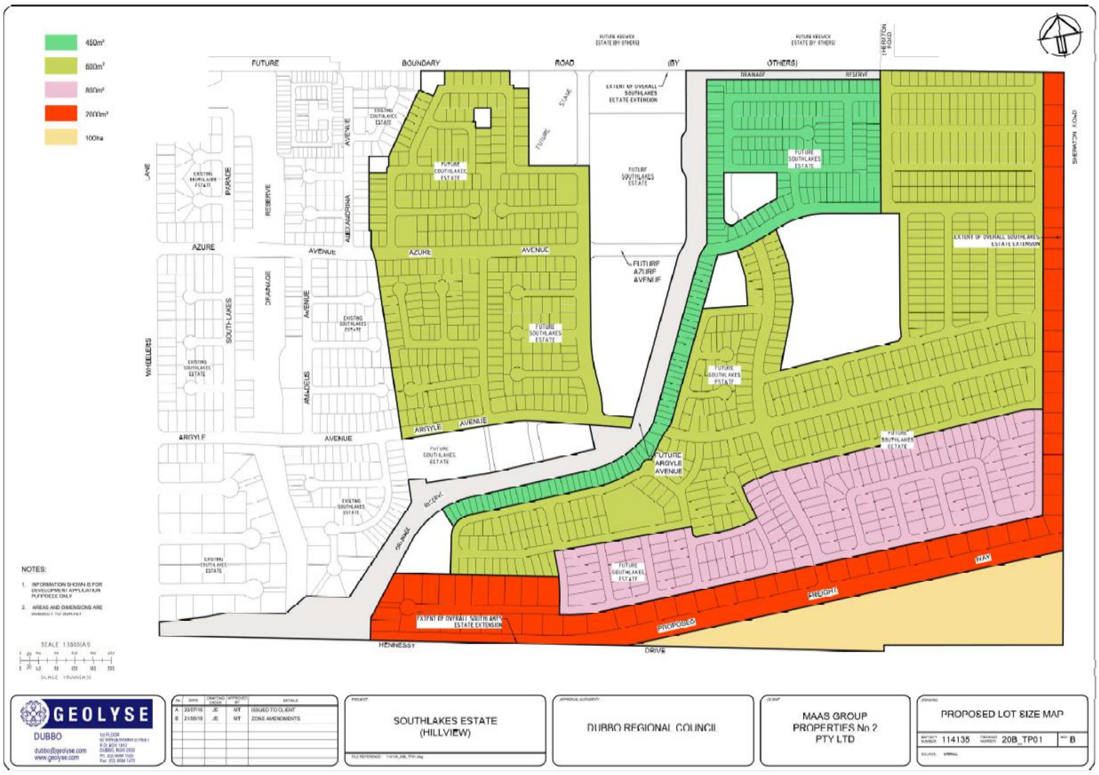


Plate 5: Proposed lot size plan extract (Source: Maas Group Properties plan number 114135_C1)

As stated above, the intention of the amendment to the minimum allotment size for residential zoned land is to provide greater flexibility and choice in residential land and housing product within the south east land release areas and the greater residential market of Dubbo.

Areas of no minimum lot size are provided for R1 land which is consistent with current minimum lot size requirements under the DLEP. In this regard, an amendment to the abovementioned Lot Size provisions of the LEP would be required in order for the future development of these sites to be permissible and compliant.

2.2.5 ANTICIPATED DEVELOPMENT TYPOLOGIES

It is anticipated that primarily the PP would facilitate a combination of single and two storey development within the Dubbo region.

The following types of housing to be provided within the R1 zoned land would be:

1. Traditional medium density (multi dwelling housing) development generally in the form of attached 2-bedroom single storey dwellings approximately 4 to 6 dwellings.

2. Small lot housing (attached and semi-detached dwellings), generally where divided by through roads and drainage corridors and in the form of attached and detached dwellings with minimal private curtilage upon local through roads.

3. Integrated house and land development (Multi dwelling housing, attached dwellings, semi-detached dwellings, and dwellings) with private roads, open space and community facilities.

It is envisaged that the R2 zoned areas would be developed with a mix of traditional house and land development with larger lot living located along the southern fringe.

It is envisaged that the RU2 zoned land would be continuance of the existing grazing land across the flood plain.

Examples of concept development designs have been compiled to give Council an understanding of the general form and style of development anticipated for the proposed zones are provided at **Appendix A**.

2.2.6 PROPOSED DEVELOPMENT OBJECTIVES

The development of the land is to be developed generally in accordance with the following objectives

- Provide for a detached, attached dwellings and multi dwelling housing in areas of increased amenity including land adjoining or opposite:
    - Neighbourhood centre shops;
    - Parks and open space; and
    - Drainage land corridor.
- Provide opportunities for community open space integrated into the subdivision design.
- Provide opportunities for an increased range of residential lot sizes and varied housing product to the community and provide options to make these housing options easier to deliver.
- Provision of local roads including loop roads and laneways for traffic circulation through these areas.

Future development would be designed in accordance with the objectives of DLEP and DDCP, in particular the development controls for privacy, noise, streetscape amenity and parking provision would be maintained.

R1 zoned land

- Provide housing with access to the landscaped 'lakes' corridor which facilitates an active recreation link between the residential zoned land and the neighbourhood centre;
- Provide both local loop roads and lane ways through the larger land areas to create an efficient subdivision layout with effective vehicle and pedestrian circulation;
- Provide varied lot sizes and housing product opportunities integrated with community facilities and open space areas upon larger land areas;
- Provide varied medium density housing options upon smaller land areas including those adjoining and adjacent to opens space and commercial areas;

The market is considered able to provide sufficient varied housing product that is attractive, modern, of good design, employs standard sustainable design provisions and is suitably landscaped to ensure an attractive and well-designed development without detriment to future resident's amenity.

It is noted this development is currently being provided within existing R1 zoned land in Southlakes Estate.

R2 zoned land:

- Provide housing with access to the landscaped 'lakes' corridor which facilitates an active recreation link between the residential zoned land and the neighbourhood centre;
- Provide local roads with a mix of traditional grid and some cu-de-sac formation through the majority of the land area to create an efficient subdivision layout with effective vehicle and pedestrian circulation and a range of streetscape typologies;
- Provide varied lot sizes and housing product opportunities with the allotments generally increasing in size as they progress from north to south of the site enclosed by 2000m^2 lots adjoining Sheraton Road

The market is considered to continue to provide attractive, modern, of good design, low density housing products that are suitably landscaped which when the land is full developed would provide for an attractive and well-designed estate.

It is noted this type of development is currently being developed within existing R2 zoned land in Southlakes Estate.

RU2 zoned land:

- Provide Rural Landscape land across the flood plain for agricultural grazing;

The proposed RU2 zoned land is considered able to provide good infrastructure and landscaped areas that would achieve the above objectives as generally designed and detailed within Councils Recreational Lands Policies and the servicing strategy provided at **Appendix B.**

2.2.7 SERVICES

A servicing strategy has been prepared and includes the provision of future local roads, water, sewer, stormwater mains infrastructure to support the future development consistent with the required service providers design requirements and similar to that of surrounding arrangements of the urban release area.

In general, telecommunications, roads, power and water service mains are being constructed/extended from the existing mains located to the west within Boundary Road, Wheelers Lane, Argyle Avenue, Azure Avenue and Henessy Road with sewer and stormwater being extended and augmented from their respective downstream mains and would be generally located within the Southlakes drainage corridor.

The land is to be serviced by all available reticulated utilities, including power, telephone, gas, water and sewerage as are available in the greater locality. Necessary provision and upgrading where required to facilitate the development is acknowledged and generally detailed within the servicing strategy provided at **Appendix B**. All services would conform to the requirements of the relevant service authority.

2.2.8 CONSISTENCY WITH EXISTING COUNCIL DECISIONS AND POLICIES

The existing 'Southlakes' development has been a fixture within the Dubbo landscape since 2010. Since that time, Council has supported a number of housing options, including medium density zoning and development approvals with no minimum lot sizes such as dual occupancy development, multi occupancy development and community planning. This PP simply aims to continue the successful execution of this Estate to cater for the needs of the growing community.

2.2.9 TRAFFIC & TRANSPORT CONSIDERATION

R1 and R2 zoned land:

The supporting *Traffic Study* prepared by Geolyse dated August 2016 and provided at **Appendix B** calculates the predicted traffic generation rates for the estate once developed in accordance with that indicated upon the masterplan plan.

Once fully constructed, the proposed residential estate would be provided with east/west and north/south local collector/spine roads that link to the surrounding local collector roads of Boundary Road, Hennessy Drive and Sheraton Road

The study identifies that the additional vehicle trips are not considered to have an adverse impact upon traffic congestion within the surrounding road network and generally result in service levels of A and B for the roads of Boundary Road, Sheraton Road and their inclusive intersections as modelled using SIDRA.

Should future development be considered to generate traffic at a higher rate than that identified within the supporting traffic impact assessment report. Such development would be required at the development application stage to demonstrate it would be suitable within the surrounding road network.

2.3 ENVIRONMENTAL CONSIDERATION

2.3.1 TOPOGRAPHY AND SOILS

The subject site has a gradual slope from north east to south west generally following the existing drainage route through the site. The landform contains scattered trees across the site however is predominantly cleared and maintained for agricultural grazing. Some stormwater drainage has been constructed and runoff is directed into the existing drainage corridor network being an informal open grass overland flow path /

channel which ultimately discharges to the designed and partially built southern drainage channel of Southlakes Estate and the Eulomogo Creek flood plain.

The land the subject of this PP, is located within the Talbragar Valley Subregion of the Brigalow Belt South Bioregion. Within this subregion Morgan and Terrey (1992) describe the soil environment as;

"Thin stony loams and texture contrast soils over most of the landscape with deeper sands and brown earths on valley floors".

This soil type is consistent with being able to sustain urban development such as residential development subject to design improvements to ensure soil salinity and erosion impact are minimised as detailed below.

2.3.2 SALINITY AND GROUNDWATER

The proposal would have the potential to increase the density of development across the subject sites of varying degree depending upon the proposed Minimum Lot Sizes and development pattern. The land is mapped by DLEP *Natural Resource Biodiversity Map Groundwater Vulnerability Map – Sheet CL_008* as being of 'Moderately High Vulnerability'. The development intention for these sites being for residential development and road and stormwater management infrastructure. The resultant development would manage stormwater collection and disposal in a controlled fashion reducing the threat to the contamination of groundwater or exacerbation of soil salinity.

A *Groundwater and Salinity Study* by Envirowest Consulting has been prepared for the future residential layout of the site and is provided at **Appendix C**. The objective of this report was to provide detailed information on potential impacts and mitigation options (if required) in relation to dryland and urban salinity processes and groundwater. The report assesses the existing salinity conditions of the soil and groundwater and determines the impact of the development on groundwater.

Generally, the report concludes that the development is suitable for the site and intended development to the area and is of a scale and location in the landscape that is not considered to be high risk and measures are recommended to ensure intended development mitigates any adverse impacts.

2.3.3 FLORA AND FAUNA

As described within the supporting *Ecological Assessment* prepared by Ozark Pty Ltd and provided at **Appendix D**, the site is completely cleared, ploughed and disturbed with few isolated trees.

No known threatened species or ecologically endangered communities have been identified as being present on these sites. The study identified that the that the vegetation noted upon the site is likely to have been derived from one of three Ecologically Endangered Communities listed under the Threatened Species Conservation Act (TSC Act) 1995. In accordance with the TSC Act the 'precautionary principle' has been adopted and an Assessment of Significance has been completed for each to characterise the potential impacts.

Assessments of significance are included within the supporting ecological assessment and having given consideration to the ecology within the subject site, the report concludes that this Proposal is:

- Unlikely to significantly affect any of the listed threatened species, fauna populations or communities.
- Unlikely to augment or significantly contribute to any of the National or State listed Key Threatening Processes, if the appropriate safeguards regarding the control of potential vertebrate pests are effectively applied.
- Unlikely to significantly affect any RAMSAR wetland or CAMBA, ROKAMBA or JAMBA listed species;
- Unlikely to significantly affect local hydrology.
- Consistent with ESD principles with regard to fauna, would not adversely affect the local biodiversity and that no issue of intergenerational or value added matters are relevant in this instance.

The report concluded that the proposed activity should not be considered to constitute a significant impact and, as such, no Species Impact Statement (SIS) is warranted. No Koala Habitat Management Plan pursuant to SEPP 44 is required.

2.3.4 BUSHFIRE

Reference is made to Dubbo City Council's *Bushfire Prone Land Map* which indicates the level of fire risk for properties. In accordance with this Map, the subject land is not identified as being located on bush fire prone land.

2.3.5 FLOODING

The subject land is identified as being within a flood planning area as identified by the DLEP. In this regard future development has the potential to be affected by flooding and result in adverse impact upon the immediate locality.

Consideration of the development intentions within flood prone land has been undertaken in the form of due diligence environmental reports, discussions with Council's Engineering Staff over the location of the proposed Southern Distributor and a *Flood Impact Assessment Report* prepared by CARDNO consulting engineers which detail the potential impact from development within the flood plain and is provided at **Appendix E**.

2.3.6 CONTAMINATION

The soils contained in the area of land proposed for rezoning under this PP are of similar quality to that present within the bounds of the adjoining Southlakes Estate. The site have previously been assessed and considered as suitable for residential use and development by past planning rezoning and current development applications across their land.

Notwithstanding, a *Contamination Investigation Study* was conducted by Envirowest Consulting Pty Ltd for the land to ensure the land is suitable for its intended use and is provided at **Appendix F**. The contamination investigation was prepared in accordance with the Contaminated Land Management Guidelines referenced by *State Environmental Planning Policy No. 55 - Remediation of Land*. The conclusion of the Contamination Investigation Report is as follows:

- The site has a land-use history of grazing;
- There is no evidence of potentially contaminating land uses or activities on the site;
- The contamination status of the site was assessed through a soil sampling and laboratory analysis program. The soil sampling program did not detect elevated levels of the analysed metals, OCP or TRH. The levels of all substances evaluated were below the EPA investigation threshold for residential and recreational land-use with access to soil. Therefore, no contamination was found;
- Several stockpiles of soil, timber and trace general refuse were located across the site. No asbestos was identified in the stockpiles on site.

The subject site is therefore suitable for the future residential and recreational land uses.

2.4 SOCIAL AND CULTURAL CONSIDERATIONS

2.4.1 ABORIGINAL ARCHAEOLOGY

An *Archaeological Survey* was conducted by Mr Jim Kelton on behalf of Dubbo City Council in August 1995 covering all of the Southlakes Estate, as well as the majority of the land adjacent to Southlakes Estate / Keswick on the Park Estate. The survey identified the presence of one (1) site located adjacent to the southern boundary of the site which is identified and recorded in the AHIMS database.

Notwithstanding the above survey, Ozark Environmental Management and Heritage conducted an *Aboriginal Archaeological Assessment* of the land to determine the presence and potential impact of the proposal upon aboriginal heritage significance of the area. The assessment is provided at **Appendix G**. The survey identified additional items of low heritage significance as they had been disturbed and damaged from past agricultural uses. In this respect and having regard to the indicative lot layout and likely servicing strategy, the existing items are likely to require removal through the issue of an AHIP.

It should be noted that if, during the further development of the site, any artefact, potential site or objects of Aboriginal Cultural Heritage Significance are uncovered, works will cease immediately pending referral for an investigation by the NSW Office of Environment and Heritage in accordance with *the National Parks and Wildlife Act 1974*.

2.4.2 EUROPEAN HERITAGE

The land to the south contains a locally listed heritage item identified by the DLEP as an 'Old Dubbo Homestead'. As the item is segregated by an existing road corridor, future freight way and the Eulomogo Creek it is anticipated that the proposed rezoning and amendments to the minimum allotment size would not adversely impact upon the item and that any future development of this land would not require consideration of the Heritage Item.

The remaining sites do not contain any locally listed European heritage items as identified by the DLEP. In this regard the proposed rezoning is not considered to adversely affect the heritage significance of the locality.

Consideration of adjoining land has been undertaken in the form of a Heritage Report also prepared by Ozark Pty Ltd. This report will be provided under separate cover to inform Stage 2 structure planning.

Intent and Provisions

3.1 OBJECTIVE

The intention of this PP is to create a planning regime that supports development of the subject land in a generally consistent manner to that of the existing Southlake's Estate. This PP would provide greater flexibility and choice in residential land and housing product and the provision of private recreation land for the adjacent to a realigned Eulomogo Creek corridor and within the south east urban release area of Dubbo from that currently available under the residential zoning regime of the DLEP.

3.2 EXPLANATION OF PROVISIONS

This PP seeks to rezone the existing R5 residential land within the south east precinct of Dubbo as shown upon supporting plans numbered **114135 sheets 20B & 39B.** This PP affects *Land Zoning Map – Sheet LZN_008B* and *Minimum Lot Size Map – Sheet LSZ_008B* of the DLEP.

The proposed rezoning and subsequent changes to the minimum allotment size of the LEP would facilitate a Master Planned Neighbourhood that would provide:

- Greater flexibility and choice in residential land and housing product within the south east urban release area and the greater residential market of Dubbo;
- Provide varied minimum allotment sizes with larger allotments located along Sheraton Road and the future Southern Distributor;
- To continue to provide for the alignment of the future Southern Distributor;
- To continue to guide land uses adjacent to Eulomogo Creek.

It is anticipated that primarily this PP would facilitate:

- A combination of low and medium density development to facilitate varied building heights;
- Varied infrastructure designed to provide stormwater management integrated into the design of proposed landscaped recreation areas;
- Reservation of land for the future Southern Distributor.

Justification

The overarching principles that guide the preparation of PP's are:

- The level of justification should be proportionate to the impact the PP would have;
- It is not necessary to address a question if it is not considered relevant to the PP; and
- The level of justification should be sufficient to allow a Gateway determination to be made with confidence that the LEP can be finalised within the timeframe proposed.

The following justification addresses each relevant question applicable to this PP to ensure confidence can be given at the Gateway determination.

4.1 NEED FOR THE PLANNING PROPOSAL

4.1.1 IS THE PROPOSAL THE RESULT OF ANY STRATEGIC STUDY OR REPORT?

This PP is not a result of a strategic study or report but rather the current demand of housing choice and residential land product and the need to appropriately zone the Eulomogo Creek flood plain to allow private management for the future.

The proposed rezoning seeks to continue with the Southlakes Master Plan which provides a regime for how the land would be developed by creating a master planned neighbourhood with a neighbourhood centre and passive and active landscape recreation areas which also serve a dual function of drainage.

Having regard to these current market forces and the success of providing housing choice and residential land product within Dubbo it is considered that there is sufficient demand within the market to warrant the expansion of the existing R1 & R2 zones and continue to vary minimum lot size requirements of both the R1 and R2 zone of the DLEP to assist the facilitation of housing choice and varied residential land product centred around the neighbourhood shopping centre within the south east of Dubbo.

The proposed zoning and minimum allotment sizes are selected having regard to the lands proximity to public recreation areas, drainage reserve, cycleway and walkways and their proximity to supporting road and infrastructure networks including public transport services and the future southern distributor.

4.1.2 IS THE PROPOSAL THE BEST MEANS OF ACHIEVING THE OBJECTIVES OR INTENDED OUTCOMES, OR IS THERE A BETTER WAY?

The desired range of housing choice and the provision of Rural Landscape land over Eulomogo creek and its flood plain is not comprehensively permissible within the existing site and is further limited by the minimum lot size restriction in accordance with the provisions of the DLEP. The submission of a PP to amend the existing zoning and lot size requirements represents the best method of achieving the desired outcome. Noting this has been the previous approval pathway for Stage 1 of Southlakes Estate.

4.2 RELATIONSHIP TO STRATEGIC PLANNING FRAMEWORK

4.2.1 IS THE PROPOSAL CONSISTENT WITH THE OBJECTIVES AND ACTIONS OF ANY APPLICABLE REGIONAL OR SUB-REGIONAL STRATEGY?

The Central West and Orana Regional Plan does not specifically identify the South East Urban Release Area, however the plan does apply to the Dubbo Regional Council LGA and the future development within the LGA.

Central West and Orana Regional Plan

The Central West and Orana Regional Plan aims to facilitate economic growth, respond to demographic changes, guide locations for new housing and inform coordinated infrastructure investment with appropriate land uses.

Direction 4.1 - The Plan identifies the subject land as an Urban Release Area (South East), catering for a large proportion of the projected population increase for the City of Dubbo. This PP provides for up to 435 additional dwellings within the Urban Release Area to assist with these housing requirements.

Direction 4.3 - The Plan also aims to provide for increased housing choice to suit changing population needs. This PP facilitates a diverse range of housing types within fully serviced areas, and within close proximity to the town shopping and recreational areas. The Plan identifies Medium Density housing as an option to cater for aging residents. The proposed removal of minimum lots sizes in certain areas of R1 zoned land provides for the design and development of housing which is accessible and affordable.

4.2.2 IS THE PROPOSAL CONSISTENT WITH COUNCIL'S LOCAL STRATEGY OR OTHER LOCAL STRATEGIC PLAN?

South East Dubbo Residential Urban Release Area Structure Plan

As detailed within the Structure Plan this is a staged process that aims to ensure residential development opportunities continue to be delivered in Dubbo and in particular the south east Residential Urban Release Area.

The role of the Plan is to set the overall direction for development in the south east Residential Urban Release Area, inform land use decisions in the LEP and allow the developers of the Southlakes Estate to pursue the continued development of the Estate having regard to overall infrastructure and servicing constraints.

The objectives of the plan are to:

- Identify the opportunities and constraints of the land and the anticipated needs of the community;
- Broadly indicate the likely future development potential of the study area;
- Enable the characteristics of the study area to determine the most appropriate location and form for development;
- Provide a broad context of the consideration, by Council, of individual rezoning submissions within the study area; and
- Establish a vision and set of development objectives which future development proposals will be required to meet;

The Plan provides forty (40) 'Strategic Residential Growth Principles' which have been considered during the preparation of this PP. The principles and a comment having regard to the PP is provided within the following table:

Strategic Residential Growth Principles	**Comment**
1. *Higher density residential development is encouraged at key locations in the Estate that ensure residents will have a high level of access to public transport, facilities, services and amenity;*	The intent of the allotment regime is to have higher densities located in close proximity to the local collector roads of the estate.
2. Seniors housing is encouraged to be provided in locations and formats that provide for integration with residential neighbourhoods, areas of public open space and neighbourhood centre development;	The Master Plan details some larger parcels in close proximity to the neighbourhood centre and lake system would be suitable for this type of development.
3. *Dual occupancy development is encouraged and promoted on land with an area greater than 900m² and a frontage of greater than 17m*	Noted.
4. *Dual occupancy development is specifically suited and encouraged as an efficient and effective urban design outcome for corner lots which allows each unit to have a separate frontage and address to a different street;*	Noted.
5. *Small format and small lot housing in the R1 general Residential zone should be provided with a zero lot line on one side boundary to encourage design quality and protect the amenity of residents;*	Noted.
6. *Council will prepare a Residential Design Guide for the use of the Dubbo Development Industry that will encourage site-responsive design and variety of housing offer;*	Noted.
7. *Where applicable and practicable, the provision of shop top housing is encouraged as a mechanism to further activate residential and commercial lands and add further variability in development types;*	Noted.
8. *Small format and integrated housing is encouraged where it can adequately mix with residential neighbourhoods and actively encourage social inclusion*	Noted.
9. *Any future amendment to DLEP to introduce a commercial zoning to facilitate a neighbourhood centre be required to include a maximum floor space limitation to limit the size and configuration of any commercial development to a neighbourhood scale*	Noted.
10. *Any PP to introduce a commercial zone to allow for neighbourhood centre development will be required to provide an Economic Impact Assessment which provides an assessment of such a proposal on the Dubbo Central District, the Orana Mall Market Place and other neighbourhood centres*	Noted.
11. *A variety of access provisions are to be provided to the neighbourhood centre development including facilities for walking, cycling onsite public transport provision and suitable parking for private cars*	Noted.
12. *Any neighbourhood centre development will be of a local scale which will not impact the residential amenity of development.*	Noted.

13. *Residential subdivision establishes a clear urban structure and hierarchy that promotes the creation of active neighbourhoods and encourages alternative forms of transport;*	The Master Plan's layout provides various connecting roads to the lakes system reserve through the estate, provided with footpaths and cycleways. The road system would be serviced with footpaths and cycleways along local collector roads linking all use areas within the estate.
14. *The natural attributes of the land should be used and reinforced in subdivision design through the placement of visible key landmark features such as parks and other focal points;*	Noted.
15. *The natural topography of the land shall be used in the design of residential subdivision. The natural site topography is an important design feature to add variation and interest to residential neighbourhoods.*	Noted.
16. *Residential subdivision shall optimise outlook and proximity to public community facilities*	Noted.
17. *Residential allotments shall be provided with a range of lot frontages which actively promotes streetscape variance and allow variation in the size and style of residential housing.*	The Master Plan has been designed to incorporate a range of lot frontages to assist the promotion of varied streetscapes.
18. *Any residential subdivision should comply with the minimum internal connectivity index score of 1.3*	The Master Plan over both Stages 1 and 2 achieves a connectivity index of 1.3.
19. *Residential development shall not be provided backing onto areas of open space and should be separated by a road or other key access point unless the development provides a suitable level of access to open space areas in accordance with the requirements of DRC (formerly Western Plains Regional Council), has open and transparent fencing and promotes living areas fronting open space.*	Noted.
20. *Any embellishment of current or future lands for the purposes of public open space over and above the requirements of the Dubbo Section 94 Contributions Plan – Open Space and Recreation Facilities shall be at the cost of the developer.*	Noted.
21. *Any developer undertaking embellishment in accordance with Strategic Growth principle 20 shall be required to enter into an appropriate agreement/s with Council in respect of long term maintenance.*	Noted.
22. *Public access and movement shall be maintained across and throughout areas of public open space.*	Noted.
23. *In any situation where an allotment may have one of its boundaries to public open space, any fencing of this boundary shall be of an open and transparent nature.*	Noted.
24. *The pedestrian and cycleway shall maintain legibility and ease of access to promote safe walking and cycling.*	Noted.
25. *Not existent*	N/A
26. *New growth areas have a variety of destinations within walking or cycling distance and the density of residential development supports the provision of required infrastructure.*	The Master Plan provides a connection to all use areas within the estate.

27. *A movement network is created of streets with bicycle lanes that allows the safe interaction and movement for all road users.*	Noted.
28. *Major public transport access is provided throughout the land including connections to the Dubbo Central Business District;*	The Master Plan details suitable connections both existing and new via local collector roads throughout the estate and ultimately to the Dubbo CBD.
29. *A hierarchy of interconnected streets is established that gives safe, convenient and clear access points within and beyond individual subdivisions in the subject area;*	The Master Plan and supporting Traffic Study (**Appendix B**) provides a safe and convenient street layout through the site and to adjoining land.
30. *The design of access and movement systems in the area ensures environmental impacts associated with groundwater and salinity are avoided or minimised;*	Noted.
31. *The access and movement system shall ensure the design of future subdivisions provides for energy efficient lot layouts and building orientation.*	The Master Plan provides a lot layout that has regard to topographical features and their influence upon required supporting infrastructure whilst also trying to achieve an energy efficient lot layout.
32. *Dubbo is maintained as a 10-minute city.*	The Traffic Study (**Appendix B**) identifies service levels of key intersections to be of levels A and B demonstrating the efficiency of the surrounding road network.
33. *Based on the information included in Figure 20, the balance of the Hillview land (Southlakes Estate) shall only be developed to the location as shown in Figure 20. Land situated in the Stage 2 Structure plan area will require the preparation of an Infrastructure and Servicing Strategy for the overall land area.*	A master planned layout is provided to demonstrate the PP's lot layout would be able to comply with a 1.3 ICI and enable the location of the Southern Distributor with flood prone land.
34. *The Infrastructure and Servicing Strategy referred to in Principle 33 above shall be prepared by the owners of the subject lands.*	Provided at **Appendix B**.
35. *The Cardno Keswick Drainage Review, August 2010 (Report No. W4823-1) is the adopted strategy for the provision of stormwater infrastructure to service the subject lands. Any developer seeking a variance to the regime included in the Strategy shall be required to prepare an independent stormwater drainage strategy that can detail how the projected stormwater volumes can be managed on the subject lands and through to receiving waters. Council is under no specific requirement to approve any alternative stormwater drainage strategy.*	Stormwater management is provided within the **Appendix B**.
36. *Any future site specific DCP for the Southlakes lands shall be required to include a detailed section providing overall infrastructure principles and information explaining how residential development is proposed to be serviced in accordance with Councils adopted policies, plans and practices.*	Noted. The provisions of the existing Dubbo DCP would be transposed for future development.
37. *Land degradation and clearing is minimised and natural assets are maintained or enhanced.*	Noted.

38. *Development meets the 'improve or maintain test' by avoiding impacts to areas of high conservation value and providing offsets for unavoidable impacts.*	The site does not comprise areas of high ecological conservation value. Refer to **Appendix D.**
39. *Any future development application for subdivision across the subject site will provide a detailed and comprehensive Salinity Study and Salinity and Groundwater Management Plan.*	Previously assessed and provided at **Appendix C**.
40. *The Fuzzy Box Woodland Endangered Ecological Community contained in Keswick shall be protected from development and enhanced with further plantings and an appropriate management and maintenance regime.*	The site is not located within 'Keswick' and does not comprise areas of high ecological conservation value. Refer to **Appendix D.**

Having regard to the above consideration of the Strategic Residential Growth Principles this PP is considered to be consistent with those of the Structure Plan.

<u>Dubbo City Urban Development Strategy - Residential Areas Development Strategy 1996-2015</u>

The purpose of the Dubbo City Residential Areas Development Strategy 1996-2015 (Strategy) is *"to provide a spatial, servicing and development control framework that will assure the timely provision of residential development opportunities which fit the needs of Dubbo and the region it services"*. The Strategy was designed to provide land for future residential development and to facilitate the servicing, staging, and release of this land.

The Strategy divides the Dubbo LGA into thirteen (13) separate precincts including seven urban precincts. The subject site falls within the 'South East Precinct'. The Strategy sets a goal to *'Identify and protect the established residential neighbourhoods and ensure a sufficient supply of suitable land to meet the future residential development needs of the city.'* The strategy also recognises this precinct as being very significant to Dubbo due to the precinct being the last extensive area for prospective residential development east of the Macquarie River.

The proposed rezoning would be consistent with the strategy for the following reasons:

- An amended R1 and R2 zone and minimum lot size distribution would facilitate the timely provision of residential development that fits the future needs of Dubbo and the region it services;
- The intent of this PP is to meet the residential housing choice needs of Dubbo;
- Development of this allotment would continue to complete the eastward phase of suburban development of Dubbo as the market changes and progresses;
- The site is located within the visible transition/eastern edge of urban development, being the Sheraton Road and Hennessy Road corridors;
- The future construction and the resultant development would have due consideration to the local environmental constraints as provided in supporting reports;
- It is anticipated that this PP would ensure the Dubbo Construction & Development Industry and the Dubbo Real Estate Industry would be provided with a secure and diverse residential land supply that is anticipated to last beyond 15 years.

<u>Dubbo City Planning & Transportation Strategy 2036</u>

The Dubbo City Planning and Transportation Strategy 2036 has been designed to provide guidance regarding the construction of roads and pedestrian pathways in Dubbo City. The 'Context' of the Plan states that the Strategy is to be considered in future strategic land use planning decisions.

The 'Context' also states that the Strategy does not represent the adopted Strategic Land Use Policy for the City and its future growth. In this regard, and due to the fact that the land is located within an expanding part of the residential area of Dubbo, this PP is considered to be generally accommodated within the scheduling, expectations and recommendations of this strategy.

It should be noted that the strategy makes the following statements to which this PP is considered to remain consistent:

"Residential Development in Dubbo is planned in three sectors, the South East Sector, the North West Sector and the South West Sector.

The Density of existing residential areas is approximately 7.8 dwellings per hectare; this is a gross figure including roads, schools and local community facilities including open space.

Should development continue at this density, the three sectors could accommodate 10,500 dwellings, sufficient until about 2050.

The scheduling for the three sectors if described in Table 2.1 and the location is described in Figure 5.1. …"

Based on recent lot sales it should be noted that the anticipated scheduling and dwelling density as discussed in the plan has altered focus on dwelling density provided within the South East Urban Release Area.

4.2.3 CONSISTENT WITH APPLICABLE STATE ENVIRONMENTAL PLANNING POLICIES

State Environmental Planning Policy	Comment
State Environmental Planning Policy No. 21 – Caravan Parks	The change in zoning would enable 'manufactured home estate' development and caravan parks as 'permitted use' within the R1 land use table subject to development consent being granted. If the land were to be developed in this manner such development would be required to ensure it achieves the relevant provisions of this plan. This PP does not include provisions that contradict or hinder the application of this policy. It is not the development intention of these sites to be developed as a caravan park.
State Environmental Planning Policy No. 36 – Manufactured Home Estates	The change in zoning would enable 'manufactured home estate' development and caravan parks as 'permitted use' within the R1 land use table subject to development consent being granted. If the land were to be developed in this manner such development would be required to ensure it achieves the relevant provisions of this plan. The PP does not include provisions that contradict or hinder the application of this policy. It is not the intention for the estate to be development as a manufactured home estate.
State Environmental Planning Policy No. 44 – Koala Habitat Protection	An Ecological Assessment provided at **Appendix D** has been prepared which assesses the impact of the proposal upon ecological communities and or their habitats. The report concluded that the proposed activity should not be considered to constitute a significant impact and, as such, no Species Impact Statement (SIS) is warranted and no Koala Habitat Management Plan pursuant to SEPP 44 should be required. In this respect the suitability of this site for residential and commercial purposes is considered suitable.
State Environmental Planning Policy No. 55 – Remediation of Land	Clause 6 of *SEPP 55 – Remediation of Land* requires the issue of contamination and remediation to be considered in zoning or rezoning proposals. A contamination investigation has been prepared for the subject land which found the land to be suitable for its intended development. In this respect the suitability of this site for residential purposes is considered suitable.

State Environmental Planning Policy No. 64 – Advertising and Signage	The change in zoning would enable limited business uses subject to development consent from Council. If signage were to form part of a future development application the provisions of *SEPP 64 – Advertising and Signage* would apply and the development would need to ensure the relevant provisions of the policy are achieved. This PP does not include provisions that contradict or hinder the application of this policy.
State Environmental Planning Policy No 65 – Design Quality of Residential Flat Development	The change in zoning would enable 'Residential Flat Buildings' and 'Shop Top Housing' development of the land subject to development consent being granted. If the land were to be developed in this manner such development would need to ensure it achieves the relevant provisions of this plan. This PP does not include provisions that contradict or hinder the application of this policy.
State Environmental Planning Policy (Affordable Rental Housing) 2009	The provisions of *SEPP (Affordable Rental Housing) 2009* would continue to apply to the land with future development under this plan being subject to development consent being granted. If the land were to be developed in this manner such development would need to ensure it achieves the relevant provisions of this plan. This PP does not include provisions that contradict or hinder the application of this policy.
State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004	The provisions of *SEPP (Building Sustainability Index: BASIX) 2004* would continue to apply to residential affected development in accordance with the provisions of this policy. This PP does not include provisions that contradict or hinder the application of this policy.
State Environmental Planning Policy (Housing for Seniors or People with a Disability) 2004	The provisions of *SEPP (Housing for Seniors or People with a Disability) 2004* would continue to apply to the land with future development under this plan being subject to development consent being granted. If the land were to be developed in this manner such development would need to ensure it achieves the relevant provisions of this plan. This PP does not include provisions that contradict or hinder the application of this policy.
State Environmental Planning Policy (Exempt and Complying Development Codes) 2008	The provisions of *SEPP (Exempt and Complying Development Codes) 2008* would continue to apply to the land generally consistent with that achievable under the current land zoning. This PP does not include provisions that contradict or hinder the application of this policy.
State Environmental Planning Policy (Infrastructure) 2007	The provisions of *SEPP (Infrastructure) 2007* would continue to apply consistent with that achievable under the current zoning. This PP does not include provisions that contradict or hinder the application of this policy.

State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007	The site is not located within any identified resource areas, potential resource areas or transitional areas. There are adjacent extractive industries to the east of Sheraton Road. The adjacent industries are provided with landscaped managed setbacks to Sheraton Road and the future residential land which are also limited via respective development consents and mining leases. An acoustic modelling report and mapping is provided at **Appendix H** and an Air Quality Assessment is also provided at **Appendix I**. Given existing development on the site and within the immediate locality this PP would be of minor significance and would not further restrict development potential or create land use conflict beyond existing arrangements.

4.2.4 IS THE PROPOSAL CONSISTENT WITH APPLICABLE PART 9.1 (2) (PREVIOUSLY S117) MINISTERIAL DIRECTIONS?

The Minister for Planning and Infrastructure, under Part 9 of the EP&A Act 1979 issues directions that local Councils must follow when preparing PP's for new Local Environmental Plans. The directions cover the following broad categories:

1. Employment and Resources
2. Environment and Heritage
3. Housing, Infrastructure and Urban Development
4. Hazard and Risk
5. Regional Planning
6. Local Plan Making

The following table provides an assessment of this PP against the relevant Part 9.1 directions.

Ministerial Direction	**Comment**
Direction 1.1 – Business and Industrial Zones	This direction is applicable as the PP would rezone land for local employment opportunities within R1 zoned land. The objectives of this direction are to encourage employment growth in suitable locations, protect employment land in business and industrial zones and support the viability of identified strategic centres.
Direction 1.3 – Mining, Petroleum Production and Extractive Industries	This direction is not applicable as the PP affected land does not prohibit the mining of coal or other minerals, production of petroleum, or winning or obtaining of extractive materials or restricting the potential development of such by permitting a land use that is likely to be incompatible with such development. It is noted that the sites are currently zoned for residential use and are provided with a buffer of existing residentially zoned land.

Direction 2.1 – Environment Protection Zones	This direction does not apply to this PP as mapped by the DLEP *Natural Resource Biodiversity Map NRB_008* as being of 'high' biodiversity significance. The area is known to contain an Endangered Ecological Community (EEC). This PP is not considered to adversely affect the EEC.
Direction 2.3 – Heritage Conservation	This direction is applicable as the PP affected land includes items, areas, objects and places of environmental heritage significance and indigenous heritage significance. This PP is considered consistent with the objectives of this direction as the existing identified heritage items and the relevant development considerations of the DLEP would remain unaffected by the PP. All future development would require due consideration in accordance with these provisions.
Direction 3.1 – Residential Zones	This direction is applicable as the PP proposes to redistribute the residential zones and minimum lot sizes across the site. This PP is considered consistent with the objectives of this direction as the redistributed rezoning and amended minimum lot sizes; • Would encourage a variety and choice of housing types to provide for the existing and future housing needs of Dubbo; • Would make more efficient use of existing and future infrastructure and services of Dubbo; • Would reduce the consumption of land for housing and associated urban development on the fringe of Dubbo; and • It is anticipated that future development would be of 'good design' having regard to current modern housing and infrastructure development and construction requirements. As stated above the PP is located in an area that contains adequate access to services such as sewerage, and water as well as public transport facilities. The future development of the site would make efficient use of these services and would reduce the need for additional development to take place upon the urban fringe of Dubbo.
Direction 3.3 – Home Occupations	This direction is applicable as the proposed R1 & R2 residential zones permit dwelling houses. The objective of this direction is to encourage the carrying out of low-impact small business in dwelling houses The PP maintains existing provisions that enable 'home occupations' to be carried out without the need of development consent.

Direction 3.4 – Integrating Land Use and Public Transport	This direction is applicable as the PP would rezone land for urban residential purposes. In accordance with the following, the rezoning of the subject site for urban residential purposes must be consistent with the aims and objectives of the following documents. *"A planning proposal must locate zones for urban purposes and include provisions that give effect to and are consistent with the aims, objectives and principles of:* *(a) Improving Transport Choice – Guidelines for planning and development (DUAP 2001), and* *(b) The Right Place for Business and Services – Planning Policy (DUAP 2001)".* With reference to the abovementioned documents, future occupants of the estate would have access to existing and planned public transport nodes which would traverse these sites and south east Dubbo. The provision of dwelling house developments in a location serviced by public transport is imperative as future residents would use such services as one of their main means of transportation around Dubbo. The development of these sites as opposed to other sites in the LGA would negate the need for new transport routes such as new bus routes and road facilities on the urban fringe.
Direction 4.3 – Flood Prone Land	This direction is applicable as this PP affects land identified as flood prone land by the DLEP. A *Flood Impact Assessment Report* provided at **Appendix E** has been prepared by CARDNO consulting engineers demonstrating partial filling of the Eulomogo Creek flood plain would have an acceptable impact.
Direction 6.1 – Approval and Referral Requirements	This direction applies to all PPs forwarded for Gateway Determination by a local authority. The proposed rezoning includes provisions that would trigger a need for concurrence, consultation, or referral to the State Government in particular the Office of Heritage for Aboriginal Heritage Impact and the Office of Water for zoning over the Eulomogo creek flood plain.
Direction 6.2 – Reserving Land for Public Purposes	This direction does not apply as this PP would realign and rezone land for public recreation purposes. The objectives of this direction are simply to facilitate the provision of public services and facilities by reserving land for public purposes and to facilitate the removal of reservations of land for public purposes where the land is no longer required for acquisition.

Direction 6.3 – Site Specific Provisions	This direction applies to all PPs forwarded for Gateway Determination by a local authority. This PP does not propose to create any specific development standards in addition to those currently within the principal environmental planning instrument other than to also provide a minimum allotment size of $600m^2$ to $800m^2$ consistent with surrounding R2 zoned land and no minimum allotment size for R1 zoned land, that is consistent with other R1 zoned land within Dubbo.

4.2.5 IS THERE ANY LIKELIHOOD THAT CRITICAL HABITAT OR THREATENED SPECIES, POPULATIONS OR ECOLOGICAL COMMUNITIES, OR THEIR HABITATS, WILL BE ADVERSELY AFFECTED AS A RESULT OF THE PROPOSAL?

An Ecological Assessment provided at **Appendix D** has been prepared which assesses the impact of the proposal upon ecological communities and or their habitats. No known threatened species or ecological communities have been identified as being currently present on these sites. The study identified that the that the vegetation noted upon the site is likely to have been derived from one of the three EECs listed under the TSC Act. In accordance with the TSC Act the 'precautionary principle' has been adopted and an Assessment of Significance has been completed for each to characterise the potential impacts.

Assessments of significance are included within the supporting ecological assessment and having given consideration to the ecology within the subject site, the report concludes the Proposal is:

- Unlikely to significantly affect any of the listed threatened species, fauna populations or communities.
- Unlikely to augment or significantly contribute to any of the National or State listed Key Threatening Processes, if the appropriate safeguards regarding the control of potential vertebrate pests are effectively applied.
- Unlikely to significantly affect any RAMSAR wetland or CAMBA, ROKAMBA or JAMBA listed species;
- Unlikely to significantly affect local hydrology.
- Consistent with ESD principles with regard to fauna, would not adversely affect the local biodiversity and no issue of intergenerational or value added matters are relevant in this instance.

The report concluded that the proposed activity should not be considered to constitute a significant impact and, as such, no Species Impact Statement (SIS) is warranted. No Koala Habitat Management Plan pursuant to SEPP 44 should be required.

This PP does not affect the existing DLEP 'Additional Local Provisions' for consideration of Natural Resource – biodiversity and Groundwater vulnerability.

4.2.6 ARE THERE ANY OTHER LIKELY ENVIRONMENTAL EFFECTS AS A RESULT OF THE PLANNING PROPOSAL AND HOW ARE THEY PROPOSED TO BE MANAGED?

The parcels of land proposed for rezoning largely consist of vacant grassland of no particular environmental value. No known threatened species or ecological communities are present on each site.

Any future development of these areas would require due consideration of relevant environmental impacts be undertaken during a development application. The proposed zoning of the Eulomogo Creek flood plain as RU2 should ensure the appropriate private management and use of the creek corridor for the future.

4.2.7 HAS THE PLANNING PROPOSAL ADEQUATELY ADDRESSED ANY SOCIAL AND ECONOMIC EFFECTS?

Due to the site's location and proximity to the Dubbo CBD and the Orana Mall, the land has adequate access to public transport and due to its location, it is anticipated that a future property owners would be within a reasonable vicinity of any required medical, educational, and retail services and facilities along with all transport means, including trains, coaches and planes to neighbouring towns and cities.

4.3 STATE AND COMMONWEALTH INTERESTS

4.3.1 ADEQUATE PUBLIC INFRASTRUCTURE FOR PROPOSAL?

Appropriate public infrastructure would be made available to all future allotments. The lots would have the capacity to be serviced by reticulated sewer, water, and stormwater infrastructure and would each be connected to electricity and telecommunications infrastructure from the surrounding existing service mains designed and installed to service the development of these estates.

As detailed above the land would enjoy reasonable access to public transport and are within close proximity of any required medical, educational, and retail services and facilities and all transport means, including trains, coaches and planes to neighbouring towns and cities.

4.3.2 VIEWS OF STATE/COMMONWEALTH PUBLIC AUTHORITIES CONSULTED IN ACCORDANCE WITH THE GATEWAY DETERMINATION?

The views of State and commonwealth public authorities would be ascertained during the formal consultation phase of this PP assessment in accordance with the Gateway Determination.

Required Instrument Amendments

5.1 AMENDED MAPPING REQUIRED

The following DLEP maps would be amended as part of the PP;

- Land Zoning Map LZN_008B of the DLEP 2011 with regard to the new R1 – General Residential, R2 – Low Density Residential and the new RU2 – Rural Landscape zoned land as shown upon supporting plan **114135 Sheet 39B**; and
- Lot Size Map LSZ_008B of the DLEP 2011 with regard to the new R1 General Residential, R2 – Low Density Residential zoned land and the new RU2 – Rural Landscape zoned land. In particular the amended minimum lot sizes would be as show upon supporting plan **114135 Sheet 20B.**

Community Consultation

6.1 TYPE OF COMMUNITY CONSULTATION REQUIRED

Section 5.5.2 of 'A Guide to Preparing Local Environmental Plans' identifies two different exhibition periods for community consultation;

- Low Impact Proposals – 14 days; and
- All other Planning Proposals (including any proposal to reclassify land) – 28 days.

The Guide describes Low Impact Proposals as having the following attributes;

- *A 'low' impact planning proposal is a planning proposal that, in the opinion of the person making the gateway determination, is;*
  - *Consistent with the pattern of surrounding land use zones and/or land uses;*

The proposed amendments to the zoning and minimum lot sizes of these site generally accords with Council's local strategies and policies as detailed above and would be consistent with other R1, R2, and RU2 zoned land within Dubbo and the immediate locality.

  - *Consistent with the strategic planning framework;*

Responses have been provided within section 4.2 of this report detailing the proposal's compliance with relevant local, regional and State planning strategies, policies, and ministerial directions.

  - *Presents no issues with regard to infrastructure servicing;*

The future residential development of these sites would have access to sewer, water, and storm water services, and would be connected with electricity and telecommunications facilities.

  - *Not a principle LEP; and*

Not relevant.

  - *Does not reclassify public land.*

This PP does not seek to reclassify existing public land.

In accordance with the responses to the above 'Low Impact Proposals' guide, the PP is considered to be of low impact as it does not seek to reclassify land and is considered generally consistent with Council Strategies and Policies, the objectives of the LEP and the EP&A Act. It is therefore suggested that a community consultation period of 14 days be applied to the exhibition of this PP.

References

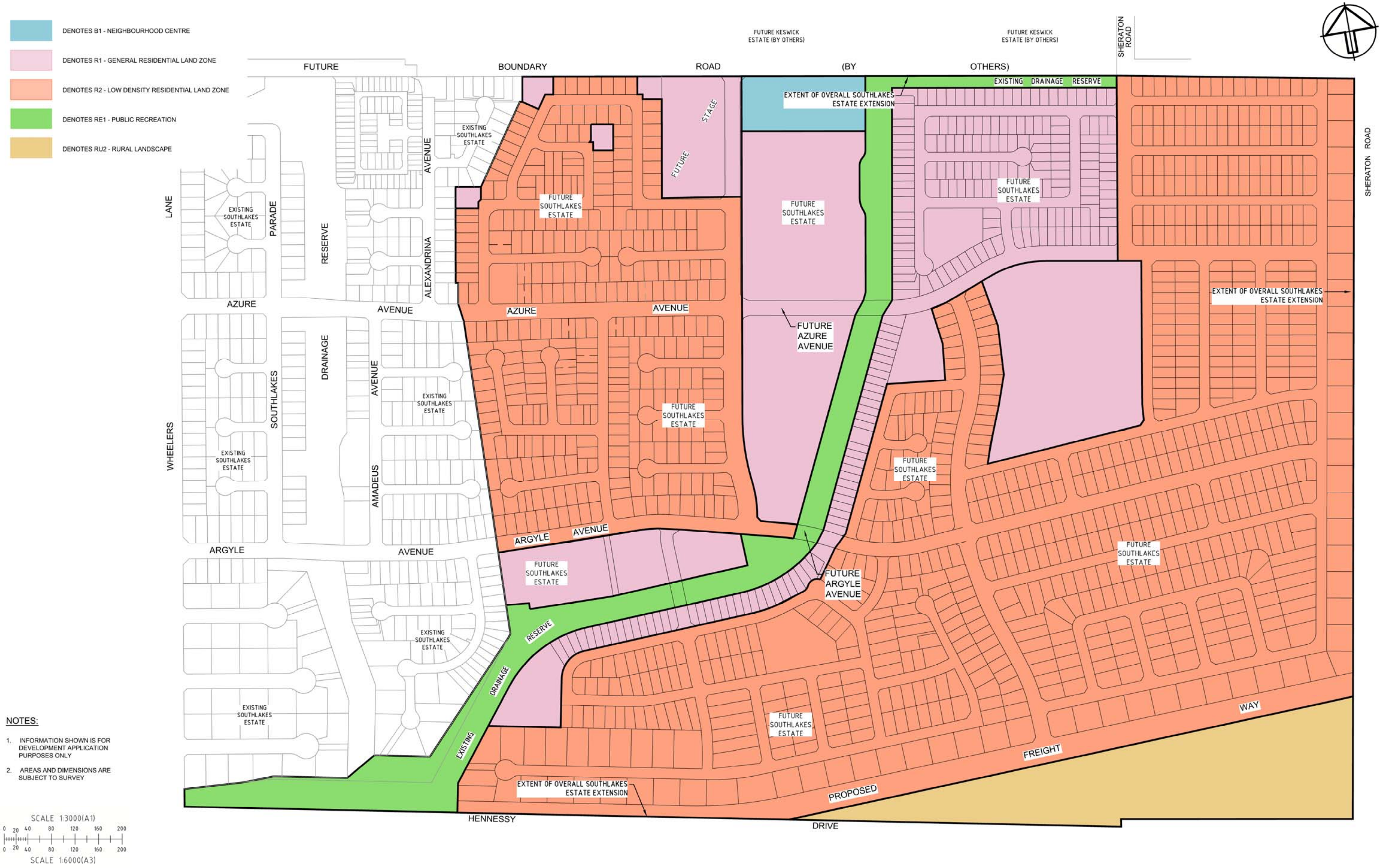
Morgan and Terrey. 1992, Nature Conservation in Western New South Wales. National Park Association, Sydney.

NSW Department of Planning (DoP). 2009a, A Guide to Preparing Local Environmental Plans, DoP, Sydney.

NSW Department of Planning (DoP). 2009a, A Guide to Preparing Planning Proposals, DoP, Sydney.

Section 117 Directions Issued by the Minister for Planning dated 1 July 2009 updated 14 April 2016

Drawings



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No	DATE	DRAFTING CHECK	APPROVED BY	DETAILS
A	02/02/17	JE	MT	ISSUED TO CLIENT
B	20/06/18	JE	MT	ZONE AMENDMENTS

PROJECT
SOUTHLAKES ESTATE (HILLVIEW)

FILE REFERENCE: 114135_39B_TP01.dwg

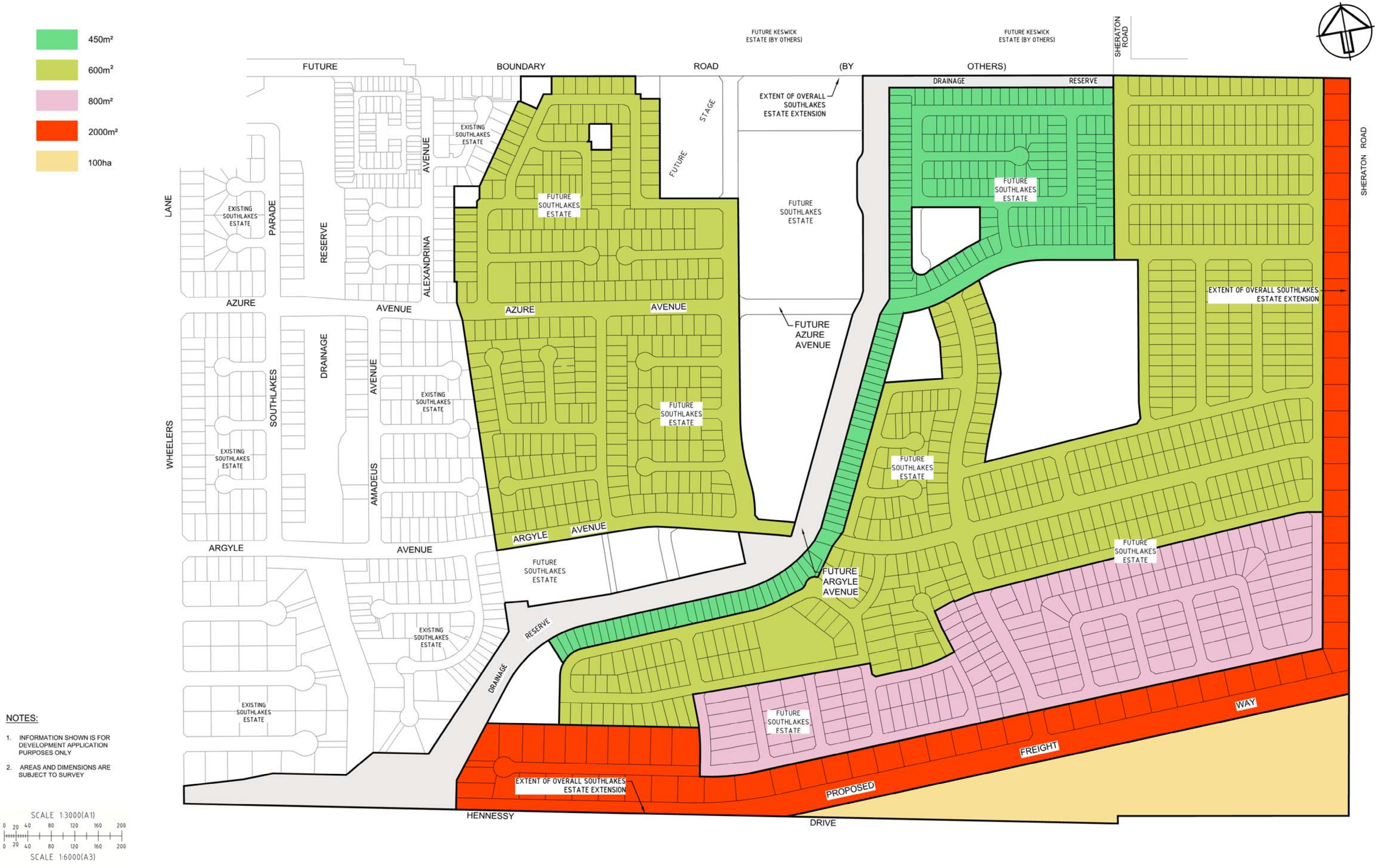
APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL

CLIENT
MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING
OVERALL ZONING PLAN

PROJECT NUMBER: 114135 DRAWING NUMBER: 39B_TP01 REV. B

SOURCE: INTERNAL



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No	DATE	DRAFTING CHECK	APPROVED BY	DETAILS
A	20/07/16	JE	MT	ISSUED TO CLIENT
B	21/06/18	JE	MT	ZONE AMENDMENTS

PROJECT: SOUTHLAKES ESTATE (HILLVIEW)
FILE REFERENCE: 114135_20B_TP01.dwg

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No.2 PTY LTD

DRAWING: PROPOSED LOT SIZE MAP
PROJECT NUMBER: 114135 DRAWING NUMBER: 20B_TP01 REV. B
SOURCE: INTERNAL

Appendix A

EXAMPLE CONCEPT DESIGNS

1. Private Recreation Areas

Rock armoured embankments (where required) with native landscaped riparian zones.

Landscaped gardens and furniture.

Detached Dwellings backing onto the lake system with transparent fencing and landscaping to delineate boundaries

2. Dual Occupancy Housing

Dual Occupancy Development

3. Community Master Planning

Lakeview Gated Community Subdivision – Aerial View

Lakeview Gated Community Subdivision - Layout

Master Planned community with local through roads directly connected to bushland reserves

Internal community facilities adjoining residential dwellings.

Internal landscaped areas adjoining residential dwellings.

Landscaped entrance to a Master Planned community delineating between the local road and community areas.

Attached and multi-unit dwellings fronting community facilities and open space areas

4. Multi Occupancy Housing

Single Storey Multi Occupancy Development

Attached dwellings fronting landscaped pathways through the subdivision

Appendix B

Servicing Strategy & Traffic Study

All prepared by Geolyse Pty Ltd

June 2017

SERVICING STRATEGY
SOUTHLAKES ESTATE DUBBO

PREPARED FOR
MAAS GROUP PROPERTIES PTY LTD

JUNE 2017

• Civil, Environmental & Structural Engineering • Surveying • Environmental • Planning • Architecture

SERVICING STRATEGY

SOUTHLAKES ESTATE DUBBO

PROPOSED RESIDENTIAL SUBDIVISION

LOT 12 IN DP1207280, LOT 399 IN DP1199356 AND

LOT 2 IN DP880413

PREPARED FOR:

MAAS GROUP PROPERTIES NO. 2 PTY LTD

JUNE 2017

GEOLYSE

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Report Title:	*Servicing Strategy*
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Client:	*Maas Group Properties No. 2 Pty Ltd*
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Geolyse Pty Ltd and the authors responsible for the preparation and compilation of this report declare that we do not have, nor expect to have a beneficial interest in the study area of this project and will not benefit from any of the recommendations outlined in this report.

The preparation of this report has been in accordance with the project brief provided by the client and has relied upon the information, data and results provided or collected from the sources and under the conditions outlined in the report.

All information contained within this report is prepared for the exclusive use of Maas Group Properties No. 2 Pty Ltd to accompany this report for the land described herein and is not to be used for any other purpose or by any other person or entity. No reliance should be placed on the information contained in this report for any purposes apart from those stated therein.

Geolyse Pty Ltd accepts no responsibility for any loss, damage suffered or inconveniences arising from, any person or entity using the plans or information in this study for purposes other than those stated above.

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1.1 INTRODUCTION

Maas Group Properties intends to develop a residential subdivision on land to the east of the existing Southlakes Estate subdivision. The extension to Southlakes Estate will also incorporate the land further to the east known as Ringlands and the overall development will complement the existing Southlakes subdivision and have major access points connecting via Azure Avenue and Argyle Avenue to Wheelers Lane and future connections to the extension of Boundary Road and to Sheraton Road and to the wider road network.

It is intended that approximately 2,080 dwelling sites be created in the overall extension to Southlakes Estate and will comprise residential allotments and medium density allotments.

This Servicing Strategy will assess the overall development of the extension of Southlakes Estate and also make provisions for the extension of the sewerage reticulation to the north and east of Southlakes to allow the future development of adjoining lands contained within the sewerage catchment.

The objective for preparing the Servicing Strategy is to determine an economic means of providing the required infrastructure to the subdivision area to allow the development of the land for residential and commercial purposes.

The Servicing Strategy will assess the provision of sewerage reticulation and the water reticulation network necessary to service the approximately 2,080 dwelling sites within the overall subdivision.

A separate Stormwater Drainage Report has been prepared and is appended to this Servicing Strategy Report to assess the drainage requirements of the subdivision particularly in relation to the trunk drainage corridor through the subdivision and discharging to the proposed detention basin to be constructed on the southern side of Hennessy Drive.

1.2 SEWERAGE RETICULATION

It is intended that approximately 2,080 dwelling sites be created in the overall subdivision comprising residential allotments and medium density allotments.

In general, the dwelling sites will comprise the following allocations:

Residential allotments	1,314 lots
Medium density dwelling units	766 units
Total dwelling sites	2,080 dwellings

Based on the criteria outlined in the *NSW Public Works Department Manual of Practice Sewer Design*, the estimated sewage generation from the extension to Southlakes Estate can be calculated as approximately 1,697 ET.

An allowance has also be made to account for the future development of the neighbourhood precinct in the northern section of the site and an allocation of 20 ET's will be made and thus the total estimated sewage generation from the subdivision is approximately 1,717 ET.

Many of the proposed dwelling lots that are located along the eastern extents of the existing Southlakes Estate can be serviced by the extension of existing gravity sewerage mains from the current subdivision. Approximately 250 dwelling lots can be serviced in this way.

The servicing of the remaining sewage generated from the overall extension of Southlakes Estate will require the provision of a major gravity sewerage main connecting to the Keswick Sewage Pump

Station. The gravity connection to the sewage pump station will service approximately 1,467 ET. In order to provide a buffer for the possible increase of dwelling density within the proposed subdivision, an additional approximate 10% allowance should be added to the estimated ET's connecting to the Keswick Sewage Pump Station.

Therefore, the total ET allocation from the overall extension of Southlakes Estate draining to the Keswick pump station should be increased to approximately 1,614 ET.

Also located within the sewage catchment draining to the Keswick Sewage Pump Station is Dubbo Regional Council's Keswick Estate that is located to the north of the extension to Southlakes Estate and sewage generated by the future development of this land will drain through the Southlakes sewerage reticulation system to the Keswick pump station.

Discussions with Council staff indicate that approximately 650 lots can be developed and an allowance of 720 ET will be made for the future development of the section of Keswick Estate within the sewage catchment.

There is an additional parcel of land to the north east of Southlakes Estate situated at the intersection of Sheraton Road and the extension of Boundary Road owned by Mr Neil O'Connor. Based on an assessment of the expected lot yield from this parcel of land, an allowance of 60 ET will be made.

On the basis of the overall sewage catchment draining to the Keswick Sewage Pump Station, the reticulation mains within the extension of Southlakes Estate and the Keswick pump station will need to cater for the following sewage loadings:

Southlakes Estate extension	1,614 ET
Future Keswick subdivision	720 ET
Future O'Conner subdivision	60 ET
Total Sewage Loading	2,394 ET

In general, 150mm diameter, 225mm diameter and 300mm diameter sewer mains will be provided in the southern section of the subdivision draining from east to west to cater for the majority of the future development of land at the eastern extents of the subdivision and the development within the southern section of the extension to Southlakes Estate.

The major gravity sewer main draining from north to south will comprise a 300mm diameter connection to the land to the north of Boundary Road (Keswick) subsequently increasing downstream to 375mm diameter, 450mm diameter and 525mm diameter sewer mains.

The 300mm diameter and 525mm diameter trunk sewer mains join at the southern end of the subdivision. When the trunk mains combine, the gravity connection to the inlet manhole at the Keswick pump station will require the construction of a 600mm diameter sewer main to transfer the expected 2,394 ET's generated from within the overall sewage catchment to the pump station.

The 600mm diameter sewer main is required due to grade limitations from the invert level of the inlet manhole and the provision of cover where the trunk sewer main crosses the eastern and western drainage channels within the drainage corridor.

All gravity sewer mains within the subdivision will be designed in accordance with Council's design criteria in terms of minimum depth, sewer main grading and ET capacity.

1.3 WATER RETICULATION

For the expected development of 2,080 dwellings in the overall extension to Southlakes Estate, the following water demands can be estimated:

Peak Instantaneous Demand	208 L/s
Peak Daily Demand	4.71 ML

Dubbo Regional Council has carried out a WATSYS analysis on the overall water reticulation network for the greater south eastern section of the area encompassing Southlakes Estate, the proposed extension of Southlakes Estate, Holmwood Estate, Magnolia Estate and Macquarie View Estate.

Council's most recent WATSYS analysis of the area was carried out in May 2016.

Whilst Council's reticulation model indicates the use of water mains with a minimum size of 150mm diameter, Council has advised that the minimum water main size that may be used in selected cul-de-sacs within the subdivision is 100mm diameter.

The water reticulation network to service the extension of Southlakes Estate has been determined generally in accordance with Council's WATSYS model with the general minimum size of the water reticulation mains to be 150mm diameter as modelled by Council, with the exception of the nominated cul-de-sacs where 100mm diameter reticulation mains have been used.

1.4 INDICATIVE SERVICING PLANS

Indicative servicing plans for sewerage and water reticulation to service the extension of Southlakes Estate have been prepared and are indicated on **Drawings C001 to C005** located in the **Drawings** Section of this Report.

1.5 STORMWATER DRAINAGE

The Stormwater Management Strategy presents an assessment of the proposed stormwater management strategy for the overall development of the Southlakes Estate residential subdivision proposed by Maas Group Properties. The stormwater assessment also includes development of the land known as Ringlands. The results show that the proposed stormwater management system results in a peak discharge from the site at Hennessy Road that matches that provided by Cardno.

It is proposed to construct a minor/major drainage system for overall development of Southlakes Estate with the minor system consisting of stormwater pits and pipes and open channels that would convey minor flows to the drainage reserve running through the site. Major flows would be conveyed along road reserves and drainage easements to the drainage reserve running through the site.

In accordance with the overall stormwater strategy for the catchment, on-site detention is proposed upstream of Hennessy Road within Southlakes Estate to control peak flows. All system components would be subject to further detailed assessment and design during the engineering design phase, based on the principles outlined in this assessment.

The stormwater modelling carried out for the preparation of this Report forms the basis of the design parameters to be adopted for the detailed engineering design of the eastern drainage channel and is accordance with the requirements outlined in Condition No. 2 from D2017-57.

1.6 CONCLUSION

This Servicing Strategy has determined the infrastructure requirements necessary for the proposed extension of Southlakes Estate. The Servicing Strategy has determined the overall framework for the effective provision of services to the subdivision.

The Servicing Strategy has provided the design guidelines for the provision of services to the subdivision in a staged manner and forms the basis for the future detailed design of the services for the extension to Southlakes Estate.

Introduction

2.1 BACKGROUND

Maas Group Properties intends to develop a residential subdivision on land to the east of the existing Southlakes Estate subdivision. The extension to Southlakes Estate will also incorporate the land further to the east known as Ringlands and the overall development will complement the existing Southlakes subdivision and have major access points connecting via Azure Avenue and Argyle Avenue to Wheelers Lane and future connections to the extension of Boundary Road and to Sheraton Road and to the wider road network.

It is intended that approximately 2,080 dwelling sites be created in the overall extension to Southlakes Estate and will comprise residential allotments and medium density allotments.

An open space corridor will be created along the central drainage line that separates the subdivision generally from the north east to the southwest of the site. The drainage corridor will be embellished with a series of decorative lakes similar to the lakes that have been developed along the existing drainage corridor in Southlakes Estate.

The drainage corridor within the extension to Southlakes Estate is known as the eastern channel whilst the drainage corridor within the existing Southlakes Estate is known as the western channel.

This Servicing Strategy will assess the overall development of the extension of Southlakes Estate and also make provisions for the extension of the sewerage reticulation to the north and east of Southlakes to allow the future development of adjoining lands contained within the sewerage catchment.

The objective for preparing the Servicing Strategy is to determine an economic means of providing the required infrastructure to the subdivision area to allow the development of the land for residential and commercial purposes.

The Servicing Strategy will assess the provision of sewerage reticulation and the water reticulation network necessary to service the approximately 2,080 dwelling sites within the subdivision.

A separate Stormwater Drainage Report has been prepared and is appended to this Servicing Strategy Report to assess the drainage requirements of the subdivision particularly in relation to the trunk drainage corridor through the subdivision and discharging to the proposed detention basin to be constructed on the southern side of Hennessy Drive.

2.2 SITE LOCATION

The Hillview property is located approximately 4km south east of the Dubbo central business district and is accessed from the north via Cobra Street and Wheelers Lane and the south via Hennessy Drive and Wheelers Lane. The Ringlands site is located to the east of the Hillview property.

The Hillview subdivision site is described as Lot 12 in DP1207280 and Lot 399 in DP1199356. The Ringlands subdivision site is described as Lot 2 in DP880413. Lot 12 has an area of approximately 2.27ha, Lot 399 has an area of approximately 128.5ha and Lot 2 has an area of approximately 48.95ha for a total development area of approximately 179.72ha.

The site is bounded by Southlakes Estate to the west, Boundary Road and Sheraton Road to the north, Hennessy Drive to the south and privately owned land to the east.

Boundary Road to the east of Wheelers Lane is currently unformed and Dubbo Regional Council proposes to extend Boundary Road to the east to connect with Sheraton Road whilst Hennessy Drive will be extended to provide a freight corridor extending further to the east and connecting to the Mitchell Highway via Basalt Drive.

Currently the site is accessed from Wheelers Lane via Azure Avenue through Southlakes Estate and crossing the western channel via a culverted bridge. A second culverted bridge and again crossing the western channel provides for an extension to Argyle Avenue to the Hillview property.

The location of the proposed extension to Southlakes Estate is indicated on **Drawing D001** located in the **Drawings** Section of this Report.

2.3 STUDY METHODOLOGY

In order to prepare the Servicing Strategy for the provision of infrastructure for the extension of Southlakes Estate, the following worktasks will be carried out:

i) Determination of development densities in the nominated land use zones to assess loading demands for sewage equivalent tenements (ET's) with expected water usage demands for the subdivision.

ii) Determination of additional sewage ET allowances to be made for the future development of lands to the north of the extension of Southlakes Estate.

iii) Determination of the sewerage catchment limits based on depth limitations for connection of a gravity main to the Keswick Sewage Pump Station to service the subdivision.

iv) Determination of a gravity sewerage reticulation system to service the subdivision lot layout and the adjoining lands draining to the Keswick Sewage Pump Station.

v) Determine the water usage demands for the various areas of the Southlakes subdivision to estimate the total peak instantaneous demand required to service the subdivision.

vi) Determine a water reticulation layout to service the subdivision generally in accordance with the WATSYS reticulation modelling previously carried out by Dubbo Regional Council for the greater south eastern section of the area encompassing Southlakes Estate, the proposed extension of Southlakes Estate, Holmwood Estate, Magnolia Estate and Macquarie View Estate.

vii) Preparation of the Servicing Strategy Report to document the investigations carried out to determine the infrastructure requirements for the proposed extension to Southlakes Estate. The Servicing Strategy will provide sufficient design guidelines for the future provision of services in a staged manner and will form the basis of the future detailed design of each service.

In summary, the Servicing Strategy will determine the overall framework for the effective provision of services to the subdivision with the required sewerage and water supply networks.

Proposed Development and Design Loadings

3.1 PROPOSED DEVELOPMENT

The site for the overall extension of the Southlakes Estate subdivision comprises Lot 12 in DP1207280, Lot 399 in DP1199356 and Lot 2 in DP880413. Lot 12 has an area of approximately 2.27ha, Lot 399 has an area of approximately 128.5ha and Lot 2 has an area of approximately 48.95ha for a total development area of approximately 179.72ha.

It is intended that approximately 2,080 dwelling sites be created in the overall subdivision comprising residential allotments and medium density allotments.

In general, the dwelling sites will comprise the following allocations:

Residential allotments	1,314 lots
Medium density dwelling units	766 units
Total dwelling sites	2,080 dwellings

The concept Master Plan for the proposed extension to Southlakes Estate is indicated on **Drawing D002** located in the **Drawings** Section of this Report.

3.2 SEWAGE DESIGN CRITERIA

3.2.1 SOUTHLAKES ESTATE SEWAGE GENERATION

The estimated sewage generation from the expected 2,080 dwellings to be developed within the subdivision can be determined based on the design criteria outlined in the *NSW Public Works Department Manual of Practice Sewer Design* and Council's policies where the following generation rates will apply:

Residential dwelling house	1 ET per dwelling
Medium density dwelling unit	0.5 ET per unit

Based on this criteria, the estimated sewage generation from development of 2,080 dwellings in the overall extension to Southlakes Estate can be calculated as approximately 1,697 ET.

An allowance should also be made to account for the future development of the neighbourhood precinct in the northern section of the site and an allocation of 20 ET's will be made and thus the total estimated sewage generation from the subdivision is approximately 1,717 ET.

Many of the proposed dwelling lots that are located along the eastern extents of the existing Southlakes Estate can be serviced by the extension of existing gravity sewerage mains from the current subdivision. Approximately 250 dwelling lots can be serviced in this way.

The servicing of the remaining sewage generated from the overall extension of Southlakes Estate will require the provision of a major gravity sewerage main connecting to the Keswick Sewage Pump Station. The gravity connection to sewage pump station will service approximately 1,467 ET. In order to provide a buffer for the possible increase of dwelling density within the proposed subdivision, an additional approximate 10% allowance should be added to the estimated ET's connecting to the Keswick Sewage Pump Station.

Therefore, the total ET allocation from the overall extension of Southlakes Estate draining to the Keswick pump station should be increased to approximately 1,614 ET.

3.2.2 ADDITIONAL SEWAGE CATCHMENTS

Also located within the sewage catchment draining to the Keswick Sewage Pump Station is Dubbo Regional Council's Keswick Estate that is located to the north of the extension to Southlakes Estate and sewage generated by the future development of this land will drain through the Southlakes sewerage reticulation system to the Keswick pump station.

Discussions with Council staff indicate that approximately 650 lots can be developed and an allowance of 720 ET will be made for the future development of the section of Keswick Estate within the sewage catchment.

There is also an additional parcel of land to the north east of Southlakes Estate situated at the intersection of Sheraton Road and the extension of Boundary Road owned by Mr Neil O'Connor.

Based on an assessment of the expected lot yield from this parcel of land, an allowance of 60 ET will be made.

3.2.3 TOTAL CATCHMENT SEWAGE GENERATION

On the basis of the overall sewage catchment draining to the Keswick Sewage Pump Station, the reticulation mains within the extension of Southlakes Estate and the Keswick pump station will need to cater for the following sewage loadings:

Southlakes Estate extension	1,614 ET
Future Keswick subdivision	720 ET
Future O'Conner subdivision	60 ET
Total Sewage Loading	2,394 ET

3.2.4 INDUSTRIAL CANDIDATE AREA NO. 1

In 1997, Terra Sciences (now Geolyse) prepared a servicing strategy on behalf of Dubbo City Council for an industrial precinct known as Industrial Candidate Area No. 1.

Industrial Candidate Area No. 1 is located to the south east of the urban area of Dubbo and comprises a total area of approximately 750 ha. The site is bounded by the Mitchell Highway to the north, Eulomogo Creek to the south and a portion of Sheraton Road to the west.

At the time of the preparation of the servicing strategy in 1997, the Industrial Candidate Area was to contain approximately 108 industrial lots ranging in size from 3,000m^2 up to approximately 7.0 ha. The section of the land to be developed in the Industrial Candidate Area was located closer to and was to have access from the Mitchell Highway and fell within three distinct catchments in terms of the provision of sewerage infrastructure.

Approximately one third of the developable area in the northwest section of the site was to be serviced by a gravity sewer main connecting to an existing Council sewer main located on the eastern side of Sheraton Road in the general vicinity of the former Caravan Park located in Sheraton Road and St Johns Primary School.

The remainder of the developable land within the Candidate Area was to be serviced by two (2) small sewage pump stations that discharged into the end of the gravity sewerage network connecting to the Sheraton Road sewer main.

To date, the Sheraton Road sewer main has been extended eastwards in association with the development of Bunnings on Sheraton Road and into the subdivision known as the Blueridge

Business Park. The Blueridge development generally encompasses the initial section of Industrial Candidate Area No. 1 that was capable of being serviced by a gravity sewer main.

At this point in time, the remainder of the Industrial Candidate Area can be serviced in accordance with the original 1997 servicing strategy with the provision of sewerage reticulation and infrastructure independent to the proposed development of the extension of Southlakes Estate.

3.3 WATER DEMAND CRITERIA

The water demand criteria normally used for the design of water reticulation systems to service subdivisions is based on standard criteria outlined in the *NSW Public Works Department Water Supply Investigation Manual,* namely:

Peak Instantaneous Demand	0.15 L/s/tenement
Peak Daily Demand	5,000 L/day/tenement

However, in Dubbo Regional Council's *AUSPEC-1 Part D11 Water Reticulation*, the Peak Instantaneous Demand is taken to be 0.10 L/s/tenement.

Additionally, water supply authorities are moving away from the adoption of a peak daily demand of 5,000 L per day per tenement. Peak Daily Demands in the range of 2,000 L per day to 3,000 L per day are commonly used.

For the assessment of the Peak Daily Demand for the overall extension to Southlakes Estate a demand of 3,000 L/day/resident tenement and 1,000 L/day/medium density unit will be adopted.

For the expected development of 2,080 dwellings in the overall extension of Southlakes Estate, the following water demands can be estimated:

Peak Instantaneous Demand	208 L/s
Peak Daily Demand	4.71 ML

It should be noted that the irrigation of the landscaped areas of the subdivision, particularly the drainage corridors will be assumed to occur at night or at other off peak times and thus the irrigation demand is not included in the Peak Instantaneous Demand calculated for the subdivision.

Proposed Servicing Infrastructure

4.1 SEWERAGE RETICULATION

The overall extension of Southlakes Estate will be serviced by gravity sewerage reticulation mains connecting to either extensions of the existing sewerage reticulation from within Southlakes Estate to the west or by draining via trunk sewerage mains to the Keswick Sewage Pump Station located in Hennessy Road to the south west of the subdivision.

As indicated previously, the Southlakes sewerage reticulation mains will also be sized to cater for the expected development of land located to the north (Keswick and O'Connor) of the extension of Southlakes Estate. To enable these land parcels to be serviced by gravity reticulation to the Keswick pump station, the sewerage mains within the extension of Southlakes will need to be increased in size to cater for the additional sewage generation.

The following components of the sewerage reticulation will be required:

- In general, 150mm diameter, 225mm diameter and 300mm diameter sewer mains will be provided in the southern section of the subdivision draining from east to west to cater for the majority of the future development of land at the eastern extents of the subdivision and the development within the southern section of the extension to Southlakes Estate.

- The major gravity sewer main draining from north to south will comprise a 300mm diameter connection to the land to the north of Boundary Road (Keswick) subsequently increasing downstream to 375mm diameter, 450mm diameter and 525mm diameter.

- The 300mm diameter and 525mm diameter trunk sewer mains join at the southern end of the Southlakes subdivision. Where the trunk mains combine, the gravity connection to the inlet manhole at the Keswick pump station will require the construction of a 600mm diameter sewer main to transfer the expected 2,394 ET's generated from within the overall sewage catchment to the pump station.

- The 600mm diameter sewer main is required due to grade limitations from the invert level of the inlet manhole and the provision of cover where the trunk sewer main crosses the eastern and western drainage channels within the drainage corridor.

An alignment for the 600mm diameter sewer main has been determined and a preliminary longitudinal section of the sewer main prepared to account for the sewage generation from development within the various sewage catchments.

Following discussions with Council's staff it has been confirmed that the original design of the Keswick Sewage Pump Station allowed for the development of the Hillview land and other land within the sewage catchment and can cater for the additional loading generated by approximately 2,394 ET's from within the catchment.

With regards to the filling of the area in the southern section of the extension to Southlakes Estate to allow the provision of gravity sewerage reticulation, the following information is provided:

- All lots that are to be filled are to filled and compacted as controlled or engineered fill in accordance with the requirements outlined in AS 3798 – 2007 *Guidelines on Earthworks for Commercial and Residential Developments.*

  Specific Sections of AS 3798 that would apply include, but are not limited to, *Section 4 - Materials*, *Section 5 - Compaction Criteria, Section 6 - Construction, Section 7 - Methods of Testing* and *Section 8 - Inspection and Testing.*

With regards to Inspection and Testing, it is noted that the placement of all controlled fill shall be subject to Level 1 Inspection and Testing.

- The construction of gravity sewer mains within the area of controlled fill shall be carried out in accordance with the requirements of the Water Services Association of Australia *Gravity Sewerage Code of Australia WSA 02 – 2014*.

  Specific Sections of WSA 02 that would apply include, but are not limited to, *Section 9.6 – Geotechnical Considerations* and *Section 9.6.2 Pipelines in Engineered or Controlled Fill*.

  It should be noted that only 150mm diameter sewer mains are planned to be constructed within the area of controlled fill with all sewer mains sized 225mm diameter and above are to be constructed and laid in natural ground.

Based on the assessments carried out, the southern section of Southlakes Estate can be control filled and gravity sewer reticulation provided to ensure this area of the subdivision can be serviced with sewage discharged by gravity to the Keswick Sewage Pump Station.

Details of the overall sewerage reticulation and the 600mm diameter trunk sewerage main are indicated on **Drawing C002, Drawing C003** and **Drawing C004** located in the **Drawings** Section of this Report.

The provision of the sewerage infrastructure to service the overall Southlakes Estate subdivision and the connections external to the site will be subject to detailed engineering design at the appropriate phase of the project.

4.2 WATER RETICULATION

Dubbo Regional Council has carried out a WATSYS analysis on the overall water reticulation network for the greater south eastern section of the area encompassing Southlakes Estate, the proposed extension of Southlakes Estate, Holmwood Estate, Magnolia Estate and Macquarie View Estate.

Council's most recent WATSYS analysis of the area was carried out in May 2016.

The water reticulation network for the development area determined by Council is indicated on **Drawing D003** located in the **Drawings** Section of this Report.

Whilst Council's reticulation model indicates the use of water mains with a minimum size of 150mm diameter, Council has advised that the minimum water main size that may be used in selected cul-de-sacs within the subdivision is 100mm diameter.

The water reticulation network to service the extension of Southlakes Estate has been determined generally in accordance with Council's WATSYS model with the general minimum size of the water reticulation mains to be 150mm diameter as modelled by Council, with the exception of the nominated cul-de-sacs where 100mm diameter reticulation mains have been used.

4.3 INDICATIVE SERVICING PLANS

Indicative servicing plans for sewerage reticulation and water reticulation to service the extension of Southlakes Estate have been prepared and are indicated on **Drawings C001 to C005** located in the **Drawings** Section of this Report.

The sewerage reticulation plans provide for the future servicing of lands located to the north of the overall extension of Southlakes Estate and provide a gravity trunk sewerage main connecting to the Keswick Sewage Pump Station.

4.4 STORMWATER DRAINAGE

A Stormwater Management Strategy for the proposed subdivision has been prepared and is attached in **Appendix A.**

The Report presents an assessment of the proposed stormwater management strategy for the Southlakes Estate residential subdivision proposed by Maas Group Properties. The stormwater assessment also includes development of the land known as Ringlands. The results show that the proposed stormwater management system results in a peak discharge from the site at Hennessy Road that matches that provided by Cardno.

It is proposed to construct a minor/major drainage system for overall development of Southlakes Estate with the minor system consisting of stormwater pits and pipes and open channels that would convey minor flows to the drainage reserve running through the site. Major flows would be conveyed along road reserves and drainage easements to the drainage reserve running through the site.

In accordance with the overall stormwater strategy for the catchment, on-site detention is proposed upstream of Hennessy Road within Southlakes Estate to control peak flows. All system components would be subject to further detailed assessment and design during the engineering design phase, based on the principles outlined in this assessment.

The stormwater modelling carried out for the preparation of this Report forms the basis of the design parameters to be adopted for the detailed engineering design of the eastern drainage channel and is accordance with the requirements outlined in Condition No. 2 from D2017-57.

References

NSW Public Works Department Manual of Practice Sewer Design
NSW Department of Public Works

NSW Public Works Department Manual of Practice Sewer Pump Station Design
NSW Department of Public Works

NSW Public Works Department Water Supply Investigation Manual
NSW Department of Public Works

Drawings

REV.	DATE	DFTD.	APPD.	DETAILS
A	25/02/16	EG	SJH	ISSUED FOR REPORT
B	02/09/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
C	25/10/16	EG	SJH	ISSUED FOR REPORT
D	23/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

MASTER SCALE

SCALE 1:7500 (A1)

0 100 200 300 400 500 600 700

0 100 200 300 400 500 600 700

SCALE 1:15000 (A3)

DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No. 2 PTY LTD

PROJECT: SOUTHLAKES ESTATE EXTENSION
PROPOSED RESIDENTIAL SUBDIVISION
WATER & SEWER RETICULATION SERVICING STRATEGY

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DRAWING: SITE LOCALITY

PROJECT NUMBER 114135	DRAWING FILE 114135_13D_D001-D003.dwg		SIZE A1
SURVEY MARK -	R.L. -	DATUM A.H.D.	SET 13D
IMAGE SOURCE GOOGLE EARTH			
STATUS ISSUED FOR REPORT	SHEET D001 OF D003		

NOTE

1. INFORMATION SHOWN IS FOR DEVELOPMENT APPLICATION PURPOSES ONLY.

REV.	DATE	DFTD.	APPD.	DETAILS
A	25/02/16	EG	SJH	ISSUED FOR REPORT
B	02/09/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
C	25/10/16	EG	SJH	ISSUED FOR REPORT
D	23/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

MASTER SCALE

SCALE 1:3000 (A1)

0 50 100 150 200 250 300

SCALE 1:6000 (A3)

DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL

CLIENT
MAAS GROUP PROPERTIES No. 2 PTY LTD

PROJECT
SOUTHLAKES ESTATE EXTENSION
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DRAWING
CONCEPT MASTER PLAN

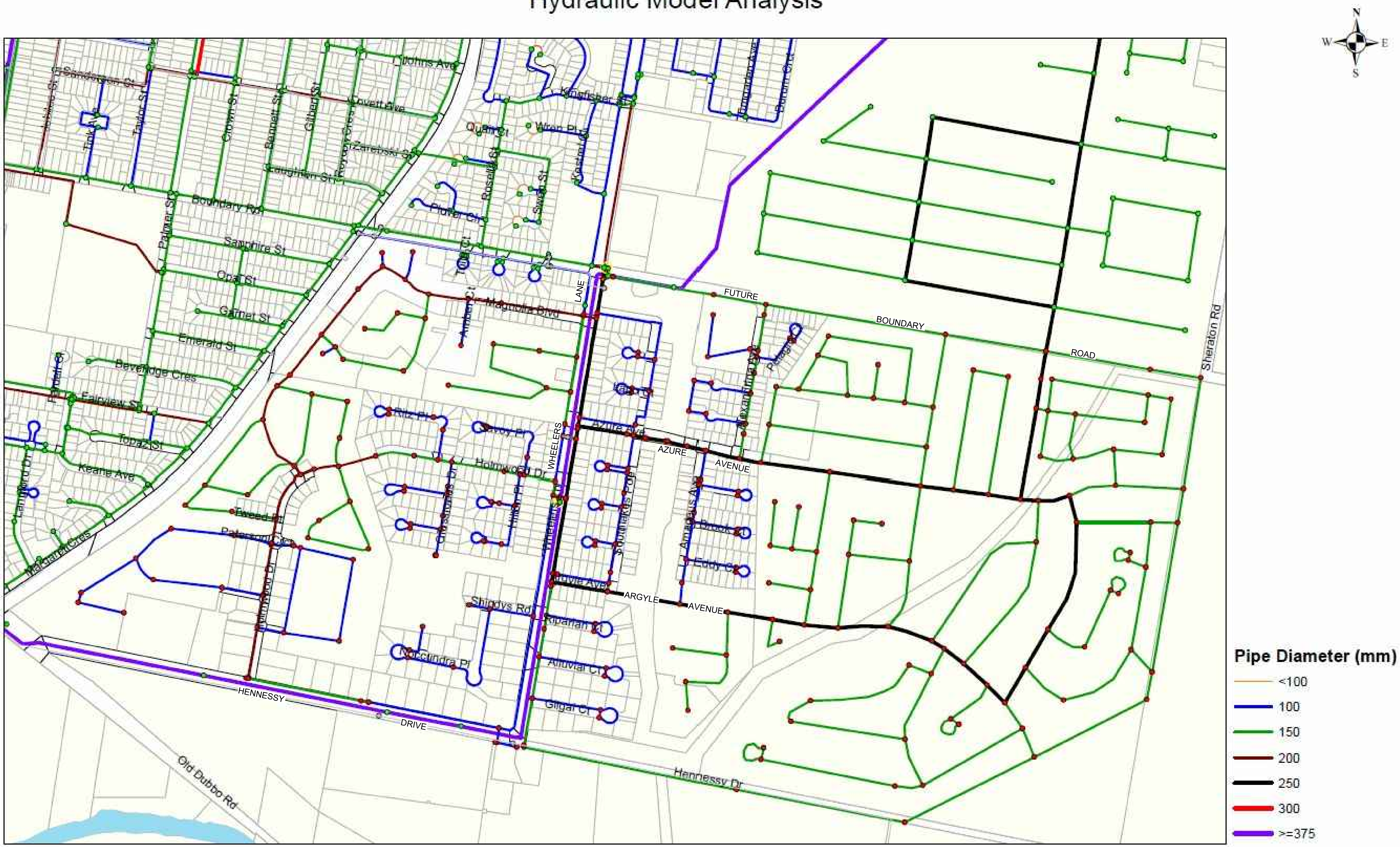
PROJECT NUMBER 114135 | DRAWING FILE 114135_13D_D001-D003.dwg | SIZE A1

SURVEY MARK - | R.L. - | DATUM A.H.D. | SET 13D

IMAGE SOURCE

STATUS ISSUED FOR REPORT | SHEET D002 OF D003

Hydraulic Model Analysis



Holmwood Dr PRV Future Water Model Layout

Date: 23/05/2016

Please note: All the dead end water mains need to closed loop to prevent water quality issues.

REV.	DATE	DFTD.	APPD.	DETAILS
A	25/02/16	EG	SJH	ISSUED FOR REPORT
B	02/09/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
C	25/10/16	EG	SJH	ISSUED FOR REPORT
D	23/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

MASTER SCALE

DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES No. 2 PTY LTD

PROJECT: SOUTHLAKES ESTATE EXTENSION
PROPOSED RESIDENTIAL SUBDIVISION
WATER & SEWER RETICULATION SERVICING STRATEGY

GEOLYSE
DUBBO
dubbo@geolyse.com
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62 WINGEWARRA STREET
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DUBBO, NSW 2830
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Fax. (02) 6887 4599

DRAWING: DUBBO REGIONAL COUNCIL'S FUTURE SOUTHLAKES ESTATE WATER MODEL

PROJECT NUMBER 114135 | DRAWING FILE 114135_13D_D001-D003.dwg | SIZE A1

SURVEY MARK - | R.L. - | DATUM A.H.D. | SET 13D

IMAGE SOURCE DUBBO REGIONAL COUNCIL

STATUS ISSUED FOR REPORT | SHEET D003 OF D003

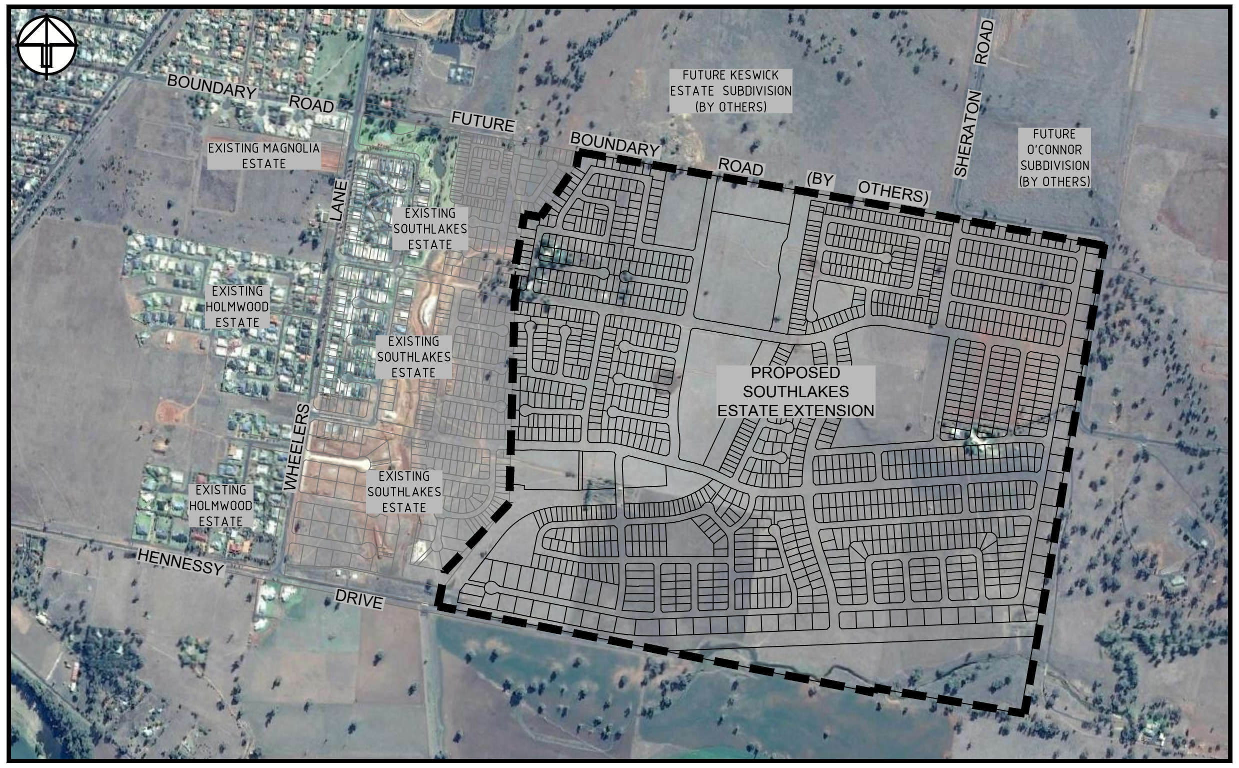
SOUTHLAKES ESTATE EXTENSION

PROPOSED RESIDENTIAL SUBDIVISION

MAAS GROUP PROPERTIES No. 2 PTY LTD

SERVICING STRATEGY PLANS FOR SEWER & WATER RETICULATION

SCHEDULE OF DRAWINGS	
DRAWING	TITLE
C001	TITLE SHEET & SITE LOCALITY
C002	SEWER RETICULATION SERVICING PLAN
C003	CONCEPT SEWER MAIN ALIGNMENT FOR CONNECTION TO THE KESWICK SPS
C004	CONCEPT 600mm Ø SEWER MAIN LONGITUDINAL SECTION
C005	WATER RETICULATION SERVICING PLAN



SITE LOCALITY
NOT TO SCALE

REV.	DATE	DFTD.	APPD.	DETAILS
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E	23/06/17	EG/MW	SJH	RINGLAND LOTS ADDED & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	GEOLYSE	SP/NM	2016
DESIGN	114135 EG Sewer Servicing Rev E.project	EG	23/06/17
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

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www.geolyse.com

DRAWING: TITLE SHEET & SITE LOCALITY

PROJECT NUMBER 114135 | DRAWING FILE 114135_12E_C001-C005.dwg | SIZE A1
SURVEY MARK REFER TO GEOLYSE SURVEY | R.L. - | DATUM A.H.D. | SET 12E
IMAGE SOURCE GOOGLE EARTH
STATUS ISSUED FOR REPORT | SHEET C001 OF C005

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- WORKING IN THE VICINITY OF TELSTRA PLANT.
- VERIFY CO-AXIAL/OPTIC FIBRE CABLE LOCATION

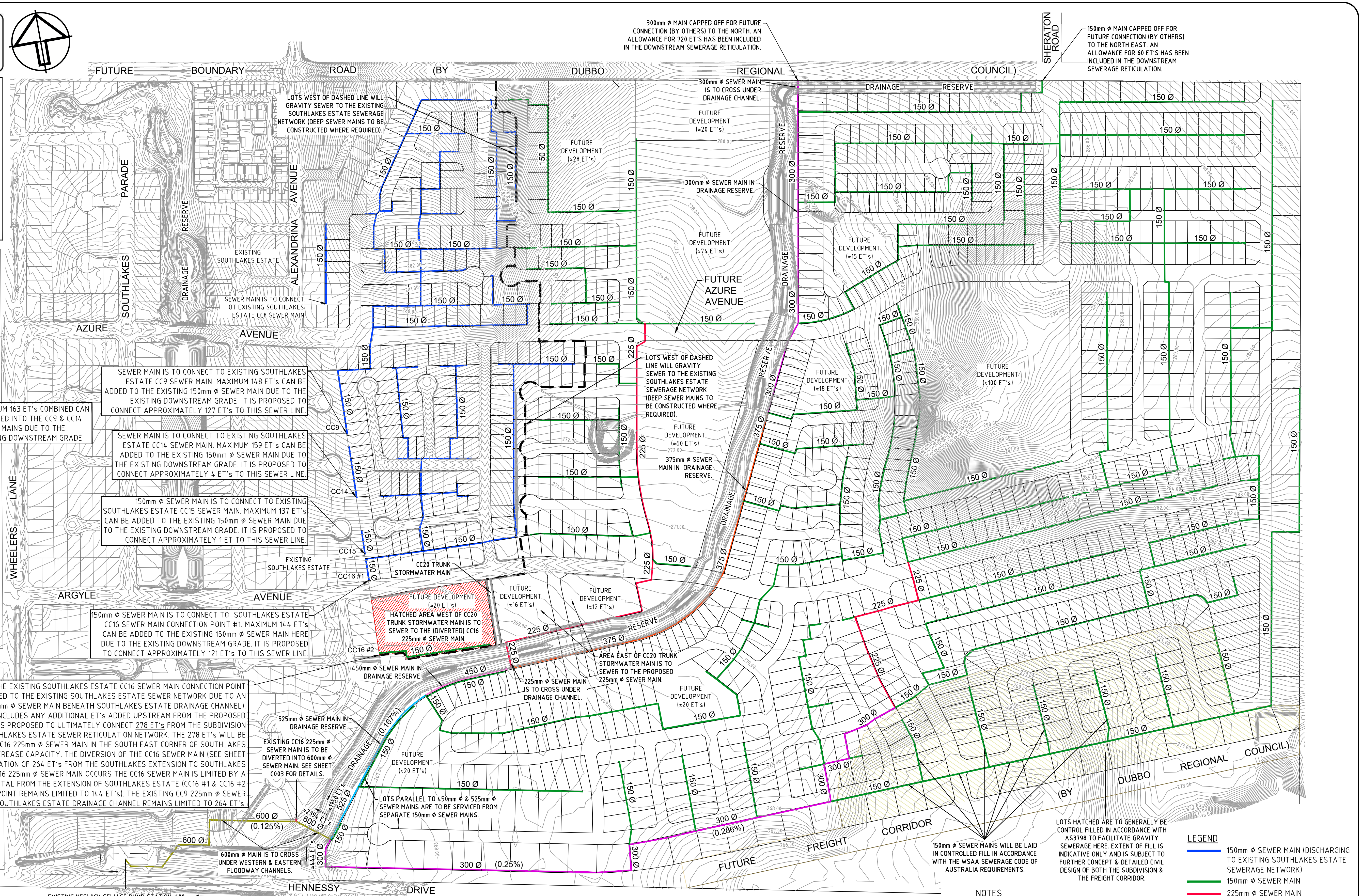
PRIOR TO ANY DEMOLITION, EXCAVATION OR CONSTRUCTION ON THE SITE, THE RELEVANT AUTHORITY SHOULD BE CONTACTED FOR POSSIBLE LOCATION OF FURTHER UNDERGROUND SERVICES AND DETAILED LOCATIONS OF ALL SERVICES.

USERS OF THIS PLAN SHOULD SATISFY THEMSELVES OF THE POSITION AND EXTENT OF SERVICES IN THE AREA OF PROPOSED WORKS.

NOTE
SEWER MAINS ARE TO BE DESIGNED IN ACCORDANCE WITH DUBBO REGIONAL COUNCIL'S DESIGN AUSPEC #1.

NOTE
AS ADVISED BY MAAS GROUP PROPERTIES TO GEOLYSE, SEWER MAINS ARE TO BE LAID UP TO 5m DEEP WHERE REQUIRED.

NOTE
THE SEWER TENEMENTS FOR THE FUTURE MEDIUM DENSITY DEVELOPMENT SITES HAVE BEEN ALLOCATED BASED ON 0.5 ET PER UNIT.



NOTE
THE ≈2394 ET'S ADDITIONAL DISCHARGE TO THE KESWICK SPS IS COMPRISED OF ≈1614 ET'S FROM SOUTHLAKES ESTATE EXTENSION + 720 ET'S FROM FUTURE KESWICK SUBDIVISION + 60 ET'S FROM FUTURE O'CONNOR SUBDIVISION.

NOTES
1. THIS PLAN IS FOR SERVICING STRATEGY PURPOSES ONLY.
2. CONTOURS SHOWN ARE NATURAL SURFACE CONTOURS WITH DESIGN CONTOURS ADDED. CONTOUR INTERVAL 0.2m.
3. ALL PROPOSED SERVICES SHOWN ARE INDICATIVE ONLY & ARE SUBJECT TO DETAILED CIVIL DESIGN.
4. FUTURE LOT & ROAD LAYOUT SHOWN IS INDICATIVE ONLY & SUBJECT TO CHANGE BY THE DEVELOPER & APPROVAL FROM DUBBO REGIONAL COUNCIL.

NOTE
THIS PLAN IS TO BE PRINTED & READ IN COLOUR.

NOTE
LOT LAYOUT WAS PROVIDED TO GEOLYSE BY MAAS GROUP PROPERTIES ON 04/05/17.

REV.	DATE	DFTD.	APPD.	DETAILS
A	24/02/16	EG	SJH	ISSUED FOR REPORT
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E	23/06/17	EG/MW	SJH	RINGLAND LOTS ADDED & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	GEOLYSE	SP/NM	2016
DESIGN	114135 EG Sewer Servicing Rev E.project	EG	23/06/17
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

MASTER SCALE
SCALE 1:3000 (A1)
0 50 100 150 200 250 300
SCALE 1:6000 (A3)
DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL

CLIENT
MAAS GROUP PROPERTIES No. 2 PTY LTD

PROJECT
SOUTHLAKES ESTATE EXTENSION
PROPOSED RESIDENTIAL SUBDIVISION
WATER & SEWER RETICULATION SERVICING STRATEGY

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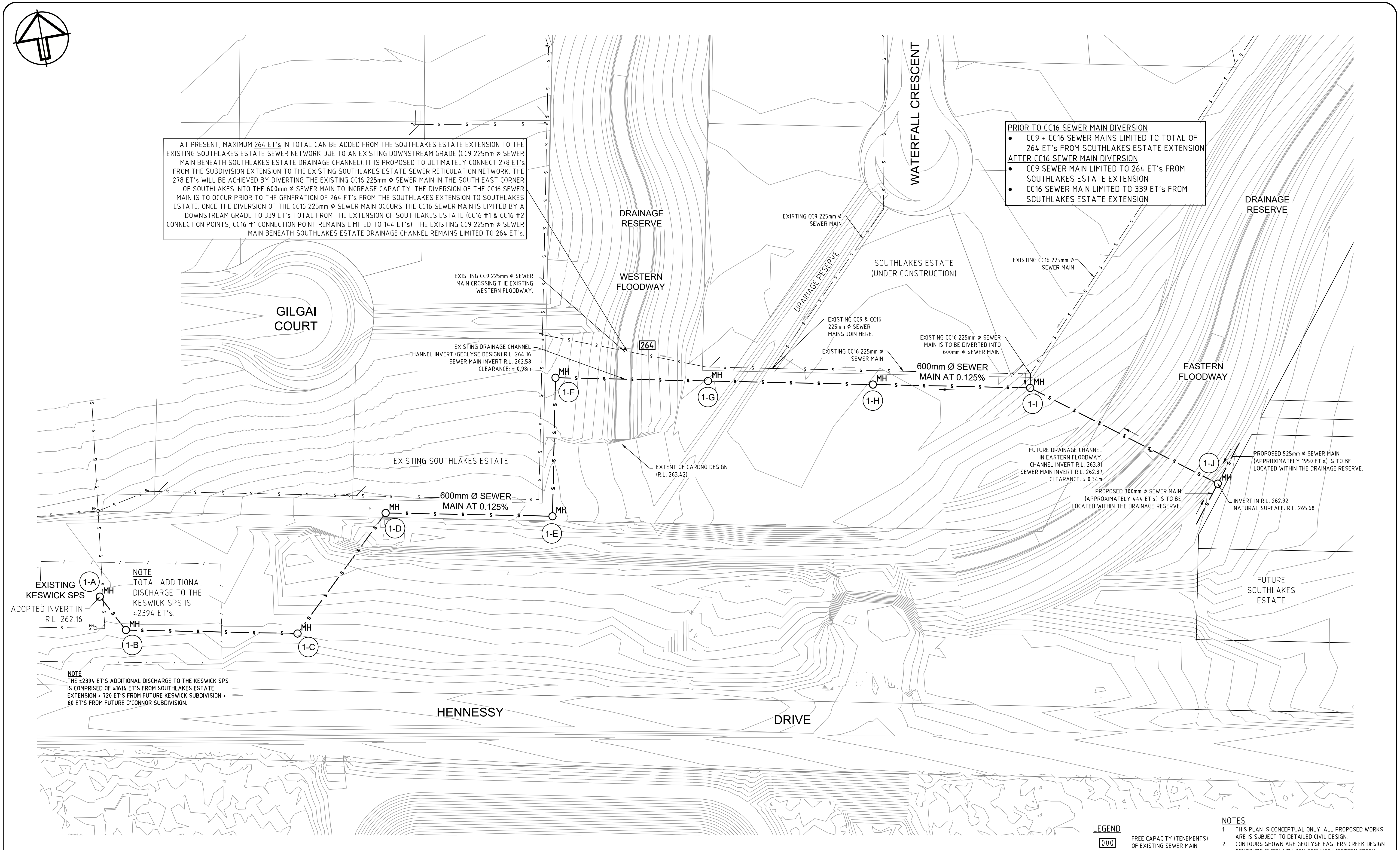
Fax. (02) 6887 4599

DRAWING
SEWER RETICULATION SERVICING PLAN

PROJECT NUMBER 114135	DRAWING FILE 114135_12E_C001-C005.dwg	SIZE A1
SURVEY MARK REFER TO GEOLYSE SURVEY	R.L. - DATUM A.H.D.	SET 12E
IMAGE SOURCE		
STATUS ISSUED FOR REPORT	SHEET C002 OF C005	



LEGEND

000	FREE CAPACITY (TENEMENTS) OF EXISTING SEWER MAIN
— s —	PROPOSED SEWER MAIN
— s —	EXISTING SEWER MAIN

NOTES
1. THIS PLAN IS CONCEPTUAL ONLY. ALL PROPOSED WORKS ARE IS SUBJECT TO DETAILED CIVIL DESIGN.
2. CONTOURS SHOWN ARE GEOLYSE EASTERN CREEK DESIGN CONTOURS OVERLAID WITH GEOLYSE WESTERN CREEK DESIGN CONTOURS & CARDNO DESIGN CONTOURS PROVIDED TO GEOLYSE BY DUBBO REGIONAL COUNCIL.
3. CONTOUR INTERVAL 0.2m.

REV.	DATE	DFTD.	APPD.	DETAILS
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	FILE	INITIALS	DATE
SURVEY	GEOLYSE	SP/NM	2016
DESIGN	114135 EG Sewer Servicing Rev E.project	EG	23/06/17
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

MASTER SCALE

SCALE 1:500 (A1)

0 10 20 30 40 50

SCALE 1:1000 (A3)

DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL

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PROJECT
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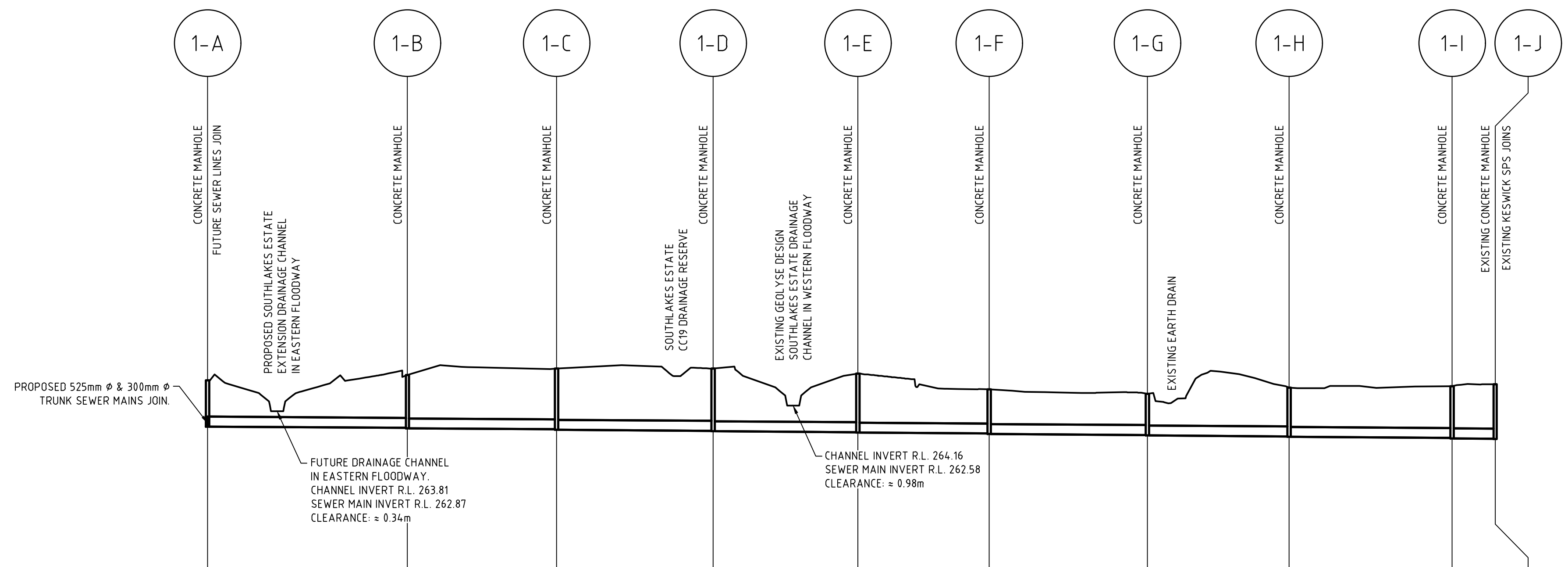
Fax. (02) 6887 4599

DRAWING
CONCEPT SEWER MAIN ALIGNMENT FOR CONNECTION TO THE KESWICK SPS

PROJECT NUMBER 114135 | DRAWING FILE 114135_12E_C001-C005.dwg | SIZE A1
SURVEY MARK REFER TO GEOLYSE SURVEY | R.L. - | DATUM A.H.D. | SET 12E
IMAGE SOURCE
STATUS ISSUED FOR REPORT | SHEET C003 OF C005



	1-A – 1-B	1-B – 1-C	1-C – 1-D	1-D – 1-E	1-E – 1-F	1-F – 1-G	1-G – 1-H	1-H – 1-I	1-I – 1-J
EQUIVALENT TENEMENTS	2394 ET'S	2394 ET'S	2394 ET'S	2394 ET'S	2394 ET'S	2394 ET'S	2394 ET'S	2394 ET'S	2394 ET'S
PIPE LENGTH (m)	60.317	45.004	47.217	43.675	39.667	47.770	42.743	49.151	13.022
GRADE (%)	0.125%	0.125%	0.125%	0.125%	0.125%	0.125%	0.125%	0.125%	0.125%
PIPE SIZE (mm)	600mm Ø TYTON 'XTREME' DICL PIPE	600mm Ø	600mm Ø	600mm Ø TYTON 'XTREME' DICL PIPE	600mm Ø	600mm Ø	600mm Ø	600mm Ø	600mm Ø

DATUM R.L. 231.000

	1-A	1-B	1-C	1-D	1-E	1-F	1-G	1-H	1-I	1-J
DEPTH TO INVERT	2.797	3.192 / 3.222	3.658 / 3.688	3.747 / 3.777	3.533 / 3.563	2.660 / 2.690	2.487 / 2.517	2.943 / 2.973	3.115 / 3.145	3.278 / 3.296
INVERT LEVEL	262.886	262.810 / 262.780	262.724 / 262.694	262.635 / 262.605	262.550 / 262.520	262.471 / 262.441	262.381 / 262.351	262.298 / 262.268	262.206 / 262.176	262.160 / 262.142
DESIGN SURFACE LEVEL	265.682	266.003	266.382	266.382	266.084	265.131	264.868	265.241	265.321	265.438
CHAINAGE	0.000	60.317	105.321	152.537	196.212	235.879	283.649	326.392	375.543	388.565

LINE 1

HORIZONTAL SCALE 1:1000 (A1) 1:2000 (A3)
VERTICAL SCALE 1:200 (A1) 1:400 (A3)

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SURVEY	GEOLYSE	SP/NM	2016
DESIGN	114135 EG Sewer Servicing Rev E.project	EG	23/06/17
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

MASTER SCALE
HORIZONTAL SCALE 1:1000 (A1) 1:2000 (A3)
0 20 40 60 80 100
0 5 10 15 20
VERTICAL SCALE 1:200 (A1) 1:400 (A3)
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CLIENT
MAAS GROUP PROPERTIES No. 2 PTY LTD
PROJECT
SOUTHLAKES ESTATE EXTENSION
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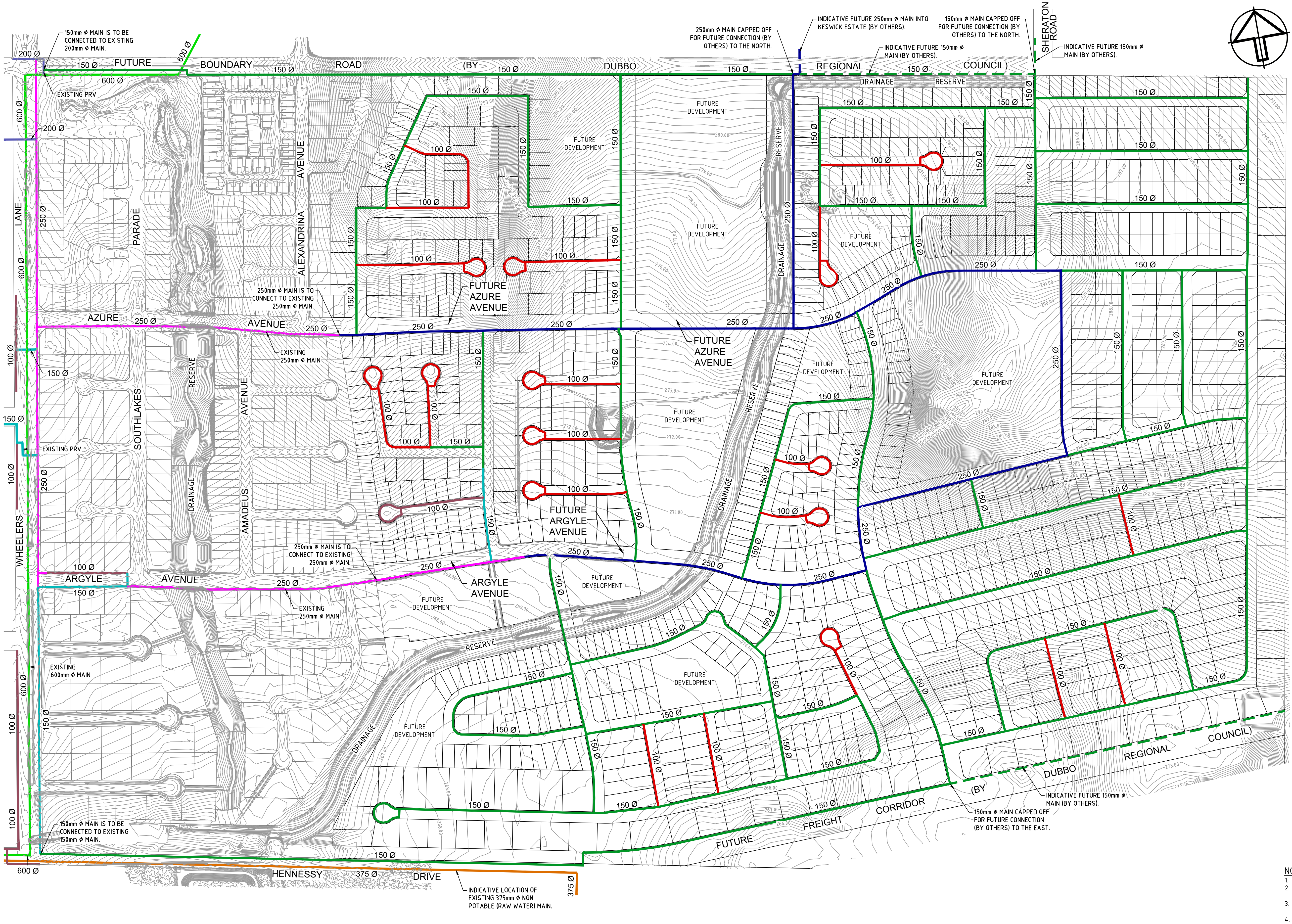
DRAWING
CONCEPT 600mm Ø SEWER MAIN
LONGITUDINAL SECTION

PROJECT NUMBER 114135 | DRAWING FILE 114135_12E_C001-C005.dwg | SIZE A1
SURVEY MARK REFER TO GEOLYSE SURVEY | R.L. - | DATUM A.H.D. | SET 12E
IMAGE SOURCE
STATUS ISSUED FOR REPORT | SHEET C004 OF C005



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NOTE
WATER MAIN SIZES ARE GENERALLY BASED UPON WATER NETWORK MODELLING CARRIED OUT BY DUBBO REGIONAL COUNCIL & PROVIDED TO GEOLYSE IN MAY 2016 HOWEVER COUNCIL HAS SINCE ADVISED THAT THE MINIMUM WATER MAIN SIZE THAT MAY BE USED IN SELECTED CUL-DE-SACS & ROADS IS 100mm DIAMETER.

NOTE
HYDRANTS & STOP VALVES ARE TO BE PROVIDED BY THE DEVELOPER AS REQUIRED BY DUBBO REGIONAL COUNCILS DESIGN AUSPEC #1.

NOTE
LOT LAYOUT WAS PROVIDED TO GEOLYSE BY MAAS GROUP PROPERTIES ON 04/05/17.

NOTE
THIS PLAN IS TO BE PRINTED & READ IN COLOUR.

LEGEND
- 100mm ø WATER MAIN
- 150mm ø WATER MAIN
- 150mm ø WATER MAIN (BY OTHERS)
- 250mm ø WATER MAIN
- 250mm ø WATER MAIN (BY OTHERS)
- EXISTING 100mm ø WATER MAIN
- EXISTING 150mm ø WATER MAIN
- EXISTING 200mm ø WATER MAIN
- EXISTING 250mm ø WATER MAIN
- EXISTING 375mm ø NON POTABLE WATER MAIN
- EXISTING 600mm ø WATER MAIN
- PRV PRESSURE REDUCING VALVE

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DESIGN	114135 EG Sewer Servicing Rev E.project	EG	23/06/17
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	23/06/17

MASTER SCALE
SCALE 1:3000 (A1)
SCALE 1:6000 (A3)
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APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL
CLIENT: MAAS GROUP PROPERTIES No. 2 PTY LTD
PROJECT: SOUTHLAKES ESTATE EXTENSION
PROPOSED RESIDENTIAL SUBDIVISION
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DRAWING: WATER RETICULATION SERVICING PLAN
PROJECT NUMBER 114135 | DRAWING FILE 114135_12E_C001-C005.dwg | SIZE A1
SURVEY MARK REFER TO GEOLYSE SURVEY | R.L. - | DATUM A.H.D. | SET 12E
IMAGE SOURCE
STATUS ISSUED FOR REPORT | SHEET C005 OF C005

Appendix A

STORMWATER MANAGEMENT STRATEGY PREPARED BY GEOLYSE

STORMWATER MANAGEMENT STRATEGY
SOUTHLAKES ESTATE DUBBO

PREPARED FOR
MAAS GROUP PROPERTIES PTY LTD

JUNE 2017

• Civil, Environmental & Structural Engineering • Surveying • Environmental • Planning • Architecture

STORMWATER MANAGEMENT STRATEGY

SOUTHLAKES ESTATE DUBBO

PROPOSED RESIDENTIAL SUBDIVISION

LOT 12 IN DP1207280, LOT 399 IN DP1199356 AND

LOT 2 IN DP880413

PREPARED FOR:

MAAS GROUP PROPERTIES NO. 2 PTY LTD

JUNE 2017

GEOLYSE

POSTAL ADDRESS PO BOX 1963 ORANGE NSW 2800

LOCATION 154 PEISLEY STREET ORANGE NSW 2800

TELEPHONE 02 6393 5000 FACSIMILE 02 6393 5050

EMAIL ORANGE@GEOLYSE.COM WEB SITE WWW.GEOLYSE.COM

Report Title:	*Stormwater Management Strategy*
Project:	*Southlakes Estate Dubbo*
Client:	*Maas Group Properties No. 2 Pty Ltd*
Report Ref.:	*114135_REO_003C.docx*
Status:	*Final*
Issued:	*29 June 2017*

Geolyse Pty Ltd and the authors responsible for the preparation and compilation of this report declare that we do not have, nor expect to have a beneficial interest in the study area of this project and will not benefit from any of the recommendations outlined in this report.

The preparation of this report has been in accordance with the project brief provided by the client and has relied upon the information, data and results provided or collected from the sources and under the conditions outlined in the report.

All information contained within this report is prepared for the exclusive use of Maas Group Properties No. 2 Pty Ltd to accompany this report for the land described herein and is not to be used for any other purpose or by any other person or entity. No reliance should be placed on the information contained in this report for any purposes apart from those stated therein.

Geolyse Pty Ltd accepts no responsibility for any loss, damage suffered or inconveniences arising from, any person or entity using the plans or information in this study for purposes other than those stated above.

TABLE OF CONTENTS

DRAWINGS

FIGURES

TABLES

Introduction

1.1 BACKGROUND

Geolyse Pty Ltd has been commissioned by Maas Group Properties to prepare a Stormwater Management Strategy to accompany a Development Application (DA) for a proposed Residential Subdivision over land described as Lot 12 in DP 1207280, Lot 399 in DP 1199356 and Lot 2 in DP 880413 at 'Southlakes Estate', Dubbo.

1.2 SITE LOCATION

The site is described as Lot 12 in DP 1207280, Lot 399 in DP 1199356 and Lot 2 in DP 880413 and is located at 'Southlakes Estate' approximately 4 kilometres south east of the Dubbo Central Business District. Including the land known as Ringlands, the site has a total combined area of approximately 179.72 hectares. The subject land is bounded by the future extension of Boundary Road and Sheraton Road to the north, Hennessy Road and its future extension to the south and the eastern extent of the existing 'Southlakes Estate' to the west.

The subject area is largely cleared of native vegetation, featuring open grasslands and gentle slopes. Other features on the site include three existing stock dams.

1.3 PURPOSE OF REPORT

The purpose of this report is to outline the proposed stormwater management strategy for the development of the overall Southlakes Estate residential subdivision. It also presents preliminary design and sizing information for key components of the water management strategy for the development of the residential subdivision.

1.4 REPORT STRUCTURE

This report is presented in four sections:

- **Section 1** provides a brief background and presents the report objectives;
- **Section 2** provides background information and details the assessment methodology;
- **Section 3** presents the results of the system and modelling and an outline of the major system components; and
- **Section 4** presents the conclusions and recommendations.

Background Information

2.1 PROPOSED DEVELOPMENT

The subject site has been identified by the developer as a suitable location for the development of a neighbourhood centre, R2 general residential lots, R1 low density residential lots, and public recreation areas.

Vehicular access will be available from Azure Avenue, Argyle Avenue, the future extension of Boundary Road, Sheraton Road and the future extension of Hennessy Road.

The overall layout of the proposed development is indicated on **Drawing No. 114135_06_C001**.

2.2 EXISTING STORMWATER DRAINAGE

The site lies within the catchment of the Eulomogo Creek which ultimately drains to the Macquarie River south of the site. The site is at the lower end of the catchment and as a result stormwater flows from the catchment upstream of the site need to be managed as they pass through the site. The internal catchment boundaries are indicated in **Drawing No. 114135_06_C002.** Further details on these catchments are outlined in **Section 2.3.2 – Sub Catchment Definition**.

A drainage reserve has been created across the site that runs from the intersection of Boundary and Sheraton Roads in the north east corner to the south west corner at Hennessy Road. The current development layout also includes an area in the south east corner that drains to the south, ultimately discharging directly to Eulomogo Creek. This area was modelled separately to the area of the development that drains via the drainage reserve. The site is currently undeveloped with only 3 farm dams and associated contour banks influencing the natural flows across the site.

2.3 SYSTEM MODELLING

2.3.1 EXISTING STUDY

Cardno prepared the *Keswick Drainage Review- Assessment of Trunk Drainage Requirements* report in 2010 for Dubbo City Council. The Cardno report modelled the entire catchment upstream of Hennessy Road, including the extension to the Southlakes Estate site. The Cardno report provided peak flows at the outlet of the Southlakes Estate site for the existing and post development scenarios (including stormwater detention basins immediately upstream of the Southlakes Estate extension site).

Cardno kindly provided hydrograph and peak flow data to enable Geolyse to replicate their modelling and factor in the expected flows from the upstream catchment.

The Cardno report looked at the trunk drainage requirements for the whole catchment which included a detention basin on the south side of Hennessy Road and detention basins immediately upstream of the Southlakes Estate site north of the extension of Boundary Road. Council provided the design drawings for the proposed Hennessy Road detention basin which were also prepared by Cardno. The Cardno report did not include any detention basins within the Southlakes Estate site and as a result detention within the Southlakes Estate site was not modelled by Cardno.

2.3.2 STORMWATER QUANTITY

The performance of the proposed stormwater management system was assessed using the XP-RAFTS hydrological model. This model is able to:

- Model spatial and temporal variations in storm rainfall across the catchment;

- Model variations in catchment characteristics;
- Model storage routing effects in drainage lines and basins; and
- Calculate discharge hydrographs at any required location in the catchment.

The analytical technique used in XP-RAFTS involves the division of the catchment into a number of sub-catchments. Sub-catchment outlets are located at the junction of drainage lines, at the site of dams or retarding basins, at points corresponding to significant changes in catchment characteristics, or at any other point of interest.

Data is required on the area and connection sequence of the sub-catchments, together with average catchment slopes, the impervious percentage, and the rainfall data for the design storm being modelled. Additional data is required to model rainfall losses and channel or pipe flow. This information is entered in several different forms depending on the data availability and the degree of refinement desired for the analysis. For this assessment the rainfall losses were modelled as initial and continuing losses.

Model Scenarios

Three catchment models were developed:

- Scenario 1- Post-development- 50% impervious for developed areas within the Southlakes Estate extension (as modelled in the Cardno report)
- Scenario 2- Post-development – 60% impervious for R2 low density residential and 80% impervious for R1 general residential within the Southlakes Estate extension.
- Scenario 3- Post-development – 60% impervious for R2 low density residential and 80% impervious for R1 general residential within the Southlakes Estate extension with on-site detention within the Southlakes catchments.

Sub-Catchment Definition

For each scenario the site was split into the catchments shown in **Drawing No. 114135_06_C002.** Catchment parameters were determined from available contour plans.

Cardno provided 100 year ARI hydrographs for the outlets of the proposed detention basins upstream of the Southlakes Estate extension (Sheraton Basin and Boundary Road Basin). The hydrographs were loaded into the model to represent the expected flows from upstream of the site.

Channel Routing

Channel lagging was adopted to model travel times between sub-catchments. The lag time was estimated by considering the distance travelled and adopting an average velocity of 1m/s for developed areas and 0.75m/s for open channels.

Rainfall Losses

The following initial and continuing losses (as adopted in the Cardno report) were used in the model:

Pervious	Initial loss	16.5 mm
	Continuing loss	5.5 mm/hr
Impervious	Initial loss	1.0 mm
	Continuing loss	0 mm/hr

Design Storms

The catchment was modelled for the 100yr Average Recurrence Interval (ARI) design storm. Design rainfall intensity/frequency/duration (IFD) data and storm temporal patterns were derived using the procedures set out in Australia Rainfall and Runoff (Institution of Engineers Australia, 1987).

Design storm durations from 30 minutes to 12 hours were modelled to determine the critical storm duration. (i.e. the storm that produced the highest peak flow) for both undeveloped and developed cases.

Stormwater Management Strategy

3.1 CONCEPTUAL STORMWATER MANAGEMENT STRATEGY

3.1.1 STORMWATER MANAGEMENT OBJECTIVES

The objectives adopted for stormwater management at the site are to:

- provide safe and efficient stormwater conveyance through the Southlakes Estate extension; and
- protect downstream drainage systems against construction and long term impacts.

3.1.2 CONCEPTUAL LAYOUT

The conceptual stormwater management system for the site is shown on **Drawing 114135_06_C003**. Preliminary sizing of the main system components has been undertaken to demonstrate that it can meet the proposed stormwater management objectives. The final system is subject to further detailed assessment during the detailed design stage to ensure it complements the proposed development layout.

The drainage channel catchment drains generally in a south westerly direction with developed areas discharging to the drainage reserve at road crossings or other locations determined by the existing contours. The south east catchment drains in a southerly direction with developed areas discharging to the proposed Hennessy Road extension and ultimately to Eulomogo Creek.

The conceptual stormwater management system includes the following major components.

Pipe and Open Drain System

The stormwater conveyance system would comprise of pipes and open drains. Generally, pipes would be used for the interlot drainage system and road drainage where kerb and guttering is proposed. Discharge from the pipe system would generally be directly into the drainage reserve.

Some sections of the development have a proposed inverted crown road design with an open channel in the centre of the road reserve. The open channel will have a low flow pipe installed beneath the channel.

The drainage reserve was also modelled as an open channel similar in cross section to that designed for the existing Southlakes Estate to the west of the site. Decorative lakes were also included in the model at key locations. A HEC-RAS model was created to confirm that the expected flows in the channel would be contained within the channel.

Pipes would be used as required to convey flow beneath roads. The interlot and roadway pipe/open channel systems would be designed to convey peak discharge for a 1 in 10 year ARI storm in accordance with Council requirements. Open drains would be designed to convey overland flow at a safe depth and velocity and with a minimum freeboard of 500 mm.

Three culvert crossings under Azure Avenue, Argyle Avenue and an unnamed road (below Argyle Ave) will also be required. **Table 3.1** gives the preliminary sizing of these culverts to ensure they can convey the expected 100 year ARI peak storm flows without overtopping the roads.

Table 3.1 – Preliminary Culvert Crossing Sizing

Crossing Location	Culvert Size
Azure Avenue	3 x 2.1m x 1.2m Reinforced Concrete Box Culvert
Argyle Ave	5 x 2.4m x 1.2m Reinforced Concrete Box Culvert
Unnamed Road (below Argyle Ave)	5 x 2.4m x 1.2m Reinforced Concrete Box Culvert

On-site Detention

Preliminary modelling showed that the developed flows from the overall Southlakes Estate extension would result in peak flows at Hennessy Road above that reported in the Cardno report. As a result on-site detention has been modelled in the R1 areas to ensure that peak flows at Hennessy Road are no greater than the Cardno report flows. The current development layout also includes an area in the south east corner that drains directly to the south and is not part of the drainage reserve catchment. This area was modelled separately to confirm required detention volumes.

A summary of the required detention basin volumes in the R1 areas is provided below in **Table 3.2**. The required detention volumes will need to be refined during the detailed design phase.

Table 3.2 – Required Detention Volumes

Catchment	Required Detention Volume (m^3)
W1	2,000
W2	7,000
W3	5,000
W6	1,000
E3	3,000
E4	5,000
E5	1,000
Eul1	12,500

Based on the results outlined in **Table 3.2**, the total detention volume to be provided within the extension of Southlakes Estate amounts to 24,000m^3 distributed between the 7 nominated sub catchments, whilst the Eulomogo Basin is to have a volume of 12,500m^3.

3.2 STORMWATER MODELLING RESULTS

3.2.1 PEAK SITE DISCHARGE

Peak flows discharging from the site were compared to the peak flows provided by Cardno. A summary of the peak flows estimated by Cardno and the scenarios modelled by Geolyse for the main drainage channel catchment are provided in **Table 3.3** below.

The final configuration of the proposed stormwater management system is subject to detailed design at which stage some adjustment to the design levels may occur. The design objectives would however remain unchanged.

Table 3.3 – Peak 100 year ARI flows at Hennessy Road

Cardno Report (m^3/s)	Geolyse Scenario 1 (m^3/s)	Geolyse Scenario 2 (m^3/s)	Geolyse Scenario 3 (m^3/s)
21.72	22.80	26.80	21.72

A summary of peak flows for the southeast Eulomogo catchment are provided below in **Table 3.4**.

Table 3.4 – Peak 100 year ARI flows South East catchment outlet

Pre-development (m^3/s)	Post-development (m^3/s)
5.55	4.65

The figures in **Table 3.3** show that the Geolyse Scenario 1 model correlates well with the figure provided by Cardno (both assume 50% impervious for developed areas). The peak flow reported for Geolyse Scenario 2 shows an increase of 4 m^3/s (17.5%) over Geolyse Scenario 1 and an increase of 5.08 m^3/s (23%) over the Cardno report figure. The peak flow for Geolyse scenario 3 shows that with on-site detention provided upstream in Southlakes Estate, the peak flows at Hennessy Road match the Cardno report figure.

The figures in **Table 3.4** show that with on-site detention provided the peak flows discharging from the south east Eulomogo catchment are below pre-development levels.

3.2.2 DRAINAGE RESERVE CHANNEL

A concept design of the proposed drainage reserve channel was prepared using available digital elevation data to allow preliminary hydraulic modelling and channel sizing to be undertaken. The concept channel design was based on the channel design prepared for the existing Southlakes Estate to the west of the Southlakes Estate extension. A typical section of the concept drainage reserve channel is shown on **Drawing 114135_06_C003**.

A HEC RAS model was prepared based on the concept design of the drainage reserve channel to allow preliminary hydraulic modelling of the expected flows to be undertaken. The HEC RAS model assumed a minimum downstream water level of 264.34m AHD as this is the 1 in 100 year ARI design peak Hennessy Road basin water level as shown on the Cardno drawing 4937-CD076 Rev 01.

The hydraulic profile of the expected 100 year ARI flow within the concept drainage reserve channel design is shown below in **Figure 1**.

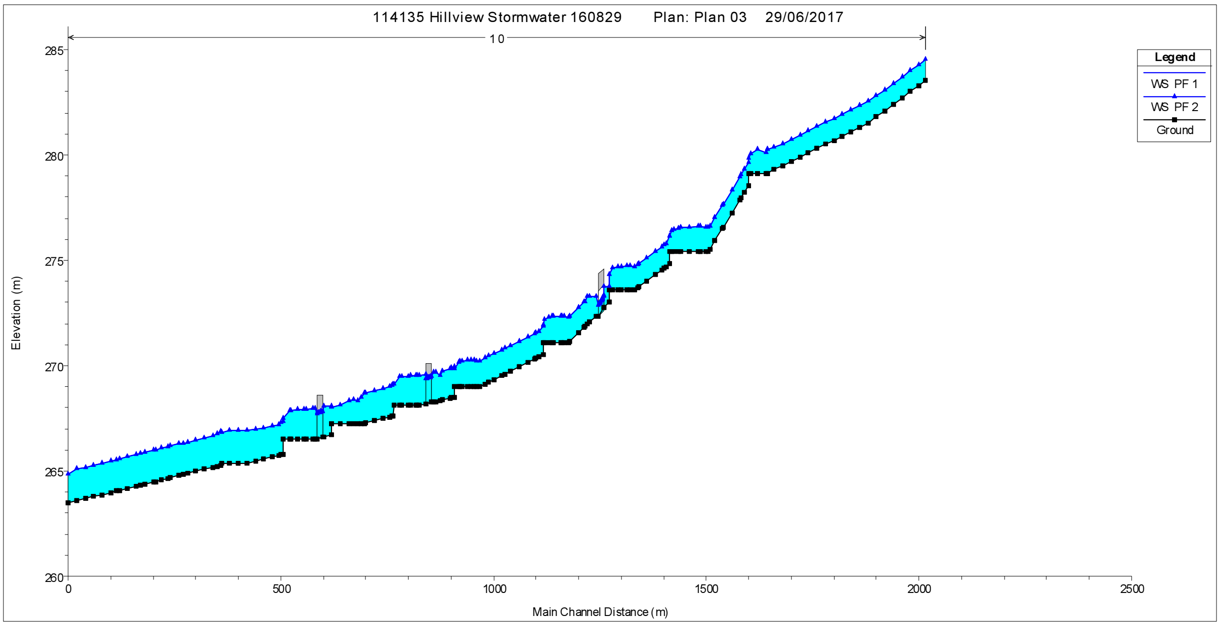

Figure 1: Concept HEC RAS Hydraulic Profile

Depths of flow in the drainage reserve channel ranged from 0.73 m to 1.59 m with a minimum freeboard of 500 mm maintained throughout. Peak velocities ranged from 0.62 - 2.73 m/s.

The preliminary hydraulic modelling showed that the expected flows from Scenario 3 were contained within the concept design drainage reserve channel and the culverts were not overtopped.

3.2.3 DESIGN DETAILS OF THE DRAINAGE RESERVE CHANNEL

Dubbo Regional Council has issued Development Consent for the eastern drainage channel through Southlakes Estate (Reference D2017-57 dated 30 May 2017).

Specifically, Consent Condition No. 2 relates to the future detailed design of the drainage channel and states:

(2) A Stormwater Drainage Management Report, including the Flood Modelling Report and Creek design, shall be provided to Council for approval prior to the issue of the Construction Certificate for the Drainage Reserve works. The Report shall include the following:

- Outlet flows to Hennessy Drive shall be no greater than the calculated amount as shown in Cardno "Keswick Drainage Review", Report No. W823-1 dated August 2010;
- All construction work shall be in accordance with Cardno "Keswick Drainage Review", Report No. W823-1 dated August 2010;
- The channel adjacent to the Boundary Road/Sheraton Road intersection needs to be designed to match with Dubbo Regional Council's Boundary Road Design, and shall liaise with Council's Technical Services Division;
- All proposed outlet pipe levels should be determined to ensure that they are free outfalls up to and including the 10 year event. This is to ensure that there is adequate clearance for outflows as well as the prevention of backflow into upstream systems;
- Upper channel at Sheraton Road to be designed to match proposed future intersection arrangement, and shall liaise with Council's Technical Services Division;
- Future road crossing culverts, which cross the proposed channel are to be designed to accommodate 100 year ARI;
- Depth and velocity product information shall be submitted with the Construction Certificate; and

- Details of the 100 year ARI flood line within the drainage reserve and adjoining property.

All works are to be undertaken in accordance with Council's adopted AUS-SPEC #1 Development Specification Series – Design and Construction, with detailed engineering plans being submitted to, and approved by Council prior to any construction works commencing.

The stormwater modelling carried out for the preparation of this Report forms the basis of the design parameters to be adopted for the detailed engineering design of the eastern drainage channel and is accordance with the requirements outlined in Condition No. 2 from D2017-57.

Conclusion

This report presents an assessment of the proposed stormwater management strategy for the overall development of the Southlakes Estate residential subdivision proposed by Maas Group Properties. The stormwater assessment also includes development of the land known as Ringlands. The results show that the proposed stormwater management system results in a peak discharge from the site at Hennessy Road that matches that provided by Cardno.

It is proposed to construct a minor/major drainage system for overall development of Southlakes Estate with the minor system consisting of stormwater pits and pipes and open channels that would convey minor flows to the drainage reserve running through the site. Major flows would be conveyed along road reserves and drainage easements to the drainage reserve running through the site.

In accordance with the overall stormwater strategy for the catchment, on-site detention is proposed upstream of Hennessy Road within Southlakes Estate to control peak flows. All system components would be subject to further detailed assessment and design during the engineering design phase, based on the principles outlined in this assessment.

The stormwater modelling carried out for the preparation of this Report forms the basis of the design parameters to be adopted for the detailed engineering design of the eastern drainage channel and is accordance with the requirements outlined in Condition No. 2 from D2017-57.

References

Institute of Engineers, 1987 *Australian Rainfall and Runoff Volume 1*

Cardno, 2010. Keswick Drainage Review- Assessment of Trunk Drainage Requirements (Report No. W4823-1)

Drawings

LEGEND

B1	NEIGHBOURHOOD CENTRE
R1	GENERAL RESIDENTIAL
R2	LOW DENSITY RESIDENTIAL
RE1	PUBLIC RECREATION
(line)	SOUTHLAKES ESTATE EXTENSION BOUNDARY

REV.	DATE	DFTD.	APPD.	DETAILS
A	24/02/16	BH	AW	ISSUED FOR INFORMATION
B	25/08/16	AJD	PPO	REVISED CATCHMENTS - ISSUED FOR INFORMATION
C	29/06/17	EG	SJH	CATCHMENTS REVISED & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

DRAWING SCALE

SCALE 1:3000 (A1)

0 50 100 150 200 250 300

SCALE 1:6000 (A3)

DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

CLIENT: MAAS GROUP PROPERTIES PTY LTD

PROJECT: SOUTHLAKES ESTATE EXTENSION

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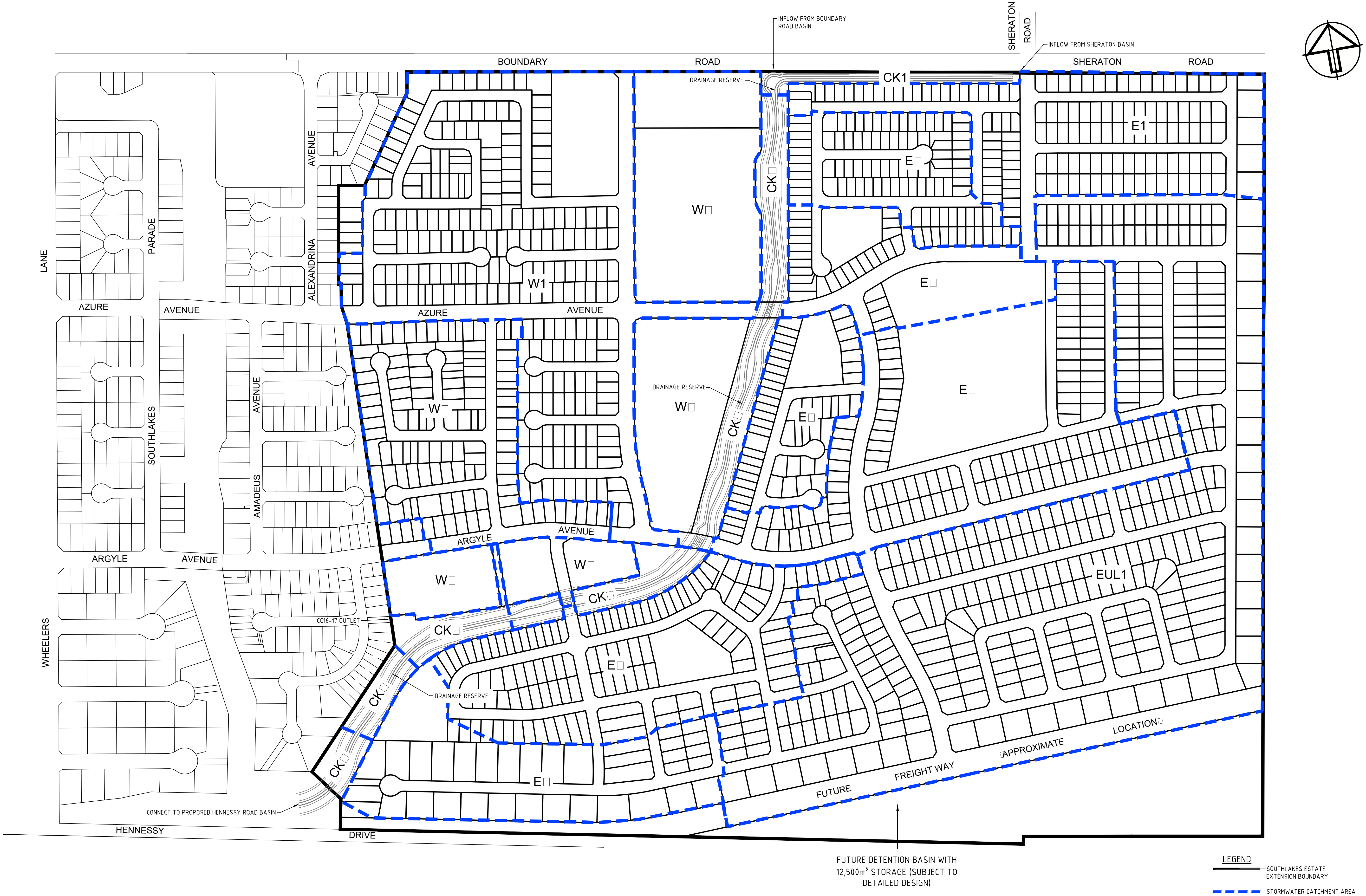
DRAWING: PROPOSED SITE LAYOUT

PROJECT NUMBER 114135 | DRAWING FILE 114135_06C_C001-C003.dwg | SIZE A1

SURVEY MARK - | R.L. - | DATUM A.H.D. | SET 06

IMAGE SOURCE

STATUS FOR REPORT | SHEET C001 OF C003



REV.	DATE	DFTD.	APPD.	DETAILS
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DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

DRAWING SCALE

SCALE 1:3000 (A1)

0 50 100 150 200 250 300

SCALE 1:6000 (A3)

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APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL

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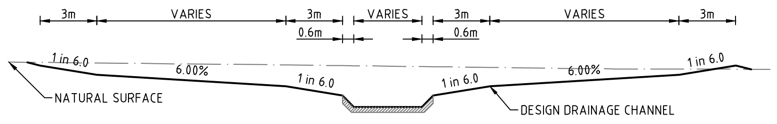
DRAWING: CONCEPT STORMWATER CATCHMENTS

PROJECT NUMBER 114135	DRAWING FILE 114135_06C_C001-C003.dwg	SIZE A1
SURVEY MARK - R.L. -	DATUM A.H.D.	SET 06
IMAGE SOURCE		
STATUS FOR REPORT	SHEET C002 OF C003	

THIS PLAN IS FOR CONCEPT DEVELOPMENT PURPOSES ONLY AND SHALL NOT BE USED FOR CONSTRUCTION. THE FINAL DESIGN IS SUBJECT TO DETAILED ENGINEERING DESIGN AND COUNCIL APPROVAL



STANDARD WIDTH CHANNEL TYPICAL SECTION 1
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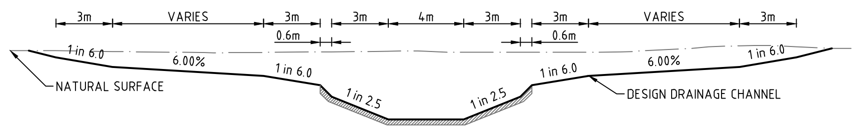
SCALE 1:400 (A3)



DECORATIVE LAKE CHANNEL TYPICAL SECTION 2
SCALE 1:200 (A1)
SCALE 1:400 (A3)

LEGEND
CONCEPT DRAINAGE RESERVE CHANNEL
CONCEPT CHANNEL CENTRELINE
HILLVIEW ESTATE BOUNDARY

REV.	DATE	DFTD.	APPD.	DETAILS
A	24/02/16	BH	AW	ISSUED FOR INFORMATION
B	25/08/16	AJD	PPO	REVISED CATCHMENTS - ISSUED FOR INFORMATION
C	29/06/17	EG	SJH	CATCHMENTS REVISED & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

DRAWING SCALE
SCALE 1:3000 (A1)
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SCALE 1:6000 (A3)
DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY: DUBBO REGIONAL COUNCIL
CLIENT: MAAS GROUP PROPERTIES PTY LTD
PROJECT: SOUTHLAKES ESTATE EXTENSION

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DRAWING: CONCEPT DRAINAGE RESERVE CHANNEL
PROJECT NUMBER 114135 | DRAWING FILE 114135_06C_C001-C003.dwg | SIZE A1
SURVEY MARK - | R.L. - | DATUM A.H.D. | SET 06
IMAGE SOURCE
STATUS FOR REPORT | SHEET C003 OF C003

TRAFFIC STUDY
SOUTHLAKES ESTATE DUBBO

PREPARED FOR
MAAS GROUP PROPERTIES PTY LTD

JUNE 2017

• Civil, Environmental & Structural Engineering • Surveying • Environmental • Planning • Architecture

TRAFFIC STUDY

SOUTHLAKES ESTATE DUBBO

PROPOSED RESIDENTIAL SUBDIVISION
LOT 12 IN DP1207280, LOT 399 IN DP1199356 AND
LOT 2 IN DP880413

PREPARED FOR:

MAAS GROUP PROPERTIES NO. 2 PTY LTD

JUNE 2017

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Report Title:	*Traffic Study*
Project:	*Southlakes Estate Dubbo*
Client:	*Maas Group Properties No. 2 Pty Ltd*
Report Ref.:	*114135_TRS_004*
Status:	*Final*
Issued:	*29 June 2017*

Geolyse Pty Ltd and the authors responsible for the preparation and compilation of this report declare that we do not have, nor expect to have a beneficial interest in the study area of this project and will not benefit from any of the recommendations outlined in this report.

The preparation of this report has been in accordance with the project brief provided by the client and has relied upon the information, data and results provided or collected from the sources and under the conditions outlined in the report.

All information contained within this report is prepared for the exclusive use of Maas Group Properties No. 2 Pty Ltd to accompany this report for the land described herein and is not to be used for any other purpose or by any other person or entity. No reliance should be placed on the information contained in this report for any purposes apart from those stated therein.

Geolyse Pty Ltd accepts no responsibility for any loss, damage suffered or inconveniences arising from, any person or entity using the plans or information in this study for purposes other than those stated above.

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Executive Summary

1.1 INTRODUCTION

Maas Group Properties intends to develop a residential subdivision on land to the east of the existing Southlakes Estate subdivision. The extension to Southlakes Estate will also incorporate the land further to the east known as Ringlands and the overall development will complement the existing Southlakes subdivision. The overall subdivision will have major access points connecting via Azure Avenue and Argyle Avenue to Wheelers Lane and future connections to the extension of Boundary Road and to Sheraton Road and to the wider road network.

It is intended that approximately 2,080 dwelling sites be created in the overall extension to Southlakes Estate and will comprise residential allotments and medium density allotments.

The Hillview property is located approximately 4km south east of the Dubbo central business district and is accessed from the north via Cobra Street and Wheelers Lane and the south via Hennessy Drive and Wheelers Lane. The Ringlands site is located to the east of the Hillview property.

The Hillview subdivision site is described as Lot 12 in DP1207280 and Lot 399 in DP1199356. The Ringlands subdivision site is described as Lot 2 in DP880413. Lot 12 has an area of approximately 2.27ha, Lot 399 has an area of approximately 128.5ha and Lot 2 has an area of approximately 48.95ha for a total development area of approximately 179.72ha.

The overall development site is bounded by Southlakes Estate to the west, Boundary Road and Sheraton Road to the north, Hennessy Drive to the south and privately owned land to the east.

1.2 TRAFFIC STUDY

Under State Environmental Planning Policy SEPP (Infrastructure) 2007, the proposed subdivision for the extension of Southlakes Estate is classified in accordance with the requirements set out in Schedule 3 of Clause 104 of the SEPP.

On this basis, a Traffic Study will need to be prepared to assist in the planning approval process for the development.

This Traffic Study will address the following issues:

- Traffic generated by the development of the overall extension of Southlakes Estate
- Access to and from the subdivision via existing roads, new roads and the connection of the subdivision roads to the wider road network
- Impact on the operation, safety and amenity of the surrounding road network
- Recommendations for the implementation of Local Area Traffic Management (LATM) devices throughout the subdivision

The Traffic Study will be prepared in accordance with the requirements outlined in the NSW Roads and Traffic Authority's (RTA) *Guide to Traffic Generating Developments.*

1.3 EXISTING TRAFFIC VOLUMES

The estimated Year 2026 AADT traffic volumes on the subject roads are summarised below:

- Wheelers Lane north of Boundary Road 9,678 vehicles per day
- Wheelers Lane south of Boundary Road 9,108 vehicles per day

- Boundary Road west of Wheelers Lane — 6,555 vehicles per day

The estimated Year 2026 peak hour traffic volumes on the subject roads are summarised below:

- Wheelers Lane north of Boundary Road — 1,204 vehicles per hour
- Wheelers Lane south of Boundary Road — 992 vehicles per hour
- Boundary Road west of Wheelers Lane — 896 vehicles per hour
- Boundary Road east of Wheelers Lane — 511 vehicles per hour
- Sheraton Road south of the Mitchell Highway — 1,024 vehicles per hour

1.4 PROPOSED DEVELOPMENT

The site for the overall extension of the Southlakes Estate subdivision comprises Lot 12 in DP1207280, Lot 399 in DP1199356 and Lot 2 in DP880413. Lot 12 has an area of approximately 2.27ha, Lot 399 has an area of approximately 128.5ha and Lot 2 has an area of approximately 48.95ha for a total development area of approximately 179.72ha.

It is intended that approximately 2,080 dwelling sites be created in the overall subdivision comprising residential allotments and medium density allotments.

In general, the dwelling sites will comprise the following allocations:

Residential allotments	1,314 lots
Medium density dwelling units	766 units
Total dwelling sites	2,080 dwellings

1.5 TRAFFIC GENERATION

The daily traffic generated by the overall extension of Southlakes Estate can be estimated as set out below:

Number of residential dwellings:	1,314 dwellings
Daily vehicle trips:	11 per dwelling
Number of residential daily trips:	14,454 trips per day
Number of medium density dwellings:	766 dwellings
Daily vehicle trips:	6 per dwelling
Number of medium density daily trips:	4,596 trips per day
Total daily vehicle trips:	14,454 trips + 4,596 trips = 19,050 trips per day

Not all trips generated by the proposed extension to Southlakes Estate will be external to the subdivision. A proportion of the generated trips will be for internal travel purposes such as visiting friends or neighbours, recreation areas or a potential commercial precinct.

The RTA estimate that approximately 25% of daily and peak hour vehicle trips are internal to the subdivision (RTA, 1993) and therefore the adjusted external daily vehicle trips generated by the subdivision is:

External daily vehicle trips: 19,050 trips x 0.75 = 14,288 trips per day.

The external trip generation of 14,288 trips per day has been used to assess the potential impacts of the development of the subdivision on the surrounding road network.

The peak hour traffic generated by the overall extension of Southlakes Estate can be estimated as set out below:

Number of residential dwellings:	1,314 dwellings
Peak hour vehicle trips:	1 per dwelling
Number of residential peak hour trips:	1,314 trips per hour
Number of medium density dwellings:	766 dwellings
Peak hour vehicle trips:	0.5 per dwelling
Number of medium density peak hour trips:	383 trips per day
Total peak hour vehicle trips:	1,314 trips + 383 trips = 1,697 trips per hour

As with the daily trip generation, the RTA estimate that 25% of the peak hour trip generation are internal to the subdivision. Therefore, the adjusted external peak hour trips generated by the subdivision is:

External peak hour trips: 1,697 trips x 0.75 = 1,272 trips per hour.

The external trip generation of 1,272 trips per hour has been used to assess the potential impacts of the development of the subdivision on the surrounding road network.

1.6 TRAFFIC IMPACT SUMMARY

The impact of the additional traffic generated by the overall extension of Southlakes Estate on the surrounding road network has been assessed in terms of:

- i) Traffic Volume for both the Daily and Peak Hour traffic generation;
- ii) Intersection Operation; and
- iii) Road Safety.

SIDRA modelling has been undertaken to assess the operation of various intersections on the surrounding road network.

1.6.1 TRAFFIC GENERATION AND ROADWAY CAPACITY

The estimated external daily traffic generation from the overall extension to Southlakes Estate is 14,288 trips per day and the external peak hour traffic generation is 1,272 trips per hour.

The increase in daily traffic volumes on Wheelers Lane north and Wheelers Lane south is 53% and 71% respectively.

The increase in peak hour traffic volumes on Wheelers Lane north and Wheelers Lane south is 38% and 58% respectively.

The increase in daily traffic volumes on Boundary Road west is 33%.

The increase in peak hour traffic volumes on Boundary Road west is 21%.

The increase in peak hour traffic volumes on Sheraton Road south of the Mitchell Highway is 25%.

The operational capacity of Wheelers Lane north following the development of the extension of Southlakes Estate is 46%, for Wheelers Lane south the operational capacity is 87%, for Boundary Road west is 95% and for Sheraton Road is 35%.

All roads are operating below the operational capacity at a Level of Service B and the impact of the additional traffic generated by the overall extension of Southlakes Estate in the Year 2026 is not significant in terms of the volume of post development traffic using Wheelers Lane and Boundary Road, noting that the existing estimated traffic volumes on the subject roads do not take into account redistribution of traffic patterns once the connection of Boundary Road through to Sheraton Road is constructed.

1.6.2 INTERSECTION MODELLING

The operation of the following intersections have been assessed using the SIDRA computer modelling program:

- Wheelers Lane and Argyle Avenue
- Wheelers Lane and Azure Avenue
- Boundary Road the north south access road
- Boundary Road and Sheraton Road with the north south road connecting to Azure Avenue.

The SIDRA modelling determined that all movements at each intersection were operating at a Level of Service A.

1.6.3 CONCLUSION

The implementation of the recommendations of this Traffic Study during the approval and development of the overall extension of Southlakes Estate will see the operation of the development with the integration of the generated traffic into the existing and planned surrounding road network.

Introduction

2.1 BACKGROUND

Maas Group Properties intends to develop a residential subdivision on land to the east of the existing Southlakes Estate subdivision. The extension to Southlakes Estate will also incorporate the land further to the east known as Ringlands and the overall development will complement the existing Southlakes subdivision. The overall subdivision will have major access points connecting via Azure Avenue and Argyle Avenue to Wheelers Lane and future connections to the extension of Boundary Road and to Sheraton Road and to the wider road network.

It is intended that approximately 2,080 dwelling sites be created in the overall extension to Southlakes Estate and will comprise residential allotments and medium density allotments.

An open space corridor will be created along the central drainage line that separates the subdivision generally from the north east to the southwest of the site. The drainage corridor will be embellished with a series of decorative lakes similar to the lakes that have been developed along the existing drainage corridor in Southlakes Estate. The drainage corridor within the extension to Southlakes Estate is known as the eastern channel whilst the drainage corridor within the existing Southlakes Estate is known as the western channel.

As Development Applications for various stages of the extension of Southlakes Estate are prepared and submitted for Council's approval, reference can be made to this Traffic Study to assess the stage of the development in the context of the overall development of the extension of Southlakes Estate.

Therefore Council will have a single Traffic Study relating to the development of the overall subdivision rather than separate traffic studies addressing separate stages and the balance of the subdivision individually.

2.2 SITE LOCATION

The Hillview property is located approximately 4km south east of the Dubbo central business district and is accessed from the north via Cobra Street and Wheelers Lane and the south via Hennessy Drive and Wheelers Lane. The Ringlands site is located to the east of the Hillview property.

The Hillview subdivision site is described as Lot 12 in DP1207280 and Lot 399 in DP1199356. The Ringlands subdivision site is described as Lot 2 in DP880413. Lot 12 has an area of approximately 2.27ha, Lot 399 has an area of approximately 128.5ha and Lot 2 has an area of approximately 48.95ha for a total development area of approximately 179.72ha.

The overall development site is bounded by Southlakes Estate to the west, Boundary Road and Sheraton Road to the north, Hennessy Drive to the south and privately owned land to the east.

Boundary Road to the east of Wheelers Lane is currently unformed and Dubbo Regional Council proposes to extend Boundary Road to the east to connect with Sheraton Road whilst Hennessy Drive will be extended to provide a freight corridor extending further to the east and connecting to the Mitchell Highway via Basalt Drive.

Currently the site is accessed from Wheelers Lane via Azure Avenue through Southlakes Estate and crossing the western channel via a culverted bridge. A second culverted bridge again crossing the western channel provides for an extension of Argyle Avenue to the Hillview property.

The location of the proposed extension to Southlakes Estate is indicated on **Drawing TS01** located in the **Drawings** Section of this Report.

2.3 TRAFFIC STUDY

Under State Environmental Planning Policy SEPP (Infrastructure) 2007, the proposed subdivision for the extension of Southlakes Estate is classified in accordance with the requirements set out in Schedule 3 of Clause 104 of the SEPP.

On this basis, a Traffic Study will need to be prepared to assist in the planning approval process for the development.

This Traffic Study will address the following issues:

- Traffic generated by the development of the overall extension of Southlakes Estate
- Access to and from the subdivision via existing roads, new roads and the connection of the subdivision roads to the wider road network
- Impact on the operation, safety and amenity of the surrounding road network
- Recommendations for the implementation of Local Area Traffic Management (LATM) devices throughout the subdivision

The Traffic Study will be prepared in accordance with the requirements outlined in the NSW Roads and Traffic Authority's (RTA) *Guide to Traffic Generating Developments.*

The methodology for the preparation of the Traffic Study is outlined in the following Section of the Report.

2.4 TRAFFIC STUDY METHODOLOGY

In carrying out the preparation of the Traffic Study, three (3) broad issues will need to be addressed as outlined below:

(a) Existing Site and Traffic Conditions

- Subdivision location;
- Road network hierarchy surrounding the development;
- Existing site access;
- Existing roadway capacity; and
- Existing traffic flow

(b) Proposed Subdivision

- Residential subdivision development concepts;
- Internal and external traffic design principles; and
- Connectivity to the surrounding road network.

(c) Traffic Impact of the Proposed Subdivision

- Traffic generation from the proposed subdivision;
- Traffic distribution within and external to the subdivision and the connection to Wheelers Lane, Boundary Road, Sheraton Road and Hennessy Drive;
- Impact of the traffic generated from the subdivision on existing traffic parameters; and
- Local area traffic management.

In order to satisfactorily address all the relevant traffic issues for the proposed subdivision, the following work tasks will need to be carried out:

1. Review all available background data, community concerns and traffic history relating to the area around the subdivision site.

2. Determine the traffic generating potential of the proposed subdivision, calculation of peak hour and daily traffic volumes and the distribution of the generated traffic within the subdivision and onto the surrounding road network to determine post development traffic volumes on the road network.

3. Assessment of the impact of the additional traffic generated by the development of the subdivision on the surrounding road network. The traffic impact assessment will carried out in terms of:

   - Road capacity;
   - Road safety;
   - Intersection operation; and
   - Access requirements.

4. Determination of a schedule of required works that may be necessary to alleviate any potential impacts caused to the surrounding road network by the development of the subdivision.

In summary, this Traffic Study will assess the existing traffic movements on the road network surrounding the development site, the expected traffic volumes generated by the proposed subdivision of the Hillview and Ringlands properties, the effect of the generated traffic on the surrounding road network and the determination of a safe and efficient means of providing access to the subdivision to cater for the additional traffic volume.

Consideration of SEPP (Infrastructure) 2007

Schedule 3 of State Environmental Planning Policy (Infrastructure) 2007 classifies developments based upon the potential to generate additional traffic onto the surrounding road network.

Developments listed in Schedule 3 of SEPP (Infrastructure) require referral to the Roads and Maritime Services (RMS) by the consent authority. The consent authority is required to take into consideration any submission that the RMS provides in response to the notice of the development.

In addition, the consent authority must consider, pursuant to Clause 104 (3) of SEPP (Infrastructure), the accessibility of the site and any potential traffic safety, road congestion or parking implications of the proposed development.

Based on Schedule 3, the classification of the proposed extension to the Southlakes subdivision is outlined in Column 2 and states:

Subdivision of Land	*200 or more allotments where the subdivision includes the opening of a public road*

As the proposed extension to the Southlakes subdivision will generate approximately 2,080 dwelling sites, Dubbo Regional Council will need to refer the application to the RMS as part of the development approval process.

Existing Traffic Conditions

4.1 ROAD NETWORK HIERARCHY

The Roads and Traffic Authority (1984) proposes four basic road classes as the basis for the functional hierarchy of a road network.

A functional classification take into account the relative balance of the traffic mobility function and amenity/access functions of streets and roads and defines the purpose of a road within the context of a road network.

The four road classes are arterial, sub-arterial, collector and local roads and are defined below.

- **Arterial Roads**

  Roads whose main function is to carry through traffic from one region to another forming the principal means of communication for major traffic movements.

- **Sub-Arterial Roads**

  Those roads which supplement the arterial roads in providing for through traffic movement to an individually determined limit that is sensitive to both roadway characteristics and adjoining land uses.

- **Collector Roads**

  Roads that distribute traffic between the arterial roads and the local street system and provide access to adjoining property.

- **Local Roads**

  Subdivisional roads whose main traffic function is to provide access to adjoining property.

An assessment of the classification of the roads leading to and surrounding the development site is indicated in **Table 4.1**.

Table 4.1 – Existing Road Classification

Road	Classification
Wheelers Lane north of Boundary Road	Sub – Arterial Road
Wheelers Lane south of Boundary Road	Sub – Arterial Road
Boundary Road west of Wheelers Lane	Sub – Arterial Road
Boundary Road east of Wheelers Lane	Not currently classified
Sheraton Road north of the future Boundary Road	Collector Road
Hennessy Drive west of Wheelers Lane	Collector Road
Hennessy Drive east of Wheelers Lane	Not currently classified
Azure Avenue	Local Road
Argyle Avenue	Local Road

4.2 EXISTING ROAD CONDITIONS

The existing configuration, conditions and intersection facilities of the road network leading to and surrounding the development site are outlined in this Section of the Traffic Study.

Wheelers Lane North of Boundary Road

Wheelers Lane north of the intersection with Boundary Road comprises two (2) configurations as outlined below:

- From the intersection of Boundary Road to the northern boundary of the Dawson Park Greyhound Racing Complex Wheelers Lane has kerb and gutter on the western side of the road and is unkerbed on the eastern side of the road. The roadway comprises two (2) southbound lanes each a minimum of 3.5m wide, two (2) northbound lanes each a minimum of 3.5m wide and a 4m wide parking lane on the western side of the road.

- From the northern boundary of Dawson Park Wheelers Lane is kerb and guttered on both sides of the road. The roadway comprises two (2) southbound lanes each a minimum of 3.5m wide, two (2) northbound lanes each a minimum of 3.5m wide and a 4m wide parking lane on the both the eastern and western sides of the road.

  From south of the intersection of Wheelers Lane and Kingfisher Street the roadway transitions to the northbound and southbound carriageways separated by a wide concrete median. The concrete median allows for protected right turns at a number of intersections along Wheelers Lane.

Wheelers Lane is speed limited at 60km/hr.

Wheelers Lane South of Boundary Road

Wheelers Lane to the south of the intersection with Boundary Road transitions to a southbound lane and a northbound lane. On the eastern side of Wheelers Lane is a central drainage/landscaped area separating the service road providing access to the allotments in Southlakes Estate fronting the Wheelers Lane road reserve.

The western side of Wheelers Lane is kerb and guttered along the frontage of Magnolia Estate and Holmwood Estate. When the Mary's Veil subdivision is developed, the western side of Wheelers Lane will be kerb and guttered on the western side for its full length between Boundary Road and Hennessy Drive.

The Wheelers Lane carriageway along the frontage of Holmwood Estate comprises a 6m wide travel lane and parking lane on the western side (for northbound traffic) and a 4m wide travel lane on the eastern side (for southbound traffic).

At the approach to the intersection with Hennessy Drive, Wheelers Lane transitions to a unkerbed carriageway with a 3.5m wide travel lane in each direction.

Wheelers Lane is speed limited at 60km/hr.

Boundary Road

Boundary Road east of the Dubbo to Molong rail crossing has kerb and gutter on the northern side with sections of kerb and gutter recently having been constructed along the frontage of Magnolia Estate on the southern side of Boundary Road. East of Magnolia Estate, the southern side of Boundary Road is also kerb and guttered.

The main section of the carriageway in Boundary Road is approximately 16m wide. The carriageway comprises a parking/bicycle lane 3m wide, an eastbound and westbound travel lane each 3.5m wide and a central turning median at 3.0m wide.

Boundary Road west of the Dubbo to Molong rail crossing is kerb and guttered both sides with a bitumen sealed width of approximately 14m. The carriageway comprises an eastbound and westbound travel lane each of approximately 3.5m with a parking lane/bicycle lane approximately 3.5m each side.

Boundary Road is speed limited at 50km/hr.

Boundary Road east of Wheelers Lane is an unformed road.

Hennessy Drive

Hennessy Drive west of the intersection with Wheelers Lane is a two lane two way carriageway with a bitumen seal width of approximately 8m. The road is centreline marked and also has considerable sections of the roadway with double barrier lines to prevent overtaking.

The recently developed Macquarie View Estate incorporates a new intersection of Holmwood Drive and Hennessy Drive consisting of a left turn lane for eastbound traffic and a right turn for westbound traffic in Hennessy Drive to access the subdivision.

A service road parallel to Hennessy Drive on the northern side provides access to lots in Holmwood Estate and Macquarie View Estate that front Hennessy Drive.

Hennessy Drive is speed limited at 60km/hr.

Hennessy Drive east of the intersection with Wheelers Lane is bitumen sealed to a width of 6m and apart from the area around the intersection with Wheelers Lane is not line marked.

Azure Avenue

Azure Avenue provides a major connection through the northern section of the existing Southlakes Estate to the land to be developed to the east.

Azure Avenue has a variable pavement width along it length comprising in general:

- Kerb and guttered both sides with a 6.2m wide parking and travel lane for both eastbound and westbound traffic separated by a 5m wide landscaped median.
- A bridge over the creek line with a sealed width of 8m kerb to kerb.

Each side of the bridge, the roadway transitions from the wider sections through the narrowing at the bridge.

The configuration of the Azure Avenue carriageway provides a high standard roadway with separated travel lanes capable of catering for increased traffic volumes accessing the extension of Southlakes Estate.

Argyle Avenue

Argyle Avenue provides a major connection through the southern section of the existing Southlakes Estate to the land to be developed to the east.

Argyle Avenue has a variable pavement width along it length comprising in general:

- Kerb and guttered both sides with a 6.2m wide parking and travel lane for both eastbound and westbound traffic separated by a 5m wide landscaped median.
- A bridge over the creek line with a sealed width of 8m kerb to kerb.

Each side of the bridge, the roadway transitions from the wider sections through the narrowing at the bridge.

The configuration of the Argyle Avenue carriageway provides a high standard roadway with separated travel lanes capable of catering for increased traffic volumes accessing the extension of Southlakes Estate.

Sheraton Road

The southern section of Sheraton Road adjacent to the Ringlands site is a two lane two way carriageway with a bitumen sealed width of approximately 7.2m. The roadway is not line marked and has narrow unsealed shoulders. This section of the roadway is speed limited at 100km/hr.

There are a series of 90^{o} bends in the road alignment with the southernmost section of the road providing access to the Holcim Quarry. The quarrying operations produce basalt products that are trucked off site using Sheraton Road to travel northwards connecting to the Mitchell Highway at its intersection with Sheraton Road.

The northern section of Sheraton Road (providing frontage to a number of schools and Bunnings) comprises a dual carriageway with two lanes in each direction together with a parallel parking lane. The carriageway in each direction is separated by a central concrete median. Each travel lane is approximately 3.5m wide and the carriageway in line marked and edgeline marked denoting the parallel parking lane.

There are a number of breaks in the central median to allow buses to turn and access and exit the student drop off and pick up facilities for the schools. Passenger vehicles in general cannot make U-turns during school hours.

There are two on grade school crossing points along Sheraton Road fronting the schools and these are manned and operated before and after school. Sheraton Road is currently speed limited to 60km/hr with a 40km/hr School Zone speed limit applying between 8.00am to 9.30am and 2.30pm to 4.00pm each school day.

Intersection of Wheelers Lane and Boundary Road

The intersection of Wheelers Lane and Boundary Road is controlled by a Give Way sign on the Boundary Road leg of the intersection with a concrete median island providing separation of the traffic streams. Whilst the intersection technically is a four way intersection, the eastern leg of Boundary Road is poorly formed and not currently in regular use. The intersection currently operates as a Tee intersection with the Wheelers Lane traffic having the right of way.

For eastbound traffic in Boundary Road a dedicated left turn lane and right turn lane is provided to access Wheelers Lane.

For northbound traffic in Wheelers Lane a dedicated left turn lane is provided to access Boundary Road.

For southbound traffic in Wheelers Lane a dedicated right turn lane is provided to access Boundary Road whilst there is a separate southbound lane for through traffic.

Intersection of Wheelers Lane and Southlakes Parade

The intersection of Wheelers Lane and Southlakes Parade forms a standard Tee intersection and is controlled by a Give Way sign on the Southlakes Parade leg of the intersection with the Wheelers Lane traffic having the right of way.

The threshold of the Southlakes Parade leg of the intersection is paved. The service road parallel to Wheelers Lane is also accessed to the south from this intersection.

Intersection of Wheelers Lane and Magnolia Boulevard

The intersection of Wheelers Lane and Magnolia Boulevard is controlled by a concrete median on the Magnolia Boulevard leg of the intersection and complies with the give way priorities at a Tee intersection with the Wheelers Lane traffic having the right of way.

Intersection of Wheelers Lane and Azure Avenue

The intersection of Wheelers Lane and Azure Avenue forms a standard Tee intersection and complies with the give way priorities at a Tee intersection with the Wheelers Lane traffic having the right of way.

Whilst the intersection pavement in Azure Avenue is wide, the central median is located beyond the paved threshold on the Azure Avenue leg of the intersection and a double barrier line extends from the paved threshold into the intersection. The service road parallel to Wheelers Lane is also accessed to the south from this intersection.

Intersection of Wheelers Lane and Holmwood Drive

The intersection of Wheelers Lane and Holmwood Drive is controlled by a double barrier line on the Holmwood Drive leg of the intersection and complies with the give way priorities at a Tee intersection with the Wheelers Lane traffic having the right of way.

Intersection of Wheelers Lane and Argyle Avenue

The intersection of Wheelers Lane and Argyle Avenue forms a standard Tee intersection and complies with the give way priorities at a Tee intersection with the Wheelers Lane traffic having the right of way.

Whilst the intersection pavement in Argyle Avenue is wide, the central median is located beyond the threshold on the Azure Avenue leg of the intersection and a double barrier line is to be extended from the median into the intersection when the bridge over the creek line is opened to traffic. The service road parallel to Wheelers Lane is also accessed to the south from this intersection.

Intersection of Wheelers Lane and Shindys Road

The intersection of Wheelers Lane and Shindys Road is controlled by a double barrier line on the Shindys Road leg of the intersection and complies with the give way priorities at a Tee intersection with the Wheelers Lane traffic having the right of way

Intersection of Wheelers Lane and Hennessy Drive

The intersection of Wheelers Lane and Hennessy Drive comprises a swept 90 degree bend. The roadway in both Wheelers Lane and Hennessy Drive is centreline marked with a double barrier line and the roadways are edgeline marked.

The eastern leg of Hennessy Drive intersects the main intersection at an approximate angle of 90 degrees at the apex of the curve of the Wheelers Lane intersection.

Intersection of Azure Avenue and Southlakes Parade

The intersection of Azure Avenue and Southlakes Parade is controlled by a roundabout. The roundabout has single approach and departure lanes on all legs of the intersection with concrete splitter islands incorporated into the main central medians of both roads.

Intersection of Sheraton Road and the Mitchell Highway

The major intersection of Sheraton Road and the Mitchell Highway is controlled by a large diameter roundabout with a speed limit of 70km/hr applying along the Mitchell Highway. The roundabout comprises 2 approach lanes and 2 departure lanes for each leg of the roundabout.

Just west of the roundabout is a set of manually activated traffic signals controlling a crossing point for pedestrians. The pedestrian crossing point is located within the concrete splitter island on the western leg of the roundabout.

Various photographs of the roads described in this Section of the Traffic Study and contained in the **Plates** Section of this Report.

4.3 EXISTING ROADWAY CAPACITY

The provision of roads within an urban area provides four main functions:

i) to cater for moving vehicles;
ii) to cater for parked vehicles;
iii) to cater for pedestrians and bicycle traffic; and
iv) to allow for development and to provide access to adjoining property.

In carrying out the above functions, a road must also be capable of handling the traffic demands placed on it. Roads have varying capacities dependent on the function they are performing. The United States Highway Capacity Manual defines capacity as follows:

> *"Capacity is the maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or roadway in one direction (or in both directions for a two-lane or three-lane highway) during a given time period under prevailing roadway and traffic conditions."*

The physical characteristics of a roadway such as lane width, alignment, frequency of intersections etc make up the prevailing roadway conditions.

Based upon its capacity and a driver's expectations of the operational characteristics of a traffic stream is a qualitative measure denoted as the level of service of a road.

Level of service definitions combine such factors as speed, travel time, safety, convenience and traffic interruptions and fall into six levels of service categories ranging from A down to F.

The *AUSTROADS Guide to Traffic Engineering Practice* describes Level of Service A as:

> *"A condition of a free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high and the general level of comfort and convenience provided is excellent."*

The *AUSTROADS Guide to Traffic Engineering Practice* describes Level of Service B as:

> *"A condition of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with Level of Service A"*

The categories are graduated from Level of Service A down through six levels to Level of Service F that is a zone of forced flow. The amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdowns occur and queuing and delays result.

Based on the physical configurations of the surrounding road network, observations of traffic movements and the methodology outlined in Part 2 *Roadway Capacity* of *AUSTROADS Guide to Traffic Engineering Practice*, the capacity and Level of Service of the surrounding roads can be determined as indicated in **Table 4.2**.

Table 4.2 – Roadway Capacity and Level of Service

Road	Level of Service	Two Way Hourly Capacity
Wheelers Lane north of Boundary Road	Level of Service B	3,600 veh/hour
Wheelers Lane south of Boundary Road	Level of Service B	1,800 veh/hour
Boundary Road	Level of Service B	1,200 veh/hour

Table 4.2 – Roadway Capacity and Level of Service

Road	Level of Service	Two Way Hourly Capacity
Azure Avenue	Level of Service B	1,200 veh/hour
Argyle Avenue	Level of Service B	1,200 veh/hour
Hennessy Drive	Level of Service B	1,200 veh/hour
Sheraton Road (southern section)	Level of Service B	1,200 veh/hour
Sheraton Road (dual carriageway section)	Level of Service B	3,600 veh/hour

4.4 AVAILABLE TRAFFIC DATA

Site specific traffic data was not collected on roads surrounding the Southlakes Subdivision for the preparation of this Traffic Study. However, a number of sources were used to collate the available traffic data for use in determining potential impacts on the surrounding road network, including:

i) Traffic Impact Assessment for Southlakes DA4 (Geolyse, July 2012)

ii) Dubbo City Council – hourly traffic volumes for the modelled road network

iii) South Keswick Quarry Traffic Impact Assessment (Barnson, October 2016)

The available traffic data for the Annual Average Daily Traffic and Peak Hour Traffic will be outlined in the following Sections of this Report.

4.5 ANNUAL AVERAGE DAILY TRAFFIC

The Geolyse July 2012 Traffic Report assessed the development of an additional 224 lots in Southlakes Estate and distributed the generated traffic volumes onto the surrounding road network. Turning movement counts were undertaken at the intersection of Wheelers Lane and Boundary Road and the proportional volumes at the intersection were used to distribute the additional traffic onto the road network.

The July 2012 Traffic Report determined the following post development AADT traffic volumes on the subject roads:

- Wheelers Lane north of Boundary Road 7,335 vehicles per day
- Wheelers Lane south of Boundary Road 6,903 vehicles per day
- Boundary Road west of Wheelers Lane 4,968 vehicles per day

As the post development traffic volumes were determined for the Year 2012 and the expected completion date for the full development of the extension to Southlakes Estate may take 10 years, it would be reasonable to carry out the assessment of the impact on the surrounding road network for the Year 2026.

On this basis, the Year 2012 traffic volumes shall be adjusted by the application of a growth factor of 2% per annum to account for the increase in traffic volumes over time.

The estimated Year 2026 AADT traffic volumes on the subject roads are summarised below:

- Wheelers Lane north of Boundary Road 9,678 vehicles per day
- Wheelers Lane south of Boundary Road 9,108 vehicles per day
- Boundary Road west of Wheelers Lane 6,555 vehicles per day

It should be noted that the estimated Year 2026 AADT traffic volumes based on the July 2012 Traffic Report do not take into account the redistribution of traffic patterns following the extension of Boundary Road through to Sheraton Road.

However, the estimated AADT provides a basis for the further assessment of the potential impacts of traffic generated by the proposed extension to Southlakes Estate.

4.6 PEAK HOUR TRAFFIC

The Geolyse July 2012 Traffic Report determined post development peak hour traffic volumes generated from Southlakes Estate on the surrounding road network.

The July 2012 Traffic Report determined the following post development peak hour traffic volumes on the subject roads:

- Wheelers Lane north of Boundary Road — 912 vehicles per hour
- Wheelers Lane south of Boundary Road — 752 vehicles per hour
- Boundary Road west of Wheelers Lane — 679 vehicles per hour

Similarly, the Year 2012 traffic volumes shall be adjusted by the application of a growth factor of 2% per annum to account for the increase in traffic volumes over time.

The estimated Year 2026 peak hour traffic volumes on the subject roads are summarised below:

- Wheelers Lane north of Boundary Road — 1,204 vehicles per hour
- Wheelers Lane south of Boundary Road — 992 vehicles per hour
- Boundary Road west of Wheelers Lane — 896 vehicles per hour

It should be noted that the estimated Year 2026 peak hour traffic volumes based on the July 2012 Traffic Report do not take into account the redistribution of traffic patterns following the extension of Boundary Road through to Sheraton Road.

However, the estimated peak hour traffic volumes provides a basis for the further assessment of the potential impacts of traffic generated by the proposed extension to Southlakes Estate.

The traffic data provided by Council assesses the peak hour traffic volume on the extension of Boundary Road through to Sheraton Road. For the Year 2026, the estimated peak hour traffic volume between Wheelers Lane and Alexandrina Avenue is approximately 511 vehicles per hour.

The Barnson Traffic Report prepared for the proposed South Keswick Quarry determined peak hour traffic volumes on Sheraton Road (south and north of the Mitchell Highway) and on the Mitchell Highway for existing conditions and for future developments in the area such as the Quarry and the connection of Boundary Road through to Sheraton Road.

The Barnson Report determine the following peak hour traffic volumes as applicable to the Year 2026:

- Sheraton Road south of the Mitchell Highway — 1,024 vehicles per hour
- Boundary Road west of Sheraton Road — 268 vehicles per hour

The traffic volume in Boundary Road west of Sheraton Road is approximately 50% of the traffic volume estimated by Council, therefore the higher traffic volume of 511 vehicles per hour will be adopted for the assessment of the extension of Boundary Road through to Sheraton Road.

Traffic Impact of the Proposed Development

5.1 PROPOSED SUBDIVISION

The site for the overall extension of the Southlakes Estate subdivision comprises Lot 12 in DP1207280, Lot 399 in DP1199356 and Lot 2 in DP880413. Lot 12 has an area of approximately 2.27ha, Lot 399 has an area of approximately 128.5ha and Lot 2 has an area of approximately 48.95ha for a total development area of approximately 179.72ha.

It is intended that approximately 2,080 dwelling sites be created in the overall subdivision comprising residential allotments and medium density allotments.

In general, the dwelling sites will comprise the following allocations:

Residential allotments	1,314 lots
Medium density dwelling units	766 units
Total dwelling sites	2,080 dwellings

The concept Master Plan for the proposed overall extension to Southlakes Estate is indicated on **Drawing TS02** located in the **Drawings** Section of this Report.

5.2 TRAFFIC GENERATION

The Roads and Traffic Authority's *Guide to Traffic Generating Developments* publishes data on the traffic generating potential of various developments ranging from residential subdivisions, commercial premises, retail premises and industrial developments.

For residential subdivisions, the *Guide to Traffic Generating Developments* indicates that the following range of traffic generation for daily vehicle trips and weekday peak hour vehicle trips as indicated below:

- Dwelling Houses
  Daily vehicle trips = 9 per dwelling
  Weekday peak hour vehicle trips = 0.85 per dwelling
- Medium Density Residential Dwellings
  Smaller units and flats (up to 2 bedrooms)
  Daily vehicle trips = 4 to 5 per dwelling

  Larger units and townhouses (3 or more bedrooms)
  Daily vehicle trips = 5 to 6.5 per dwelling
  Weekday peak hour vehicle trips = 0.5 to 0.65 per dwelling

Dubbo Regional Council has had discrete traffic assessment carried out on selected streets within the City by TEC Pty Ltd that indicates the traffic generation rates attributable to dwelling houses in Dubbo are higher than the generation rates determined by the RTA.

The applicable traffic generation rates to be used in this Traffic Study are summarised below:

- Dwelling Houses
  Daily vehicle trips = 11 per dwelling
  Weekday peak hour vehicle trips = 1.0 per dwelling

- Medium Density Residential Dwellings
  Daily vehicle trips = 6 per dwelling
  Weekday peak hour vehicle trips = 0.5 per dwelling

Based on the adopted traffic generation rates and the proposed dwelling sites throughout the subdivision, the daily and peak hour traffic generation for the overall extension of Southlakes Estate is set out in the following Section of this Report.

5.2.1 DAILY TRAFFIC GENERATION

The daily traffic generated by the overall extension of Southlakes Estate can be estimated as set out below:

Number of residential dwellings:	1,314 dwellings
Daily vehicle trips:	11 per dwelling
Number of residential daily trips:	14,454 trips per day
Number of medium density dwellings:	766 dwellings
Daily vehicle trips:	6 per dwelling
Number of medium density daily trips:	4,596 trips per day
Total daily vehicle trips:	14,454 trips + 4,596 trips = 19,050 trips per day

Not all trips generated by the proposed extension to Southlakes Estate will be external to the subdivision. A proportion of the generated trips will be for internal travel purposes such as visiting friends or neighbours, recreation areas or a potential commercial precinct.

The RTA estimate that approximately 25% of daily and peak hour vehicle trips are internal to the subdivision (RTA, 1993) and therefore the adjusted external daily vehicle trips generated by the subdivision is:

External daily vehicle trips: 19,050 trips x 0.75 = 14,288 trips per day.

The external trip generation of 14,288 trips per day will be used to assess the potential impacts of the development of the subdivision on the surrounding road network.

5.2.2 PEAK HOUR TRAFFIC GENERATION

The peak hour traffic generated by the overall extension of Southlakes Estate can be estimated as set out below:

Number of residential dwellings:	1,314 dwellings
Peak hour vehicle trips:	1 per dwelling
Number of residential peak hour trips:	1,314 trips per hour
Number of medium density dwellings:	766 dwellings
Peak hour vehicle trips:	0.5 per dwelling
Number of medium density peak hour trips:	383 trips per day
Total peak hour vehicle trips:	1,314 trips + 383 trips = 1,697 trips per hour

As with the daily trip generation, the RTA estimate that 25% of the peak hour trip generation are internal to the subdivision. Therefore, the adjusted external peak hour trips generated by the subdivision is:

External peak hour trips: 1,697 trips x 0.75 = 1,272 trips per hour.

The external trip generation of 1,272 trips per hour will be used to assess the potential impacts of the development of the subdivision on the surrounding road network.

5.3 TRAFFIC DISTRIBUTION

Traffic generated by the development of the overall extension to Southlakes Estate will access the subdivision via the following external road connections:

- Wheelers Lane and Azure Avenue
- Wheelers Lane and Argyle Avenue
- The future extension of Boundary Road and Alexandrina Avenue
- The future extension Boundary Road and the main north south internal road linking Argyle Avenue and Azure Avenue
- The future extension of Boundary Road and the intersection with Sheraton Road and the north south internal road linking Azure Avenue through to the new Boundary Road and Sheraton Road intersection.
- Argyle Avenue and a new road connection to the future extension of Hennessy Drive

The travel paths taken by the future residents of the overall subdivision to access the external road network are subjective and will be dependent on trip destination and purpose.

Major attractors for the residential traffic generated by the subdivision are the CBD area of Dubbo for work and shopping purposes, Orana Mall for shopping purposes and once the extension of Boundary Road is completed, the school precinct in Sheraton Road and Bunnings will be a major attractor.

A subjective assessment of the traffic distribution external to the subdivision via the various connections to the external road network is set out below in estimated percentage terms of the total traffic generation from the subdivision, noting that the assumption is made that all extensions to the surrounding road network have been completed:

- Wheelers Lane and Azure Avenue 25%
- Wheelers Lane and Argyle Avenue 20%
- Boundary Road and Alexandrina Avenue 10%
- Boundary Road and north south road 15%
- Boundary Road and Sheraton Road 20%
- Argyle Avenue through to Hennessy Drive 10%

Based on the estimated percentages, the daily traffic and peak hour traffic volumes distributed to the surrounding road network is set out in **Table 5.1**.

Table 5.1 – Traffic Volume Distribution to the External Road Network

Road	Percentage Distribution	Daily Traffic Volume (trips per day)	Peak Hour Traffic Volume (trips per hour)
Wheelers Lane and Azure Avenue	25%	3,572	318
Wheelers Lane and Argyle Avenue	20%	2,858	255
Boundary Road and Alexandrina Avenue	10%	1,429	127
Boundary Road and north south road	15%	2,142	190
Boundary Road and Sheraton Road	20%	2,858	255
Argyle Avenue to Hennessy Drive	10%	1,429	127
Totals	**100%**	**14,288**	**1,272**

The distribution of the traffic volumes onto the external road network is indicated on **Drawing TS03** located in the **Drawings** Section of this Report.

5.4 IMPACT OF GENERATED TRAFFIC

The impact of the additional traffic generated by the overall extension of Southlakes Estate on the surrounding road network will be assessed in terms of:

i) Traffic Volume for both the Daily and Peak Hour traffic generation;

ii) Intersection Operation; and

iii) Road Safety.

SIDRA modelling will be undertaken to assess the operation of various intersections on the surrounding road network.

5.4.1 PROPOSED ROAD UPGRADES

Discussions have been held with staff of Dubbo Regional Council regarding the proposed road upgrades that are to be carried out on the surrounding road network.

The proposed road upgrades will include:

- Construction of a roundabout at the intersection of Wheelers Lane and Boundary Road.
- Extension of Boundary Road through to Sheraton Road.
- Construction of a roundabout at the intersection of Boundary Road and Alexandrina Avenue.
- Construction of a Tee intersection at the intersection of Boundary Road and the main north south access road from the Southlakes subdivision.
- Construction of a roundabout at the four way intersection of Boundary Road, Sheraton Road the access road from the Southlakes subdivision.

The general details of the proposed road upgrades are summarised below.

1. The roundabout to be constructed at the intersection of Wheelers Lane and Boundary Road is a large diameter roundabout with 2 circulating lanes within the roundabout. Each approach leg to the roundabout will comprise 2 lanes whilst the departure legs to Boundary Road will comprise a single lane. The departure legs to Wheelers Lane will comprise 2 lanes.

Concrete splitter islands will be provided on each leg to separate the approach and departure lanes of the roundabout.

2. The upgrade of Boundary Road between Wheelers Lane and Alexandrina Avenue will comprise a single lane in each direction, will include an on road cycle lane and a concrete separation median between the travel lanes. In general, no access will be available to land fronting this section of Boundary Road following the upgrade.

   From the intersection of Alexandrina Avenue through to Sheraton Road, Boundary Road will be upgraded to a rural road standard with a single lane in each direction and tabledrains outside the carriageway of the road.

3. The roundabout to be constructed at the intersection of Boundary Road and Alexandrina Avenue is a large diameter roundabout with 1 circulating lane within the roundabout. The approach leg to the roundabout from the western end of Boundary Road will comprise 2 lanes whilst all other approach and departure legs to the roundabout will comprise a single lane.

   Concrete splitter islands will be provided on each leg to separate the approach and departure lanes of the roundabout.

4. The intersection of Boundary Road and the main subdivision north south access road will comprise a standard Tee configuration controlled by Give Way signs with Boundary Road traffic having priority.

5. The roundabout to be constructed at the intersection of Boundary Road, Sheraton Road the access road from the subdivision will be a large diameter roundabout with 1 circulating lane within the roundabout. The approach and departure legs to the roundabout will comprise a single lane.

   Concrete splitter islands will be provided on each leg to separate the approach and departure lanes of the roundabout.

5.4.2 TRAFFIC VOLUME

Based on the Average Daily Traffic and Peak Hour traffic volumes on Wheelers Lane and Boundary Road as outlined in **Section 4.5** and **Section 4.6**, the impacts of the traffic generated by the extension of Southlakes Estate has been assessed.

A comparison of the existing daily and peak hour traffic volumes on the subject roads and the post development traffic volumes is indicated in **Table 5.2**.

Table 5.2 – Comparison of Existing and Post Development Traffic Volumes

Road	Estimated Year 2026 Traffic Volume	Post Development Traffic Volume	Percentage Increase
Wheelers Lane north of Boundary Road – Daily Traffic Volume	9,678 trips per day	14,822 trips per day	53%
Wheelers Lane north of Boundary Road – Peak Hour Traffic Volume	1,204 trips per hour	1,662 trips per hour	38%
Wheelers Lane south of Boundary Road – Daily Traffic Volume	9,108 trips per day	15,538 trips per day	71%
Wheelers Lane south of Boundary Road – Peak Hour Traffic Volume	992 trips per hour	1,565 trips per hour	58%

Table 5.2 – Comparison of Existing and Post Development Traffic Volumes

Road	Estimated Year 2026 Traffic Volume	Post Development Traffic Volume	Percentage Increase
Boundary Road west of Wheelers Lane – Daily Traffic Volume	6,555 trips per day	8,697 trips per day	33%
Boundary Road west of Wheelers Lane – Peak Hour Traffic Volume	896 trips per hour	1,086 trips per hour	21%
Boundary Road east of Wheelers Lane – Daily Traffic Volume	NA	3,571 trips per day	NA
Boundary Road east of Wheelers Lane – Peak Hour Traffic Volume	510 trips per hour	827 trips per hour	62%
Sheraton Road at future intersection with Boundary Road – Daily Traffic Volume	NA	2,858 trips per day	NA
Sheraton Road at future intersection with Boundary Road – Peak Hour Traffic Volume	510 trips per hour	765 trips per hour	50%
Sheraton Road south of the Mitchell Highway – Peak Hour Traffic Volume	1,024 vehicles per hour	1,279 vehicles per hour	25%
Hennessy Drive – Daily Traffic Volume	NA	1,429 trips per day	NA
Hennessy Drive – Peak Hour Traffic Volume	NA	127 trips per hour	NA

The increase in daily traffic volumes on Wheelers Lane north and Wheelers Lane south is 53% and 71% respectively.

The increase in peak hour traffic volumes on Wheelers Lane north and Wheelers Lane south is 38% and 58% respectively.

The increase in daily traffic volumes on Boundary Road west is 33%.

The increase in peak hour traffic volumes on Boundary Road west is 21%.

The increase in peak hour traffic volumes on Sheraton Road south of the Mitchell Highway is 25%.

A comparison will be made with the post development peak hour traffic volumes on each road with the actual traffic volume capacity of the road in its current configuration.

Based on the roadway capacities determined in **Section 4.3** of this Traffic Study, a comparison of the post development peak hour traffic volume and the actual road capacity is indicated in **Table 5.3**. The operational capacity is the percentage of actual volume capacity that the road is functioning at.

Table 5.3 – Post Development Peak Hour Capacity

Road	Post Development Peak Hour Capacity Year 2026	Road Capacity at a Level of Service B (Refer to Section 3.3)	Operational Capacity
Wheelers Lane north	1,662 vehicles per hour	3,600 vehicles per hour	46%
Wheelers Lane south	1,565 vehicles per hour	1,800 vehicles per hour	87%
Boundary Road west	1,086 vehicles per hour	1,200 vehicles per hour	91%
Sheraton Road	1,279 vehicles per hour	3,600 vehicles per hour	35%

The operational capacity of Wheelers Lane north following the development of the extension of Southlakes Estate is 46%, for Wheelers Lane south the operational capacity is 87%, for Boundary Road west is 91% and for Sheraton Road is 35%.

All roads are operating below the operational capacity at a Level of Service B and the impact of the additional traffic generated by the overall extension of Southlakes Estate in the Year 2026 is not significant in terms of the volume of post development traffic using Wheelers Lane and Boundary Road, noting that the existing estimated traffic volumes on the subject roads do not take into account redistribution of traffic patterns once the connection of Boundary Road through to Sheraton Road is constructed.

5.4.3 INTERSECTION ASSESSMENT

The operation of the following intersections will be assessed using the SIDRA computer modelling program:

- Wheelers Lane and Argyle Avenue
- Wheelers Lane and Azure Avenue
- Boundary Road and the north south access road
- Boundary Road and Sheraton Road with the north south road connecting to Azure Avenue.

It is proposed that the intersection of Boundary Road, Sheraton Road and the north south road connecting to Azure Avenue is to be constructed as a four way roundabout.

The operation of the intersections of Wheelers Lane and Boundary Road and Boundary Road and Alexandrina Avenue will not be assessed for this Traffic Study as Council has had extensive modelling of the operation of these intersections carried out in developing the detailed design of the roundabouts to be constructed at these intersections.

5.4.3.1 Wheelers Lane and Argyle Avenue

The operation of the intersection of Wheelers Lane and Argyle Avenue will be assessed for the nominal peak hour using the SIDRA modelling program.

The intersection turning movements for the peak hour traffic generated from the overall extension of Southlakes Estate are indicated on **Drawing TS04** in the **Drawings** Section of this Report.

A summary of the SIDRA modelling for the operation of the intersection on Wheelers Lane is indicated in **Table 5.4**.

The SIDRA modelling results for the assessment of this intersection are included in **Appendix A.**

Table 5.4 – Wheelers Lane and Argyle Avenue Intersection Operating Parameters

Scenario	Vehicles on Movement	Average Delay (seconds)	95% Queue Length (metres)	Overall Level of Service (LOS)
Nominal Peak Hour				
Argyle Avenue Westbound				
Left Turn into Wheelers Lane	33 vehicles per hour	5.3	5.0	LOS A
Right Turn into Wheelers Lane	135 vehicles per hour	6.4	5.0	LOS A
Wheelers Lane Northbound				
Right Turn into Argyle Avenue	33 vehicles per hour	6.3	2.0	LOS A
Straight Through Northbound	100 vehicles per hour	0.3	2.0	LOS A
Wheelers Lane Southbound				
Left Turn into Argyle Avenue	135 vehicles per hour	5.6	0.0	LOS A
Straight Through Southbound	100 vehicles per hour	0.3	0.0	LOS A

All movements at the intersection operate at a Level of Service A and thus the intersection will operate satisfactorily for the development of the overall extension to Southlakes Estate.

5.4.3.2 Wheelers Lane and Azure Avenue

The operation of the intersection of Wheelers Lane and Azure Avenue will be assessed for the nominal peak hour using the SIDRA modelling program.

The intersection turning movements for the peak hour traffic generated from the overall extension of Southlakes Estate are indicated on **Drawing TS05** in the **Drawings** Section of this Report.

A summary of the SIDRA modelling for the operation of the intersection on Wheelers Lane is indicated in **Table 5.5**. The SIDRA modelling results for the assessment of this intersection are included in **Appendix A.**

Table 5.5 – Wheelers Lane and Azure Avenue Intersection Operating Parameters

Scenario	Vehicles on Movement	Average Delay (seconds)	95% Queue Length (metres)	Overall Level of Service (LOS)
Nominal Peak Hour				
Azure Avenue Westbound				
Left Turn into Wheelers Lane	44 vehicles per hour	6.7	13.0	LOS A
Right Turn into Wheelers Lane	215 vehicles per hour	9.2	13.0	LOS A
Wheelers Lane Northbound				
Right Turn into Azure Avenue	44 vehicles per hour	7.1	3.0	LOS A
Straight Through Northbound	180 vehicles per hour	0.5	3.0	LOS A

Table 5.5 – Wheelers Lane and Azure Avenue Intersection Operating Parameters

Scenario	Vehicles on Movement	Average Delay (seconds)	95% Queue Length (metres)	Overall Level of Service (LOS)
Wheelers Lane Southbound				
Left Turn into Azure Avenue	215 vehicles per hour	5.6	0.0	LOS A
Straight Through Southbound	180 vehicles per hour	0.0	0.0	LOS A

All movements at the intersection operate at a Level of Service A and thus the intersection will operate satisfactorily for the development of the overall extension to Southlakes Estate.

5.4.3.3 Boundary Road and the North South Access Road

The operation of the intersection of Boundary Road and the north south access road will be assessed for the nominal peak hour using the SIDRA modelling program.

The intersection turning movements for the peak hour traffic generated from the overall extension of Southlakes Estate are indicated on **Drawing TS06** in the **Drawings** Section of this Report.

A summary of the SIDRA modelling for the operation of the intersection on Wheelers Lane is indicated in **Table 5.6**.

The SIDRA modelling results for the assessment of this intersection are included in **Appendix A.**

Table 5.6 – Boundary Road and Access Road Intersection Operating Parameters

Scenario	Vehicles on Movement	Average Delay (seconds)	95% Queue Length (metres)	Overall Level of Service (LOS)
Nominal Peak Hour				
Access Road Northbound				
Left Turn into Boundary Road	48 vehicles per hour	5.8	3.0	LOS A
Right Turn into Boundary Road	48 vehicles per hour	8.6	3.0	LOS A
Boundary Road Eastbound				
Right Turn into Access Road	48 vehicles per hour	6.7	3.0	LOS A
Straight Through Eastbound	255 vehicles per hour	0.3	3.0	LOS A
Boundary Road Westbound				
Left Turn into Access Road	48 vehicles per hour	5.6	0.0	LOS A
Straight Through Westbound	255 vehicles per hour	0.0	0.0	LOS A

All movements at the intersection operate at a Level of Service A and thus the intersection will operate satisfactorily for the development of the overall extension to Southlakes Estate.

5.4.3.4 Boundary Road and Sheraton Road Roundabout

The operation of the intersection of Boundary Road, Sheraton Road and the north south subdivision access road will be assessed as a roundabout for the nominal peak hour using the SIDRA modelling program.

The intersection turning movements for the peak hour traffic generated from the overall extension of Southlakes Estate are indicated on **Drawing TS07** in the **Drawings** Section of this Report.

A summary of the SIDRA modelling for the operation of the intersection on Wheelers Lane is indicated in **Table 5.7**.

The SIDRA modelling results for the assessment of this intersection are included in **Appendix A.**

Table 5.7 – Boundary Road, Sheraton Road and Access Road Roundabout Operating Parameters

Scenario	Vehicles on Movement	Average Delay (seconds)	95% Queue Length (metres)	Overall Level of Service (LOS)
Nominal Peak Hour				
Access Road Northbound				
Left Turn into Boundary Road	1 vehicles per hour	6.3	5.0	LOS A
Right Turn into Sheraton Road	1 vehicles per hour	10.2	5.0	LOS A
Straight Through Northbound	128 vehicles per hour	6.6	5.0	LOS A
Boundary Road Eastbound				
Right Turn into Access Road	1 vehicles per hour	9.1	13.0	LOS A
Straight Through Eastbound	7 vehicles per hour	6.9	13.0	LOS A
Left Turn into Sheraton Road	335 vehicles per hour	5.2	13.0	LOS A
Sheraton Road Westbound				
Left Turn into Access Road	1 vehicles per hour	6.7	2.0	LOS A
Straight Through Westbound	7 vehicles per hour	9.3	2.0	LOS A
Right Turn into Sheraton Road	15 vehicles per hour	12.8	2.0	LOS A
Sheraton Road Southbound				
Right Turn into Boundary Road	335 vehicles per hour	8.3	14.0	LOS A
Straight Through Southbound	128 vehicles per hour	4.7	14.0	LOS A
Left Turn into Sheraton Road	15 vehicles per hour	5.1	14.0	LOS A

All movements at the roundabout operate at a Level of Service A and thus the intersection will operate satisfactorily for the development of the overall extension to Southlakes Estate.

5.4.4 LOCAL AREA TRAFFIC MANAGEMENT

The proposed subdivision for the overall extension of Southlakes Estate will extend the design concepts included in the development of the subdivision to date. The design of the subdivision has incorporated various influencing factors relating to topography, drainage and connection to the existing road network.

The need to provide safe and efficient traffic movement within the subdivision coupled with the amenity of the residential areas is of importance in developing the subdivision layout.

The Traffic Authority of NSW (1985) states that the main traffic related principles to be observed in the design of a residential subdivision are:

- To provide a safe environment for pedestrians, cyclists and motorists;
- To ensure convenient vehicular access to properties for residents, visitors, service and emergency vehicles;
- To reduce traffic conflicts, both vehicular and pedestrian;
- To give priority to through traffic on major roads, segregated where possible from pedestrian activity;
- To ensure that the road layout will accommodate public transport; and
- To provide a suitable residential environment. This includes limitation of noise generated by traffic and the provision of landscaping that does not compromise safety nor impede traffic movement.

The lot layout and road pattern developed for the extension of Southlakes Estate provides many residential areas that form quiet neighbourhood precincts consisting of cul-de-sacs running off roadways linking the main thoroughfares through the site.

Intersections have been predominantly designed as T-junctions and will be subject to the usual Give Way priority for the through traffic. A large roundabout will be provided at the 4-way intersection created at the eastern end of Azure Avenue. Similarly, a large roundabout will be provided at the 4-way intersection created at the eastern end of Argyle Avenue. Two smaller roundabouts are to be provided at four way intersections in the southern section of the subdivision.

The major thoroughfares through the subdivision will include central medians to provide separation of the travel lanes and to control the turning movements of vehicles into and out of the side street network.

Good sight distance is provided at all intersections and the design geometry of the roads will ensure that both the vertical and horizontal alignment provides for the safety of both vehicular traffic and pedestrians.

A series of paved footpaths will be provided throughout the subdivision to provide pedestrian refuges at the crossing points of the roads and to provide linkages to the cycleway network along the creekline within the subdivision.

The Local Area Management Plans for both Traffic and Pedestrians are indicated on **Drawing TS08** and **Drawing TS09** located in the **Drawings** Section of this Report.

5.4.5 TRAFFIC IMPACT SUMMARY

The impact of the additional traffic generated by the overall extension of Southlakes Estate on the surrounding road network has been assessed in terms of:

i) Traffic Volume for both the Daily and Peak Hour traffic generation;

ii) Intersection Operation; and

iii) Road Safety.

SIDRA modelling has been undertaken to assess the operation of various intersections on the surrounding road network.

5.4.5.1 Traffic Generation and Roadway Capacity

The estimated external daily traffic generation from the overall extension to Southlakes Estate is 14,288 trips per day and the external peak hour traffic generation is 1,272 trips per hour.

The increase in daily traffic volumes on Wheelers Lane north and Wheelers Lane south is 53% and 71% respectively.

The increase in peak hour traffic volumes on Wheelers Lane north and Wheelers Lane south is 38% and 58% respectively.

The increase in daily traffic volumes on Boundary Road west is 33%.

The increase in peak hour traffic volumes on Boundary Road west is 21%.

The increase in peak hour traffic volumes on Sheraton Road south of the Mitchell Highway is 25%.

The operational capacity of Wheelers Lane north following the development of the overall extension of Southlakes Estate is 46%, for Wheelers Lane south the operational capacity is 87%, for Boundary Road west is 91% and for Sheraton Road is 35%.

All roads are operating below the operational capacity at a Level of Service B and the impact of the additional traffic generated by the overall extension of Southlakes Estate in the Year 2026 is not significant in terms of the volume of post development traffic using Wheelers Lane and Boundary Road, noting that the existing estimated traffic volumes on the subject roads do not take into account redistribution of traffic patterns once the connection of Boundary Road through to Sheraton Road is constructed.

5.4.5.2 Intersection Modelling

The operation of the following intersections have been assessed using the SIDRA computer modelling program:

- Wheelers Lane and Argyle Avenue
- Wheelers Lane and Azure Avenue
- Boundary Road the north south access road
- Boundary Road and Sheraton Road with the north south road connecting to Azure Avenue

The SIDRA modelling determined that all movements at each intersection were operating at a Level of Service A.

Recommendations

The impact of the additional traffic generated by the overall extension of Southlakes Estate on the surrounding road network has been assessed in terms of:

i) Traffic Volume for both the Daily and Peak Hour traffic generation;

ii) Intersection Operation; and

iii) Road Safety.

SIDRA modelling has been undertaken to assess the operation of various intersections on the surrounding road network.

The estimated external daily traffic generation from the overall extension to Southlakes Estate is 14,288 trips per day and the external peak hour traffic generation is 1,272 trips per hour.

The increase in daily traffic volumes on Wheelers Lane north and Wheelers Lane south is 53% and 71% respectively.

The increase in peak hour traffic volumes on Wheelers Lane north and Wheelers Lane south is 38% and 58% respectively.

The increase in daily traffic volumes on Boundary Road west is 33%.

The increase in peak hour traffic volumes on Boundary Road west is 21%.

The increase in peak hour traffic volumes on Sheraton Road south of the Mitchell Highway is 25%.

In completing the assessment of the impact of the additional traffic generated by the extension of Southlakes Estate, the following recommendations are made:

- The increase in traffic volumes on the roads surrounding Southlakes Estate will not change the classifications of the roads under a functional road hierarchy.
- The post development peak hour traffic on Wheelers Lane north is 46% of the operational capacity of the road at a Level of Service B
- The post development peak hour traffic on Wheelers Lane south is 87% of the operational capacity of the road at a Level of Service B.
- The post development peak hour traffic volume on Boundary Road west is 91% of the operation capacity of the road at a Level of Service B.
- The post development peak hour traffic on Sheraton Road south of the Mitchell Highway is 35% of the operational capacity of the road at a Level of Service B.
- The intersection of Wheelers Lane and the Boundary Road is to be developed as a major roundabout in accordance with the construction plans prepared by Council.
- The intersection of Boundary Road and Alexandrina Avenue is to be developed as a roundabout in accordance with the construction plans prepared by Council.
- The intersection of Boundary Road and Sheraton Road is to be developed as a roundabout.
- The intersections modelled using SIDRA all operate at a Level of Service A.
- Local Area Traffic Management facilities for vehicles and pedestrians are to be installed as outlined in **Section 5.4.4** of this Traffic Study.
- The design and construction of all recommended facilities are to be carried out in accordance with the appropriate standards, codes and requirements of Dubbo Regional Council.

The implementation of the recommendations of this Traffic Study during the approval and development of the overall extension of Southlakes Estate will see the operation of the development with the integration of the generated traffic into the existing and planned surrounding road network.

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Proposed South Keswick Quarry – Traffic Impact Assessment October 2016. Barnson.

Drawings

REV.	DATE	DFTD.	APPD.	DETAILS
A	03/06/16	EG	SJH	ISSUED FOR REPORT
B	02/09/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
C	25/10/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
D	29/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

MASTER SCALE

SCALE 1:7500 (A1)

0 100 200 300 400 500 600 700

0 100 200 300 400 500 600 700

SCALE 1:15000 (A3)

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APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL

CLIENT
MAAS GROUP PROPERTIES No. 2 PTY LTD

PROJECT
SOUTHLAKES ESTATE EXTENSION
PROPOSED RESIDENTIAL SUBDIVISION

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DRAWING
SITE LOCALITY

PROJECT NUMBER 114135 | DRAWING FILE 114135_15D_TS01-TS09.dwg | SIZE A1

SURVEY MARK - | R.L. - | DATUM A.H.D. | SET 15D

IMAGE SOURCE GOOGLE EARTH

STATUS ISSUED FOR REPORT | SHEET TS01 OF TS09

NOTES
INFORMATION SHOWN IS FOR DEVELOPMENT APPLICATION PURPOSES ONLY.

REV.	DATE	DFTD.	APPD.	DETAILS
A	03/06/16	EG	SJH	ISSUED FOR REPORT
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D	29/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

MASTER SCALE
SCALE 1:3000 (A1)
0 50 100 150 200 250 300
0 50 100 150 200 250 300
SCALE 1:6000 (A3)
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DUBBO REGIONAL COUNCIL

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DRAWING
CONCEPT MASTER PLAN

PROJECT NUMBER 114135	DRAWING FILE 114135_15D_TS01-TS09.dwg	SIZE A1
SURVEY MARK -	R.L. - DATUM A.H.D.	SET 15D
IMAGE SOURCE		
STATUS ISSUED FOR REPORT	SHEET TS02 OF TS09	

NOTE
1. INFORMATION SHOWN IS FOR DEVELOPMENT APPLICATION PURPOSES ONLY. LOT LAYOUT IS SUBJECT TO CHANGE.

REV.	DATE	DFTD.	APPD.	DETAILS
A	03/06/16	EG	SJH	ISSUED FOR REPORT
B	02/09/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
C	25/10/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
D	29/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

MASTER SCALE
SCALE 1:3000 (A1)
0 50 100 150 200 250 300
SCALE 1:6000 (A3)
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MAAS GROUP PROPERTIES No. 2 PTY LTD
PROJECT
SOUTHLAKES ESTATE EXTENSION
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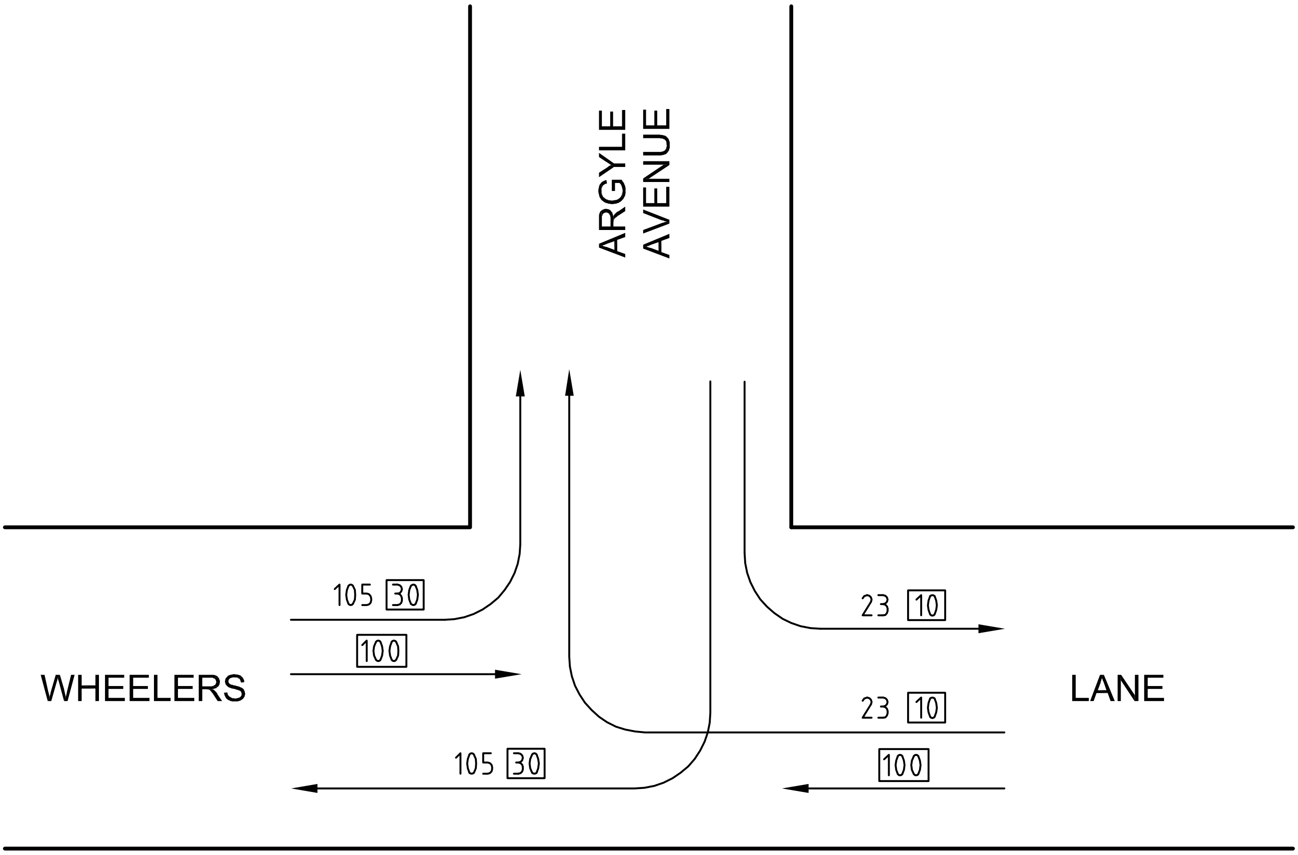
DRAWING
EXTERNAL TRAFFIC DISTRIBUTION

PROJECT NUMBER 114135 | DRAWING FILE 114135_15D_TS01-TS09.dwg | SIZE A1
SURVEY MARK - | R.L. - | DATUM A.H.D. | SET
IMAGE SOURCE
15D
STATUS ISSUED FOR REPORT | SHEET TS03 OF TS09



NOMINAL PEAK HOUR TURNING MOVEMENTS

20 ~ DENOTES NOMINAL PEAK HOUR TURNING MOVEMENTS

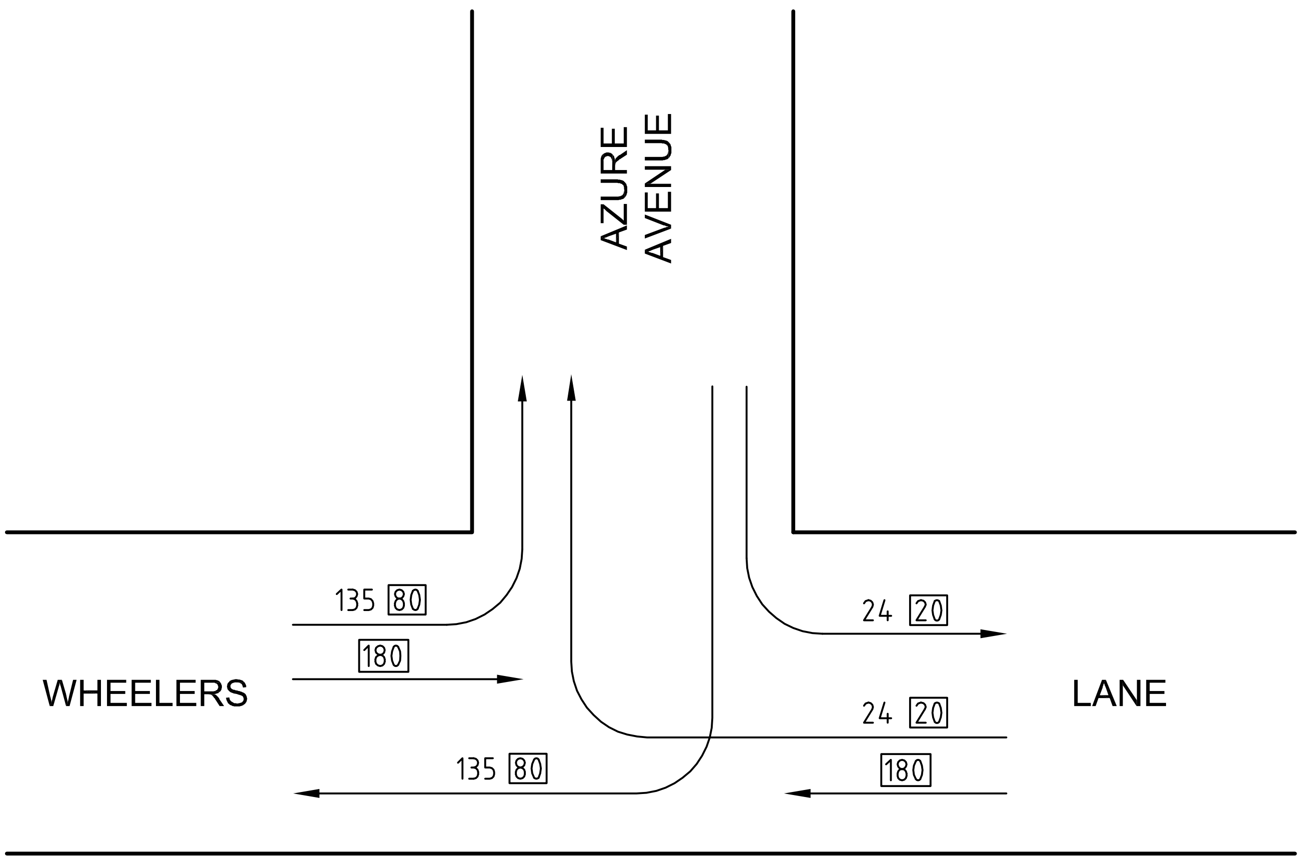
10 ~ NUMBERS IN BOXES DENOTE EXISTING TURNING MOVEMENTS

GEOLYSE

DRAWING TS04

INTERSECTION TURNING MOVEMENTS
AT WHEELERS LANE AND ARGYLE
AVENUE INTERSECTION

DATE: 27/06/2017
REF: 114135_15D_TS01-TS09.dwg



NOMINAL PEAK HOUR TURNING MOVEMENTS

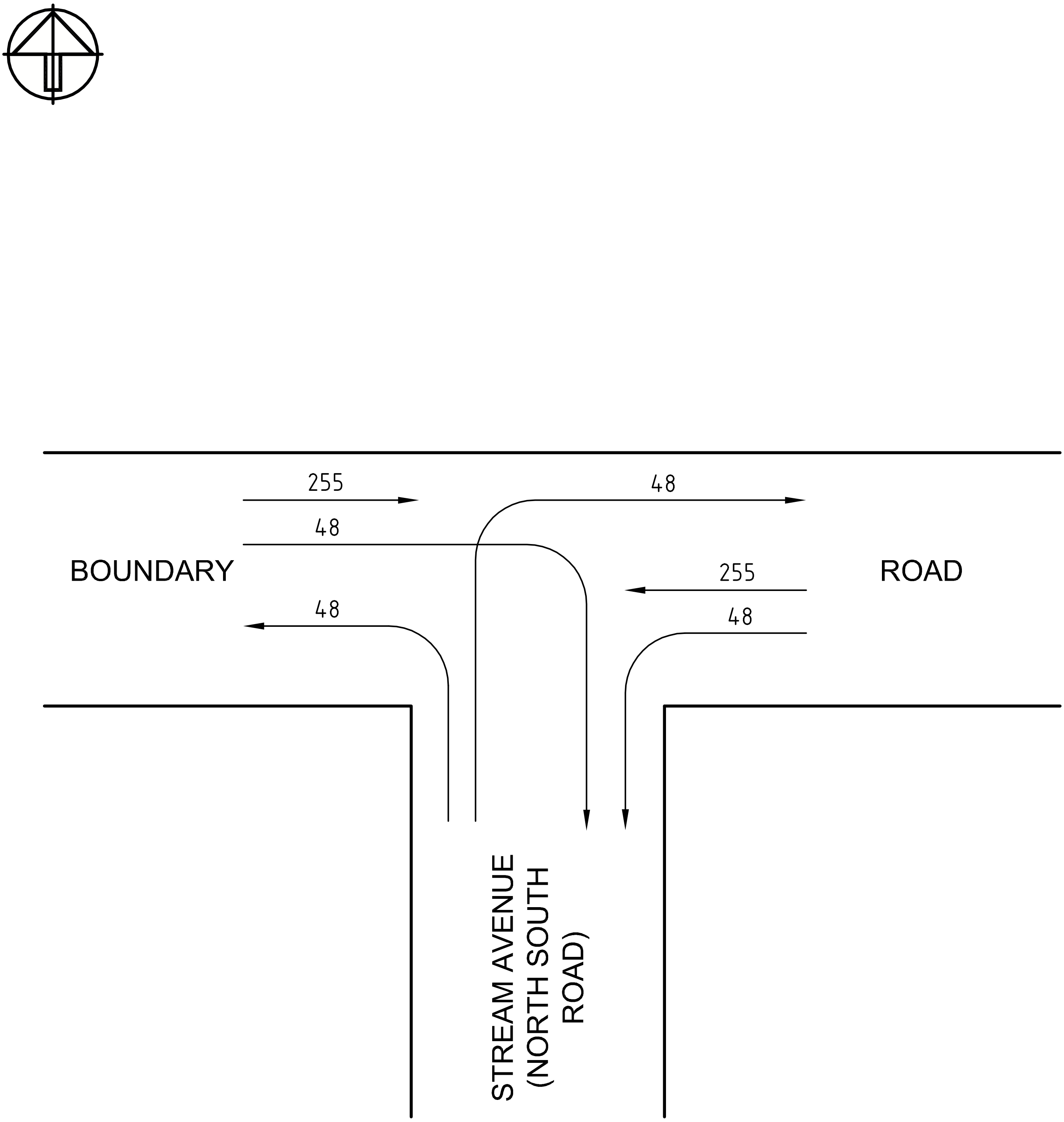
20 ~ DENOTES NOMINAL PEAK HOUR TURNING MOVEMENTS

10 ~ NUMBERS IN BOXES DENOTE EXISTING TURNING MOVEMENTS

GEOLYSE

DRAWING TS05
INTERSECTION TURNING MOVEMENTS
AT WHEELERS LANE AND AZURE
AVENUE INTERSECTION

DATE: 27/06/2017
REF: 114135_15D_TS01-TS09.dwg



NOMINAL PEAK HOUR TURNING MOVEMENTS

20 ~ DENOTES NOMINAL PEAK HOUR TURNING MOVEMENTS

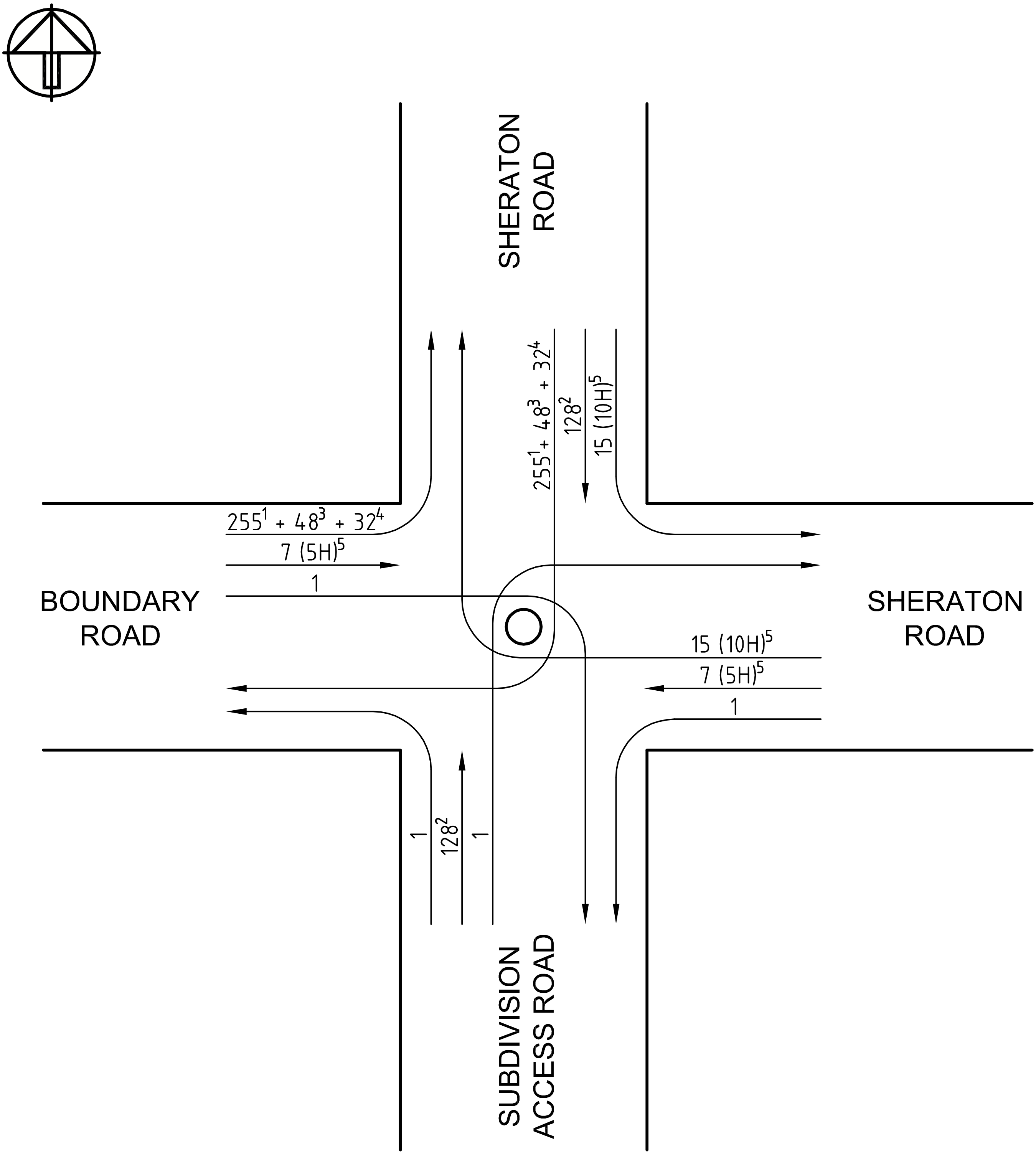
GEOLYSE

DRAWING TS06

INTERSECTION TURNING MOVEMENTS AT BOUNDARY ROAD AND STREAM AVENUE (NORTH SOUTH ROAD) INTERSECTION

DATE: 27/06/2017

REF: 114135_15D_TS01-TS09.dwg



INTERSECTION TURNING MOVEMENTS AT
BOUNDARY ROAD AND SHERATON ROAD

[1] ~ DENOTES DRC TRAFFIC VOLUME
[2] ~ DENOTES SOUTHLAKES TRAFFIC
[3] ~ DENOTES SOUTHLAKES TRAFFIC FROM STREAM AVENUE (NORTH SOUTH ROAD)
[4] ~ DENOTES SOUTHLAKES TRAFFIC FROM ALEXANDRINA AVENUE
[5] ~ DENOTES BARNSON TRAFFIC
20 ~ DENOTES NOMINAL PEAK HOUR TURNING MOVEMENTS
15 (10H) ~ DENOTES 10 HEAVY VEHICLES INCLUDED IN TOTAL

GEOLYSE

DRAWING TS07
INTERSECTION TURNING MOVEMENTS
AT BOUNDARY ROAD AND SHERATON
ROAD INTERSECTION

DATE: 27/06/2017
REF: 114135_15D_TS01-TS09.dwg

LEGEND

EXISTING/PROPOSED KERB/MEDIANS

NOTES
1. THIS PLAN IS FOR DEVELOPMENT APPLICATION PURPOSES ONLY.
2. FUTURE STAGE LOT & ROAD LAYOUT SHOWN IS INDICATIVE ONLY & SUBJECT TO FUTURE DEVELOPMENT APPLICATIONS.

REV.	DATE	DFTD.	APPD.	DETAILS
A	03/06/16	EG	SJH	ISSUED FOR REPORT
B	02/09/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
C	25/10/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
D	29/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

MASTER SCALE

SCALE 1:3000 (A1)

0 50 100 150 200 250 300

SCALE 1:6000 (A3)

DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL

CLIENT
MAAS GROUP PROPERTIES No. 2 PTY LTD

PROJECT
SOUTHLAKES ESTATE EXTENSION
PROPOSED RESIDENTIAL SUBDIVISION

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DRAWING
LOCAL AREA ROAD TRAFFIC MANAGEMENT PLAN

PROJECT NUMBER 114135	DRAWING FILE 114135_15D_TS01-TS09.dwg		SIZE A1
SURVEY MARK -	R.L. -	DATUM A.H.D.	SET
IMAGE SOURCE			15D
STATUS ISSUED FOR REPORT	SHEET TS08 OF TS09		

NOTES
1. THIS PLAN IS FOR DEVELOPMENT APPLICATION PURPOSES ONLY.
2. FUTURE STAGE LOT & ROAD LAYOUT SHOWN IS INDICATIVE ONLY & SUBJECT TO FUTURE DEVELOPMENT APPLICATIONS.

REV.	DATE	DFTD.	APPD.	DETAILS
A	03/06/16	EG	SJH	ISSUED FOR REPORT
B	02/09/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
C	25/10/16	EG	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT
D	29/06/17	MW	SJH	CLIENT AMENDMENTS & ISSUED FOR REPORT

	FILE	INITIALS	DATE
SURVEY	-	-	-
DESIGN	-	-	-
DRAINS/ HEC-RAS MODELLING	-	-	-
ENGINEERING/ SURVEYING APPROVAL		SJH	29/06/17

MASTER SCALE
SCALE 1:3000 (A1)
0 50 100 150 200 250 300
SCALE 1:6000 (A3)
DO NOT SCALE FROM THESE DRAWINGS. ALL MEASUREMENTS SHALL BE CONFIRMED ON SITE AND WITH GEOLYSE PTY. LTD. PRIOR TO CONSTRUCTION

APPROVAL AUTHORITY
DUBBO REGIONAL COUNCIL
CLIENT
MAAS GROUP PROPERTIES No. 2 PTY LTD
PROJECT
SOUTHLAKES ESTATE EXTENSION
PROPOSED RESIDENTIAL SUBDIVISION

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DRAWING
LOCAL AREA PEDESTRIAN TRAFFIC MANAGEMENT PLAN

PROJECT NUMBER 114135 | DRAWING FILE 114135_15D_TS01-TS09.dwg | SIZE A1
SURVEY MARK - | R.L. - | DATUM A.H.D. | SET
IMAGE SOURCE
STATUS ISSUED FOR REPORT | SHEET TS09 OF TS09 | 15D

Plates

Plate 1: Wheelers Lane southbound approaching the intersection with Boundary Road

Plate 2: Intersection of Wheelers Lane and Boundary Road

Plate 3: Intersection of Wheelers Lane and Boundary Road

Plate 4: Boundary Road westbound

Plate 5: Boundary Road eastbound

Plate 6: Left turn lane from Wheelers Lane into Boundary Road

Plate 7: Intersection of Wheelers Lane and Magnolia Boulevard

Plate 8: Intersection of Wheelers Lane and Southlakes Parade

Plate 9: Intersection of Wheelers Lane and Azure Avenue

Plate 10: Service road parallel to Wheelers Lane

Plate 11: Intersection of Wheelers Lane and Holmwood Drive

Plate 12: Wheelers Lane southbound at the approach to the intersection with Shindys Road

Plate 13: Intersection of Wheelers Lane and Argyle Avenue

Plate 14: Intersection of Wheelers Lane and Hennessy Drive

Plate 15: Hennessy Drive east of Wheelers Lane

Plate 16: Hennessy Drive east at intersection with Wheelers Lane

Plate 17: Hennessy Drive westbound

Plate 18: Roundabout at the intersection of Azure Avenue and Southlakes Parade

Plate 19: Bridge over the creek line on Azure Avenue

Plate 20: Typical road carriageway in Azure Avenue

Plate 21: Typical road carriageway in Argyle Avenue

Plate 22: Bridge over the creek line in Argyle Avenue

Plate 23: Sheraton Road at future intersection with Boundary Road

Plate 24: Sheraton Road northbound

Plate 25: Sheraton Road looking south over the Ringlands site.

Plate 26: Sheraton Road northbound approaching dual carriageway.

Plate 27: Sheraton Road dual carriageway northbound.

Plate 28: Sheraton Road dual carriageway southbound.

Plate 29: Sheraton Road northbound on approach to the Mitchell Highway roundabout.

Plate 30: Sheraton Road and Mitchell Highway roundabout.

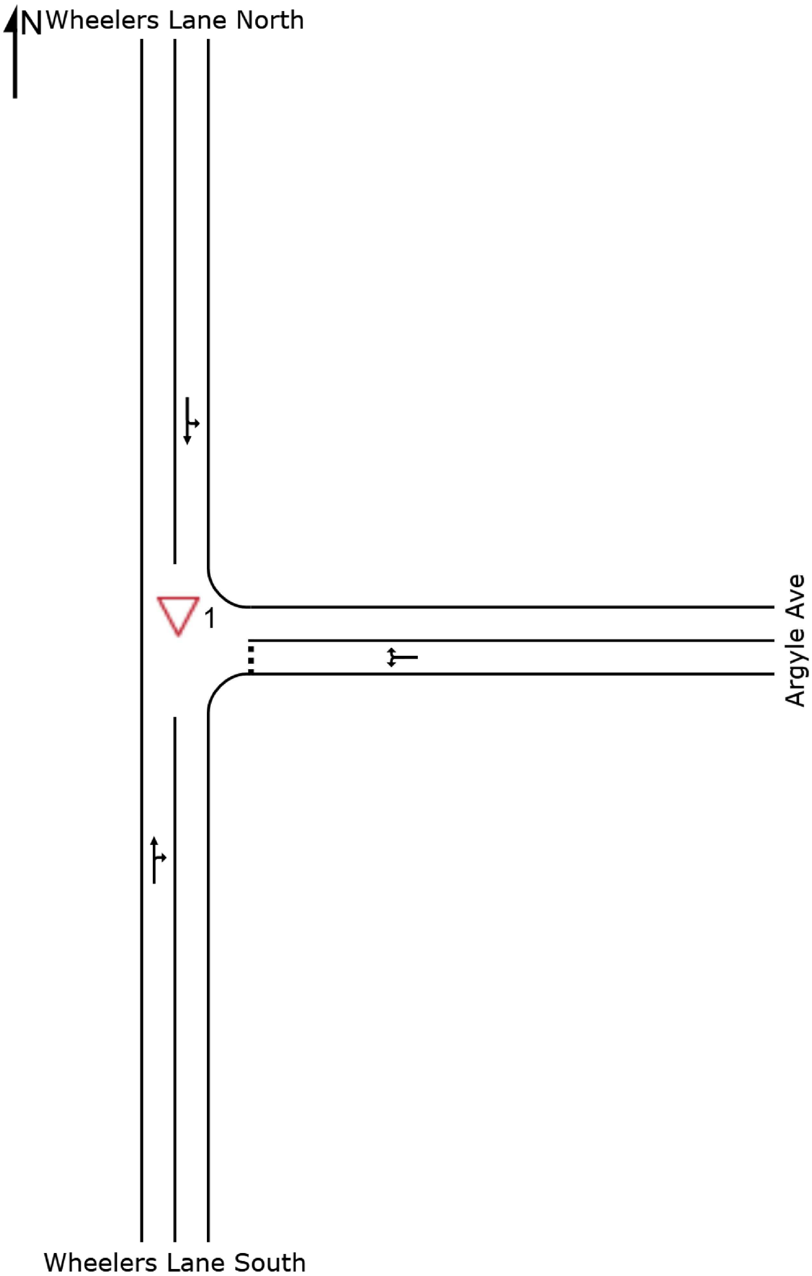
Appendix A

SIDRA Modelling Results

SITE LAYOUT

▽ Site: 1 [Post Development - 27 JUNE 2017]

WHEELERS LANE - ARGYLE AVE INTERSECTION
Giveway / Yield (Two-Way)



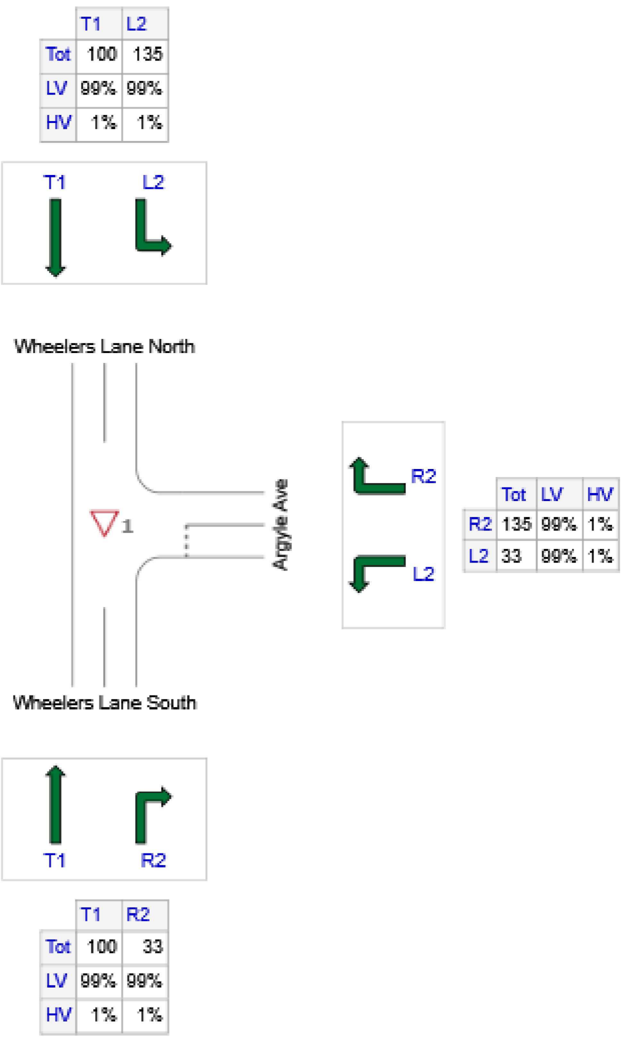
INPUT VOLUMES

Vehicles and pedestrians per 60 minutes

Site: 1 [Post Development - 27 JUNE 2017]

WHEELERS LANE - ARGYLE AVE INTERSECTION
Giveway / Yield (Two-Way)

Volume Display Method: Total and %



	All MCs	Light Vehicles (LV)	Heavy Vehicles (HV)
S: Wheelers Lane South	133	132	1
E: Argyle Ave	168	166	2
N: Wheelers Lane North	235	233	2
Total	536	531	5

LANE LEVEL OF SERVICE

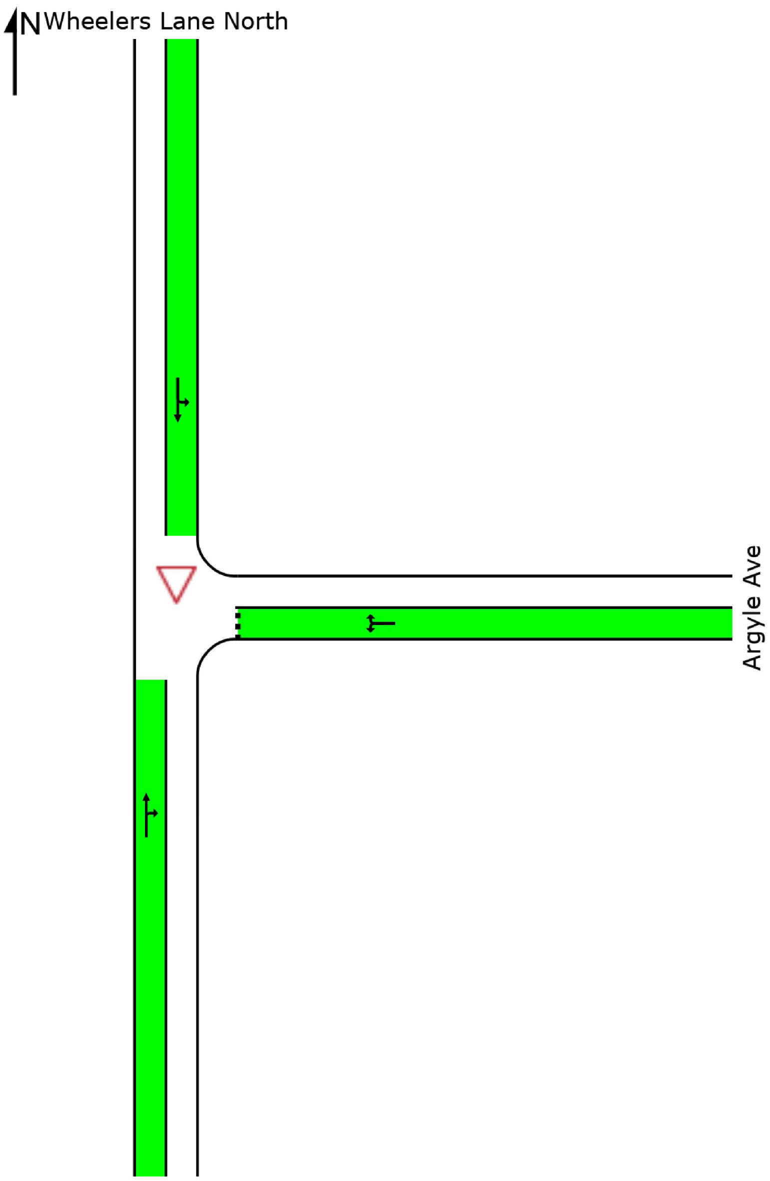
Lane Level of Service

Site: 1 [Post Development - 27 JUNE 2017]

WHEELERS LANE - ARGYLE AVE INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	North	Intersection
LOS	NA	A	NA	NA



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

DELAY (CONTROL)

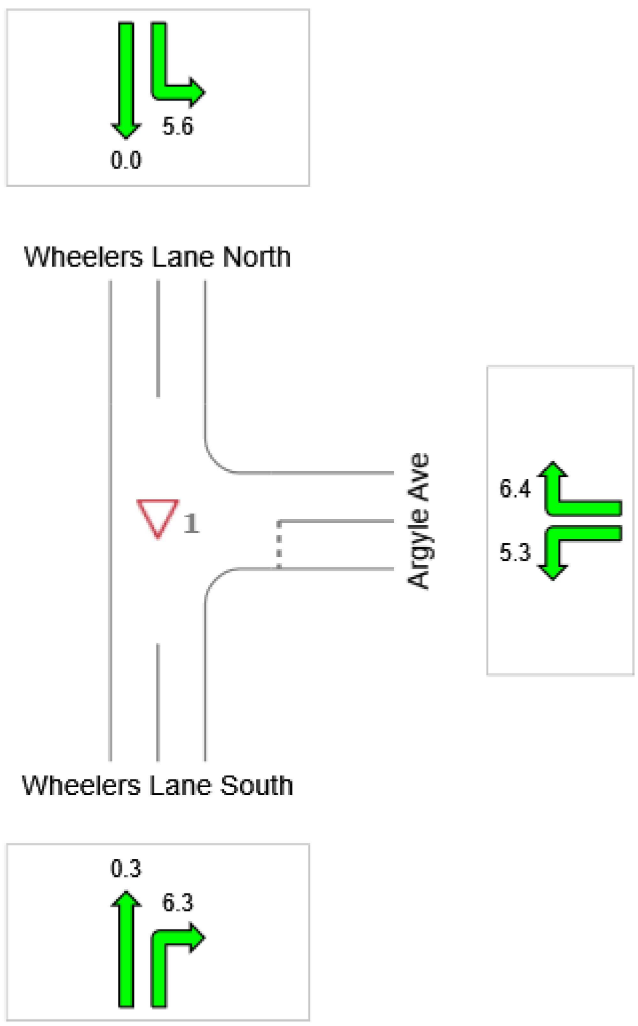
Average control delay per vehicle, or average pedestrian delay (seconds)

▽ Site: 1 [Post Development - 27 JUNE 2017]

WHEELERS LANE - ARGYLE AVE INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	North	Intersection
Delay (Control)	1.8	6.2	3.2	3.8
LOS	NA	A	NA	NA



Colour code based on Level of Service

LOS A	LOS B	LOS C	LOS D	LOS E	LOS F

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

QUEUE DISTANCE (%ILE)

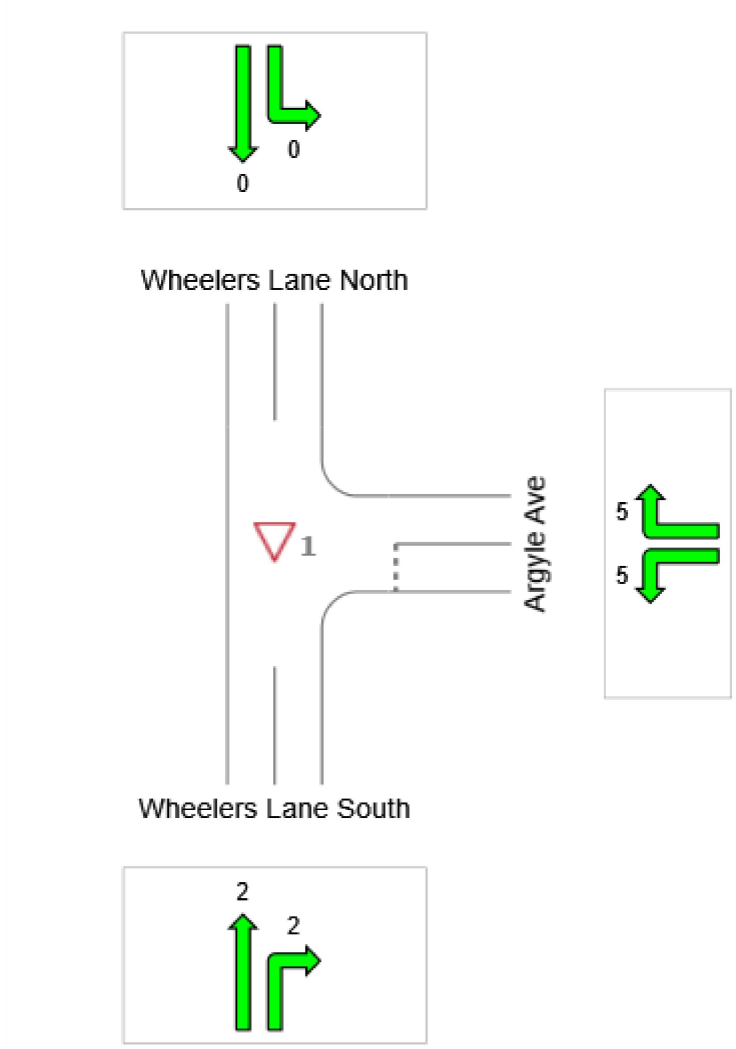
Largest 95% Back of Queue Distance for any lane used by vehicle movement (metres)

▽ Site: 1 [Post Development - 27 JUNE 2017]

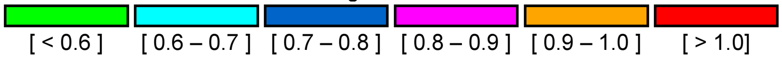
WHEELERS LANE - ARGYLE AVE INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	North	Intersection
Vehicle Queue (%ile)	2	5	0	5



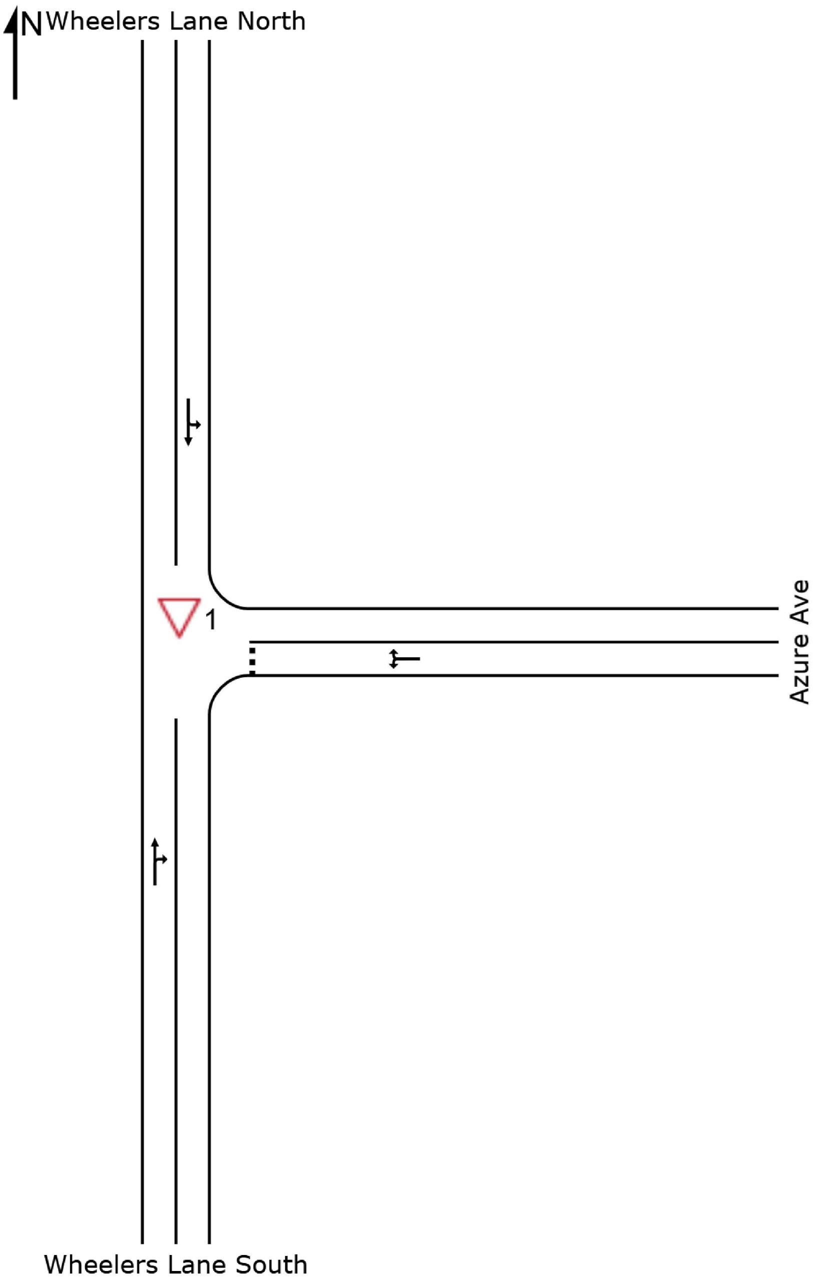
Colour code based on Queue Storage Ratio



SITE LAYOUT

▽ Site: 1 [Post Development -27 JUNE 2017]

WHEELERS LANE - AZURE AVE INTERSECTION
Giveway / Yield (Two-Way)



Organisation: GEOLYSE PTY LTD | Created: Tuesday, June 27, 2017 12:15:35 PM
Project: Not Saved

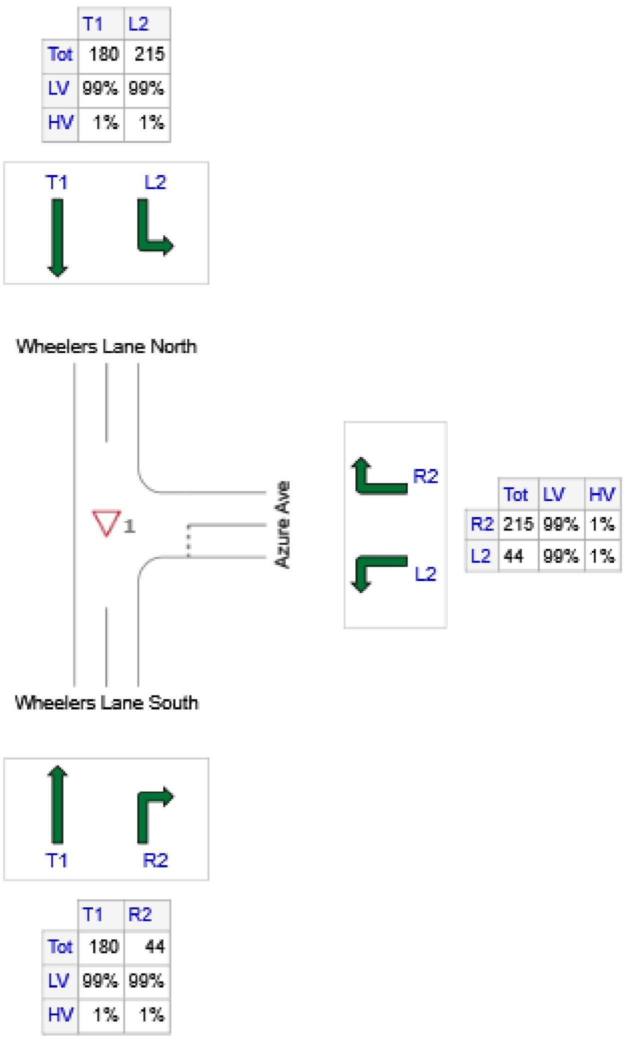
INPUT VOLUMES

Vehicles and pedestrians per 60 minutes

▽ Site: 1 [Post Development -27 JUNE 2017]

WHEELERS LANE - AZURE AVE INTERSECTION
Giveway / Yield (Two-Way)

Volume Display Method: Total and %



	All MCs	Light Vehicles (LV)	Heavy Vehicles (HV)
S: Wheelers Lane South	224	222	2
E: Azure Ave	259	256	3
N: Wheelers Lane North	395	391	4
Total	878	869	9

LANE LEVEL OF SERVICE

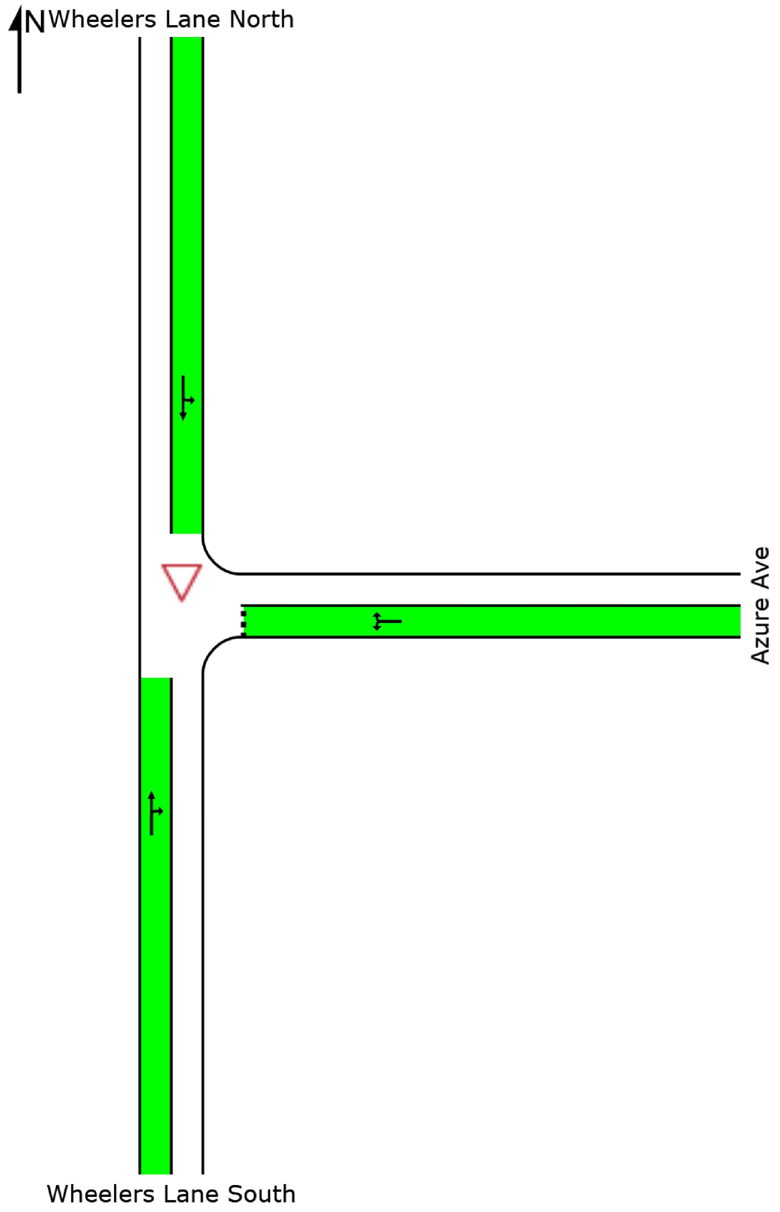
Lane Level of Service

Site: 1 [Post Development -27 JUNE 2017]

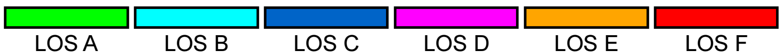
WHEELERS LANE - AZURE AVE INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	North	Intersection
LOS	NA	A	NA	NA



Colour code based on Level of Service



Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

DELAY (CONTROL)

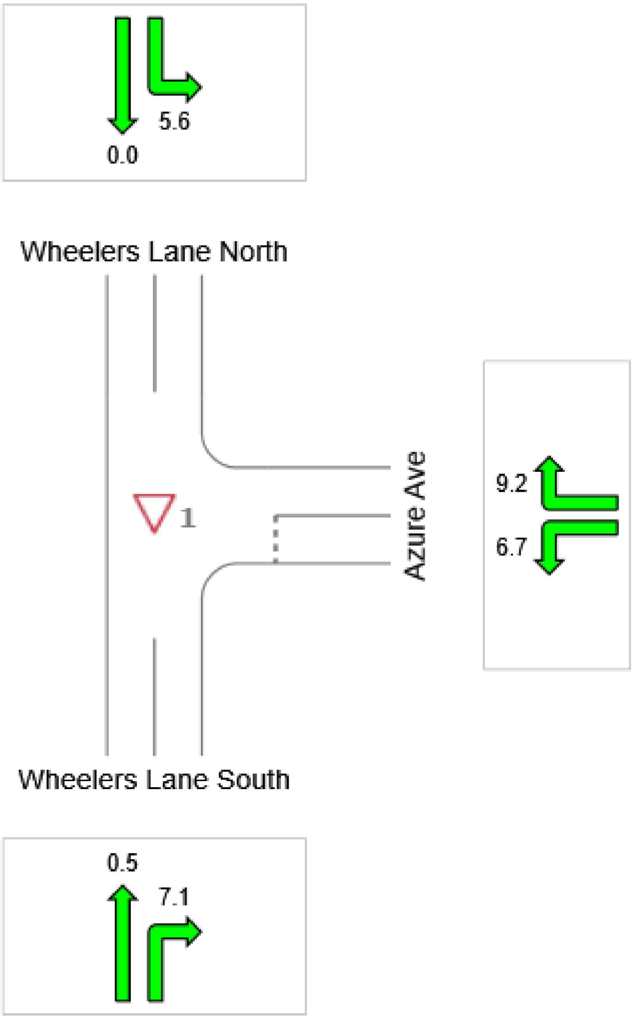
Average control delay per vehicle, or average pedestrian delay (seconds)

▽ Site: 1 [Post Development -27 JUNE 2017]

WHEELERS LANE - AZURE AVE INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	North	Intersection
Delay (Control)	1.8	8.8	3.0	4.4
LOS	NA	A	NA	NA



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

QUEUE DISTANCE (%ILE)

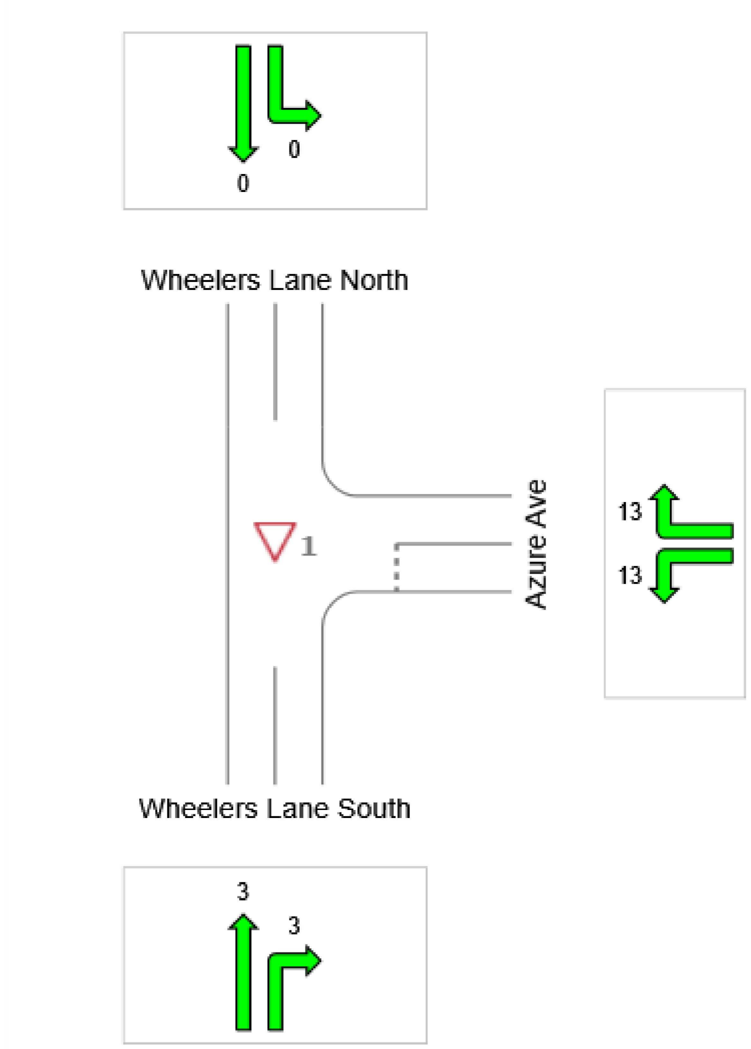
Largest 95% Back of Queue Distance for any lane used by vehicle movement (metres)

▽ Site: 1 [Post Development -27 JUNE 2017]

WHEELERS LANE - AZURE AVE INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	North	Intersection
Vehicle Queue (%ile)	3	13	0	13



Colour code based on Queue Storage Ratio

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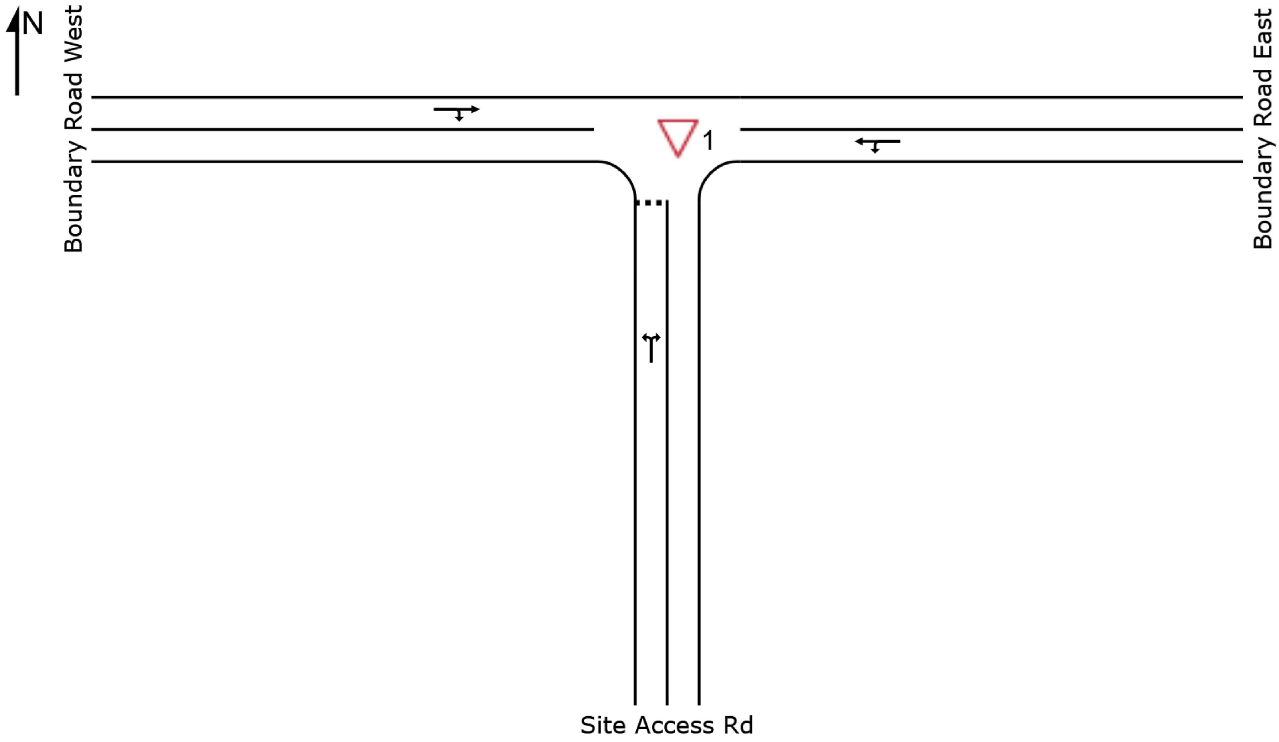
SITE LAYOUT

▽ Site: 1 [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SITE ACCESS ROAD INTERSECTION
Giveway / Yield (Two-Way)



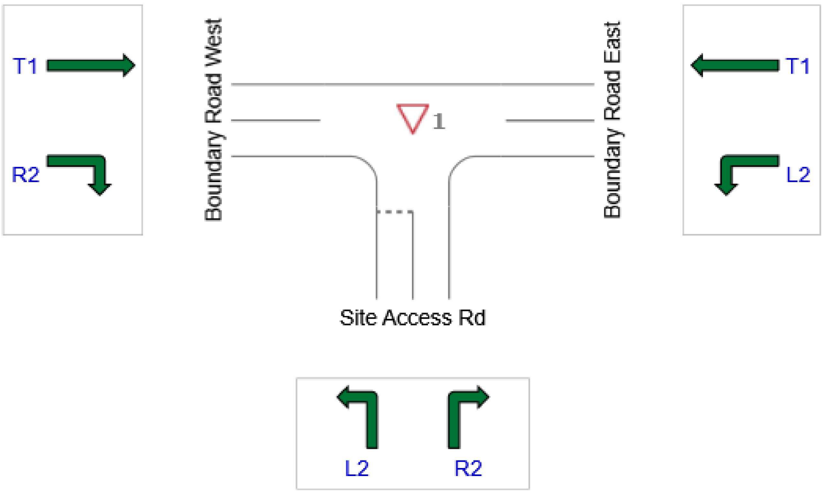
INPUT VOLUMES

Vehicles and pedestrians per 60 minutes

Site: 1 [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SITE ACCESS ROAD INTERSECTION
Giveway / Yield (Two-Way)

Volume Display Method: Total and %



HV	LV	Tot	
1%	99%	255	T1
1%	99%	48	R2

	Tot	LV	HV
T1	255	99%	1%
L2	48	99%	1%

	L2	R2
Tot	48	48
LV	99%	99%
HV	1%	1%

	All MCs	Light Vehicles (LV)	Heavy Vehicles (HV)
S: Site Access Rd	96	95	1
E: Boundary Road East	303	300	3
W: Boundary Road West	303	300	3
Total	702	695	7

Organisation: GEOLYSE PTY LTD | Created: Tuesday, June 27, 2017 12:24:34 PM
Project: Not Saved

LANE LEVEL OF SERVICE

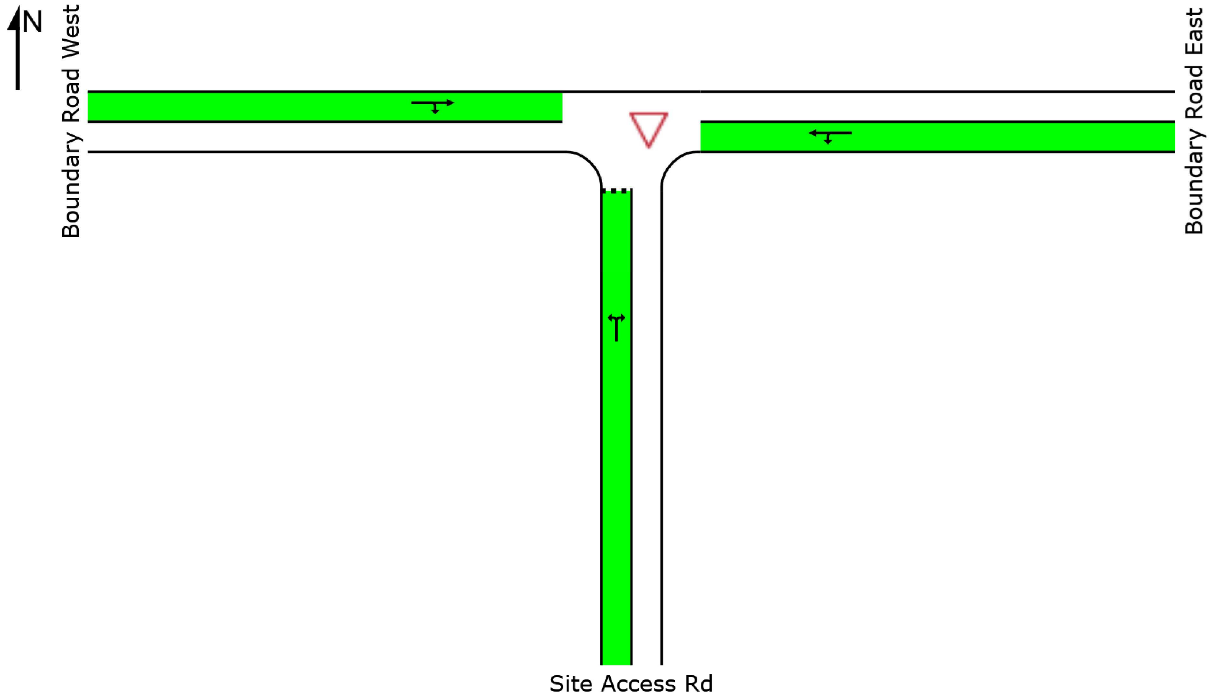
Lane Level of Service

Site: 1 [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SITE ACCESS ROAD INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	West	Intersection
LOS	A	NA	NA	NA



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

DELAY (CONTROL)

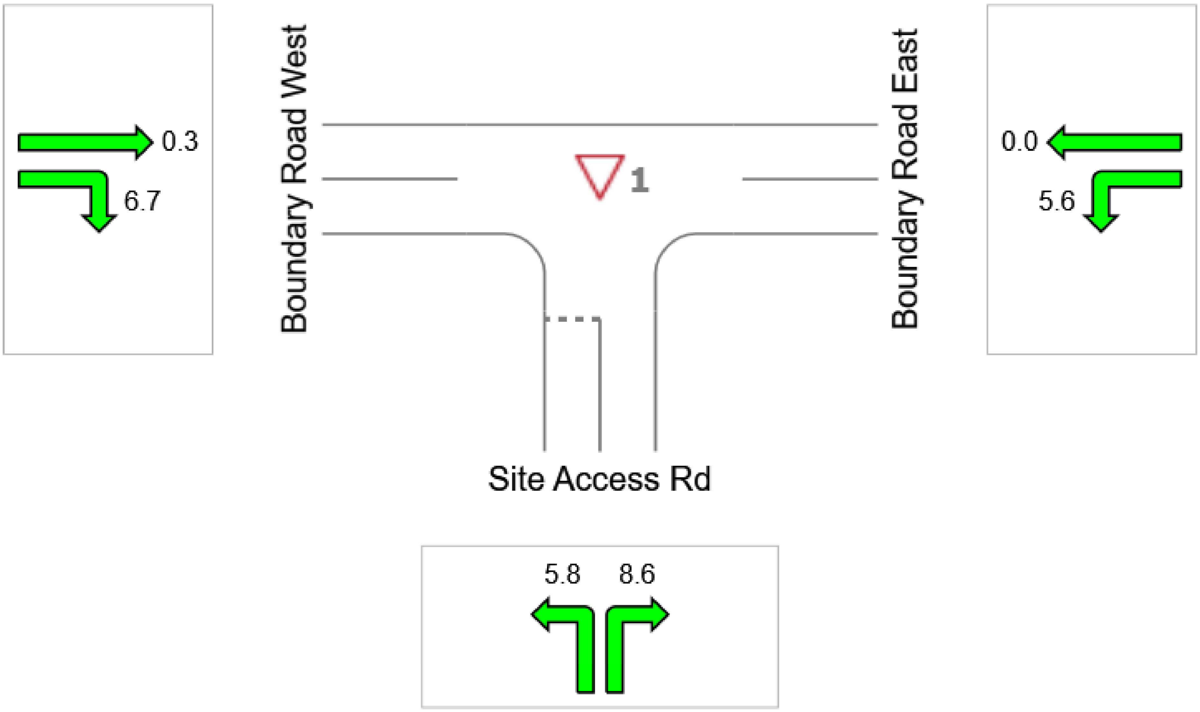
Average control delay per vehicle, or average pedestrian delay (seconds)

▽ Site: 1 [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SITE ACCESS ROAD INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	West	Intersection
Delay (Control)	7.2	0.9	1.3	1.9
LOS	A	NA	NA	NA



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

QUEUE DISTANCE (%ILE)

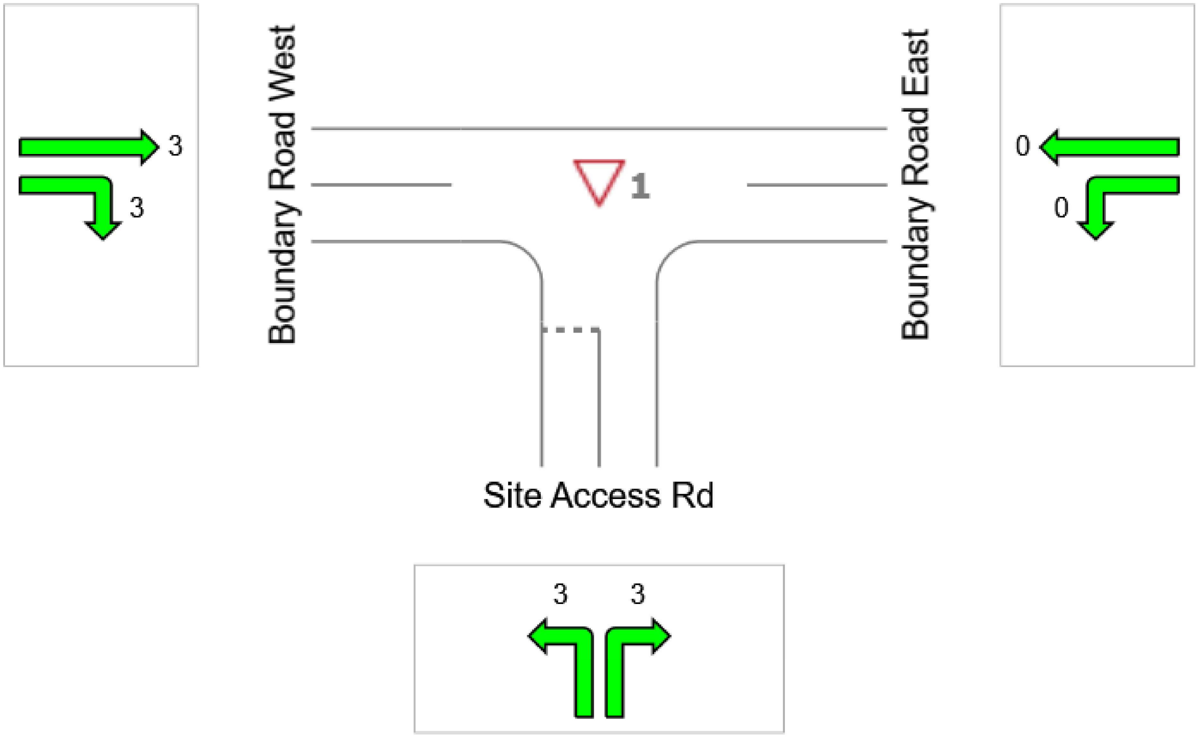
Largest 95% Back of Queue Distance for any lane used by vehicle movement (metres)

▽ Site: 1 [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SITE ACCESS ROAD INTERSECTION
Giveway / Yield (Two-Way)

All Movement Classes

	South	East	West	Intersection
Vehicle Queue (%ile)	3	0	3	3



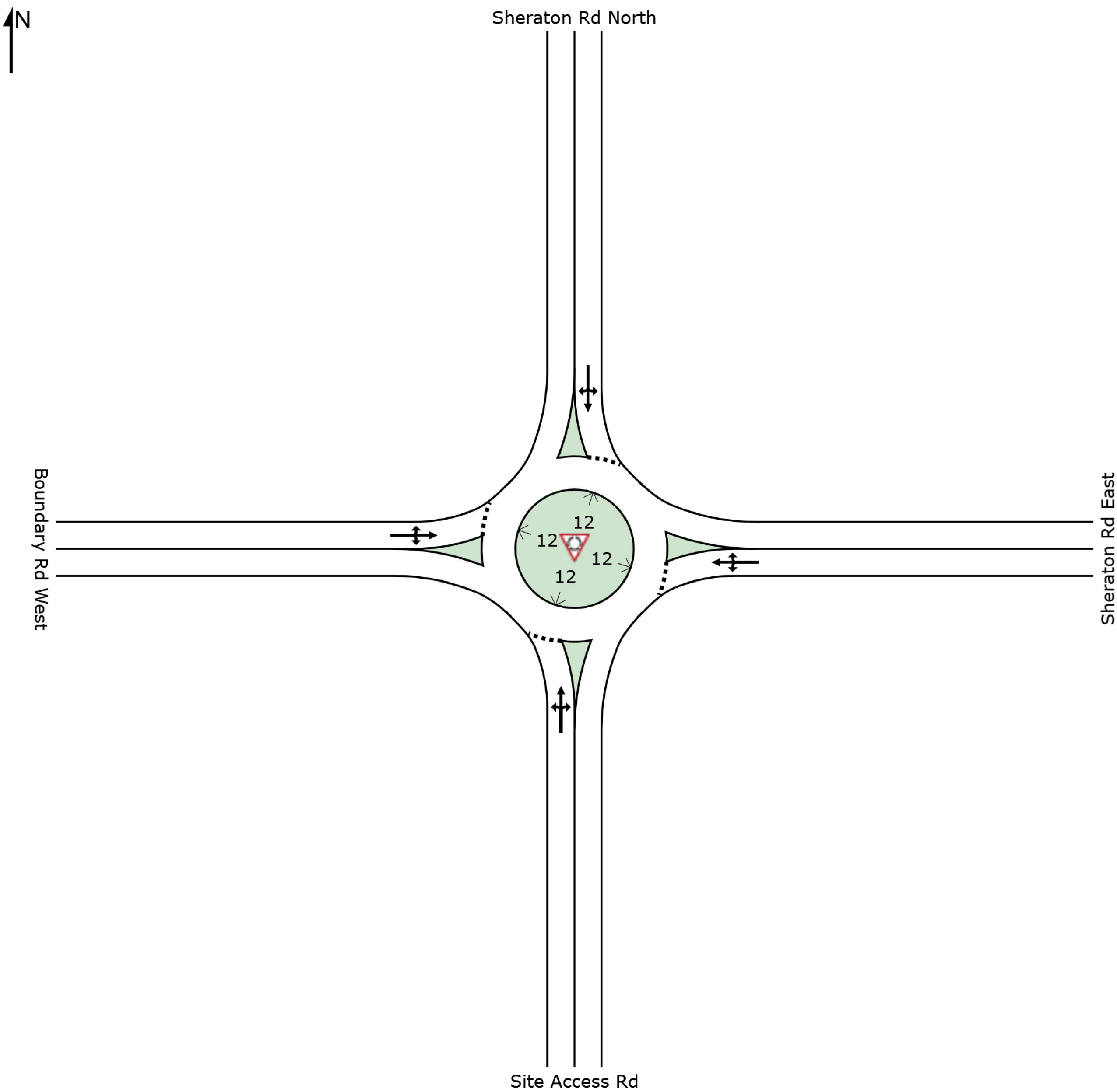
Colour code based on Queue Storage Ratio

[< 0.6] [0.6 – 0.7] [0.7 – 0.8] [0.8 – 0.9] [0.9 – 1.0] [> 1.0]

SITE LAYOUT

Site: [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SHERATON ROAD ROUNDABOUT
Roundabout



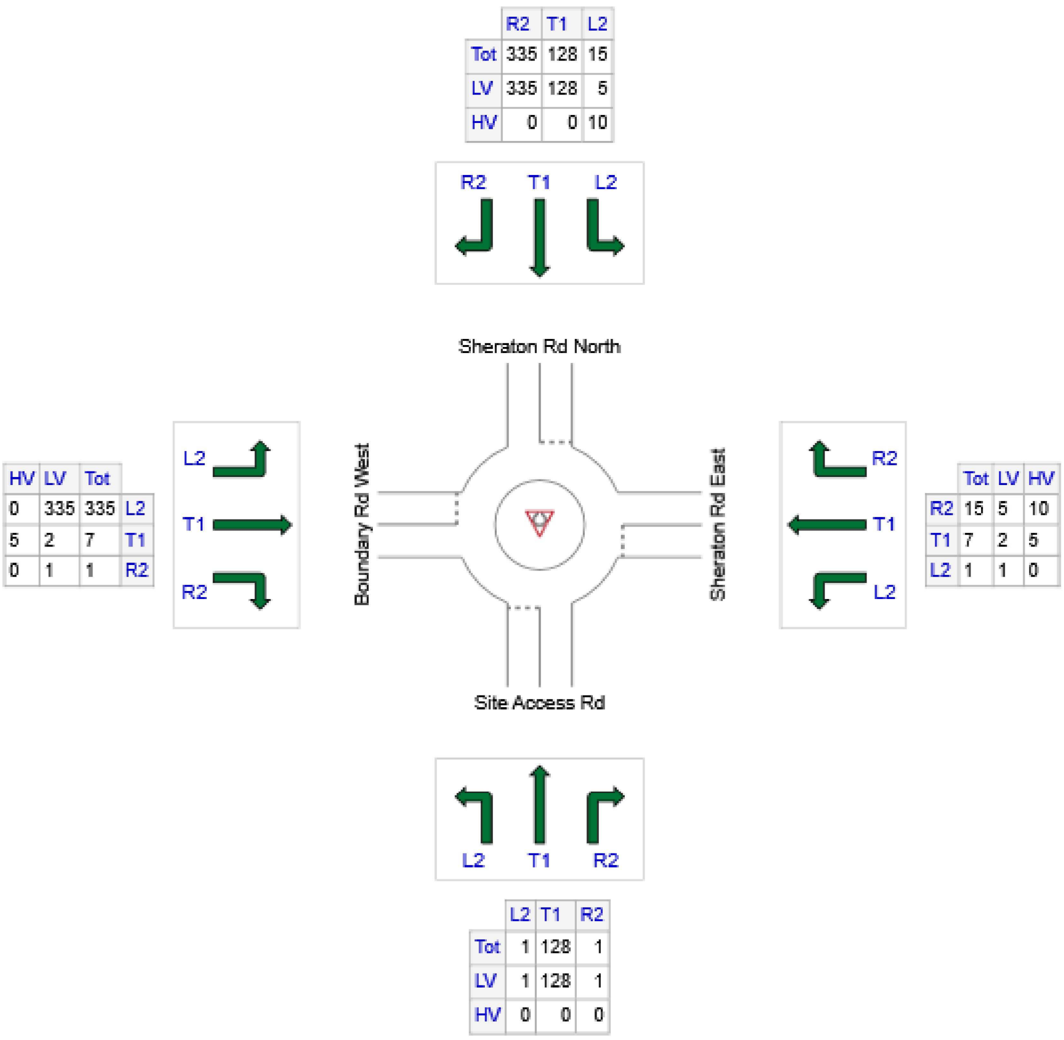
INPUT VOLUMES

Vehicles and pedestrians per 60 minutes

Site: [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SHERATON ROAD ROUNDABOUT
Roundabout

Volume Display Method: Separate



	All MCs	Light Vehicles (LV)	Heavy Vehicles (HV)
S: Site Access Rd	130	130	0
E: Sheraton Rd East	23	8	15
N: Sheraton Rd North	478	468	10
W: Boundary Rd West	343	338	5
Total	974	944	30

LANE LEVEL OF SERVICE

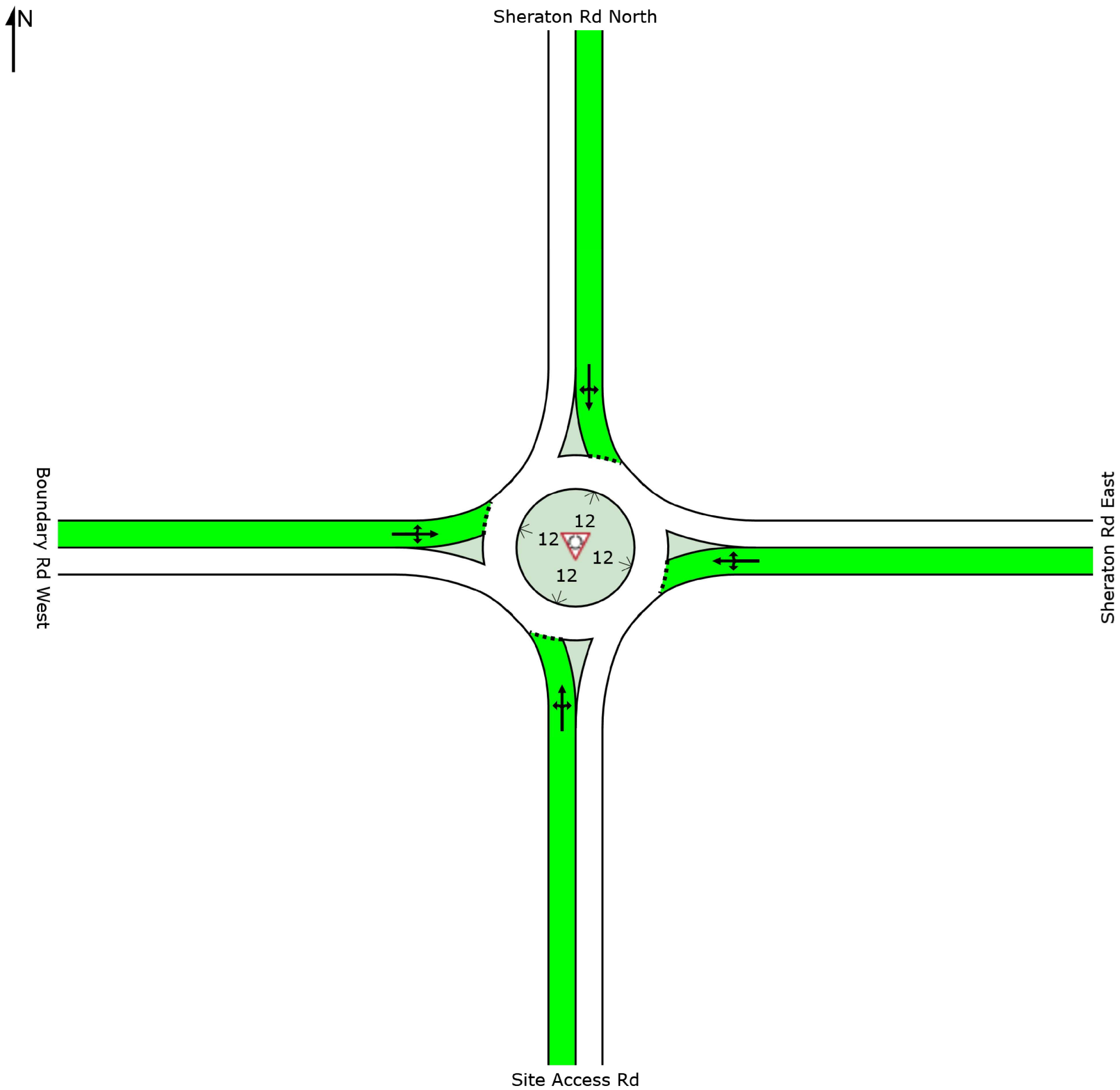
Lane Level of Service

Site: [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SHERATON ROAD ROUNDABOUT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	A	A	A	A	A



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

DELAY (CONTROL)

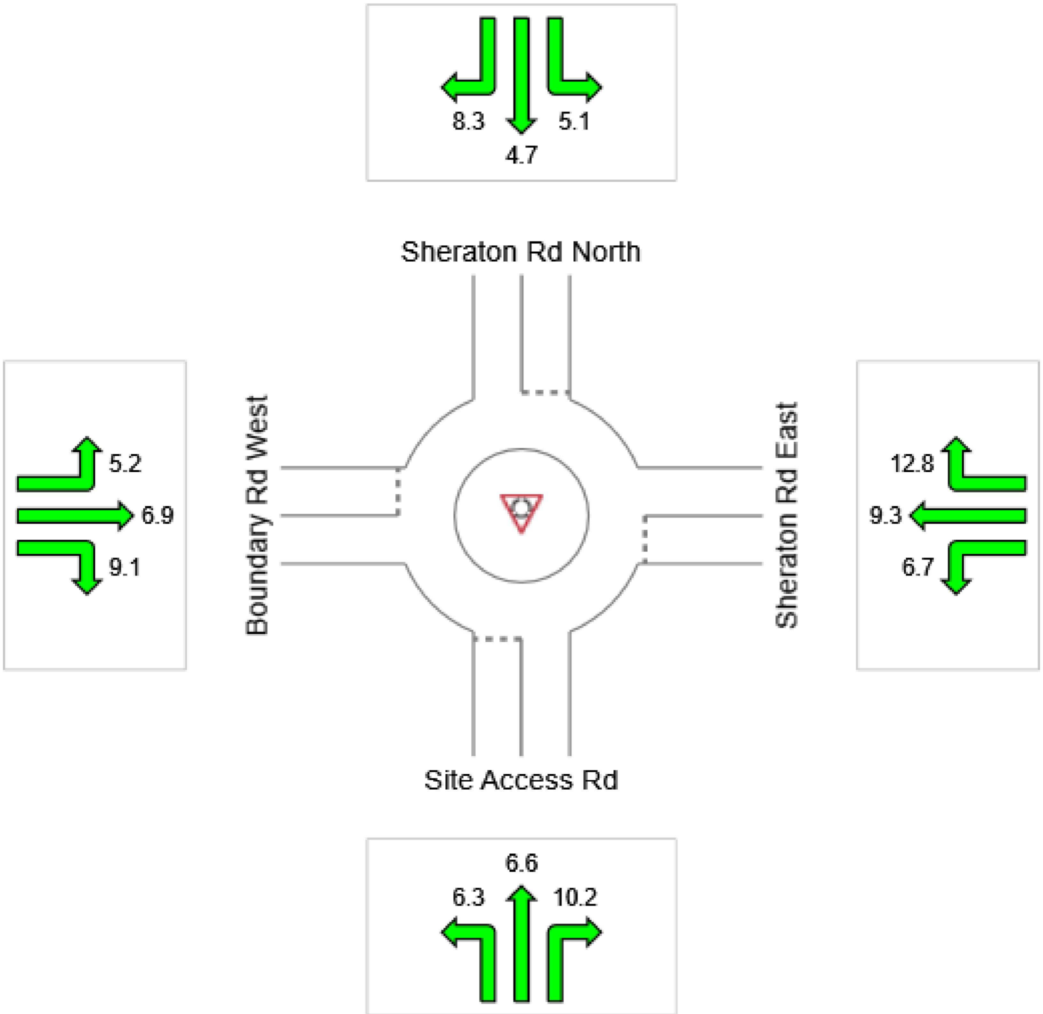
Average control delay per vehicle, or average pedestrian delay (seconds)

Site: [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SHERATON ROAD ROUNDABOUT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
Delay (Control)	6.6	11.5	7.2	5.3	6.5
LOS	A	A	A	A	A



Colour code based on Level of Service

LOS A LOS B LOS C LOS D LOS E LOS F

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

QUEUE DISTANCE (%ILE)

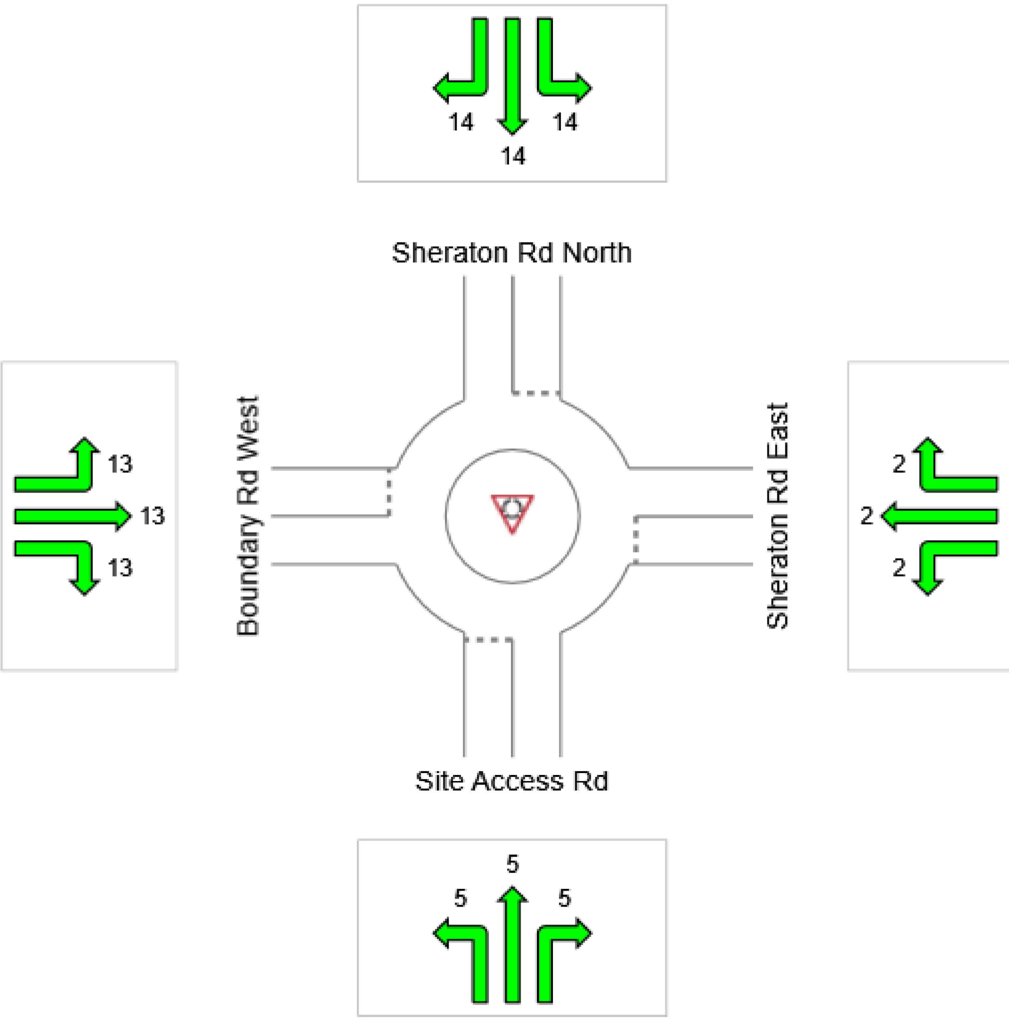
Largest 95% Back of Queue Distance for any lane used by vehicle movement (metres)

Site: [Post Development - 27 JUNE 2017]

BOUNDARY ROAD - SHERATON ROAD ROUNDABOUT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
Vehicle Queue (%ile)	5	2	14	13	14



Colour code based on Queue Storage Ratio

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Appendix C

Groundwater and Salinity Study

Prepared by Envirowest Consulting Pty Ltd

March 2017

Groundwater and salinity study

Lot 2 DP880413

24R Sheraton Road, Dubbo NSW

Ref: R7891s1
Date: 9 March 2017

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Report number:	R7891s1
Date:	9 March 2017

Executive summary

Background

A residential subdivision is proposed for Lot 2 DP880413, 24R Sheraton Road Dubbo NSW. The subdivision design will include residential lots, access roads, a proposed freight way and a riparian zone. A groundwater salinity assessment is required as part of the development process.

Objectives of the investigation

A site investigation was undertaken to assess the existing salinity conditions of the soil and groundwater and determine the impact of the development on groundwater.

Investigation

A soil and groundwater investigation was undertaken of the site. An initial investigation and desktop review was undertaken to collect existing information on groundwater on and around the site and the likelihood of salinity across the site. A detailed investigation was undertaken on 10 and 11 January 2017.

The detailed site investigation included landscape description, soil investigation, laboratory analysis and groundwater investigation. The soil profile investigation was undertaken by constructing 25 boreholes up to 9m in depth. Representative soil samples were collected and analysed for pH, electrical conductivity, colour, dispersion, texture, chlorides and exchangeable sodium percentage.

The investigation results and proposed development were evaluated to identify impacts and recommend management outcomes to minimise impact on salinity occurrence. Soil moisture levels under land-use scenarios were modelled using rainfall data to estimate infiltration. Soil moisture and infiltration was simulated by the CLASS U3M-1D model with daily rainfall inputs from 1980 to 2014. Surface water flow containing sediment, nitrogen and phosphorus were modelled using Chafer (2003).

The impact of the development on water infiltration on the site was discussed and best practice procedures recommended which will minimise the effects on groundwater.

Conclusions

The site had a pasture grazing land-use. No bare areas resulting from sheet erosion or salinity were identified. The risk of erosion is low

Soils on the site comprised topsoil of variable depth consisting of strong brown to dark red loamy sand to silty clay. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

The northern half of the site is located in the Dubbo Basalt Hydro-geological Landscape (HGL). Lithology of the Dubbo Basalt Hydro-geological Landscape consists of Cainozoic basalt consisting of in situ Olivine rich alkali basalt with some colluvial material and quartzite derived from the underlying sandstone and siltstone. Soil salinity is isolated at areas along drainage lines, at the intersection with the Purlewaugh formation, depressions and footslopes. Saline soils also occur due to local perching of the water table. Groundwater flow is unconfined to semi-confined in consolidated fractured rock. Groundwater salinity is fresh to marginal.

The southern section of the site is located in the Purlewaugh/Napperby HGL. The landscape is characterised by low flat hills and rises with a stepped geomorphology. Lithology of the

Purlewaugh/Napperby HGL consists of Purlewaugh Formation, Napperby Formation and Boulderwood Formation comprising mainly ferruginous red siltstone, carbonaceous mudstone, fine to medium grained lithic sandstone, ironstone, minor coal and minor conglomerate. Groundwater flow is unconfined to semi-confined flows through fractures in sandstone and sedimentary bedrock, permeable soils and saprolite. Lateral flow occurs through colluvial sediments on lower slopes. High recharge rates occur across the landscape particularly in areas where cropping is practised. Water electrical conductivity is moderate to high.

The change in slope in the central to southern section of the site is an example of stepped geomorphology characteristic of the Purlewaugh/Napperby HGL. It is also the expected location of the intersection of the Dubbo Basalt and Purlewaugh Formation. The stepped landscape broadly correspond to resistant layers in the stratigraphy. Saline areas in the Purlewaugh/Napperby HGL typically occur at these stepped locations and also at the intersection of the Dubbo Basalt and Purlewaugh Formation.

Subsoil samples collected from two boreholes constructed along the stepped geomorphology contained moderately to highly saline subsoils from 1m. Subsoils in other boreholes located in the northern half of the site and along Eulomogo Creek were non-saline. All topsoils samples were determined to be non-saline.

Groundwater or groundwater indicators were not encountered in the soil to a depth of 9m. Groundwater monitoring bores within 1km of the site and installed to depths of 15m have been mostly dry since monitoring began in 2005. Groundwater recharge within the Dubbo Basalt HGL is greatest on plateau areas and within the Purlewaugh/Napperby HGL is high across the landscape. Groundwater residence times are short.

No groundwater discharge areas were identified on the site.

Modelling of soil moisture levels over the past 34 years indicated variations in infiltration occur with the amount of rainfall pre and post development. Variations occur due to seasonal rainfall and land-use. Irrigation of lawn of 1mm/day results in infiltration in years with high rainfall at 1m and no infiltration at 3m.

Overall site the infiltration will be reduced in the development. Reduced infiltration is a result of the increase in runoff due to impermeable areas (roads, roofs, driveways) and increase in deep rooted vegetation extracting soil moisture from depth. The establishment of trees in strategic areas will offset any additional infiltration from lawn over watering.

The risk of groundwater contamination from the proposed land-use is equal or lower to the current land-use. Nitrogen contributions will decrease as a result of smaller available areas for fertilisation and a decrease in animal waste; domestic pet waste will generally be disposed off-site. Phosphorous and sediment contributions will also decrease. Washing of cars on permeable areas will not be a significant contributor to nutrient levels. Reuse of greywater will be small volumes of unregulated use or larger volumes which require specific conditions of use or regulation by Council. Conditions of use and regulation will ensure overwatering does not occur.

No impact on groundwater including contamination and changed groundwater levels is expected from the development if recommendations are adopted. The development will not impact on quantity or quality of both unconfined and confined aquifers.

Recommendations

The development water and soil design will include:

- Promote plantings of deep rooted vegetation as street trees, along the proposed freight way and within the riparian zone
- Deep rooted trees should be established in the road reserves in accordance with council policy of 1 tree per block
- Additional plantings of deep rooted vegetation in the road reserves located at the geological interface. The trees should be planted with 20m spacings (25 trees/ha).
- Planting of trees in expected areas of lithological/hydrological interfaces to minimise saline soils/groundwater
- Piping of surface water off-site
- Promote water sensitive design of dwellings and gardens
- Stormwater retention basins lined with an impermeable layer
- Design road levels similar to natural soil levels to minimise excavations
- Earthworks comprising cut should be minimised
- Excavated material with elevated salinity should be backfilled, utilised as fill under roads or disposed to landfill
- Assessment of soil salinity prior to house construction to enable appropriate design of footings

Contents

1. Introduction

A residential subdivision is proposed for Lot 2 DP880413, 24R Sheraton Road Dubbo NSW. The subdivision design will include residential lots, access roads a proposed freight way and a riparian zone. A groundwater salinity assessment is required as part of the development process.

2. Scope of work

Envirowest Consulting Pty Ltd was commissioned by Steven Guy on behalf of Maas Group Properties, to undertake a groundwater investigation and salinity study of Lot 2 DP880413, 24R Sheraton Road Dubbo NSW. The objective was to assess the existing conditions and possible future impact of the proposed development on soil, groundwater and salinity.

3. Site identification

Address	24R Sheraton Road Dubbo NSW
Client	Maas Group Properties Pty Ltd
Deposited plans	Lot 2 DP880413
Universal grid reference	UTM Zone 55H, E655142m, N6428025m
Locality map	Figure 1
Site plan	Figure 2
Photographs	Figure 14
Area	Approximately 50 hectares
Dates of inspection and assessment	10 and 11 January 2017

4. Proposed development

The proposed development is a residential subdivision which will include a proposed freight way and a riparian zone (Figure 13). The proposed lots will have hard surface areas comprising roofs and driveways where rainfall will run-off into stormwater pipes and permeable areas comprising lawns and gardens where infiltration into the soil will occur. Roads, footpaths and a stormwater system will be constructed throughout the estate. The dwellings will be serviced by town sewer. The existing dam and drainage line on the property will be remediated to form a riparian zone and enable transfer of stormwater off the estate to Eulomogo Creek. The riparian zone is expected to be planted with trees.

5. Site condition and surrounding environment

5.1 Land-use

The current land-use is stock grazing on semi-improved pasture. An occupied residential dwelling is located in the central section of the site.

5.2 Vegetation

The site has been predominately cleared of native tree species. Eucalypts and cyprus pines occur within the south eastern section of the site. Pasture species are exotic and native grasses and legumes with weeds. The weed species include Paterson's curse, cat head, clover, saffron thistle and khaki weed.

5.3 Topography

The site is predominantly located on a mid-slope. A hillock is located in the north western section. Stepped geomorphology occurs in the central to southern section of the site. Aspect is predominantly south and slopes are gently inclined and generally less than 5%. Elevation ranges between 268 and 295 metres above sea level. The lowest elevation occurs on the southern boundary where Eulomogo Creek traverses the site. No groundwater seepage or discharge areas were observed on the site.

5.4 Soils and geology

The majority of the site is located within the Wongarbon Soil Landscape. The south western corner of the site is located within the Bunglegumbie Soil Landscape (Murphy *et al.* 1998).

Soil in the Wongarbon landscape consists of euchrozems and red and brown cracking clays. Parent material is basalt. Soil salinity occurs as isolated areas along drainage lines, depression and footslopes. Soils are slightly to moderately erodible with erosion hazard increasing on slopes of 3 to 8% when cultivated or surface cover is low.

Soil in the Bunglegumbie landscape consists of red brown earths, red earth, non-calcic brown soils and yellow podzolic/solodic soils. Parent material is relatively old and weathered alluvium. Soil salinity problems are absent. Erosion hazard is low on slopes less than 3%.

Lithology of the southern section of the site is Napperby Formation comprising siltstone thinly interbedded with fine-medium grained lithic quartz sandstone with minor conglomerate. Lithology of the northern section is Cainozoic Basalt comprising tholeiite, alkali basalt and alkali ultramafic (Colquhoun *et al.*1997). The site inspections and borehole construction identified the hillock in the north western section comprised of rounded quartz sandstone with strong hematite cementing possibly reworked volcanic. The hillock is expected to be an isolated plug that provides a geological contrast for groundwater movement.

Soils on the site comprised topsoil of strong brown to dark red loamy sand to silty clay of variable depth. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

5.5 Surface water

A dam has been formed within the site and is fed by the natural slope of the site forming a shallow drainage line running north to south west. Surface water over the site predominantly flows south and into the Eulomogo Creek. Eulomogo Creek flows east to west through the southern section of the site.

Eulomogo Creek empties into the Macquarie River approximately 1.8km west of the site.

5.6 Groundwater

The Australian Natural Resources Atlas identifies the site within the Upper Macquarie Alluvium Groundwater Management Unit. The management unit has an area of 414km^2 with approximately 17.95 GL consumed per year. Average salinity levels are greater than 1500mg/L.

A search of the NSW DPI groundwater database located thirty two bores within 1km of the site including eight bores constructed on the site. The bores are predominantly located to the north and south west. Two bores are licensed for monitoring and form part of the Dubbo Regional Council salinity network. The DRC monitoring bores are located in unconfined sand, gravel and clay to depths of less than 7.5m. Other bores are licensed for domestic, stock, commercial, test and public/municipal/town water supplies and have water bearing zones at depths greater than 6m.

Eight bores have been constructed across the site to depths from 29m to 149m. One bore is licensed for stock supplies and had water bearing zones from 57m in consolidated sandstone. No details are provided for the other bores and it is expected they did not intercept groundwater and were not cased.

6. Groundwater and soil salinity investigation

The groundwater and soil salinity investigation comprised a desktop study, field assessment and soil analysis. The desktop study included a review of soil landscape maps, hydro-geological landscapes and groundwater databases. Soil moisture modelling was also undertaken.

The field assessment included an initial site investigation and detailed profile descriptions and soil analysis in a grid pattern over the site. The soil and landscape information collected provided an adequate description of the physical processes on the site to enable salinity issues to be identified and managed. The frequency of tests undertaken was in accordance to the frequency in Table 1 of Lillicrap and McGhie (2002) for moderately intensive construction.

6.1 Soil landscapes

Soil landscape data was reviewed for information regarding soil types in the locality, occurrence of salinity, erosion and sodic soils.

6.2 Hydro-geological landscapes

Hydro-geological landscape (HGL) data for the locality was reviewed (Figure 3) for information regarding the groundwater aquifer including lithology, aquifer type, recharge and discharge characteristics.

6.3 Groundwater

An investigation of registered bores in the area was undertaken to determine the depth and salinity of the groundwater. Groundwater information was found from a review of the NSW Primary Industries website and Dubbo Regional Council Salinity Network.

The groundwater was divided into deep and shallow groundwater. Deep groundwater is located in river gravels, sands and sandstone at depths greater than 15 metres. The shallow groundwater is expected to generally be unconfined in a local aquifer controlled by drainage lines and/or lithological contrasts within the site.

Water criteria for salinity are presented in Tables 1 and 2. The conversion from EC (dS/m) to total dissolved solids or TDS (mg/L) is undertaken by applying the conversion factor of 640 for an average concentration of salts present (Lillicrap and McGhie 2002).

Table 1. Drinking water criteria for salinity (ADWG 2004)

Criteria	EC (dS/m)	Total dissolved solids -Salinity (mg/L)
Good quality drinking water	0.78	500
Acceptable based on taste	0.78-1.56	500-1000
Unsatisfactory taste	1.56	Greater than 1000
Seawater	Greater than 55	-

Table 2. Total dissolved solids of water for agricultural use (Reid 1990)

Class	Description	Total dissolved solids -Salinity (mg/L)
1	Low salinity	0-175
2	Medium salinity	175-500
3	High salinity	500-1500
4	Very high salinity	1500-3500
5	Extremely high salinity	>3500

Table 3. Guidelines on salinity class determination (Dubbo City Council Urban Salinity Plan)

Electrical conductivity (dS/m)	Salinity class
0-2	Low
2-6	Moderate
6-15	High
>15	Extreme

6.4 DLWC groundwater vulnerability mapping

The NSW Department of Land and Water Conservation have undertaken groundwater vulnerability mapping of the Dubbo locality (Piscope and Dwyer 2001). The vulnerability mapping utilises the DRASTIC technique which is a composite description of all the major geologic and hydro-geologic factors that affect and control groundwater movement into, through and out of an area. It involves the overlaying of various hydro-geological settings via a Geographical Information System (GIS). Each hydro-geological setting describes topography, soil type, bedrock type, estimate of rainfall and net recharge depth to watertable (DTWT), aquifer yield, relative conductivity and any particular features associated with the setting that are available. Groundwater vulnerability is classified into high, moderately high, moderate, low moderate and low (Figure 4).

6.5 Dubbo LEP (2011) groundwater vulnerability map

The Dubbo LEP (2011) Natural Resource – Groundwater vulnerability map describes the areas within the Dubbo Regional Council area where groundwater is considered vulnerable to depletion and contamination as a result of development (Figure 5).

6.6 Hydraulic model

An unsaturated moisture movement model is appropriate to evaluate the hydraulic flows of the existing and proposed land-use. The moisture model selected was CLASS U3M-1D as released by CRC Catchment Hydrology (Vaze *et al*. 2004).

6.6.1 Inputs

The model inputs are daily rainfall and evaporation. The model used climate data from 1980 to 2014 (SILO) under pre and post land-use scenarios (Table 4) to predict soil moisture and excess soil moisture. The pre development land-use comprised improved pasture and a residential area.

The post development land-use comprised residential lots, roadways and vegetated road reserves. The vegetated areas will be planted to trees as offset for possible over irrigation of lawns.

The model input data was rainfall and evaporation for the inferred climate at Hennessy Drive as obtained from SILO. The key soil moisture pre land-use scenario was pasture and post development land-use scenario was irrigated lawn. The key scenarios (Table 4) were applied across the time period for pre and post development scenarios in the land-use areas.

Table 4. Land-use in the soil moisture model

Land-use	Pre development (ha)	Post development (ha)	Rainfall parameter
Improved pasture	49.4	0	100% Rainfall
Urban (Dwellings and lawns)	0.1	28.5	Rainfall plus 1mm/day
Road verges	0	3.7	Rainfall (allowance for road runoff)
Roads	0.5	7.1	Run off site
Tree areas	0	10.7	Rainfall plus 1mm/day (allowance for lawn overwatering)
Total	50	50	

Other parameters applied in the model are soil type and depth and default values (Table 5).

Table 5. Model parameters

Parameter	Data/description
Soil profile	Layer 1 1600-3000 Layer 2 900-1600 Layer 3 300-900 Layer 4 0-300 (topsoil)
Land-use	Pasture, lawn, default climate
Soil hydraulic parameters	Layer 1 Sandy clay Layer 2 Light clay Layer 3 Sandy clay Layer 4 Silty clay loam (topsoil) CLASS U3M-1D
Time step	Default
Root distribution	Default

6.6.2 Outputs

The outputs from the model are soil moisture and excess soil moisture by layer in 10 cm increments. Excess soil moisture is the lateral drainage component and is the difference between available moisture and saturated soil moisture.

6.6.3 Nutrient model

A simulation model was developed to predict surface runoff, sediment loss, nitrogen and phosphorus export, pre and post development. The area for each land-use pre and post development was estimated from site walkover, topographical map, subdivision plans and an aerial photograph. The site was classified into the different land-use areas pre and post development. These areas are summarised in Table 6.

Table 6. Land use areas for nutrient model

Land-use areas (ha)	Pre	Post
Improved pasture	47.2	0
Disturbed landscapes	2.2	0
Roads (earth)	0.5	0
Roads (sealed)	0	7.1
Urban (dwellings and lawn)	0.1	28.5
Open space	0	3.7
Trees	0	10.7
Total	50	50

Land-use on-site are as follows;

- *Improved grazing* is the main pre-development land-use. Superphosphate is regularly applied and clovers and other pasture species sown to improve pasture. The pasture area is assumed to be improved for sediment loss and feed.
- *Disturbed landscapes* refers to the eroded drainage line and dam that has been established.
- *Roads (earth)* is a calculation of farm tracks and roads that have been created on-site.
- *Roads (sealed)* is a calculation of bitumen roads that will be on-site post development.
- Urban (dwellings and lawns) is based on the area proposed for 600m^2, 800m^2 and 2,000m^2 lots.
- *Open space* refers to road reserves.
- *Trees* refers to vegetation cover over the site which is recommended.

Sediment, nitrogen and phosphorus export was estimated for low, median and high scenarios for each land-use class as detailed in Appendix 1 (Chafer 2003).

6.7 Initial site investigation

An initial site investigation was conducted by collecting information on vegetation, slope, bare areas and other indicators of salinity at 100 locations across the site (Figure 6). This density is in accordance with the recommendations by Lillicrap and McGhie (2002).

6.8 Detailed profile descriptions and laboratory analysis

Twenty seven boreholes were constructed with an EVH truck mounted hydraulic drilling rig with solid auger on 10 and 11 January 2017 to provide information on the soil profiles and enable sampling. The boreholes were constructed at various local elevations on the site (Figure 7). Six boreholes were constructed to a depth of 9m or drill refusal. A 50mm diameter monitoring well was constructed along Eulomogo Creek (BH27) and at the expected stepped geomorphology and geological interface (BH16) to intercept groundwater.

The soil profile was described for colour, texture and moisture. Soil samples were collected from seven boreholes at 100mm, 200mm, 300mm, 500mm, and 500mm intervals to the depth of the borehole. Additional samples were collected from potentially saline material identified from visual observation. The sampling is expected to provide an adequate description of subsoil salinity conditions. Soil samples were analysed for pH, electrical conductivity and dispersion.

Soil electrical conductivity (EC) results of the 1:5 (soil:water suspension) were converted to saturated extracts (ECe). EC values are converted to ECe by using a multiplier factor (Charman and Murphy, 1991), which is dependent on the soil texture (Table 7). Saline soils are defined as those with an electrical conductivity (ECe) greater than 4 dS/m (Charman and Murphy, 2001). Soil salinity ratings and effects on plant growth are presented in Table 8.

Table 7. ECe texture based conversion factors (Charman and Murphy 2001)

Soil texture	Conversion factor
Loamy sand, clayey sand, sand	23
Sandy loam, fine sandy loam, light sandy clay loam	14
Loam, loam fine sandy, silt loam, sandy clay loam	9.5
Clay loam, silty clay loam, fine sandy clay loam	8.6
Sandy clay, silty clay, light clay	7.5
Light medium clay, medium clay, heavy clay	5.8

Table 8. Soil salinity ratings based on ECe readings

Salinity rating	ECe (dS/m)*	Effects on Plants
Non saline (NS)	0-2	Salinity effects negligible
Slightly saline (SS)	2-4	Very salt sensitive plant growth restricted
Moderately saline (MS)	4-8	Salt sensitive plant growth restricted
Highly saline (HS)	8-16	Only salt tolerant plants unaffected
Extremely saline (ES)	>16	Only extremely tolerant plants unaffected

*ECe - Electrical conductivity of a saturated extract

Soil with ECe below 2 dS/m will have negligible effects on plant growth and soil stability. Soil with ECe of between 2 and 4 dS/m may restrict very salt sensitive plant growth. Soil with ECe between 4 and 8 dS/m will restrict the growth of salt sensitive plants.

Samples were analysed for dispersion using the Emerson aggregate test. Table 9 details the eight dispersion classes.

Table 9. Emerson dispersion classes

Class	Description
1	Highly dispersive (slakes, complete dispersion)
2	Moderately dispersive, slakes, some dispersion
3	Slightly dispersive, slakes, some dispersion after remoulding
4	Non-dispersive, slakes, carbonate or gypsum present
5	Non-dispersive, slakes, dispersion in shaken suspension
6	Non-dispersive, slakes, flocculates in shaken suspension
7	Non-dispersive, no slaking, swells in water
8	Non-dispersive, no slaking, does not swell in water

Representative soil samples were collected from the topsoil and subsoil and analysed for chloride and sodicity. Chloride criteria for corrosiveness to building material are presented in Table 10 and are an extract from AS2159-1995 Piling – design and installation.

Aggressive soils criteria for salinity and sulfate impacts on building structures are presented in Australia Standard AS2870-2011 (Appendix 2). The AS2870 standard also describes requirements to mitigate salinity and sulphate on footings.

Table 10. Chloride corrosiveness to building materials (AS2159-1995 Piling – design and installation)

Concrete piles		Steel piles	
Chlorides in water (mg/kg)	Soil conditions for low permeability soils or all soils above groundwater	Chlorides in water (mg/kg)	Soil conditions for low permeability soils or all soils above groundwater
<2,000	Non-aggressive	<1,000	Non-aggressive
2,000-6,000	Non-aggressive	1,000-10,000	Non-aggressive
6,000-12,000	Mild	10,000-20,000	Mild
12,000-30,000	Moderate	>20,000	Moderate
>30,000	Severe		

Sodicity is expressed as a percentage of the cation exchange capacity or exchangeable sodium percentage (ESP). Ranking of sodicity is presented in Table 11 (Lillicrap and McGhie 2002). An ESP of less than 5% indicates a non-sodic soil, ESP of between 5 and 15% indicates a sodic soil and an ESP of greater than 15% indicates a highly sodic soil.

Table 11. Ranking of exchangeable sodium percentage

Exchangeable sodium percentage	Ranking
<5%	Non-sodic
5-15%	Sodic
>15%	Highly sodic

7. Results and discussion

7.1 Soil landscape maps

The majority of the site is located within the Wongarbon Soil Landscape. The south western corner section of the site is located within the Bunglegumbie Soil Landscape (eSpade 2017).

Soil in the Wongarbon landscape consists of euchrozems and red and brown cracking clays. Parent material is basalt. Soil salinity occurs as isolated areas along drainage lines, depression and footslopes. Soils are slightly to moderately erodible with erosion hazard increasing on slopes of 3 to 8% when cultivated or surface cover is low.

Soil in the Bunglegumbie landscape consists of red brown earths, red earth, non-calcic brown soils and yellow podzolic/solodic soils. Parent material is relatively old and weathered alluvium. Soil salinity problems are absent. Erosion hazard is low on slopes less than 3%.

7.2 Hydro-geological landscapes

The northern half of the site is located in the Dubbo Basalt HGL and the southern half of the site is in the Purlewaugh/Napperby HGL (eSpade 2017). The site and associated hydro-geological landscapes are depicted in Figure 3.

Lithology of the Dubbo Basalt HGL consists of Cainozoic basalt consisting of in-situ Olivine rich alkali basalt with some colluvial material and quartzite derived from the underlying sandstone and siltstone. Soil salinity is isolated at areas along drainage lines, at the intersection with the Purlewaugh formation depressions and footslopes. Saline soils also occur due to local perching of the water table. Groundwater flow is unconfined to semi-confined in consolidated fractured rock. Groundwater salinity is fresh to marginal.

The southern section of the site is located in the Purlewaugh/Napperby HGL. The landscape is characterised by low flat hills and rises with a stepped geomorphology. Lithology of the

Purlewaugh/Napperby HGL consists of Purlewaugh Formation, Napperby Formation and Boulderwood Formation comprising mainly ferruginous red siltstone, carbonaceous mudstone, fine to medium grained lithic sandstone, ironstone, minor coal and minor conglomerate. Large areas of salinity occur along contours and are repeated at different topographic levels. Severe salt sites occur in the lower landscape. Salt load is very high to extreme due to water readily mobilising salts stored within the sedimentary pile. Groundwater flow is unconfined to semi-confined flows through fractures in sandstone and sedimentary bedrock, permeable soils and saprolite. Lateral flow occurs through colluvial sediments on lower slopes. High recharge rates occur across the landscape particularly in areas where cropping is practised. Water electrical conductivity is moderate to high.

7.3 Groundwater

7.3.1 OEH registered bores

Thirty two registered water abstraction bores were identified within a 1km radius of the site on the NSW Government Department of Primary Industries website (2017) (Figure 8). Data known about each bore within 1km of the site from the Department of Primary Industries website is summarised in Appendix 3. Bores are predominantly located to the north and south west of the site.

Two bores form part of the Dubbo Regional Council salinity network and as such have been constructed to intersect shallow unconfined groundwater. The characteristics of these bores are discussed in Section 7.3.2. The remainder of the bores are licenced for domestic, stock, commercial, test and public/municipal/town water.

Water-bearing zones (WBZ's) and standing water levels were recorded for fourteen bores. The Department of Primary Industries website shows that SWL's and WBZ's in bores (for which data was recorded) were at depths greater than 7m (Figure 8 and Appendix 3). The water bearing zones are located in unconfined sand, gravel and clay and confined sandstone.

A salinity description was recorded for four bores. All were considered to contain non-saline water, with descriptions of 'good', '0-500ppm' and 'fresh'. '

7.3.2 Dubbo Regional Council salinity network

Two Dubbo Regional Council (DRC) monitoring bores are located at less than 1km from the site and twelve are located between 1 and 2km west to north of the site (Figure 9 and Appendix 4). Bore depths ranged from 2m to 15m with water bearing zones located in unconfined regolith comprising clay. The majority of bores have been dry since monitoring begun in March 2005 and three of the bores have not been monitored due to accessibility issues.

The bores identified within 1km of the site are identified as DCC19 and DCC20 (Figure 10). DCC19 is located on the northern boundary of the site and has a depth of 3m. DCC20 is located to the west of the site and has a depth of 15m. DCC19 and DCC20 have generally been dry or too shallow to bail since monitoring began in March 2005 indicating groundwater in the northern section of the site is greater than 3m and in the southern section greater than 15m.

Standing water levels in Dubbo Regional Council (DRC) monitoring bores within 2km of the site in July to November 2016 ranged between 2.01m and 7.05m and five were dry (Table 11 and Figure 9). Electrical conductivity of these bores was classed as low salinity. Levels of total dissolved solids were medium to high for agricultural use with levels ranging between 371mg/L to 909mg/L (Appendix 4).

7.3.3 On-site groundwater

A groundwater monitoring well was installed in BH16 located in the western section of the site at the presumed stepped geomorphology and lithological interface between medium grained lithic sandstone and tertiary basalt. The well was installed at a depth of 5.6m in clayey sand and sandy clay with drill refusal on rock. Groundwater was not encountered in the monitoring well one week after construction.

Table 11. Dubbo Regional Council salinity network

Sampling location (see Figure 10)	Depth (m)	Date sampled	Standing water level (m)	EC (dS/m)	Total dissolved solids (EC x 640) (mg/L)
DCC18	15	Jul-16	2.94	1.23	787
		Sep-16	2.71	1.11	710
		Nov-16	3.61	1.42	909
DCC19	3	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC20	15	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC42	2	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC44	6	Jul-16	2.41	0.79	506
		Sep-16	2.15	0.58	371
		Nov-16	2.66	0.87	557
DCC45	9	Jul-16	6.60	1.25	800
		Sep-16	6.31	1.17	749
		Nov-16	7.04	1.17	749
DCC49	15	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC53	9	Jul-16	Missing	-	-
		Sep-16	Missing	-	-
		Nov-16	Missing	-	-
DCC87	6	Jul-16	Missing	-	-
		Sep-16	Missing	-	-
		Nov-16	Missing	-	-
DCC111	6	Jul-16	Dry	-	-
		Sep-16	Dry	-	-
		Nov-16	Dry	-	-
DCC115	9	Jul-16	Missing	-	-
		Sep-16	Missing	-	-
		Nov-16	Missing	-	-
DCC116	3.5	Jul-16	2.88	0.99	634
		Sep-16	2.69	0.84	538
		Nov-16	2.02	0.96	614

TSTB- too shallow to bail

The second groundwater monitoring well was installed in BH27 located on the northern bank of Eulomogo Creek. The well was installed at 3.9m in clayey sand with gravel and cobbles with drill refusal on rock. Groundwater was not encountered one week after construction.

Unconfined groundwater may occur along the drainage line following periods of high rainfall.

Eight bores have been historically constructed across the site to depths from 29m to 149m. One bore is licensed for stock supplies and have water bearing zones from 57m in consolidated sandstone. No details are provided for the other bores and it is expected they did not intercept groundwater and were not cased.

7.4 Groundwater vulnerability

The Department of Land and Water Conservation (Piscope and Dwyer 2001) identifies the majority of the site as having a low groundwater vulnerability rating (Figure 4). The south western section of the site had a moderate groundwater vulnerability rating.

Land adjacent the eastern boundary has a low groundwater vulnerability rating and adjacent the western boundary had a moderately high groundwater vulnerability. Land to the south west and along the Macquarie River had a high groundwater vulnerability rating.

7.5 Dubbo LEP (2011) groundwater vulnerability map

The Dubbo LEP (2011) identifies the site in a moderately high groundwater vulnerability area (Figure 5). Areas to the south west along the Macquarie River and to the east have a high groundwater vulnerability rating. No groundwater vulnerability rating applies to land to the north east.

7.6 Initial site investigation

The initial site investigation was conducted on an 70m x 70m grid across the site (Figure 6 and Appendix 5).

The site has a historical land-use of grazing. Minor amounts of cropping are expected to have occurred on the mid to lower slopes of the site.

Scattered eucalypts and cyprus pines occur within the south eastern section of the site. A residential area including dwelling, tennis court and swimming pool were identified in the central area of the site. A large machinery shed and associated horse stables were also identified within this area.

Pasture species are exotic grasses and legumes with weeds. The weed species include Paterson's curse, hedge mustard, cat head, clover, saffron thistle and khaki weed. Vegetation cover was greater than 90% across the majority of the site. Bare areas were due to farm tracks.

The majority of the site was very gently inclined with slopes ranging from 0 to 2%.

Basalt cobbles were identified in the north western section of the site.

No indicators of salinity were observed.

7.7 Soil characteristics

Boreholes were constructed to depths of 2m, 3m, 9m or drill refusal. Drill refusal due to rock was encountered in the majority of boreholes from depths between 1.1m and 9m. Borelogs are presented in Appendix 6.

7.7.1 Texture and colour

Soils on the site comprised topsoil of of strong brown to dark red loamy sand to silty clay of variable depth. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

Table 12. Soil colour, texture, pH, EC and ECe (detailed profile descriptions)

Borehole No - depth (mm)	Soil colour	Soil texture	pH	EC1:5	ECe (dS/m)	Emerson aggregate test
1-100	Strong brown	Sandy clay	6.7	0.12	0.90	5
1-200	Strong brown	Fine sandy clay	7.1	0.12	0.90	5
1-300	Strong brown	Light clay with fine sand and fine gravel	7.3	0.11	0.83	5
1-500	Strong brown	Light clay with fine sand and fine gravel	7.3	0.11	0.83	5
1-1000	Strong brown	Light clay with fine sand and fine gravel	7.3	0.12	0.9	5
1-1500	Strong brown	Light clay with fine sand and fine gravel	7.4	0.17	1.28	6
1-2000	Dark yellowish brown	Light clay	7.5	0.20	1.50	6
1-2500	Dark yellowish brown	Medium clay	7.6	0.21	1.22	6
1-3000	Dark yellowish brown	Medium clay	7.6	0.17	0.99	6
1-3500	Dark yellowish brown	Sandy clay	7.7	0.15	1.23	6
1-4000	Dark yellowish brown	Sandy clay with fine gravel	8.1	0.16	1.20	5
1-4500	Dark yellowish brown	Sandy clay with fine gravel	8.2	0.18	1.35	5
1-5000	Dark yellowish brown	Sandy clay loam	8.4	0.15	1.43	5
1-5500	Yellowish brown	Fine sandy clay loam	8.2	0.13	1.24	5
1-6000	Yellowish brown	Fine sandy clay loam	8.3	0.13	1.24	5
1-6500	Yellowish brown	Fine sandy clay loam with gravel	8.3	0.12	1.14	5
1-7000	Yellowish brown	Fine sandy clay loam with gravel	8.4	0.10	0.95	5
1-7500	Yellowish brown	Sandy clay	7.9	0.08	0.60	3
1-8000	Yellowish brown	Silty clay	8.5	0.07	0.53	3
1-8500	Light yellowish brown	Silty clay	8.2	0.09	0.68	3
1-9000	Yellowish brown	Silty clay	8.2	0.08	0.60	3
3-100	Reddish brown	Sandy clay loam	5.8	0.03	0.29	3
3-200	Reddish brown	Fine sandy clay loam	6.3	0.02	0.15	3
3-300	Dark red	Fine sandy clay	6.7	0.01	0.08	3
3-500	Dark red	Light clay	6.6	0.01	0.08	5
3-1000	Dark red	Light clay	6.9	0.02	0.15	5
3-1500	Dark red	Medium clay	6.8	0.01	0.06	5
3-1800	Dark red	Medium clay	7.1	0.01	0.06	3
4-100	Reddish brown	Sandy loam	5.8	0.04	0.56	3
4-200	Dark red	Silty clay	5.6	0.02	0.17	2
4-300	Dark red	Silty clay with gravel	6.1	0.02	0.17	3
12-100	Dusky red	Loamy fine sand	5.4	0.02	0.19	2
12-200	Dusky red	Sandy clay loam	5.8	0.02	0.19	1
12-300	Dark red	Silty clay	6.4	0.01	0.08	1
12-500	Reddish brown	Silty clay	6.6	0.01	0.08	3
12-1000	Yellowish red	Silty clay	7.3	0.02	0.15	5
12-1500	Yellowish red	Silty clay	7.3	0.02	0.15	3
12-2000	Reddish brown	Silty clay	7.3	0.02	0.15	3
12-2500	Brown	Silty clay	7.5	0.02	0.15	2
12-3000	Strong brown	Light clay	6.6	0.02	0.15	2
12-3500	Brown	Sandy clay with gravel	6.8	0.02	0.15	2
12-4000	Strong brown	Sandy clay with gravel	7.3	0.02	0.15	2
12-4500	Dark brown	Sandy clay with gravel	6.8	0.02	0.15	2
12-5000	Dark brown	Sandy clay with gravel	7.0	0.02	0.15	2

13-1600	Light yellowish brown	Loamy sand	8.9	0.16	3.68	3
15-2800	Pinkish grey	Silty loam	8.6	0.11	1.05	1
16-100 (MW2)	Dark brown	Loamy sand	4.9	0.03	0.69	2
16-200 (MW2)	Brown	Loamy sand	5.0	0.03	0.69	2
16-500 (MW2)	Reddish brown	Loamy sand	5.7	0.0	0.46	2
16-1500 (MW2)	Dark red	Loamy sand	8.3	0.08	1.84	2
16-2500 (MW2)	Reddish brown	Clayey sand	8.5	0.27	6.21	2
16-3000 (MW2)	Brown	Sandy clay	8.4	0.29	2.18	2
16-3500 (MW2)	Light grey	Clayey sand	9.5	0.41	9.43	2
16-4000 (MW2)	Reddish grey	Sandy clay	9.3	0.40	3.0	2
16-4500 (MW2)	Brown	Fine sandy clay loam	9.2	0.32	3.04	2
16-5000 (MW2)	Reddish grey	Clayey sand	9.5	0.34	7.82	2
16-5500 (MW2)	Dark yellowish brown	Fine sandy clay loam with gravel	9.3	0.31	2.67	2
17-700	Light grey	Fine sandy clay loam	7.6	0.04	0.34	3
18-700	Pale yellow	Sand	7.3	0.02	0.46	2
19-1600	Pale yellow	Silty clay	9.6	0.38	2.85	3
19-2500	Light grey	Sandy clay with gravel	8.9	0.12	0.90	2
20-100	Very dark brown	Loamy sand	5.9	0.03	0.69	3
20-200	Dark brown	Loamy sand	6.6	0.03	0.69	2
20-300	Dark brown	Loamy sand	6.9	0.03	0.69	2
20-500	Reddish brown	Sandy clay	9.0	0.11	0.83	2
20-1000	Reddish brown	Light clay with gravel	9.5	0.53	3.98	3
20-1500	Strong brown	Sandy clay	9.5	0.56	4.20	2
20-2000	Strong brown	Sandy clay	9.3	0.52	3.90	2
20-2500	Grey brown	Silty clay	9.0	0.57	4.28	2
20-3000	Grey brown	Silty clay	9.4	0.60	4.50	2
20-3500	Strong brown	Sandy clay	9.4	0.55	4.20	2
20-4000	Strong brown	Sandy clay	9.6	0.55	4.13	2
20-4500	Strong brown	Sandy clay	9.7	0.52	3.90	2
20-4900	Strong brown	Sandy clay	9.7	0.45	3.38	2
27-100 (MW1)	Dark brown	Loamy sand	6.0	0.03	0.69	3
27-200 (MW1)	Strong brown	Loamy sand	5.7	0.02	0.46	3
27-300 (MW1)	Strong brown	Loamy sand	6.1	0.02	0.46	3
27-500 (MW1)	Dark medium brown	Sandy clay loam	6.6	0.02	0.19	3
27-1000 (MW1)	Dark red	Light clay	6.7	0.01	0.08	3
27-1500 (MW1)	Red	Light clay	6.9	0.01	0.08	3
27-2000 (MW1)	Reddish brown	Loamy sand with gravel	6.7	0.02	0.46	3
27-2500 (MW1)	Brown	Loamy sand with gravel	7.3	0.02	0.46	3
27-3000 (MW1)	Brown	Loamy sand	7.5	0.02	0.46	3
27-3500 (MW1)	Dark brown	Sandy clay with gravel	7.7	0.02	0.46	3

7.7.2 Salinity (electrical conductivity)

All topsoils samples were determined to be non-saline. Subsoils in the majority of the site were classified as non-saline (BH1, BH3, BH4, BH12 and BH27) with electrical conductivity of less than 2dS/m (Figure 10).

Subsoil samples collected from two boreholes (BH16 and BH20) constructed along the stepped geomorphology contained moderately to highly saline subsoils from 1m (Table 12).

7.7.3 pH
The topsoil was slightly acidic (Table 12). The pH generally increased with increasing depth. Subsoil was generally slightly alkaline.

7.7.4 Emerson aggregate test
Topsoil and subsoil on the site was non-dispersive to slightly dispersive in BH1, BH3 and BH27. Topsoil and subsoil was moderately to highly dispersive in BH12, BH16 and BH20 (Table 12).

7.7.5 Chlorides
Levels of chlorides in the samples analysed were less than 2,000mg/kg and considered non-aggressive soils for concrete and steel piles (Table 13).

Table 13. Soil results for chlorides and exchangeable sodium percentage (ESP) (Appendix 7)

Sample ID	Borehole and depth (mm) (Figure 5)	Chlorides (mg/kg)	ESP (%)
BH16-100	16-100	7.6	3.3
BH16-1500	16-1500	50	36.5

ND – Not detected at the laboratory limits

7.7.6 Exchangeable sodium percentage
Exchangeable sodium percentage for the topsoil sample collected from Borehole 16 at the expected geological interface was non-sodic. The subsoil sample was highly sodic (Table 13).

7.8 Indicators of salinity
7.8.1 Bare soil
No bare soil resulting from sheet erosion or salinity were present on site

7.8.2 Salt crystals
No salt crystals present on site.

7.8.3 Vegetation indicators
No highly salt tolerant plant species are present on site.

7.8.4 Die back
No vegetation or tree die back was observed on or surrounding the site.

7.8.5 Effects on buildings
The existing dwelling located on the site had no evidence of salinity impact.

7.8.6 Conditions of roads
No evidence of surface undulations or break-up of bitumen on the roads surrounding the site.

7.9 Soil moisture model
The soil moisture varies with rainfall in both land-use scenarios. Soil moisture at 1m and 3m depths was greater under irrigated lawn with large variations throughout the year. Soil moisture levels under irrigated lawn was saturated for a short time in some years at 1m and did not exceed field capacity at 3m depth (Figures 11 and 12).

Management of areas with elevated salinity identified at the geological interface with permanent vegetation will prevent mobilization of salts in the surface or subsurface.

7.10 Nitrogen

Nitrogen soil levels in the grazing system are typically low with concentrated areas around animal wastes. Nitrogen fertilisers are also used in cropping operations and biological synthesis occurs in legumes. Off-site movement occurs from sediment loss. Water soluble nitrogen has potential to leach into the groundwater.

Post development sources of nitrogen are from fertilisers applied to lawns. Post development fertilisation will only occur in a small proportion of the site that is lawns and gardens. Nitrogen fertilisation is not expected to occur on the road verge. Nitrogen fertiliser will not be required in native gardens. The impact from lawn fertilisers will be less than the impact of animal wastes. Maintained gardens and lawns will have the capacity to utilise the nitrogen applied. The impact of nitrogen fertiliser post development will be reduced.

The nutrient balance indicates the development will reduce nitrogen export by 194 kg/year under the median scenarios (Table 14). Reduced pasture area and an increase in hard surface areas has resulted in a decrease in the nitrogen loss.

Table 14. Land-use nitrogen export pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushland	0.00	25.68	-25.68
Disturbed landscapes	26.4	0.00	26.4
Remediated gullies	0.00	3.00	-3.00
Improved pasture	420.08	0.00	420.08
Roads (sealed)	0.00	42.60	-42.60
Roads (earth)	1.10	0.00	1.10
Urban	0.61	173.85	-173.24
Urban (open space)	0.00	11.84	-11.84
TOTAL	448.19	253.97	194.22

7.11 Phosphorus

The main phosphorus sources pre-development are from animal waste and fertilisers. Horses are currently grazed on the site. Off-site movement of phosphorus will occur in sediments and susceptible times are when vegetation cover is low.

Stock numbers will decrease in the post development land-use. Domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter. The result will be a decrease contribution of phosphorus on the site.

Phosphorus binds to soil and the primary method of movement is in sediments. Vegetation cover is expected to be higher post development resulting in filtering of runoff, reduced sediment loads exported and consequently lower phosphorus export.

The nutrient balance indicates the development will decrease phosphorus export by 0.82 kg/year under the median scenarios (Table 15). Phosphorus export will increase under the high scenarios. This is at the extreme end of the modelling and is only expected to occur occasionally in small areas of the site. Riparian planting and wetland design can reduce phosphorus levels at stormwater discharge areas.

Table 15. Land-use phosphorus exports pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushland	0.00	1.39	-1.39
Disturbed landscapes	2.73	0.00	2.73
Improved pasture	63.72	0.00	63.72
Roads (sealed)	0.00	12.78	-12.78
Roads (earth)	0.86	0.00	0.86
Urban	0.22	51.87	-51.87
Urban (open space)	0.00	0.63	-0.63
TOTAL	67.49	66.67	0.82

7.12 Sediment

The nutrient balance indicates the development will reduce sediment by 14,899 kg/year under the median scenario (Table 16). Sediments are reduced due to the decrease in contribution from the pasture area.

Table 16. Land-use sediment export pre and post development (kg/year)

Land-use areas	Pre-development	Post-development	Impact
Native bushland	0.00	428.00	-428.00
Disturbed landscapes	1,914.00	0.00	1,914.00
Improved pasture	24,544.00	0.00	24,544.00
Roads (sealed)	0.00	1,349.00	-1,349.00
Roads (earth)	70.00	0.00	70.00
Urban	30.00	8,550.00	-8,520.00
Urban (open space)	0.00	1,332.00	-1,332.00
TOTAL	26,558.00	11,659.00	14,899.00

7.13 Garden fertilisers and chemicals

Minor usage of herbicides may occur post development on lawns. All fertilisers and agricultural chemicals will be utilised by the vegetation or degrade rapidly in the environment. No impact on surface water or groundwater will occur.

No industrial activities including bulk storage or use of chemicals will occur in the development.

7.14 Other contaminants

7.14.1 Greywater reuse

NSW Health approves the following methods for greywater reuse:

- Bucketing: Generally only small volumes of greywater are reused and the action is unlikely to occur during wet weather. Risk of overwatering and therefore impact on groundwater is low.
- Greywater diversion devices: Does not require Council approval if conditions relating to installation and use are met. Conditions include undertaking checks and maintenance of the irrigation system, use biodegradable detergents low in phosphorus, sodium, boron and chloride, no irrigation during rain, undertake a water balance prior to installation, monitor soil and plant response to irrigation, do not overwater and notify the local water utility of the device. Notification to the local water utility (Dubbo Regional Council) ensures Council is aware the system is in place and can check on compliance. Conditions ensure the water is used sustainably with minimal impact on the groundwater.
- Greywater treatment system: Requires approval from Council. Council can regulate the suitability and number of systems in the locality and check on the satisfactory operation of the system. Regulation of the system ensures minimal impact on groundwater.

7.14.2 Car washing
Minor washing of cars by householders is expected to be undertaken post development. Most car owner clean cars in commercial washing bays. Small numbers of cars will be washed either on permeable areas resulting in infiltration or non-permeable areas with water moving into the reticulated stormwater system and off-site. Water and detergents infiltrating permeable areas will be utilised by vegetation. Some deeper infiltration may occur but volumes are not expected to be significant. Car washing is not expected to occur during rain.

8. Soil and water impact assessment

8.1 Soil
Surface soils and subsoils in the northern and southern sections of the site were non-saline. Moderate to highly saline subsoils were identified at a depth of greater than 1m at the expected geological interface through the central to southern section of the site. The moderate to highly saline subsoils are associated with the sandstone lithology. Excavation works from the development are not expected to intercept the saline subsoil, following adoption of the recommendations in this report

8.2 Water

8.2.1 Surface water
Runoff will be directed into a piped stormwater system. The pipes will discharge into a stormwater management system proposed to be constructed off-site to the west. The existing dam located on site will be decommissioned.

8.2.2 Groundwater

8.2.2.1 Recharge
Modelling has shown under a number of scenarios that soil moisture infiltration will not be significant in the development. Moderate irrigation of lawns will not result in infiltration at a depth of 3m. The proposed planting of deep-rooted vegetation as street trees and within the southern road reserve will aid in the extraction of soil moisture within the profile and reduce the occurrence of deep infiltration that may occur in high rainfall years. .

Additional infiltration in the non-saline areas from possible over irrigation of lawn will not contribute to salinity. Large areas of impervious surface (roads and roof areas) will increase in rainfall runoff and reduce infiltration. Deep infiltration of groundwater within the area is expected to be similar pre and post development. Groundwater levels are not expected to rise as a result of the development.

Regular monitoring has been undertaken by the NSW Office of Water of the Dubbo town water supply extraction area located south west of the site. These bores have shown a long term declining trend with falls of up to 18m (Smithson, 2010).

8.2.2.2 Discharge
No shallow groundwater discharge areas were identified on the site. Discharge is unlikely to occur at the boundary between the basalt and sandstone lithology in the central to southern section as this was not observed from surface or subsurface observations.

8.2.2.3 Clause 7.5 of the Dubbo LEP 2011

(1) The objective of this clause is to maintain the hydrological functions of key groundwater systems and to protect vulnerable groundwater resources from depletion and contamination as a result of inappropriate development.

Response: The development and groundwater at the site is described in the Groundwater and Salinity report prepared by Envirowest Consulting Pty Ltd (Report number R7891s1).

(2) This clause applies to the land identified as "Groundwater vulnerability" on the Natural Resources – Groundwater Vulnerability Map.

Response: The site is located in a mapped moderately high groundwater vulnerability area.

(3) Before determining a development application for development on land to which this clause applies, the consent authority must consider:

> *(a) whether the development (including any on-site storage or disposal of solid or liquid waste chemicals) will cause any groundwater contamination or any adverse effect on groundwater dependent ecosystems.*

Response:
The development has a low potential to adversely affect groundwater and groundwater dependent ecosystems. Groundwater and groundwater dependent ecosystems may be impacted by use of fertilisers on lawns and gardens, greywater reuse and car washing. The post development impact is expected to be similar or less than under the pre-development agricultural land-use.

Post development lawn inputs will only occur in a small proportion of the site that is lawns and gardens. Nitrogen fertiliser will not be required in native gardens. The impact from lawn fertilisers will be managed by riparian vegetation and stormwater design which will removed any potential increase in nitrogen rich fertilizers. Maintained gardens and lawns will have the capacity to utilise the nitrogen applied. The impact of nitrogen inputs post development will be reduced.

The post development scenario is expected to result in a decrease in contribution of phosphorus, nitrogen and suspended sediments. Fertilizer use in the residential subdivision with be less than the agricultural land-use. Stock numbers will decrease in the post development land-use while domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter disposed as refuse to landfill.

Minor usage of herbicides may occur post development on lawns. All fertilisers and agricultural chemicals are not residual and will be utilised by the vegetation or degrade rapidly in the environment. No impact on surface water or groundwater will occur.

NSW Health approves the following methods for greywater reuse:

- Bucketing: Generally only small volumes of greywater are reused and the action is unlikely to occur during wet weather. Risk of overwatering and therefore impact on groundwater is low.
- Greywater diversion devices: Does not require Council approval if conditions relating to installation and use are met. Conditions include undertaking checks and maintenance of the irrigation system, use biodegradable detergents low in phosphorus, sodium, boron and chloride, no irrigation during rain, undertake a water balance prior to installation, monitor

soil and plant response to irrigation, do not overwater and notify the local water utility of the device. Notification to the local water utility (Dubbo Regional Council) ensures Council is aware the system is in place and can check on compliance. Conditions ensure the water is used sustainably with minimal impact on the groundwater.

- Greywater treatment system: Requires approval from Council. Council can regulate the suitability and number of systems in the locality and check on the satisfactory operation of the system. Regulation of the system ensures minimal impact on groundwater.

Minor washing of cars by householders is expected to be undertaken post development. Most car owners clean cars in commercial washing bays. Small numbers of cars will be washed either on permeable areas resulting in infiltration or non-permeable areas with water moving into the reticulated stormwater system and off-site. Water and detergents infiltrating permeable areas will be utilised by vegetation. Some deeper infiltration may occur but volumes are not expected to be significant. Car washing is not expected to occur during rain.

No industrial activities including bulk storage or use of chemicals will occur in the development.

(b) The cumulative impact (including the impact on nearby groundwater extraction for potable water supply or stock water supply) of the development and any other existing development on groundwater.

Response:
Impact on groundwater from nitrogen contamination is expected to be less post development compared to pre-development due to lower contributions from animals and fertilisers. Other contaminates such as greywater reuse and car washing are expected to have a negligible impact on groundwater quality due to low risk of overwatering resulting in deep infiltration and regulation. The cumulative impact of the development and adjacent existing development on groundwater quality is expected to be negligible.

(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

(a) The development is designed, sited and will be managed to avoid any significant adverse environmental impact, or
(b) If that impact cannot be avoided by adopting feasible alternatives – the development is designed, sited and will be managed to minimise that impact, or
(c) If that impact cannot be minimised – the development will be managed to mitigate that impact.

No impacts from the development are expected if additional implementations are adopted. Offset contingences have also been proposed to provide additional assurance.

Mitigation measures will be adopted within the development to off-set the unlikely impacts on groundwater quality. The mitigation measures will comprise planting of deep-rooted vegetation off-sets as street trees and in the southern road reserve. The vegetation will intercept groundwater and nutrients and will reduce the potential impact on groundwater quality.

Deep-rooted vegetation comprising native species selected from the species list provided in DCC Water Wise and Salt Tolerant Plants list (no date) will be planted in proposed open space.

8.3 Vegetation

Most of the site contains annual species which are shallow rooted. No impact from saline soils and groundwater on the vegetation was observed.

Pasture grasses will be replaced with introduced or native garden species including deep rooted perennials. Garden species to be planted will be shallow rooted or salt tolerant and no impact on growth is expected. Trees will be planted as street trees, within the proposed freight way road reserve and within the riparian zone. The proposed residential development will contain irrigated and unirrigated lawns with plantings of shrubs and trees. Ecowise gardens of native and drought tolerant species will be promoted in the development. Costs associated with irrigation will ensure overwatering and leaching does not occur. On-site shallow groundwater is not expected to be a viable source of irrigation water due to the unreliable shallow groundwater aquifer. The deeper confined aquifer has been proven as a reliable source however recent reports suggest licences may be difficult due to groundwater decline within the upper Macquarie groundwater management area. The use of fertiliser and herbicides on lawn will be utilised by plants and will not move out of the rooting zone.

The new land-use will contain a mix of shallow and deep rooted vegetation. Species planted in lawns will utilise soil moisture all year round compared to the current pasture species mix which are mostly summer active only. Trees will be planted along roadways, garden areas and the riparian zone.

8.4 Infrastructure

Non to slightly saline soils were identified to a depth of 9.0m across the majority of the site which is below the footing depth for residential buildings. Moderately to highly saline soils were identified from 1.0m in the central to southern section of the assessment area. Excavations that are required to be at depths greater than 1.0m in the central to southern section of the assessment area should be consider salt protected materials for services and be undertaken in accordance with building in saline areas. Groundwater is present at depths greater than building depths. No special construction requirements addressing salinity are expected to be required for infrastructure including roads and buildings in the remainder of the site.

8.5 Pollution risk control

The subsoil is clay with depth of greater than 9 metres to groundwater. The soil layer provides significant filtration and absorption capacity to reduce contamination loading.

Occasional fertilizer and chemical use is expected from the residential land-use. Fertilisers will be utilised by plants. All agricultural chemicals degrade rapidly in the environment. No impact on surface water or groundwater will occur.

The site currently has a grazing land-use. Waste from the animals contains significant nutrients and pathogens which has potential to move in surface water flows.

Stock will be excluded in the post development land-use. Domestic pet numbers on the site are expected to increase. The majority of domestic pet scats are expected to be disposed to landfill by collection of the scats by owners or removal with kitty litter. The result will be a decrease contribution by animals to nutrients on the site.

Vegetation cover around the dwellings, in the nature strips and riparian zone will provide a biofilter resulting in reduced sediment loads exported. Nutrient impact on surface water will be reduced post development.

The site area is considered important as it forms part of the Macquarie River catchment. ANZECC (2000) has determined water quality indicators for river systems in regard to various environmental values (Table 17). The environmental values relate to the protection of:

- aquatic ecosystems
- aquatic foods
- primary contact recreation
- secondary contact recreation
- drinking water
- visual amenity
- irrigation water supplies
- homestead water supplies
- livestock water supplies
- human consumption of fish

The irrigation water quality indicators are considered appropriate for the catchment. The potential impact of the development on each water quality indicator has been assessed (Table 18). Potential issues relate to current and future land-use and management of the site.

The impact of the development on each water quality indicator will be negligible.

8.6 Earthworks

Moderate earthworks are expected for the development. Excavations in the central to southern section of the site should be restricted to depths of less than 1m reducing the risk of exposure of saline subsoils. The roads will be designed to ensure road levels are as close as possible to the existing natural levels to ensure saline-subsoils are not exposed. Subsoils in the majority of the site were classified as non-saline to slightly saline.

8.7 Other impacts of the development

Nil

9. Management recommendation

9.1 Design

The development water and soil design will include:

- Promote plantings of deep rooted vegetation as street trees, along the proposed freight way and within the riparian zone
- Deep rooted trees should be established in the road reserves in accordance with council policy of 1 tree per block
- Additional plantings of deep rooted vegetation in the road reserves located at the geological interface. The trees should be planted with 20m spacings (25 trees/ha).
- Planting of trees in expected areas of lithological/hydrological interfaces to minimise saline soils/groundwater
- Piping of surface water off-site
- Promote water sensitive design of dwellings and gardens
- Stormwater retention basins lined with an impermeable layer
- Design road levels similar to natural soil levels to minimise excavations
- Earthworks comprising cut should be minimised
- Excavated material with elevated salinity should be backfilled, utilised as fill under roads or disposed to landfill

- Assessment of soil salinity prior to house construction to enable appropriate design of footings

Table 17. Impacts of development on water quality (Environmental objectives)

Indicator	Objective	Impact of development
Nitrogen	5 mg/L	Nitrogen may be applied to the site as fertilisers. Nitrogen will be used by plants, digested by microbes or volatilised into the atmosphere. Infiltration for nitrogen into the subsoil and impact on groundwater systems will not occur. Maintenance of groundcover by minimal cultivation and no grazing are important factors in reducing nitrogen export. Nutrient modelling indicates nitrogen will decrease on site.
Faecal coliform	<10 cfu/100mL to 10,000cfu/100mL	The site will be serviced by the town sewer. No impact on faecal coliform levels is expected to result from the development.
Aluminium	5 mg/L	No impact.
Iron	0.2 mg/L	No impact.
Manganese	0.2 mg/L	No impact.
Dissolved oxygen	>6.5 mg/L	No effluent applied to the site. Vegetated areas are expected to be managed. No impact.
Phosphorus	0.05mg/L	Phosphorus may be applied to the site as fertilisers or in domestic pet scats. Domestic pet scats are expected to be removed by collection by owners or disposal of kitty litter and will not significantly contribute to phosphorus levels on the site. Phosphorus will be used by plants and absorbed in the soil. Groundcover will be enhanced in the development resulting in reduced sediment and phosphorus export. Post development fertiliser application rates will be reduced and the effect on phosphorus less. Nutrient modelling indicates phosphorous will decrease on site post development. Riparian planting and will additionally reduce phosphorus levels at stormwater discharge areas.
pH	between 6.0 and 8.5	Fertilisers have a declining influence on pH and effects off-site will be negligible.
Cyanobacteria	-	Cyanobacteria are dependent on the levels of nitrogen, phosphorus and water temperature. The development will not increase nitrogen and phosphorus therefore will have negligible impact. No cyanobacteria are present in fertilisers.
Conductivity	-	Exposure of saline soils and off-site movement will be minimised by adoption of recommendations including minimising depth of cut and implementation of erosion and sediment control plans. No impact expected.
Turbidity	-	Negligible impact due to small size of the development and the absence of any disturbed areas on site.

9.2 Buildings

Soil saturated extract electrical conductivity (EC_e) was determined to be less than 1.84 dS/m in the soil samples tested within the expected footing depth range of 0.6m (exposure classification A1). The lowest soil pH was 4.9 (exposure classification A2). Design characteristic strength for concrete is a minimum 25MPa and minimum curing requirement is continuous curing for at least 3 days will be required for the most aggressive sites (Appendix 2). Minimum reinforcement cover for concrete in soils is 45mm (Appendix 2). Site specific testing should be undertaken to classify the soil for footing design and construction in accordance with AS2870-2011 and confirm exposure classification (Appendix 2).

9.3 Exposure classification for concrete

Soil saturated extract electrical conductivity (EC_e) was determined to be <4dS/m in the soil samples tested from the expected footing depth (Table 13). The soil pH was greater than 4.9. Exposure classification for concrete is A2. Minimum design characteristic strength for concrete is 25MPa and minimum curing requirement is continuous curing for at least 3 days (Appendix 2). Minimum reinforcement cover for concrete in soils is 45mm (Appendix 2).

10. Conclusions

The site had a pasture grazing land-use. No bare areas resulting from sheet erosion or salinity were identified. The risk of erosion is low

Soils on the site comprised topsoil of variable depth consisting of strong brown to dark red loamy sand to silty clay. Subsoils were dark yellowish brown to red sandy clay to medium clay with increasing weathered basalt cobble and weathered rock with depth. Basalt cobbles and weathered rock were encountered from varying depths over the site between 1.1 to 9.0m resulting in drill refusal.

The northern half of the site is located in the Dubbo Basalt Hydro-geological Landscape (HGL). Lithology of the Dubbo Basalt Hydro-geological Landscape consists of Cainozoic basalt consisting of in situ Olivine rich alkali basalt with some colluvial material and quartzite derived from the underlying sandstone and siltstone. Soil salinity is isolated at areas along drainage lines, at the intersection with the Purlewaugh formation, depressions and footslopes. Saline soils also occur due to local perching of the water table. Groundwater flow is unconfined to semi-confined in consolidated fractured rock. Groundwater salinity is fresh to marginal.

The southern section of the site is located in the Purlewaugh/Napperby HGL. The landscape is characterised by low flat hills and rises with a stepped geomorphology. Lithology of the Purlewaugh/Napperby HGL consists of Purlewaugh Formation, Napperby Formation and Boulderwood Formation comprising mainly ferruginous red siltstone, carbonaceous mudstone, fine to medium grained lithic sandstone, ironstone, minor coal and minor conglomerate. Groundwater flow is unconfined to semi-confined flows through fractures in sandstone and sedimentary bedrock, permeable soils and saprolite. Lateral flow occurs through colluvial sediments on lower slopes. High recharge rates occur across the landscape particularly in areas where cropping is practised. Water electrical conductivity is moderate to high.

The change in slope in the central to southern section of the site is an example of stepped geomorphology characteristic of the Purlewaugh/Napperby HGL. It is also the expected location of the intersection of the Dubbo Basalt and Purlewaugh Formation. The stepped landscape broadly correspond to resistant layers in the stratigraphy. Saline areas in the Purlewaugh/Napperby HGL typically occur at these stepped locations and also at the intersection of the Dubbo Basalt and Purlewaugh Formation.

Subsoil samples collected from two boreholes constructed along the stepped geomorphology contained moderately to highly saline subsoils from 1m. Subsoils in other boreholes located in the northern half of the site and along Eulomogo Creek were non-saline. All topsoils samples were determined to be non-saline.

Groundwater or groundwater indicators were not encountered in the soil to a depth of 9m. Groundwater monitoring bores within 1km of the site and installed to depths of 15m have been mostly dry since monitoring began in 2005. Groundwater recharge within the Dubbo Basalt HGL is greatest on plateau areas and within the Purlewaugh/Napperby HGL is high across the landscape. Groundwater residence times are short.

No groundwater discharge areas were identified on the site.

Modelling of soil moisture levels over the past 34 years indicated variations in infiltration occur with the amount of rainfall pre and post development. Variations occur due to seasonal rainfall and land-use. Irrigation of lawn of 1mm/day results in infiltration in years with high rainfall at 1m and no infiltration at 3m.

Overall site the infiltration will be reduced in the development. Reduced infiltration is a result of the increase in runoff due to impermeable areas (roads, roofs, driveways) and increase in deep rooted vegetation extracting soil moisture from depth. The establishment of trees in strategic areas will offset any additional infiltration from lawn over watering.

The risk of groundwater contamination from the proposed land-use is equal or lower to the current land-use. Nitrogen contributions will decrease as a result of smaller available areas for fertilisation and a decrease in animal waste; domestic pet waste will generally be disposed off-site. Phosphorous and sediment contributions will also decrease. Washing of cars on permeable areas will not be a significant contributor to nutrient levels. Reuse of greywater will be small volumes of unregulated use or larger volumes which require specific conditions of use or regulation by Council. Conditions of use and regulation will ensure overwatering does not occur.

No impact on groundwater including contamination and changed groundwater levels is expected from the development if recommendations are adopted. The development will not impact on quantity or quality of both unconfined and confined aquifers.

11. Recommendations

The development water and soil design will include:

- Promote plantings of deep rooted vegetation as street trees, along the proposed freight way and within the riparian zone
- Deep rooted trees should be established in the road reserves in accordance with council policy of 1 tree per block
- Additional plantings of deep rooted vegetation in the road reserves located at the geological interface. The trees should be planted with 20m spacings (25 trees/ha).
- Planting of trees in expected areas of lithological/hydrological interfaces to minimise saline soils/groundwater
- Piping of surface water off-site
- Promote water sensitive design of dwellings and gardens
- Stormwater retention basins lined with an impermeable layer
- Design road levels similar to natural soil levels to minimise excavations
- Earthworks comprising cut should be minimised
- Excavated material with elevated salinity should be backfilled, utilised as fill under roads or disposed to landfill
- Assessment of soil salinity prior to house construction to enable appropriate design of footings

12. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the clients requirements. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

The investigation identifies the actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing is interpreted by geologists, engineers or scientists who then render an opinion about overall conditions, the nature and extent of likely impacts of the proposed development, and appropriate remediation measures. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no sub surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. It is thus import to understand the limitations of the investigation and recognise that we are not responsible for these limitations.

This report, including data contained, its findings and conclusions, remain the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted for the persons identified in that section after full payment for the services involved in preparation of the report. This report should not be used by persons or for purposes other than those stated, and not reproduced without the permission of Envirowest Consulting Pty Ltd.

13. References

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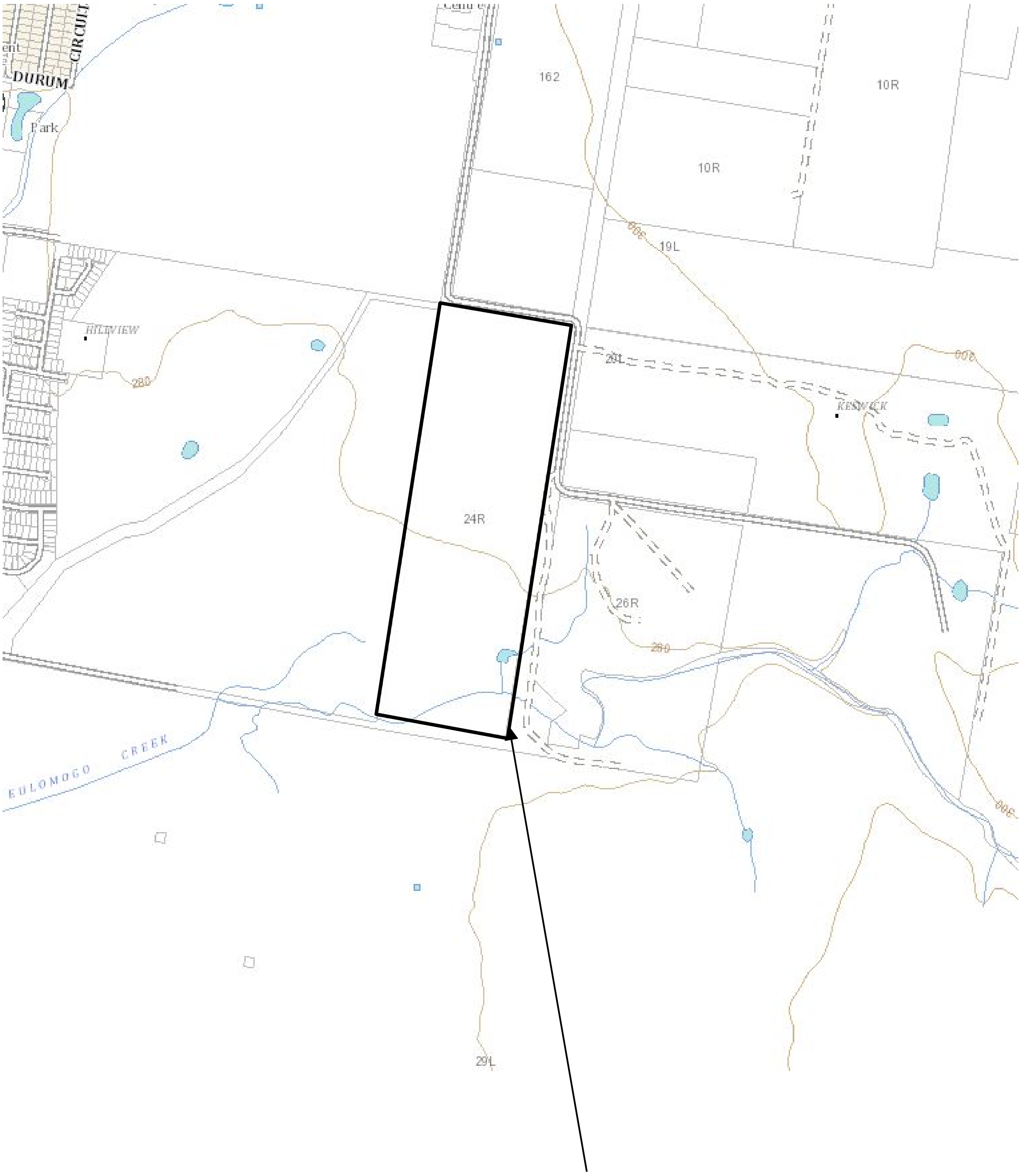
Figures

North



Investigation area

Figure 1: Locality plan	
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW	
	Envirowest Consulting Pty Ltd

Job – R7891s1	Drawn by: AP	Date: 20/01/2017

Legend

⊗	Sampling location	— · —	Fence
▬	Lot boundary	▬	Eulomogo Creek and drainage line
	Dam		

Approximate Scale 1: 6,200

0 62 124 248m

Figure 2: Site plan		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017

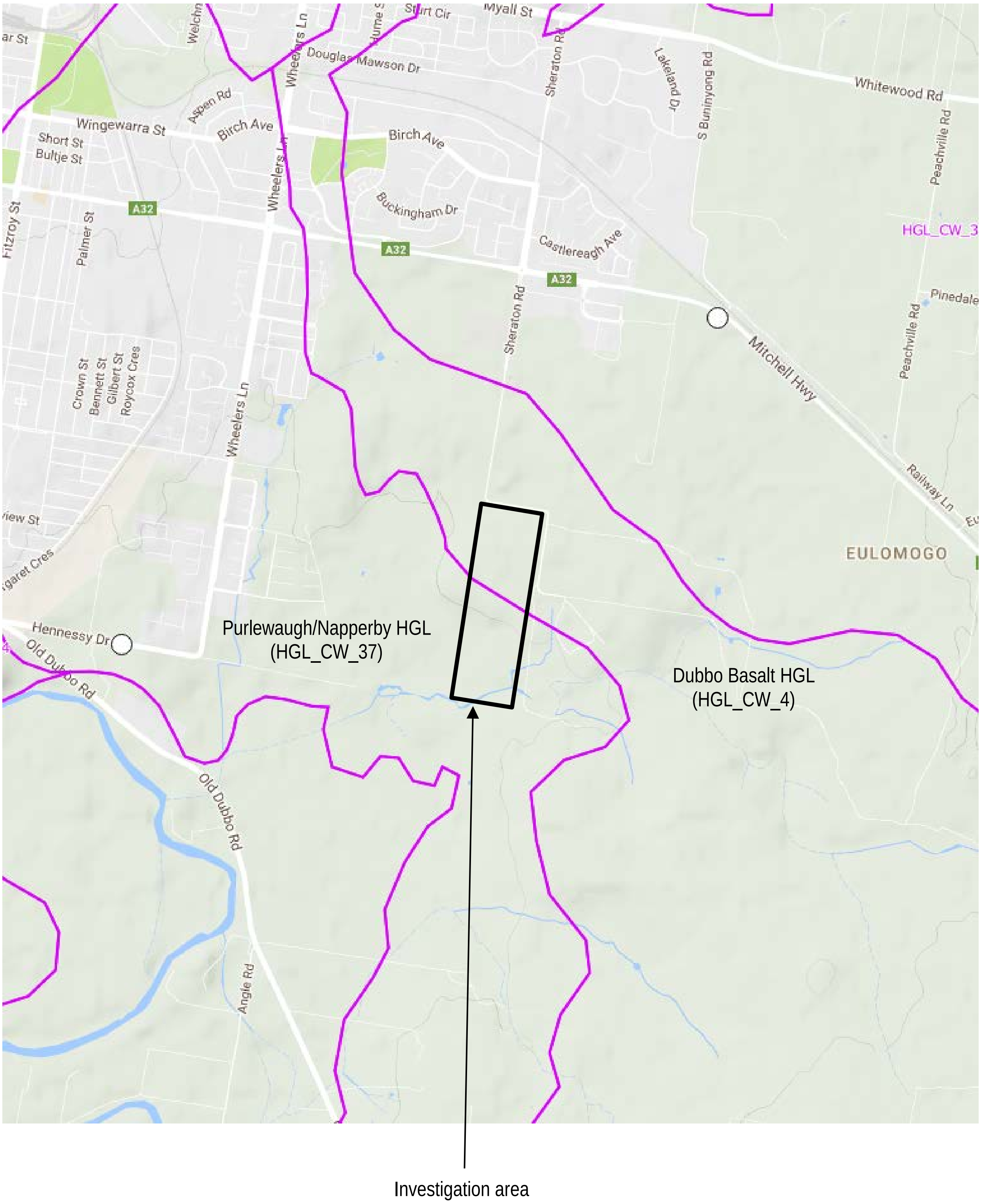


Figure 3: Hydro-geological landscapes (eSpade 2017)		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: -	Date: 20/1/2017

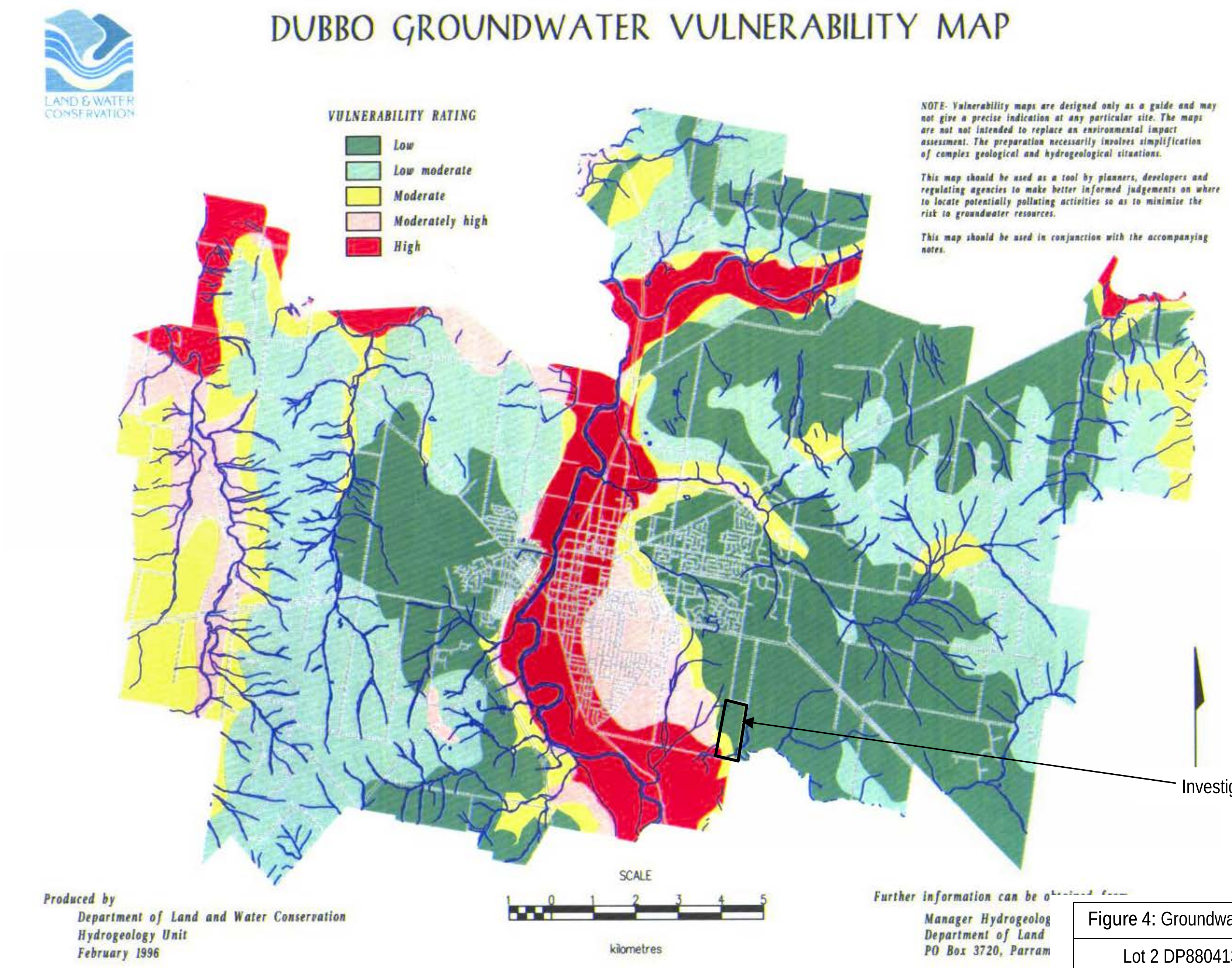


Figure 4: Groundwater vulnerability map of Dubbo - DECCW		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 20/01/2017

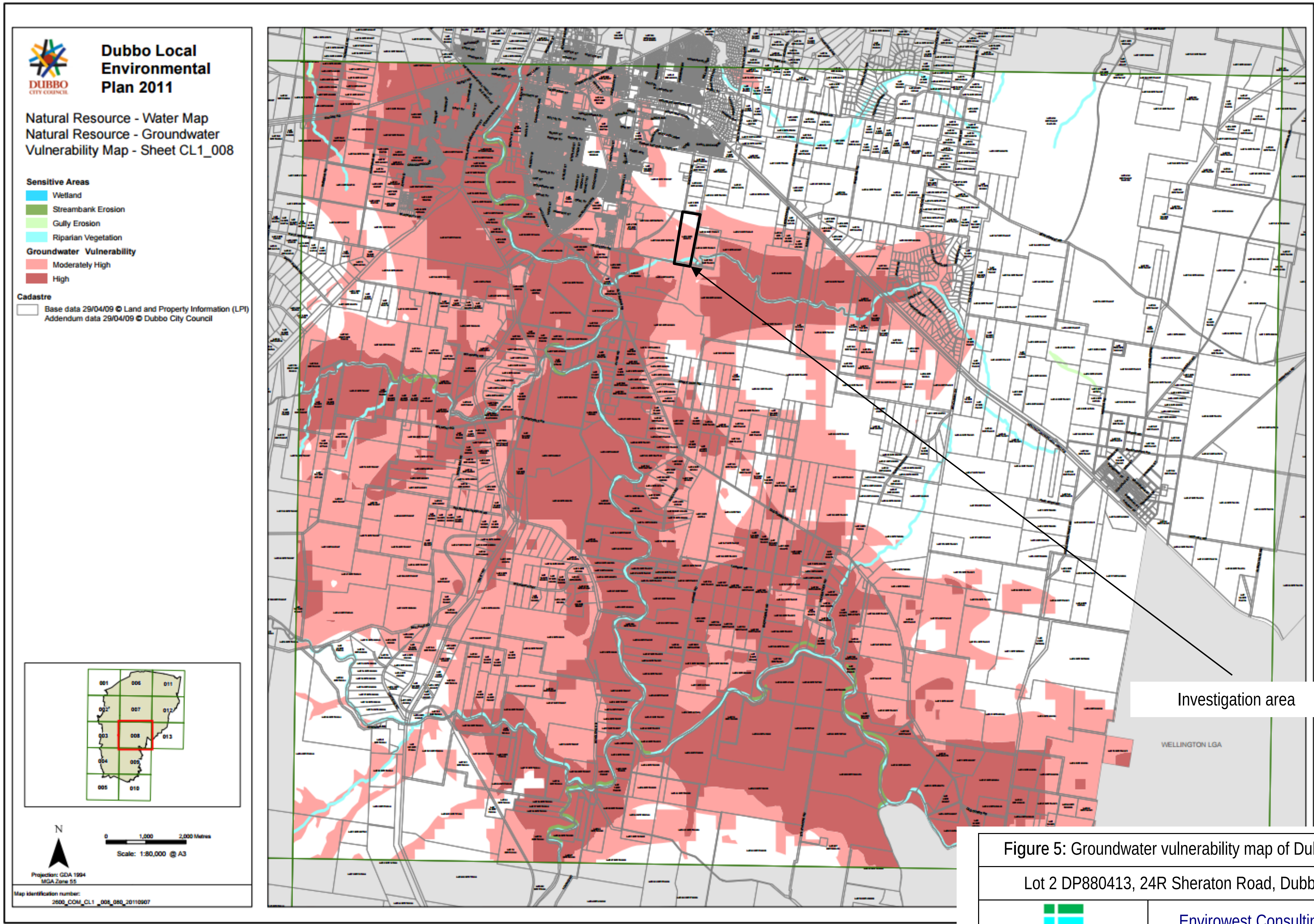
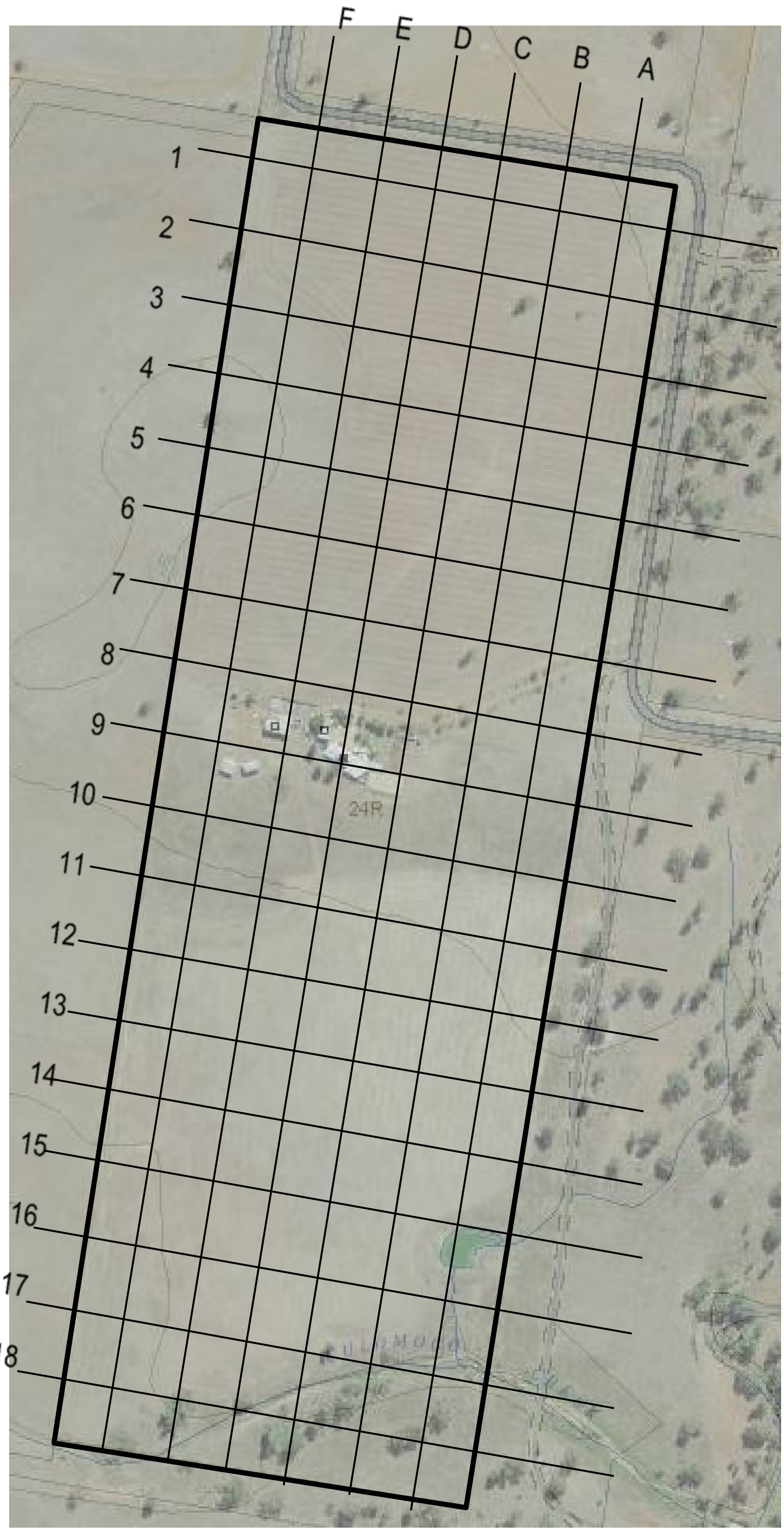


Figure 5: Groundwater vulnerability map of Dubbo - DCC		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 20/01/2017



North

Legend

Investigation area

Approximate Scale 1: 6,800

0 68 136 272m

Figure 6: Initial investigation locations		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017

Legend

Investigation area

Approximate Scale 1: 6,800

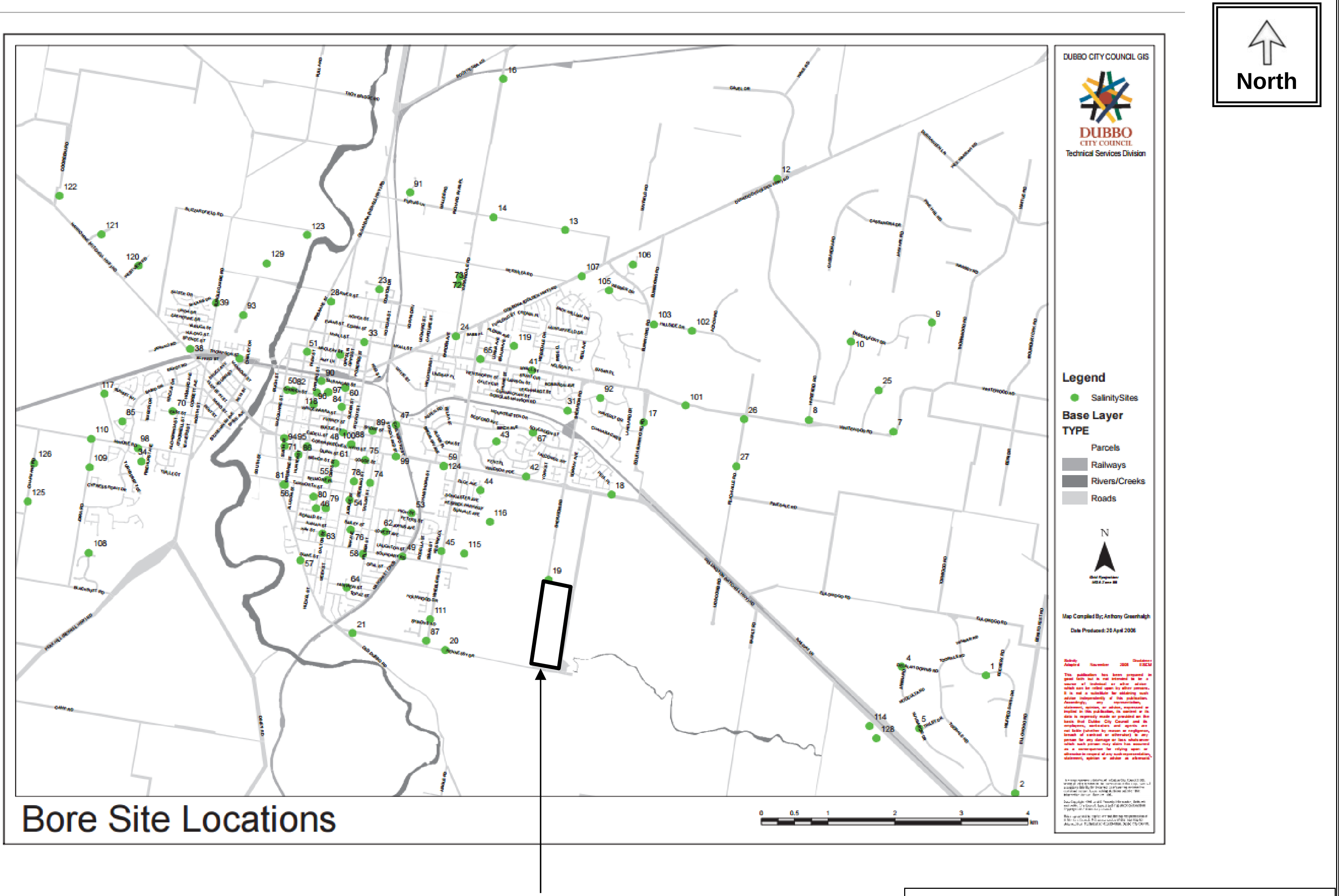
0 68 136 272m

Figure 7: Detailed investigation locations		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017

Approximate Scale 1: 15,200

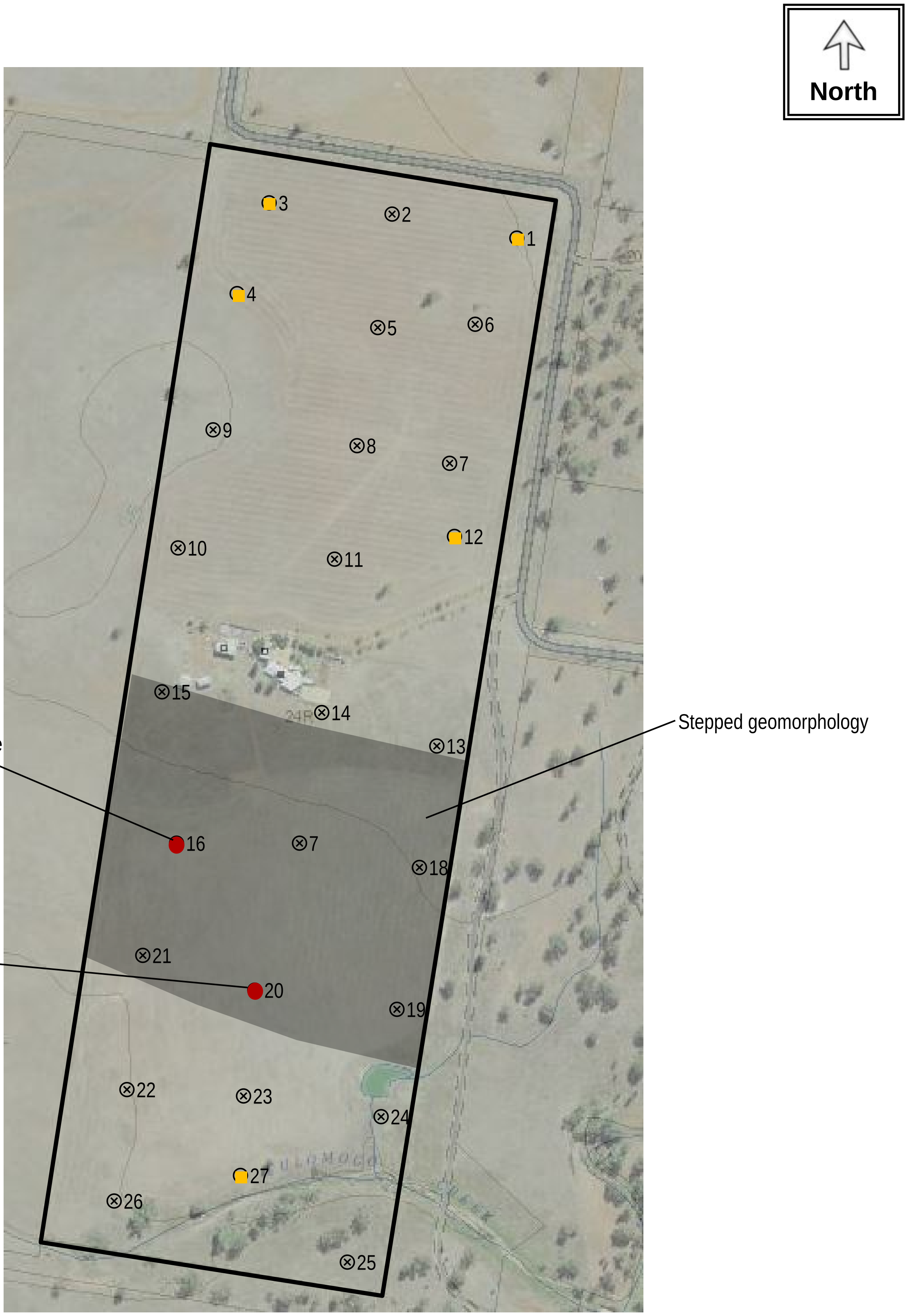
0 152 304 608m

Figure 8: Location of groundwater bores within 1km of the site		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: AP	Date: 20/01/2017



Investigation area

Figure 9: Dubbo Regional Council Salinity Network		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 20/01/2017



Approximate Scale 1: 6,800

0 68 136 272m

Legend

Investigation area	Saline soil identified in profile
Non-saline to slightly saline soil identified in soil profile to drilling depth	

Figure 10: Soil analysis results for salinity		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: LD	Date: 30/01/2017

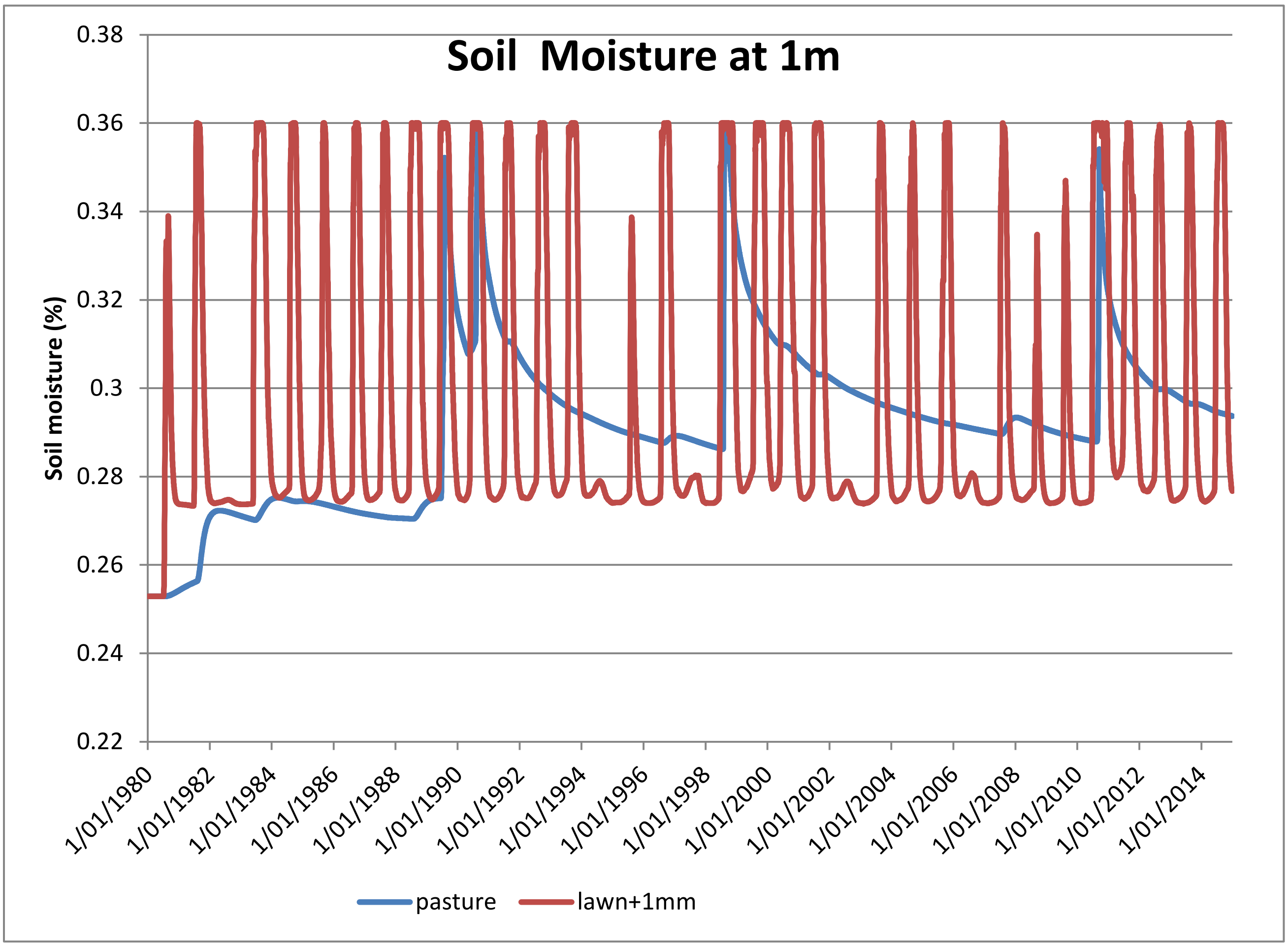


Figure 11. Soil moisture at 1m		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: LD	Date: 30/01/2017

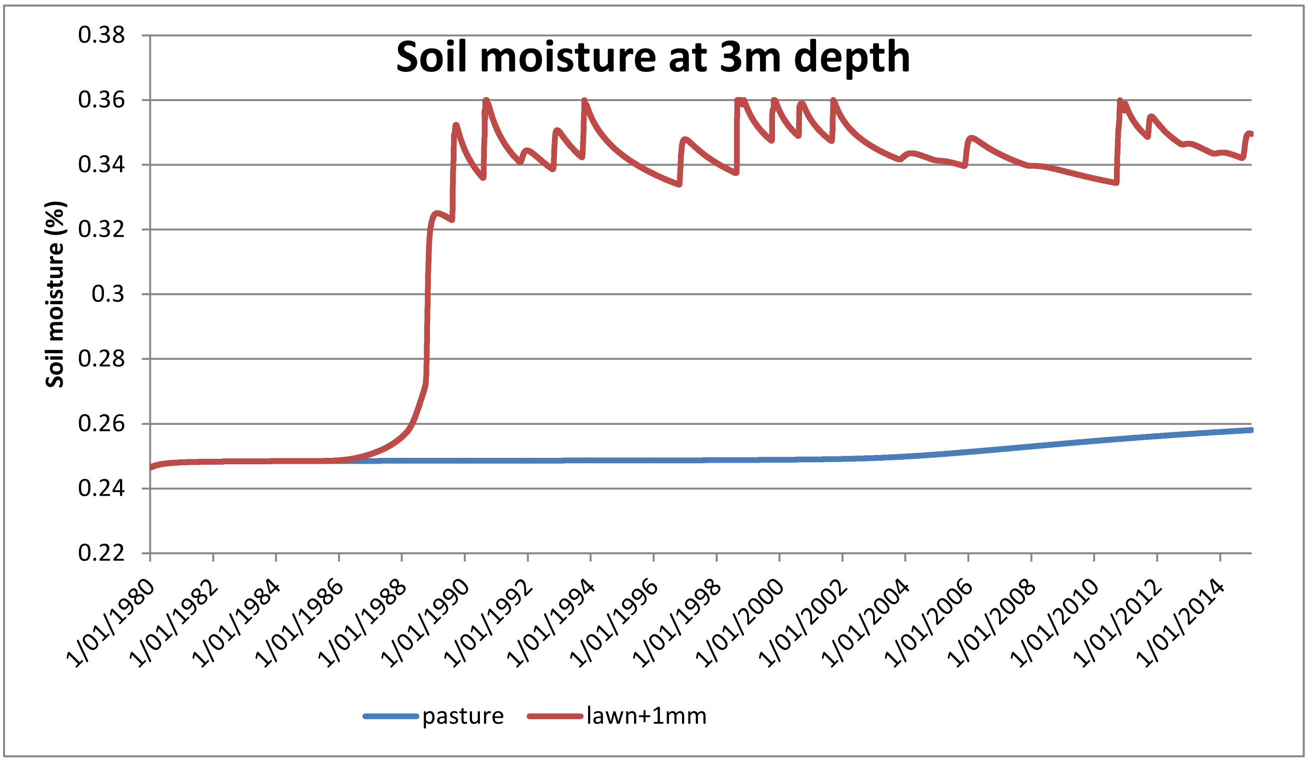


Figure 12. Soil moisture at 3m		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job – R7891s1	Drawn by: LD	Date: 30/01/2017

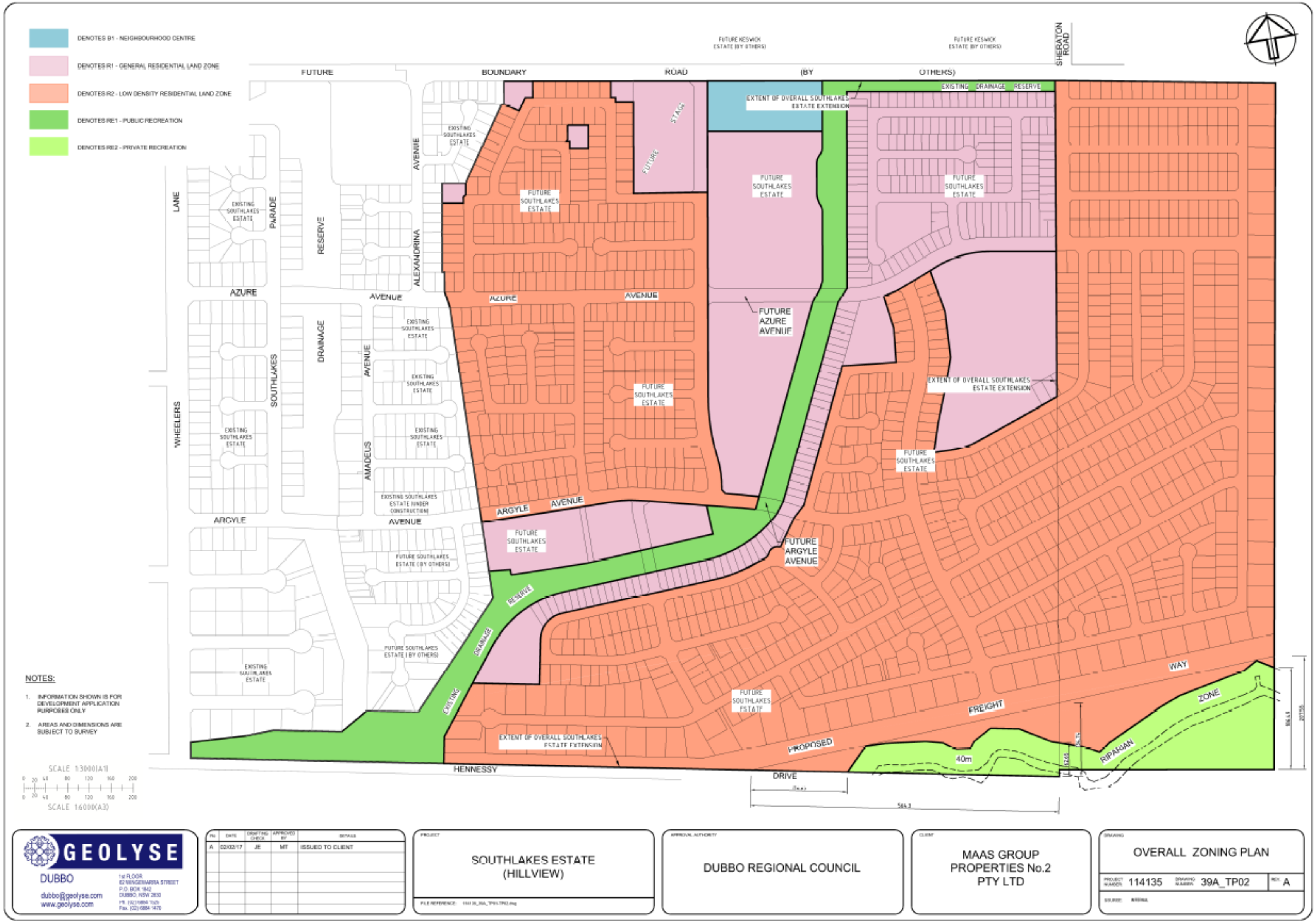


Figure 13: Proposed zoning plan		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891s1	Drawn by: -	Date: 3/2/2017

Figure 14. Photographs of the site

Looking south across paddocks

Looking north across Eulomogo Creek

Looking east across paddocks

Looking west over the site

Appendices

Appendix 1. Nutrient and sediment modelling
Appendix 2. Aggressive soils, extract from Australia Standards, AS 2870-2011, 2011
Appendix 3. Details of registered bores within 1km of the site – NSW Department of Primary Industries
Appendix 4. Salinity results from the Dubbo Regional Council Salinity Network
Appendix 5. Initial site investigation characteristics
Appendix 6. Field and laboratory sheets
Appendix 7. Reference methods for soil testing
Appendix 8. SGS laboratory report SE160957 and chain of custody form

Appendix 1. Nutrient and sediment modelling

Land-use export rates for sediments, nitrogen and phosphorus mg/kg/year (Chafer 2003)

	Suspended sediment (kg/ha/yr)		
Land use class	Low	Median	High
Native bushland	20	40	60
Disturbed landscapes	330	870	2290
Remediated gullies	165	435	1145
Cropped	420	570	720
Pine plantations	65	380	680
Improved pasture	140	520	870
Unimproved pasture	140	190	230
Roads (sealed)	140	190	230
Roads (earth)	25	140	500
Urban	30	300	1200
Urban (open space)	160	360	1000
Rural residential	140	190	230
Industrial	180	200	4800
Commercial	180	200	4800
Golf course	0	10	20
Orchard	490	680	870

	Total Nitrogen (kg/ha/yr)		
Land use class	Low	Median	High
Native bushland	0.9	2.4	4
Disturbed landscapes	4.2	12	20
Remediated gullies	2.1	6	10
Cropped	4.2	8.9	13.5
Pine plantations	0.8	2.9	8.3
Improved pasture	4.2	8.9	13.5
Unimproved pasture	1.3	3.2	5.1
Roads (sealed)	2	6	10
Roads (earth)	1.3	2.2	3.1
Urban	2.2	6.1	10
Urban (open space)	1.3	3.2	5.1
Rural residential	2.2	6.1	10
Industrial	4	7.4	10
Commercial	4	7.4	10
Golf course	0	3.2	5
Orchard	1.7	8.9	5

	Total Phosphorus		
Land use class	Low	Median	High
Native bushland	0.01	0.13	0.25
Disturbed landscapes	0.3	1.24	2.2
Remediated gullies	0.15	0.62	1.1
Cropped	0.5	1.35	2.2
Pine plantations	0.1	1.16	2.5
Improved pasture	0.5	1.35	2.2
Unimproved pasture	0.1	0.17	0.25
Roads (sealed)	0.3	1.8	3.4
Roads (earth)	0.3	1.72	3.2
Urban	0.2	1.82	3.6
Urban (open space)	0.1	0.17	0.25
Rural residential	0.2	1.72	3.6
Industrial	1.4	1.82	2.2
Commercial	1.4	1.8	2.2
Golf course	0	0.3	3.6
Orchard	0.1	0.3	0.5

Sediment export kg/yr LOW	PRE	POST	IMPACT
Native bushland	0.00	214.00	-214.00
Disturbed landscapes	726.00	0.00	726.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	6608.00	0.00	6608.00
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	994.00	-994.00
Roads (earth)	12.50	0.00	12.50
Urban	3.00	855.00	-852.00
Urban (open space)	0.00	592.00	-592.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**7349.50**	**2655.00**	**4694.50**

MEDIAN	PRE	POST	IMPACT
Native bushland	0.00	428.00	-428.00
Disturbed landscapes	1914.00	0.00	1914.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	24544.00	0.00	24544.00
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	1349.00	-1349.00
Roads (earth)	70.00	0.00	70.00
Urban	30.00	8550.00	-8520.00
Urban (open space)	0.00	1332.00	-1332.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**26558.00**	**11659.00**	**14899.00**

HIGH	PRE	POST	IMPACT
Native bushland	0.00	642.00	-642.00
Disturbed landscapes	5038.00	0.00	5038.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	41064.00	0.00	41064.00
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	1633.00	-1633.00
Roads (earth)	250.00	0.00	250.00
Urban	120.00	34200.00	-34080.00
Urban (open space)	0.00	3700.00	-3700.00
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**46472.00**	**40175.00**	**6297.00**

Total Nitrogen kg/yr

LOW	**PRE**	**POST**	**IMPACT**
Native bushland	0.00	0.00	0.00
Disturbed landscapes	9.24	0.00	9.24
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	198.24	0.00	198.24
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	14.20	-14.20
Roads (earth)	0.65	0.00	0.65
Urban	0.22	62.70	-62.48
Urban (open space)	0.00	4.81	-4.81
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**208.35**	**81.71**	**126.64**

MEDIAN	**PRE**	**POST**	**IMPACT**
Native bushland	0.00	25.68	-25.68
Disturbed landscapes	26.40	0.00	26.40
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	420.08	0.00	420.08
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	42.60	-42.60
Roads (earth)	1.10	0.00	1.10
Urban	0.61	173.85	-173.24
Urban (open space)	0.00	11.84	-11.84
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**448.19**	**253.97**	**194.22**

HIGH	**PRE**	**POST**	**IMPACT**
Native bushland	0.00	42.80	-42.80
Disturbed landscapes	44.00	0.00	44.00
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	637.20	0.00	637.20
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	71.00	-71.00
Roads (earth)	1.55	0.00	1.55
Urban	1.00	285.00	-284.00
Urban (open space)	0.00	18.87	-18.87
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**683.75**	**417.67**	**266.08**

Total Phosphorus kg/yr

LOW	PRE	POST	IMPACT
Native bushland	0.00	0.11	-0.11
Disturbed landscapes	0.66	0.00	0.66
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	23.60	0.00	23.60
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	2.13	-2.13
Roads (earth)	0.15	0.00	0.15
Urban	0.02	5.70	-5.68
Urban (open space)	0.00	0.37	-0.37
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**24.43**	**8.31**	**16.12**

MEDIAN	PRE	POST	IMPACT
Native bushland	0.00	1.39	-1.39
Disturbed landscapes	2.73	0.00	2.73
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	63.72	0.00	63.72
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	12.78	-12.78
Roads (earth)	0.86	0.00	0.86
Urban	0.18	51.87	-51.69
Urban (open space)	0.00	0.63	-0.63
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**67.49**	**66.67**	**0.82**

HIGH	PRE	POST	IMPACT
Native bushland	0.00	2.68	-2.68
Disturbed landscapes	4.84	0.00	4.84
Remediated gullies	0.00	0.00	0.00
Cropped	0.00	0.00	0.00
Pine plantations	0.00	0.00	0.00
Improved pasture	103.84	0.00	103.84
Open area	0.00	0.00	0.00
Roads (sealed)	0.00	24.14	-24.14
Roads (earth)	1.60	0.00	1.60
Urban	0.36	102.60	-102.24
Urban (open space)	0.00	0.93	-0.93
Rural residential	0.00	0.00	0.00
Industrial	0.00	0.00	0.00
Commercial	0.00	0.00	0.00
Golf course	0.00	0.00	0.00
Orchard	0.00	0.00	0.00
TOTAL	**110.64**	**130.34**	**-19.70**

Appendix 2. Aggressive soils, extract from Australian Standards, *AS 2870-2011*, 2011

Exposure classification for concrete in saline soils

Saturated extract electrical conductivity (EC_e), *dS/m*	Exposure classification
<4	A1
4-8	A2
8-16	B1
>16	B2

Notes:
1. Guidance on concrete in saline soils can be found in CCAA T56
2. Exposure classifications are from AS 3600
3. The currently accepted method of determining the salinity level of the soil is by measuring the extract electrical conductivity (*EC*) of a soil and water mixture in deciSiemens per metre (dS/m) and using conversion factors that allow for the soil texture, to determine the saturated extract electrical conductivity (EC_e)
4. The division between a non-saline and saline soil is generally regarded as an EC_e value of 4dS/m, therefore no increase in the minimum concrete strength is required below this value

Exposure classification for concrete in sulfate soils

Exposure conditions			Exposure classification	
Sulfates (expressed as SO_4)*		pH	Soil conditions A**	Soil conditions B†
In soil (ppm)	In groundwater (ppm)			
<5,000	<1,000	>5.5	A2	A1
5,000-10,000	1,000-3,000	4.5-5.5	B1	A2
10,000-20,000	3,000-10,000	4-4.5	B2	B1
>20,000	>10,000	<4	C2	B2

* Approximately 100ppm SO_4 = 80ppm SO_3
** Soil conditions A – high permeability soils (e.g. sands and gravels) that are in groundwater
† Soil conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater

Minimum design characteristic strength (f_c') and curing requirements for concrete

Exposure classification	Minimum f_c' MPa	Minimum initial curing requirement
A1	20	Cure continuously for at least 3 days
A2	25	
B1	32	Cure continuously for at least 7 days
B2	40	
C1	≥50	
C2	≥50	

Minimum reinforcement cover for concrete

Exposure classification	Minimum cover in saline soils * mm	Minimum cover in sulfate soils ** (mm)
A1	See Clause 5.3.2	40
A2	45	50
B1	50	60
B2	55	65
C1	†	70
C2	†	85

* Where a damp-proofing membrane is installed, the minimum reinforcement cover in saline soils may be reduced to 30mm.
** Where a damp-proofing membrane is installed, the minimum reinforcement cover in sulfate soils may be reduced by 10mm.
† Saline soils have a maximum exposure classification of B2.

Appendix 3. Details of registered bores within 1km of the site – NSW Department of Primary Industries.

Bore record No. (Figure 8)	Eastings	Northings	Drilled / Completed depth (m)	Salinity description	Water bearing zones (m)	Standing water level (m)	Date drilled and or tested	Purpose
GW802554	654491	6428905	9	-	6.5-7.5	-	2004	Monitoring
GW801343	65493	6428486	59	-	-	-	1992	Unknown
GW802528	654952	6428393	3	-	2-3	2.9	2004	Monitoring
GW005558	654961	6428252	57.9	-	26.2-33.8	18.3	1959	Stock
GW801344	655053	6428466	32	-	-	-	1992	Unknown
GW801345	655153	6428459	34	-	-	-	1992	Unknown
GW044627	655566	6428489	-	-	-	-	1975	Domestic / Stock
GW043040	655879	6428423	87.78	-	-	-	1974	Stock, domestic
GW003368	656208	6427678	49.68	Fresh	43.9	34.7	1935	Unknown
GW803646	655720	6427105	10	-	-	-	2008	Industrial / Commercial
GW037126	654588	6426101	57.9	-	-	-	1973	Test Bore / Public Municiple
GW060589	654612	6425978	12.5	-	-	-	-	Stock
GW042708	654431	6426104	49.3	Good	7-23.7	6.7	1974	Town water supply
GW801334	654198	6426159	46	-	13-35	12.9	2001	Town water supply
GW043755	654223	6426199	61	Good	7.9-20.7 41.1-47.5	6	1973	Test Bore
GW035817	653989	6426295	54.8	-	6-25.2	5.1	1973	Test
GW043754	654147	6426385	76.2	-	40.8-46.8	6	1973	Test
GW042707	653923	6426548	46.6	0-500ppm	41.1-46.5	7	1974	Town water
GW043753	654020	6426603	68.5	-	15.2-22.8	7.2	1973	Test bore
GW096140	653928	6426550	48	-	41.2-47	15.9	2003	Town water
GW805385	-	-	-	-	-	-	-	-
GW058296	653743	6427346	29.5	-	19.8-29.5	19.8	1983	Stock/ Domestic
GW055350	653851	6427529	21.6	-	-	-	-	Stock/ Domestic
GW055351	654606	6427302	-	-	-	-	-	Stock
GW801338	654839	6428083	149	-	-	-	1992	Unknown
GW801339	655140	6428060	29	-	-	-	1992	Unknown
GW011014	655192	6428002	67.1	-	57.9-60.9	-	1954	Stock
GW801341	655069	6427708	83	-	-	-	1992	Unknown
GW066591	654792	6427484	93	-	-	-	1990	Domestic / Stock
GW801342	654991	6427237	72	-	-	-	1991	Unknown
GW801337	654636	6426994	65	-	-	-	1992	Unknown
GW801340	654937	6426884	53	-	-	-	1992	Unknown

Appendix 4. Salinity and Standing Water Level (SWL) data from Dubbo Regional Council Salinity Network

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Mar-05	EC(dS/m)	-	TSTB	TSTB	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	2.9	14.72	DRY	DRY	DRY	DRY	DRY	DRY	5.46	DRY	DRY
Apr-05	EC(dS/m)	-	TSTB	-	-	TSTB	0.3	-	-	-	-	-	-
	SWL (m)	5.91	2.83	14.57	0.2	6	6.8	DRY	DRY	DRY	DRY	DRY	DRY
May-05	EC(dS/m)	-	-	-	-	-	0.3	-	-	-	-	-	-
	SWL (m)	DRY	DRY	14.9	DRY	DRY	5.87	DRY	DRY	DRY	DRY	DRY	DRY
Jun-05	EC(dS/m)	-	-	-	-	-	1.4	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	5.95	DRY	DRY	DRY	DRY	DRY	DRY
Jul-05	EC(dS/m)	-	-	-	-	-	1.3	-	-	-	-	0.3	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.9	DRY	DRY	DRY	DRY	7.01	DRY
Aug-05	EC(dS/m)	-	-	-	-	-	1.3	-	-	-	-	0.4	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.4	DRY	DRY	DRY	DRY	8.0	DRY
Sep-05	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	0.1	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.76	DRY	DRY	DRY	DRY	5.87	DRY
Oct-05	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	0.2	0.7
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.45	DRY	DRY	DRY	DRY	6.37	2.3
Nov-05	EC(dS/m)	-	-	-	-	-	-	-	-	-	1.00	0.2	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.4	DRY	DRY	DRY	3.81	6.4	DRY
Dec-05	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.80	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	3.71	DRY	DRY
Jan-06	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	0.3	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.04	8.0	DRY
Feb-06	EC(dS/m)	-	-	TSTB	-	-	TSTB	-	-	-	0.90	TSTB	TSTB
	SWL (m)	DRY	DRY	-	DRY	DRY	8.75	DRY	DRY	DRY	3.80	8.5	3.26
Mar-06	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.00	DRY	DRY
Apr-06	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	1.40	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	4.6	DRY	DRY	DRY	4.53	DRY	DRY

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
May-06	EC(dS/m)	-	-	-	-	-	0.7	-	-	-	1.10	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	3.29	DRY	DRY	DRY	4.98	DRY	3.26
Jun-06	EC(dS/m)	-	-	-	-	-	1.0	-	-	-	1.00	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	4.25	DRY	DRY	DRY	5.30	DRY	3.3
Jul-06	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	TSTB	0.1	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	2.87	DRY	DRY	DRY	5.81	5.75	DRY
Aug-06	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	0.3	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.42	DRY	DRY	DRY	DRY	7.59	DRY
Sep-06	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.45	DRY	DRY	DRY	DRY	DRY	DRY
Oct-06	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Nov-06	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Dec-06	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Jan-07	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.5	DRY	DRY	DRY	DRY	DRY	3.29
Feb-07	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	4.96	DRY	DRY	DRY	DRY	DRY	3.3
Mar-07	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.43	DRY	DRY	DRY	DRY	DRY	DRY
Apr-07	EC(dS/m)	-	-	-	-	-	1.8	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.46	DRY	DRY	DRY	DRY	DRY	3.3
May-07	EC(dS/m)	-	-	-	-	-	0.8	-	-	-	-	TSTB	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.09	DRY	DRY	DRY	DRY	6.33	3.3
Jun-07	EC(dS/m)	TSTB	TSTB	-	-	-	0.7	-	-	-	-	-	TSTB
	SWL (m)	4.59	2.79	DRY	DRY	DRY	7.47	DRY	DRY	DRY	DRY	5.47	3.32

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Jul-07	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.62	DRY	DRY	DRY	DRY	DRY	3.25
Aug-07	EC(dS/m)	1.7	TSTB	1.00	-	-	0.9	-	-	-	1.00	-	-
	SWL (m)	4.52	2.69	14.36	DRY	DRY	7.31	DRY	DRY	DRY	7.53	DRY	DRY
Sep-07	EC(dS/m)	TSTB	TSTB	-	-	-	0.9	-	-	-	1.00	-	-
	SWL (m)	5.85	2.75	17.61	DRY	DRY	7.33	DRY	DRY	DRY	4.86	DRY	DRY
Oct-07	EC(dS/m)	-	-	-	-	-	TSTB	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.69	DRY	DRY	DRY	DRY	DRY	DRY
Nov-07	EC(dS/m)	-	-	-	-	-	TSTB	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.74	DRY	DRY	DRY	DRY	DRY	DRY
Dec-07	EC(dS/m)	-	-	-	-	-	TSTB	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.28	DRY	DRY	DRY	DRY	DRY	DRY
Jan-08	EC(dS/m)	-	-	-	-	-	TSTB	-	-	-	-	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.79	DRY	DRY	DRY	DRY	DRY	3.29
Feb-08	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	3.16	DRY	DRY
Mar-08	EC(dS/m)	-	-	-	-	-	0.5	-	-	-	0.90	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.3	-	DRY	DRY	3.3	DRY	DRY
Apr-08	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY	DRY	4.00	DRY	DRY
May-08	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY	DRY	4.70	DRY	DRY
Jun-08	EC(dS/m)	-	-	-	-	-	DRY	-	-	-	0.90	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY	DRY	5.05	DRY	DRY
Jul-08	EC(dS/m)	-	-	-	-	-	-	-	-	-	1.10	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY	DRY	5.00	DRY	DRY
Aug-08	EC(dS/m)	-	-	-	-	-	7.9	-	-	-	0.85	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.25	-	DRY	DRY	5.00	DRY	DRY

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Sep-08	EC(dS/m)	-	-	-	-	-	0.9	-	-	-	-	0.2	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.56	-	DRY	DRY	DRY	6.2	DRY
Oct-08	EC(dS/m)	-	-	-	-	-	-	-	-	-	1.10	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY	DRY	5.01	DRY	DRY
Nov-08	EC(dS/m)	-	-	-	-	-	0.7	-	-	-	-	0.2	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.4	-	DRY	DRY	DRY	6.08	DRY
Dec-08	EC(dS/m)	-	-	-	-	-	1.0	-	-	-	-	0.5	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.47	-	DRY	DRY	DRY	7.32	DRY
Jan-09	EC(dS/m)	-	-	-	-	-	-	New	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	bore	DRY	DRY	DRY	DRY	DRY
Feb-09	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Mar-09	EC(dS/m)	-	-	-	-	-	1.01	TSTB	-	-	1.16	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.6	11.38	DRY	DRY	4.15	DRY	DRY
Apr-09	EC(dS/m)	-	-	-	-	-	1.14	-	-	-	1.16	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.41	DRY	DRY	DRY	4.15	DRY	DRY
May-09	EC(dS/m)	-	-	TSTB	-	-	-	-	-	-	1.15	-	-
	SWL (m)	DRY	DRY	14.61	DRY	DRY	DRY	DRY	DRY	DRY	4.35	DRY	DRY
Jun-09	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Jul-09	EC(dS/m)	-	-	TSTB	-	-	0.96	-	-	1.99	1.02	-	-
	SWL (m)	DRY	DRY	14.70	DRY	DRY	7.35	DRY	DRY	4.88	4.56	DRY	DRY
Aug-09	EC(dS/m)	-	-	TSTB	-	-	1.08	-	-	2.47	1.19	-	-
	SWL (m)	DRY	DRY	14.78	DRY	DRY	7.96	DRY	DRY	5.13	4.70	DRY	DRY
Sep-09	EC(dS/m)	-	-	-	-	-	1.23	-	-	2.69	1.26	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.15	DRY	DRY	5.37	4.86	DRY	DRY
Oct-09	EC(dS/m)	-	-	TSTB	-	-	TSTB	-	-	2.41	1.11	0.52	-
	SWL (m)	DRY	DRY	14.77	DRY	DRY	8.79	DRY	DRY	4.64	4.81	7.38	DRY
Nov-09	EC(dS/m)	-	-	TSTB	-	-	1.5	-	-	-	1.53	-	-
	SWL (m)	DRY	DRY	14.78	DRY	DRY	8.52	DRY	DRY	DRY	5.01	DRY	DRY

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Dec-09	EC(dS/m)	-	-	TSTB	-	-	1.33	-	-	2.09	1.40	-	-
	SWL (m)	DRY	DRY	14.68	DRY	DRY	7.83	DRY	DRY	4.53	4.69	DRY	DRY
Jan-10	EC(dS/m)	-	-	-	-	-	-	-	-	2.69	TSTB	-	TSTB
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.83	5.17	DRY	3.41
Feb-10	EC(dS/m)	-	-	-	-	-	TSTB	1.34	-	2.36	1.06	-	0.4
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.74	10.47	DRY	4.49	5.24	-	2.33
Mar-10	EC(dS/m)	-	-	-	-	-	-	1.68	-	2.58	TSTB	0.4	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	10.89	DRY	4.67	5.78	7.47	DRY
Apr-10	EC(dS/m)	-	TSTB	-	-	-	TSTB	-	-	3.07	TSTB	-	0.31
	SWL (m)	DRY	2.87	DRY	DRY	DRY	8.95	DRY	DRY	4.92	5.58	-	1.43
May-10	EC(dS/m)	-	-	-	-	-	-	-	-	3.19	-	DRY	0.51
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.86	DRY	DRY	1.57
Jun-10	EC(dS/m)	-	-	-	-	-	-	-	-	2.62	-	-	0.47
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	5.07	DRY	-	0.3
Jul-10	EC(dS/m)	-	-	-	-	-	-	-	-	2.49	TSTB	-	0.62
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.84	5.79	-	0.59
Aug-10	EC(dS/m)	-	-	-	-	-	0.87	-	-	1.79	TSTB	-	0.78
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.55	DRY	DRY	3.65	5.82	-	0.74
Sep-10	EC(dS/m)	-	-	-	-	-	0.75	-	-	1.70	-	-	0.67
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.36	DRY	DRY	3.60	DRY	-	1.03
Oct-10	EC(dS/m)	-	-	-	-	-	-	-	-	-	1.10	-	0.32
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	5.29	-	2.45
Nov-10	EC(dS/m)	-	-	-	-	-	0.38	-	-	0.85	0.55	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	3.68	DRY	DRY	1.80	2.65	-	-
Dec-10	EC(dS/m)	-	-	-	-	-	0.56	-	-	1.24	0.70	-	0.74
	SWL (m)	DRY	DRY	DRY	DRY	DRY	5.09	DRY	DRY	3.25	2.92	-	1.84
Jan-11	EC(dS/m)	-	-	-	-	-	0.75	-	-	1.63	0.85	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.5	DRY	DRY	4.70	3.20	-	DRY
Feb-11	EC(dS/m)	-	-	-	-	-	1.06	-	-	TSTB	0.69	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.21	DRY	DRY	5.48	3.90	DRY	DRY

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Mar-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	0.74	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	4.20	DRY	DRY
Apr-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	1.08	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	5.59	DRY	DRY
May-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Jun-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	TSTB	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	5.82	DRY	DRY
Jul-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Aug-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Sep-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	TSTB	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	5.80	DRY	DRY
Oct-11	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
Nov-11	EC(dS/m)	-	TSTB	-	-	-	-	-	-	0.72	-	-	2.47
	SWL (m)	DRY	2.93	DRY	DRY	DRY	DRY	DRY	DRY	4.60	DRY	DRY	1.23
Dec-11	EC(dS/m)	-	-	-	-	-	1.14	-	-	-	-	-	1.56
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.3	DRY	DRY	DRY	DRY	DRY	0.95
Jan-12	EC(dS/m)	-	-	-	-	-	1.22	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.48	DRY	DRY	DRY	DRY	DRY	DRY
Feb-12	EC(dS/m)	-	-	-	-	-	1.31	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.4	DRY	DRY	DRY	DRY	-	-
Mar-12	EC(dS/m)	1.43	TSTB	-	-	-	1.88	-	-	-	-	-	-
	SWL (m)	3.73	2.82	DRY	DRY	DRY	8.03	DRY	DRY	DRY	DRY	-	-
Apr-12	EC(dS/m)	2.01	-	-	-	-	2.14	-	-	-	-	-	-
	SWL (m)	4.25	DRY	DRY	DRY	DRY	8.62	DRY	DRY	DRY	DRY	-	-
May-12	EC(dS/m)	2.24	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	4.83	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Jun-12	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Jul-12	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Aug-12	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Sep-12	EC(dS/m)	-	-	-	-	-	1.04	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.5	DRY	DRY	DRY	DRY	-	-
Oct-12	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Nov-12	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Dec-12	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Jan-13	EC(dS/m)	-	-	-	-	-	1.31	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.53	DRY	DRY	DRY	DRY	-	-
Feb-13	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY
Mar-13	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	0.54
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	1.58
Apr-13	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	0.3
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	1.63
May-13	EC(dS/m)	1.12	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	2.42	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY
Jun-13	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY
Jul-13	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	DRY
Aug-13	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Sep-13	EC(dS/m)	-	-	-	-	-	TSTB	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.68	DRY	DRY	DRY	DRY	-	-
Oct-13	EC(dS/m)	-	-	-	-	-	TSTB	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	8.68	DRY	DRY	DRY	DRY	-	-
Nov-13	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Dec-13	EC(dS/m)	-	-	-	-	-	1.05	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	7.98	DRY	DRY	DRY	DRY	-	-
Jan-14	EC(dS/m)	-	-	-	-	-	1.24	-	-	-	TSTB	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	5.60	DRY	DRY	DRY	5.30	-	-
Feb-14	EC(dS/m)	-	-	-	-	-	1.09	-	-	-	1.17	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	5.42	DRY	DRY	DRY	5.18	-	-
Mar-14	EC(dS/m)	-	-	-	-	-	1.25	-	-	-	1.22	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.08	DRY	DRY	DRY	5.00	-	-
Apr-14	EC(dS/m)	-	-	-	-	-	1.11	-	-	-	1.11	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	6.24	DRY	DRY	DRY	5.09	-	-
May-14	EC(dS/m)	1.02	-	-	-	-	0.94	-	-	-	-	-	-
	SWL (m)	2.59	DRY	DRY	DRY	DRY	5.98	DRY	DRY	DRY	DRY	-	-
Jun-14	EC(dS/m)	1.14	-	-	-	-	0.99	-	-	-	-	-	-
	SWL (m)	2.78	DRY	DRY	DRY	DRY	6.03	DRY	DRY	DRY	DRY	-	-
Jul-14	EC(dS/m)	1.25	-	-	-	-	1.03	-	-	-	-	-	-
	SWL (m)	2.91	DRY	DRY	DRY	DRY	6.20	DRY	DRY	DRY	DRY	-	-
Aug-14	EC(dS/m)	1.09	-	-	-	-	1.19	-	-	-	-	-	-
	SWL (m)	4.21	DRY	DRY	DRY	DRY	6.89	DRY	DRY	DRY	DRY	-	-
Sep-14	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	-	-	-	-	-	-	-	-	-	-	-	-
Oct-14	EC(dS/m)	-	-	-	-	-	-	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	-	-
Nov-14	EC(dS/m)	1.57	TSTB	-	-	-	1.35	-	-	-	-	-	-
	SWL (m)	4.87	2.85	DRY	DRY	DRY	7.95	DRY	DRY	DRY	DRY	-	-

TSTB – Too shallow to bail

Dubbo Regional Council Salinity Network site number (Figure 9)		DCC18	DCC19	DCC20	DCC42	DCC44	DCC45	DCC49	DCC53	DCC87	DCC111	DCC115	DCC116
Sampling date	Drilled depth (m)	15	3	15	2	6	9	15	9	6	6	9	3.5
Dec-14	EC(dS/m)	1.70	TSTB	-	-	-	1.34	-	-	-	-	-	-
	SWL (m)	4.51	2.80	DRY	DRY	DRY	7.90	DRY	DRY	DRY	DRY	-	-
Jan-15	EC(dS/m)	1.42	-	-	-	-	1.25	-	-	-	-	-	-
	SWL (m)	4.69	DRY	DRY	DRY	DRY	6.61	DRY	-	-	DRY	-	-
Mar-15	EC(dS/m)	-	-	-	-	-	1.15	-	-	-	-	-	-
	SWL (m)	DRY	DRY	DRY	DRY	DRY	5.91	DRY	-	-	DRY	-	-
May-15	EC(dS/m)	1.49	-	-	-	-	1.19	-	-	-	-	-	-
	SWL (m)	3.31	DRY	DRY	DRY	DRY	7.02	DRY	-	-	DRY	-	-
Jul-15	EC(dS/m)	1.21	-	-	-	-	1.03	-	-	-	-	-	-
	SWL (m)	3.00	DRY	DRY	DRY	DRY	6.41	DRY	-	-	DRY	-	-
Sep-15	EC(dS/m)	0.98	-	-	-	-	1.09	-	-	-	-	-	-
	SWL (m)	4.87	DRY	DRY	DRY	DRY	7.85	DRY	-	-	DRY	-	-
Nov-15	EC(dS/m)	1.64	-	-	-	-	1.35	-	-	-	-	-	-
	SWL (m)	4.69	DRY	DRY	DRY	DRY	7.90	DRY	-	-	DRY	-	-
Jan-16	EC(dS/m)	-	-	-	-	0.65	2.13	-	-	-	-	-	0.15
	SWL (m)	DRY	DRY	DRY	DRY	1.29	7.50	DRY	-	-	DRY	-	2.14
Mar-16	EC(dS/m)	-	-	-	-	0.92	2.42	-	-	-	-	-	0.84
	SWL (m)	DRY	DRY	DRY	DRY	1.87	7.71	DRY	-	-	DRY	-	2.28
May-16	EC(dS/m)	-	-	-	-	1.69	1.69	-	-	-	-	-	0.94
	SWL (m)	DRY	DRY	DRY	DRY	7.31	7.31	DRY	-	-	DRY	-	2.49
Jul-16	EC(dS/m)	1.23	-	-	-	0.79	1.25	-	-	-	-	-	0.99
	SWL (m)	2.94	DRY	DRY	DRY	2.41	6.60	DRY	-	-	DRY	-	2.88
Sep-16	EC(dS/m)	1.11	-	-	-	0.58	1.17	-	-	-	-	-	0.84
	SWL (m)	2.71	DRY	DRY	DRY	2.15	6.31	DRY	-	-	DRY	-	2.69
Nov-16	EC(dS/m)	1.42	-	-	-	0.87	1.17	-	-	-	-	-	0.96
	SWL (m)	3.61	DRY	DRY	DRY	2.66	7.04	DRY	-	-	DRY	-	2.02

TSTB – Too shallow to bail

Appendix 5. Initial site investigation characteristics

Location (Figure 6)	Vegetation	Slope (%)	Bare areas	Indicators of salinity	Surface rocks	Trees (within 50m)
A1	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
A2	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
A3	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
A4	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
A5	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
A6	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
A7	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
A8	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
A9	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
A10	Pasture grasses, hedge mustard, rat's tail grass, campulana	0-1% S	Nil	Nil	Nil	Nil
A11	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
A12	Pasture grasses, hedge mustard, rat's tail grass, campulana, saffron thistle, yellow flowered pea	2% S	Nil	Nil	Nil	Nil
A13	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
A14	Pasture grasses, Paterson's curse, wild oats and paper daisy	0-1% S	Nil	Nil	Nil	Nil
A15	Pasture grasses, Paterson's curse, wild oats, umbrella grass and paper daisy	2% S	Bare areas due to drainage areas into dam	Nil	Nil	Nil
A16	Spear grass, wild oats, wild lettuce, paspalum	5% E towards drainage line	Nil	Nil	Nil	Nil
A17	Wild oats, skeleton weeds, wild lettuce, foxtail	0-1% S	Nil	Nil	Nil	Cyprus pines, eucalypt
A18	Cathead, wild oats, wild lettuce, hedge mustard	0-1% N	Nil	Nil	Nil	Cyprus pines
B1	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
B2	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
B3	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
B4	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
B5	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
B6	Pasture grasses including wild oats and shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
B7	Pasture grasses including wild oats and shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
B8	Pasture grasses including wild oats and shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
B9	Pasture grasses including wild oats and shepherd's purse	0-1% S	Nil	Nil	Nil	Nil

B10	Pasture grasses, hedge mustard, rat's tail grass, campulana	0-1% S	Nil	Nil	Nil	Nil
B11	Pasture grasses, hedge mustard, rat's tail grass, campulana	0-1% S	Nil	Nil	Nil	Nil
B12	Pasture grasses, hedge mustard, rat's tail grass, campulana, saffron thistle, yellow flowered pea	2% S	Nil	Nil	Nil	Nil
B13	Pasture grasses, hedge mustard, rat's tail grass, campulana, saffron thistle, yellow flowered pea	2% S	Nil	Nil	Nil	Nil
B14	Pasture grasses, Paterson's curse, wild oats and paper daisy	0-1% S	Nil	Nil	Nil	Nil
B15	Pasture grasses, Paterson's curse, wild oats, umbrella grass and paper daisy	2% S	Bare areas due to drainage areas into dam	Nil	Nil	Nil
B16	Spear grass, wild oats, wild lettuce, paspalum	1% W	Nil	Nil	Nil	Nil
B17	Hedge mustard, amaranth, saffron thistle, skeleton weed, wild sage, wild oats, plantain, foxtail	0-% N	Scattered	Nil	Nil	Eucalypt
B18	Cathead, wild oats, wild lettuce, hedge mustard	0-1% N	Nil	Nil	Nil	Cyprus pines
C1	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
C2	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
C3	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
C4	Pasture grasses including lucerne, wild oats, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
C5	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
C6	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
C7	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
C8	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
C10	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
C11	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Nil	Nil
C12	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Nil	Nil
C13	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
C14	Pasture grasses, Paterson's curse, wild oats, paper daisy	2% S	Nil	Nil	Nil	Nil
C15	Nightshade, wild oats, pasture grasses, paper daisy	0-1% N	Nil	Nil	Nil	Nil
C16	Spear grass, wild oats, wild lettuce, paspalum	0-1% S	Nil	Nil	Nil	Nil
C17	Paspalum, red grass, shepherds purse	0-1% S	Nil	Nil	Nil	Nil
C18	Wild lettuce, thistle, wild oats, hedge mustard	0-1% N	Nil	Nil	Nil	Cyprus pine, eucalypt
D1	Pasture grass, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
D2	Pasture grass, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
D3	Pasture grass, rat's tail grass, hedge mustard, Paterson's curse, campulana	1% N	Nil	Nil	Nil	Nil
D4	Pasture grass, rat's tail grass, hedge mustard, Paterson's curse, campulana	1% N	Nil	Nil	Nil	Nil

D5	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
D6	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
D7	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
D8	Pasture grasses including wild oats, shepherd's purse	0-1% S	Nil	Nil	Nil	Nil
D10	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
D11	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
D12	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
D13	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Nil	Nil
D14	Wild oats, umbrella grass, Paterson's curse, yellow flowered legume	0-1% SE	Nil	Nil	Nil	Ni
D15	Wild oats, umbrella grass, Paterson's curse, yellow flowered legume	0-1% SE	Nil	Nil	Nil	Ni
D16	Wild oats, umbrella grass, Paterson's curse, yellow flowered legume	0-1% SE	Nil	Nil	Nil	Cyprus pine
D17	Pasture grass, wild oats, umbrella grass, Lucerne, Paterson's curse	0-1% S	Nil	Nil	Nil	Eucalypt
D18	Wild oats, saffron thistle, spear grass, Paterson's curse	3% S	Nil	Nil	Nil	Eucalypt
E1	Pasture grass, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
E2	Pasture grass, rat's tail grass, hedge mustard	1% S	Nil	Nil	Nil	Nil
E3	Pasture grass, rat's tail grass, hedge mustard, saffron thistle	3% N	Nil	Nil	Nil	Nil
E4	Pasture grass, rat's tail grass, hedge mustard, saffron thistle	3% N	Nil	Nil	Nil	Nil
E5	Lucerne, cathead, hedge mustard	2% E	Nil	Nil	Scattered rocks	Nil
E6	Lucerne, cathead, hedge mustard	2% E	Nil	Nil	Scattered rocks	Nil
E7	Lucerne, cathead, hedge mustard	2% SE	Nil	Nil	Nil	Nil
E8	Lucerne, cathead, hedge mustard	2% SE	Nil	Nil	Nil	Nil
E10	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Scattered rocks	Nil
E11	Pasture grasses, hedge mustard, rat's tail grass,	2% S	Nil	Nil	Scattered rocks	Nil
E12	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Scattered rocks	Nil
E13	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Scattered rocks	Nil
E14	Wild oats, prairie grass, Paterson's curse, hedge mustard, saffron thistle	2% SW	Nil	Nil	Nil	Nil
E15	Saffron thistle, spear grass, wild oats, wild lettuce, paspalum, saffron thistle	3% W	Nil	Nil	Nil	Nil
E16	Saffron thistle, spear grass, wild oats, wild lettuce, paspalum, saffron thistle	3% W	Nil	Nil	Nil	Nil
E17	Wild oats, Lucerne, foxtail	3% SW	Nil	Nil	Nil	Eucalypt
E18	Pasture grasses, saffron thistle, wild oats, wild sagehedge mustard	0-1% S	Nil	Nil	Nil	Eucalypt
F1	Pasture grasses, hedge mustard, rat's tail grass	1-2% N	Nil	Nil	Nil	Nil
F2	Pasture grasses, hedge mustard, rat's tail grass	1-2% N	Nil	Nil	Nil	Nil
F3	Pasture grasses, hedge mustard, rat's tail grass	1-2% N	Nil	Nil	Nil	Nil

F4	Pasture grasses, hedge mustard, rat's tail grass, lucerne	4 % N	Nil	Nil	Scattered rocks	Nil
F5	Lucerne, cathead, hedge mustard	2% E	Nil	Nil	Scattered rocks	Nil
F6	Lucerne, cathead, hedge mustard	2% S	Nil	Nil	Scattered rocks	Nil
F7	Lucerne, cathead, hedge mustard	2% S	Nil	Nil	Nil	Nil
F8	Lucerne, cathead, hedge mustard	2% S	Nil	Nil	Nil	Nil
F9	Lucerne, cathead, hedge mustard	2% S	Nil	Nil	Nil	Nil
F10	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Scattered rocks	Nil
F11	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Scattered rocks	Nil
F12	Pasture grasses, hedge mustard, rat's tail grass	2% S	Nil	Nil	Scattered rocks	Nil
F13	Pasture grasses, hedge mustard, rat's tail grass, campulana	2% S	Nil	Nil	Scattered rocks	Nil
F14	Pasture grass, hedge mustard, lucerne	2% S	Nil	Nil	Nil	Nil
F15	Wild oats, Lucerne, Paterson's curse, clover, saffron thistle	1% NW	Nil	Nil	Nil	Nil
F16	Wild oats, Lucerne, Paterson's curse, clover, saffron thistle	1% NW	Nil	Nil	Nil	Nil
F17	Wild oats, hedge mustard, Lucerne, pasture grass, saffron thistle	0-1% SW	Nil	Nil	Nil	Eucalypt
F18	Wild oats, hedge mustard, Lucerne, pasture grass, saffron thistle	0-1% SW	Nil	Nil	Nil	Eucalypt

Appendix 5. Field and laboratory sheets

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	1	**GPS:** 55H 655142mE 6428025mN	

Surface description

Slope:	0-1%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil on surface		
Surface cover:	Lucerne, wild oats		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 200	Strong brown sandy clay	X	M	6.7	0.12	0.90	5
		X		7.1	0.12	0.90	5
200 to 1800	Reddish brown sandy clay with fine gravel and sand	X	M	7.3	0.11	0.83	5
		X		7.3	0.11	0.83	5
		X		7.3	0.12	0.90	5
		X		7.4	0.17	1.28	6
1800 to 2200	Dark yellowish brown light clay	X	M	7.5	0.20	1.50	6
2200 to 3200	Dark yellowish brown medium clay	X	M	7.6	0.21	1.22	6
		X		7.6	0.17	0.99	6
3200 to 4900	Dark yellowish brown sandy clay with fine gravel	X	M	7.7	0.15	1.23	6
		X	M	8.1	0.16	1.20	5
		X		7.2	0.18	1.35	5
4900 to 9000	Dark yellowish brown fine sandy clay loam with white mottles and weathered ironstone from 5600mm	X	M	8.4	0.15	1.43	5
		X		8.2	0.13	1.24	5
		X		8.3	0.13	1.24	5
		X		8.3	0.12	1.14	5
		X		8.4	0.10	0.95	5
		X		7.9	0.08	0.60	3
		X		8.5	0.07	0.53	3
		X		8.2	0.09	0.68	3
		X		8.2	0.08	0.60	3
9000	End of hole, refusal on basalt cobbles						
Notes: Nil							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	2	**GPS:**	55H 655003mE 6428055mN		

Surface description

Slope:	0%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil on surface		
Surface cover:	Lucerne, wild oats, hedge mustard and foxtail		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Red sandy loam		M				
400 to 2000	Red sandy clay with weathered ironstone		M				
2000	End of hole						
Notes: Nil							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	3	**GPS:**	55H 654866mE 6428071mN		

Surface description

Slope:	1%	Aspect:	West
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil on surface		
Surface cover:	Lucerne, wild oats, hedge mustard, foxtail, saffron thistle, wild sage		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Reddish brown sandy clay loam	X	M	5.8	0.03	0.29	3
100 to 400	Reddish brown fine sandy clay	X	M	6.3	0.02	0.15	3
		X		6.7	0.01	0.08	3
400 to 1400	Dark red light clay	X	M	6.6	0.01	0.08	5
		X		6.9	0.02	0.15	5
1400 to 1800	Dark red medium clay	X	M	6.8	0.01	0.06	5
		X		7.1	0.01	0.06	3
1800	End of hole, refusal on rock						
Notes: Hit rock at 1,200mm 20m west							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	4	**GPS:**	55H 654832mE 6427974mN		

Surface description

Slope:	0-1%	Aspect:	North west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil on surface		
Surface cover:	Wild oats, Lucerne, umbrella grass		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Reddish brown sandy loam	X	M	5.8	0.04	0.56	3
100 to 300	Dark red silty clay with gravel	X	M	5.6	0.02	0.17	2
		X	D	6.1	0.02	0.17	3
300 to 1400	Basalt rock						
1400	End of hole, refusal on basalt cobbles						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	5	GPS:	55H 654991mE 6427929mN		

Surface description

Slope:	0-1%	Aspect:	West
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, Lucerne, hedge mustard, nightshade, foxtail		
% surface cover	98% due to vegetation shading		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Red sandy loam		M				
400 to 800	Red sandy clay		M				
800 to 1700	Red light clay		M				
1700 to 2200	Dark red light clay		M				
2200 to 3000	Brown light clay		M				
3000	End of hole						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		Job no: 7891	Date: 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	6	GPS:	55H 655102mE 6427929mN

Surface description

Slope:	1%	Aspect:	West
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, Lucerne, red flowered mallow, nightshade		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 200	Brown sandy loam		M				
200 to 2200	Brown sandy clay		M				
2200 to 3000	Dark red clay		M				
3000	End of hole						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	7	**GPS:**	55H 655061mE 6427789mN

Surface description

Slope:	0-1%	Aspect:	East
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, hedge mustard, khaki weed		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 300	Brown sandy loam		M				
300 to 1700	Red sandy clay		M				
1700 to 2000	Brown light clay		M				
2000	End of hole						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	8	**GPS:**	55H 654962mE 6427810mN		

Surface description

Slope:	0-1%	Aspect:	South east
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Lucerne, wild oats, hedge mustard		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 300	Brown sandy loam		M				
300 to 1300	Brownish red sandy clay		M				
1300 to 2000	Brown sandy loam		M				
2000	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	9	**GPS:**	55H 654798mE 6427829mN		

Surface description

Slope:	0-1%	Aspect:	East
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Saffron thistle, wild oats, fat hen		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 1500	Dark red clayey gravel with basalt cobbles		M				
1500	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	10	**GPS:** 55H 654753mE 6427691mN	

Surface description

Slope:	0-1%	Aspect:	East
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Lucerne, fat hen, Paterson's curse		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Dark reddish brown silty clay		M				
400 to 800	Dark red sandy clay		M				
800 to 1400	Dark brownish red gravelly clay (weathered basalt)		D				
1400 to 2400	Light brown sandy clay with increasing gravel		D				
2400	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	11	**GPS:**	55H 654932mE 6427677mN

Surface description

Slope:	0-1%	Aspect:	East
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Surface float		
Surface cover:	Wild oats, Lucerne, hedge mustard		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Red sandy loam		D				
100 to 200	Dark red sandy loam		D				
200 to 1600	Dark red sandy clay with gravel from 800mm		D				
1600 to 1700	Reddish brown gravelly clay		D				
1700 to 2800	Brown sandy clay		D				
2800 to 3000	Yellowish brown sandy clay with calcite nodules		D				
3000 to 4100	Brownish yellow sandy clay		D				
4100 to 4200	Strong brown sandy clay		D				
4200	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 10/01/2017	
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	12	**GPS:**	55H 655067mE 6427703mN

Surface description

Slope:	0-1%	Aspect:	East
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Rye grass, hedge mustard		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Dusky red loamy fine sand	X	M	5.4	0.02	0.19	2
100 to 200	Dusky red sandy clay loam	X	M	5.8	0.02	0.19	1
200 to 800	Dark red silty clay	X	M	6.4	0.01	0.08	1
		X		6.6	0.01	0.08	3
800 to 2400	Reddish brown to yellowish red	X	M	7.3	0.02	0.15	5
	silty clay	X		7.3	0.02	0.15	3
		X		7.3	0.02	0.15	3
		X		7.5	0.02	0.15	2
2700 to 4400	Strong brown sandy clay with	X		6.6	0.02	0.15	2
	gravel. Gravel abundance	X	M	6.8	0.02	0.15	2
	increasing with depth.	X		6.3	0.02	0.15	2
4400 to 5000	Dark brown sandy clay with	X		6.8	0.02	0.15	2
	increasing gravel	X	M	7.0	0.02	0.15	2
5000	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	13	**GPS:**	55H 655050mE 6427465mN

Surface description

Slope:	0-1%	Aspect:	South
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, Paterson's curse		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Brown loamy sand		D				
400 to 1000	Brownish red silty clay		D				
1000 to 1500	Yellowish brown sandy clay with trace mottles and gravel		D				
1500 to 1700	Light yellowish brown loamy sand (weathered rock)	X	D	8.9	0.16	3.68	3
1700	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 10/01/2017
Address: Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole: 14	**GPS:** 55H 654921mE 6427500mN	

Surface description

Slope:	0-3%	Aspect:	South
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, juncus, Paterson's curse		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 500	Reddish brown silty clay		D				
500 to 900	Brownish grey silty clay with trace gravel and sand		D				
900 to 1000	Orange silty sand with weathered rock		D				
1000	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 10/01/2017
Address: Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole: 15	**GPS:** 55H 654732mE 6427557mN	

Surface description

Slope:	0-3%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Cobbles and ironstone gravel		
Surface cover:	Wild oats, Paterson's curse		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 600	Dark red loamy sand with increasing gravel		D				
600 to 1100	Dark red/brown sandy clay		D				
1100 to 2700	Yellowish brown sandy clay with cobbles		M				
2700 to 2900	Pinkish grey silty loam with grey mottles (weathered rock)	X	D	8.6	0.11	1.05	1
2900	End of hole, drill refusal						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 10/01/2017
Address: Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole: 16	**GPS:** 55H 654745mE 6427358mN	

Surface description

Slope:	0-1%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Lucerne, wild oats		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 1800	Brown to reddish brown loamy sand	X	M	4.9	0.03	0.69	2
		X		5.0	0.03	0.69	2
		X		5.7	0.02	0.46	2
		X		8.3	0.08	1.84	2
1800 to 2800	Reddish brown clayey sand with trace mottles	X	D	8.5	0.27	6.21	2
2800 to 3400	Brown sandy clay with trace mottles	X	D	8.4	0.29	2.18	2
3400 to 5600	Light grey to reddish grey clayey sand to sandy clay	X	D	9.5	0.41	9.43	2
		X		9.3	0.40	3.00	2
		X		9.2	0.32	3.04	2
		X		9.5	0.34	7.82	2
		X		9.3	0.31	2.67	2
5600	End of hole, drill refusal						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	17	**GPS:**	55H 654886mE 6427356mN		

Surface description

Slope:	0-1%	Aspect:	South
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Paterson’s curse, Lucerne, wild oats		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Dark brown silty clay loam		D				
400 to 600	Dark reddish brown silty clay with fine gravel		D				
600 to 1100	Light grey fine sandy clay loam (weathered rock)	X	D	7.6	0.04	0.34	3
1100	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 10/01/2017
Address: Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole: 18	**GPS:** 55H 655031mE 6427311mN	

Surface description

Slope:	0-1%	Aspect:	South
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Lucerne, Paterson’s curse		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Brown loamy sand		D				
400 to 700	Grey sandy clay		M				
700 to 1400	Pale yellow sand	X	D	7.3	0.02	0.46	2
1400 to 1500	Brownish red silty gravel		D				
1500	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	19	**GPS:**	55H 655013mE 6427238mN		

Surface description

Slope:	0-1%	Aspect:	South
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Surface rocks		
Surface cover:	Wild oats, Paterson's curse		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Brown loamy sand		D				
400 to 900	Grey/red sandy clay		M				
900 to 1000	Red loamy sand		D				
1000 to 2500	Pale yellow to light grey silty clay to sandy clay (weathered rock)	X X	D	9.6 8.9	0.38 0.12	2.85 0.90	3 2
2500	End of hole, drill refusal						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 11/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	20	**GPS:**	55H 654843mE 6427225mN

Surface description

Slope:	1%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Trace cobbles		
Surface cover:	Lucerne, wild oats, pasture grasses		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: LD					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 300	Dark brown loamy sand	X	M	5.9	0.03	0.69	3
		X	M	6.6	0.03	0.69	2
		X		6.9	0.03	0.69	2
300 to 1600	Reddish brown to strong brown	X	M	9.0	0.11	0.83	2
	sandy clay to light clay	X		9.5	0.53	3.98	3
		X		9.5	0.56	4.20	2
1600 to 2300	Strong brown sandy clay	X	M	9.3	0.52	3.90	2
2300 to 3300	Grey brown silty clay with fine	X		9.0	0.57	4.28	2
	gravel	X		9.4	0.60	4.50	2
3300 to 4900	Strong brown sandy clay with	X	D	9.4	0.55	4.20	2
	course gravel from 3600	X		9.6	0.55	4.13	2
	including alluvial gravel	X		9.7	0.52	3.90	2
		X	M	9.7	0.45	3.38	2
4900	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 11/01/2017
Address: Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole: 21	**GPS:** 55H 654672mE 6427280mN	

Surface description

Slope:	0-1%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Lucerne and wild oats		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 500	Brownish red sandy loam		D				
500 to 1100	Dark reddish brown red sandy clay with trace gravel		D				
1100 to 2000	Yellow/brown silty clay with gravel		D				
2000	End of hole						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	22	**GPS:**	55H 654691mE 6427080mN		

Surface description

Slope:	4%	Aspect:	South west
Morphological type:	Lower slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, hedge mustard, Paterson's curse, Lucerne, saffron thistle		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 800	Brown loamy sand with cobble at 300mm		M				
800 to 1500	Red sandy clay cobbles at 1500mm		M				
1500 to 1900	Brown sandy clay with gravel		D				
1900	End of hole, refusal on rock						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 10/01/2017
Address: Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole: 23	**GPS:** 55H 654796mE 6427052mN	

Surface description

Slope:	0-1%	Aspect:	West
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Spear grass, wild oats, lucerne, hedge mustard, umbrella grass, campulana, Paterson's curse, yellow flowered pea, paper daisy, saffron thistle		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Brown loamy sand		M				
400 to 2000	Red sandy clay		M				
2000	End of hole						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	24	**GPS:**	55H 654945mE 6427042mN

Surface description

Slope:	2%	Aspect:	South
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Surface rocks		
Surface cover:	Umbrella grass, couch grass, wild oats, hedge mustard		
% surface cover	90%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH | Logged by: DL

Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	FILL – Pale grey gravelly loam		M				
400 to 600	Brown sandy loam		M				
600 to 1100	Brown sandy clay		M				
1100 to 2000	Reddish brown sandy clay with gravel from 2000mm		M				
2000 to 2900	Brown sandy clay with gravel		M				
2900	End of hole, drill refusal						

Notes:

Salinity assessment

Client: Maas Group Properties Pty Ltd	**Job no:** 7891	**Date:** 10/01/2017
Address: Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole: 25	**GPS:** 55H 654928mE 6426860mN	

Surface description

Slope:	1-2%	Aspect:	North west
Morphological type:	Lower-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, hedge mustard, wild lettuce, saffron thistle, spear grass		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 300	Brown loamy sand		M				
300 to 500	Reddish brown sandy clay loam		M				
500 to 2500	Red sandy clay		M				
2500 to 3000	Brown sandy clay		M				
3000	End of hole						
Notes:							

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:**	7891	**Date:**	10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo				
Borehole:	26	**GPS:**	55H 654673mE 6426990mN		

Surface description

Slope:	0-1%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Wild oats, Lucerne, hedge mustard, nightshade		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 100	Brown sandy loam		M				
100 to 600	Reddish brown sandy loam		M				
600 to 1700	Dark grey brown sandy clay with coarse sand and trace fine alluvial gravel from 1000mm		D				
1700 to 2400	Reddish brown sandy clay with coarse sand and trace fine alluvial gravel		D				
2400 to 2600	Dark brown sandy clay		D				
2600	End of hole, refusal on rock						

Notes:

Salinity assessment

Client: Maas Group Properties Pty Ltd		**Job no:** 7891	**Date:** 10/01/2017
Address:	Lot 2 DP880413 Sheraton Road, Dubbo		
Borehole:	27	**GPS:**	55H 654819mE 6426972mN

Surface description

Slope:	0-1%	Aspect:	South west
Morphological type:	Mid-slope		
Land-use:	Grazing		
Disturbance:	High		
Erosion:	Nil		
Coarse fragments:	Nil		
Surface cover:	Lucerne, wild oats		
% surface cover	100%		
Salinity:	Nil		

Sub-surface description

Sample method: EVH		Logged by: DL					
Depth (mm)	Soil description (texture, colour, coarse fragments, mottles, roots, structure)	Sample	M/D	pH (1:5 water)	EC (dS/m)	ECe	Emerson aggregate test
0 to 400	Strong brown loamy sand with trace gravel	X	D	6.0	0.03	0.69	3
		X		5.7	0.02	0.46	3
		X		6.1	0.02	0.46	3
400 to 800	Dark reddish brown sandy clay loam	X	D	6.6	0.03	0.19	3
800 to 1800	Dark red light clay with trace basalt cobbles	X	M	6.7	0.01	0.08	3
		X		6.9	0.01	0.08	3
1800 to 2500	Reddish brown to brown loamy sand with weathered rock horizon	X	D	6.7	0.02	0.46	3
		X		7.3	0.02	0.46	3
2500 to 3100	Brown loamy sand with clay and cobbles	X	M	7.5	0.02	0.46	3
3100 to 3900	Dark brown clayey sand with gravel and trace clay and cobbles	X	M	7.7	0.02	0.46	3
3900	End of hole, refusal on rock						
Notes:							

Appendix 7. Reference methods for soil testing

Reference Methods:

Colour: Munsell (2000) In 'Munsell Soil Colour Charts' (Gretag Macbeth: NY)

Field texture: McDonald RC, Isbell RF, Speight JG, Walker, Hopkins MS (1990) Australian Soil and Land Survey Field Handbook pp.115-124 (Inkata Press: Melbourne)

PH: AS1289.4.3.1-1997 Method of testing soil for engineering purposes – Soil Chemical Tests-Determination of the pH value of a soil – Electrometric method

Salinity: Rayment GE and Higginson FR (1992) Australian Laboratory Handbook of Soil and Water Chemical Methods (Method 3A1, pp.15-16) (Inkata Press Melbourne) Electrical conductivity of saturated extract is based on conversions of EC (1:5) and soil texture class, to give a more accurate assessment of soil salinity hazard (Salavich PG and Peterson GH (1993) Estimating the electrical conductivity of soil paste extracts from 1:5 soil water suspensions and texture. Australian Journal of Soil Research 31, 3-81)

Appendix 8. SGS laboratory report SE160957 and chain of custody form

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Ashleigh Pickering
Client	ENVIROWEST CONSULTING PTY LIMITED
Address	PO BOX 8158 ORANGE NSW 2800
Telephone	61 2 63614954
Facsimile	(Not specified)
Email	ashleigh@envirowest.net.au
Project	**7891**
Order Number	(Not specified)
Samples	42

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE160957 R0**
Date Received	17/1/2017
Date Reported	24/1/2017

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Bennet Lo
Senior Organic Chemist/Metals Chemist

Dong Liang
Metals/Inorganics Team Leader

Kamrul Ahsan
Senior Chemist

Ly Kim Ha
Organic Section Head

Snezana Kostoska
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VOC's in Soil [AN433] Tested: 19/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Benzene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
m/p-xylene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o-xylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Xylenes*	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Total BTEX	mg/kg	0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Benzene	mg/kg	0.1	<0.1	<0.1
Toluene	mg/kg	0.1	<0.1	<0.1
Ethylbenzene	mg/kg	0.1	<0.1	<0.1
m/p-xylene	mg/kg	0.2	<0.2	<0.2
o-xylene	mg/kg	0.1	<0.1	<0.1
Total Xylenes*	mg/kg	0.3	<0.3	<0.3
Total BTEX	mg/kg	0.6	<0.6	<0.6
Naphthalene	mg/kg	0.1	<0.1	<0.1

Volatile Petroleum Hydrocarbons in Soil [AN433] Tested: 19/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
TRH C6-C9	mg/kg	20	<20	<20	<20	<20	<20
Benzene (F0)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TRH C6-C10	mg/kg	25	<25	<25	<25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	<25	<25	<25

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
TRH C6-C9	mg/kg	20	<20	<20
Benzene (F0)	mg/kg	0.1	<0.1	<0.1
TRH C6-C10	mg/kg	25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25

TRH (Total Recoverable Hydrocarbons) in Soil [AN403] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
TRH C10-C14	mg/kg	20	<20	<20	120	<20	<20
TRH C15-C28	mg/kg	45	<45	910	3400	<45	<45
TRH C29-C36	mg/kg	45	<45	52	<45	<45	<45
TRH C37-C40	mg/kg	100	<100	<100	<100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	<25	450	<25	<25
TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	450	<25	<25
TRH >C16-C34 (F3)	mg/kg	90	<90	930	3100	<90	<90
TRH >C34-C40 (F4)	mg/kg	120	<120	<120	<120	<120	<120
TRH C10-C36 Total	mg/kg	110	<110	960	3500	<110	<110
TRH C10-C40 Total	mg/kg	210	<210	960	3500	<210	<210

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
TRH C10-C14	mg/kg	20	<20	<20
TRH C15-C28	mg/kg	45	140	<45
TRH C29-C36	mg/kg	45	51	<45
TRH C37-C40	mg/kg	100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	<25
TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25
TRH >C16-C34 (F3)	mg/kg	90	170	<90
TRH >C34-C40 (F4)	mg/kg	120	<120	<120
TRH C10-C36 Total	mg/kg	110	190	<110
TRH C10-C40 Total	mg/kg	210	<210	<210

PAH (Polynuclear Aromatic Hydrocarbons) in Soil [AN420] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total PAH (18)	mg/kg	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Total PAH (NEPM/WHO 16)	mg/kg	0.8	<0.8	<0.8	<0.8	<0.8	<0.8

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Naphthalene	mg/kg	0.1	<0.1	<0.1
2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1
1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1
Acenaphthene	mg/kg	0.1	<0.1	<0.1
Fluorene	mg/kg	0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.1	<0.1	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1
Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1
Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1
Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1
Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	<0.2	<0.2
Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3
Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2
Total PAH (18)	mg/kg	0.8	<0.8	<0.8
Total PAH (NEPM/WHO 16)	mg/kg	0.8	<0.8	<0.8

OC Pesticides in Soil [AN420] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 18/1/2017 (continued)

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SR73 SOIL - 11/1/2017 SE160957.034	SR91 SOIL - 11/1/2017 SE160957.035	SR113 SOIL - 11/1/2017 SE160957.036
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 18/1/2017 (continued)

PARAMETER	UOM	LOR	SR184 SOIL - 11/1/2017 SE160957.037	SR224 SOIL - 11/1/2017 SE160957.038
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) [AN122] Tested: 23/1/2017

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
Exchangeable Sodium, Na	mg/kg	2	17	530
Exchangeable Sodium, Na	meq/100g	0.01	0.07	2.3
Exchangeable Sodium Percentage*	%	0.1	3.3	36.5

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 19/1/2017

			BH16-100	BH16-1500
			SOIL	SOIL
			-	-
			11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.041	SE160957.042
Chloride	mg/kg	0.25	7.6	50

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017

PARAMETER	UOM	LOR	SR1 SOIL - 11/1/2017 SE160957.001	SR2 SOIL - 11/1/2017 SE160957.002	SR3 SOIL - 11/1/2017 SE160957.003	SR4 SOIL - 11/1/2017 SE160957.004	SR5 SOIL - 11/1/2017 SE160957.005
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	19	18	20	11	18
Copper, Cu	mg/kg	0.5	6.7	6.0	5.5	4.2	6.8
Lead, Pb	mg/kg	1	5	6	5	4	6
Nickel, Ni	mg/kg	0.5	9.8	8.5	8.5	5.1	7.6
Zinc, Zn	mg/kg	0.5	14	18	13	9.6	13
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR6 SOIL - 11/1/2017 SE160957.006	SR7 SOIL - 11/1/2017 SE160957.007	SR8 SOIL - 11/1/2017 SE160957.008	SR9 SOIL - 11/1/2017 SE160957.009	SR10 SOIL - 11/1/2017 SE160957.010
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	19	11	23	36	9.9
Copper, Cu	mg/kg	0.5	7.5	5.1	7.3	7.1	3.2
Lead, Pb	mg/kg	1	6	5	6	8	4
Nickel, Ni	mg/kg	0.5	10	4.6	9.5	14	3.1
Zinc, Zn	mg/kg	0.5	15	12	14	22	6.2
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR11 SOIL - 11/1/2017 SE160957.011	SR12 SOIL - 11/1/2017 SE160957.012	SR13 SOIL - 11/1/2017 SE160957.013	SR14 SOIL - 11/1/2017 SE160957.014	SR15 SOIL - 11/1/2017 SE160957.015
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	9.2	11	16	58	50
Copper, Cu	mg/kg	0.5	3.9	4.8	6.5	18	17
Lead, Pb	mg/kg	1	5	5	6	9	9
Nickel, Ni	mg/kg	0.5	4.4	7.0	11	41	34
Zinc, Zn	mg/kg	0.5	7.4	8.9	14	45	31
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017 (continued)

PARAMETER	UOM	LOR	SR16 SOIL - 11/1/2017 SE160957.016	SR17 SOIL - 11/1/2017 SE160957.017	SR18 SOIL - 11/1/2017 SE160957.018	SR19 SOIL - 11/1/2017 SE160957.019	SR20 SOIL - 11/1/2017 SE160957.020
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	41	36	36	24	27
Copper, Cu	mg/kg	0.5	14	13	12	11	11
Lead, Pb	mg/kg	1	8	11	8	8	7
Nickel, Ni	mg/kg	0.5	25	20	17	16	16
Zinc, Zn	mg/kg	0.5	23	21	22	24	22
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR21 SOIL - 11/1/2017 SE160957.021	SR22 SOIL - 11/1/2017 SE160957.022	SR23 SOIL - 11/1/2017 SE160957.023	SR24 SOIL - 11/1/2017 SE160957.024	SR25 SOIL - 11/1/2017 SE160957.025
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	0.3	0.4	0.4	<0.3
Chromium, Cr	mg/kg	0.3	41	65	59	63	40
Copper, Cu	mg/kg	0.5	13	18	20	20	15
Lead, Pb	mg/kg	1	7	9	9	9	9
Nickel, Ni	mg/kg	0.5	24	42	52	50	32
Zinc, Zn	mg/kg	0.5	25	35	41	40	29
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR26 SOIL - 11/1/2017 SE160957.026	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	0.4	0.4	0.3	0.4	0.3
Chromium, Cr	mg/kg	0.3	67	58	50	63	64
Copper, Cu	mg/kg	0.5	22	23	19	26	22
Lead, Pb	mg/kg	1	10	11	10	8	9
Nickel, Ni	mg/kg	0.5	52	62	40	83	48
Zinc, Zn	mg/kg	0.5	59	64	58	50	49
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017 (continued)

PARAMETER	UOM	LOR	SR31 SOIL - 11/1/2017 SE160957.031	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SRA SOIL - 11/1/2017 SE160957.039	SRB SOIL - 11/1/2017 SE160957.040
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	0.3	0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	49	53	59	21	9.7
Copper, Cu	mg/kg	0.5	21	22	22	6.0	3.4
Lead, Pb	mg/kg	1	10	10	10	5	4
Nickel, Ni	mg/kg	0.5	41	50	48	8.3	2.9
Zinc, Zn	mg/kg	0.5	58	40	44	17	5.1
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
Arsenic, As	mg/kg	3	-	-
Cadmium, Cd	mg/kg	0.3	-	-
Chromium, Cr	mg/kg	0.3	-	-
Copper, Cu	mg/kg	0.5	-	-
Lead, Pb	mg/kg	1	-	-
Nickel, Ni	mg/kg	0.5	-	-
Zinc, Zn	mg/kg	0.5	-	-
Calcium, Ca	mg/kg	5	180	230
Magnesium, Mg	mg/kg	5	190	590
Sodium, Na	mg/kg	5	22	450
Potassium, K	mg/kg	10	590	360

Mercury in Soil [AN312] Tested: 20/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Mercury	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	<0.05

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Mercury	mg/kg	0.05	<0.05	<0.05

Moisture Content [AN002] Tested: 20/1/2017

PARAMETER	UOM	LOR	SR1 SOIL - 11/1/2017 SE160957.001	SR2 SOIL - 11/1/2017 SE160957.002	SR3 SOIL - 11/1/2017 SE160957.003	SR4 SOIL - 11/1/2017 SE160957.004	SR5 SOIL - 11/1/2017 SE160957.005
% Moisture	%w/w	0.5	8.7	4.9	4.0	9.1	5.6

PARAMETER	UOM	LOR	SR6 SOIL - 11/1/2017 SE160957.006	SR7 SOIL - 11/1/2017 SE160957.007	SR8 SOIL - 11/1/2017 SE160957.008	SR9 SOIL - 11/1/2017 SE160957.009	SR10 SOIL - 11/1/2017 SE160957.010
% Moisture	%w/w	0.5	7.7	3.5	6.5	3.5	2.0

PARAMETER	UOM	LOR	SR11 SOIL - 11/1/2017 SE160957.011	SR12 SOIL - 11/1/2017 SE160957.012	SR13 SOIL - 11/1/2017 SE160957.013	SR14 SOIL - 11/1/2017 SE160957.014	SR15 SOIL - 11/1/2017 SE160957.015
% Moisture	%w/w	0.5	5.3	3.6	3.2	7.7	8.1

PARAMETER	UOM	LOR	SR16 SOIL - 11/1/2017 SE160957.016	SR17 SOIL - 11/1/2017 SE160957.017	SR18 SOIL - 11/1/2017 SE160957.018	SR19 SOIL - 11/1/2017 SE160957.019	SR20 SOIL - 11/1/2017 SE160957.020
% Moisture	%w/w	0.5	7.1	8.3	6.7	6.3	6.2

PARAMETER	UOM	LOR	SR21 SOIL - 11/1/2017 SE160957.021	SR22 SOIL - 11/1/2017 SE160957.022	SR23 SOIL - 11/1/2017 SE160957.023	SR24 SOIL - 11/1/2017 SE160957.024	SR25 SOIL - 11/1/2017 SE160957.025
% Moisture	%w/w	0.5	5.8	12	7.4	6.4	4.8

PARAMETER	UOM	LOR	SR26 SOIL - 11/1/2017 SE160957.026	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030
% Moisture	%w/w	0.5	8.5	6.3	6.3	4.8	5.7

PARAMETER	UOM	LOR	SR31 SOIL - 11/1/2017 SE160957.031	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SR73 SOIL - 11/1/2017 SE160957.034	SR91 SOIL - 11/1/2017 SE160957.035
% Moisture	%w/w	0.5	4.3	5.3	5.7	1.3	5.5

Moisture Content [AN002] Tested: 20/1/2017 (continued)

PARAMETER	UOM	LOR	SR113 SOIL - 11/1/2017 SE160957.036	SR184 SOIL - 11/1/2017 SE160957.037	SR224 SOIL - 11/1/2017 SE160957.038	SRA SOIL - 11/1/2017 SE160957.039	SRB SOIL - 11/1/2017 SE160957.040
% Moisture	%w/w	0.5	2.2	7.9	7.6	5.2	2.2

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
% Moisture	%w/w	0.5	6.3	10

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN040/AN320	A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.
AN040	A portion of sample is digested with Nitric acid to decompose organic matter and Hydrochloric acid to complete the digestion of metals and then filtered for analysis by ASS or ICP as per USEPA Method 200.8.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is refernced to Rayment and Higginson, 1992, sections 15D3 and 15N1.-
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
AN312	Mercury by Cold Vapour AAS in Soils: After digestion with nitric acid, hydrogen peroxide and hydrochloric acid, mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is reported directly and also corrected by subtracting Naphthalene (from VOC method AN433) where available.
AN403	Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents.
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN420	(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN420	SVOC Compounds: Semi-Volatile Organic Compounds (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN433	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
		IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/en/terms-and-conditions. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

SE160957 R0

STATEMENT OF QA/QC PERFORMANCE

CLIENT DETAILS

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Project	**7891**
Order Number	(Not specified)
Samples	42

LABORATORY DETAILS

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SGS Reference	**SE160957 R0**
Date Received	17 Jan 2017
Date Reported	25 Jan 2017

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Matrix Spike	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	1 item
	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	3 items

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	42 Soil
Date documentation received	17/1/2017	Type of documentation received	COC
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	21.5°C	Sufficient sample for analysis	Yes
Turnaround time requested	Standard		

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH16-100	SE160957.041	LB117341	11 Jan 2017	17 Jan 2017	08 Feb 2017	23 Jan 2017	08 Feb 2017	23 Jan 2017
BH16-1500	SE160957.042	LB117341	11 Jan 2017	17 Jan 2017	08 Feb 2017	23 Jan 2017	08 Feb 2017	23 Jan 2017

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117281	12 Jan 2017	17 Jan 2017	09 Feb 2017	20 Jan 2017	09 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117281	12 Jan 2017	17 Jan 2017	09 Feb 2017	20 Jan 2017	09 Feb 2017	24 Jan 2017

Moisture Content

Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR1	SE160957.001	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR2	SE160957.002	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR3	SE160957.003	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR4	SE160957.004	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR5	SE160957.005	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR6	SE160957.006	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR7	SE160957.007	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR8	SE160957.008	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR9	SE160957.009	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR10	SE160957.010	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR11	SE160957.011	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR12	SE160957.012	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR13	SE160957.013	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR14	SE160957.014	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR15	SE160957.015	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR16	SE160957.016	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR17	SE160957.017	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR18	SE160957.018	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR19	SE160957.019	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR20	SE160957.020	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR21	SE160957.021	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR22	SE160957.022	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR23	SE160957.023	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR24	SE160957.024	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR25	SE160957.025	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR26	SE160957.026	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR27	SE160957.027	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR28	SE160957.028	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR29	SE160957.029	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR30	SE160957.030	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR31	SE160957.031	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR32	SE160957.032	LB117208	12 Jan 2017	17 Jan 2017	26 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR33	SE160957.033	LB117208	12 Jan 2017	17 Jan 2017	26 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR73	SE160957.034	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR91	SE160957.035	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR113	SE160957.036	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR184	SE160957.037	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR224	SE160957.038	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SRA	SE160957.039	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SRB	SE160957.040	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
BH16-100	SE160957.041	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
BH16-1500	SE160957.042	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

OC Pesticides in Soil (continued)

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH16-100	SE160957.041	LB117119	11 Jan 2017	17 Jan 2017	18 Jan 2017	18 Jan 2017	15 Feb 2017	18 Jan 2017
BH16-1500	SE160957.042	LB117119	11 Jan 2017	17 Jan 2017	18 Jan 2017	18 Jan 2017	15 Feb 2017	18 Jan 2017

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR1	SE160957.001	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR2	SE160957.002	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR3	SE160957.003	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR4	SE160957.004	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR5	SE160957.005	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR6	SE160957.006	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR7	SE160957.007	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR8	SE160957.008	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR9	SE160957.009	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR10	SE160957.010	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR11	SE160957.011	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR12	SE160957.012	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR13	SE160957.013	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR14	SE160957.014	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR15	SE160957.015	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR16	SE160957.016	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR17	SE160957.017	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR18	SE160957.018	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR19	SE160957.019	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR20	SE160957.020	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR21	SE160957.021	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR22	SE160957.022	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR23	SE160957.023	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR24	SE160957.024	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR25	SE160957.025	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR26	SE160957.026	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued)

Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR28	SE160957.028	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR29	SE160957.029	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR30	SE160957.030	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR31	SE160957.031	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR32	SE160957.032	LB117336	12 Jan 2017	17 Jan 2017	11 Jul 2017	23 Jan 2017	11 Jul 2017	24 Jan 2017
SR33	SE160957.033	LB117336	12 Jan 2017	17 Jan 2017	11 Jul 2017	23 Jan 2017	11 Jul 2017	24 Jan 2017
SRA	SE160957.039	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SRB	SE160957.040	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
BH16-100	SE160957.041	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
BH16-1500	SE160957.042	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Tetrachloro-m-xylene (TCMX) (Surrogate)	SR27	SE160957.027	%	60 - 130%	109
	SR28	SE160957.028	%	60 - 130%	115
	SR29	SE160957.029	%	60 - 130%	80
	SR30	SE160957.030	%	60 - 130%	109
	SR31	SE160957.031	%	60 - 130%	105
	SR32	SE160957.032	%	60 - 130%	100
	SR33	SE160957.033	%	60 - 130%	105
	SR73	SE160957.034	%	60 - 130%	105
	SR91	SE160957.035	%	60 - 130%	108
	SR113	SE160957.036	%	60 - 130%	107
	SR184	SE160957.037	%	60 - 130%	107
	SR224	SE160957.038	%	60 - 130%	109

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
2-fluorobiphenyl (Surrogate)	SR27	SE160957.027	%	70 - 130%	100
	SR28	SE160957.028	%	70 - 130%	78
	SR29	SE160957.029	%	70 - 130%	110
	SR30	SE160957.030	%	70 - 130%	78
	SR31	SE160957.031	%	70 - 130%	110
	SR32	SE160957.032	%	70 - 130%	80
	SR33	SE160957.033	%	70 - 130%	80
d14-p-terphenyl (Surrogate)	SR27	SE160957.027	%	70 - 130%	92
	SR28	SE160957.028	%	70 - 130%	86
	SR29	SE160957.029	%	70 - 130%	112
	SR30	SE160957.030	%	70 - 130%	78
	SR31	SE160957.031	%	70 - 130%	112
	SR32	SE160957.032	%	70 - 130%	76
	SR33	SE160957.033	%	70 - 130%	94
d5-nitrobenzene (Surrogate)	SR27	SE160957.027	%	70 - 130%	90
	SR28	SE160957.028	%	70 - 130%	74
	SR29	SE160957.029	%	70 - 130%	110
	SR30	SE160957.030	%	70 - 130%	84
	SR31	SE160957.031	%	70 - 130%	112
	SR32	SE160957.032	%	70 - 130%	80
	SR33	SE160957.033	%	70 - 130%	88

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SR27	SE160957.027	%	60 - 130%	72
	SR28	SE160957.028	%	60 - 130%	71
	SR29	SE160957.029	%	60 - 130%	94
	SR30	SE160957.030	%	60 - 130%	75
	SR31	SE160957.031	%	60 - 130%	77
	SR32	SE160957.032	%	60 - 130%	71
	SR33	SE160957.033	%	60 - 130%	71
d4-1,2-dichloroethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	110
	SR28	SE160957.028	%	60 - 130%	109
	SR29	SE160957.029	%	60 - 130%	104
	SR30	SE160957.030	%	60 - 130%	112
	SR31	SE160957.031	%	60 - 130%	109
	SR32	SE160957.032	%	60 - 130%	109
	SR33	SE160957.033	%	60 - 130%	112
d8-toluene (Surrogate)	SR27	SE160957.027	%	60 - 130%	79
	SR28	SE160957.028	%	60 - 130%	80
	SR29	SE160957.029	%	60 - 130%	75
	SR30	SE160957.030	%	60 - 130%	81
	SR31	SE160957.031	%	60 - 130%	78
	SR32	SE160957.032	%	60 - 130%	76
	SR33	SE160957.033	%	60 - 130%	79
Dibromofluoromethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	96
	SR28	SE160957.028	%	60 - 130%	95

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

VOC's in Soil (continued) — Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Dibromofluoromethane (Surrogate)	SR29	SE160957.029	%	60 - 130%	92
	SR30	SE160957.030	%	60 - 130%	98
	SR31	SE160957.031	%	60 - 130%	98
	SR32	SE160957.032	%	60 - 130%	98
	SR33	SE160957.033	%	60 - 130%	100

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SR27	SE160957.027	%	60 - 130%	72
	SR28	SE160957.028	%	60 - 130%	71
	SR29	SE160957.029	%	60 - 130%	94
	SR30	SE160957.030	%	60 - 130%	75
	SR31	SE160957.031	%	60 - 130%	77
	SR32	SE160957.032	%	60 - 130%	71
	SR33	SE160957.033	%	60 - 130%	71
d4-1,2-dichloroethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	110
	SR28	SE160957.028	%	60 - 130%	109
	SR29	SE160957.029	%	60 - 130%	104
	SR30	SE160957.030	%	60 - 130%	112
	SR31	SE160957.031	%	60 - 130%	109
	SR32	SE160957.032	%	60 - 130%	109
	SR33	SE160957.033	%	60 - 130%	112
d8-toluene (Surrogate)	SR27	SE160957.027	%	60 - 130%	79
	SR28	SE160957.028	%	60 - 130%	80
	SR29	SE160957.029	%	60 - 130%	75
	SR30	SE160957.030	%	60 - 130%	81
	SR31	SE160957.031	%	60 - 130%	78
	SR32	SE160957.032	%	60 - 130%	76
	SR33	SE160957.033	%	60 - 130%	79
Dibromofluoromethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	96
	SR28	SE160957.028	%	60 - 130%	95
	SR29	SE160957.029	%	60 - 130%	92
	SR30	SE160957.030	%	60 - 130%	98
	SR31	SE160957.031	%	60 - 130%	98
	SR32	SE160957.032	%	60 - 130%	98
	SR33	SE160957.033	%	60 - 130%	100

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number	Parameter	Units	LOR

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Number	Parameter	Units	LOR	Result
LB117281.001	Mercury	mg/kg	0.05	<0.05

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB117067.001		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1
		Alpha BHC	mg/kg	0.1	<0.1
		Lindane	mg/kg	0.1	<0.1
		Heptachlor	mg/kg	0.1	<0.1
		Aldrin	mg/kg	0.1	<0.1
		Beta BHC	mg/kg	0.1	<0.1
		Delta BHC	mg/kg	0.1	<0.1
		Heptachlor epoxide	mg/kg	0.1	<0.1
		Alpha Endosulfan	mg/kg	0.2	<0.2
		Gamma Chlordane	mg/kg	0.1	<0.1
		Alpha Chlordane	mg/kg	0.1	<0.1
		p,p'-DDE	mg/kg	0.1	<0.1
		Dieldrin	mg/kg	0.2	<0.2
		Endrin	mg/kg	0.2	<0.2
		Beta Endosulfan	mg/kg	0.2	<0.2
		p,p'-DDD	mg/kg	0.1	<0.1
		p,p'-DDT	mg/kg	0.1	<0.1
		Endosulfan sulphate	mg/kg	0.1	<0.1
		Endrin Aldehyde	mg/kg	0.1	<0.1
		Methoxychlor	mg/kg	0.1	<0.1
		Endrin Ketone	mg/kg	0.1	<0.1
		Isodrin	mg/kg	0.1	<0.1
		Mirex	mg/kg	0.1	<0.1
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	%	-	99

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB117067.001		Naphthalene	mg/kg	0.1	<0.1
		2-methylnaphthalene	mg/kg	0.1	<0.1
		1-methylnaphthalene	mg/kg	0.1	<0.1
		Acenaphthylene	mg/kg	0.1	<0.1
		Acenaphthene	mg/kg	0.1	<0.1
		Fluorene	mg/kg	0.1	<0.1
		Phenanthrene	mg/kg	0.1	<0.1
		Anthracene	mg/kg	0.1	<0.1
		Fluoranthene	mg/kg	0.1	<0.1
		Pyrene	mg/kg	0.1	<0.1
		Benzo(a)anthracene	mg/kg	0.1	<0.1
		Chrysene	mg/kg	0.1	<0.1
		Benzo(a)pyrene	mg/kg	0.1	<0.1
		Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1
		Dibenzo(ah)anthracene	mg/kg	0.1	<0.1
		Benzo(ghi)perylene	mg/kg	0.1	<0.1
		Total PAH (18)	mg/kg	0.8	<0.8
	Surrogates	d5-nitrobenzene (Surrogate)	%	-	82
		2-fluorobiphenyl (Surrogate)	%	-	84
		d14-p-terphenyl (Surrogate)	%	-	76

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Soluble Anions (1:5) in Soil by Ion Chromatography (continued)

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR	Result
LB117119.001	Chloride	mg/kg	0.25	<0.25

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number	Parameter	Units	LOR	Result
LB117335.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
LB117336.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
LB117337.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
	Calcium, Ca	mg/kg	5	<5
	Magnesium, Mg	mg/kg	5	<5
	Sodium, Na	mg/kg	5	<5
	Potassium, K	mg/kg	10	<10

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR	Result
LB117067.001	TRH C10-C14	mg/kg	20	<20
	TRH C15-C28	mg/kg	45	<45
	TRH C29-C36	mg/kg	45	<45
	TRH C37-C40	mg/kg	100	<100
	TRH C10-C36 Total	mg/kg	110	<110

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB117101.001	Monocyclic Aromatic Hydrocarbons	Benzene	mg/kg	0.1	<0.1
		Toluene	mg/kg	0.1	<0.1
		Ethylbenzene	mg/kg	0.1	<0.1
		m/p-xylene	mg/kg	0.2	<0.2
		o-xylene	mg/kg	0.1	<0.1
	Polycyclic VOCs	Naphthalene	mg/kg	0.1	<0.1
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	96
		d4-1,2-dichloroethane (Surrogate)	%	-	109
		d8-toluene (Surrogate)	%	-	75
		Bromofluorobenzene (Surrogate)	%	-	70
	Totals	Total BTEX	mg/kg	0.6	<0.6

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB117101.001		TRH C6-C9	mg/kg	20	<20
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	96
		d4-1,2-dichloroethane (Surrogate)	%	-	109
		d8-toluene (Surrogate)	%	-	75

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.031	LB117281.014		Mercury	mg/kg	0.05	<0.05	<0.05	200	0
SE160960.007	LB117281.024		Mercury	mg/kg	0.05	<0.05	<0.05	200	0

Moisture Content

Method: ME-(AU)-[ENV]AN002

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160956.011	LB117208.011		% Moisture	%w/w	0.5	<0.5	<0.5	200	0
SE160957.010	LB117208.022		% Moisture	%w/w	0.5	2.0	1.8	82	13
SE160957.020	LB117208.033		% Moisture	%w/w	0.5	6.2	6.6	46	7
SE160957.030	LB117208.044		% Moisture	%w/w	0.5	5.7	5.8	47	3
SE160957.040	LB117208.055		% Moisture	%w/w	0.5	2.2	1.8	80	22
SE160957.042	LB117208.058		% Moisture	%w/w	0.5	10	10	40	1

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.036	LB117067.034		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Lindane	mg/kg	0.1	<0.1	<0.1	200	0
			Heptachlor	mg/kg	0.1	<0.1	<0.1	200	0
			Aldrin	mg/kg	0.1	<0.1	<0.1	200	0
			Beta BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Delta BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	200	0
			o,p'-DDE	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	200	0
			Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	200	0
			trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	200	0
			p,p'-DDE	mg/kg	0.1	<0.1	<0.1	200	0
			Dieldrin	mg/kg	0.2	<0.2	<0.2	200	0
			Endrin	mg/kg	0.2	<0.2	<0.2	200	0
			o,p'-DDD	mg/kg	0.1	<0.1	<0.1	200	0
			o,p'-DDT	mg/kg	0.1	<0.1	<0.1	200	0
			Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	200	0
			p,p'-DDD	mg/kg	0.1	<0.1	<0.1	200	0
			p,p'-DDT	mg/kg	0.1	<0.1	<0.1	200	0
			Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	200	0
			Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	200	0
			Methoxychlor	mg/kg	0.1	<0.1	<0.1	200	0
			Endrin Ketone	mg/kg	0.1	<0.1	<0.1	200	0
			Isodrin	mg/kg	0.1	<0.1	<0.1	200	0
			Mirex	mg/kg	0.1	<0.1	<0.1	200	0
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.16	0.16	30	1

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthylene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluorene	mg/kg	0.1	<0.1	<0.1	200	0
			Phenanthrene	mg/kg	0.1	<0.1	<0.1	200	0
			Anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Chrysene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

PAH (Polynuclear Aromatic Hydrocarbons) in Soil (continued) — Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ (mg/kg)	0.2	<0.2	<0.2	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	134	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	175	0
			Total PAH (18)	mg/kg	0.8	<0.8	<0.8	200	0
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.5	30	9
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.6	30	10
			d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.5	30	10
SE160957.033	LB117067.032		Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthylene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluorene	mg/kg	0.1	<0.1	<0.1	200	0
			Phenanthrene	mg/kg	0.1	<0.1	<0.1	200	0
			Anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Chrysene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ (mg/kg)	0.2	<0.2	<0.2	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	134	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	175	0
			Total PAH (18)	mg/kg	0.8	<0.8	<0.8	200	0
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.4	0.4	30	7
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.4	0.4	30	5
			d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.4	30	11

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.005	LB117335.014		Arsenic, As	mg/kg	3	<3	<3	94	11
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	200	0
			Chromium, Cr	mg/kg	0.3	18	18	33	2
			Copper, Cu	mg/kg	0.5	6.8	6.4	38	5
			Lead, Pb	mg/kg	1	6	5	48	4
			Nickel, Ni	mg/kg	0.5	7.6	7.2	37	5
			Zinc, Zn	mg/kg	0.5	13	13	45	0
SE160957.014	LB117335.024		Arsenic, As	mg/kg	3	<3	<3	86	28
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	138	0
			Chromium, Cr	mg/kg	0.3	58	57	31	1
			Copper, Cu	mg/kg	0.5	18	19	33	3
			Lead, Pb	mg/kg	1	9	9	41	2
			Nickel, Ni	mg/kg	0.5	41	41	31	0
			Zinc, Zn	mg/kg	0.5	45	44	35	1
SE160957.024	LB117336.014		Arsenic, As	mg/kg	3	<3	<3	81	7
			Cadmium, Cd	mg/kg	0.3	0.4	0.4	113	1
			Chromium, Cr	mg/kg	0.3	63	65	31	2
			Copper, Cu	mg/kg	0.5	20	21	32	7
			Lead, Pb	mg/kg	1	9	9	41	4
			Nickel, Ni	mg/kg	0.5	50	57	31	13
			Zinc, Zn	mg/kg	0.5	40	41	35	2
SE160957.033	LB117336.024		Arsenic, As	mg/kg	3	<3	<3	70	6
			Cadmium, Cd	mg/kg	0.3	0.3	0.3	121	11
			Chromium, Cr	mg/kg	0.3	59	59	31	1

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued)

Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.033	LB117336.024		Copper, Cu	mg/kg	0.5	22	23	32	3
			Lead, Pb	mg/kg	1	10	10	40	1
			Nickel, Ni	mg/kg	0.5	48	49	31	1
			Zinc, Zn	mg/kg	0.5	44	45	35	4
SE160960.006	LB117337.014		Arsenic, As	mg/kg	3	4	<3	61	23
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	143	0
			Chromium, Cr	mg/kg	0.3	43	36	31	18
			Copper, Cu	mg/kg	0.5	15	15	33	1
			Lead, Pb	mg/kg	1	13	13	38	4
			Nickel, Ni	mg/kg	0.5	33	29	32	13
			Zinc, Zn	mg/kg	0.5	14	15	44	3
SE160960.015	LB117337.024		Arsenic, As	mg/kg	3	<3	<3	70	13
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	178	0
			Chromium, Cr	mg/kg	0.3	16	15	33	11
			Copper, Cu	mg/kg	0.5	12	13	34	5
			Lead, Pb	mg/kg	1	19	16	36	17
			Nickel, Ni	mg/kg	0.5	19	19	33	4
			Zinc, Zn	mg/kg	0.5	32	32	36	2

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		TRH C10-C14	mg/kg	20	<20	<20	200	0
			TRH C15-C28	mg/kg	45	<45	<45	200	0
			TRH C29-C36	mg/kg	45	<45	<45	200	0
			TRH C37-C40	mg/kg	100	<100	<100	200	0
			TRH C10-C36 Total	mg/kg	110	<110	<110	200	0
			TRH C10-C40 Total	mg/kg	210	<210	<210	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	<25	<25	200	0
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	200	0
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	200	0
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	200	0
SE160957.033	LB117067.031		TRH C10-C14	mg/kg	20	<20	<20	200	0
			TRH C15-C28	mg/kg	45	<45	<45	200	0
			TRH C29-C36	mg/kg	45	<45	<45	200	0
			TRH C37-C40	mg/kg	100	<100	<100	200	0
			TRH C10-C36 Total	mg/kg	110	<110	<110	200	0
			TRH C10-C40 Total	mg/kg	210	<210	<210	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	<25	<25	200	0
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	200	0
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	200	0
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	200	0

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.003	LB117101.014	Monocyclic Aromatic	Benzene	mg/kg	0.1	<0.1	<0.1	200	0
			Toluene	mg/kg	0.1	<0.1	<0.1	200	0
			Ethylbenzene	mg/kg	0.1	<0.1	<0.1	200	0
			m/p-xylene	mg/kg	0.2	<0.2	<0.2	200	0
			o-xylene	mg/kg	0.1	<0.1	<0.1	200	0
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.9	4.9	50	0
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.5	5.6	50	2
			d8-toluene (Surrogate)	mg/kg	-	3.8	3.9	50	2
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.6	3.6	50	0
		Totals	Total Xylenes*	mg/kg	0.3	<0.3	<0.3	200	0
			Total BTEX	mg/kg	0.6	<0.6	<0.6	200	0
SE160960.013	LB117101.025	Monocyclic Aromatic	Benzene	mg/kg	0.1	<0.1	<0.1	200	0
			Toluene	mg/kg	0.1	<0.1	<0.1	200	0
			Ethylbenzene	mg/kg	0.1	<0.1	<0.1	200	0
			m/p-xylene	mg/kg	0.2	<0.2	<0.2	200	0
			o-xylene	mg/kg	0.1	<0.1	<0.1	200	0
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

VOC's in Soil (continued) — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.013	LB117101.025	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.6	50	7
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.9	5.3	50	9
			d8-toluene (Surrogate)	mg/kg	-	4.0	3.6	50	9
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	3.7	50	3
		Totals	Total Xylenes*	mg/kg	0.3	<0.3	<0.3	200	0
			Total BTEX	mg/kg	0.6	<0.6	<0.6	200	0

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.003	LB117101.014		TRH C6-C10	mg/kg	25	<25	<25	200	0
			TRH C6-C9	mg/kg	20	<20	<20	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.9	4.9	30	0
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.5	5.6	30	2
			d8-toluene (Surrogate)	mg/kg	-	3.8	3.9	30	2
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.6	3.6	30	0
		VPH F Bands	Benzene (F0)	mg/kg	0.1	<0.1	<0.1	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	200	0
SE160960.013	LB117101.025		TRH C6-C10	mg/kg	25	<25	<25	200	0
			TRH C6-C9	mg/kg	20	<20	<20	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.6	30	7
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.9	5.3	30	9
			d8-toluene (Surrogate)	mg/kg	-	4.0	3.6	30	9
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	3.7	30	3
		VPH F Bands	Benzene (F0)	mg/kg	0.1	<0.1	<0.1	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	200	0

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117341.002		Exchangeable Sodium, Na	mg/kg	2	NA	390	80 - 120	118

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117281.002		Mercury	mg/kg	0.05	0.22	0.2	70 - 130	110

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		Heptachlor	mg/kg	0.1	0.2	0.2	60 - 140	102
		Aldrin	mg/kg	0.1	0.2	0.2	60 - 140	98
		Delta BHC	mg/kg	0.1	0.2	0.2	60 - 140	108
		Dieldrin	mg/kg	0.2	<0.2	0.2	60 - 140	92
		Endrin	mg/kg	0.2	0.2	0.2	60 - 140	112
		p,p'-DDT	mg/kg	0.1	0.2	0.2	60 - 140	124
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.15	0.15	40 - 130	97

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		Naphthalene	mg/kg	0.1	4.4	4	60 - 140	109
		Acenaphthylene	mg/kg	0.1	4.3	4	60 - 140	108
		Acenaphthene	mg/kg	0.1	4.2	4	60 - 140	104
		Phenanthrene	mg/kg	0.1	4.1	4	60 - 140	103
		Anthracene	mg/kg	0.1	3.9	4	60 - 140	96
		Fluoranthene	mg/kg	0.1	4.2	4	60 - 140	106
		Pyrene	mg/kg	0.1	3.5	4	60 - 140	88
		Benzo(a)pyrene	mg/kg	0.1	5.0	4	60 - 140	125
	Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	96
		2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	100
		d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	96

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117119.002		Chloride	mg/kg	0.25	97	100	70 - 130	97

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117335.002		Arsenic, As	mg/kg	3	49	50	80 - 120	98
		Cadmium, Cd	mg/kg	0.3	51	50	80 - 120	102
		Chromium, Cr	mg/kg	0.3	48	50	80 - 120	95
		Copper, Cu	mg/kg	0.5	47	50	80 - 120	93
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	50	50	80 - 120	101
		Zinc, Zn	mg/kg	0.5	48	50	80 - 120	96
LB117336.002		Arsenic, As	mg/kg	3	49	50	80 - 120	97
		Cadmium, Cd	mg/kg	0.3	51	50	80 - 120	101
		Chromium, Cr	mg/kg	0.3	47	50	80 - 120	94
		Copper, Cu	mg/kg	0.5	46	50	80 - 120	93
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	50	50	80 - 120	99
		Zinc, Zn	mg/kg	0.5	47	50	80 - 120	95
LB117337.002		Arsenic, As	mg/kg	3	48	50	80 - 120	96
		Cadmium, Cd	mg/kg	0.3	48	50	80 - 120	97
		Chromium, Cr	mg/kg	0.3	47	50	80 - 120	95
		Copper, Cu	mg/kg	0.5	47	50	80 - 120	95
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	48	50	80 - 120	97
		Zinc, Zn	mg/kg	0.5	48	50	80 - 120	96

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued)

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117337.002		Calcium, Ca	mg/kg	5	49	50	80 - 120	98
		Magnesium, Mg	mg/kg	5	48	50	80 - 120	95
		Sodium, Na	mg/kg	5	48	50	80 - 120	97
		Potassium, K	mg/kg	10	480	500	80 - 120	95

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		TRH C10-C14	mg/kg	20	31	40	60 - 140	78
		TRH C15-C28	mg/kg	45	<45	40	60 - 140	85
		TRH C29-C36	mg/kg	45	<45	40	60 - 140	90
	TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	32	40	60 - 140	80
		TRH >C16-C34 (F3)	mg/kg	90	<90	40	60 - 140	98
		TRH >C34-C40 (F4)	mg/kg	120	<120	20	60 - 140	80

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117101.002	Monocyclic Aromatic	Benzene	mg/kg	0.1	2.1	2.9	60 - 140	72
		Toluene	mg/kg	0.1	1.8	2.9	60 - 140	62
		Ethylbenzene	mg/kg	0.1	1.9	2.9	60 - 140	67
		m/p-xylene	mg/kg	0.2	4.7	5.8	60 - 140	82
		o-xylene	mg/kg	0.1	2.1	2.9	60 - 140	72
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.6	5	60 - 140	92
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.2	5	60 - 140	104
		d8-toluene (Surrogate)	mg/kg	-	3.8	5	60 - 140	75
		Bromofluorobenzene (Surrogate)	mg/kg	-	5.2	5	60 - 140	103

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117101.002		TRH C6-C10	mg/kg	25	<25	24.65	60 - 140	88
		TRH C6-C9	mg/kg	20	<20	23.2	60 - 140	79
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.6	5	60 - 140	92
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.2	5	60 - 140	104
		d8-toluene (Surrogate)	mg/kg	-	3.8	5	60 - 140	75
		Bromofluorobenzene (Surrogate)	mg/kg	-	5.2	5	60 - 140	103
	VPH F Bands	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	7.25	60 - 140	123

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.005	LB117281.004		Mercury	mg/kg	0.05	0.21	<0.05	0.2	98

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.028	LB117067.033		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha BHC	mg/kg	0.1	<0.1	<0.1	-	-
			Lindane	mg/kg	0.1	<0.1	<0.1	-	-
			Heptachlor	mg/kg	0.1	0.2	<0.1	0.2	81
			Aldrin	mg/kg	0.1	0.2	<0.1	0.2	75
			Beta BHC	mg/kg	0.1	<0.1	<0.1	-	-
			Delta BHC	mg/kg	0.1	0.2	<0.1	0.2	83
			Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	-	-
			o,p'-DDE	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	-	-
			Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	-	-
			trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	-	-
			p,p'-DDE	mg/kg	0.1	<0.1	<0.1	-	-
			Dieldrin	mg/kg	0.2	<0.2	<0.2	0.2	76
			Endrin	mg/kg	0.2	<0.2	<0.2	0.2	100
			o,p'-DDD	mg/kg	0.1	<0.1	<0.1	-	-
			o,p'-DDT	mg/kg	0.1	<0.1	<0.1	-	-
			Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	-	-
			p,p'-DDD	mg/kg	0.1	<0.1	<0.1	-	-
			p,p'-DDT	mg/kg	0.1	0.2	<0.1	0.2	124
			Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	-	-
			Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	-	-
			Methoxychlor	mg/kg	0.1	<0.1	<0.1	-	-
			Endrin Ketone	mg/kg	0.1	<0.1	<0.1	-	-
			Isodrin	mg/kg	0.1	<0.1	<0.1	-	-
			Mirex	mg/kg	0.1	<0.1	<0.1	-	-
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.16	0.17	-	106

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.031		Naphthalene	mg/kg	0.1	3.9	<0.1	4	98
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	-	-
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	-	-
			Acenaphthylene	mg/kg	0.1	3.9	<0.1	4	98
			Acenaphthene	mg/kg	0.1	4.2	<0.1	4	104
			Fluorene	mg/kg	0.1	<0.1	<0.1	-	-
			Phenanthrene	mg/kg	0.1	3.9	<0.1	4	97
			Anthracene	mg/kg	0.1	3.6	<0.1	4	90
			Fluoranthene	mg/kg	0.1	4.0	<0.1	4	100
			Pyrene	mg/kg	0.1	3.7	<0.1	4	92
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	-	-
			Chrysene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(a)pyrene	mg/kg	0.1	4.8	<0.1	4	121
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	-	-
			Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	4.8	<0.2	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	5.0	<0.3	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	4.9	<0.2	-	-
			Total PAH (18)	mg/kg	0.8	32	<0.8	-	-
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.4	-	90
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.4	-	90

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

PAH (Polynuclear Aromatic Hydrocarbons) in Soil (continued)

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.031	Surrogates	d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.4	-	94

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.005	LB117335.004		Arsenic, As	mg/kg	3	42	<3	50	78
			Cadmium, Cd	mg/kg	0.3	42	<0.3	50	85
			Chromium, Cr	mg/kg	0.3	45	6.6	50	77
			Copper, Cu	mg/kg	0.5	57	19	50	76
			Lead, Pb	mg/kg	1	54	20	50	69 ⑨
			Nickel, Ni	mg/kg	0.5	43	4.9	50	77
			Zinc, Zn	mg/kg	0.5	51	15	50	72
SE160957.015	LB117336.004		Arsenic, As	mg/kg	3	30	<3	50	55 ⑨
			Cadmium, Cd	mg/kg	0.3	39	<0.3	50	77
			Chromium, Cr	mg/kg	0.3	84	50	50	67 ⑨
			Copper, Cu	mg/kg	0.5	55	17	50	76
			Lead, Pb	mg/kg	1	44	9	50	69 ⑨
			Nickel, Ni	mg/kg	0.5	70	34	50	73
			Zinc, Zn	mg/kg	0.5	69	31	50	76
SE160957.039	LB117337.004		Arsenic, As	mg/kg	3	44	<3	50	84
			Cadmium, Cd	mg/kg	0.3	44	<0.3	50	88
			Chromium, Cr	mg/kg	0.3	63	21	50	84
			Copper, Cu	mg/kg	0.5	52	6.0	50	92
			Lead, Pb	mg/kg	1	49	5	50	87
			Nickel, Ni	mg/kg	0.5	53	8.3	50	89
			Zinc, Zn	mg/kg	0.5	64	17	50	95

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.032		TRH C10-C14	mg/kg	20	39	<20	40	98
			TRH C15-C28	mg/kg	45	<45	<45	40	110
			TRH C29-C36	mg/kg	45	<45	<45	40	98
			TRH C37-C40	mg/kg	100	<100	<100	-	-
			TRH C10-C36 Total	mg/kg	110	120	<110	-	-
			TRH C10-C40 Total	mg/kg	210	<210	<210	-	-
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	40	<25	40	100
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	40	<25	-	-
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	40	113
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	-	-

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004	Monocyclic Aromatic	Benzene	mg/kg	0.1	2.1	<0.1	2.9	72
			Toluene	mg/kg	0.1	1.9	<0.1	2.9	66
			Ethylbenzene	mg/kg	0.1	1.9	<0.1	2.9	64
			m/p-xylene	mg/kg	0.2	4.7	<0.2	5.8	80
			o-xylene	mg/kg	0.1	2.1	<0.1	2.9	71
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	-	-
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.8	-	86
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	5.5	-	100
			d8-toluene (Surrogate)	mg/kg	-	3.7	4.0	-	73
			Bromofluorobenzene (Surrogate)	mg/kg	-	5.0	3.6	-	101
		Totals	Total Xylenes*	mg/kg	0.3	6.8	<0.3	-	-
			Total BTEX	mg/kg	0.6	13	<0.6	-	-

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004		TRH C6-C10	mg/kg	25	<25	<25	24.65	85
			TRH C6-C9	mg/kg	20	<20	<20	23.2	79
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.8	-	86
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	5.5	-	100
			d8-toluene (Surrogate)	mg/kg	-	3.7	4.0	-	73
			Bromofluorobenzene (Surrogate)	mg/kg	-	5.0	3.6	-	101
		VPH F	Benzene (F0)	mg/kg	0.1	2.1	<0.1	-	-

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub-sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Volatile Petroleum Hydrocarbons in Soil (continued)

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004	VPH F	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	7.25	117

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

Chain of Custody Form – Ref 7891

Sheet 1 of 3

Ref:	7891		Sample matrix			Sample preservation			Analysis				
Investigator:	Envirowest Consulting 9 Cameron Place PO Box 8158 ORANGE NSW 2800								SGS Method Code				
Telephone:	(02) 6361 4954								CL1		CL10		
Facsimile:	(02) 6360 3960												
Email:	ashleigh@envirowest.net.au												
Contact Person:	Ashleigh Pickering												
Invoice:	accounts@envirowest.net.au												
Laboratory:	SGS SYDNEY 16/33 Maddox Street ALEXANDRIA NSW 2015		Water	Soil	Sludge	Cool	HNO3/HCl	Unpre-served	7 Metals	OC Pesticides	TRH/BTEXN/PAH/ 8 metals		
Quotation #:													
Courier/CN:													
Sample ID	**Container***	**Sampling Date/Time**											
SR1	A	11/01/2017		X		X		X	X				
SR2	A	11/01/2017		X		X		X	X				
SR3	A	11/01/2017		X		X		X	X				
SR4	A	11/01/2017		X		X		X	X				
SR5	A	11/01/2017		X		X		X	X				
SR6	A	11/01/2017		X		X		X	X				
SR7	A	11/01/2017		X		X		X	X				
SR8	A	11/01/2017		X		X		X	X				
SR9	A	11/01/2017		X		X		X	X				
SR10	A	11/01/2017		X		X		X	X				
SR11	A	11/01/2017		X		X		X	X				
SR12	A	11/01/2017		X		X		X	X				
SR13	A	11/01/2017		X		X		X	X				
SR14	A	11/01/2017		X		X		X	X				
SR15	A	11/01/2017		X		X		X	X				

SGS EHS Alexandria Laboratory

SE160957 COC

Received: 17 – Jan – 2017

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.

Sampler name: Ashleigh Pickering
Date : 11 & 12/01/2017 Time:

Relinquished by: (print and signature) Ashleigh Pickering APickering Date 16/01/2017 Time 17:00

Received by: (print and signature) S. Suhey Date 17/01/17 Time @ 11.40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

Chain of Custody Form – Ref 7891

Ref: **7891**
Investigator: Envirowest Consulting
9 Cameron Place
PO Box 8158
ORANGE NSW 2800
Telephone: (02) 6361 4954
Facsimile: (02) 6360 3960
Email: ashleigh@envirowest.net.au
Contact Person: Ashleigh Pickering
Invoice: accounts@envirowest.net.au

Laboratory: SGS SYDNEY
16/33 Maddox Street
ALEXANDRIA NSW 2015

Quotation #:
Courier/CN:

			Sample matrix			**Sample preservation**			**Analysis**				
									SGS Method Code				
									CL1		**CL10**		
Sample ID	**Container***	**Sampling Date/Time**	Water	Soil	Sludge	Cool	HNO3/HCl	Unpre-served	7 Metals	OC Pesticides	TRH/BTEXN/PAH/ 8 metals		
SR16	A	11/01/2017		X		X		X	X				
SR17	A	11/01/2017		X		X		X	X				
SR18	A	11/01/2017		X		X		X	X				
SR19	A	11/01/2017		X		X		X	X				
SR20	A	11/01/2017		X		X		X	X				
SR21	A	11/01/2017		X		X		X	X				
SR22	A	11/01/2017		X		X		X	X				
SR23	A	11/01/2017		X		X		X	X				
SR24	A	11/01/2017		X		X		X	X				
SR25	A	11/01/2017		X		X		X	X				
SR26	A	11/01/2017		X		X		X	X				
SR27	A	11/01/2017		X		X		X		X	X		
SR28	A	11/01/2017		X		X		X		X	X		
SR29	A	11/01/2017		X		X		X		X	X		
SR30	A	11/01/2017		X		X		X		X	X		

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.

Sampler name: Ashleigh Pickering
Date : 11 & 12/01/2017 Time:

Relinquished by: (print and signature)	Ashleigh Pickering	Date 16/01/2017	Time 17:00	Received by: (print and signature)	Date 17/1/17	Time 11:40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

Chain of Custody Form – Ref 7891

Ref:	**7891**
Investigator:	Envirowest Consulting 9 Cameron Place PO Box 8158 ORANGE NSW 2800
Telephone:	(02) 6361 4954
Facsimile:	(02) 6360 3960
Email:	ashleigh@envirowest.net.au
Contact Person:	Ashleigh Pickering
Invoice:	accounts@envirowest.net.au
Laboratory:	SGS SYDNEY 16/33 Maddox Street ALEXANDRIA NSW 2015
Quotation #:	
Courier/CN:	

			Sample matrix			**Sample preservation**			**Analysis**					
									SGS Method Code					
									CL1		**CL10**			
Sample ID	**Container***	**Sampling Date/Time**	Water	Soil	Sludge	Cool	HNO3/HCl	Unpre-served	7 Metals	OC Pesticides	TRH/BTEXN/PAH/ 8 metals	Chlorides	Cations	Exchangeable sodium percentage
SR31	A	11/01/2017		X		X		X		X	X			
SR32	A	12/02/2017		X		X		X		X	X			
SR33	A	12/02/2017		X		X		X		X	X			
SR73	A	11/01/2017		X		X		X		X				
SR91	A	11/01/2017		X		X		X		X				
SR113	A	11/01/2017		X		X		X		X				
SR184	A	11/01/2017		X		X		X		X				
SR224	A	11/01/2017		X		X		X		X				
SRA	A	11/01/2017		X		X		X	X					
SRB	A	11/01/2017		X		X		X	X					
BH16-100	A	11/01/2017		X		X		X				X	X	X
BH16-1500	A	11/01/2017		X		X		X				X	X	X

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.	Sampler name: Ashleigh Pickering Date : 11 & 12/01/2017 Time:
Relinquished by: (print and signature) Ashleigh Pickering [signature] Date 16/01/2017 Time 17:00	Received by: (print and signature) [signature] Date 17/1/17 Time 11:40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

Appendix D

ECOLOGICAL ASSESSMENT

Prepared by Ozark Environmental & Heritage Management Pty Ltd

March 2017

Overview of the north bank of Eulomogo Creek, facing west

Environmental and
Heritage Management P/L

ECOLOGICAL ASSESSMENT: SUBDIVISION OF LOT 2 DP880413 SHERATON ROAD, DUBBO NSW

MARCH 2017

Report Prepared by

OzArk Environmental & Heritage Management Pty Ltd

For

MAAS Group Properties Pty Ltd

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DOCUMENT CONTROLS

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<tr><td>Document Description</td><td colspan="5">Biodiversity Assessment Subdivision of Lot 2 DP880413, Dubbo NSW, Dubbo Regional LGA</td></tr>
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<tr><td colspan="2">Prepared For</td><td colspan="4">Prepared By</td></tr>
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</table>

EXECUTIVE SUMMARY

OzArk Environmental & Heritage Management was engaged by MAAS Group Properties to complete an ecology assessment for the proposed subdivision of Lot 2 DP880413 at 24R Sheraton Road, Dubbo NSW.

This investigation has been completed to fulfil the requirements of Part 4 of the *Environmental Planning and Assessment Act 19*79 (EP&A Act), to take into account all matters affecting or likely to affect the environment as a result of the proposal.

Field assessment of the Subject Site was undertaken by Phillip Cameron (Principal Ecologist of OzArk) on Friday 6 January 2017.

The majority of the Subject Site has continued or historical agricultural practices, infrastructure provision and low density rural housing. Satellite imagery of the Subject Site (**Figure 3-1**) demonstrates high levels of broad scale land clearance for grazing and cropping.

Grey Box (*Eucalyptus microcarpa*), Yellow Box (*E. melliodora*), Rough-barked Apple (*Angophora floribunda*) and Fuzzy Box (*E. conica*) are dominant trees along the Eulomogo Creek line in the Subject Site. This community was mapped by NSW OEH as PCT ID:81 Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion (**Figures 3-1, 3-2 and Table 3-1**). Approximately 4.5ha of this area is considered to be the community and the majority occurs south of Eulomogo Creek.

The areas mapped by NSW OEH as PCT ID:45 Plains Grass grassland on alluvial mainly clay soils in the Riverina Bioregion and NSW South Western Slopes Bioregion in the Subject Site, were ground truthed as 'not native vegetation' (**Table 3-1**).

PCT ID:81 is an endangered ecological community listed in the NSW TSC Act (*Inland Grey Box Woodland*). This total EEC patch size (i.e. the same vegetation community that extends onto surrounding property) is 77.7 ha (determined by VIS map 4358) thus 5.9 percent of the local viable population is within the proposal.

The Commonwealth listed EEC with a similar name does not occur in the Subject Site as it's too weedy to meet the minimum quality criterion.

Eulomogo Creek forms part of the FM Act listing for the '*aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River.'* The creek is in poor condition however provides connectivity to the Macquarie River.

This report assumes the NSW EEC will not be affected by the proposal. An Assessment of Significance has been completed to characterise the potential impacts and concluded it would not be significant. If the Inland Grey Box EEC is affected, where more than five percent of the viable local population is cleared, then it would be a significant impact and a Species Imapct Statement and Biodiversirty Offsetting approved by NSW OEH would be needed.

No listed plants or animals were recorded during the assessment.

No ground water dependant ecological communities or trees with hollows will be affected by the proposal.

On the basis of regional records, reports and the presence of suitable habitat, 15 threatened items listed in the schedules of the TSC Act and / or EPBC Act that can used agricultural landscapes as habitat were assessed as likely to be affected by the Proposal (**Table 4-7**). Assessments of significance were conducted for these species (**Appendix 5**). Having given consideration to the ecology within the Subject Site, it is apparent that the Proposal is:

- unlikely to significantly affect any of the listed threatened species, fauna populations or communities.
- unlikely to augment or significantly contribute to any of the National or State listed Key Threatening Processes, if the appropriate safeguards regarding the control of potential vertebrate pests are effectively applied.
- unlikely to significantly affect any Ramsar wetland or any CAMBA, ROKAMBA or JAMBA listed species;
- unlikely to significantly affect local hydrology.
- consistent with ESD principles with regard to fauna, would not adversely affect the local biodiversity and no issue of inter-generational or value added matters are relevant in this instance.

The proposed activity should not be considered to constitute a significant impact and, as such, no Species Impact Statement (SIS) is warranted. No Koala Habitat Management Plan pursuant to SEPP 44 should be required.

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1 THE PROJECT

OzArk Environmental & Heritage Management was engaged by MAAS Group Properties to complete an ecology assessment for the proposed subdivision of Lot 2 DP880413 at 24R Sheraton Road, Dubbo NSW (**Figures 1-1** to **1-3**).

This investigation has been completed to fulfil the requirements of Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), to take into account all matters affecting or likely to affect the environment as a result of the proposal.

Figure 1-1: Location Map and Subject Site.

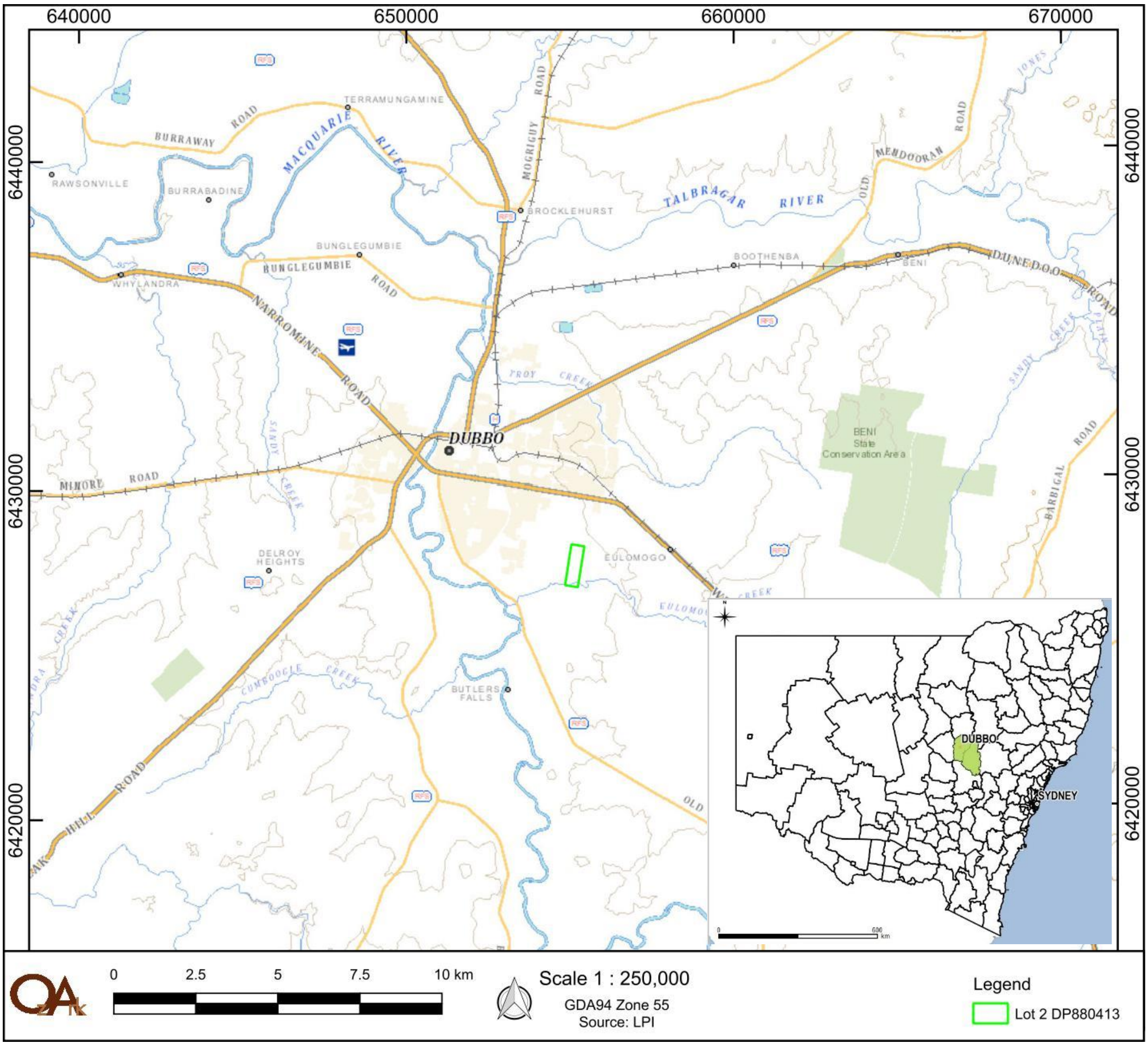


Figure 1-2: Map showing satellite imagery of the Subject Site (Lot 2 DP880413).

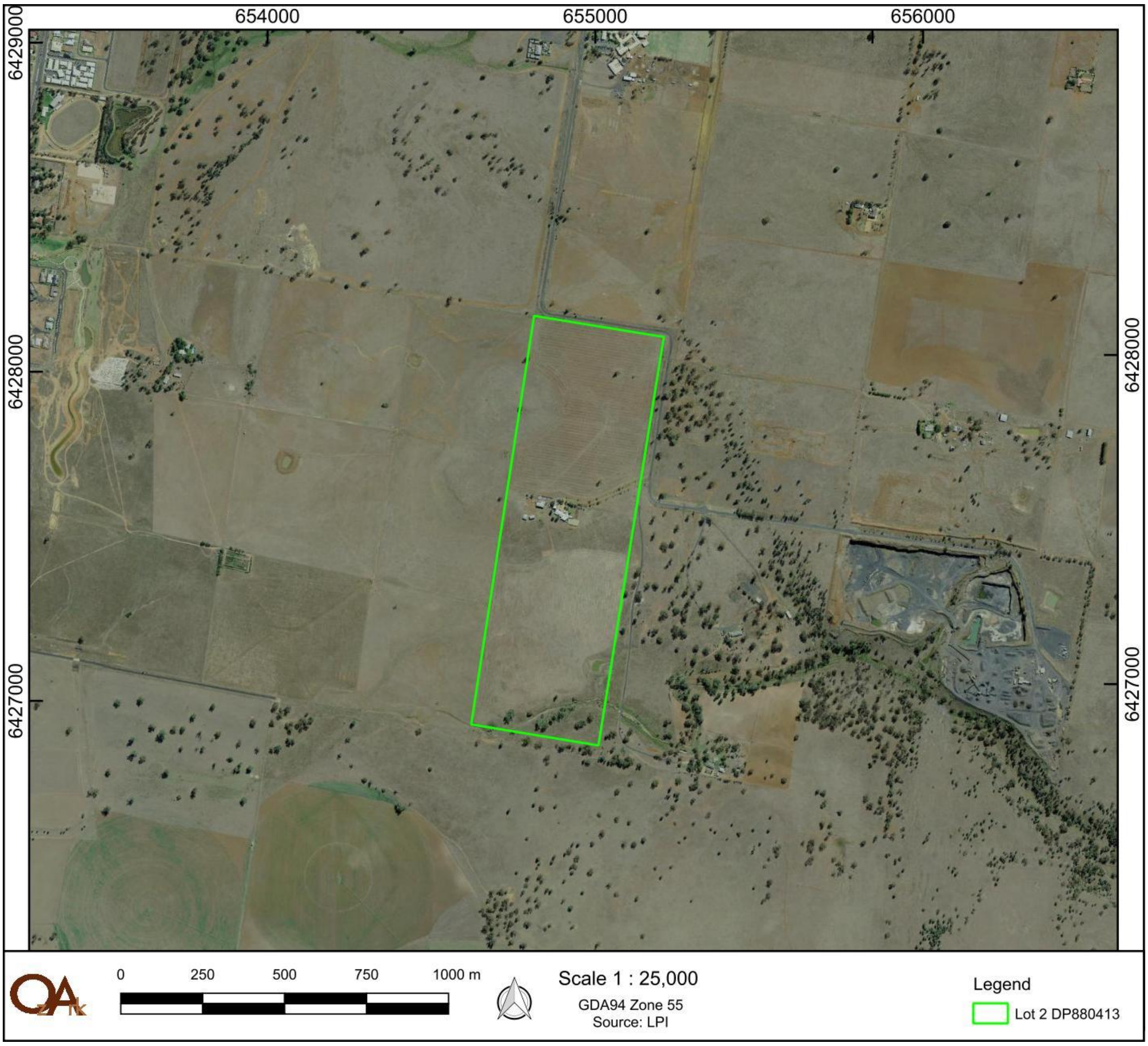
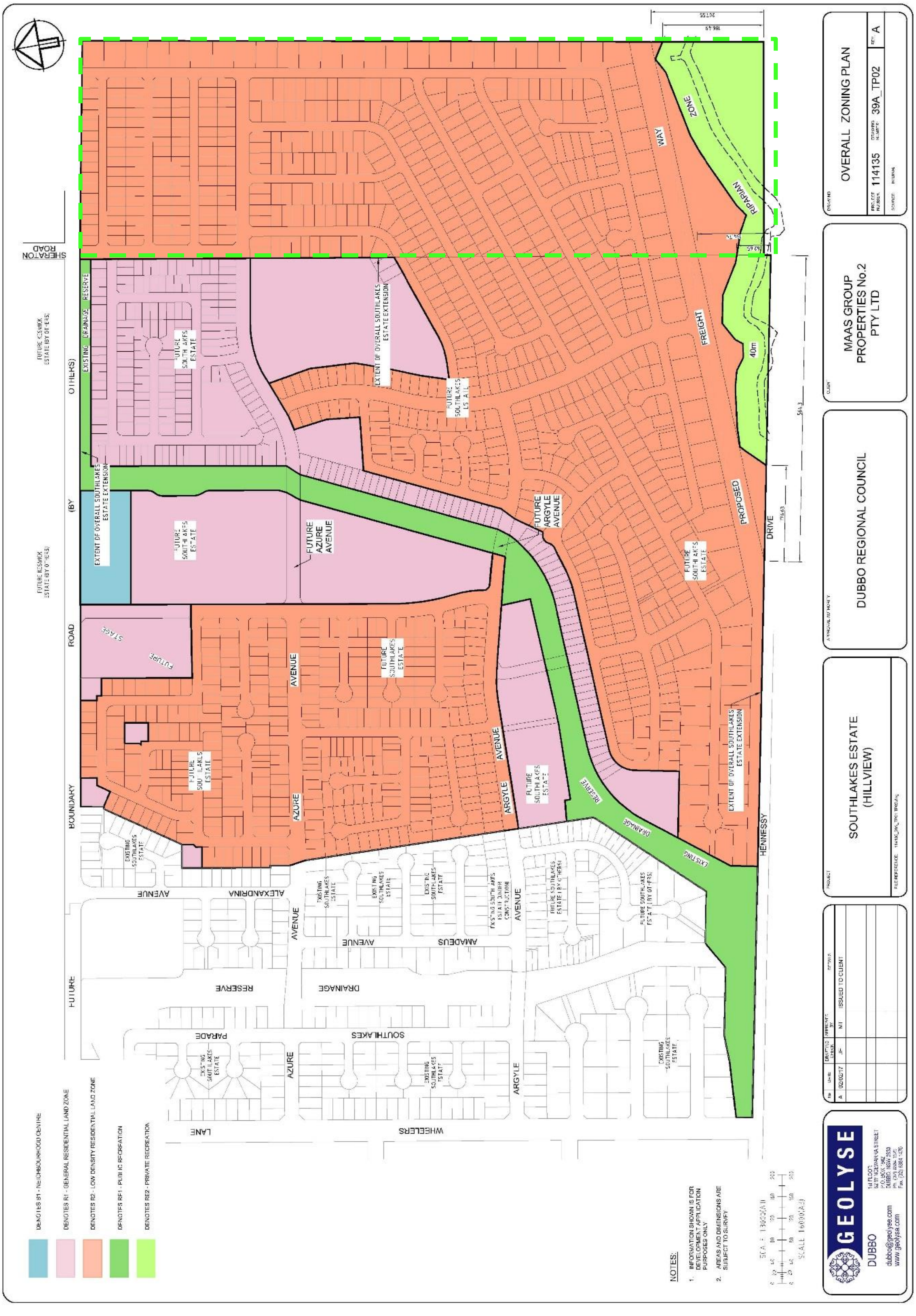


Figure 1-3: Map showing the lot layout for the proposed subdivision within the Subject Site (green dashed line).



1.2 LOCATION

The Subject Site is located in Central West NSW on Lot 2 DP880413, encompassing approximately 51 hectares of land, located approximately 4.7 kilometres southeast of the Dubbo CBD at 24R Sheraton Road (

Figure 1-2).

1.1 LEGISLATIVE CONTEXT

1.1.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) is the principal planning legislation for the state, providing a framework for the overall environmental planning and assessment of development proposals. Under the EP&A Act there are three distinctive processes, which are:

- Part 3.1 (Previously Part 3A) 'State Significant Infrastructure', which regulates specific types of 'Infrastructure' and requires an Environmental Assessment report to be prepared and submitted to the Department of Planning and Infrastructure for the Minister's approval;
- Part 4, which regulates 'development' requires a development application to be accompanied by an Environmental Impact Statement 'prepared by or on behalf of the applicant in the form prescribed by the regulations.'
- Part 5, which regulates 'activities' and requires a REF for determination by a state self-determining authority.

The proposal is to be undertaken by MASS, under Part 4 of the Act. This ecological assessment and report will support a Development Application to Dubbo Regional Council for Approval.

1.1.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* protects nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as matters of national environmental significance. Matters of national environmental significance relevant to biodiversity are:

- Wetlands of international importance.
- Nationally threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.

Significance of impacts is determined in accordance with the *Significance impact guidelines 1.1– matters of national environmental significance* (Department of Environment, Water, Heritage and the Arts, 2006).

Where a proposal is likely to have a significant impact on a matter of national environmental significance, the proposal is referred to the Commonwealth Environment Minister via the Department of the Environment and Energy (DoEE). The Minister then determines whether the proposal is a 'controlled action'. If a proposal is declared a controlled action, an assessment of the action is carried out and the Minister makes a decision to approve, approve with conditions, or not approve the proposed action. A requirement for biodiversity offsetting is triggered in controlled actions.

1.1.3 Other Relevant legislation, Plans and Policies

A summary of applicable environmental legislation have been provided in **Table 1-1**.

Table 1-1: Environmental considerations.

Environmental considerations	Comment
An area reserved or dedicated under the *National Parks and Wildlife Act 1974*?	No
Is the proposal located within land reserved or dedicated within the meaning of the Crown Lands Act 1989 for preservation of other environmental protection purposes?	No
A World Heritage Area?	No
Environmental Protection Zones in environmental planning instruments?	No
Lands protected under SEPP 14 – Coastal Wetlands?	No
Lands protected under SEPP 26 – Littoral Rainforests?	No
Lands protected under SEPP 71 – Coastal Protection?	No
Lands protected under SEPP 44 – Koala Protection?	No
Lands protected under SEPP - Sydney's drinking water?	No
Land identified as wilderness under the *Wilderness Act 1987* or declared as wilderness under the *National Parks and Wildlife Act 1974*?	No
Aquatic reserves dedicated under the *Fisheries Management Act 1994*?	No
Wetland areas dedicated under the Ramsar Wetlands Convention?	No
Land subject to a conservation agreement under the *National Parks and Wildlife Act 1974*?	No
Land identified as State Forest under the *Forestry Act 1916*?	No
Western Lands Lease	No
Freehold or Crown Land. If Crown Land, what type?	Freehold
Land within a mining subsidence district?	No
Acid sulphate area?	No
Protected riparian habitat?	**Yes**
Critical habitat NSW?	No
Critical habitat nationally?	No

Table 1–2 summarises relevant ecological approvals or licenses required from State or National bodies prior to undertaking the works.

Table 1-2: Summary of other relevant legislation, licensing and approval required.

Act	Authority	Requirements
NSW *Threatened Species Conservation Act 1995* (TSC Act)	Office of Environment & Heritage (OEH)	This act aims to conserve biological diversity, promote ecologically sustainable development, prevent extinctions and promote recovery of threatened entities, protect critical habitat, assess the impacts of actions on, and encourage the conservation of, threatened entities. An assessment of the potential impacts of the Proposal on threatened species, populations, ecological communities and critical habitat listed on the TSC Act must be undertaken in accordance with section 5A of the EP&A Act (7-part test).Where a significant impact is likely to occur a Species Impact Statement (SIS) must be prepared for projects assessed under Part 4 and Part 5 of the EP&A Act. The content of a SIS is outlined in Sections 110–112 of the Threatened Species Conservation Act 1995 (TSC Act) and includes requesting Director-General's requirements.
Native Vegetation Act 1997 (NV Act)	OEH	The Native Vegetation Act 2003 (NV Act) regulates the clearing of native vegetation on all land in NSW. The NV Act requires development approval from the Central West Local Land Services for the clearing of any native vegetation. Currently, it is illegal to remove or damage vegetation, without a permit, from within 40 metres of the banks of nominated waterways in NSW (Category B Riparian Land, State Protected Land or SPL). As this project will be assessed under Part 4 of the EP&A Act, the NVA Act applies.
Noxious Weeds Act 1993 (NW Act)	NSW Department of Primary Industries (NSW DPI)	The Noxious Weeds Act 1993 (NW Act) guides the management of declared noxious weeds within Local Government Areas (LGAs) and provides for a coordinated approach to the removal and control of scheduled noxious weeds across the State. Individual land holders and managers are required under the NW Act to control noxious weeds declared for their area according that have been proclaimed under the NW Act. A list of declared noxious weeds for the Dubbo LGAs is provided in **Appendix 1**. In addition to the NW Act, an effort to gain control of weeds in Australia led to the development of a National Weeds Strategy. The strategy was first developed in 1997 and further refined in 2007 by the Commonwealth of Australia and issued under the authority of the National Resource Management Ministerial Council. Detailed management procedures have been outlined under the strategy and published for the control of 21 of the 32 recognised Weeds of National Significance (WoNS). WoNS are recognised as having potential to cause a significant impact upon natural values including: threats to human health and safety; threats to pastoral and agricultural industries; threats to water quality and supply; threats to indigenous flora; and threats to biodiversity and cultural values. A list of WoNS known or predicted to occur in the Subject Site has been provided in the Appendices.
Fisheries Management Act 1994 (FM Act)	DPI and OEH	The objective of the Fisheries Management Act 1994 Act (FM Act) is to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. The developer will need to obtain a 'whole of project permit' to engage in a dredging (trenching) and reclamation activity (section 199, Part 7, Div 3 of the FM Act 1994) for the purpose of rehabilitation within the banks of the Eulomogo Creek in Subject Site. Under the 'integrated development' provisions of the *NSW Environmental Planning and Assessment Act 1979*. The developer will need to seek approval from DPI for a permit to temporarily or permanently block fish

Act	Authority	Requirements
		passage (section 219, of the FM Act 1994). If required, allow eight weeks to obtain this permit.
NSW National Parks and Wildlife Act 1974 (NP&W Act)	OEH	The NP&W Act aims to conserve nature, habitat, ecosystems, ecosystem processes and biological diversity at the community, species and genetic levels. Under this Act all native fauna is protected, threatened or otherwise. Schedule 13 of the act lists protected plants which shall not be harmed or picked on any land either on or off National Park estate. With regard to threatened species a person must not: a) harm any animal that is of, or is part of, a threatened species, an endangered population or an endangered ecological community, or b) use any substance, animal, firearm, explosive, net, trap, hunting device or instrument or means whatever for the purpose of harming any such animal.
Water Management 2000 (WM Act)	NSW Office of Water (NoW)	The WM Act provides for the protection of river and lakeside land in NSW and aims to provide for the sustainable management of the water sources throughout NSW. All controlled development on or under waterfront land is regulated by the Act. The Act aims to minimise impacts on waterfront land and water courses and requires buffer zone, called the riparian corridor, between the waterfront and the adjacent development. NoW administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity. Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary. The Subject Site borders Eulomogo Creek and may require a permit under WM Act. A water access licence may be required under the WM Act prior to commencement of works if water is to be sourced from a creek or a river (for water trucks etcetera). Allow a minimum of 28 days prior to the commencement of the works.
Water Act 1912	NoW	There are still some provisions in the Water Act 1912 that are yet to be incorporated into the WM Act. Under Part 8 of the Act, approval is required for a "controlled work". A "controlled work" is defined as an earthwork, embankment or levee or any work proposed to be constructed, on land that form part of a bank of a river or is within a designated floodplain and that is declared by order of the Ministerial Corporation published in the Gazette to be a controlled work. The subdivision will occur on the edges of the Macquarie River floodplain. Under Part 4 of the EPA Act, the developer may be required to submit a Controlled Works Application to NoW. Seek further advice from this department.
SEPP44 – Koala Habitat Protection	NSW Planning & Environment	This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline: • by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and • by encouraging the identification of areas of core koala habitat, and • by encouraging the inclusion of areas of core koala habitat in environment protection zones. SEPP 44 aims to identify areas of potential and core Koala Habitat. These are described as follows:

Act	Authority	Requirements
		• Core Koala Habitat is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females, and recent and historical records of a population. • Potential Koala Habitat is defined as areas of native vegetation where the trees listed in Schedule 2 of SEPP 44 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component. SEPP 44 does not apply to the Dubbo Local Government area, however Koala habitat still requires consideration.
Local Environment Plan	Dubbo Regional Council	The Subject Site is zoned as R2 (Low density residential). The application of ISEPP does not override the need to consider zoning controls under a LEP.
National Wildlife Corridors Plan	DoE	Works have been assessed against the types of biodiversity links (wildlife corridors) defined in of the National Wildlife Corridors Plan. Mitigation and redesign in sensitive ecological areas would be recommended to avoid large scale clearing. Offsets and rehabilitation will be consistent with this plan.

Biodiversity offsetting policies

Biodiversity offsets may be required as a condition of approval or a concurrence under the NSW EP&A Act or the EPBC Act. Both State and National levels of government aim to 'maintain, enhance or improve biodiversity', through the developer.

Following consultation with Dubbo Regional Council (DRC), offsetting is required by Council. DRC are currently developing offsetting policies. To ensure offsetting is consistent with Councils requirements, this chapter was written taking into consideration their feedback to date.

Offsets would demonstrate an 'improve or maintain' outcome. Offsets are best directed at improving the habitat for all threatened species and connectivity to remnants. Plants used for revegetation would be consistent with those locally occurring in the Subject Site and would improve Eulomogo Creek bank stability, address erosion and assist in managing salinity.

DRC Offsetting Objectives

To meet offsetting requirements the offsetting package would:

- improve creek structural stability, and the condition and extent of native vegetation suitable for listing as a NSW EEC (Fuzzy Box, Box-gum Woodland, Inland Grey Box Woodland). The *Water Management Act 2000 Guidelines for controlled activities* (2008) would be used as a guide for works within the proposed waterway the end result.
- maintain or improve the extent, distribution and condition of the existing native vegetation in the offset area.
- support the recovery of priority fauna populations, and threatened species, populations and communities.

DRC Offsetting Principles

The following principles would be considered when developing biodiversity offsets:

1. Offsets will be used as a last resort, after consideration of alternatives to avoid and/or mitigate impacts.
2. Offset areas be kept within the Dubbo Regional Government Area (either wholly or in part – as a contiguous area of native vegetation).
3. Council stipulate the offset area will be publically accessible.
4. Offsets must be of the same vegetation type and be at least the size, equivalent biodiversity value and configuration of the vegetation lost through development and be additional to existing native vegetation areas.
5. Offsetting must achieve biodiversity benefits in perpetuity and be registered on title.
6. Offset conditions must be monitored, enforceable, clearly mapped, recorded and publicly available.
7. An offset area, once designated, cannot be used for offsetting of subsequent developments in future.

1.2 STUDY AIMS

The scope and aims of this report are to:

- Determine biodiversity values of the Subject Site including identifying protected and threatened flora and fauna species, populations and ecological communities and their habitats.
- Identify the ecological constraints of the proposal.
- Identify the impacts of the proposed activity on flora and fauna species, populations, ecological communities and critical habitat.
- Address the requirements of the relevant legislation including the EP&A Act, the TSC Act and the EPBC Act.
- Assess the significance of the impact of the proposed activities on species, ecological communities and populations listed under the TSC Act and EPBC Act.
- Propose environmental management measures to minimise, mitigate and if necessary offset impacts.

2 METHODOLOGY

The flora and fauna assessment has been completed in accordance with Section 5a of the EP&A Act and the EPBC Act for threatened species populations and ecological communities potentially affected by the proposal.

The methodology employed for this report consisted of:

- A desktop and literature review of ecological databases and literature sources as direct references for the survey undertaken.
- A field survey of the Subject Site.

2.1 PERSONNEL

2.1.1 Field assessment

Field assessment of the Subject Site was undertaken by Phillip Cameron (Principal Ecologist of OzArk) on 6 January 2017.

2.1.2 Reporting

Reporting components were completed by:

- Main Author: Phillip Cameron
- Editor: Jane Book
- QMS: Phillip Cameron

2.1.3 Licensing and qualifications

OzArk operates under NSW Department of Primary Industries (DPI) Ethics Approval No 11/5475 and NSW Scientific Research License 101087. Key details of scientific personnel from OzArk EHM are provided in **Table 2–1**.

Table 2-1: Summary of OzArk qualifications.

Name	Position	CV Details
Phil Cameron	Principal Ecologist Senior Project Manager	• BSc. Major in Biology. Macquarie University. • Ass Dip App Sci. University of Queensland. • Certified Environmental Practitioner (EIANZ). • Lean Six Sigma Certificate (Sydney Uni) • OEH BioBanking and Bio-certification Assessor: accreditation number 0117 • OEH Scientific License: 101087. • NSW DPI Ethics Approval 11/5475. • Practicing member of the NSW Ecological Consulting Association. • Practicing member of the Environment Institute of Australia and New Zealand (EIANZ) Member. • National Railtrack Safety Induction (ARTC and John Holland Inductions).

Name	Position	CV Details
		• WHS White Card and Blue Card. • Apply First Aid (Parasol) ID: 6007221.
Jane Book	Environmental Scientist	• Masters of Environmental and Business Management (Newcastle Uni) • Graduate Certificate in Environmental and Business Management • Bachelor of Applied Science (Hons) • Member Royal Zoological Society, National Trust, NSW Ecological Consulting Association

2.2 DATABASE SEARCHES AND LITERATURE REVIEWS

Preliminary assessments drew on a number of information sources including previous preliminary reporting and information held on government databases and archives. Data was used to assist in identifying distributions, suitable habitats and known records of threatened species to guide field investigations. Information sources included:

- Aerial Photograph Interpretation (API) of the landscape and previous vegetation maps.
- Literature reviews to determine vegetation and species habitat(s) within the proposed Subject Site and environs.
- Review of flora and fauna records contained in the OEH Threatened Species Database, EPBC Protected Matters Search and DPI Records Viewer.
- NSW Wildlife Atlas/Bionet GIS data request and website search.
- Australia Museum records.
- Royal Botanical Gardens (PlantNet NSW Flora Online).
- NSW Atlas of Living Australia records.
- Birds Australia Atlas.

2.3 PREDICTIVE MODEL FOR THREATENED SPECIES DETECTION

The concepts of the modelling formed the basis of the methodology designed for the current assessment. These reflect the predominant patterns of threatened species distribution as elicited from prior survey work.

Remnant patch size is the primary factor appearing to determine the location of threatened plants and animals in the region and to a lesser degree in disturbed habitats proximity to a permanent water supply. Predictive modelling for EECs in the locality is fairly straight forward as it can be summarised as likely to be any native vegetation left in the valley floor and on the undulating hills which is suitable for cropping or grazing agriculture.

An assessment of likelihood of occurrence was made for threatened species of flora, fauna, populations, ecological communities and migratory species identified from the database searches identified in **Section 2.2**. Five terms for the likelihood of occurrence of species are used in this report. This assessment was based on database or other records, presence or absence of suitable habitat, features of the proposal site, results of the field survey and professional judgement. The terms for likelihood of occurrence are defined below:

- “Yes” = the species was or has been observed on the site.
- “Likely” = a medium to high probability that a species uses the site.
- “Potential” = suitable habitat for a species occurs on the site, but there is insufficient information to the species as likely to occur, or unlikely to occur.
- “Unlikely” = a very low to low probability that a species uses the site.
- “No” = habitat on-site and in the vicinity is unsuitable for the species.

The background searches detailed in **Section 2.2 (Appendix 2)** enabled a predictive model of threatened flora and fauna occurrence to be developed for the Subject Site (**Section 4.1.5**).

The ecology and habitat requirements of threatened species, populations, and endangered ecological communities and the likelihood of those occurring within the Project Area are detailed in **Appendix 3**.

2.4 FIELD SURVEY

2.4.1 General survey methodology

The survey methods employed during the field investigations in the Subject Site were based on relevant recovery and threat abatement plans and the following documents:

- Threatened Species Survey And Assessment: Guidelines for Developments and Activities- Working Draft (DEC 2004).
- Field Survey Methods (DECCW 2009).
- Survey guidelines for Australia’s threatened birds: Guidelines for detecting birds listed as threatened under the EPBC Act (DEWHA 2010a).
- Survey guidelines for Australia’s threatened bats: Guidelines for detecting bats listed as threatened under the EPBC Act (DEWHA 2010b).
- Survey guidelines for Australia’s threatened mammals: Guidelines for detecting mammals as threatened under the EPBC Act. (DEWHA 2010c).
- Survey guidelines for Australia’s threatened frogs: Guidelines for detecting frogs listed as threatened under the EPBC Act (DEWHA 2010d).

2.4.2 Floristic survey methods

During the desktop assessment phase about six hectares of native vegetation was predicted to remain on the property (the rest had been ploughed for agriculture) and subsequently three vegetation plots were undertaken following Biobanking Assessment Methodology (2014). Plot details are as follows:

- Plot 1 (GDAz55 654777E,6426906N). This plot was within grassy woodland mapped as native vegetation.
- Plot 2 (GDAz55 654675E,6426910N). This plot was within a grassland area mapped as native vegetation.
- Plot 3 (GDAz55 654930E,6426869N). This plot was within a grassland area mapped as native vegetation.

Additional survey of the Subject Site followed the "Random Meander Technique" described by Cropper (1993). Special consideration was given to locating rare or threatened plants identified as having the potential to occur in **Appendix 2**.

Plant Identification

Plant identification followed nomenclature in Harden 1990–2002, Cunningham et al. 1992, Royal Botanic Gardens (RBG 2014a), and PlantNet NSW Flora Online (RBG 2014b). The national conservation significance of flora was determined by referencing *Rare or Threatened Australian Plants* (ROTAP) (Briggs and Leigh 2006) and the Schedules associated with the TSC Act or the EPBC Act.

2.4.3 Fauna survey methods and habitat assessment

A general habitat assessment was carried out to assess habitat features such as the presence of hollow bearing trees, logs and the potential for suitable habitat to provide breeding, nesting, feeding and roosting resources for native species.

Opportunistic fauna observations and targeted searches were carried out during the field survey to identify cryptic species in the Subject Site. Fauna identification was achieved via:

- Identification of scats, diggings, tracks and other traces.
- Direct observation: ie bird watching.
- Ground, leaf litter and other refuge searches.
- Searches for indirect evidence of mammals (vocalisation, tracks, scats, burrows etc.).
- Targeted assessment – Pink-tailed Worm Lizard

Fauna species identification

All fauna was readily identified through the use of available standard references (Strahan, R. [ed.] 1983 Groves *et al.* 2005).

2.4.4 Hollow bearing trees

Habitat values of trees assessed in the Subject Site were considered for their potential to provide habitat for the regions hollow dependant threatened fauna.

2.5 SURVEY EFFORT

All areas mapped as native vegetation or thought to possess native vegetation was assessed on foot. All trees with hollows inside the Subject Site were assessed and considered. Ploughed paddocks were not accessed unless it was essential to do so to determine if native vegetation was present.

Where ground debris or rocks were present they were overturned to search for frogs and reptiles in these areas. A targeted Pink-tailed Worm-Lizard search was undertaken in the area mapped as native vegegation but ground truthed as ‘not native vegetation’ (**Figure 3-1**). This area has basalt outcrops and suitable surface rocks. Approximately 300 rocks were overturned in this area as per EPBC Act survey guidelines for this species.

All native trees were assessed for evidence of Koala use.

2.6 LIMITATIONS

Not all animals and plants can be fully accounted for within any given Subject Site. The presence of threatened species is not static. It changes over time, often in response to longer term natural forces that can, at any time, be dramatically influenced by man-made disturbance. As such, the ‘precautionary approach’ for species occurrence has been adopted where required.

The above-mentioned constraints are not considered to compromise the scientific rigour of the field assessment.

3 EXISTING ENVIRONMENT

3.1 LANDSCAPE CONTEXT

The majority of the Subject Site has continued or historical agricultural practices, infrastructure provision and low density rural housing. Satellite imagery of the Subject Site (**Figure 3-1**) demonstrates high levels of broad scale land clearance for grazing and cropping. The Land Use mapping provided by the NSW government shows the areas as 'grazing' (**Figure 3-3**), this map is probably dated or incorrect.

3.2 CLIMATE OF THE SUBJECT SITE

The Subject Site experiences warm to very warm (hot) summers, and has an average rainfall of 590 millimetres, which occurs throughout the year. The average maximum temperature is 33.2 degrees Celsius and the average minimum temperature 18.2 degrees (Bureau of Meteorology 2017).

3.3 TOPOGRAPHY AND GEOLOGY

Low hills with long slopes characterise the locality. The Subject Area is located on the undulating plain above the Macquarie River floodplain at approximately 270m Australian Height Datum (AHD) in the south to 280m AHD in the north with the highest point (mapped as native vegetation but ground truthed as 'cropped paddock') being 290m AHD on the northwestern boundary (**Figure 3-2**).

3.4 VEGETATION

Grey Box (*Eucalyptus microcarpa*), Yellow Box (*E. melliodora*), Rough-barked Apple (*Angophora floribunda*) and Fuzzy Box (*E. conica*) are dominant trees along the Eulomogo Creek line in the Subject Site. This community was mapped by NSW OEH as PCT ID:81 Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion (**Figures 3-1, 3-2 and Table 3-1**). Approximately 4.5ha of this area is considered to be the community and the majority of it occurs south of Eulomogo Creek.

The areas mapped as PCT ID:45 Plains Grass grassland on alluvial mainly clay soils in the Riverina Bioregion and NSW South Western Slopes Bioregion, were ground truthed as 'not native vegetation' (**Table 3-1**).

3.1 GROUND WATER DEPENDENT COMMUNITIES

Land along Eulomogo Creek is mapped as having a moderate potential for groundwater interaction.

3.2 MITCHELL LANDSCAPES AND SOIL OF THE SUBJECT SITE

Mitchells Landscapes in Subject Site includes "Goonoo Slopes" and "Dubbo Basalts" (**Figure 3-4**).

Goonoo Slopes are characterised by extensive undulating to stepped low hills with long slopes on sub-horizontal Triassic/Jurassic quartz sandstone, conglomerates, siltstone, shale and some coal. Stony yellow earths with sandstone outcrop on ridgelines to yellow harsh texture-contrast soils in shallow valleys (Mitchell 2002).

The Dubbo Basalts landscape unit includes slightly elevated plains and low hills on flat lying Tertiary basalt and trachyte flows, roughly parallel to the present course of the Macquarie River, with local relief to 10 metres. The Macquarie Alluvial Plain landscape unit is a plain associated with the Macquarie River main alluvial fan and distributary stream system with local relief of one to three metres.

3.1 HYDROLOGY OF THE SUBJECT SITE

The Subject Site is within the Talbragar Valley sub region of the Central West Catchment Management Area (CMA) situated within the larger Brigalow Belt South Bioregion (BBSB) (Thackway and Cresswell 2000). Eulomogo Creek transects the southern portion of the Subject Site. One small dam also exists on the southern portion of the Subject Site. All surface water drains south into adjoining agricultural / disturbed land and into the Macquarie River approximately 1.2 kilometres to the south.

Figure 3-1: Vegetation map (aerial background).

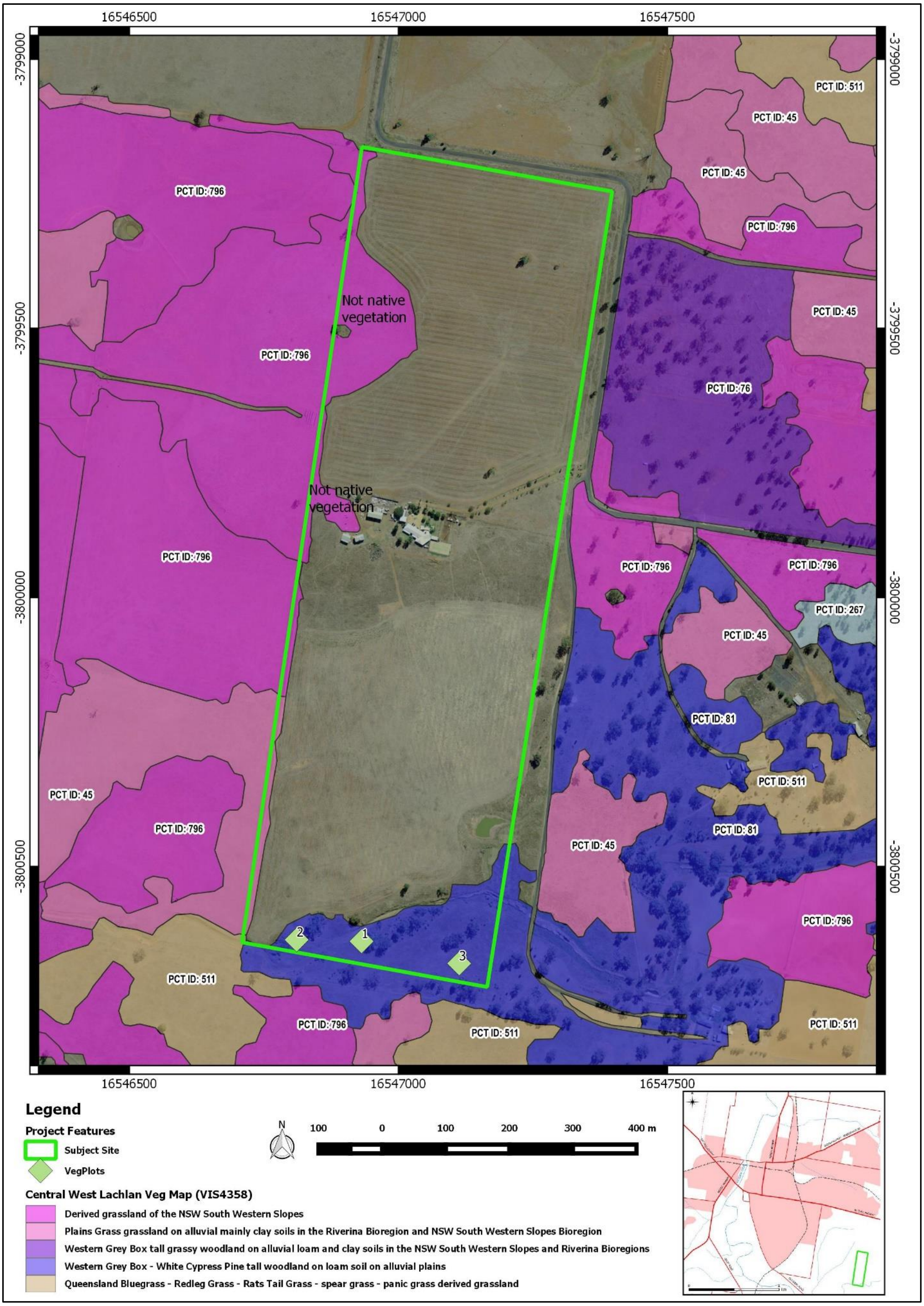


Figure 3-2: Topography of the Subject Site.

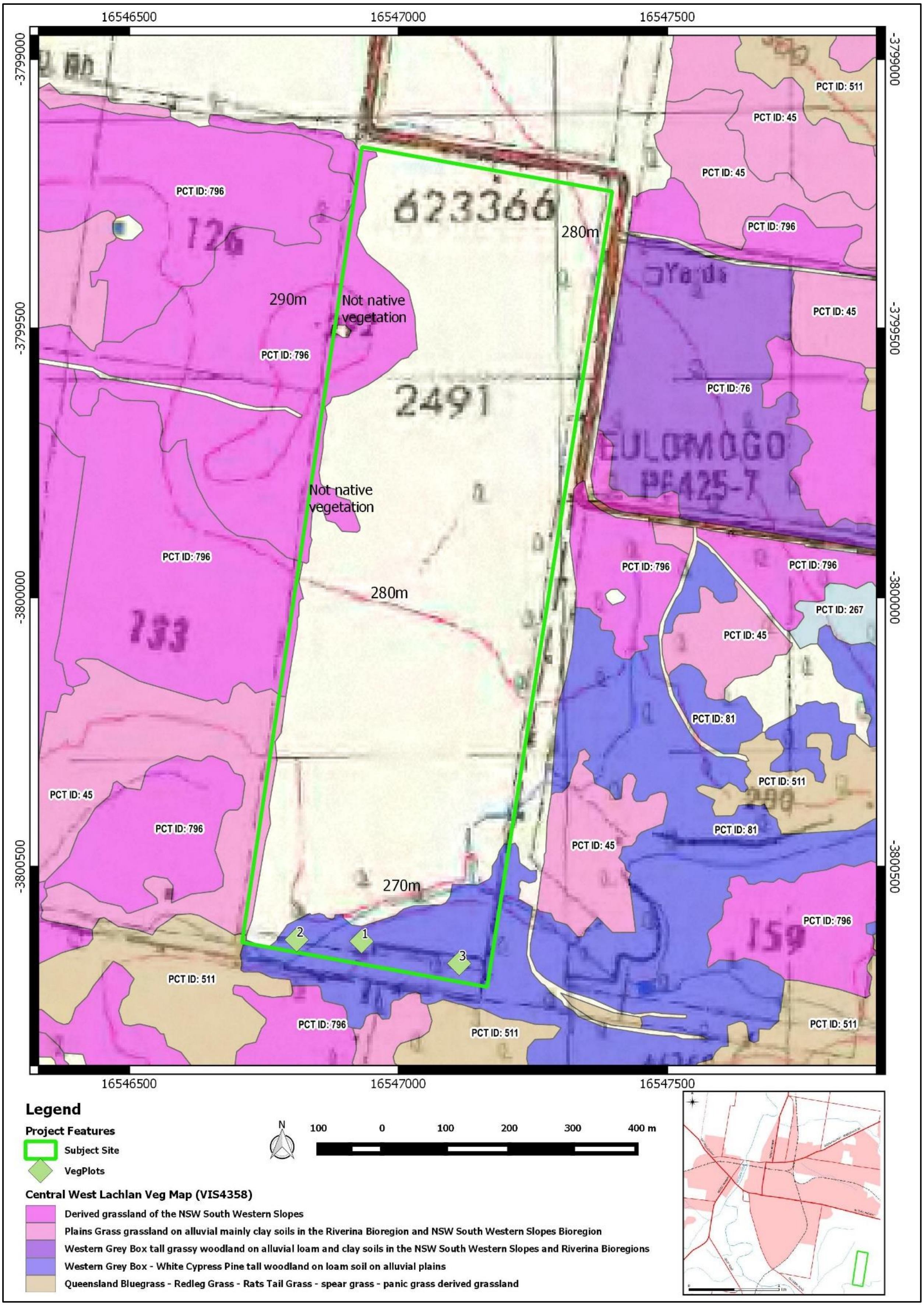


Figure 3-3: Map showing land use in the Subject Site.

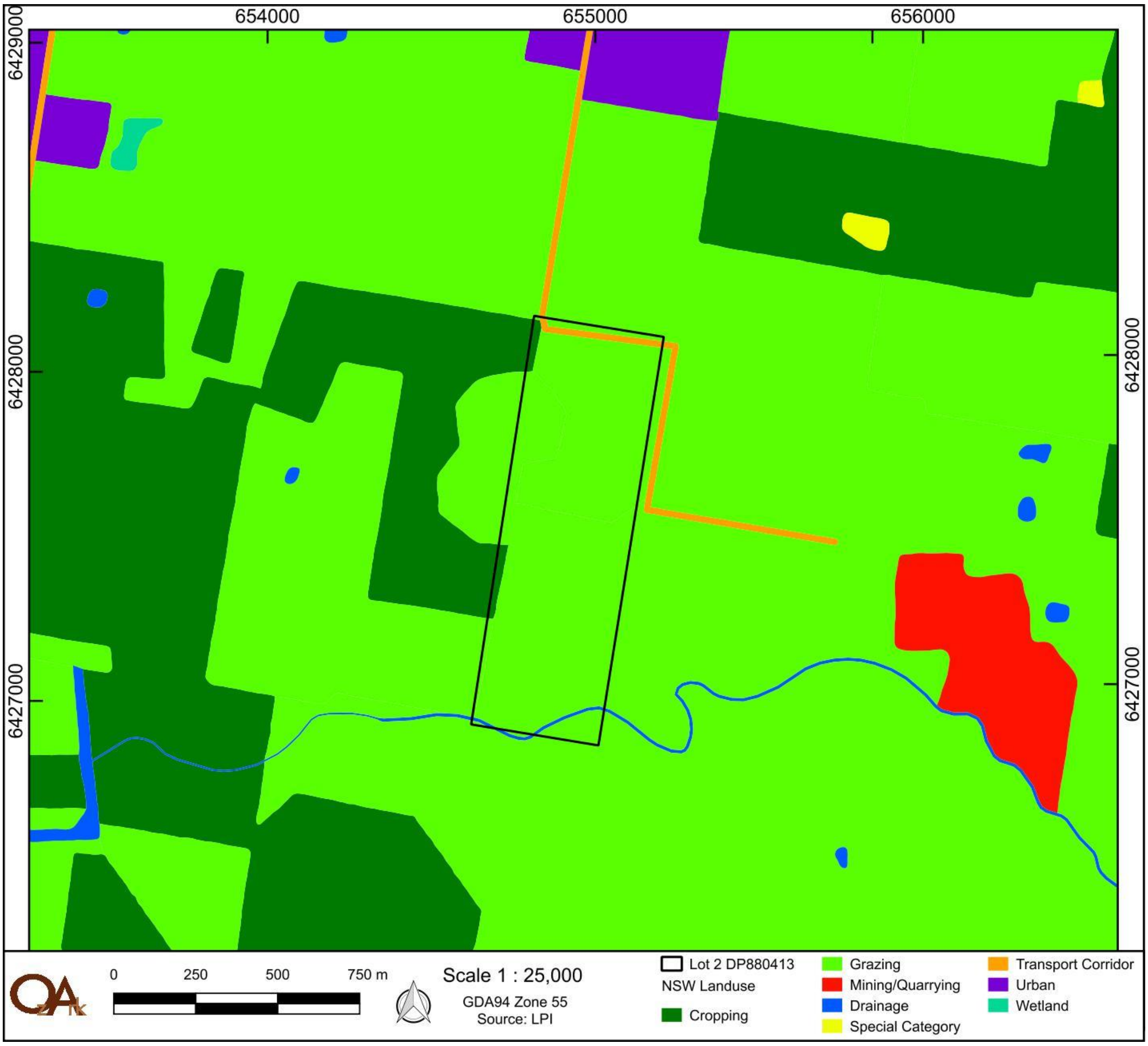
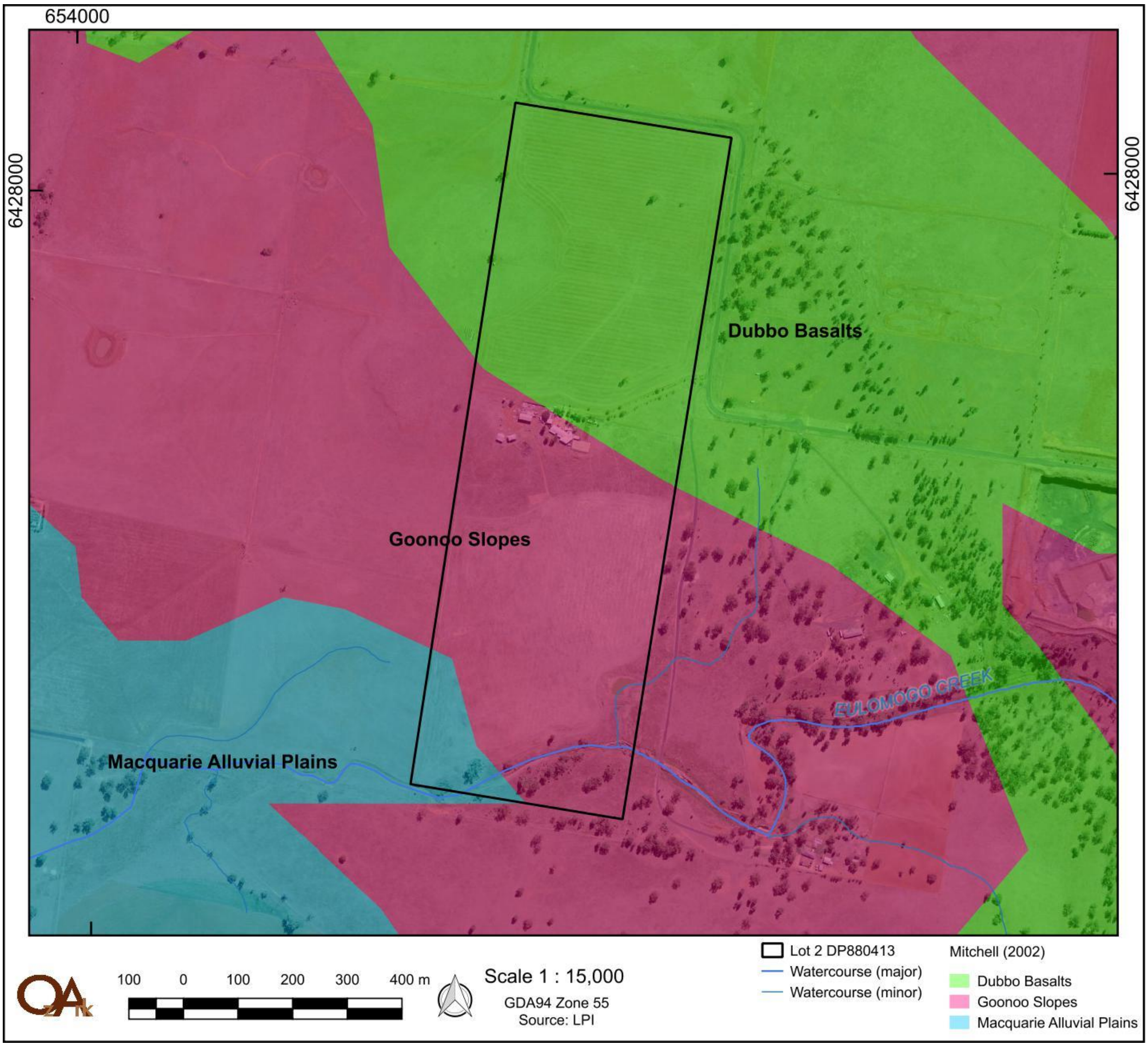


Figure 3-4: Mitchell's Landscapes in the Subject Site



3.2 LAND-USE

Examination of satellite imagery and visual inspection of the Subject Site confirmed the area has been cleared of vegetation, although some remnant trees exist in the southern and south-eastern portion, adjacent to Eulomogo Creek. House, shed and driveway construction has occurred in the central parts of the Subject Site (**Table 3-1**). The Subject Site is composed of several fenced paddocks that have undergone prolonged grazing. Visual inspection confirmed that the large northern and southern paddocks have been ploughed. Two low voltage powerlines and an earthen dam have been constructed in the southeast corner of the Subject Site. Most of the Subject Site therefore falls under the NPW Regulation definition of 'disturbed land', with the exception perhaps of: a low hill along the north western boundary (no native vegetation was recorded in this area); some areas to the east and west of the house and sheds; and the south eastern parts of the Subject Site in the vicinity of Eulomogo Creek.

Table 3-1: Landscapes in the Subject Site

		PCT ID:81 Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion
		Paddocks south of the house not mapped as native vegetation
		Paddocks north of the house not mapped as native vegetation. The photo showing the tree on the adjoining property was mapped as native vegetation but at ground truthing it wasn't.

3.3 Biodiversity links (Wildlife connectivity corridors)

Fauna wildlife corridors are usually associated with waterways, wetlands and riverine environments or specific continuous habitats (for example escarpments, woodlands).

The Subject Site is situated central to several protected forests and reserves including Beni State Conservation Area, Cobbora State Forest, Goonoo National Park, Goonoo State Conservation Area (SCA), Yarindury State Forest. Regionally the habitat surrounding within the Subject Site is likely to provide a movement pathway or stepping stone habitat between these reserves and the Macquarie River.

Goonoo SCA is recognised as an Important Bird Area (IBA) by Birdlife International (http://www.birdlife.org/worldwide/index.html). It is the core conservation area of the Mallee Fowl, Ground Cuckoo-shrike, Gilberts Whistler, Chestnut-rumped Heathwren, Spotted Quail-Thrush, Glossy Black Cockatoo and one of only two known populations of Eastern Pygmy Possum on public land in the region. Goonoo is also a regional stronghold of the vulnerable Greater Long-eared Bat (Ellis & Turbill, 2002).

Consequently, Goonoo SCA is considered a significant environmental feature of the Central West, and arguably one of the more significant environmental features of inland NSW. It provides connectivity for migrating birds between the semi-arid lands to the west and hinterland (and coast) to the east.

The Subject Site has connectivity along Eulomogo Creek but little elsewhere on the property.

4 RESULTS

4.1 DATABASE AND LITERATURE RESULTS

Appendix 1 provides a complete list of database searches and lists of threatened flora, fauna and ecological communities identified through the background searches and annotated with the potential to be recorded in the Subject Site. A map displaying threatened flora and fauna records for the Subject Site can be seen on **Figure 4-1**.

4.1.1 NSW OEH Listed items

A search of the NSW OEH Threatened Species Profiles using Central West CMA Talbragar Valley subregion predicts 98 listed items as having potential to be present in the Subject Site.

Table 4-1: NSW OEH Listed items predicted to occur in the Central West CMA Talbragar Valley subregion.

NSW OEH Threatened Species	Known	Predicted	Total
Animal > Amphibians		1	1
Animal > Bats	3	1	4
Animal > Birds	29	9	38
Animal > Marsupials	4	2	6
Animal > Reptiles		1	1
Community > Threatened Ecological Communities	3		3
Plant > Epiphytes and Climbers	1		1
Plant > Herbs and Forbs	2	1	3
Plant > Orchids	1		1
Plant > Shrubs	6		6
Threat > Disease		3	3
Threat > Habitat Loss/Change		9	9
Threat > Other Threat		1	1
Threat > Pest Animal		14	14
Threat > Weed		7	7
Grand Total	**49**	**49**	**98**

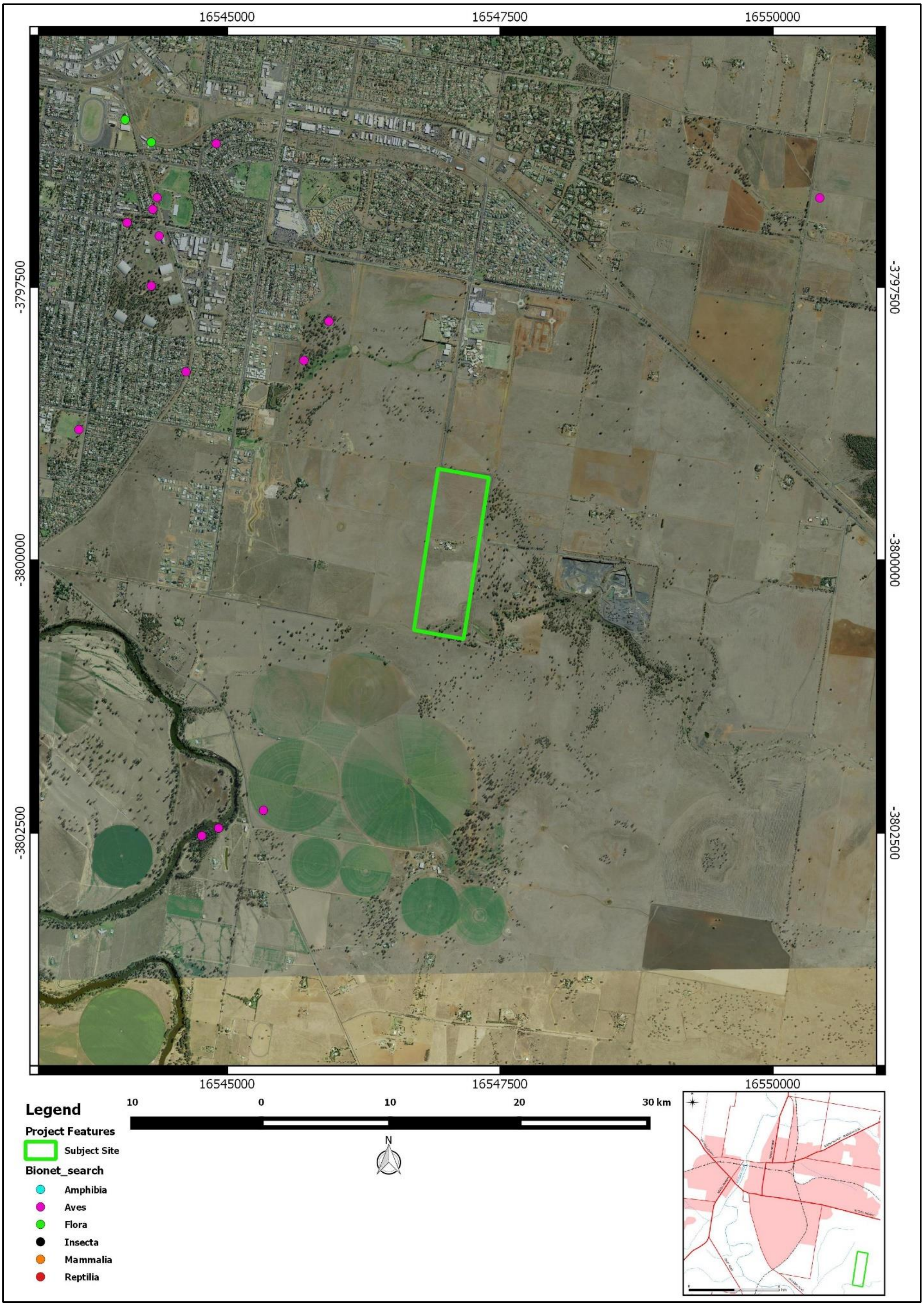
4.1.2 Threatened species and endangered populations within 10 kilometres of the Subject Site

A total of 81 records of 30 threatened species have been previously recorded within a ten kilometre radius of the Subject Site (Bionet: search date 4 January 2017) (**Table 4-2**). As can be seen from **Figure 4-1**, many of these records are around the urban environs of Dubbo.

Table 4-2: Threatened species, extinct and endangered populations within 10 kilometres of the Subject Site.

Species	Number of records
Australian Painted Snipe Rostratula australis	**2**
Barking Owl Ninox connivens	**5**
Bilby Macrotis lagotis	**1**
Black Falcon Falco subniger	**1**
Black-chinned Honeyeater (eastern subspecies) Melithreptus gularis gularis	**1**
Brown Treecreeper (eastern subspecies) Climacteris picumnus victoriae	**1**
Commersonia procumbens	3
Corben's Long-eared Bat Nyctophilus corbeni	**1**
Flame Robin Petroica phoenicea	**1**
Glossy Black-Cockatoo Calyptorhynchus lathami	**2**
Glossy Ibis Plegadis falcinellus	**1**
Grey-crowned Babbler (eastern subspecies) Pomatostomus temporalis temporalis	**16**
Homoranthus darwinioides	1
Koala Phascolarctos cinereus	**1**
Leafless Indigo Indigofera efoliata	**8**
Little Eagle Hieraaetus morphnoides	**4**
Little Lorikeet Glossopsitta pusilla	**2**
Magpie Goose Anseranas semipalmata	**2**
Marsh Sandpiper Tringa stagnatilis	**1**
Mauve Burr-daisy Calotis glandulosa	**2**
Pine Donkey Orchid Diuris tricolor	**3**
Rainbow Bee-eater Merops ornatus	**5**
Red-tailed Tropicbird Phaethon rubricauda	**1**
Regent Honeyeater Anthochaera phrygia	**7**
Ruff Philomachus pugnax	**1**
Sharp-tailed Sandpiper Calidris acuminata	**1**
Speckled Warbler Chthonicola sagittata	**1**
Spotted Harrier Circus assimilis	**3**
Superb Parrot Polytelis swainsonii	**2**
White-fronted Chat Epthianura albifrons	**1**
Grand Total	**81**

Figure 4-1: OEH Bionet records of threatened flora and fauna within 10km of the Subject Site (Data Source: NSW OEH 4 January 2017).



4.1.3 EPBC Protected Matters Report

The DoE Protected Maters report predicts the following protected matters that may or are likely to occur in the Subject Site:

- 14 Listed threatened species
- 10 Migratory species
- 11 Marine species
- Six Commonwealth Lands
- Five EECs

The Regent Honeyeater, Superb Parrot, South-eastern Long-eared Bat, White-throated Needletail and Rufous Fantail are known to occur or have habitat in the Subject Site.

4.1.4 Local context (Biodiversity impact assessments)

Many ecological surveys have taken place in proximity to the Subject Site. The largest and most relevant ecological survey was undertaken by OzArk (2013) as part of the approval process for the Dubbo Zirconium Project. Other relevant surveys include:

- Ecological Assessment: Ecological Assessment: Subdivision Of Lot 399 DP 1199356 and Lot 503 DP1152321, Boundary Road, Dubbo, NSW. (OzArk 2015).
- Tree Assessment: Lot G DP417757, 411 Macquarie Street Dubbo, NSW. Report to Geolyse (OzArk 2014).
- Ecological Assessment: Keswick Stage 5 Residential subdivision (52.5 ha) (OzArk 2013).
- Ecological Assessment: LH Ford Bridge. Report to Dubbo City Council OzArk (2013).
- Biodiversity Assessment for the Dubbo Zirconium Project. Report to Alkane Resources (OzArk 2013).
- Ecological Assessment: Dubbo to Wellington 66kv Powerline Upgrade. Report to Essential Energy. August 2012 (OzArk 2012);
- Ecological Assessment: Proposed recycled water reticulation scheme in three areas within the village of Wongarbon. Report to Dubbo City Council (OzArk 2010).
- Ecological Assessment: Golden Highway/Boothenba Road realignment and intersection improvements. Report to the Roads and Traffic Authority (OzArk 2010)
- *Dubbo Bird List*. Prepared by the Dubbo Field Naturalist Society (Hosking et al. 2010);
- *Status of Vertebrate Fauna And Their Habitat In The Central West Catchment* (Goldney, Kerle and Fleming 2007);
- Ecological Overview of Three Reserves: Jones Creek Reserve, Cumboogle Flora Reserve and Wongarbon Tank Reserve. Dubbo Local Government Area, NSW (OzArk 2009);
- Ecological and Archaeological Assessment: Proposed Wongarbon Sewerage Scheme (WSS) including the Wongarbon Sewerage Treatment Plant (STP) and the associated reticulation scheme within the village of Wongarbon. Report to Dubbo City Council (OzArk (2006).
- Ecological and Archaeological Assessment: 2.4 km Road Rehabilitation and Minor Alignment Shift, c. 16 km Southeast of Dubbo, NSW. Report to Dubbo City Council. (OzArk

2005).

- *Community Data Search And Biodiversity Survey Of The Brigalow Belt South Bioregion Stage 1* (NSW NPWS 2002); and
- *Report On Preliminary Fauna Survey Of The Pilliga And Goonoo Forests.* November 1999 to January 2000 (NSW NPWS 2000).

The research indicates that woodlands dominated by Fuzzy Box (*Eucalyptus conica*) Inland Grey Box (*E. microcarpa*) and White Box (*E. albens*) / Yellow Box (*E. melliodora*) dominate the Dubbo Regional LGA. These woodlands are all listed as Endangered Ecological Communities (EECs) or Threatened Ecological Communities (TECs) under the TSC Act and/or the EPBC Act.

Threatened species such as the Black-chinned Honeyeater, Brown Treecreeper, Diamond Firetail, Grey-crowned Babbler, Speckled Warbler, Little Eagle are commonly recorded in these remnant woodlands in Dubbo. To a lesser extent the Hooded Robin and Varied Sittella are known to occur. Migratory species (EPBC Act) known to occur in the area include the Swift Parrot, Superb Parrot and Rainbow Bee-eater. Although Koalas have been recorded in the locality, they are not a common sighting and it is suggested that riparian areas such as the Macquarie River provide a highway for Koalas to move to more suitable habitat and climatic conditions. The Barking Owl is also known to occur along the Macquarie River. Due to the ease in identifying microbats from echolocation recordings, several species of threatened microbat are also known from the area. These include the Yellow-bellied Sheath-tailed Bat, Greater long-eared Bat, Little Pied Bat and Large-eared Pied Bat.

4.1.5 Predictive model for threatened species detection

As a result of the background searches and literature review, 91 protected matters listed in the schedules of the FM and/and TSC or/and EPBC Act have been previously identified as having habitat present or occurring in the locality.

Of these, 45 protected matters are considered to have potential to occur in the Subject Site (**Table 4-3**). Further details regarding these species can be found in **Appendix 3**.

Table 4-3: Protected matters with potential to occur in the Subject Site

	Common Name	Scientific Name	TSC Act	EPBC Act Status	Potential to occur in Subject Site
1	Ausfeld's Wattle	*Acacia ausfeldii*	V		Potential
2	Barking Owl	*Ninox connivens*	V		Likely
3	Black Falcon	*Falco subniger*	V		Potential
4	Black-breasted Buzzard	*Hamirostra melanosternon*	V		Potential
5	Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V		Potential
6	Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	V		Likely
7	Cattle Egret	*Ardea ibis*		M	Potential

	Common Name	Scientific Name	TSC Act	EPBC Act Status	Potential to occur in Subject Site
8	Diamond Firetail	*Stagonopleura guttata*	V		Likely
9	Flame Robin	*Petroica phoenicea*	V		Potential
10	Fork-tailed Swift	*Apus pacificus*		M	Potential
11	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	*Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions*	EEC		Yes
12	Glossy Black-cockatoo	*Calyptorhynchus lathami*	V		Potential
13	Great Egret,			M	Potential
14	Greater Long-eared Bat	*Nyctophilus timoriensis/corbeni (South-eastern form)*	V	E	Potential
15	Grey Falcon	*Falco hypoleucos*	E		Potential
16	Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	V		Yes
17	Homoranthus darwinioides	*Homoranthus darwinioides*	V	V	Potential
18	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions/Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of		EEC	E	Yes
19	Koala	*Phascolarctos cinereus*	V		Potential
20	Little Eagle	*Hieraaetus morphnoides*	V		Potential
21	Little Lorikeet	*Glossopsitta pusilla*	V		Potential
22	Little Pied Bat	*Chalinolobus picatus*	V		Potential
23	Major Mitchell's Cockatoo	*Lophochroa leadbeateri*	V		Potential
24	Masked Owl	*Tyto novaehollandiae*	V		Potential
25	Painted Honeyeater	*Grantiella picta*	V		Potential
26	Pine Donkey Orchid	*Diuris tricolor*	V		Likely
27	Rainbow Bee-eater	*Merops ornatus*		M	Potential
28	Regent Honeyeater	*Anthochaera phrygia*	CE	E	Likely
29	Rufous Fantail			M	Potential
30	Satin Flycatcher			M	Potential
31	Scant Pomaderris	*Pomaderris queenslandica*	E		Potential
32	Scarlet Robin	*Petroica boodang*	V		Potential
33	Speckled Warbler	*Pyrrholaemus saggitatus*	V		Yes
34	Spotted Harrier	*Circus assimilis*	V		Potential
35	Spotted-tailed Quoll	*Dasyurus maculatus*	V	E	Potential
36	Square-tailed Kite	*Lophoictinia isura*	V		Potential
37	Superb Parrot	*Polytelis swainsonii*	V	V	Likely
38	Swift Parrot	*Lathamus discolor*	E	E	Potential
39	Turquoise Parrot	*Neophema pulchella*	V		Potential
40	Varied Sittella	*Daphoenositta chrysoptera*	V		Likely
41	White Box-Yellow Box-Blakely's Red Gum Grassy		EEC	CE TEC	Yes
42	White-throated Needletail	*Hirundapus caudacutus*		Listed	Potential
43	Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V		Potential

	Common Name	Scientific Name	TSC Act	EPBC Act Status	Potential to occur in Subject Site
44		*Tylophora linearis*	V	E	Potential
45	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River EEC (NSW FM Act).		EEC (TSC Act)		Yes

E- Endangered.
EP- Endangered Population.
EEC- Endangered Ecological Community.
CEEC- Critically Endangered Ecological Community
V- Vulnerable
M- Migratory or Marine (EPBC Act)
CE- Critically Endangered
TEC – Threatened Ecological Community

4.2 FIELD SURVEY RESULTS

4.2.1 Vegetation communities and habitat

The Subject Site is almost completely cleared, ploughed and disturbed with a few isolated trees.

Section 3.4 describes OEH (VIS Map 3458) maps remnant vegetation in the southern end of the Subject Site correctly but the grassland mapped in the northern part of the Subject Site has not been mapped correctly.

Approximately 4.5ha of PCT ID:81 Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion (**Figures 3-1, 3-2 and Table 3-1**) occurs in the Subject Site along Eulomogo Creek, mostly on its southern side. The term 'approximately' does not indicate a lack of mapping skill by the consultant, it indicates the lower stratum is weedy and there is no hard line of division between 'a weedy paddock with a few native trees' (not a native vegetation community) and a 'native woodland community remnant with a weedy understory' (a native vegetation community).

Threatened and endangered ecological communities

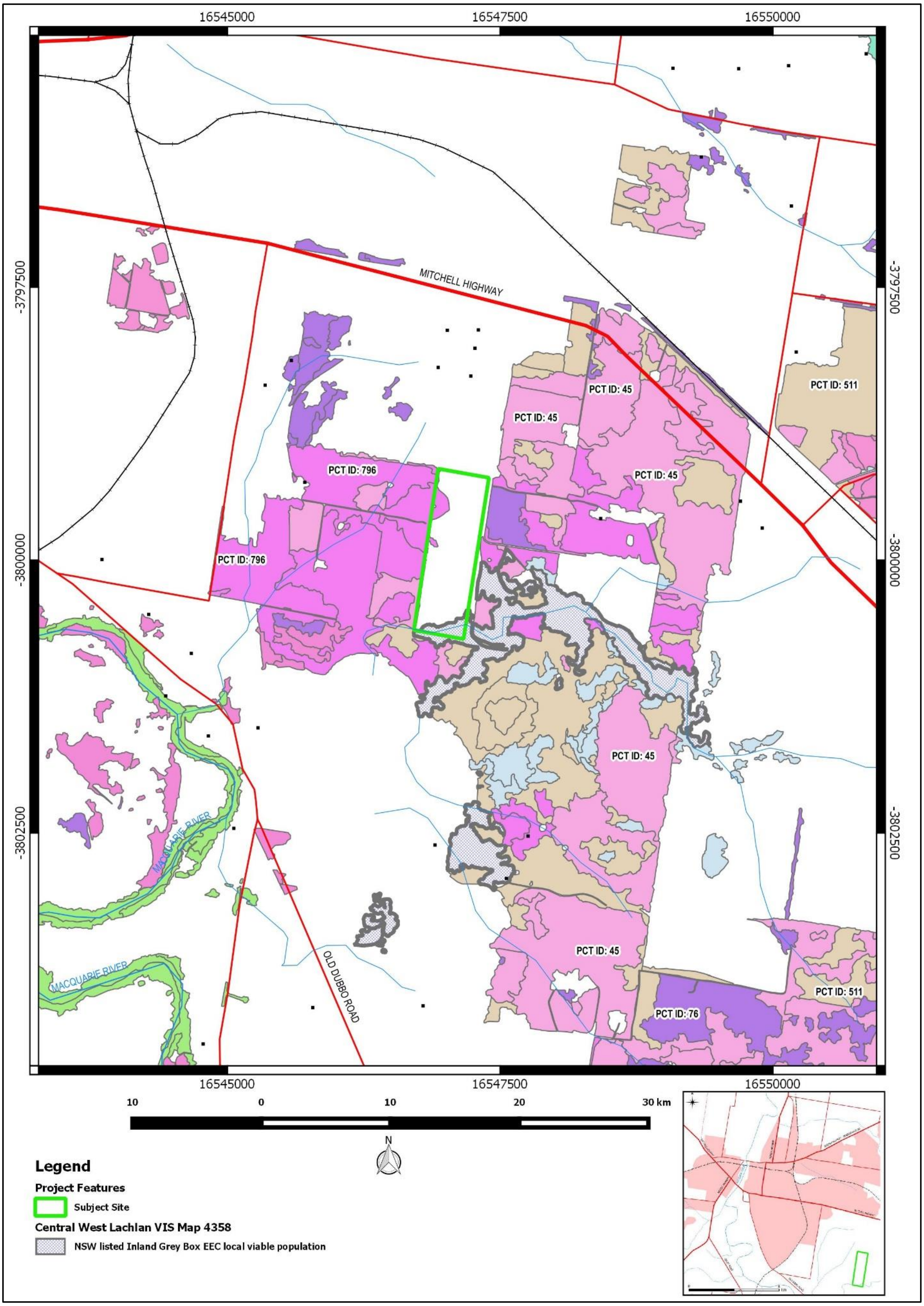
PCT ID:81 Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion is an endangered ecological community listed in the NSW TSC Act (*Inland Grey Box Woodland*). This EEC total patch size (i.e. the same vegetation community that extends onto surrounding property) is 77.7 ha (determined by VIS map 4358) in the Subject Site is 5.9 percent of the local viable population of the EEC.

The Commonwealth listed EEC with a similar name does not occur in the Subject Site as it's too weedy to meet the minimum quality criterion.

Eulomogo Creek forms part of the FM Act listing for the '*aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River.'* The creek is in poor condition however provides connectivity to the Macquarie River.

An Assessment of Significance has been completed for each to characterise the potential impacts.

Figure 4-2: Viable local population of the NSW Inland Grey Box Woodland EEC



4.2.2 Flora species

Seventy-two (72) species of vascular flora was recorded during the assessment (**Table 4-4** and **4-5**). All plots recorded a high incidence of non-native plant species, indicative of the disturbed nature of the ground surface. Overall there were 31 species of native plants and 41 species of weeds, not including the five species of native trees recorded, the ground stratum was 36% native (or 64% weedy).

Table 4-4: Summary of native species recorded by plot.

Plot number		*1*	*2*	*3*
TOTAL species / plot		61	27	27
Total species	*72*			
Native Plant Species	31	28	8	7
Non-native sp.	41	33	31	21
% Native Plant Species	43	38	11	11
% non-native	57	62	89	89

Table 4-5: Summary of stratum details by plot.

STRATUM DETAILS	PLOT 1	PLOT 2	PLOT 3
Native canopy cover - upper stratum (%)	25	0	0
Native Mid stratum	0	1	0
Native Lower stratum (not grass) (%)	3	6	6
Native Lower stratum (grasses) (%)	12	7	6
(%) of exotic grasses	85	90	95

Threatened and endangered flora

No species of listed threatened flora were recorded or considered likely to occur in the Subject Site.

Exotic and noxious flora

One species of Class 4 ‘Locally Controlled Weed’ declared in the Local Control Authority area of Dubbo Regional Council was recorded in the Subject Site. This was isolated and very infrequent African Boxthorn (*Lycium ferocissimum*) plants. See **Appendix 2** for complete DRC Noxious weed listings. This species is also listed as a Weeds of National Significance (WoNs). Management of this weed requires coordination among all levels of government, organisations and individuals with weed management responsibilities.

4.2.3 Fauna species

Twenty-three (23) species of fauna recorded during the assessment. This included two reptile and frogs and 19 birds.

Threatened species

No species of threatened fauna were recorded in the Subject Site. The lack of diverse, quality habitat in the Subject Site reduces the potential of many threatened species known for the locality having habitat present in the Subject Site or occurring. However, due to known survey limitations (**Section 2.6**), some threatened species are considered likely to occur or have habitat in the Subject Site based on available habitat and previous records. These are listed in **Section 4.3**.

The targeted survey for the Pink-tailed work lizard did not reveal any individuals or suitable habitat. As the Subject Site does not contain a trachite deposit (known Pink-tailed Worm Lizard habitat in the locality) geologically it is not considered to be prime habitat.

Endangered populations

No endangered fauna populations considered likely to occur within the Subject Site.

4.2.4 Fauna habitat

General fauna habitat

Fauna habitat in the Subject Site is restricted to derived grassland with the odd isolated eucalypt. Open/disturbed areas favours common generalist species which are capable of utilising open ground for foraging and common disturbance-tolerant species which are ubiquitous in modified habitats.

Isolated trees within the cleared/disturbed areas are known to contribute to the viability of wildlife populations in agricultural mosaic landscapes by maintaining connectivity between larger patches of remnant vegetation (Gibbons *et*. *al*. 2008).

Koala habitat

State Environmental Planning Policy (SEPP) 44 does not apply to the Dubbo Regional LGA. Potential Koala habitat still requires management under the EPBC Act. The Approved Recovery Plan for the Koala (DECC 2008) provides lists of koala food trees categorised as primary, secondary and supplementary within Koala Management Areas (KMAs). Primary food trees exhibit a level of use that is significantly higher than that of other Eucalyptus species and is independent of tree density. The Dubbo Regional LGA is within KMA 6: Western Slopes. Large populations of koalas occur on the western slopes and plains, in particular the Pilliga region (Kavanagh and Barrott 2001) and in Gunnedah (Smith 1992) and Walgett LGAs (J. Callaghan, Australian Koala Foundation, pers. comm.). In the south of this KMA, a population of koalas occurs along the Murrumbidgee River at Narrandera. River Red Gum is listed as primary food source, Yellow Box and White Box are listed as a secondary food source and Red Stringybark is listed as a supplementary food source.

The Subject Site is considered "potential koala habitat". Koalas are known to be a transient species in the locality, specifically along the Macquarie River. The lack of records in the Subject

Site is not considered to represent the absence of koalas, rather that habitat away from the riverine environment is not considered to be core koala habitat. As such, the Subject Site is considered 'potential' Koala habitat (as Koalas will move through cleared paddocks to access suitable habitat) as no resident population or breeding females are considered to occur in the Subject Site.

Critical habitat

There are four declared critical habitats in NSW and three recommendations for critical habitat status in NSW.

Five Commonwealth critical habitats are listed in the EPBC Act.

None of these identified areas of critical habitat are located within the boundaries of the Subject Site.

Aquatic habitat

Aquatic habitat in the Subject Site is poor with a high nutrient loading (**Table 4-5**). Although some aquatic habitat such as grasses, rushes and sedges are present and provide refuge for a variety of species, cattle has impacted the quality and suitability of this habitat. Eulomogo Creek and various dams in the Subject Site provide suitable foraging areas and habitat for water birds, waders and migratory birds as well as habitat for aquatic species such as frogs, turtles and fish. The creek is in poor condition and is unlikely to provide habitat for threatened fish species.

Although emergent aquatic vegetation increases the possibility that threatened birds would breed in this area, the lack of terrestrial vegetation cover and impacts by cattle reduce this potential. Furthermore, the majority of migratory waders do not breed in Australia.

Table 4-6: Summary of water condition and aquatic habitat in Eulomogo Creek.

Nutrient Loading		Eulomogo Creek
Filamentous algae		**Yes**
Water weeds (Azola / Salvinia)		**Yes**
Weeds on banks		**Yes**
Cumbungi, reeds, bullrush		**Yes**
Native tree death		No
Bad smells from the water		**Yes**
Surface scum		**Yes**
Stock refusing to drink		No
		High (7/9)
Macro-invertebrate pollution tolerance data		
Rating of water	**Sensitivity**	**Present**
	very sensitive organisms	
	stonefly nymphs	
4 = Excellent	mayfly nymphs	
	freshwater shrimp	

	freshwater crayfish	x
	sensitive organisms	
	dobonsonflys (alderflies)	
	mussels	
	freshwater prawns	
3 or > = Good	freshwater crayfish	x
	dragonfly nymphs	
	damselfly nymphs	
	caddisfly nymphs	
	water mites	
	tolerant organisms	
	beetle (Coleoptera)	x
	true bugs (Hemiptera)	
2 or > = Fair	leech	
	freshwater snail	
	flatworm	
	very tolerant organisms	
	black fly larvae	x
	mosquito larvae	x
1 or > = Poor	fly larvae	x
	non-biting midges (including bloodworms)	x
	freshwater worms	
Overall rating		**Poor**
Habitat Features		
	Habitat Type	Permanent water
	Pool Size	4m wide, 200m long
	Bank Slope	40 to 90 degrees
	Depth (Max Av)	0.5m
	Substrate type	sand and basalt rock
	Downstream connectivity	good / continuous
	Waterway Condition	Poor
	Contributions to cover	NIL
	Submerged physical	NIL
	Submerged biological	NIL
	Emergent reeds / plants	Bull rush, water ribbons (all impacted by cattle)
	Canopy % over water (50m)	20%
	General terrestrial veg cover	Derived Grassland (formerly Fuzzy Box Woodland)
	Temperature (10cm)	21 degrees Celsius

4.2.5 Protected Matters - Migratory and marine species

Background searches revealed the potential presence of several migratory species in the locality. The Fork-tailed Swift and White-throated Needletail are almost exclusively aerial (including foraging) and as such can be recorded over many habitats. The Rainbow Bee-eater is known to have breeding habitat in sandy areas near the Macquarie River in Dubbo and has potential to occur in the Subject Site. Likewise the Satin Flycatcher, Rufous Fantail (seasonal migrants) are likely to occur and forage in riverine environments including Eulomogo Creek. However, a lack of perching opportunities decreases the likelihood that these species would be recorded in the Subject Site. The Superb Parrot, Regent Honeyeater and Swift Parrot are unlikely to have foraging resources in the Subject Site during the non-breeding period due to a lack of flowering resources. Furthermore a lack of flowering species in the Subject Site, deplete the potential for most winter migrants to occur in the Subject Site.

4.2.6 Key Threatening Processes

Key threatening processes are processes that, in the opinion of the relevant Scientific Committee, adversely affect threatened species populations or ecological communities, or could cause species, populations or ecological communities that are not threatened to become threatened

Of the 36 Key Threatening Processes (KTP) listed in the schedules of the TSC Act, five are currently operating in the Subject Site. These include:

- Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).
- Predation by the European red fox (*Vulpes vulpes*).
- Predation by the feral cat (*Felis catus*).
- Removal of dead wood and dead trees.
- Removal of hollow bearing trees.

Of the 20 Key Threatening Processes (KTP) listed in the schedules of the EPBC Act, eight are currently operating in the Subject Site. These include:

- Competition and land degradation by rabbits.
- Land clearance.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases.
- Novel biota and their impact on biodiversity.
- Predation by European red fox.
- Predation by feral cats.
- Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species.

4.3 SUMMARY

On the basis of regional records, reports and the presence of suitable habitat, 15 threatened items listed in the schedules of the TSC Act and / or EPBC Act were assessed as likely to occur or have habitat in the Subject Site and be affected by the Proposal (**Table 4-7**). Assessments of significance were conducted for these species (**Appendix 5**).

Table 4-7: Threatened species known to occur or have potential occur in the Subject Site.

	Common Name	Scientific Name	TSC Act	EPBC Act	Potential to occur in Subject Site	Significance Assessment
1	Barking Owl	*Ninox connivens*	V		Likely hunting grounds	7-Part Test (TSC Act)
2	Black Falcon	*Falco subniger*	V		Potential hunting grounds	7-Part Test (TSC Act)
3	Cattle Egret	*Ardea ibis*		M	Potential to occur	Assessment of Significance (EPBC Act)
4	Fork-tailed Swift	*Apus pacificus*		M	Potential foraging area	Assessment of Significance (EPBC Act)
5	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions		EEC		Precautionary Principle	7-Part Test (TSC Act)
6	Great Egret			M	Potential	Assessment of Significance (EPBC Act)
7	Grey Falcon	*Falco hypoleucos*	E		Potential hunting grounds	7-Part Test (TSC Act)
8	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions		EEC	TEC	Precautionary Principle	7-Part Test (TSC Act)
9	Little Eagle	*Hieraaetus morphnoides*	V		Potential hunting grounds	7-Part Test (TSC Act)
10	Rainbow Bee-eater	*Merops ornatus*		M	Potential breeding habitat and foraging habitat	Assessment of Significance (EPBC Act)
11	Spotted Harrier	*Circus assimilis*	V		Potential hunting grounds	7-Part Test (TSC Act)
12	Square-tailed Kite	*Lophoictinia isura*	V		Potential hunting grounds	7-Part Test (TSC Act)
13	White Box-Yellow Box-Blakely's Red Gum Grassy		EEC	CE TEC	Precautionary Principle	7-Part Test (TSC Act)
14	White-throated Needletail	*Hirundapus caudacutus*		M	Potential foraging area	Assessment of Significance (EPBC Act)
15	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River EEC (NSW FM Act).		EEC		Eulomogo Creek forms part of the listing for this EEC.	7-Part Test (TSC Act)

E - Endangered. **V- Vulnerable**
EEC - Endangered Ecological Community. **CE- Critically Endangered**
CEEC- Critically Endangered Ecological Community **TEC – Threatened Ecological Community**
M- Migratory or Marine (EPBC Act)

5 IMPACTS

5.1 TERRESTRIAL FLORA AND ECOLOGICAL COMMUNITIES

It is anticipated that 45 hectares will be directly affected by the activity in the Subject Site. The vegetation identified as Inland Grey Box EEC at the southern end of the lot will not be impacted.

5.2 TERRESTRIAL FAUNA AND FAUNA HABITATS

It is unlikely that fauna species would be directly impacted in the Subject Site as a result of the Proposal. Fauna may be impacted by:

- Vegetation removal for the establishment of the residential infrastructure.
- Disturbance associated with machinery (noise, dust vibration).
- Collisions with vehicles.
- Impact to grassy habitat.

The potential loss of cleared and disturbed habitat represents an insignificant loss of habitat for native fauna.

Hollow dependent fauna would not be impacted as no hollow bearing trees will be removed.

Assessments of Significance for those threatened species considered likely to be affected by the Proposal (**Section 6**) determined that the Proposal would have no significant impact. Suitable high quality habitat for threatened species will exist adjacent to the Subject Site and will remain undisturbed.

5.2.1 Wildlife Corridors and Connectivity

Impact to already cleared and disturbed tussock grasslands will not fragment an existing remnant nor affect a wildlife corridor.

5.2.2 Critical habitat

No areas defined as critical habitat in NSW or in the Commonwealth will be affected by the activity.

5.3 KEY THREATENING PROCESSES

A number of Key Threatening Processes (KTP) listed on the schedules of the TSC Act may be exacerbated by the Proposal. These KTP's include:

- Anthropogenic climate change (TSC Act)
- Clearing of native vegetation (TSC Act);
- Invasion of native plant communities by exotic perennial grasses (TSC Act).

- Land clearance (EPBC Act).

The clearing of native vegetation is a major contributor to the loss of biodiversity. In the determination, the NSW Scientific Committee found that 'clearing of any area of native vegetation, including areas less than two hectares in extent, may have significant impacts on biological diversity'.

5.4 INVASIVE SPECIES

Ground disturbing activities may:

- Increase weed invasion. The spread of noxious weeds may occur during construction within the Subject Site given the weedy environments within the larger area.
- Increase opportunities for feral animals. The proposed works may improve habitat conditions for pests that thrive on disturbed and cleared environments. There is some potential for construction workers to leave food scraps and debris that may encourage these animals. It is unlikely that local populations would increase as a result of the activity.
- Introduce pests and pathogens. No known plant pathogens are likely to be introduced into the area during construction work.

5.5 NOISE/VIBRATION

Construction associated with the subdivision is unlikely to affect any native fauna given the disturbed cleared nature of the Subject Site. Within semi-urban areas, noise and vibration is unlikely to increase above background traffic noise.

While impacts are likely, it is anticipated that any sensitive mobile fauna utilising the area would be able to migrate to surrounding areas of similar habitat such as riparian habitat (Macquarie River) or nearby reserves and conservation networks for the duration of the works.

5.6 TRAFFIC IMPACTS

Light and heavy vehicle movements within the Subject Site would be required during the construction of the subdivision infrastructure. The majority of fauna are mobile and will have a chance to disperse to adjacent riparian habitat.

5.7 DUST/EROSION

Construction activities would increase dust levels. However revegetation activities associated with improving the condition of Eulomogo Creek would improve dust and erosion on site.

5.8 MATTERS OF NATIONAL ENVIRONMENTAL SIGNIFICANCE

The EPBC Act provides a mechanism for assessing the environmental impact of activities and developments, where 'Matters of National Environmental Significance' (MNES) may be affected by the proposed activities. Impacts to Matters of National Environmental Significance are listed in **Table 5–1**.

Table 5-1: Matters of National Environmental Significance.

Matter of NES	Impact
Any environmental impact on a World Heritage property	No
Any impacts on wetlands of international importance	No. The proposal would not impact on any water quality or flows of the area. Due to the distance from wetland areas it is considered that the works would have no significant impacts.
Any environmental impact on Commonwealth listed threatened species or ecological communities	**Threatened Ecological Communities (TECs) -** No Commonwealth listed TECs are within the Subject Site. **Fauna** – The majority of fauna species are mobile species and in most instances are capable of migrating away from the proposed Subject Site. Noise and vibration associated with the proposal is likely to disturb birds or terrestrial fauna briefly, however none of the migratory species potentially occurring in the locality is likely to have 'important habitat' in the Subject Site. **Flora** - No listed commonwealth flora was considered likely to occur in the Subject Site.
Any environmental impact on Commonwealth listed migratory species	Migratory birds are mobile species and in most instances are capable of migrating away from the proposed Subject Site. The Subject Site represents potential, yet unlikely habitat for many of the identified migratory species.
Does the project affect any national heritage places	No
Does any part of the proposal involve a nuclear action?	No
Any environmental impact on Commonwealth marine area?	No
Any direct or indirect effect on Commonwealth land?	No

6 SIGNIFICANCE ASSESSMENTS

The appropriate management of ecological items is usually determined on the basis of their assessed significance as well as the likely impacts of any Proposal. Significance of a species, population or community is determined by appointed NSW and National Scientific Committees. Cultural and public significance are considerations within the significance determination process. Within the framework of an impact assessment, impacts to listed significant item must be assessed at a State (under the TSC Act) or National (under the EPBC Act) level – even if it is the same species. The following sections identify State or nationally listed threatened (significant) species then determines if impacts are 'significant'.

Significant can be defined as: there is a real chance/greater than 50 per cent chance, that the action (direct or indirect) will cause a viable local population to go extinct.

6.1 AFFECTED SPECIES

It should be noted that in the *Threatened species assessment guidelines: The assessment of significance* (DECC 2007), a species does not have to be considered as part of the assessment of significance if adequate surveys or studies have been carried out that clearly show that the species, population or community:

- does not occur in the Subject Site, or
- will not use on-site habitats on occasion, or
- Will not be influenced by off-site impacts of the proposal.

Otherwise all species likely to occur in the Subject Site (based on general species distribution information) and known to use that type of habitat, would be considered in the rationale that determines the list of threatened species, populations and ecological communities for the assessment of significance.

6.2 SIGNIFICANT COMMUNITIES, POPULATIONS OR SPECIES WITHIN THE SUBJECT SITE

There are 11 fauna species and four[1] EECs identified as being affected by the Proposal (**Table 4-7)**. Consideration of the type and scale of habitat to be removed has resulted in the conclusion that no threatened species would be significantly affected by the Proposal (**Table 6–1**). The preparation of a Species Impact Statement will not be required for the Project.

Appendix 5 provides detailed assessment of affected species and full version of seven-part tests and assessments of significance.

[1] Only one EEC (Inland Grey Box) has been mapped in the Subject Site but technically components of Box Gum and Fuzzy BoxEECs are also present.

Table 6-1: Summary of the assessment of significance and seven-part tests

TSC Act significance assessments								
Threatened species, or communities	7-Part Test Questions							Likely significant impact?
	a	b	c	d	e	f	g	
Barking Owl	N	X	N	Y	X	Y	Y	**No**
Black Falcon	N	X	N	Y	X	Y	Y	**No**
Little Eagle	N	X	N	Y	X	Y	Y	**No**
Grey Falcon	N	X	N	Y	X	Y	Y	**No**
Spotted Harrier	N	X	N	Y	X	Y	Y	**No**
Square-tailed Kite	N	X	N	Y	X	Y	Y	**No**
White Box-Yellow Box-Blakely's Red Gum Grassy	X	X	Y	Y	X	Y	Y	**No**
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	X	X	Y	Y	X	Y	Y	**No**
Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	X	X	Y	Y	X	Y	Y	**No**
Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River EEC (NSW FM Act).	X	X	Y	Y	X	Y	Y	**No**

EPBC Act Assessments[2,3,4,5]		
Threatened species, or communities	**Important population**	**Likely significant impact?**
White-throated Needletail	No	No
Rainbow Bee-eater	No	No
Cattle Egret	No	No
Fork-tailed Swift	No	No
Great Egret	No	No

Notes: Y= Yes (negative impact), N= No (no or positive impact), X= not applicable, ?= unknown impact.

1. Significance Assessment Questions as set out in the *Threatened Species Conservation Act 1995/ Environmental Planning and Assessment Act 1979.*
- **a** in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,
- **b** in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,
- **c** in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:
  - (i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
  - (ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,
- **d** in relation to the habitat of a threatened species, population or ecological community:
  - (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and
  - (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and
  - (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,
- **e** whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),
- **f** whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,
- **g** whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

2. Refer to DEWHA 2013 for significant impact criteria.

3. Important Population as determined by the *Environment Protection and Biodiversity Conservation Act 1999*, is one that for a vulnerable species:
- **a** is likely to be key source populations either for breeding or dispersal
- **b** is likely to be necessary for maintaining genetic diversity
- **c** is at or near the limit of the species range.

4. A ‘population of a species’ is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable threatened species, occurrences include but are not limited to:

a • a geographically distinct regional population, or collection of local populations, or

b • a population, or collection of local populations, that occurs within a particular bioregion.

5. Population' as defined under the EPBC Act, in relation to migratory species, means the entire population or any geographically separate part of the population of any species or lower taxon of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries including Australia.

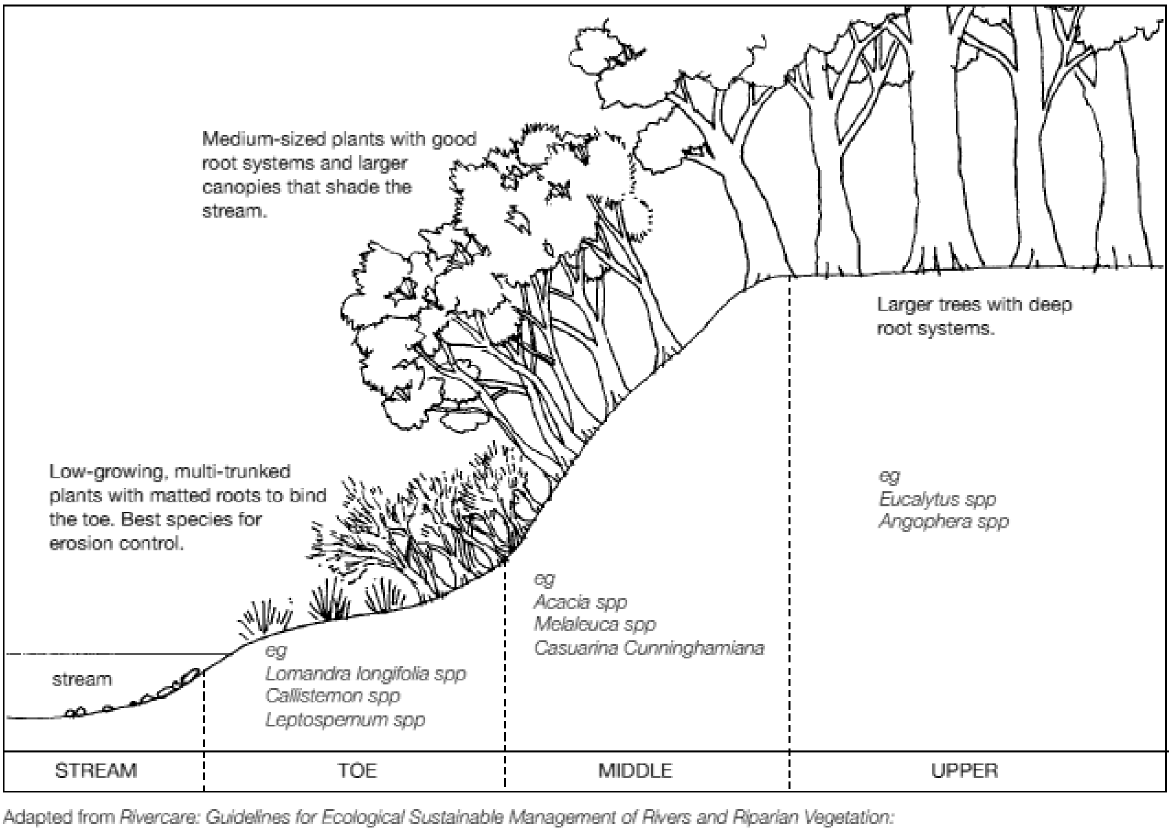
7 RECOMMENDATIONS

The following mitigation measures have been made in regards to the Proposal.

1. Areas to be cleared in the Subject Site should be clearly marked with high visibility nightline to ensure that approved boundary clearing creep does not occur.
2. Any change in design outside the assessed impact footprint within the Subject Site will require further ecological survey.
3. All food scraps and rubbish are to be appropriately disposed of in sealed receptacles to prevent foraging habitats for foxes, rats, dogs and cats.
4. An Erosion and Sediment Control Plan (ESCP), shall be prepared for the works and would be in line with Landcom's Managing Urban Stormwater, Soils & Construction Guidelines (The Blue Book) (Landcom 2004).
    - Erosion and sedimentation control measures would be installed around Eulomogo Creek and not be removed until disturbed areas have stabilised.
    - Maintenance and checking of the erosion and sedimentation controls would be undertaken on a regular basis and records kept and provided at any time upon request.
    - Sediment would be cleared from behind barriers on a regular basis and all controls would be managed in order to work effectively at all times.
5. Best practice weed management should be in place to prevent the transfer of weed seeds and vegetative materials, including the washdown of vehicles entering or leaving the worksite.
6. Ongoing weed control should be undertaken in the Subject Site.
    - As per the Noxious Weeds Act, Class 4 Noxious Weeds must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed.
    - Ensure all seed and seed head is collected and disposed of.
7. Stockpiles in the Project Site in their present state are likely to provide refuge for invasive species and should be refined and reduced.
8. Under the NV Act, a permit from the Central West Local Land Services is required to clear within 40 metres of Eulomogo Creek. The current project will not impact within 40 metres of this waterway. Should the project need to impact within 40 metres of this waterway (even for rehabilitation / revegetation) then further advice from this department should be sought.

9. Under the FM Act, a permit from DPI is required for any rehabilitation, reclamation or dredging work within the banks of the Eulomogo Creek. Should the project need to impact within 40 metres of this waterway (even for rehabilitation / revegetation) then further advice from this department should be sought.
10. Under the 'integrated development' provisions of the NSW EPA Act, MAAS may require approval from DPI for a permit to temporarily or permanently block fish passage (if Eulomogo Creek is to be blocked). The current proposal does not require the creek to be blocked.
11. Under the WM Act, MAAS will require a controlled activity approval for the Proposal if works are to occur within 40 metres of Eulomogo Creek. Should the project need to impact within 40 metres of this waterway (even for rehabilitation / revegetation) then further advice from this department should be sought.
12. Rehabilitation and revegetation efforts should be directed at restoring the Eulomogo Creek riparian zone. This would include maintaining a 40 metre buffer (at least) from the edge of the banks. Connectivity within this riparian zone to the existing Keswick Estate Green Corridor (Macquarie River to Orana Mall) is recommended. **Figure 7-1** provides guidance for rehabilitation along the creek and additional information had been provided below for species selection.

Figure 7-1: Proposed cross section showing revegetation of the creek.



Adapted from *Rivercare: Guidelines for Ecological Sustainable Management of Rivers and Riparian Vegetation:* Raine, A.W & Gardiner, J.N, (1995), LWRRDC, Canberra.

- The proposed species list for areas requiring planting is:
    - Upper stratum (on the Upper Creek Bank, see **Figure 7-1**)
        - White Box (Eucalyptus albens) / Yellow Box (Eucalyptus melliodora) / Fuzzy Box (Eucalyptus conica) at 30 metre spacing.
        - Inland Grey Box (Eucalyptus microcarpa) at 50 metre spacing
        - Mid stratum - (on the Middle Creek Bank, see **Figure 7-1**)
            - Acacia hakeoides, Acacia pycnantha, Acacia decora, Dodonaea viscosa subsp. cuneata, Western Boobialla (Myoporum montanum), Pittosporum angustifolium, Silver Cassia (Senna form taxon 'artemisioides') at 30 metre spacing.
    - Lower stratum (on the Toe Creek Bank, see **Figure 7-1**)
        - Grasses - Austrostipa bigeniculata, Austrodanthonia caespitosa, Kangaroo Grass (Themeda australis), Redleg Grass (Bothriochloa macra), Chloris truncata, Austrostipa scabra, Dichanthium sericeum, Enteropogon acicularis, Panicum effusum.
            - The grass species can be commercially purchased, the remaining species are likely to recover unassisted. The recommended sowing rate is 0.25kg / hectare and the seed supplier will provide instructions on how to prepare the area.
        - Other - Dichopogon strictus, Hydrocotyle laxiflora, Podolepis jaceoides, Vittadinia cuneata, Wahlenbergia luteola, Atriplex semibaccata, Lomandra filiformis subsp. coriacea.
    - Lower stratum (in the Creek bed and walls, see **Figure 7-1**)
            - Lomandra filiformis subsp. coriacea, Lomandara longifolia, Carex appressa, Cypress excellatus, Phragmities australis and Juncus spp. The recommended planting rate is one plant per metre square of the final creek bed area of extent and walls of ponds.

8 CONCLUSION

Having given consideration to the ecology within the Subject Site, it is apparent that the Proposal is:

- unlikely to significantly affect any of the listed threatened species, fauna populations or communities.
- unlikely to augment or significantly contribute to any of the National or State listed Key Threatening Processes, if the appropriate safeguards regarding the control of potential vertebrate pests are effectively applied.
- unlikely to significantly affect any Ramsar wetland or any CAMBA or JAMBA listed species.
- unlikely to significantly affect local hydrology.
- consistent with ESD principles with regard to fauna, would not adversely affect the local biodiversity and no issue of inter-generational or value added matters are relevant in this instance.

The proposed activity should not be considered to constitute a significant impact and, as such, no Species Impact Statement (SIS) is warranted. No Koala Habitat Management Plan pursuant to SEPP 44 should be required.

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OzArk (2013c).	Biodiversity Assessment for the Dubbo Zirconium Project. Report to Alkane Resources.
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10 PLATES

	Plate 1: *Biometric* plot 1.
	Plate 2: *Biometric* plot 2.
	Plate 3: *Biometric* plot 3.

APPENDIX 1: TERMS AND ABBREVIATIONS

Terminology	Abbreviation	Description
Activity		Has the same meaning as in the EP&A Act, ie the nature of the proposed activity is described in **Section 1.1**. The EP&A Act definition refers to physical 'activity' in relation to land that is specified by a regulation to be a work for the purposes of the Act
Australian Bureau of Meteorology	BOM	
Australian Height Datum	AHD	
Catchment Management Authority	CMA	Thirteen CMAs have been established, the specific functions of CMAs are described in the *Catchment Management Authorities Act 2003.* The CMAs are responsible for managing natural resources at the catchment scale. Key roles include preparing Catchment Action Plans (CAPs) and managing incentive programs to implement the plans. CMA's have now been superseded by Local Land Services (LLS), however the boundaries still apply for ecological database searches.
Core Koala Habitat		State Environmental Planning Policy (SEPP) 44: core koala habitat means an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.
Dubbo Regional Council	Council	
Ecologically Sustainable Development.	ESD	The EPBC Act sets out the principles of ecologically sustainable development which apply to certain decisions made under the Act. These principles are: • The need to integrate economic, environmental, social and equitable considerations. • The precautionary principle. • The principle of inter-generational equity. • The conservation of biological diversity. and • Improved valuation, pricing and incentive mechanisms.
Endangered Ecological Community	EEC	An ecological community specified in Part 3 of Schedule 1 of the TSC Act or within the schedules of the EPBC Act.
Endangered population		Population specified in Part 2 of Schedule 1 of the TSC Act.
Environmental Impact Statement	EIS	Describes the positive and negative environmental effects of a proposed action and provides potential management measures to ameliorate these impacts.
Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).	EPBC Act	Provides for the protection of the environment, especially matters of national environmental significance, and provides a national assessment and approvals process.
Environmental Planning and Assessment Act 1979 (NSW).	EP&A Act	Provides the legislative framework for land use planning and development assessment in NSW.

Terminology	Abbreviation	Description
Fisheries Management Act 1994 (NSW).	FM Act	Administered by the Minister for Primary Industries, except Part 7 (Division 2), which is administered jointly by the Minister for Minister for the Environment and the Minister for Heritage and the Minister Assisting the Minister for Minister for the Environment and the Minister for Heritage.
Ground Water Dependent Ecosystems	GDEs	Groundwater Dependent Ecosystems (GDEs) are ecosystems that are partially or completely dependent on underground water for their existence or health.
Interim Biogeographic Regionalisation for Australia	IBRA	IBRA is a biogeographic regionalisation of Australia developed by the Australian Government's Department of Sustainability, Environment, Water, Population and Communities. It was developed for use as a planning tool, for example for the establishment of a National Reserve System.
Impact Footprint		Areas that will be physically disturbed during the process of implementing the proposal.
Likely		Taken to be a real chance or possibility (NPWS 1996).
Local Environmental Plan	LEP	A type of planning instrument made under Part 3 of the EP&A Act.
Local Government Area	LGA	
Local population		The population that occurs within a given Subject Site, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated (NPWS 1996). In this instance a local population are those that occur within the Subject Site.
Low condition/Moderate to Good Condition (as per BBAM 2008).	Low Condition Moderate to Good Condition	Native woody vegetation is in low condition if: The over-storey per cent foliage cover is <25% of the lower value of the over-storey per cent foliage cover benchmark for that vegetation type AND <50% of groundcover vegetation is indigenous species, or >90% of the area is ploughed or fallow, or 90% of the groundcover vegetation is regrowth but not protected regrowth. Remnant native vegetation and protected regrowth cannot be cleared if it is a vegetation type that is >70% cleared and NOT in low condition (ie Moderate to Good).
Locality		Area within a 50km radius of the Subject Site.
Matters of national environmental significance.	MNES	Refers to the seven matters of national environmental significance as defined by the EPBC Act.
National Parks and Wildlife Act 1974 (NSW)	NPW Act	Under the National Parks and Wildlife Act, the Director-General of the NPWS is responsible for the care, control and management of all national parks, historic sites, nature reserves, reserves, Aboriginal areas and state game reserves. State conservation areas, karst conservation reserves and regional parks are also administered under the Act. The Director-General is also responsible under this legislation for the protection and care of native fauna and flora, and Aboriginal places and objects throughout NSW.

Terminology	Abbreviation	Description
Native Vegetation Act 2003 (NSW)	NV Act	The native vegetation legislation was introduced in 2005. The Native Vegetation Act 2003 (NV Act) and Native Vegetation Regulation 2005 (NV Regulation) has delivered: • the Government's commitment to end broad scale clearing, to protect the health of our land, rivers and wildlife • investment security and increased flexibility for farmers • new powers to local catchment management authorities (CMAs) to make decisions in the best interests of the community.
Noxious Weeds Act 1993 (NSW)	Noxious Weeds Act	An Act to provide for the identification, classification and control of noxious weeds.
NSW Office of Water	NOW	
Office of Environment and Heritage	OEH	Formally known as the Department of the Environment, Climate Change and Water (DECCW).
Potential Koala Habitat		SEPP 44: potential koala habitat means areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.
Regional Environmental Plan	REP	A type of planning instrument made under Part 3 of the EP&A Act.
Regional Vegetation Community	RVC	Regionally, a vegetation map for the Namoi CMA has been produced (ELA 2009a). This mapping product is underpinned by a Regional Vegetation Community (RVC) classification which is linked to the vegetation type classification in the *Biometric* Vegetation Types Database.
Rural Fires Act 1997 (NSW)	RF Act	
State Environmental Planning Policy (Infrastructure) 2007.	Infrastructure SEPP	The Infrastructure SEPP has specific planning and approval provisions for 25 types of infrastructure or facilities such as education, hospitals, roads, railways, emergency services, water supply and electricity generation and transmission. The SEPP assists the NSW Government agencies, local government, other private infrastructure providers and the communities they support by simplifying the planning process and by providing consistent planning provisions across all local government areas in NSW. The SEPP contains planning provisions including: • where the infrastructure facilities are permissible • what infrastructure development can be assessed and approved by a public authority under Part 5 of the Environmental Planning and Assessment (EP&A) Act 1979 • what infrastructure development requires consent under Part 4 of the EP&A Act • what infrastructure development is exempt or complying development.

Terminology	Abbreviation	Description
State Environmental Planning Policy No.44 – Koala Habitat	SEPP 44	This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline: (a) by requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat, and (b) by encouraging the identification of areas of core koala habitat, and (c) by encouraging the inclusion of areas of core koala habitat in environment protection zones. Applicable for projects determined under Part 4 and 5 of the EP&A Act.
State Environmental Planning Policy	SEPP	A type of planning instrument made under Part 3 of the EP&A Act.
Strahler stream order		Strahler stream order and are used to define stream size based on a hierarchy of tributaries.
Subject Site		The Subject Site is the area that was targeted for ecological assessment and encompasses all aspects of the Proposal.
The Proposal		The proposed activity to be carried out by the Proponent as detailed in **Section 1.1** of this report.
Threatened species		A species specified in Schedule 1 Part 1 (endangered species), Part 4 (presumed extinct) and Schedule 2 (vulnerable species) of the TSC Act, within the schedules of the FM Act or within the Schedules of the EPBC Act.
Threatened Species Conservation Act 1995 (NSW)	TSC Act	The objects of this Act are as follows: (a) to conserve biological diversity and promote ecologically sustainable development, and (b) to prevent the extinction and promote the recovery of threatened species, populations and ecological communities, and (c) to protect the critical habitat of those threatened species, populations and ecological communities that are endangered, and (d) to eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities, and (e) to ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed, and (f) to encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

APPENDIX 2: DATABASE SEARCH RESULTS

DESKTOP DATABASE SEARCH RESULTS

A summary of databases searches indicated for TSC and EPBC listed species, ecological communities and populations. Copies of the OEH threatened species database search (TSC Act), NSW DPI records viewer (FM Act) and DoE Protected Matters (EPBC Act) threatened species database searches have been provided in the following table.

Name of database searched	Date of search	Type of search	Comment
DoE Register of Critical Habitat http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl	4.1.2017	Subject Site	No critical habitat area registered in the Subject Site.
Department of Sustainability, Environment, Water, Population and Communities (DoE) Protected Matters (EPBC Act) Database. http://www.environment.gov.au/erin/ert/epbc/index.html	4.1.2017	Subject Site including 5km buffer	Listed Threatened Ecological Communities: 5 Listed Migratory Species: 14 Listed Threatened Species: 10 Listed Marine Species:11 Commonwealth Lands: 6 Places on the RNE: 13 Invasive Species: 26 Several species listed are known to occur or have habitat in the Subject Site.
Office of Environment and Heritage (OEH) Threatened Species online database: http://www.environment.nsw.gov.au/threatenedspecies/	4.1.2017	Combined geographic and habitat search in Central West (Talbragar Valley)	A search of the NSW OEH Threatened Species Profiles using Central West CMA Talbragar Valley subregion predicts 98 listed items as having potential to be present in the Subject Site.
BioNet Atlas of NSW Wildlife 2014. Data License agreement	4.1.2017	Licensed Report of all Valid Records of Threatened (listed on TSC Act 1995) ,Commonwealth listed ,CAMBA listed ,JAMBA listed or ROKAMBA listed Entities in selected area [North: -32.21 West: 148.57 East: 148.67 South: -32.31]	Search returned a total of 81 records of 30 species.
Department of Primary Industries Noxious Weeds http://weeds.dpi.nsw.gov.au/WeedDeclarations/Results	4.1.2017	Dubbo LGA	109 Noxious Weeds are listed as occurring in the Dubbo LGA. Many have the potential to occur in the Subject Site.
SEPP 44: Koala Habitat Protection http://www.legislation.nsw.gov.au/fragview/inforce/epi%2B5%2B1995%2Bcd%2B0%2BN?	4.1.2017	Dubbo LGA	Wellington LGA is not listed in SEPP Schedule 1 of the SEPP. Thus, SEPP 44 does not apply. Koalas are, however, known to occur in the Dubbo LGA and Fuzzy Box are Schedule 2 listed feed tree species. As such, SEPP 44 does not apply, however, koala habitat will be considered.
Office of Environment and Heritage (OEH) Key Threatening Processes. http://www.environment.nsw.gov.au/threatenedspe	4.1.2017		37 KTPs are currently listed under the TSC Act.

Name of database searched	Date of search	Type of search	Comment
cies/aboutKTPSinNSW.htm			
Department of Sustainability, Environment, Water, Population and Communities (DoE) Key Threatened Processes http://www.environment.gov.au/biodiversity/threatened/ktp.html	4.1.2017		19 KTPs are currently listed under the EPBC Act.
Bird Life Australia (Important Bird Areas: IBA) http://www.birdlife.org/datazone/site/search	4.1.2017	Subject Site	No IBA is located within the Subject Site. The Subject Site is situated directly south of the Goonoo IBA.
DPI Records Viewer http://www.dpi.nsw.gov.au/fisheries/species-protection/records/viewer	4.1.2017	Dubbo LGA	Three species of fish have been previously recorded in the Dubbo LGA. Including the: • Freshwater catfish population • Murray Cod • Trout Cod None of these species are likely to occur or have important habitat in the Subject Site. They all are likely to occur in the Macquarie River in Dubbo.
Atlas of Living Australia http://biocache.ala.org.au/explore/your-area	4.1.2017	10.0 km of point (-32.274452,148.63289	519 records of 51 species - State Conservation Endangered. No threatened species have been previously recorded in the Subject Site however this does not mean that they do not have habitat in the Subject Site. The Little Eagle, Grey-crowned Babbler and Speckled Warbler are the closest threatened species records.

OEH THREATENED SPECIES DATABASE RESULTS

CMA Sub Region & Profiles Report

18/09/2014

CMA Sub-Region Profile ID	Scientific Name	Common Name	Occurrence
Central West - Talbragar Valley			
10056	Anseranas semipalmata	Magpie Goose	Known
10105	Botaurus poiciloptilus	Australasian Bittern	Predicted
10113	Burhinus grallarius	Bush Stone-curlew	Known
10116	Lophochroa leadbeateri	Major Mitchell's Cockatoo	Predicted
10140	Calyptorhynchus lathami	Glossy Black-Cockatoo	Known
10155	Cercartetus nanus	Eastern Pygmy-possum	Predicted
10157	Chalinolobus dwyeri	Large-eared Pied Bat	Predicted
10159	Chalinolobus picatus	Little Pied Bat	Known
10171	Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	Known
10207	Dasyurus maculatus	Spotted-tailed Quoll	Predicted
10221	Dichanthium setosum	Bluegrass	Predicted
10243	Diuris tricolor	Pine Donkey Orchid	Known
10259	Liopholis whitii	White's Skink	Predicted
10275	Ephippiorhynchus asiaticus	Black-necked Stork	Predicted
10330	Falco hypoleucos	Grey Falcon	Known
10335	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	Known
10354	Goodenia macbarronii	Narrow Goodenia	Predicted
10382	Grus rubicunda	Brolga	Predicted
10395	Hamirostra melanosternon	Black-breasted Buzzard	Predicted
10412	Hoplocephalus bitorquatus	Pale-headed Snake	Predicted
10455	Lathamus discolor	Swift Parrot	Predicted
10459	Leipoa ocellata	Malleefowl	Predicted
10479	Limosa limosa	Black-tailed Godwit	Predicted
10495	Lophoictinia isura	Square-tailed Kite	Known
10519	Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	Known
10523	Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Known
10555	Neophema pulchella	Turquoise Parrot	Known
10561	Ninox connivens	Barking Owl	Known
10568	Nyctophilus corbeni	Corben's Long-eared Bat	Known
10580	Oxyura australis	Blue-billed Duck	Known
10582	Pachycephala inornata	Gilbert's Whistler	Predicted
10604	Petaurus norfolcensis	Squirrel Glider	Known
10616	Phascolarctos cinereus	Koala	Known
10621	Philotheca ericifolia	Philotheca ericifolia	Known
10645	Polytelis swainsonii	Superb Parrot	Known

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CMA Sub-Region			
Profile ID	Scientific Name	Common Name	Occurrence
10656	Pomaderris queenslandica	Scant Pomaderris	Predicted
10660	Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	Known
10722	Chthonicola sagittata	Speckled Warbler	Known
10734	Rostratula australis	Australian Painted Snipe	Known
10735	Rulingia procumbens	Rulingia procumbens	Known
10741	Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Known
10759	Sminthopsis macroura	Stripe-faced Dunnart	Predicted
10768	Stagonopleura guttata	Diamond Firetail	Known
10771	Stictonetta naevosa	Freckled Duck	Predicted
10783	Swainsona sericea	Silky Swainson-pea	Known
10815	Tylophora linearis	Tylophora linearis	Known
10820	Tyto novaehollandiae	Masked Owl	Predicted
10837	White Box Yellow Box Blakely's Red Gum Woodland	White Box Yellow Box Blakely's Red Gum Woodland	Known
10841	Anthochaera phrygia	Regent Honeyeater	Known
10857	Zieria ingramii	Keith's Zieria	Known
20001	Alteration of habitat following subsidence due to longwall mining	Alteration of habitat following subsidence due to longwall mining	Predicted
20002	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	Predicted
20003	Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations	Infection by Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species and populations	Predicted
20004	Competition from feral honey bees, Apis mellifera L.	Competition from feral honey bees, Apis mellifera L.	Predicted
20005	Introduction of the Large Earth Bumblebee Bombus terrestris (L.)	Introduction of the Large Earth Bumblebee Bombus terrestris (L.)	Predicted
20006	Bushrock removal	Bushrock removal	Predicted
20007	Loss or degradation (or both) of sites used for hill-topping by butterflies	Loss or degradation (or both) of sites used for hill-topping by butterflies	Predicted
20008	Predation by the Feral Cat Felis catus (Linnaeus, 1758)	Predation by the Feral Cat Felis catus (Linnaeus, 1758)	Predicted
20009	Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	Predicted
20010	Invasion of the Yellow Crazy Ant, Anoplolepis gracilipes (Fr. Smith) into NSW	Invasion of the Yellow Crazy Ant, Anoplolepis gracilipes (Fr. Smith) into NSW	Predicted
20011	Removal of dead wood and dead trees	Removal of dead wood and dead trees	Predicted
20012	Herbivory and environmental degradation caused by feral deer	Herbivory and environmental degradation caused by feral deer	Predicted
20014	High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	Predicted
20015	Predation by the European Red Fox Vulpes Vulpes (Linnaeus, 1758)	Predation by the European Red Fox Vulpes Vulpes (Linnaeus, 1758)	Predicted
20016	Predation by Gambusia holbrooki Girard, 1859 (Plague Minnow or Mosquito Fish)	Predation by Gambusia holbrooki Girard, 1859 (Plague Minnow or Mosquito Fish)	Predicted
20017	Competition and habitat degradation by Feral Goats, Capra hircus Linnaeus 1758	Competition and habitat degradation by Feral Goats, Capra hircus Linnaeus 1758	Predicted
20018	Invasion of native plant communities by exotic perennial grasses	Invasion of native plant communities by exotic perennial grasses	Predicted
20020	Predation, habitat degradation, competition and disease transmission by Feral Pigs, Sus scrofa Linnaeus 1758	Predation, habitat degradation, competition and disease transmission by Feral Pigs, Sus scrofa Linnaeus 1758	Predicted
20021	Importation of Red Imported Fire Ants Solenopsis invicta Buren 1972	Importation of Red Imported Fire Ants Solenopsis invicta Buren 1972	Predicted
20023	Clearing of native vegetation	Clearing of native vegetation	Predicted

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CMA Sub-Region			
Profile ID	Scientific Name	Common Name	Occurrence
20024	Competition and grazing by the feral European Rabbit, Oryctolagus cuniculus (L.)	Competition and grazing by the feral European Rabbit, Oryctolagus cuniculus (L.)	Predicted
20025	Anthropogenic Climate Change	Anthropogenic Climate Change	Predicted
20026	Infection of native plants by Phytophthora cinnamomi	Infection of native plants by Phytophthora cinnamomi	Predicted
20027	Invasion of native plant communities by Chrysanthemoides monilifera	Invasion of native plant communities by Chrysanthemoides monilifera	Predicted
20043	Invasion and establishment of the Cane Toad (Bufo marinus)	Invasion and establishment of the Cane Toad (Bufo marinus)	Predicted
20044	Invasion, establishment and spread of Lantana (Lantana camara L. sens. Lat)	Invasion, establishment and spread of Lantana (Lantana camara L. sens. Lat)	Predicted
20052	Invasion and establishment of exotic vines and scramblers	Invasion and establishment of exotic vines and scramblers	Predicted
20061	Acacia ausfeldii	Ausfeld's Wattle	Known
20065	Invasion and establishment of Scotch Broom (Cytisus scoparius)	Invasion and establishment of Scotch Broom (Cytisus scoparius)	Predicted
20072	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions	Known
20079	Loss of Hollow-bearing Trees	Loss of Hollow-bearing Trees	Predicted
20088	Crinia sloanei	Sloane's Froglet	Predicted
20108	Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	Predicted
20111	Glossopsitta pusilla	Little Lorikeet	Known
20116	Predation and hybridisation by Feral Dogs, Canis lupus familiaris	Predation and hybridisation by Feral Dogs, Canis lupus familiaris	Predicted
20129	Petroica phoenicea	Flame Robin	Known
20131	Hieraaetus morphnoides	Little Eagle	Known
20133	Petroica boodang	Scarlet Robin	Known
20134	Circus assimilis	Spotted Harrier	Known
20135	Daphoenositta chrysoptera	Varied Sittella	Known
20143	Epthianura albifrons	White-fronted Chat	Known
20153	Invasion of native plant communities by African Olive Olea europaea subsp. cuspidata (Wall. ex G. Don) Cif.	Invasion of native plant communities by African Olive Olea europaea subsp. cuspidata (Wall. ex G. Don) Cif.	Predicted
20240	Bothriochloa biloba	Lobed Bluegrass	Known
20265	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Predicted
20271	Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners Manorina melanocephala	Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners Manorina melanocephala	Predicted

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DOE PROTECTED MATTERS

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	14
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	6
Commonwealth Heritage Places:	None
Listed Marine Species:	11
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	13
State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	26
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area
Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	Endangered	Community likely to occur within area
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community may occur within area
Weeping Myall Woodlands	Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Endangered	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat may occur within area
Polytelis swainsonii Superb Parrot [738]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Fish		
Bidyanus bidyanus Silver Perch, Bidyan [76155]	Critically Endangered	Species or species habitat may occur within area
Maccullochella macquariensis Trout Cod [26171]	Endangered	Species or species habitat may occur within area
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Nyctophilus corbeni South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat may occur within area
Plants		
Androcalva procumbens [87153]	Vulnerable	Species or species habitat likely to occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Reptiles		
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		

Name	Status	Type of Presence
Fish		
Bidyanus bidyanus Silver Perch, Bidyan [76155]	Critically Endangered	Species or species habitat may occur within area
Maccullochella macquariensis Trout Cod [26171]	Endangered	Species or species habitat may occur within area
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Nyctophilus corbeni South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat may occur within area
Plants		
Androcalva procumbens [87153]	Vulnerable	Species or species habitat likely to occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Reptiles		
Aprasia parapulchella Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		

Name	Threatened	Type of Presence
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Postal Commission
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Bank of Australia
Defence - DUBBO - HUTTED CAMP SITE
Defence - DUBBO TRAINING DEPOT

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat may occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato)		
Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Historic		
Dubbo High School Main Building	NSW	Indicative Place
Dubbo Pioneer Cemetery	NSW	Indicative Place
Dubbo Showground Grandstand	NSW	Indicative Place
Eastonville	NSW	Indicative Place
Salvation Army Citadel (former)	NSW	Indicative Place
Dubbo Courthouse	NSW	Registered
Dundullimal Homestead and Stone Barn	NSW	Registered
Gaol (former) and Residence	NSW	Registered
Lands Board Office Building	NSW	Registered
Police Inspectors Residence	NSW	Registered
Public School	NSW	Registered
RAAF Base Dubbo (former)	NSW	Registered
Talbragar Shire Council Chambers (former)	NSW	Registered

Invasive Species [Resource Information]

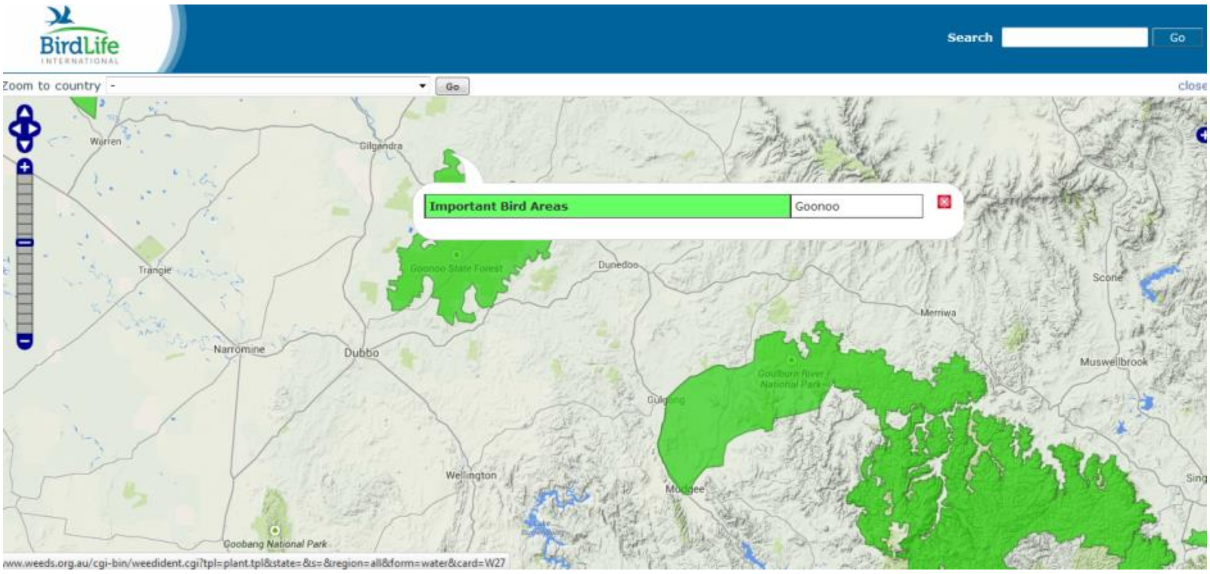
Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos		
Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis		
European Goldfinch [403]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

BIRDLIFE INTERNATIONAL-IMPORTANT BIRD AREAS



ATLAS OF LIVING AUSTRALIA

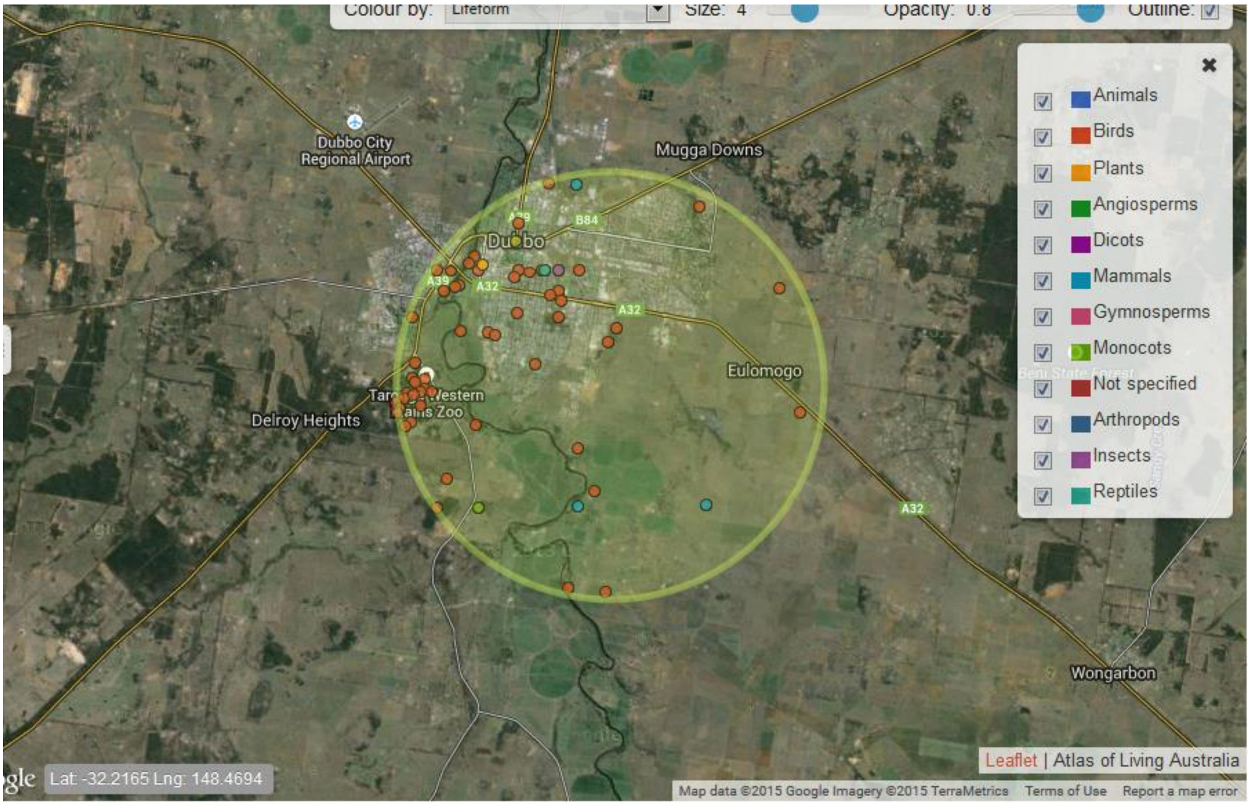
5KM CIRCLE

44 species recorded: 206 results for [all records] - within 5.0 km of point (-32.274452, 148.63289) State Conservation Endangered.

Name of species	Number of records
Australian Painted Snipe Rostratula australis	4
Barking Owl Ninox (Hieracoglaux) connivens	7
Bindjulang Dasyurus maculatus	2
Black Callitris Callitris endlicheri	5
Black-chinned Honeyeater Melithreptus (Eidopsarus) gularis gularis	1
Blue-billed Duck Oxyura australis	3
Brolga Grus (Mathewsia) rubicunda	1
Brown Treecreeper (eastern Subspecies) Climacteris (Climacteris) picumnus victoriae	2
Bush Stone-curlew Burhinus (Burhinus) grallarius	3
Diamond Firetail Stagonopleura (Stagonopleura) guttata	3
Emu # Dromaius novaehollandiae #	4
Flame Robin Petroica (Littlera) phoenicea	1
Glossy Black-cockatoo Calyptorhynchus (Calyptorhynchus) lathami	16
Golden Sun Moth Synemon plana	1
Grey Falcon Falco (Hierofalco) hypoleucos	1
Grey-crowned Babbler Pomatostomus (Pomatostomus) temporalis temporalis	12
Homoranthus Darwinioides Homoranthus darwinioides	1
Ingram's Zieria Zieria ingramii	1
Leafless Indigo Indigofera efoliata	9
Little Eagle Hieraaetus (Hieraaetus) morphnoides	16
Little Lorikeet Glossopsitta pusilla	17
Magpie Goose Anseranas semipalmata	3
Major Mitchell's Cockatoo Lophochroa leadbeateri	3
Malleefowl Leipoa ocellata	11
Mauve Burr-daisy Calotis glandulosa	2
Painted Honeyeater Grantiella picta	3
Pale-headed Snake Hoplocephalus bitorquatus	1
Red-tailed Tropicbird Phaethon rubricauda	1
Regent Honeyeater Anthochaera (Xanthomyza) phrygia	12
River Red Gum # Eucalyptus camaldulensis #	3
Rulingia Procumbens Rulingia procumbens	2
Silky Glycine Glycine canescens	1
Speckled Warbler Chthonicola sagittata	19
Spotted Harrier Circus assimilis	6
Spotted-throat Cowslip Diuris tricolor	3
Square-tailed Kite Lophoictinia isura	3
Stripe-faced Dunnart Sminthopsis macroura	9
Superb Parrot Polytelis swainsonii	4

Swamp Bush-pea # Pultenaea glabra #	**1**
Swift Parrot Lathamus discolor	**2**
Varied Sittella Daphoenositta (Neositta) chrysoptera	**4**
Weeping Myall Acacia pendula	**1**
White-browed Treecreeper Climacteris (Climacterobates) affinis affinis	**1**
White-fronted Chat Epthianura (Epthianura) albifrons	**1**
Grand Total	**206**

Not listed under TSC or EPBC Act in the Dubbo LGA

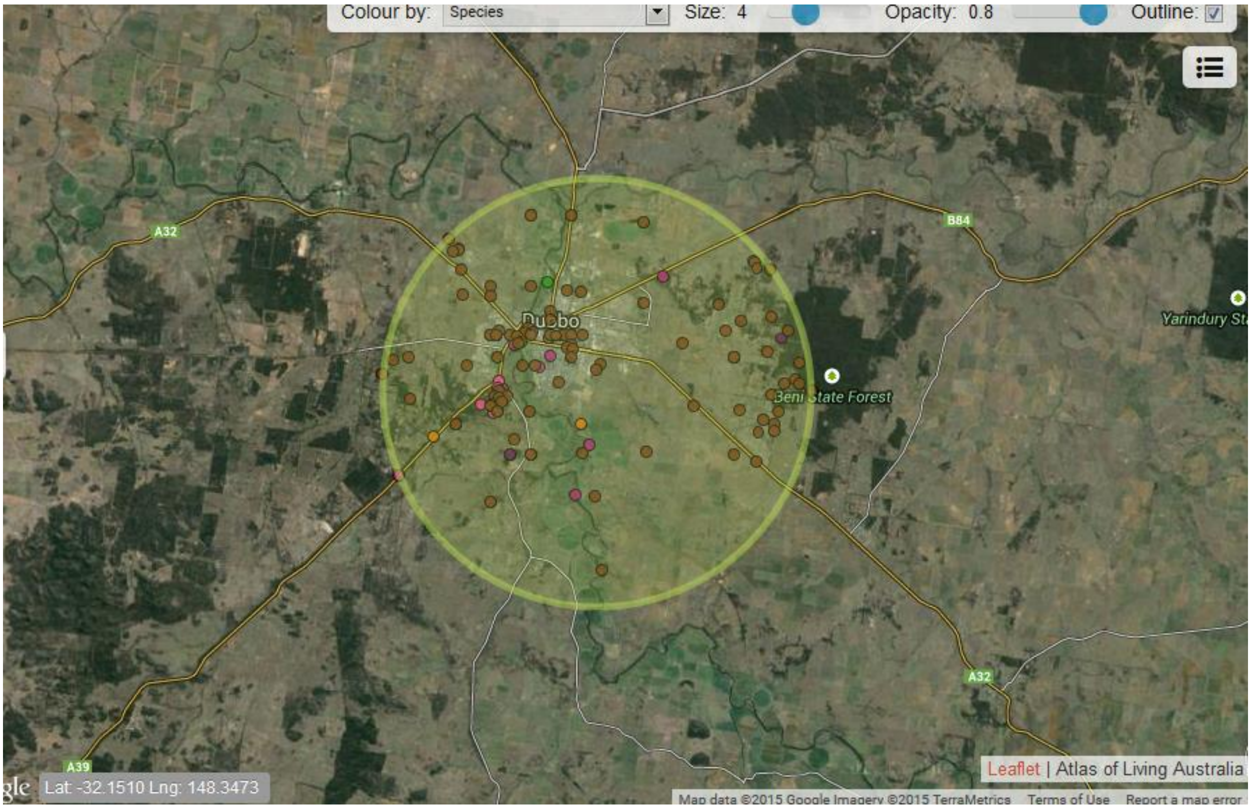


10KM CIRCLE

51 species: 519 results for [all records] - within 10.0 km of point (-32.274452, 148.63289) State Conservation Endangered

Name of species	Number of records
Acacia pendula Weeping Myall	2
Anseranas semipalmata Magpie Goose	8
Anthochaera (Xanthomyza) Phrygia Regent Honeyeater	14
Burhinus (Burhinus) grallarius Bush Stone-curlew	4
Calidris (Erolia) ferruginea Curlew Sandpiper	2
Callitris endlicheri Black Callitris	8
Calotis glandulosa Mauve Burr-daisy	2
Calyptorhynchus (Calyptorhynchus) lathami Glossy Black-cockatoo	16
Chalinolobus picatus Little Pied Bat	3

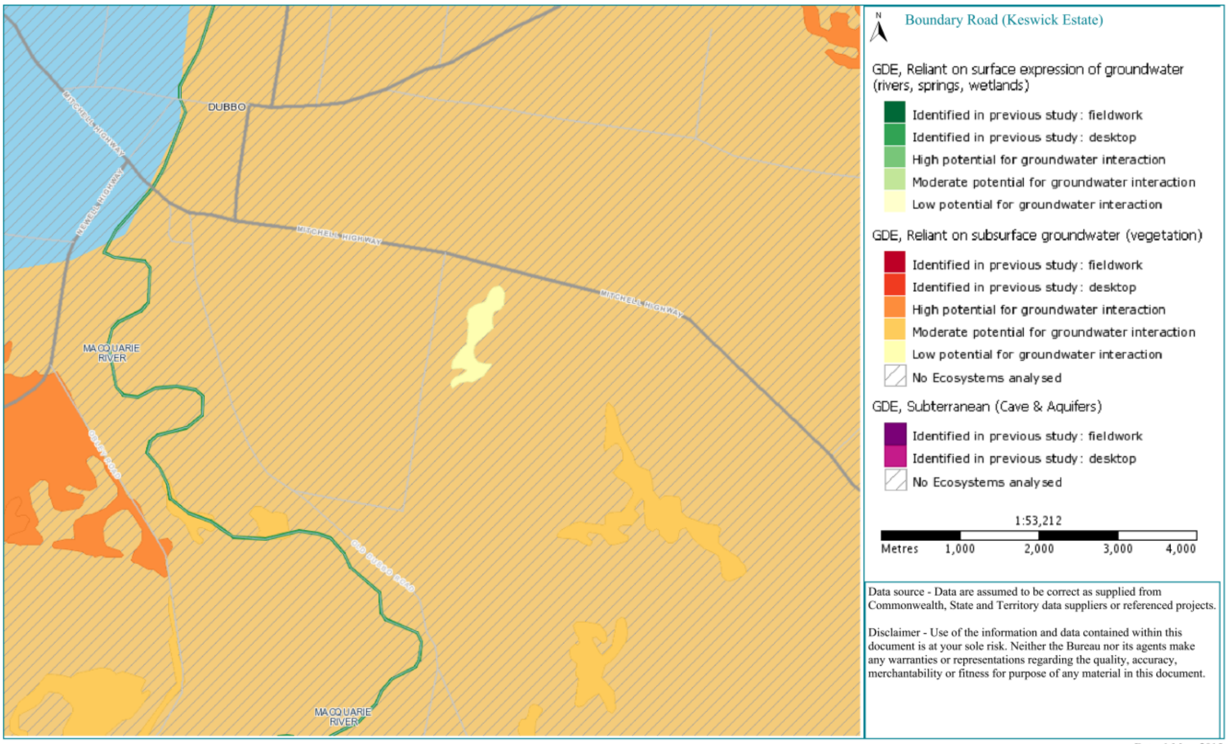
Chthonicola sagittata Speckled Warbler	68
Circus assimilis Spotted Harrier	21
Climacteris (Climacteris) picumnus victoriae Brown Treecreeper (eastern Subspecies)	4
Climacteris (Climacterobates) affinis affinis White-browed Treecreeper	1
Daphoenositta (Neositta) chrysoptera Varied Sittella	20
Dasyurus maculatus Bindjulang	2
Diuris tricolor Spotted-throat Cowslip	8
Dromaius novaehollandiae Emu	18
Epthianura (Epthianura) albifrons White-fronted Chat	14
Eucalyptus camaldulensis River Red Gum	5
Falco (Hierofalco) hypoleucos Grey Falcon	1
Geophaps (Geophaps) scripta Squatter Pigeon	1
Glossopsitta pusilla Little Lorikeet	45
Glycine canescens Silky Glycine	2
Grantiella picta Painted Honeyeater	4
Grus (Mathewsia) rubicunda Brolga	2
Hamirostra melanosternon Black-breasted Buzzard	2
Hieraaetus (Hieraaetus) morphnoides Little Eagle	76
Homoranthus darwinioides Homoranthus Darwinioides	1
Hoplocephalus bitorquatus Pale-headed Snake	1
Indigofera efoliata Leafless Indigo	11
Lathamus discolor Swift Parrot	2
Leipoa ocellata Malleefowl	13
Lophochroa leadbeateri Major Mitchell's Cockatoo	5
Lophoictinia isura Square-tailed Kite	4
Melanodryas (Melanodryas) cucullata cucullata Hooded Robin	1
Melithreptus (Eidopsarus) gularis gularis Black-chinned Honeyeater	1
Neophema (Neophema) pulchella Turquoise Parrot	1
Ninox (Hieracoglaux) connivens Barking Owl	11
Oxyura australis Blue-billed Duck	5
Pachycephala (Timixos) inornata Gilbert's Whistler	5
Petroica (Littlera) phoenicea Flame Robin	10
Phaethon rubricauda Red-tailed Tropicbird	5
Polytelis swainsonii Superb Parrot	7
Pomatostomus (Pomatostomus) temporalis temporalis Grey-crowned Babbler	36
Pultenaea glabra Swamp Bush-pea	1
Rostratula australis Australian Painted Snipe	12
Rulingia procumbens Rulingia Procumbens	3
Sminthopsis macroura Stripe-faced Dunnart	9
Stagonopleura (Stagonopleura) guttata Diamond Firetail	20
Synemon plana Golden Sun Moth	1
Zieria ingramii Ingram's Zieria	1
Grand Total	**519**



ATLAS OF GROUNDWATER DEPENDENT ECOSYSTEMS

Australian Government
Bureau of Meteorology

Groundwater Dependent Ecosystem Map Report



Date: 1 May, 2015

Dubbo Regional Council Noxious Weed List

African boxthorn	4	Locally Controlled Weed
Lycium ferocissimum		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
African feather grass	5	Restricted Plant
Pennisetum macrourum		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
African turnip weed - eastern	5	Restricted Plant
Sisymbrium thellungii		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
African turnip weed - western	5	Restricted Plant
Sisymbrium runcinatum		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Alligator weed	2	Regionally Prohibited Weed
Alternanthera philoxeroides		*The plant must be eradicated from the land and that land must be kept free of the plant*
Anchored water hyacinth	1	State Prohibited Weed
Eichhornia azurea		*The plant must be eradicated from the land and that land must be kept free of the plant*
Annual ragweed	5	Restricted Plant
Ambrosia artemisiifolia		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Arrowhead	4	Locally Controlled Weed
Sagittaria montevidensis		*The plant must not be sold, propagated or knowingly distributed*
Artichoke thistle	5	Restricted Plant
Cynara cardunculus		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Asparagus - climbing asparagus fern	4	Locally Controlled Weed
Asparagus plumosus		*The plant must not be sold, propagated or knowingly distributed*
Asparagus - ground asparagus	4	Locally Controlled Weed
Asparagus aethiopicus		*The plant must not be sold, propagated or knowingly distributed*
Asparagus weeds	4	Locally Controlled Weed
Asparagus species		*The plant must not be sold, propagated or knowingly distributed*
Athel pine	5	Restricted Plant
Tamarix aphylla		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Bear-skin fescue	5	Restricted Plant
Festuca gautieri		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Black knapweed	1	State Prohibited Weed
Centaurea nigra		*The plant must be eradicated from the land and that land must be kept free of the plant*
Black willow	2	Regionally Prohibited Weed
Salix nigra		*The plant must be eradicated from the land and that land must be kept free of the plant*
Blackberry	4	Locally Controlled Weed
Rubus fruticosus species aggregate		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*

Blue heliotrope	4	Locally Controlled Weed
Heliotropium amplexicaule		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread*
Boneseed	1	State Prohibited Weed
Chrysanthemoides monilifera subsp. *monilifera*		*The plant must be eradicated from the land and that land must be kept free of the plant*
Bridal creeper	4	Locally Controlled Weed
Asparagus asparagoides		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Bridal veil creeper	1	State Prohibited Weed
Asparagus declinatus		*The plant must be eradicated from the land and that land must be kept free of the plant*
Broomrapes	1	State Prohibited Weed
Orobanche species		*The plant must be eradicated from the land and that land must be kept free of the plant*
Burr ragweed	5	Restricted Plant
Ambrosia confertiflora		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Cabomba	5	Restricted Plant
Cabomba species		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Cape broom	4	Locally Controlled Weed
Genista monspessulana		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Cat's claw creeper	2	Regionally Prohibited Weed
Dolichandra unguis-cati		*The plant must be eradicated from the land and that land must be kept free of the plant*
Cayenne snakeweed	5	Restricted Plant
Stachytarpheta cayennensis		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Chilean needle grass	4	Locally Controlled Weed
Nassella neesiana		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Chinese violet	1	State Prohibited Weed
Asystasia gangetica subsp. *micrantha*		*The plant must be eradicated from the land and that land must be kept free of the plant*
Clockweed	5	Restricted Plant
Gaura parviflora		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Columbus grass	4	Locally Controlled Weed
Sorghum x *almum*		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread*
Coolatai grass	3	Regionally Controlled Weed
Hyparrhenia hirta		*The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed*
Corn sowthistle	5	Restricted Plant
Sonchus arvensis		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Dodder	5	Restricted Plant

Cuscuta species		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Espartillo - broad kernel	5	Restricted Plant
Amelichloa caudata		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Espartillo - narrow kernel	5	Restricted Plant
Amelichloa brachychaeta		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Eurasian water milfoil	1	State Prohibited Weed
Myriophyllum spicatum		*The plant must be eradicated from the land and that land must be kept free of the plant*
European hackberry	4	Locally Controlled Weed
Celtis australis		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread*
Fine-bristled burr grass	5	Restricted Plant
Cenchrus brownii		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Fireweed	4	Locally Controlled Weed
Senecio madagascariensis		*The plant must not be sold, propagated or knowingly distributed*
Flax-leaf broom	4	Locally Controlled Weed
Genista linifolia		*The plant must not be sold, propagated or knowingly distributed*
Fountain grass	5	Restricted Plant
Cenchrus setaceus		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Frogbit	1	State Prohibited Weed
Limnobium laevigatum		*The plant must be eradicated from the land and that land must be kept free of the plant*
Gallon's curse	5	Restricted Plant
Cenchrus biflorus		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Gamba grass	5	Restricted Plant
Andropogon gayanus		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Giant reed	4	Locally Controlled Weed
Arundo donax		*The plant must not be sold, propagated or knowingly distributed*
Glaucous starthistle	5	Restricted Plant
Carthamus leucocaulos		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Golden thistle	5	Restricted Plant
Scolymus hispanicus		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Green cestrum	3	Regionally Controlled Weed
Cestrum parqui		*The plant must be fully and continuously suppressed and destroyed*
Grey sallow	2	Regionally Prohibited Weed
Salix cinerea		*The plant must be eradicated from the land and that land must be kept free of the plant*
Harrisia cactus	4	Locally Controlled Weed
Harrisia species		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Hawkweeds	1	State Prohibited Weed

Hieracium species		*The plant must be eradicated from the land and that land must be kept free of the plant*
Honey locust	3	Regionally Controlled Weed
Gleditsia triacanthos		*The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed*
Horsetails	1	State Prohibited Weed
Equisetum species		*The plant must be eradicated from the land and that land must be kept free of the plant*
Hydrocotyl	1	State Prohibited Weed
Hydrocotyl ranunculoides		*The plant must be eradicated from the land and that land must be kept free of the plant*
Hymenachne	1	State Prohibited Weed
Hymenachne amplexicaulis and hybrids		*The plant must be eradicated from the land and that land must be kept free of the plant*
Johnson grass	4	Locally Controlled Weed
Sorghum halepense		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Karroo thorn	1	State Prohibited Weed
Acacia karroo		*The plant must be eradicated from the land and that land must be kept free of the plant*
Kidney-leaf mud plantain	1	State Prohibited Weed
Heteranthera reniformis		*The plant must be eradicated from the land and that land must be kept free of the plant*
Kochia	1	State Prohibited Weed
Bassia scoparia		*The plant must be eradicated from the land and that land must be kept free of the plant*
Koster's curse	1	State Prohibited Weed
Clidemia hirta		*The plant must be eradicated from the land and that land must be kept free of the plant*
Lagarosiphon	1	State Prohibited Weed
Lagarosiphon major		*The plant must be eradicated from the land and that land must be kept free of the plant*
Leafy elodea	4	Locally Controlled Weed
Egeria densa		*The plant must not be sold, propagated or knowingly distributed*
Lippia	4	Locally Controlled Weed
Phyla canescens		*The plant must not be sold, propagated or knowingly distributed* ***except incidentally in hay or lucerne***
Long-leaf willow primrose	3	Regionally Controlled Weed
Ludwigia longifolia		*The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed*
Mesquite	2	Regionally Prohibited Weed
Prosopis species		*The plant must be eradicated from the land and that land must be kept free of the plant*
Mexican feather grass	1	State Prohibited Weed
Nassella tenuissima		*The plant must be eradicated from the land and that land must be kept free of the plant*
Mexican poppy	5	Restricted Plant
Argemone mexicana		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Miconia	1	State Prohibited Weed

Miconia species		*The plant must be eradicated from the land and that land must be kept free of the plant*
Mikania vine	1	State Prohibited Weed
Mikania micrantha		*The plant must be eradicated from the land and that land must be kept free of the plant*
Mimosa	1	State Prohibited Weed
Mimosa pigra		*The plant must be eradicated from the land and that land must be kept free of the plant*
Mossman River grass	5	Restricted Plant
Cenchrus echinatus		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Mother-of-millions	4	Locally Controlled Weed
Bryophyllum species		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Pampas grass	3	Regionally Controlled Weed
Cortaderia species		*The plant must be fully and continuously suppressed and destroyed and the plant must not be sold, propagated or knowingly distributed*
Parkinsonia	2	Regionally Prohibited Weed
Parkinsonia aculeata		*The plant must be eradicated from the land and that land must be kept free of the plant*
Parthenium weed	1	State Prohibited Weed
Parthenium hysterophorus		*The plant must be eradicated from the land and that land must be kept free of the plant*
Pond apple	1	State Prohibited Weed
Annona glabra		*The plant must be eradicated from the land and that land must be kept free of the plant*
Prickly acacia	1	State Prohibited Weed
Acacia nilotica		*The plant must be eradicated from the land and that land must be kept free of the plant*
Prickly pear - common pear	4	Locally Controlled Weed
Opuntia stricta		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Prickly pear - Hudson pear	4	Locally Controlled Weed
Cylindropuntia rosea		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Prickly pear - smooth tree pear	4	Locally Controlled Weed
Opuntia monacantha		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Prickly pear - tiger pear	4	Locally Controlled Weed
Opuntia aurantiaca		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Prickly pear - velvety tree pear	4	Locally Controlled Weed
Opuntia tomentosa		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Red rice	5	Restricted Plant

Oryza rufipogon		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Rhus tree	4	Locally Controlled Weed
Toxicodendron succedaneum		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Rubber vine	1	State Prohibited Weed
Cryptostegia grandiflora		*The plant must be eradicated from the land and that land must be kept free of the plant*
Sagittaria	4	Locally Controlled Weed
Sagittaria platyphylla		*The plant must not be sold, propagated or knowingly distributed*
Salvinia	2	Regionally Prohibited Weed
Salvinia molesta		*The plant must be eradicated from the land and that land must be kept free of the plant*
Scotch broom	4	Locally Controlled Weed
Cytisus scoparius		*The plant must not be sold, propagated or knowingly distributed*
Senegal tea plant	1	State Prohibited Weed
Gymnocoronis spilanthoides		*The plant must be eradicated from the land and that land must be kept free of the plant*
Serrated tussock	4	Locally Controlled Weed
Nassella trichotoma		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Siam weed	1	State Prohibited Weed
Chromolaena odorata		*The plant must be eradicated from the land and that land must be kept free of the plant*
Silk forage sorghum	4	Locally Controlled Weed
Sorghum species hybrid cultivar "Silk"		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread*
Silverleaf nightshade	4	Locally Controlled Weed
Solanum elaeagnifolium		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Smooth-stemmed turnip	5	Restricted Plant
Brassica barrelieri subsp. *oxyrrhina*		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Soldier thistle	5	Restricted Plant
Picnomon acarna		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Spongeplant	1	State Prohibited Weed
Limnobium spongia		*The plant must be eradicated from the land and that land must be kept free of the plant*
Spotted knapweed	1	State Prohibited Weed
Centaurea stoebe subsp. *micranthos*		*The plant must be eradicated from the land and that land must be kept free of the plant*
Texas blueweed	5	Restricted Plant
Helianthus ciliaris		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Tree-of-heaven	4	Locally Controlled Weed
Ailanthus altissima		*The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed*
Tropical soda apple	1	State Prohibited Weed

Solanum viarum		*The plant must be eradicated from the land and that land must be kept free of the plant*
Water caltrop	1	State Prohibited Weed
Trapa species		*The plant must be eradicated from the land and that land must be kept free of the plant*
Water hyacinth	2	Regionally Prohibited Weed
Eichhornia crassipes		*The plant must be eradicated from the land and that land must be kept free of the plant*
Water lettuce	1	State Prohibited Weed
Pistia stratiotes		*The plant must be eradicated from the land and that land must be kept free of the plant*
Water soldier	1	State Prohibited Weed
Stratiotes aloides		*The plant must be eradicated from the land and that land must be kept free of the plant*
Willows	4	Locally Controlled Weed
Salix species		*The plant must not be sold, propagated or knowingly distributed*
Witchweeds	1	State Prohibited Weed
Striga species		*The plant must be eradicated from the land and that land must be kept free of the plant*
Yellow burrhead	1	State Prohibited Weed
Limnocharis flava		*The plant must be eradicated from the land and that land must be kept free of the plant*
Yellow nutgrass	5	Restricted Plant
Cyperus esculentus		*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*

APPENDIX 3: ASSESSMENT OF LIKELIHOOD OF THREATENED SPECIES, COMMUNITIES AND POPULATIONS

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Australasian Bittern	*Botaurus poiciloptilus*	Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (Typha spp.) and spikerushes (Eleoacharis spp.). Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds; there are usually six olive-brown eggs to a clutch.	Endangered	Endangered	Known	Species or species habitat may occur within Area	Unlikely
Ausfeld's Wattle	Acacia ausfeldii	Found to the east of Dubbo in the Mudgee-Ulan-Gulgong area of the NSW South Western Slopes bioregion, with some records in the adjoining Brigalow Belt South, South Eastern Highlands and the Sydney Basin bioregions. Populations are recorded from Yarrobil National Park, Goodiman State Conservation Area and there is a 1963 record from Munghorn Gap Nature Reserve. A large population is also known from Tuckland State Forest to the northwest of Gulgong. Established plants are likely to be killed by fire, as mature and juvenile plants have a single-stemmed growth form. Associated species include Eucalyptus albens, E. blakelyi and Callitris spp., with an understorey dominated by Cassinia spp. and grasses.	Vulnerable		Known		Potential
Bilby	Macrotis lagotis	Once widespread in arid, semi-arid and relatively fertile areas, the Bilby is now restricted to arid regions and remains a threatened species. The Bilby prefers arid habitats because of the spinifex grass and acacia shrub.	Presumed extinct	Vulnerable			No
Barking Owl	*Ninox connivens*	Nesting occurs during mid-winter and spring. Female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging starts 2 weeks later. Young are dependent for several months Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 kilometres away, though humans rarely hear this response farther than 1.5 kilometres. Because disturbance reduces the pair's foraging time, and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season.	Vulnerable		Known		Likely. Pair known to occupy territory adjacent to the Macquarie River. Hunting ground may exist in the Subject Site. Hollow bearing trees adjacent to a permanent watercourse (breeding habitat) does not occur in the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Black Falcon	Falco subniger	The Black Falcon is widely, but sparsely, distributed in New South Wales, mostly occurring in inland regions. Some reports of 'Black Falcons' on the tablelands and coast of New South Wales are likely to be referable to the Brown Falcon. In New South Wales there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling hundreds of kilometres (Marchant & Higgins 1993). The Black Falcon occurs as solitary individuals, in pairs, or in family groups of parents and offspring.	Vulnerable		Known		Potential
Black-breasted Buzzard	*Hamirostra melanosternon*	Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands. Not a powerful hunter, despite its size, mostly taking reptiles, small mammals, birds, including nestlings, and carrion. Also specialises in feeding on large eggs, including those of emus, which it cracks on a rock. Breeds from August to October near water in a tall tree. The stick nest is large and flat and lined with green leaves. Normally two eggs are laid.	Vulnerable		Predicted		Potential. Hunting ground may exist in the Subject Site, however tall trees near water (breeding habitat) do not occur in the Subject Site.
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	Occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, especially Mugga Ironbark (*Eucalyptus sideroxylon*), White Box (*E. albens*), Inland Grey Box (*E. microcarpa*), Yellow Box (*E. melliodora*) and Forest Red Gum (*E. tereticornis*). Also inhabits open forests of smooth-barked gums, stringybarks, ironbarks and tea-trees. A gregarious species usually seen in pairs and small groups of up to 12 birds. Feeding territories are large making the species locally nomadic. Recent studies have found that the Black-chinned Honeyeater tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares Breeds solitarily or co-operatively, with up to five or six adults, from June to December. The nest is placed high in the crown of a tree, in the uppermost lateral branches, hidden by foliage. It is a compact, suspended, cup-shaped nest. Two or three eggs are laid and both parents and occasionally helpers feed the young.	Vulnerable		Known		Potential.
Black-necked Stork	*Ephippiorhynchus asiaticus*	Black-necked Storks are mainly found on shallow, permanent, freshwater terrestrial wetlands, and surrounding marginal vegetation, including swamps, floodplains, watercourses and	Endangered		Predicted		Unlikely. Wetland habitat suitable for this species

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters, as well as extending into adjacent grasslands, paddocks and open savannah woodlands. They also forage within or around estuaries and along intertidal shorelines, such as saltmarshes, mudflats and sandflats, and mangrove vegetation. In NSW, Black-necked Storks breed in late spring and summer. Breeding activity has been recorded in most months, with activities from nest construction to fledging of young recorded from May to January. Most activity, however, takes place between June and December, and clutches present May to September. In NSW, Storks usually nest in a tall, live and isolated paddock tree, but also in other trees, including paperbarks, or even lower shrubs within wetlands. The nest is a large platform, 1-2 metres in diameter, made in a live or dead tree, in or near a freshwater swamp. The clutch-size of nests in NSW is not properly known, but nests have been observed with from one to three young in the nest. Broods of four young have been recorded in northern Queensland.					does not occur in the Subject Site.
Black-tailed Godwit	*Limosa limosa*	Primarily a coastal species. Usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. Further inland, it can also be found on mudflats and in water less than 10 cm deep, around muddy lakes and swamps. Individuals have been recorded in wet fields and sewerage treatment works. Forages for insects, crustaceans, molluscs, worms, larvae, spiders, fish eggs, frog eggs and tadpoles in soft mud or shallow water. Roosts and loafs on low banks of mud, sand and shell bars. Frequently recorded in mixed flocks with Bar-tailed Godwits.	Vulnerable		Predicted		Unlikely. Suitable habitat for this species does not occur in the Subject Site.
Blue-billed Duck	*Oxyura australis*	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Blue-billed Ducks will feed by day far from the shore, particularly if dense cover is available in the central parts of the wetland. They feed on the bottom of swamps eating seeds, buds, stems, leaves, fruit and small aquatic insects such as the larvae of midges, caddisflies and dragonflies. Blue-billed Ducks are partly migratory, with short-distance movements between breeding swamps and overwintering lakes	Vulnerable		Known		Unlikely. Suitable habitat for this species does not occur in the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		with some long-distance dispersal to breed during spring and early summer. Blue-billed Ducks usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed. The most common clutch size is five or six. Males take no part in nest-building or incubation. Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes.					
Brolga	*Grus rubicunda*	Though Brolgas often feed in dry grassland or ploughed paddocks or even desert claypans, they are dependent on wetlands too, especially shallow swamps, where they will forage with their head entirely submerged. They feed using their heavy straight bill as a ‘crowbar’ to probe the ground or turn it over, primarily on sedge roots and tubers. They will also take large insects, crustaceans, molluscs and frogs. The nest comprises a platform of grasses and sticks, augmented with mud, on an island or in the water. Two eggs are laid from winter to autumn.	Vulnerable		Known		Unlikely. Suitable habitat for this species does not occur in the Subject Site.
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. Sedentary, considered to be resident in many locations throughout its range; present in all seasons or year-round at many sites; territorial year-round, though some birds may disperse locally after breeding. Gregarious and usually observed in pairs or small groups of eight to 12 birds; terrestrial and arboreal in about equal proportions; active, noisy and conspicuous while foraging on trunks and branches of trees and amongst fallen timber; spend much more time foraging on the ground and fallen logs than other treecreepers.	Vulnerable		Known		Likely

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		When foraging in trees and on the ground, they peck and probe for insects, mostly ants, amongst the litter, tussocks and fallen timber, and along trunks and lateral branches; up to 80% of the diet is comprised of ants; other invertebrates (including spiders, insects larvae, moths, beetles, flies, hemipteran bugs, cockroaches, termites and lacewings) make up the remaining percentage; nectar from Mugga Ironbark (*Eucalyptus sideroxylon*) and paperbarks, and sap from an unidentified eucalypt are also eaten, along with lizards and food scraps; young birds are fed ants, insect larvae, moths, craneflies, spiders and butterfly and moth larvae. Hollows in standing dead or live trees and tree stumps are essential for nesting. The species breeds in pairs or co-operatively in territories which range in size from 1.1 to 10.7 ha (mean = 4.4 ha). Each group is composed of a breeding pair with retained male offspring and, rarely, retained female offspring. Often in pairs or cooperatively breeding groups of two to five birds.					
Bush Stone-curlew	*Burhinus grallarius*	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber. Largely nocturnal, being especially active on moonlit nights. Feed on insects and small vertebrates, such as frogs, lizards and snakes. Nest on the ground in a scrape or small bare patch. Two eggs are laid in spring and early summer.	Endangered		Known		Unlikely.
Cattle Egret	Ardea ibis	The Cattle Egret is widespread and common according to migration movements and breeding localities surveys. Two major distributions have been located; from north-east Western Australia to the Top End of the Northern Territory and around south-east Australia. The Cattle Egret breeds in coastal areas.		Migratory > Listed		Species or species habitat may occur within area	Potential.
Curlew Sandpiper	Calidris (Erolia) ferruginea	In Australia, Curlew Sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers. Records occur in all states during the non-breeding period, and also during the breeding season when many non-breeding one year old birds remain in Australia rather than migrating north. They are occasionally recorded in the Tablelands and are widespread in the Riverina and south-west NSW, with scattered records elsewhere. Curlew Sandpipers forage on mudflats and nearby shallow water.	Endangered	Migratory > Marine> Listed			Unlikely. Previously recorded in 10km radius however suitable habitat for this species does not occur in the Subject Site.
Diamond Firetail	*Stagonopleura guttata*	Usually encountered in flocks of between five to 40 birds, occasionally more. Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands.	Vulnerable		Known		Likely. Habitat within the Subject Site may be suitable for this species. Requires

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Groups separate into small colonies to breed, between August and January. Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests. Birds roost in dense shrubs or in smaller nests built especially for roosting. Appears to be sedentary, though some populations move locally, especially those in the south. Has been recorded in some towns and near farm houses.					shrubby understorey.
Eastern Pygmy-possum	Cercartetus nanus	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (Pseudocheirus peregrinus) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	Vulnerable		Predicted		Unlikely.
Fork-tailed Swift	Apus pacificus	The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia (Higgins 1999). In NSW, the Fork-tailed Swift is recorded in all regions. Many records occur east of the Great Divide, however, a few populations have been found west of the Great Divide. These are widespread but scattered further west of		Migratory > Listed		Species or species habitat may occur within area	Potential. Suitable habitat for this species does not occur in the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		the line joining Bourke and Dareton. Sightings have been recorded at Milparinka, the Bulloo River and Thurloo Downs (Higgins 1999).					
Flame Robin	*Petroica phoenicea*	Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The groundlayer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes. In winter, birds migrate to drier more open habitats in the lowlands (ie valleys below the ranges, and to the western slopes and plains). Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration. In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees. In winter, occasionally seen in heathland or other shrublands in coastal areas. Birds forage from low perches, from which they sally or pounce onto small invertebrates which they take from the ground or off tree trunks, logs and other coarse woody debris. Flying insects are often taken in the air and sometimes gleans for invertebrates from foliage and bark. In their autumn and winter habitats, birds often sally from fence-posts or thistles and other prominent perches in open habitats. Occur singly, in pairs, or in flocks of up to 40 birds or more; in the non-breeding season they will join up with other insectivorous birds in mixed feeding flocks. Breeds in spring to late summer. Nests are often near the ground and are built in sheltered sites, such as shallow cavities in trees, stumps or banks. Builds an open cup nest made of plant materials and spider webs. Eggs are oval in shape and are pale bluish- or greenish-white and marked with brownish blotches; clutch size is three or four eggs.	Vulnerable		Known		Potential. Habitat within the Subject Site may be suitable for this species. Requires shrubby understorey.
Freckled Duck	*Stictonetta naevosa*	Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and	Vulnerable		Predicted		Unlikely. Suitable habitat for this species does not occur in the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		vegetative parts of aquatic grasses and sedges and small invertebrates. Nesting usually occurs between October and December but can take place at other times when conditions are favourable. Nests are usually located in dense vegetation at or near water level.					
Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	Fuzzy Box Woodland on alluvial Soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions	Community occurs on brown loam or clay, alluvial or colluvial soils on prior streams and abandoned channels or slight depressions on undulating plains or flats of the western slopes. Community often occurs upslope from River Red Gum communities above frequently inundated areas of the floodplain. It also occurs on colluvium soils on lower slopes and valley flats. Less than 5% of the original extent is estimated to remain. Shrubs include Wilga, Deane's Wattle, Hop Bush, Cassia, Water Bush and Sifton Bush.	Endangered Ecological Community		Known		Yes. Known to occur in Subject Site.
Golden Sun Moth	Synemon plana	The Golden Sun Moth's NSW populations are found in the area between Queanbeyan, Gunning, Young and Tumut. The species' historical distribution extended from Bathurst (central NSW) through the NSW Southern Tablelands, through to central and western Victoria, to Bordertown in eastern South Australia. Occurs in Natural Temperate Grasslands and grassy Box-Gum Woodlands in which groundlayer is dominated by wallaby grasses Austrodanthonia spp. Grasslands dominated by wallaby grasses are typically low and open - the bare ground between the tussocks is thought to be an important microhabitat feature for the Golden Sun Moth, as it is typically these areas on which the females are observed displaying to attract males.	Endangered	Critically Endangered			No. One previous record in proximity to the Subject Site is likely to be incorrect. No suitable habitat for this species occurs in the Subject Site.
Gilbert's Whistler	*Pachycephala inornata*	The Gilbert's Whistler occurs in a range of habitats within NSW, though the shared feature appears to be a dense shrub layer. It is widely recorded in mallee shrublands, but also occurs in box-ironbark woodlands, Cypress Pine and Belah woodlands and River Red Gum forests. Though at this stage it is only known to use this habitat along the Murray, Edwards and Wakool Rivers. Within the mallee the species is often found in association with an understorey of spinifex and low shrubs including wattles, hakeas, sennas and hop-bushes. In woodland habitats, the understorey comprises dense patches of shrubs, particularly thickets of regrowth *Callitris* pine. Parasitic 'cherries' (*Exocarpus* species)	Vulnerable		Known		Unlikely.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		appear to be an important habitat component in Belah and Red Gum communities, though in the latter case other dense shrubs, such as Lignum and wattles, are also utilised. The Gilbert's Whistler forages on or near the ground in shrub thickets and in tops of small trees. Its food consists mainly of spiders and insects such as caterpillars, beetles and ants, and occasionally, seeds and fruits are eaten. The movements of this species are poorly known but it is believed that generally it does not make any regular large-scale movements and pairs may hold and defend territories all year round.					
Great Egret, White Egret	Ardea alba	Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species, and roost at night in groups. The Great Egret usually feeds alone. It feeds on molluscs, amphibians, aquatic insects, small reptiles, crustaceans and occasionally other small animals, but fish make up the bulk of its diet. The Great Egret usually hunts in water, wading through the shallows, or standing motionless before stabbing at prey. Birds have also been seen taking prey while in flight.		Migratory > Listed		Species or species habitat likely to occur within area	Potential
Glossy Black-cockatoo	*Calyptorhynchus lathami*	Inhabits open forest and woodlands of the coast and the Great Dividing Range up to 1000 metres in which stands of she-oak species, particularly Black She-oak (*Allocasuarina littoralis*), Forest She-oak (*A. torulosa*) or Drooping She-oak (*A. verticillata*) occur. In the Riverina area, again usually associated with woodlands containing Drooping She-oak but also recorded in open woodlands dominated by Belah (Casuarina cristata). Feeds almost exclusively on the seeds of several species of she-oak (Casuarina and Allocasuarina species), shredding the cones with the massive bill. Dependent on large hollow-bearing eucalypts for nest sites. One or two eggs are laid between March and August.	Vulnerable	Endangered (Only South-Australian Sub-species).	Known		Potential. Goonoo SCA is a stronghold for this species.
Greater Long-eared Bat	*Nyctophilus timoriensis/corbeni (South-eastern form)*	The South-eastern Long-eared Bat occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands. The species also occurs in Bulloke woodland, Brigalow woodland, Belah woodland, Smooth-barked Apple, *Angophora leiocarpa,* woodland; River Red Gum, *Eucalyptus camaldulensis,* forests lining watercourses and lakes, Black Box, *Eucalyptus largiflorens,* woodland, dry sclerophyll forest.	Vulnerable	Endangered	Predicted	Species or species habitat may occur within Area	Potential. Some trees with small hollows or decorating bark in the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions/Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia		Inland Grey Box Woodland occurs on fertile soils of the western slopes and plains of NSW. The community generally occurs where average rainfall is 375- 800 mm pa and the mean maximum annual temperature is 22- 26°C. There is a correlation between the distribution of *Eucalyptus microcarpa* communities and soils of Tertiary and Quaternary alluvial origin, largely corresponding with the Red Brown Earths. The majority of remnant patches of Inland Grey Box Woodland survive with trees largely intact but with the shrub or ground layers degraded to varying degrees through grazing or pasture modification. Some species that are part of the community appear intolerant to heavy grazing by domestic stock and are confined to the least disturbed remnants.	Endangered Ecological Community	Endangered	Known	Community may occur within area	Yes. Known to occur in the Subject Site on undulating land and footslopes
Grey Falcon	*Falco hypoleucos*	Usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey. Preys primarily on birds, especially parrots and pigeons, using high-speed chases and stoops; reptiles and mammals are also taken. Like other falcons it utilises old nests of other birds of prey and ravens, usually high in a living eucalypt near water or a watercourse; peak laying season is in late winter and early spring; two or three eggs are laid.	Endangered		Known		Potential to have hunting areas within the Subject Site.
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Flight is laborious so birds prefer to hop to the top of a tree and glide down to the next one. Birds are generally unable to cross large open areas. Live in family groups that consist of a breeding pair and young from previous breeding seasons. A group may consist of up to fifteen birds. All members of the family group remain close to each other when foraging. A soft 'chuck' call is made by all birds as a way of keeping in contact with other group members.	Vulnerable		Known		Yes. Known. Suitable habitat for this species is known to occur in the Subject Site

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Feed on invertebrates, either by foraging on the trunks and branches of eucalypts and other woodland trees or on the ground, digging and probing amongst litter and tussock grasses Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year round, and old nests are often dismantled to build new ones. Breed between July and February. Usually two to three eggs are laid and incubated by the female. During incubation, the adult male and several helpers in the group may feed the female as she sits on the nest. Young birds are fed by all other members of the group. Territories range from one to fifty hectares (usually around ten hectares) and are defended all year. Territorial disputes with neighbouring groups are frequent and may last up to several hours, with much calling, chasing and occasional fighting.					
Homoranthus darwinioides	*Homoranthus darwinioides*	Rare in the central tablelands and western slopes of NSW, occurring from Putty to the Dubbo district. It is found west of Muswellbrook between Merriwa and Bylong, and north of Muswellbrook to Goonoo SF. The species has been collected from Lee's Pinch, but not relocated at its original locality north of Mt Coricudgy above the headwaters of Widden Brook. Goonoo SF is established as a definite locality. Grows in in various woodland habitats with shrubby understoreys, usually in gravely sandy soils. Landforms the species has been recorded growing on include flat sunny ridge tops with scrubby woodland, sloping ridges, gentle south-facing slopes, and a slight depression on a roadside with loamy sand. Associated species include Callitris endlicheri, Eucalyptus crebra, E. fibrosa, E. trachyphloia, E. beyeri subsp. illaquens, E. dwyeri, E. rossii, Leptospermum divaricatum, Melaleuca uncinata, Calytrix tetragona, Allocasuarina spp. and Micromyrtus spp. Flowers in spring or from March to December. The species has been cultivated in Sydney from Rylstone cuttings and at Burrendong Arboretum near Wellington. Forms small shrubs or shrublets, often in tangled masses. It has a localised distribution and may be the dominant undershrub at some sites. Its abundance in populations ranges from rare (only one plant at site) to very locally abundant.	Vulnerable	Vulnerable	Known		Potential to occur in the Subject Site. Known to occur in Goonoo SCA.
Lathams Snipe	Gallinago hardwickii	Latham's Snipe is a non-breeding visitor to south-eastern Australia. The distribution of Latham's Snipe is naturally		Listed		Species or species	Unlikely. Suitable habitat for this

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		fragmented (although, because of the mobility of the species, this is unlikely to have any effect on survival). The distribution is fragmented because the preferred habitat (ie freshwater wetlands) occurs in patches throughout the non-breeding grounds (Weston 2006, pers. comm.).				habitat may occur within area	species does not occur in the Subject Site.
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey. Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season. May breed any time between July and November, often rearing several broods. The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than 1 metre to 5 metres above the ground. The nest is defended by both sexes with displays of injury-feigning, tumbling across the ground. A clutch of two to three is laid and incubated for fourteen days by the female. Two females often cooperate in brooding.	Vulnerable		Known		Unlikely
Keith's Zieria		Grows in dry sclerophyll forest on light sandy soils. All known populations have been recorded in Eucalyptus-Callitris woodland or open forest with a shrubby to heathy understorey. Mostly from gentle slopes in red-brown and yellow-brown sandy loams, often with a rocky surface. Associated and understorey species include Eucalyptus crebra, Eucalyptus fibrosa, Eucalyptus dwyeri, Eucalyptus beyeriana, Eucalyptus microcarpa, Callitris endlicheri, Allocasuarina diminuta, Allocasuarina distyla, Allocasuarina verticillata, Leptospermum divaricatum, Leptospermum parvifolium, Acacia triptera, Acacia gladiiformis, Acacia brownii, Grevillea floribunda, Grevillea triternata, Hakea decurrens, Boronia glabra, Philotheca salsolifolia, Leucopogon attenuatus, Melaleuca uncinata, Melaleuca erubescens, Kunzea parvifolia, Calytrix tetragona, Brachyloma daphnoides, Melichrus urceolatus, Cassinia aculeata, Dodonaea viscosa subsp. spatulata, Dodonaea peduncularis, Dodonaea heteromorpha, Dillwynia sericea, Hibbertia riparia, Dampiera	Endangered	Endangered	Known		Unlikely.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		lanceolata, Dianella longifolia, Prostanthera species and Goodenia species. Flowering time is in spring and plants bear fruit in summer. Plants can produce flowers and fruits any time between July and March. Grows only in small localised populations within the north-east and central areas of Goonoo State Forest. Population sizes vary from 6 to 80 individuals. The age structure within populations may be even and single-aged or uneven and multi-aged.					
Koala	*Phascolarctos cinereus*	Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Inactive for most of the day, feeding and moving mostly at night. Spend most of their time in trees, but will descend and traverse open ground to move between trees. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Generally solitary, but have complex social hierarchies based on a dominant male with a territory overlapping several females and sub-ordinate males on the periphery. Females breed at two years of age and produce one young per year.	Vulnerable		Known	Species or species Known to occur within Area	Potential
Leafless Indigo	Indigofera efoliata	Indigofera efoliata occurs in the central western slopes of NSW, from Dubbo to Geurie (Ayres et al., 1996). In August 1955, the species was recorded along the Dubbo to Minore railway line and road, on Wallaringa and Geurie properties and in Goonoo State Forest (DECC, 2005). Forty eight sites were searched in November 1997, but no plants were found. There are only two early records that contain precise locality details, both of which have been either heavily grazed or cleared of native vegetation, with one site now supporting a dense cover of weeds (Mackay & Gross, 1998). The species is very rare and considered to be possibly extinct (DECC, 2005). The species occurs within the Central West (NSW) Natural Resource Management Regions (DECC, 2005). Indigofera efoliata prefers stony ground in red-brown sandy loam on a slight rise, among ironstone formation (Harden, 1991; Ayres et al., 1996; Mackay & Gross, 1998). It appears to inhabit Yellow-box (Eucalyptus melliodora) woodland (Mackay & Gross, 1998), E. crebra–Callitris glaucophylla dry sclerophyll forest and E. microcarpa–Callitris glaucophylla tall woodland (DECC, 2005). The	Endangered	Endangered	Known		Unlikely.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		average annual rainfall where the species has been recorded is between 475 and 600 mm (Mackay & Gross, 1998).					
Large-eared Pied Bat	*Chalinolobus dwyeri*	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. There are scattered records from the New England Tablelands and North West Slopes.	Vulnerable	Vulnerable	Predicted	Species or species habitat may occur within Area	Unlikely
Little Eagle	*Hieraaetus morphnoides*	Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Lays two or three eggs during spring, and young fledge in early summer. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.	Vulnerable		Known		Potential have hunting grounds in the Subject Site
Little Lorikeet	Glossopsitta pusilla	Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards Gregarious, travelling and feeding in small flocks (<10), though often with other lorikeets. Flocks numbering hundreds are still occasionally observed and may have been the norm in past centuries. Roosts in treetops, often distant from feeding areas. Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like Allocasuarina. Nesting season extends from May to September. In years when flowering is prolific, Little Lorikeet pairs can breed twice, producing 3-4 young per attempt. However, the survival rate of fledglings is unknown. Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophoras, Melaleucas and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species.	Vulnerable		Known		Potential

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Little Pied Bat	*Chalinolobus picatus*	Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress-pine forest, mallee, Bimbil box. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings. Can tolerate high temperatures and dryness but need access to nearby open water. Feeds on moths and possibly other flying invertebrates.	Vulnerable		Known		Potential.
Magpie Goose	*Anseranas semipalmata*	Mainly found in shallow wetlands (less than 1 metre deep) with dense growth of rushes or sedges. Equally at home in aquatic or terrestrial habitats; often seen walking and grazing on land; feeds on grasses, bulbs and rhizomes. Activities are centred on wetlands, mainly those on floodplains of rivers and large shallow wetlands formed by run-off; breeding can occur in both summer and winter dominated rainfall areas and is strongly influenced by water level; most breeding now occurs in monsoonal areas; nests are formed in trees over deep water; breeding is unlikely in south-eastern NSW. Often seen in trios or flocks on shallow wetlands, dry ephemeral swamps, wet grasslands and floodplains; roosts in tall vegetation.	Vulnerable		Known		Unlikely. Suitable habitat for this species does not occur in the Subject Site.
Major Mitchell's Cockatoo	*Lophochroa leadbeateri*	Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water. Feeds mostly on the ground, especially on the seeds of native and exotic melons and on the seeds of species of saltbush, wattles and cypress pines. Normally found in pairs or small groups, though flocks of hundreds may be found where food is abundant. Nesting, in tree hollows, occurs throughout the second half of the year; nests are at least 1 kilometre apart, with no more than one pair every 30 square kilometres.	Vulnerable		Known		Potential to occur in the Subject Site.
Malleefowl	*Leipoa ocellata*	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 mm mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as Inland Grey Box, Ironbark or Bimble Box Woodlands with thick understorey, or in other woodlands such dominated by Mulga or native Cypress Pine species.	Endangered	Endangered	Predicted	Species or species habitat known to occur within area	No. Suitable habitat for this species does not occur in the Subject Site. No mallee habitat in the Subject Site or adjacent mallee habitat.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Prefers areas of light sandy to sandy loam soils and habitats with a dense but discontinuous canopy and dense and diverse shrub and herb layers. Although Malleefowl will occupy areas within five years of fire, they prefer older age classes, with little breeding in areas less than 20 years after fire, and in one study the highest densities recorded in long unburnt mallee (60 to 80 years post fire). A pair may occupy a range of between 50 and 500 ha, overlapping with those of their neighbours. Mainly forage in open areas on seeds of acacias and other native shrubs (*Cassia, Beyeria, Bossiaea*), buds, flowers and fruits of herbs and various shrubs, insects (cockroaches, ants, soil invertebrates), and cereals if available. Incubate eggs in large mounds that contain considerable volumes of sandy soil. The litter within the mounds must be dampened for it to decompose and provide heat for incubation of eggs. Up to 34 eggs may be laid in a single season, though usually between 15 and 24 (and clutches smaller in dry years). The male monitors the temperature within the egg chamber using its bill, and regularly works the mound during the breeding season to maintain a constant temperature around 34 degrees. The chicks hatch after between 49 and 96 days (average around 60) and can walk as soon as they emerge from the mound, can run quickly within two hours and can fly within 24 hours.					
Masked Owl	*Tyto novaehollandiae*	Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting. Lives in dry eucalypt forests and woodlands from sea level to 1100 m. A forest owl, but often hunts along the edges of forests, including roadsides. The typical diet consists of tree-dwelling and ground mammals, especially rats. Pairs have a large home-range of 500 to 1000 hectares.	Vulnerable		Known		Potential. Suitable breeding habitat (large hollow bearing trees and tall forest trees) for this species does not occur in the Subject Site. Potential to hunt in the Subject Site.
Murray Cod	Maccullochella peelii peelii	The Murray Cod is the largest freshwater fish found in Australia. It is a long lived predator species that is highly territorial and aggressive. It occurs naturally in the waterways of the Murray–Darling Basin in a wide range of warm water habitats that range from clear, rocky streams to slow flowing turbid rivers and billabongs. The upper reaches of the Murray and Murrumbidgee Rivers are considered too cold to contain suitable habitat.	FM Act	Vulnerable		Species or species habitat may occur within Area	No. The works will not occur in proximity likely habitat

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Mauve Burr-daisy	Calotis glandulosa	Found in montane and subalpine grasslands in the Australian Alps. Found in subalpine grassland (dominated by Poa spp.), and montane or natural temperate grassland dominated by Kangaroo Grass (Themeda australis) and Snow Gum (Eucalyptus pauciflora) Woodlands on the Monaro and Shoalhaven area.	Vulnerable	Vulnerable	Known		No
Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions		This EEC is known from parts of the Local Government Areas of Berrigan, Bland, Bogan, Carrathool, Conargo, Coolamon, Coonamble, Corowa, Forbes, Gilgandra, Griffith, Gwydir, Inverell, Jerilderee, Lachlan, Leeton, Lockhart, Moree Plains, Murray, Murrumbidgee, Narrabri, Narranderra, Narromine, Parkes, Urana, Wagga Wagga and Warren, and but may occur elsewhere in these bioregions.	Endangered Ecological Community	Endangered	Known	Community may occur within area	No
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland		Native tussock grasslands, such as the Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland, once occurred over a large area of Australia (DEWR 2007). The species composition of tussock grasslands varies throughout its range and is influenced by factors such as rainfall, soil, geology and land use history. These influences may vary the expression of the ecological community over short periods or across small distances (Butler 2007 unpublished).	Natural Temperate Grassland of the Southern Tablelands (NSW Act)	Critically Endangered		Community may occur within area	No
Painted Honeyeater	*Grantiella picta*	Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema. Insects and nectar from mistletoe or eucalypts are occasionally eaten. Nest from spring to autumn in a small, delicate nest hanging within the outer canopy of drooping eucalypts, she-oak, paperbark or mistletoe branches.	Vulnerable		Known		Potential.
Painted Snipe	Rostratula australis	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Vulnerable	Vulnerable	Known	Species or species habitat may	No

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds. The nest consists of a scrape in the ground, lined with grasses and leaves. Breeding is often in response to local conditions; generally occurs from September to December. Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter.				occur within Area	
Pale-headed Snake	*Hoplocephalus bitorquatus*	Found mainly in dry eucalypt forests and woodlands, cypress woodland and occasionally in rainforest or moist eucalypt forest. Favours streamside areas, particularly in drier habitats. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees. The main prey is tree frogs although lizards and small mammals are also taken.	Vulnerable		Predicted		Unlikely. Suitable habitat for this species does not occur in the Subject Site.
Pink-tailed Legless Lizard	Aprasia parapulchella	The Pink-tailed Worm Lizard is only known from the Central and Southern Tablelands, and the South Western Slopes. There is a concentration of populations in the Canberra/Queanbeyan Region. Other populations have been recorded near Cooma, Yass, Bathurst, Albury and West Wyalong. This species is also found in the Australian Capital Territory. Inhabits sloping, open woodland areas with predominantly native grassy groundlayers, particularly those dominated by Kangaroo Grass (Themeda australis). Sites are typically well-drained, with rocky outcrops or scattered, partially-buried rocks. Commonly found beneath small, partially-embedded rocks and appear to spend considerable time in burrows below these rocks; the burrows have been constructed by and are often still inhabited by small black ants and termites. Feeds on the larvae and eggs of the ants with which it shares its burrows. It is thought that this species lays two eggs inside the ant nests during summer; the young first appear in March.	Vulnerable	Vulnerable	Not identified in Central West Sub CMAs Pilliga or Talbragar Valley		No. However previously recorded near Dubbo. Suitable habitat for this species in the Central West CMA is known to occur on trachyte soils where small flat basalt rocks litter the surface.
Painted Snipe	Rostratula benghalensis (sensu lato)	Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	Endangered	Endangered		Species or species habitat may occur within area	No

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Philotheca ericifolia	*Philotheca ericifolia*	Known only from the upper Hunter Valley and Pilliga to Peak Hill districts of NSW. The records are scattered over a range of over 400 kilometres between West Wyalong and the Pilliga Scrub. Site localities include Pilliga East State Forest, Goonoo State Forest, Hervey Range, Wingen Maid Nature Reserve, Toongi, Denman, Rylstone district and Kandos Weir. Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies. It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include Melaleuca uncinata, Eucalyptus crebra, E. rossii, E. punctata, Corymbia trachyphloia, Acacia triptera, A. burrowii, Beyeria viscosa, Philotheca australis, Leucopogon muticus and Calytrix tetragona. Flowering time is in the spring. Fruits are produced from November to December. Noted as being a "moisture-loving plant", with plants common on the sides of a particular spur of the Hervey Ranges where soakage from the high background provides sufficient moisture for the plants. Also recorded growing in a recently burnt site (wildfire) and within a regeneration zone resulting from clearing. Populations comprise from 3-12 adult plants to approx. 200 plants (mostly seedlings in one population). Also described as uncommon, scattered, common, locally occasional and locally frequent. Populations in Pilliga State Forest consist of hundreds or thousands of individuals. A very large population occurs in Lincoln State Forest near Gilgandra.		Vulnerable (Commonwealth listed only)			No. Not identified in searches however known to have once occurred near Dubbo.
Pine Donkey Orchid	*Diuris tricolor*	The Pine Donkey Orchid grows in sclerophyll forest among grass, often with native Cypress Pine (*Callitris spp.*). It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW. Usually recorded as common and locally frequent in populations, however only one or two plants have also been observed at sites. The species has been noted as growing in large colonies. Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. Associated species include *Callitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta*, Ironbark and *Acacia* shrubland.	Vulnerable		Known		Likely. Recorded in similar grassland in proximity to the Subject Site

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		The understorey is often grassy with herbaceous plants such as *Bulbine* species. Flowers from September to November or generally spring. The species is a tuberous, deciduous terrestrial orchid and the flowers have a pleasant, light sweet scent.					
Powerful Owl	Ninox connivens	Territorial pairs respond strongly to recordings of Barking Owl calls from up to 6 km away, though humans rarely hear this response farther than 1.5 km. Because disturbance reduces the pair's foraging time, and can pull the female off her eggs even on cold nights, recordings should not be broadcast unnecessarily nor during the nesting season. Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. Is flexible in its habitat use and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils. Roost in shaded portions of tree canopies, including tall midstorey trees with dense foliage such as Acacia and Casuarina species. During nesting season, the male perches in a nearby tree overlooking the hollow entrance. Preferentially hunts small arboreal mammals such as Squirrel Gliders and Ringtail Possums, but when loss of tree hollows decreases these prey populations it becomes more reliant on birds, invertebrates and terrestrial mammals such as rodents and rabbits. Can catch bats and moths on the wing, but typically hunts by sallying from a tall perch. Requires very large permanent territories in most habitats due to sparse prey densities. Monogamous pairs hunt over as much as 6000 hectares, with 2000 hectares being more typical in NSW habitats. Two or three eggs are laid in hollows of large, old trees. Living eucalypts are preferred though dead trees are also used. Nest sites are used repeatedly over years by a pair, but they may switch sites if disturbed by predators (e.g. goannas). Nesting occurs during mid-winter and spring. Female incubates for 5 weeks, roosts outside the hollow when chicks are 4 weeks old, then fledging starts two weeks later. Young are dependent for several months	Vulnerable		Predicted		Unlikely. Suitable habitat for this species does not occur in the Subject Site.
Regent Honeyeater	*Anthochaera phrygia*	The Regent Honeyeater is a flagship threatened woodland bird whose conservation will benefit a large suite of other threatened and declining woodland fauna. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and	Critically Endangered	Endangered	Known	Species or species habitat may	Likely. Over-wintering feeding resources. Breeding habitat

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		riparian forests of River Sheoak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast. In the last 10 years Regent Honeyeaters have been recorded in urban areas around Albury where woodlands tree species such as Mugga Ironbark and Yellow Box were planted 20 years ago. The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises: *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata,* E.mckieana, E. macrorhyncha, E. laevopinea, and Angophora floribunda. Nectar and fruit from the mistletoes A. miquelii, A. pendula, A. cambagei are also eaten during the breeding season. When nectar is scarce lerp and honeydew comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings. A shrubby understorey is an important source of insects and nesting material.				occur within Area	does not occur in the Subject Site
Ruff	Philomachus pugnax	The Ruff is a rare but regular visitor to Australia, being recorded in all States and Territories. In Australia the Ruff is found on generally fresh, brackish of saline wetlands with exposed mudflats at the edges. It is found in terrestrial wetlands including lakes, swamps, pools, lagoons, tidal rivers, swampy fields and flood lands. They are occasionally seen on sheltered coasts, in harbours, estuaries, seashores and are known to visit sewage farms and salt works. They are sometimes found on wetlands surrounded by dense vegetation including grass, sedges, saltmarsh and reeds. They have been observed on sand spits and other sandy habitats including shingles. The Ruff forages on exposed mudflats, in shallow water and occasionally on dry mud. They have been observed foraging in dry waterside plants and in swampy areas next to aeration tanks in sewage farms. They prefer to roost amongst shorter vegetation (Higgins & Davies 1996).		Marine Migratory			No. Previously recorded in the Dubbo LGA. No suitable habitat for this species exists in the Subject Site
Rainbow Bee-eater	Merops ornatus	The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins 1999).		Migratory JAMBA		Species or species habitat may	Potential. Suitable breeding habitat (deep sandy banks near

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water (Badman 1979; Boekel 1976; Fry 1984; Roberts 1979; Storr 1984a, 1984b, 1985a). It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia, and has been recorded in various other habitat types including heathland, sedgeland, vine forest and vine thicket, and on beaches (Higgins 1999). The Rainbow Bee-eater occurs in open woodlands and shrublands, including mallee, and in open forests that are usually dominated by eucalypts. It also occurs in grasslands (Gibson 1986; Jones 1986; Leach 1988; Longmore 1978; McEvey & Middleton 1968; Saunders & Ingram 1995; Woinarski et al. 1988, 1989) and, especially in arid or semi-arid areas, in riparian, floodplain or wetland vegetation assemblages (Badman 1989; Gee et al. 1996; Gibson 1986; Gibson & Cole 1988; Henle 1989; Longmore 1978; Storr 1977; Woinarski et al. 1988).				occur within area	waterways) for this species does not occur in the Subject Site. Potential to hunt in the Subject Site, however more likely to occur near rivers and flowing creeks.
Red-tailed Tropicbird	Phaethon rubricauda	Marine Breeds in coastal cliffs and under bushes in tropical Australia. Nests on cliffs of the northern hills and southern mountains on the main island at Lord Howe Island.	Vulnerable				No
Scarlet Robin	*Petroica boodang*	The Scarlet Robin lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. The Scarlet Robin breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 meters in altitude. The Scarlet Robin is primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. In autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees. Birds forage from low perches, fence-posts or on the ground, from where they pounce on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer.	Vulnerable		Predicted		Potential.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season. This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 meters above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub. In autumn and winter, the Scarlet Robin joins mixed flocks of other small insectivorous birds which forage through dry forests and woodlands.					
Satin Flycatcher	*Myiagra cyanoleuca*	Satin Flycatchers inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, and on migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests (Blakers et al. 1984; Emison et al. 1987; Officer 1969). Satin Flycatchers mainly inhabit eucalypt forests, often near wetlands or watercourses. They generally occur in moister, taller forests than the Leaden Flycatcher, Myiagra rebecula, often occurring in gullies		Listed		Species or species habitat may occur in the Subject Site	Potential
Rufous Fantail	*Rhipidura rufifrons*	The Rufous Fantail occurs in coastal and near coastal districts of northern and eastern Australia (Lindsey 1992). Rhipidura rufifrons rufifrons has breeding populations occurring from about the South Australia-Victoria border, through south and central Victoria, on and east of the Great Divide in New South Wales (NSW), and north to about the NSW-Queensland border; and R. r. intermedia has breeding populations occurring on and east of the Great Divide, from about the NSW-Queensland border, north to the Cairns-Atherton region, Queensland (Higgins et al. 2006). Both subspecies winter farther north from Cape York Peninsula in Queensland to Torres Strait and southern Papua New Guinea. The two subspecies intergrade in a zone between the Queensland-NSW border ranges and the Clarence-Orara rivers in NSW (Scodde & Mason 1999).		Listed		Species or species habitat known to occur within area	Potential
Sharp-tailed Sandpiper	*Calidris acuminata*	The Sharp-tailed Sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage (Cramp 1985; Higgins & Davies 1996).		Marine Migratory			Unlikely.
Silky Swainson-pea	*Swainsona sericea*	Silky Swainson-pea has been recorded from the Northern Tablelands to the Southern Tablelands and further inland on the slopes and plains. There is one isolated record from the far north-west of NSW. Its stronghold is on the Monaro. Also found in South Australia, Victoria and Queensland.	Vulnerable		Known		Unlikely.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Found in Natural Temperate Grassland and Snow Gum Eucalyptus pauciflora Woodland on the Monaro. Found in Box-Gum Woodland in the Southern Tablelands and South West Slopes. Sometimes found in association with cypress-pines Callitris spp. Habitat on plains unknown. Regenerates from seed after fire.					
Silver Perch	Bidyanus bidyanus	Silver Perch were once widespread and abundant throughout most of the Murray-Darling river system. They have now declined to low numbers or disappeared from most of their former range. Only one remaining secure and self-sustaining population occurs in NSW in the central Murray River downstream of Yarrawonga weir, as well as several anabranches and tributaries	Vulnerable (FM Act)				No. Habitat suitable for this species will not be impacted.
Sloane's Froglet	*Crinia sloanei*	It is typically associated with periodically inundated areas in grassland, woodland and disturbed habitats.	Vulnerable		Predicted		Unlikely
Speckled Warbler	*Pyrrholaemus saggitatus*	The Speckled Warbler lives in a wide range of *Eucalyptus* dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside. A clutch of 3-4 eggs is laid, between August and January, and both parents feed the nestlings. The eggs are a glossy red-brown, giving rise to the unusual folk names 'Blood Tit' and 'Chocolate bird'. Some cooperative breeding occurs. The species may act as host to the Black-eared Cuckoo. Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-rumped, Brown and Striated Thornbill.	Vulnerable		Known		Yes. Known to occur in similar habitat in the Central West.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Spotted Harrier	*Circus assimilis*	Occurs in grassy open woodland including acacia and mallee remnants, inland riparian woodland, and grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn), with young remaining in the nest for several months. Preys on terrestrial mammals (egg bandicoots, bettongs, and rodents), birds and reptile, occasionally insects and rarely carrion.	Vulnerable		Known		Potential to have hunting ground in the Subject Site.
Spotted-tailed Quoll	*Dasyurus maculatus*	Use 'latrine sites', often on flat rocks among boulder fields and rocky cliff-faces; these may be visited by a number of individuals; latrine sites can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Mostly nocturnal, although will hunt during the day; spends most of the time on the ground, although also an excellent climber and may raid possum and glider dens and prey on roosting birds. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects; also eats carrion and takes domestic fowl. Females occupy home ranges up to about 750 hectares and males up to 3500 hectares; usually traverse their ranges along densely vegetated creek lines. Average litter size is five; both sexes mature at about one year of age.	Vulnerable	Endangered	Known		Potential. Habitat may occur in the Subject Site however the lack of timber and ground debris probably excludes this species.
Scant Pomaderris	*Pomaderris queenslandica*	Widely scattered but not common in north-east NSW and in Queensland. It is only known from a few locations on the New England Tablelands and North West Slopes, including near Torrington and Coolatai, and also from several locations on the NSW north coast. Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Endangered		Known		Potential to occur in the Subject Site. Known to occur in Goonoo SCA.
Square-tailed Kite	*Lophoictinia isura*	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses.	Vulnerable		Known		Potential to have hunting territory within the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		In arid north-western NSW, has been observed in stony country with a ground cover of chenopods and grasses, open acacia scrub and patches of low open eucalypt woodland. Is a specialist hunter of passerines, especially honeyeaters, and most particularly nestlings, and insects in the tree canopy, picking most prey items from the outer foliage? Appears to occupy large hunting ranges of more than 100kilometer2. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.					
Squirrel Glider	*Petaurus norfolcensis*	Inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. Prefers mixed species stands with a shrub or Acacia midstorey. Live in family groups of a single adult male one or more adult females and offspring. Require abundant tree hollows for refuge and nest sites. Diet varies seasonally and consists of Acacia gum, eucalypt sap, nectar, honeydew and manna, with invertebrates and pollen providing protein.	Vulnerable		Predicted		Unlikely to occur in the Subject Site.
Stripe-faced Dunnart	*Sminthopsis macroura*	Native dry grasslands and low dry shrublands, often along drainage lines. During periods of hot weather they shelter in cracks in the soil, in grass tussocks or under rocks and logs.	Vulnerable		Predicted		Unlikely. The lack of understorey, woody debris precludes this species from occurring in the Subject Site
Superb Parrot	*Polytelis swainsonii*	Inhabit Box-Gum, Box-Cypress-pine and Boree Woodlands and River Red Gum Forest. In the Riverina the birds nest in the hollows of large trees (dead or alive) mainly in tall riparian River Red Gum Forest or Woodland. On the South West Slopes nest trees can be in open Box-Gum Woodland or isolated paddock trees. Species known to be used are Blakely's Red Gum, Yellow Box, Apple Box and Red Box. Nest in small colonies, often with more than one nest in a single tree. Breed between September and January. May forage up to 10 kilometres from nesting sites, primarily in grassy box woodland.	Vulnerable	Vulnerable	Known	Species or species habitat likely to occur within area	Likely

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Feed in trees and understorey shrubs and on the ground and their diet consists mainly of grass seeds and herbaceous plants. Also eaten are fruits, berries, nectar, buds, flowers, insects and grain.					
Swift Parrot	*Lathamus discolor*	Migrates to the Australian south-east mainland between March and October. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Inland Grey Box *E. microcarpa*, Grey Box *E. moluccana* and Blackbutt *E. pilularis*. Return to some foraging sites on a cyclic basis depending on food availability. Following winter they return to Tasmania where they breed from September to January, nesting in old trees with hollows and feeding in forests dominated by Tasmanian Blue Gum *Eucalyptus globulus*.	Endangered	Endangered	Known	Species or species habitat likely to occur within Area	Potential to occur. Feeding resources may occur in the Subject Site, however Breeding habitat is in Tasmania
Turquoise Parrot	*Neophema pulchella*	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from August to December. It lays four or five white, rounded eggs on a nest of decayed wood dust.	Vulnerable		Known		Potential to occur on the edge of the forested portions of the Subject Site adjoining grassy areas. Breeding habitat does not occur in the Subject Site.
Trout Cod	Maccullochella macquariensis	The Trout Cod is endemic to the southern Murray-Darling river system, including the Murrumbidgee and Murray Rivers, and the Macquarie River in central NSW. The species was once widespread and abundant in these areas but has undergone dramatic declines in its distribution and abundance over the past century. The last known reproducing population of Trout Cod is confined to the Murray River below Yarrawonga downstream to Tocumwal.	Endangered FM Act	Endangered		Species or species habitat may occur within area	No

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
Varied Sittella	Daphoenositta chrysoptera	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years. Generation length is estimated to be 5 years.	Vulnerable		Known		Likely.
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		Characterised by the presence or prior occurrence of White Box, Yellow Box and/or Blakely's Red Gum. The trees may occur as pure stands, mixtures of the three species or in mixtures with other trees, including wattles. Commonly co-occurring eucalypts include Apple Box (*E. bridgesiana*), Red Box (*E. polyanthemos*), Candlebark (*E. rubida*), Snow Gum (*E. pauciflora*), Argyle Apple (*E. cinerea*), Brittle Gum (*E. mannifera*), Red Stringybark (*E. macrorhyncha*), Grey Box (*E. microcarpa*), Cabbage Gum (*E. amplifolia*) and others. The understorey in intact sites is characterised by native grasses and a high diversity of herbs; the most commonly encountered include Kangaroo Grass (*Themeda australis*) Poa Tussock (*Poa sieberiana*), wallaby grasses (*Austrodanthonia spp.*), spear-grasses (*Austrostipa spp.*), Common Everlasting (*Chrysocephalum apiculatum*), Scrambled Eggs (*Goodenia pinnatifida*), Small St John's Wort (*Hypericum gramineum*), Narrow-leafed New Holland Daisy (*Vittadinia muelleri*) and blue-bells (*Wahlenbergia spp.*). Shrubs are generally sparse or absent, though they may be locally common. Remnants generally occur on fertile lower parts of the landscape where resources such as water and nutrients are abundant. Sites with particular characteristics, including varying age classes in the trees, patches of regrowth, old trees with hollows and fallen timber on the ground are very important as wildlife habitat. Sites in the lowest parts of the landscape often support very large trees which have leafy crowns and reliable nectar flows - sites important for insectivorous and nectar feeding birds. Sites that retain only a grassy groundlayer and with few or no trees remaining are important for rehabilitation, and to rebuild connections between sites of better quality. Remnants support many species of threatened fauna and flora.	EEC	Critically Endangered	Known	Community likely to occur within area	Yes. Known to on areas of higher ground in the Dubbo area.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Retention of remnants is important as they contribute to productive farming systems (stock shelter, seed sources, sustainable grazing and water-table and salinity control). The fauna of remnants (insectivorous birds, bats, etc.) can contribute to insect control on grazing properties. Some of the component species (e.g. wattles, she-oaks, native legumes) fix nitrogen that is made available to other species in the community, while fallen timber and leaves recycle their nutrients. Disturbed remnants are considered to form part of the community, including where the vegetation would respond to assisted natural regeneration.					
White-fronted Chat	Epthianura albifrons	Regularly observed in the saltmarsh of Newington Nature Reserve (with occasional sightings from other parts of Sydney Olympic Park and in grassland on the northern bank of the Parramatta River). Current estimates suggest this population consists of 8 individuals. Regularly observed in the saltmarsh and on the sandy shoreline of a small island of Towra Point Nature Reserve. This population is estimated to comprise 19-50 individuals. The Newington and Towra Point populations are thought to be disjunct from each other (and from the nearest populations outside Sydney Metropolitan CMA). Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs. They are insectivorous, feeding mainly on flies and beetles caught from or close to the ground. Have been observed breeding from late July through to early March, with 'open-cup' nests built in low vegetation. Nests in the Sydney region have also been seen in low isolated mangroves. Nests are usually built about 23 cm above the ground (but have been found up to 2.5 metres above the ground). Two to three eggs are laid in each clutch, and the complete nesting cycle from nest-building to independent young is approximately 50 days. Birds can breed at one year of age and are estimated to live for five years.	Endangered population		Known		No. Suitable habitat for this species does not occur in the Subject Site.
White-bellied Sea-Eagle	Haliaeetus leucogaster	The White-bellied Sea-Eagle is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. It also extends inland along some of the larger waterways, especially in eastern Australia. The inland limits of the species are most restricted in south-central and south-western Australia, where it is confined to a narrow band along the coast (Barrett et al. 2003; Bilney & Emison 1983; Blakers et al. 1984; Marchant & Higgins 1993). Recent analysis indicates that the distribution of the sea-		Listed		Species or species habitat likely to occur within area	Unlikely. Suitable habitat for this species does not occur in the Subject Site.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		eagle may shift in response to climatic conditions, with an apparent decreased occupancy of inland sites (and increased occupancy of coastal sites) during drought conditions (Shephard et al. 2005a). Breeding has been recorded from only a relatively small area of the total distribution. Breeding records are patchily distributed, mainly along the coastline, and especially the eastern coast, extending from Queensland to Victoria, and to Tasmania. Breeding has also been recorded at some sites further inland, e.g. around the Murray, Murrumbidgee and Lachlan Rivers in northern Victoria and south-west NSW, and at other large drainage systems and water storages (Marchant & Higgins 1993). Although known breeding sites are widely dispersed, the species could potentially breed throughout much of its range (Birds Australia 2006c, pers. comm.).					
White-throated Needletail	Hirundapus caudacutus	The White-throated Needletail is widespread in eastern and south-eastern Australia (Barrett et al. 2003; Blakers et al. 1984; Higgins 1999). In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains. Further south on the mainland, it is widespread in Victoria, though more so on and south of the Great Divide, and there are few records in western Victoria outside the Grampians and the South West. The species occurs in adjacent areas of south-eastern South Australia, where it extends west to the Yorke Peninsula and the Mount Lofty Ranges. It is widespread in Tasmania (Barrett et al. 2003; Blakers et al. 1984; Higgins 1999). White-throated Needletails only occur as vagrants in the Northern Territory (recorded in the Top End, including around Darwin, Katherine and Mataranka and Tennant Creek; and further south around Alice Springs) and in Western Australia (at disparate sites from the Mitchell Plateau in the Kimberley, south to the Nullarbor Plain and Augusta in the South West, and west to Barrow Island, the Houman Abrolhos and the Swan River Plain) (Barrett et al. 2003; Blakers et al. 1984; Brooker et al. 1979; Sedgwick 1978; Slater 1964; Storr 1987; Storr et al. 1986; Wheeler 1959). The species is also a vagrant to various outlying islands, including Norfolk, Lord Howe, Macquarie, Christmas and Cocos-Keeling Islands (Barrand 2005; Green 1989; McAllan et al. 2004; Schodde et al. 1983; Stokes et al. 1984; Warham 1961a).		Listed			Potential.
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows. When foraging for insects, flies high and fast over the forest canopy, but lower in more open country.	Vulnerable		Known		Potential.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Forages in most habitats across its very wide range, with and without trees; appears to defend an aerial territory. Breeding has been recorded from December to mid-March, when a single young is born. Seasonal movements are unknown; there is speculation about a migration to southern Australia in late summer and autumn.					
	Commersonia procumbens	Grows in sandy sites, often along roadsides. Recorded in *Eucalyptus dealbata* and *Eucalyptus sideroxylon* communities, *Melaleuca uncinata* scrub, under mallee eucalypts with a *Calytrix tetragona* understorey, and in a recently burnt Ironbark and *Callitris* area. Also in *Eucalyptus fibrosa* subsp. *nubila, Eucalyptus dealbata, Eucalyptus albens* and *Callitris glaucophylla* woodlands north of Dubbo. Other associated species include Acacia triptera, Callitris endlicheri, Eucalyptus melliodora, Allocasuarina diminuta, Philotheca salsolifolia, Xanthorrhoea species, Exocarpus cupressiformis, Leptospermum parvifolium and Kunzea parvifolia. Fruiting period is summer to autumn. Flowers from August to December. Appears to produce seed which persists for some time in the seed bank. Large numbers of seedlings have been observed germinating after fire at sites where the species was not apparent above ground before the fires. Clusters of individuals may be clonal. The species is often found as a pioneer species of disturbed habitats. It has been recorded colonising disturbed areas such as roadsides, the edges of quarries and gravel stockpiles and a recently cleared easement under power lines. Has been recorded in populations of 50+ individuals of various ages, 28 plants on the western side of the road and 58 plants on the sunnier eastern side. Populations may comprise a single cohort of individuals, or have a multi-aged structure where some individuals appear to be old with thickened runners.	Vulnerable	Vulnerable	Known	Species or species habitat likely to occur within area	Unlikely. Suitable soil for this species does not occur in the Subject Site. Known to occur along the Golden Highway on red sandy ridges.
	Tylophora linearis	Grows in dry scrub and open forest. Recorded from low-altitude sedimentary flats in dry woodlands of Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla and Allocasuarina luehmannii. Also grows in association with Acacia hakeoides, Acacia lineata, Melaleuca uncinata, Myoporum species and Casuarina species. Flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later.	Vulnerable	Endangered	Known	Species or species habitat may occur within area	Potential. Disturbance most likely precludes this species from occurring in the Subject Site. Known to occur in Goonoo SCA.

Common Name	Scientific Name	Habitat and Ecology (OEH Species Profile and /or EPBC SPRAT Profile)	TSC Act Status	EPBC Act Status	OEH Threatened Species Search	DSEWPaC Protected Matters Search	Potential to occur
		Very low number of confirmed populations and has been recorded in very low abundances.					

APPENDIX 4: SURVEY RESULTS

Key to Table

BB Score: Braun Banquet Score
L: Lower stratum
U: Upper Stratum
M: Middle stratum

Braun Banquet Score	Cover
0	Absent from quadrant
0.1	Represented by a solitary item (<5% cover)
0.5	Represented by a few (<5) items (<5% cover)
1	Represented by >5 items (<5% cover)
2	Represented by many (>5) items (5-25% cover)
3	Represented by many (>5) items (25 - 50% cover)
4	Represented by many (>5) items (50-75% cover)
5	Represented by many (>5) items (75-100% cover)

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
Cat Head	*Emex australis*	Lower			0.5	0.5	0.1	
Scarlet/ Blue Pimpernal	*Anagallis arvensis* *	Lower		*	0.5			
Broomrape	*Orobanche minor* *	Lower		*		1	0.5	
Cape Weed	*Arctotheca calendula* *	Lower		*				
Khaki Weed	*Alteranthera pungens*	Lower		*	0.1	0.1		
Nodding Thistle	*Carduus nutans subsp. nutans*	Lower		*#				
Saffron Thistle	*Carthamus lanatus* *	Lower		*		0.5	0.5	
Maltese Cockspur	*Centaurea melitensis**	Lower		*	0.1	2		
Spear Thistle	*Cirsium vulgare* *	Lower		*	0.1	0.5		
Flax-leaf Fleabane	*Conyza bonariensis*	Lower		*	1	1		
Lucerne	*Medicago sativa* *	Lower			2	3	3	
	Hedypnois rhagadioloides ssp. cretica *	Lower		*				
Flatweed	*Hypochaeris glabra* *	Lower		*	1	1	1	
Flatweed hairy	*Hypochaeris radicata**	Lower		*				
Hawkweed	*Leotodon taraxacoides**	Lower		*				
Varigated Thistle	*Silybum marianum* *	Lower		*				
	Sisymbrium erysimoides	Lower		*				
Scourweed	*Sisyrinchium sp. A sensu*	Lower		*				
Prickley Cow Thistle	*Sonchus asper*	Lower		*				
Common Sow Thistle	*Sonchus oleraceus*	Lower		*				
Stagger Weed	*Stachys arvensis*	Lower		*				
Skeleton Weed	*Chondrilla juncea*	Lower		*	1	1	1	
	Amsinckia intermedia	Lower		*				
Paterson's Curse	*Echium plantagineum* *	Lower		*	1	1	1	
Vipers Bugloss	*Echium vulgare**	Lower		*				
Potato Weed	*Heliotropium europaeum**	Lower		*		0.5		
Turnip	*Brassica rapa subsp. sylvestris**	Lower		*			1	
Brassica	*Brassica tournefortii* *	Lower		*	1	1		
Shepherd's Purse	*Capsella bursa-pastoris**	Lower		*	2	2	1	
Argentine Peppercress	*Lepidium africanum**	Lower		*				
Peppercress	*Lepidium bonariense**	Lower		*		0.5	1	
	Silene gallica var. gallica *	Lower		*				
	Stellaria media *	Lower		*				
Proliferous Pink	*Petrorhagia nanteuilii*	Lower		*	0.5	0.5	1	
Paddy Melon	*Cucumis myriocarpus subsp. leptodermis*	Lower		*				
Haresfoot clover	*Trifolium arvense* *	Lower		*	3	3	3	

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	Weed	Plot 1	Plot 2	Plot 3	Plot 4
	Trifolium campestre *	Lower		*				
	Trifolium dubium *	Lower		*				
White Clover	*Trifolium repens* *	Lower		*	0.5	0.5	2	
	Trifolium subterraneum *	Lower		*				
	*Medicago arabica**	Lower		*		0.5		
	Medicago minima *	Lower		*				
	*Geranium spp.**	Lower		*	0.5	0.5		
	Juncus bufonius *	Lower		*				
	Lamium amplexicaule *	Lower		*				
White Horehound	*Marrubium vulgare**	Lower		*	0.1	0.1	0.5	
Pennyroyal	*Mentha pulegium**	Lower		*				
Vervain	*Salvia verbenaca**	Lower		*				
Spiked Malvastrum	*Malvastrum americanum*	Lower		*				
Oxalis	*Oxalis corniculata**	Lower		*	1	1		
Blackberry Nightshade	*Solanum nigram*	Lower		*	0.5			
Small Nettle	*Urtica urens**	Lower		*	0.5			
Purpletop	*Verbena bonariensis**	Lower		*	0.5			
Nagoora Burr	*Xanthium pungens**	Lower		*#				
Tall Fleabane	*Conzya alibida*	Lower			1	1	1	
Mexican Poppy	*Argemone ochroleuca**	Lower		*				
African Lovegrass	*Eragrostis curvula*	Lower		*	0.5		0.5	
Great Brome	*Bromus diandrus*	Lower (Grass)		*	0.5	0.5		
Praire Grass	*Bromus cartharticus**	Lower (Grass)		*	2	1	1	
Soft Brome	*Bromus molliformis* *	Lower (Grass)		*	2	2		
Small Quaker Grass	*Briza minor**	Lower (Grass)		*				
Quaker Grass	*Briza major**	Lower (Grass)		*				
Stinkgrass	*Eragrostis cilianensis**	Lower (Grass)		*	0.5	0.5	1	
Barley Grass	*Hordeum leporinum* *	Lower (Grass)		*	2	1	2	
Oats	*Avena fatua**	Lower (Grass)		*	3	3	3	
Golden Top	*Lamarckia aurea* *	Lower (Grass)		*				
Perennial Rye	*Lolium perennens*	Lower (Grass)		*	1	1	2	
Wimera Ryegrass	*Lolium rigidum**	Lower (Grass)		*				
Squirrel Tail Fescue	*Vulpia bromoides* *	Lower (Grass)		*				
Rhodes Grass	*Chloris virgata*	Lower (Grass)		*	1	1		
	Vulpia myuros *	Lower (Grass)		*				
Pepper-leaved Senna				*	0.5			
Prickley Pear	*Opuntia stricta**	Mid		*#				

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
African Boxthorn	*Lycium ferocissimum**	Mid		*#	0.1			
Pepper Tree		Upper			33	31	21	
Native Carrot	*Daucus glochidiatus*		Lower					
Guinea flower	*Hibbertia sp.*		Lower					
Slender Dock	*Rumex brownii*		Lower		2	1		
	Pomax umbellata		Lower					
Hairy Joyweed	*Alternanthera nana*		Lower		1			
Twining Fringe Lily	*Thysanotus patersonii*		Lower				1	
Common Fringe Lily	*Thysanotus tuberosus*		Lower					
	Dichopogon fimbriatus		Lower					
	Bulbine bulbosa		Lower					
Leek Lily	*Bulbine semibarbata*		Lower		1			
	Asteraceae sp.		Lower					
Purple Burr-daisy	*Calotis cuneifolia*		Lower		1			
Showy Burr-daisy	*Calotis cymbacantha*		Lower					
Yellow Burr-daisy	*Calotis lappulacea*		Lower					
Bogan Flea	*Calotis hispidula*		Lower		1			
	Cassinia arcuata		Lower					
	Cassinia arculeata		Lower					
	Cassinia leavis		Lower					
Common Sneezeweed	*Centipeda cunninghamii*		Lower					
	Chrysocephalum apiculatum		Lower					
Bears Ear	*Cymbonotus preissianus*		Lower					
	Cynoglossum australe		Lower					
Small Orange Sunray	*Hyalosperma semisterile*		Lower					
	Hydrocotyle laxiflora		Lower					
Yam Daisy	*Microseris lanceolata*		Lower					
Sunray	*Rhodanthe diffusa ssp. leucactina*		Lower					
Fuzzweed /New Holland Daisy			Lower		1			
Tall Grounsel	*Senecio quadridentatus*		Lower					
Common Sunray	*Triptilodiscus pygmaeus*		Lower					
	Vittadinia cervicularis var. cervicularis		Lower					
	Vittadinia cuneata var. cuneata		Lower					
	Vittadinia cuneata var. hirsute		Lower					
Golden Everlasting	*Xerochrysum bracteata*		Lower					

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
Sticky Everlasting	*Xerochrysum viscosa*		Lower					
	Cynoglossum suaveolens		Lower					
	Brassica nigra		Lower					
	Lepdiium sp.		Lower					
	Wahlenbergia communis		Lower		2			
	Wahlenbergia gracilis		Lower					
	Wahlenbergia stricta ssp stricta		Lower					
Mouse-ear Chickweed	*Cerastium glomeratum*		Lower					
Pig Weed								
	Centrolepis strigosa subsp. strigosa		Lower					
Early nancy	*Wurmbea dioica*		Lower					
Kidney Weed	*Dichondra repens*		Lower		1			
Dense Stonecrop	*Crassula colorata*		Lower					
Australian Stonecrop	*Crassula sieberiana*		Lower					
Sundew	*Drosera peltata*		Lower					
Caustic Weed	*Euphorbia drummondii*		Lower		1			
Slender Tick-trefoil	*Desmodium varians*		Lower					
Kneed Swainson-pea	*Swainsona reticulata*		Lower					
Leafy Stenophylla	*Templetonia stenophylla*		Lower					
Woolly Clover	*Trifolium tomentosum*		Lower					
Twining Glycine	*Glycine clandestina*		Lower		1	1		
	Glycine latifolia		Lower					
	Glycine tabacina		Lower					
	Glycine tomentosa / canescens		Lower					
Burr Medic	*Medicago polymorpha*		Lower					
Narrow-leaved Fumitory	*Fumaria densiflora*		Lower					
Blue Crowfoot	*Erodium crinitum*		Lower		1	1	0.5	
	Geranium homeanum		Lower		1			
	Geranium retorsum		Lower					
	Geranium solanderi var. solanderi		Lower					
Native Storksbill	*Pelagonium australe*		Lower					
	Goodenia hederacea ssp. hederacea		Lower					
	Gonocarpus elatus [Hill Raspwort]		Lower					
Toothed Raspwort	*Halogaris odontocarpa*		Lower					

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
Tiny Star	*Hypoxis glabella var. glabella*		Lower			1		
Austral Bugle	*Ajuga australis*		Lower					
Native Pennyroyal	*Mentha satureioides*		Lower					
	Linum marginale		Lower					
Rock Isotome	*Isotoma axillaris*		Lower					
	Lomandra filiformis ssp. coriacea		Lower					
Spiky-headed Matt Rush	*Lomandra longifolia*		Lower					
Many-flowered matt Rush	*Lomandra multiflora subsp. Multiflora*		Lower					
Small-flowered mallow	*Malva parvifolia*		Lower					
	Sida corrugata		Lower					
Winter Apple	*Eremophila debilis*		Lower					
Pink Fingers	*Caladenia carnea*		Lower					
Tiger Orchid	*Diuris sulphurea*		Lower					
	Microtis unifolia		Lower					
	Pterostylis bicolor		Lower					
Midget Greenhood	*Pterostylis mutica*		Lower					
Dwarf Greenhood	*Pterostylis nana*		Lower					
Autumn Greenhood	*Pterostylis revoluta*		Lower					
	Oxalis perennans		Lower					
	Oxalis radicosa		Lower					
	Dianella revoluta subsp.		Lower					
Small Sago Weed	*Plantago turrifera*		Lower					
Rock Fern	*Cheilanthes austrotenuifolia*		Lower					
Mulga Fern	*Cheilanthes sieberi*		Lower					
Narrawa Burr	*Solanum cinereum*		Lower					
Slender violet-bush	*Hybanthus monopetalus*		Lower					
Purple Wiregrass	*Aristida jerichoensis*		Lower (grass)		1			
	Aristida ramosa		Lower (grass)					
Wallaby Grass	*Austrodanthonia erianthia*		Lower (grass)					
Common Wallaby Grass	*Austrodanthonia caespitosa*		Lower (grass)		1			
	Austrodanthonia sp.		Lower (grass)					
Wallaby Grass	*Austrodanthonia bipartita*		Lower (grass)					
Dense Foxtail Grass	*Austrostipa densiflora*		Lower (grass)					
Rough Spear Grass	*Austrostipa scabra subs scabra*		Lower (grass)		2	1	1	
	Austrostipa ramosa		Lower (grass)					
Spear Grass	*Austrostipa sp.*		Lower (grass)		1			
Slender Bamboo Grass	*Austrostipa verticillata*		Lower (grass)					

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	Weed	Plot 1	Plot 2	Plot 3	Plot 4
Plains Grass	*Austrostipa*		Lower (grass)		1	1	2	
Red-Leg Grass	*Bothriochloa macra*		Lower (grass)		1	2	1	
Short Chloris	*Chloris truncata*		Lower (grass)					
Tall Chloris	*Chloris ventricosa*		Lower (grass)					
	Cynodon dactylon		Lower (grass)					
Queensland Bluegrass	*Dichanthium serecium*		Lower (grass)					
	Dichelachne micrantha		Lower (grass)					
Cotton Panic	*Digitaria brownii*		Lower (grass)		1			
	Digitaria sp.		Lower (grass)					
Awnless barnyard Grass	*Echinochloa colona*		Lower (grass)					
Common Wheatgrass	*Elymus scaber*		Lower (grass)					
Slender bottlewashers	*Ennaepogon gracilis*		Lower (grass)					
Curly Windmill Grass	*Enteropogon acicularis*		Lower (grass)		2		1	
Brown Lovegrass	*Eragrostis brownii*		Lower (grass)					
Purple Love Grass	*Eragrostis lacunaria*		Lower (grass)					
Hairy Panic	*Panicum effusum*		Lower (grass)		1	1		
	Poa sieberiana		Lower (grass)					
Western Rat's Tail Grass	*Sporobolus crebra*		Lower (grass)				1	
	Thyridolepis mitchelliana		Lower (grass)					
Five-minute Grass	*Tripogon loliformis*		Lower (grass)					
	Cyperus sp.		Lower (sedge)					
	Carex inversa		Lower (sedge)					
Tall sedge	*Carex appressa*		Lower (sedge)					
Rough Sas Sedge	*Gahnia aspera*		Lower (sedge)					
Common Bog Rush	*Shoenus apogon*		Lower (sedge)					
	Juncas arcutus		Lower (sedge)					
	Juncas arculeata		Lower (sedge)					
	Juncus aridicola		Lower (sedge)					
	Juncas sp.		Lower (sedge)					
			Lower (sedge)					
Water Ribbons			Lower (sedge)					
Bull Rush	*Typha*		Lower (sedge)		3			
Hill Oak	*Allocasuarina verticillata*		Mid					
Climbing Saltbush	*Einadia hastata*		Mid					
Creeping Saltbush	*Einadia nutans subs. Nutans*		Mid					
	Enchylaena tomentosa		Mid					
Eastern Cotton Bush	*Maireana microphylla.*		Mid		1			
Galvanised Burr			Mid					

Common Name	Scientific Name	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
	Acacia cheelii		Mid					
	Acacia deanei subsp. deanei		Mid					
Western Golden Wattle	*Acacia decora*		Mid					
Currawang	*Acacia doratoloxyn*		Mid					
	Acacia implexa ?		Mid					
Boree	*Acacia vestita*		Mid					
	Acacia lineata		Mid					
Mudgee Wattle	*Acacia spectabilis*		Mid					
Sword-leaf Wattle	*Acacia gladiformis*		Mid					
	Mirbelia pungens		Mid					
Small-leaf Bush-pea	*Pultenaea foliolosa*		Mid					
	Pultenaea microphylla		Mid					
Senna	*Senna artemisioides subsp. zygophylla*		Mid					
Silver cassia	*Senna artemisioides*		Mid					
Butterbush	*Pittosporum angustifolium*		Mid					
Hooked Needlewood	*Hakea tephrosperma*		Mid					
	Dodonaea boroniifolia		Mid					
Hopbush	*Dodonaea sp.*		Mid					
Narrow-leafed hopbush	*Dodonaea viscosa subsp. augustissim*		Mid					
	Dodonaea viscosa subsp. cuneata		Mid					
Cherry Ballart	*Exocarpos cupressiformis*		Mid					
White Cypress Pine	*Callitris endlicheri*		Upper		1			
Black Cypress Pine	*Callitris glaucophylla*		Upper					
White Box	*Eucalyptus albens*		Upper					
Fuzzy Box	*Eucalyptus conica*		Upper		1			
Tumbledown Red Gum	*Eucalyptus dealbata*		Upper					
Dwyer's Red Gum	*Eucalyptus Dwyeri*		Upper					
Yellow Box	*Eucalyptus melliodora*		Upper		1			
Rough barked Apple	*Angophora floribunda*		Upper		1			
Inland Grey Box	*Eucalyptus microcarpa*		Upper		1			
Kurrajong			Upper					
TOTAL Species / Plot					*28*	*8*	*7*	
Total species	*72*							
Native Plant Species (NPS)	31				28	8	7	0

Common Name	*Scientific Name*	Stratum (weed)	Stratum (Native)	*Weed*	Plot 1	Plot 2	Plot 3	Plot 4
No. weeds	41				32	30	20	0
% NPS	43.06							
% Weeds	56.94							

Family	Class	Scientific Name	Common Name	Legal Status	Subject Site	Native	Non-native
Mammalia	Carnivora	Vulpes vulpes	Red Fox		**x**		x
Amphibia	Myobatrachidae	Crinia signifera	Common Eastern Froglet	P	x	x	
Amphibia	Myobatrachidae	Limnodynastes peroni	Striped Marsh Frog	P	x	x	
Reptilia	Scincidae	Menetia greyii	Dwarf Skink	P	x	x	
Reptilia	Scincidae	Morethia boulengeri	South-eastern Morethia Skink	P	x	x	
Aves	Motacillidae	Anthus australis	Australasian Pipit	P	x	x	
Aves	Artamidae	Gymnorhina tibicen	Australian Magpie	P	x	x	
Aves	Corvidae	Corvus coronoides	Australian Raven	P	x	x	
Aves	Anatidae	Tadorna tadornoides	Australian Shelduck	P	x	x	
Aves	Campephagidae	Coracina novaehollandiae	Black-faced Cuckoo-shrike	P	x	x	
Aves	Anatidae	Anas castanea	Chestnut Teal	P	x	x	
Aves	Sturnidae	Sturnus vulgaris	Common Starling	P	x	x	
Aves	Cacatuidae	Eolophus roseicapilla	Galah	P	x	x	
Aves	Anatidae	Anas gracilis	Grey Teal	P	x		x
Aves	Passeridae	Passer domesticus	House Sparrow		x	x	
Aves	Monarchidae	Grallina cyanoleuca	Magpie-lark	P	x	x	
Aves	Charadriidae	Vanellus miles	Masked Lapwing	P	x	x	
Aves	Sturnidae	Aplornis metallica	Metallic Starling		x		x
Aves	Falconidae	Falco cenchroides	Nankeen Kestrel	P	x	x	
Aves	Anatidae	Anas superciliosa	Pacific Black Duck	P	x	x	
Aves	Artamidae	Cracticus nigrogularis	Pied Butcherbird	P	x	x	
Aves	Threskiornithidae	Threskiornis spinicollis	Straw-necked Ibis	P	x	x	
Aves	Cacatuidae	Cacatua galerita	Sulphur-crested Cockatoo	P	x	x	
Aves	Ptilonorhynchidae	Amblyornis newtonianus	Superb Fairy-wren	P	x	x	
Aves	Ardeidae	Egretta novaehollandiae	White-faced Heron	P	x	x	
Aves	Rhipiduridae	Rhipidura leucophrys	Willie Wagtail	P	x	x	

APPENDIX 5: ASSESSMENTS OF SIGNIFICANCE

7-PART TEST CRITERIA

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.	Not relevant.	Local population: Barking Owls occur in the Dubbo area, with breeding habitat known to occur in large hollow bearing trees adjacent to watercourses. As no impact will occur to suitable riparian large hollow bearing trees known to be used for breeding, the proposal is unlikely to disrupt a local population of Barking Owls.	Local population: These species of bird of prey are known to occur in the Dubbo area. Due to the mobile nature of these species, hunting grounds in cleared (semi-suburban) and riparian habitat cannot be considered critical to the survival of this species, as similar habitat along the riparian zone is abundant in the locality (Macquarie River). It is likely that these birds of prey may hunt on open ground associated with the floodplain. Vehicle movement and noise associated with the Proposal may impact birds hunting, however the short nature of this noise is unlikely to disrupt a viable local population of the species such that they are placed at a risk of extinction Breeding sites for these birds of prey are likely to occur in tall trees associated with riparian environments outside the Subject Site near the Macquarie or Talbragar River. No likely breeding trees would be removed. Furthermore, no breeding sites have been	Not relevant

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
			previously recorded by the species in the Subject Site. Habitat critical to the survival of these species \is unlikely to occur in the Subject Site given the less disturbed habitats are available in the locality. Thus a viable local population of the species is unlikely to be placed at risk of extinction.	
b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.	Not relevant.	Not relevant	Not relevant	Not relevant
c) in the case of an endangered ecological community or CE ecological community, whether the action proposed: (i) is likely to have an adverse effect on the extent of the ecological community such that its occurrence is likely to be placed at risk of extinction, or	The Proposal would not place this EEC at risk of local extinction.	Not relevant	Not relevant	Eulomogo Creek drains into the Macquarie River that forms part of the listing for this aquatic EEC. The EEC will not become locally extinct as the works will only affect small areas of its extent.

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,				
d) in relation to habitat of a threatened species, population or ecological community: (i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and (ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and (iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.	The Subject Site has already had habitat removed, fragmented and now exists in a derived grassland state.	Any component of habitat/resource is considered important. The Subject Site contains likely hunting grounds for the Barking Owl. It is unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline. It is unlikely that the action will adversely affect habitat critical to the survival of the species.	Any component of habitat / resource is considered important. The Subject Site contains likely hunting grounds and potential breeding resources. Due to grassy habitat within the Subject Site, no roost or breeding sites will be impacted. It is unlikely that the Proposal would isolate and decrease the availability of quality habitat to the extent that the species is likely to decline. It is unlikely that the action will adversely affect habitat critical to the survival of the species	The EEC extends beyond the Subject Site and is in a degraded state. Recovery of this EEC will occur once the works have completed.
e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).	Critical habitat does not occur in the locality.	Critical habitat has not been declared for this species and at present there are no habitats listed as critical in the locality.	Critical habitat has not been declared for these species and at present there are no habitats listed as critical in the locality.	Critical habitat does not occur in the locality.

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
f) whether the actions proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan.	There are no recovery or threat abatement plans for this EEC.	Two recovery plans relevant to this species exist: Draft Recovery Plan for the Barking Owl Recovery Plan for the Large Forest Owls Seven large hollow bearing trees suitable as a breeding site will be removed, however as noted its location next to a busy road make it highly unlikely to be used. Impact will occur in the short term to likely hunting territory.	There are no recovery or threat abatement plans for these species. Vegetation removal contributes to the threats facing this species. However habitat restoration and rehabilitation is consistent with the recovery plans for these species.	There is no recovery plan for this EEC.
g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.	KTPs such as clearing of native vegetation, will be exacerbated by the Proposal. Predation by the European red fox (*Vulpes vulpes*) and Predation by the feral cat (*Felis catus*), have or are currently occurring with Subject Site.	As per left hand column	As per left hand column	The alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands has been listed as a KTP in Schedule 3 of the TSC Act. Even though the creek flow will not be altered in the long-term, construction works in the vicinity of the creek may impact its viability in the short term. Degradation of native riparian vegetation along NSW waterways has been listed as a KTP in Schedule 6 of the FM Act. The clearing of riparian vegetation and machinery access to the riparian zone increases erosion and siltation, and may impact habitat including reproductive sites for species in this aquatic ecological community. This clearing is however minimal.

7-Part Test Criteria	Fuzzy Box Woodland White Box Woodland Inland Grey Box Woodland	Barking Owl	Black Falcon Grey Falcon Little Eagle Spotted Harrier Square-tailed Kite	Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River (NSW FM Act).
				The clearing of native vegetation has been listed as a KTP in Schedule 3 of the TSC Act
Conclusion	The Proposal is not likely to significantly impact a locally occurring population of this EEC such that it is placed at risk of local extinction. A SIS is not warranted. It would however be appropriate to offset the loss of vegetation following recommendations in this report.	A local population being placed at risk of extinction is unlikely due to the large amount of surrounding analogous habitat adjoining the Subject Site. A Species Impact Statement is not required	A local population being placed at risk of extinction is unlikely due to the large amount of surrounding analogous habitat adjoining the Subject Site. A Species Impact Statement is not required.	Recommendations in this report will ensure a high level of soil and sediment controls are implemented. A SIS is not required.

DoE Assessments of Significance - Migratory Species

Criteria: An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:	White-throated Needletail, Fork-tailed Swift, Rainbow Bee-eater, Cattle Egret, Great Egret.
substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	All species are predicted to have occasional habitat in the Subject Site. **Fork-tailed Swift (Apus pacificus) and White-throated Needletail (Hirundapus caudacutus)** The White-throated Needletail and Fork-tailed Swift are aerial species for which the Subject Site will not represent 'important habitat' and no impacts are expected due to the ability of this species to forage over a wide variety of land use, including human infrastructure and large water bodies and wetland areas in Dubbo. **Great Egret (Ardea alba) and Cattle Egret (Bubulcus ibis)** These species are predicted to occur, within or nearby to the Subject Site during periods of inundation. Furthermore the Cattle Egret is predicted to occur during the non-breeding period when cattle are stocked. There is no record of either in the Subject Site. Any such impacts involving habitat would be minor and may be mitigated by the habitat creation and enhancement activities noted above for other wetland species. The proposed action would have minimal effects on any local population of these species. **Rainbow Bee-eater Merops ornatus** The Macquarie River is a known place for congregation of flocks and is core breeding habitat for the species. The Rainbow Bee-eater is most often found in open forests, woodlands and shrublands, and cleared areas, usually near water. It will use disturbed sites with sandy soils such as river banks, quarries, cuttings and mines or exposed sites on cleared flats to build its nesting tunnels. Providing that recommendations in this report are followed there will be no impact to individual birds or a long term decrease in the population.
result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or	The local area has a history of clearing and habitat modification, which has benefited a number of feral and invasive flora and fauna species. The proponent proposes to ensure the spread of weeds and feral fauna is not enhanced by the project that will contribute to the overall enhancement of habitat for all species.
seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	It is unlikely that the Proposal would interfere with an ecologically significant proportion of any of these species. It is unlikely that these species would be significantly impacted by the Project. Referral to the DoE is not required.

Appendix E

FLOOD IMPACT ASSESSMENT REPORT

Prepared by CARDNO Pty Ltd

March 2017

Our Ref: 59915164-L02:BCP/bcp
Contact: Dr Brett C. Phillips

27th March 2017

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The Manager,
Maas Group Properties
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Attention: Mr Steven Guy

Dear Steven,

FURTHER FLOODING INFORMATION FOR LOT 399 DP 1199356 (HILLVIEW) IN DUBBO

In response to your recent request, we are pleased to provide the following flooding advice for Lot 399 DP 1199356 (Hillview) in Dubbo.

1. BACKGROUND

1.1 Location

The location of Lot 399 DP 1199356 (Hillview) in Dubbo is indicated in **Figure 1**. The property is located adjacent to the downstream reach of the Eulomogo Creek.

1.2 Keswick Drainage Review

In 2010 the Keswick Drainage Review prepared by Cardno Willing updated the feasibility study reported by Willing & Partners in 1995. The Willing & Partners report investigated the trunk drainage and water quality requirements that would allow development in the Keswick area to proceed in an orderly fashion. Since 1995 residential development has become established with imminent plans for further development. The establishment of two schools and commercial development has also occurred.

The investigations have been completed in two parts.

The first part involved reviewing the hydrology of the area and re-estimating the peak flow rate and volume of runoff. This required the conceptual location and sizing of flood retarding basins, and connecting trunk drainage channels with the aim of reducing the estimated future runoff from the developed catchment to no more than undeveloped catchment, and in the location where drainage works have already been constructed, no more than the 1995 estimates of peak flow.

Notwithstanding these objectives the lower part of Eulomogo Creek is in a degraded condition and is continuing to experience severe erosion of the bed and banks. A related study of the lower part of Eulomogo Creek [Cardno, 2010] identified that a significant factor contributing to bank instability is the increase in the peak flow rate and volume of runoff during small frequent events, typically having an average recurrence interval up to 5 years. Therefore practical opportunities to include measures to reduce the impact of the small frequent storms were included in the drainage strategy including the use of multi-staged outlets to selected retarding basins.

The second part of the study considered water quality issues and identified, at a conceptual level the type and size of facilities required to achieve runoff water quality consistent with current NSW guidelines for total phosphorus, total nitrogen, and suspended solids. In some instances the water quality facilities have been integrated with the flood retardation basins.

1.3 Firgrove Estate Flooding Assessments

Assessments of rainfall, runoff and flooding in the Firgrove Estate and the upper Eulomogo Creek catchment have been ongoing since 2012.

In a Discussion Paper dated 20 January 2012, various tasks that were undertaken at the time to investigate rainfall, runoff and flooding in Firgrove Estate were described. These included:

- Assembly of an xp**rafts** model of the Eulomogo Creek catchment upstream of the Railway Line based on model parameters that have been adopted elsewhere in Dubbo;
- Input 100 yr ARI design storm bursts for a range of durations and estimate the critical duration 100 yr ARI peak flow;
- Compare the 100 yr ARI peak flow with an alternate estimate and if appropriate adjust the model parameters to achieve broad agreement;
- Estimation of runoff during the storms of 18 November 2000 and 3-4 December 2010;
- Creation of a local 1D/2D xp**swmm2D** model of the reach of Eulomogo Creek and Firgrove Estate. Upstream boundary conditions are flows generated by the xp**rafts** model of the Eulomogo Creek catchment while the downstream boundary condition is based on normal flow conditions.
- Running of the model to assess the flood extents and the magnitude of any flow down the flood runner during November 2000 and/or 3-4 December 2010 (if possible) and during a 100 yr ARI event.

It was concluded from these assessments that:

- The frequency of the November 2000 and December 2010 floods inferred from the peak flows estimated using the initial loss / continuing loss model are close to the estimated frequency of the storm bursts except for the synthetic December 2010 storm where the severity of the peak flow is far greater than the severity of the (synthetic) rainfall;
- The frequency of the November 2000 and December 2010 floods inferred from the peak flows estimated using the ARBM loss model are comparable to the estimated frequency of the storm bursts;
- The Eastern NSW procedure appears to underestimate the design flows at Toorale Rd in comparison with the observed flooding and the estimated frequency of the storm bursts.

The peak flows for the November 2000 and December 2010 events estimated by the hydrological model using the two loss models are also plotted in **Figure 2** in order to infer the severity of these events from the relevant flood frequency curves.

A 2D floodplain model was assembled and was run to estimate the flood extents, depths and velocities in the November 2000, December 2010 and the 100 yr ARI events for both initial loss / continuing loss and ARBM models. It was concluded from a comparison of the observed and predicted flood levels for the December 2010 flood that:

- The synthetic December 2010 storm gave flood levels far closer to the observed levels than the Dubbo Airport storm adjusted to match the daily reading at the Geurie PO;
- The level of agreement for the IL/CL loss model and the ARBM model (with 40% soil saturation) with the observed levels was good considering the method used to create the synthetic December 2010 storm

The 100 yr ARI flood levels were also estimated using both loss models. In the case of the ARBM model an initial condition of 65% soil saturation was adopted when assessing the design floods to account for antecedent rainfall prior to the design storm burst.

It was concluded that while the IL/CL and ARBM loss models gave comparable estimates of the peak flows in design floods that ARBM loss model gave flood severities for the historical floods were in better agreement with the assessed rainfall severity than the IL/CL model.

1.4 Australian Rainfall & Runoff

The most commonly encountered hydrological problem associated with estimating flood flows is that of estimating the flood flow of a given Annual Exceedance Probability (AEP) at a location where the historical monitored information is inadequate for frequency analysis. These locations are referred to as ungauged catchments. Numerous alternative techniques have been developed historically in the different regions of Australia to provide the necessary design flow predictions in ungauged catchments. The current diversity of approaches has resulted in predicted flows varying significantly at the interfaces between regions. It was recognised that there was a need to develop generic techniques that can be applied across the whole country, to test these techniques, and to develop appropriate guidance in their usage.

The aim of Stage 2 of Project 5 was to test the suitability of alternative national approaches to the estimation of design peak flow predictions for ungauged catchments

Stage 2 developed a firm basis for recommendations on the methods for regional flood frequency estimation (RFFE) included in the revised ARR Chapter (4th edition).

The application of empirical scale correction factors with these regional flood prediction equations has most recently been presented as a case study for eastern Australia by Zaman et al (2013)[1]. These procedures supersede the current Eastern NSW procedure.

A trial application of this procedure is presented in **Figure 2**. It lends great support to the previous modelling results and suggests that it may be appropriate to re-visit the ARBM initial moisture condition to lower the design peak flows to broadly match the RFFE values.

[1] Zaman, M. A., Haddad, K. & Rahman, A. 2013, "Application of empirical scale correction factors with regional flood prediction equations: A case study for eastern Australia", *Australian Journal of Water Resources*, Vol. 16, No. 2, pp. 141-150, http://dx.doi.org/10.7158/W12-008.2013.16.2

2. OBJECTIVE

The objective of the assessment is to provide information on the impact of the proposed development layout on Lot 399 DP 1199356 (Hillview) in relation to flooding in a 100 yr ARI event.

3. BENCHMARK CONDITIONS

3.1 Local 1D/2D Floodplain Model

In order to estimate 100 yr ARI flood levels in the lower reach of Eulomogo Creek a local 1D/2D model was assembled of the Eulomogo Creek floodplain and a reach of the Macquarie River in June 2015.

The hydraulic study area is identified in **Figure 3.**

The adopted grid size was 2 m x 2 m in the area of detailed interest (Hillview) and was 5 m x 5 m elsewhere on the floodplain (refer **Figure 3**).

Figure 4 shows the study area and roughness zones adopted in the TUFLOW model.

Inflows were generated using an updated **xprafts** model of the Eulomogo Creek catchment in combination with post-development flows at Hennessy Drive. The updated **xprafts** model was run and it was determined that the 6 hour storm was critical in the lower reach of Eulomogo Creek. The Keswick catchment model was also re-run to estimated inflows under the 6 hour storm burst.

The runoff from the Eulomogo Creek and Keswick catchments under a 6 hour storm was combined with the adopted 100 yr ARI hydrograph in the Macquarie River. The significant difference in size of the Macquarie River catchment upstream of Dubbo and the Eulomogo Creek and Keswick Creek catchments is expected to lead to significant differences in the timing of runoff from these catchments. As indicated in **Figure 7** runoff from the Eulomogo Creek and Keswick Creek catchments would peak far earlier than the more slowly rising flood in the Macquarie River.

The 1D/2D model included the proposed Hennessy Drive Basin. The downstream boundary based on the flood levels in Macquarie River.

The model was run over a 60 hour period to ensure that the interaction of peak flooding in the Macquarie River with Eulomogo Creek was assessed.

3.2 Results

The 100 yr ARI flood was assessed under benchmark conditions. The estimated 100 yr ARI flood levels and flood extents in the study area and in the vicinity of Hillview are given **Figures 5** and **6** respectively. The calculated flood levels at two reference locations (identified in Figure 3) are plotted in **Figure 7**. The peak 100 yr ARI flood level at these two locations are:

Location P1	264.56 m AHD
Location P2	266.20 m AHD

It was concluded that flooding in a 100 yr ARI event in the vicinity of Hillview is just beyond the influence of the Macquarie River and is governed by runoff from the Eulomogo Creek catchment.

The estimated 100 yr ARI flood depths in the study area and in the vicinity of Hillview are given **Figures 8** and **9** respectively.

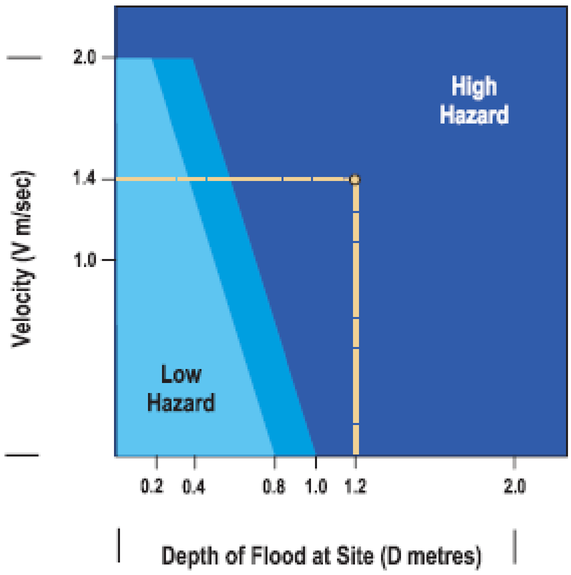
The estimated 100 yr ARI flood velocities in the study area and in the vicinity of Hillview are given **Figures 10** and **11** respectively

When considering pedestrian and vehicular stability, three velocity x depth criteria were identified as follows:

Velocity x Depth	Comment
≤ 0.4 m^2/s	This is typically adopted by Councils as a limit of stability for pedestrians
0.4 – 0.6 m^2/s	Unsafe for pedestrians but safe for vehicles if overland flood depths do not exceed around 0.3 m
> 0.6 m^2/s	This is typically adopted by Councils as a limit of stability for vehicles

The estimated 100 yr ARI velocity x depth in the study area and in the vicinity of Hillview are given **Figures 12** and **13** respectively.

Experience from studies of floods throughout NSW and elsewhere has allowed authorities to develop methods of assessing the hazard to life and property on floodplains. This experience has been used in developing the NSW Floodplain Development Manual to provide guidelines for managing this hazard. These guidelines are shown schematically below.



Provisional Hazard Categories (after Figure L2, NSW Government, 2005)

To use the diagram, it is necessary to know the average depth and velocity of floodwaters at a given location. If the product of depth and velocity exceeds a critical value (as shown below), the flood flow will create a **high hazard** to life and property. There will probably be danger to persons caught in the floodwaters, and possible structural damage. Evacuation of persons would be difficult.

By contrast, in **low hazard** areas people and their possessions can be evacuated safely by trucks. Between the two categories a transition zone is defined in which the degree of hazard is dependent on site conditions and the nature of the proposed development.

This calculation leads to a provisional hazard rating. The provisional hazard rating may be modified by consideration of effective flood warning times, the rate of rise of floodwaters, duration of flooding and ease or otherwise of evacuation in times of flood. The estimated 100 yr ARI provisional flood hazard in the study area and in the vicinity of Hillview are given **Figures 14** and **15** respectively.

4. FUTURE CONDITIONS

The floodplian model of Eulomogo Creek which was assembled previously in June 2015 was modified to represent the proposed landform adjacent to Eulomogo Creek given in **Figure 16** and to run the model to assess the flood impacts. The proposed lot layout is overlaid the 100 yr ARI flood extent under Existing Conditions in **Figure 17**. It is noted from **Figure 17** that in the vicinity of Eulomogo Creek the proposed road would need to be formed by filling. It was assumed that this fill would be contained by a vertical wall along the boundary of the road reserve.

While it is noted that the creek line plotted in **Figure 16** broadly aligns with the alignment of Eulomogo Creek (as disclosed by ALS data) it is noted that the creek alignment appears to deviate north of the plotted alignment in the vicinity of lot boundary at the western end of the section of Eulomogo Creek located within the property.

The 100 yr ARI flood level contours, depths, velocities, velocity x depth and hazards under Future Conditions are plotted in **Figures 18 – 22** respectively.

5. FLOOD IMPACT ASSESSMENT

The impacts of the proposed landform adjacent to Eulomogo Creek on 100 yr ARI flood levels are plotted in **Figure 23**.

It is noted from **Figure 23** that the proposed filling locally increases 100 yr ARI flood levels. The majority of the impact is located within Hillview Estate but the impacts do extend onto the adjoining property. These impacts on the adjoining property are considered to be minor given the current rural use.

A zone of reduced 100 yr ARI flood levels located in the vicinity of lot boundary at the western end of the section of Eulomogo Creek indicates that the proposed filling is partially blocking flood flows that occur under Existing Conditions. This is consistent with the creek alignment which appears to deviate north of the plotted alignment in the vicinity of lot boundary at the western end of the section of Eulomogo Creek located within the property.

An impact is also disclosed on the eastern boundary of the property. This is due to a local drainage line through the property being filled within the property. No attempt was made to locally redirect these flows to reduce the impact. This would need to be considered when designing the land form.

We would be pleased to further discuss our findings with you upon your request.

Yours faithfully

Brett C. Phillips

………………………………

Dr Brett C. Phillips
Director, Water Engineering
for **Cardno**

Figure 1 Location of Lot 399 DP 1199356 (Hillview) (Source: Geolyse)

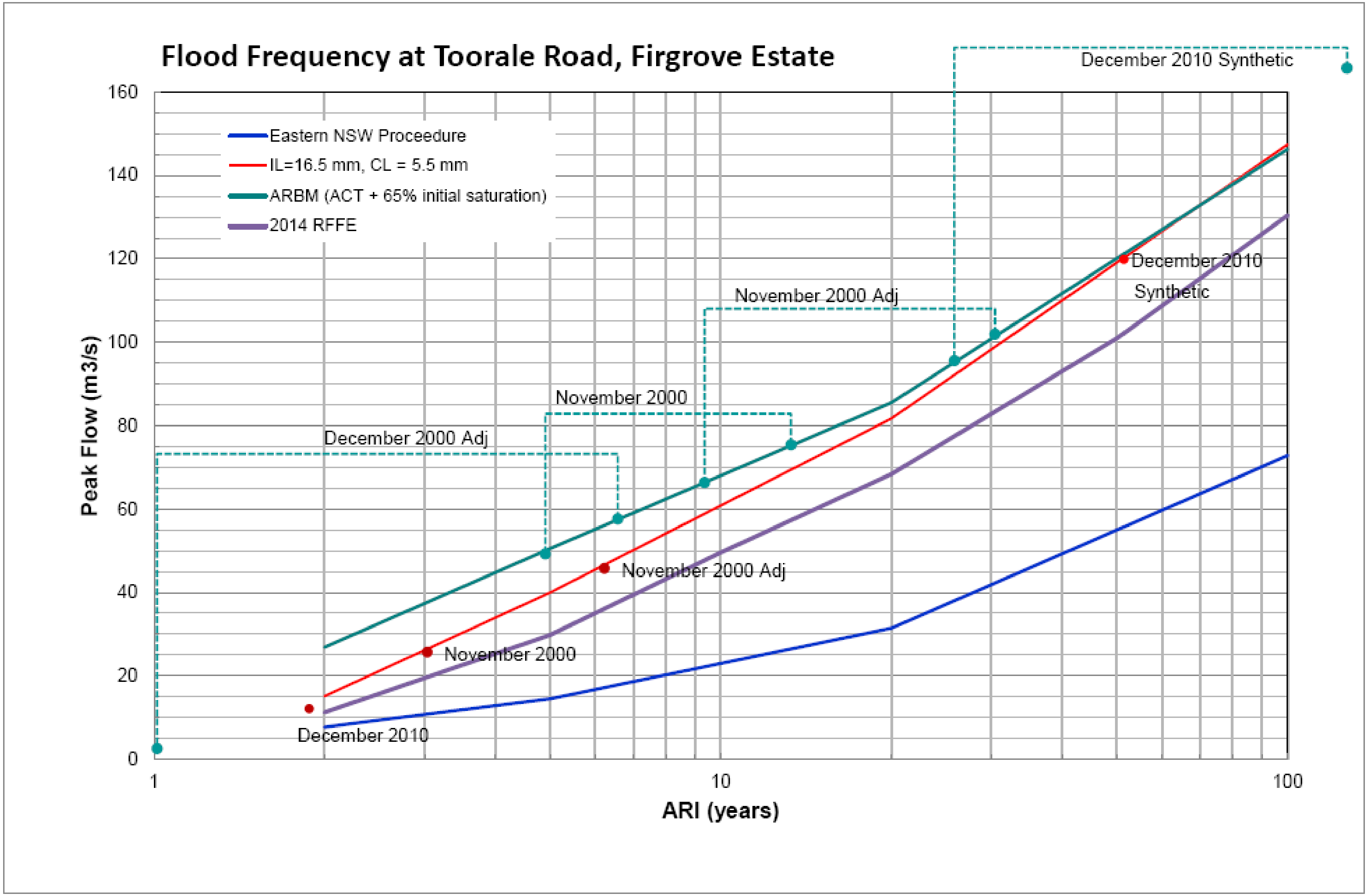


Figure 2 Flood Frequency Curves at Toorale Road, Firgrove Estate

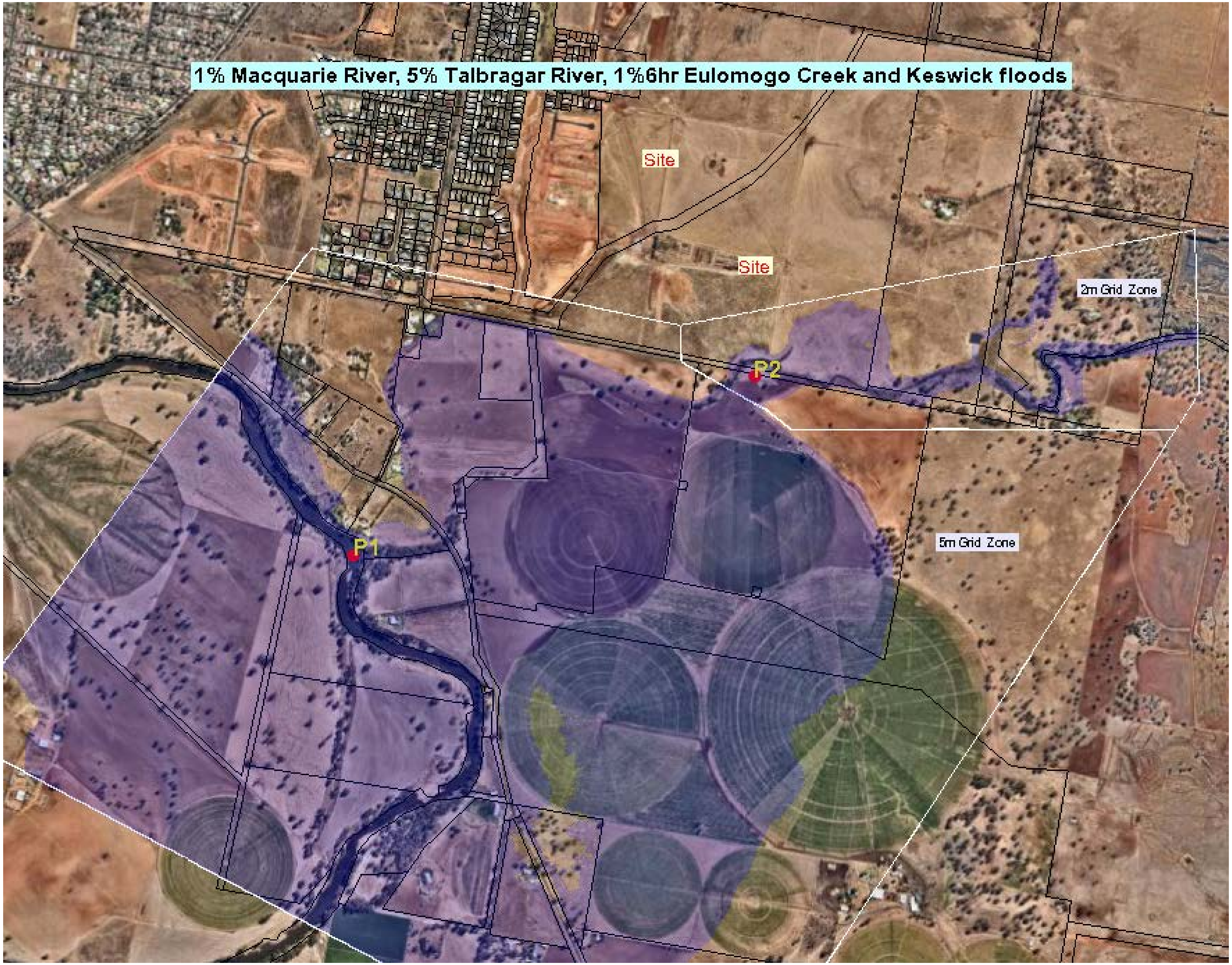


Figure 3 Lower Reach of Eulomogo Creek and Model Extents

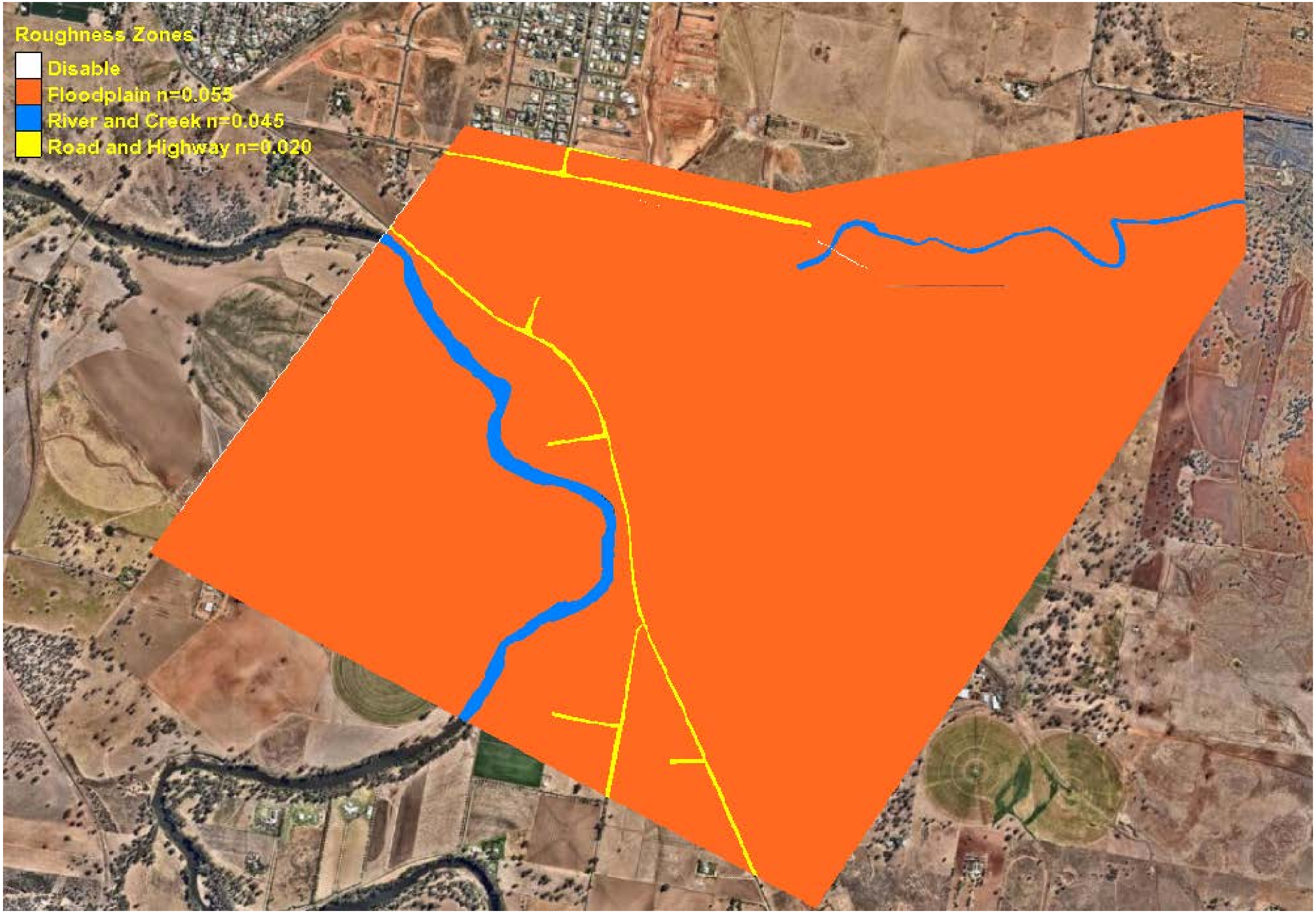


Figure 4 Adopted Existing Conditions Roughness Zones

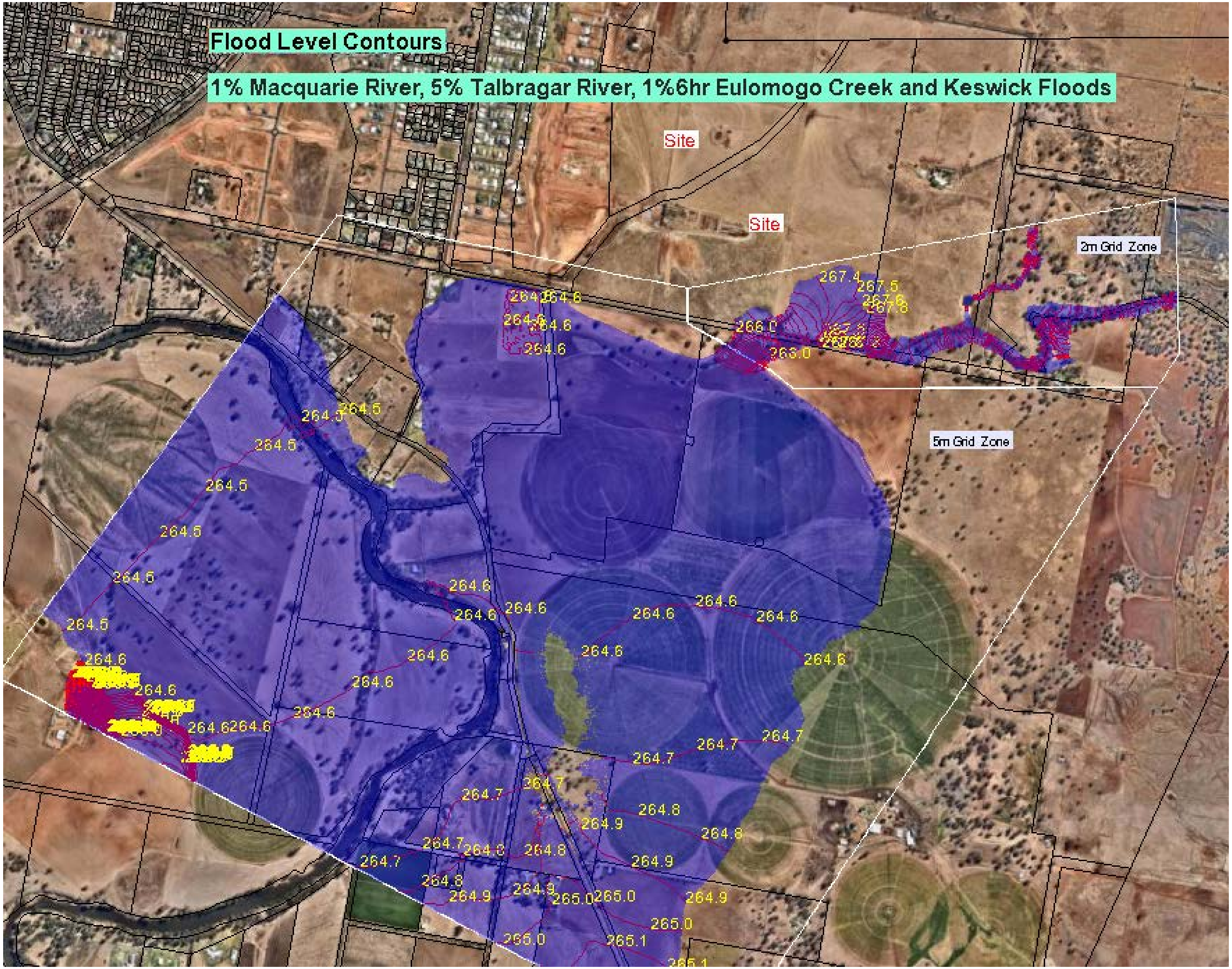


Figure 5 100 yr ARI Flood Levels Depths

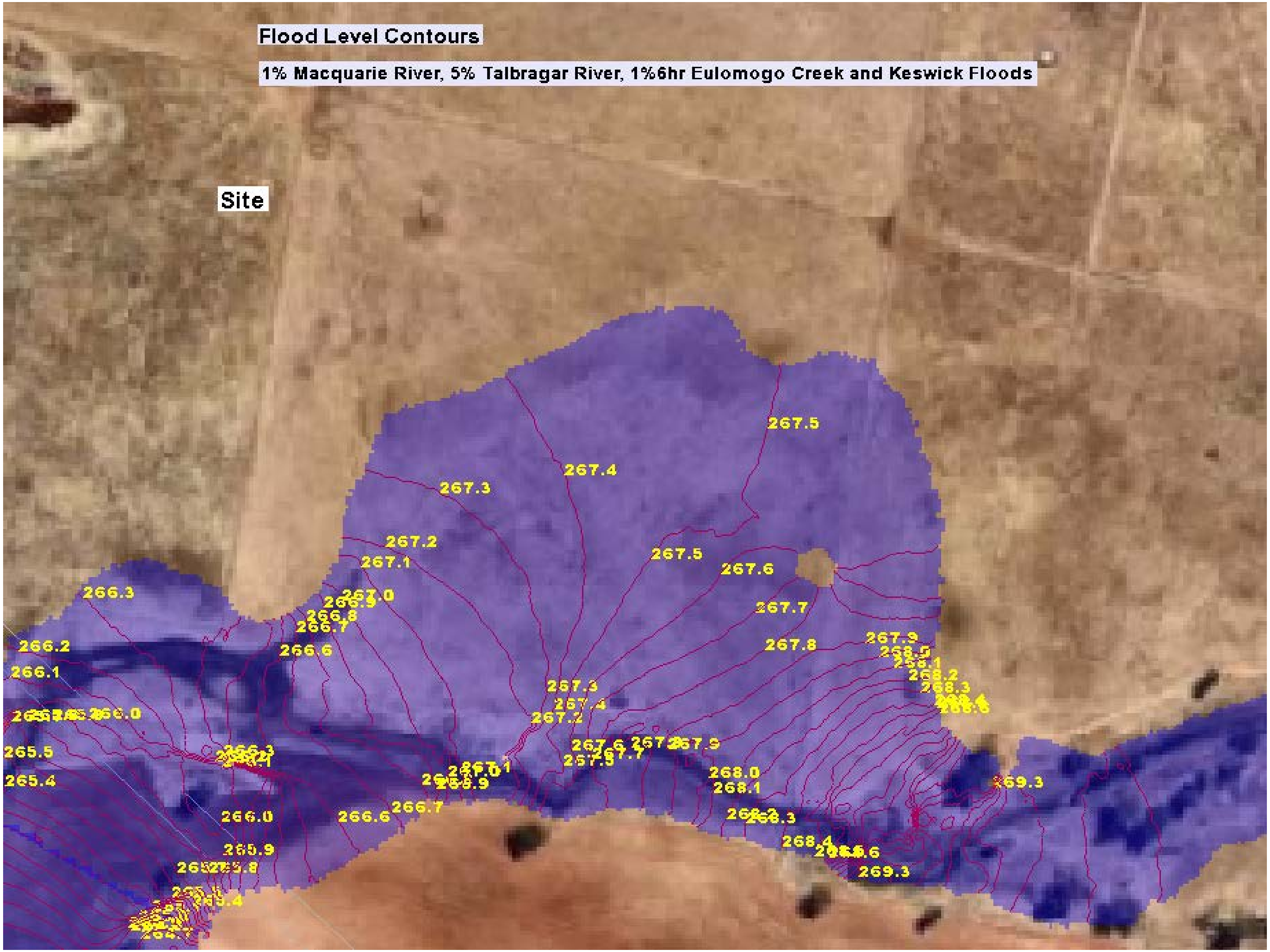


Figure 6 Zoomed 100 yr ARI Flood Levels – Hillview

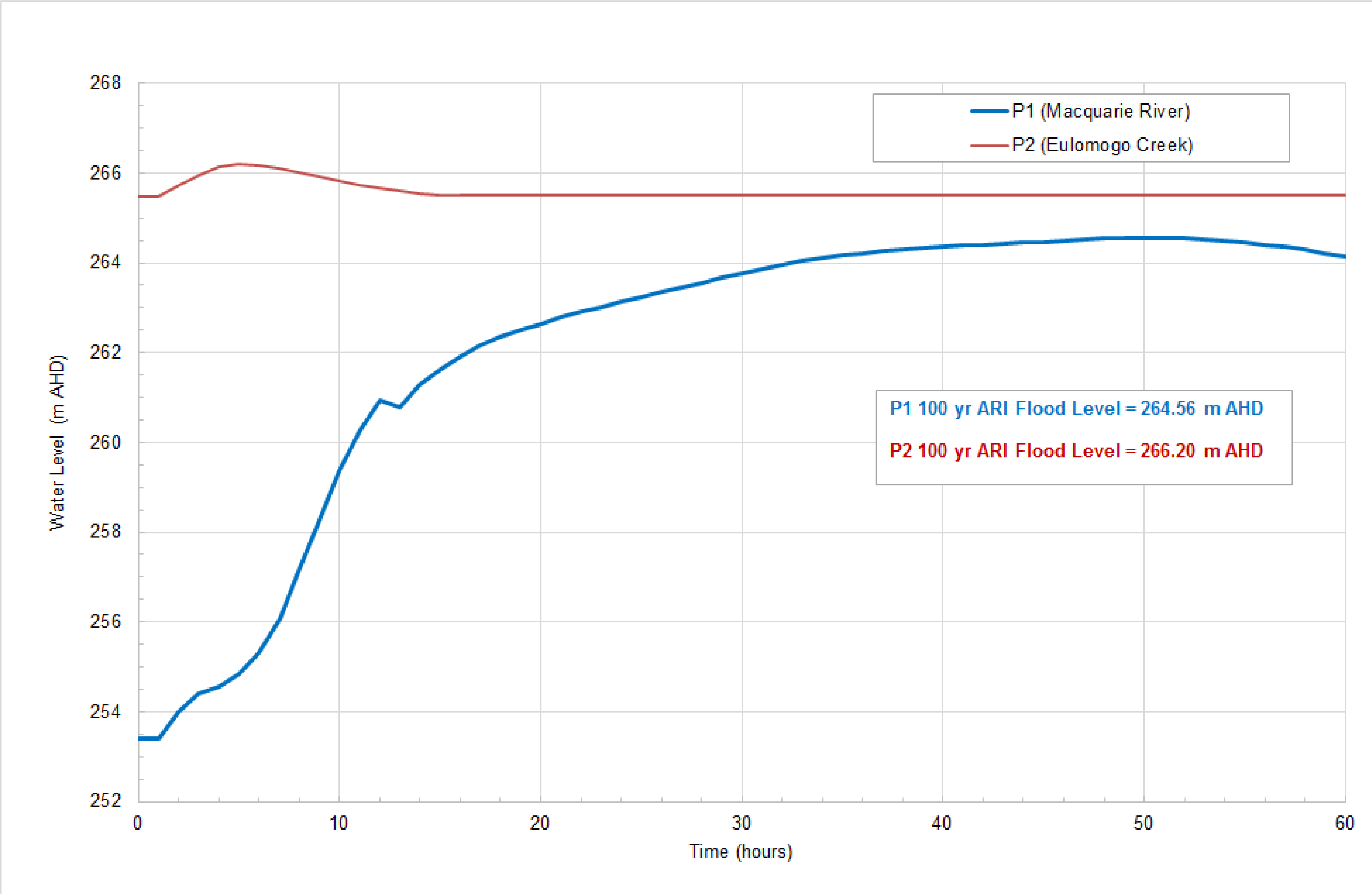


Figure 7 100 yr ARI Flood Levels at Reference Locations

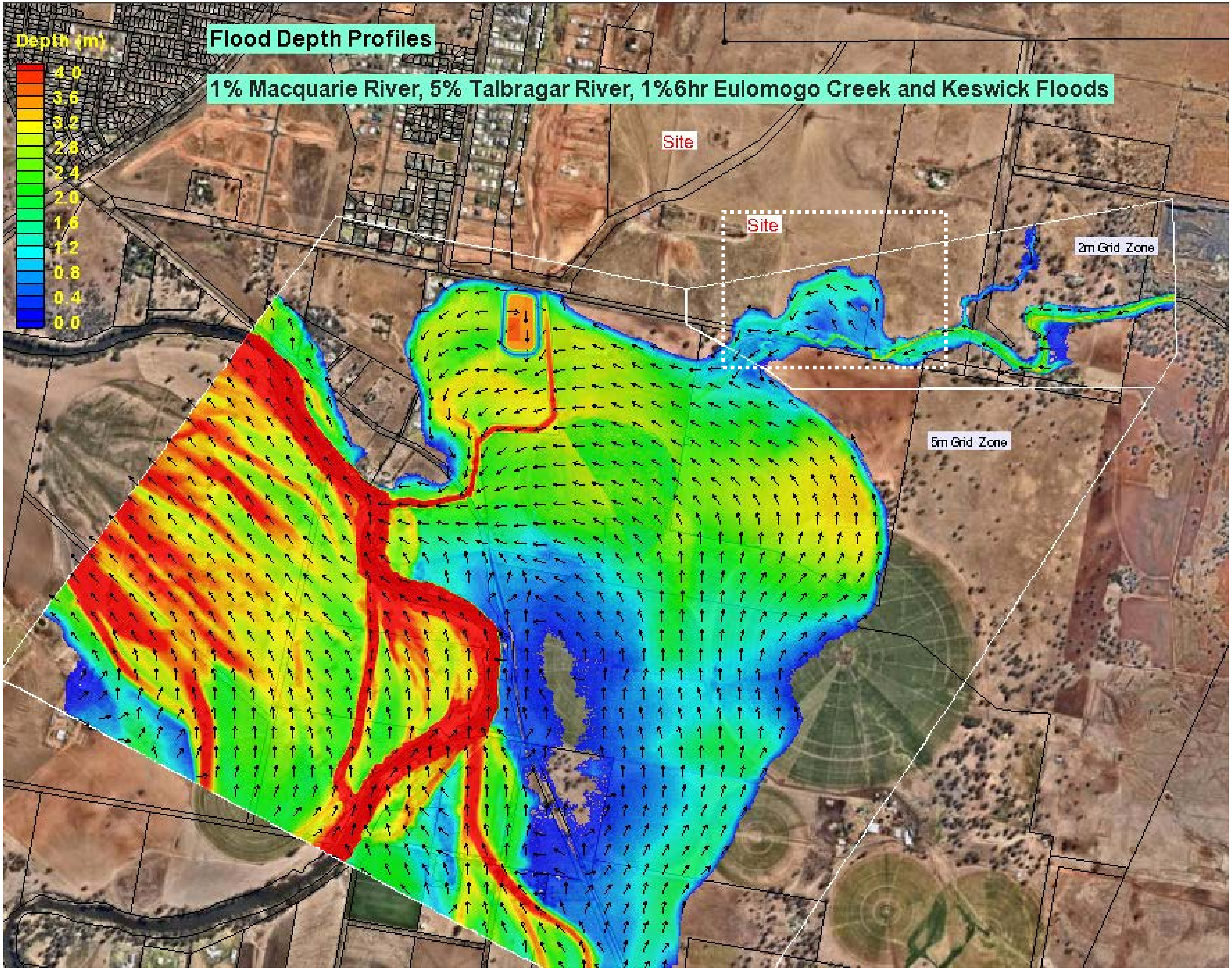


Figure 8 100 yr ARI Flood Depths

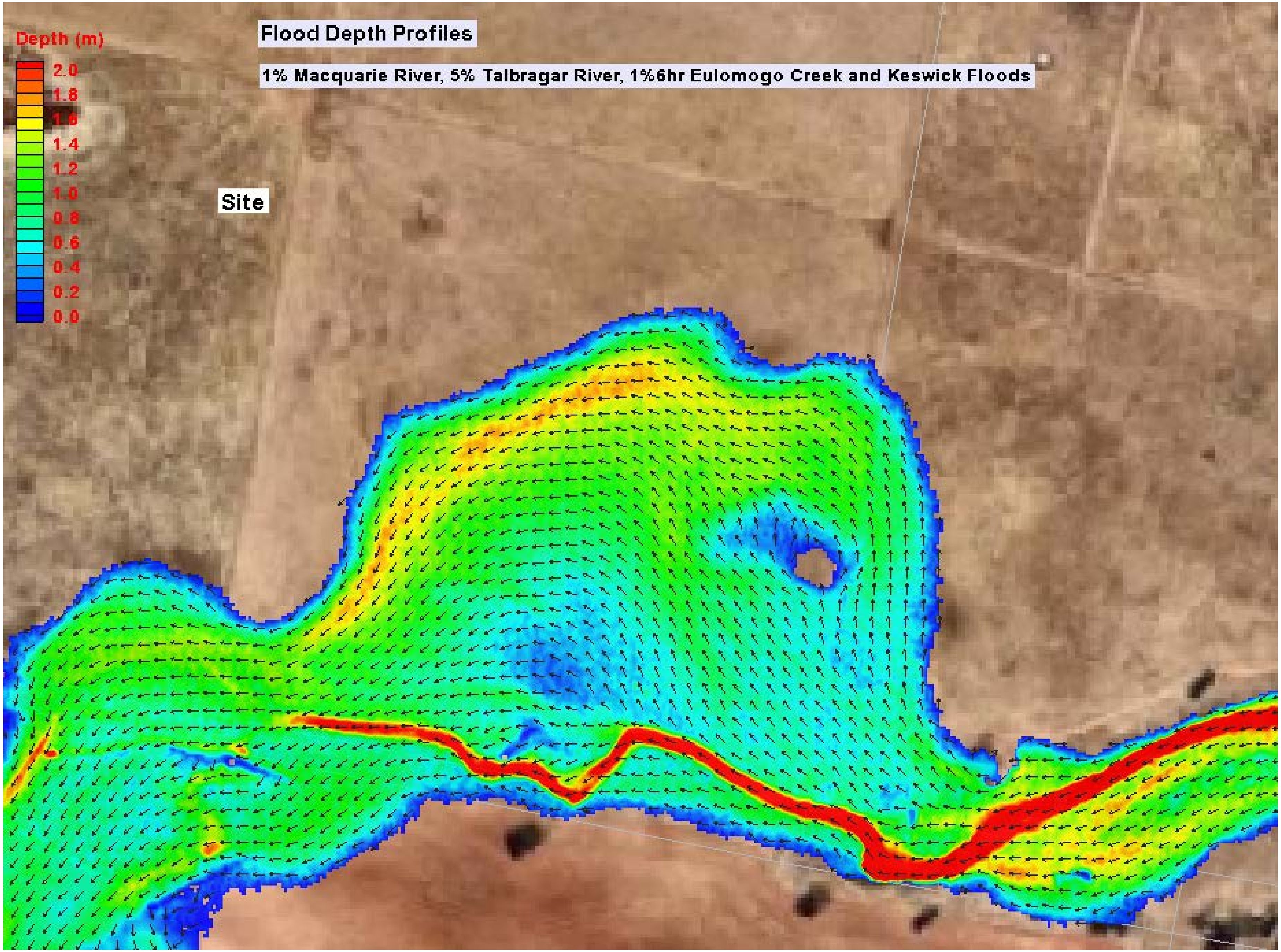


Figure 9 Zoomed 100 yr ARI Flood Depths - Hillview

Figure 10 100 yr ARI Flood Velocities

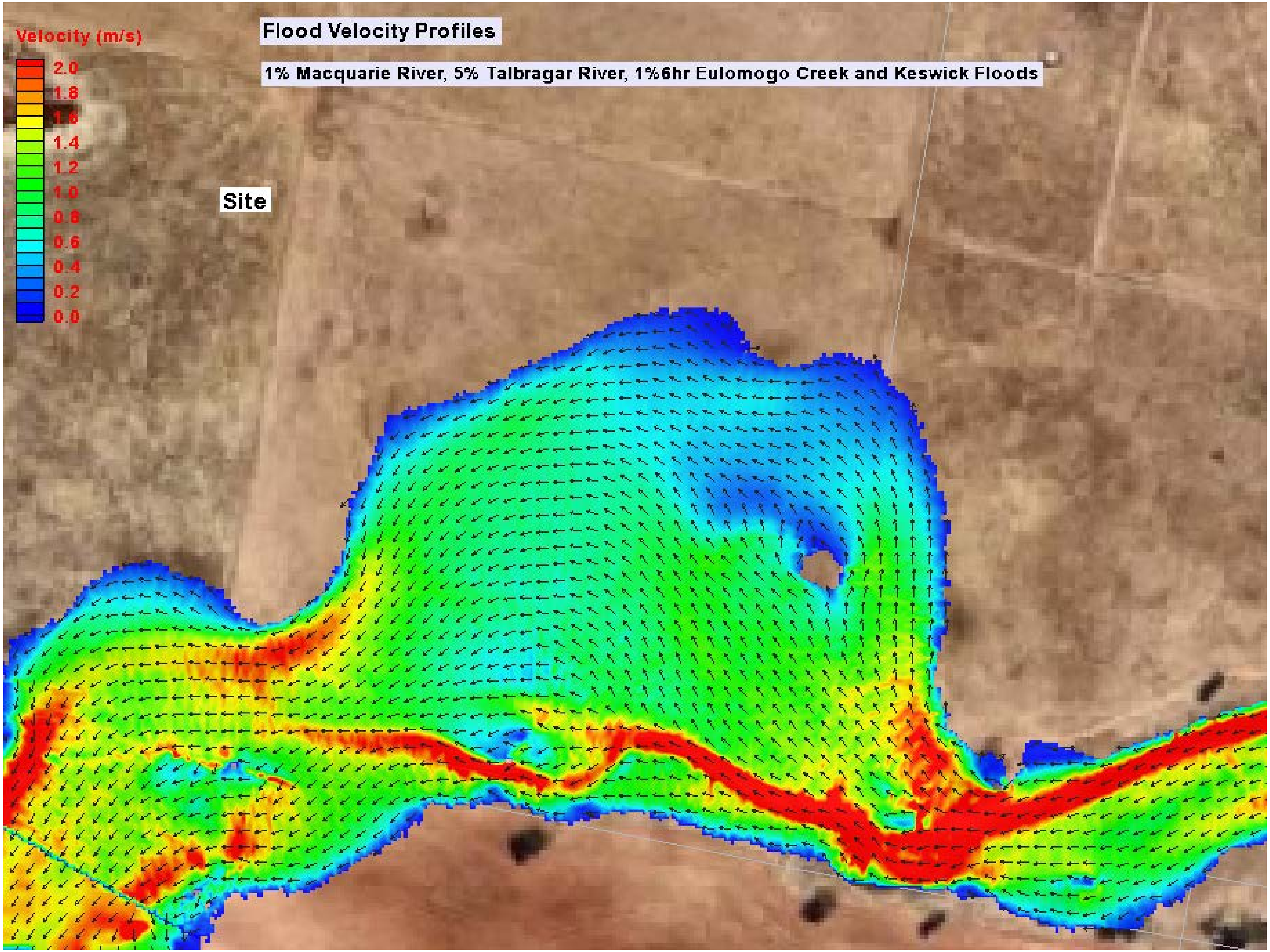


Figure 11 Zoomed 100 yr ARI Flood Velocities - Hillview

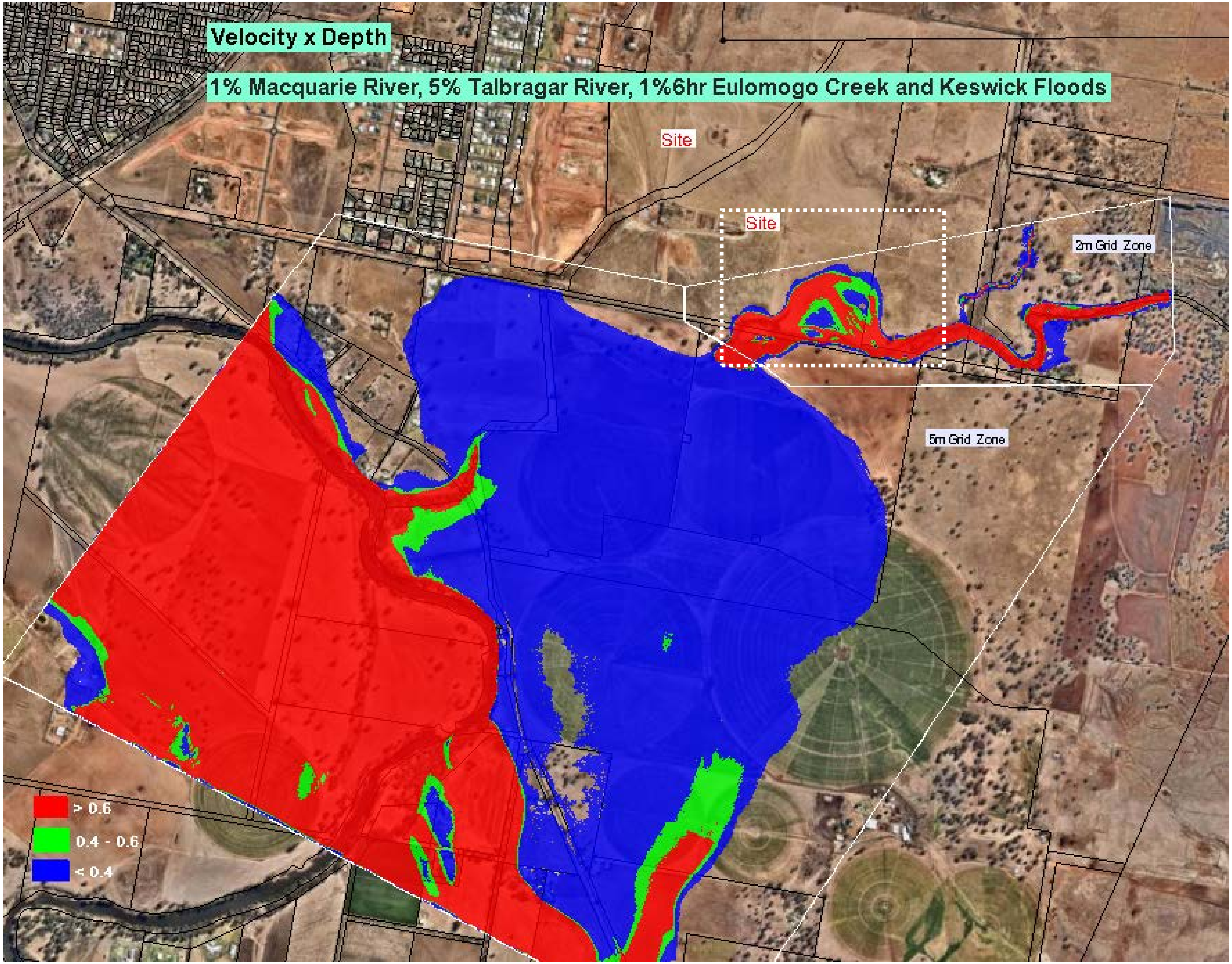


Figure 12 100 yr ARI Flood Velocity x Depth

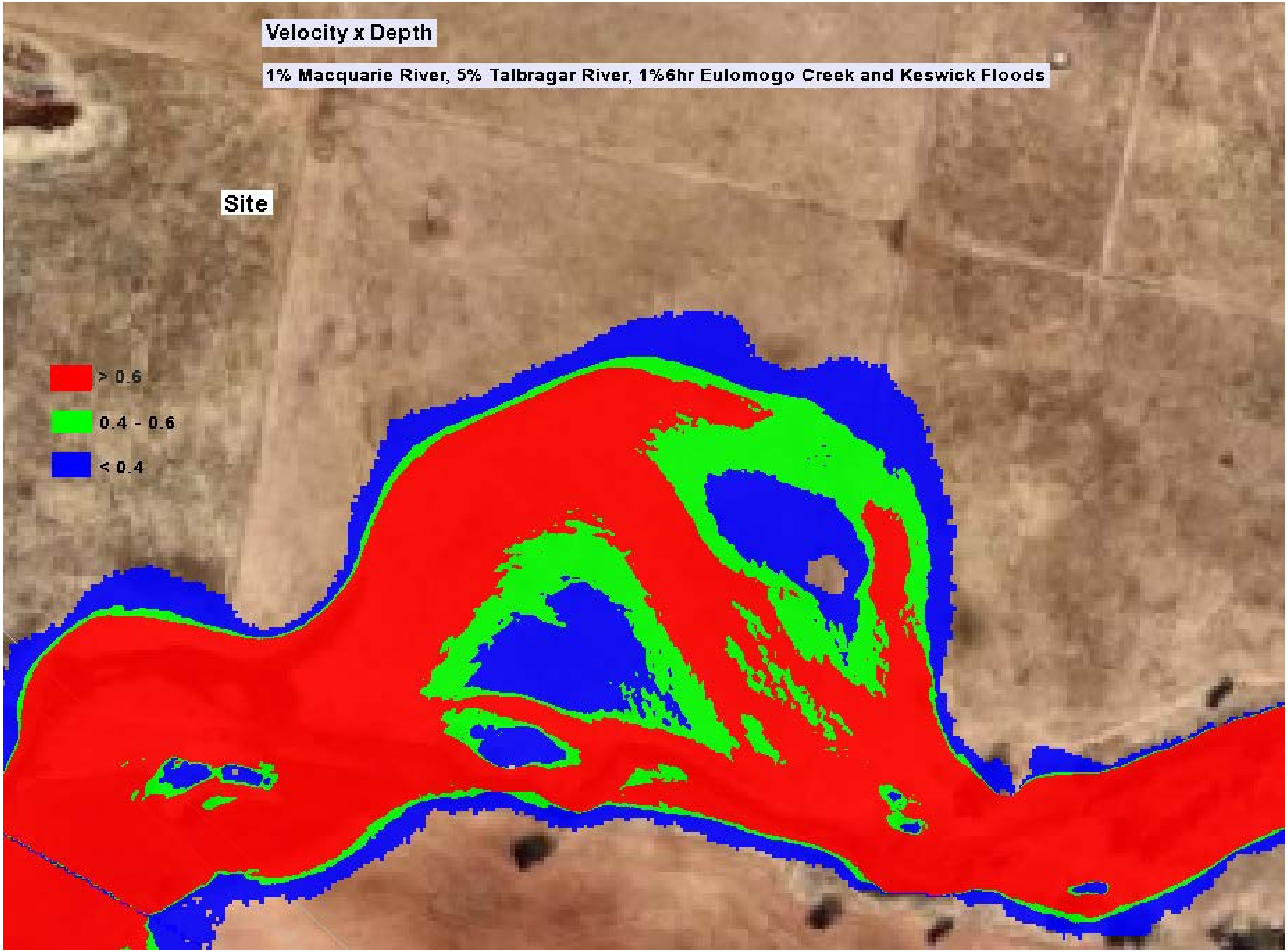


Figure 13 Zoomed 100 yr ARI Flood Velocity x Depth - Hillview

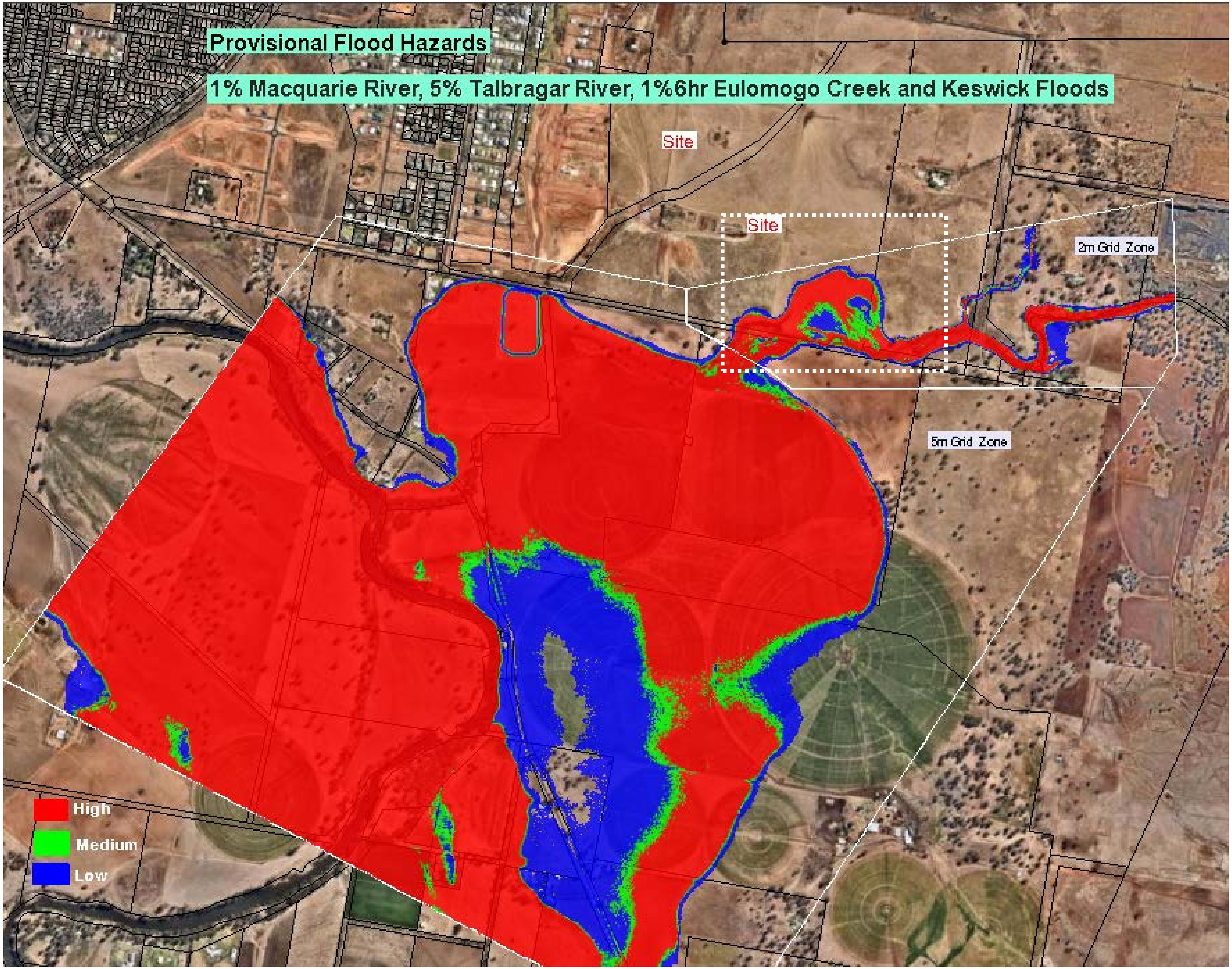


Figure 14   100 yr ARI Flood Hazards

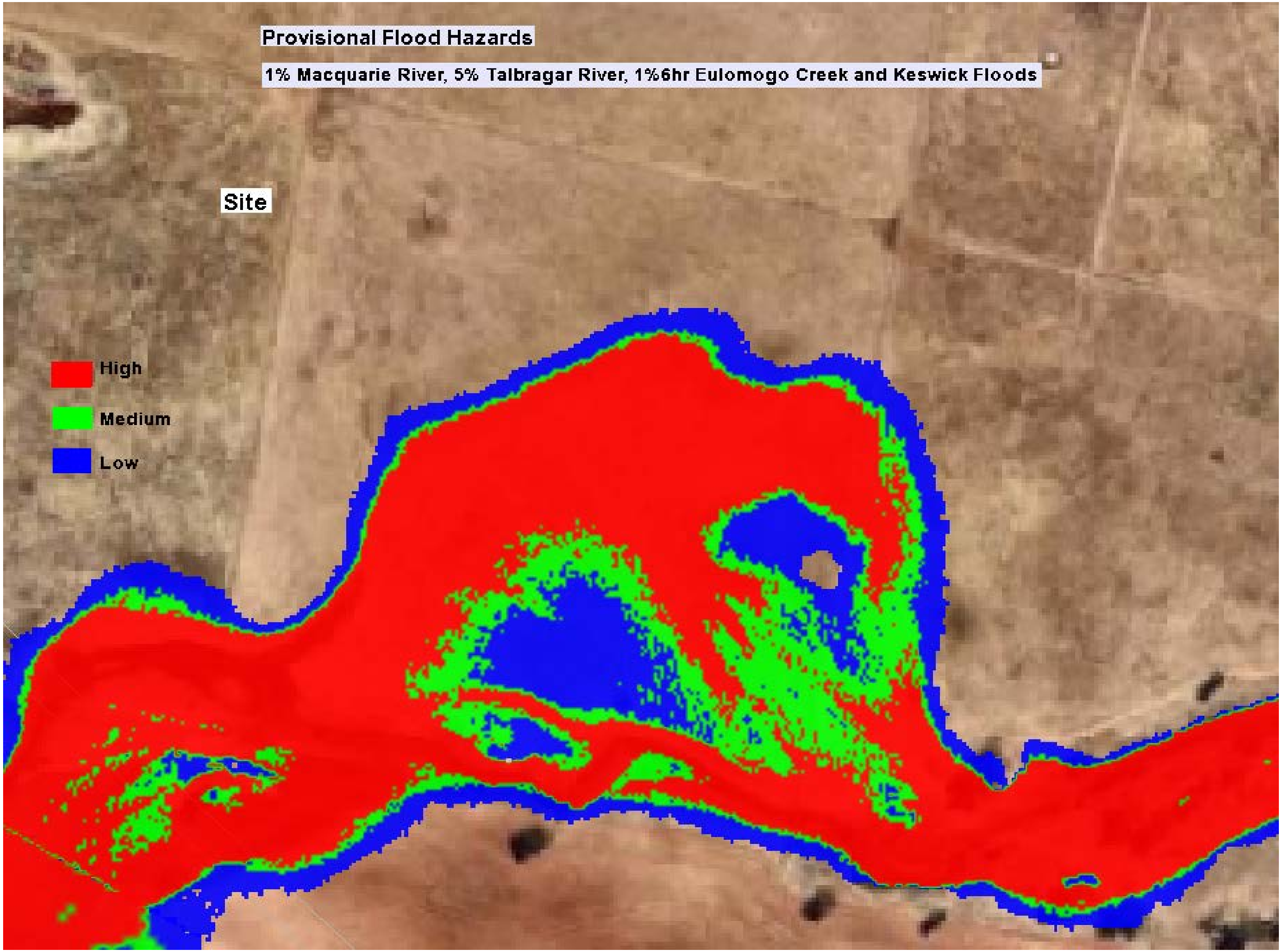


Figure 15 Zoomed 100 yr ARI Flood Hazards - Hillview

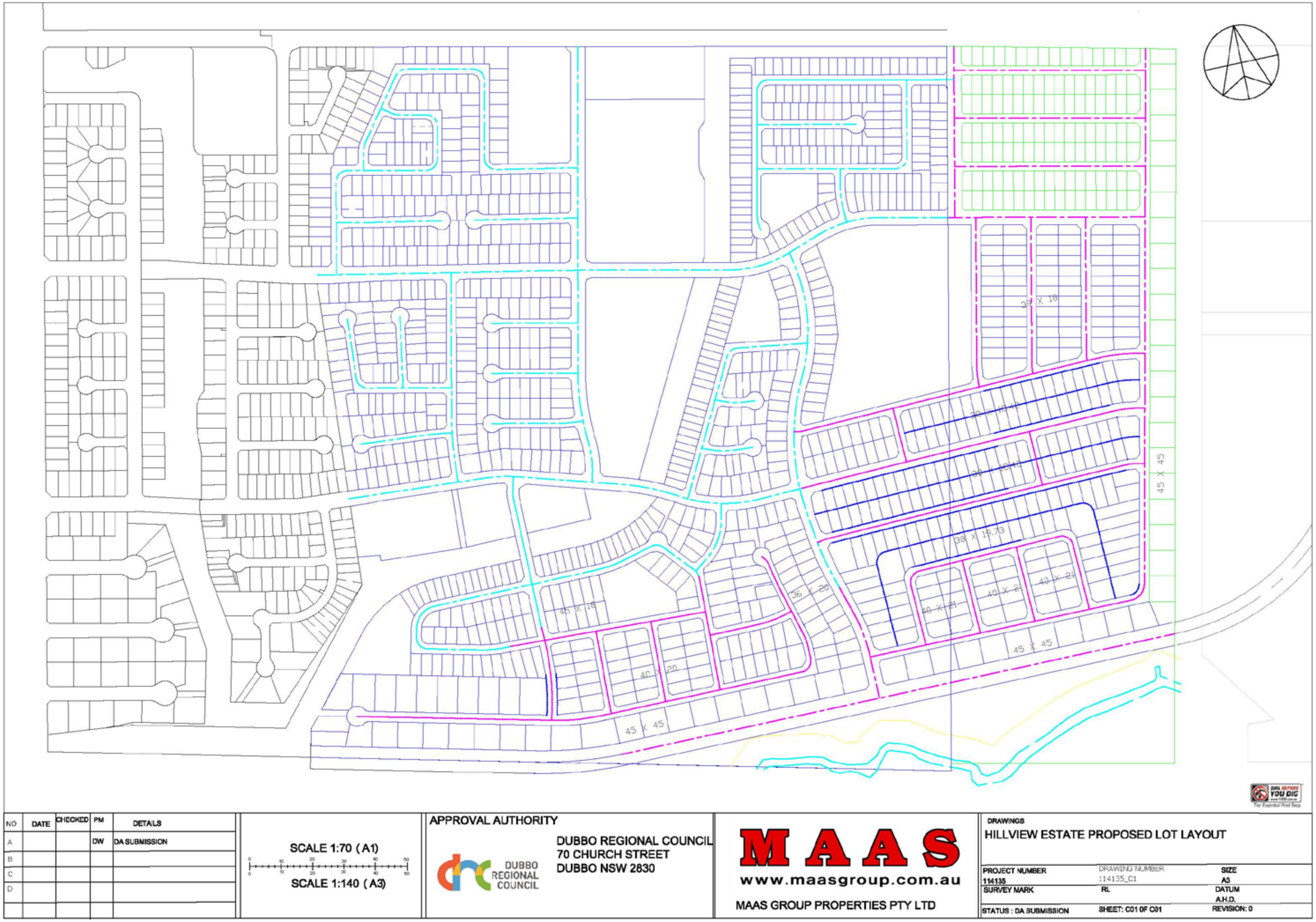


Figure 16 Proposed Lot Layout for Hillview Estate

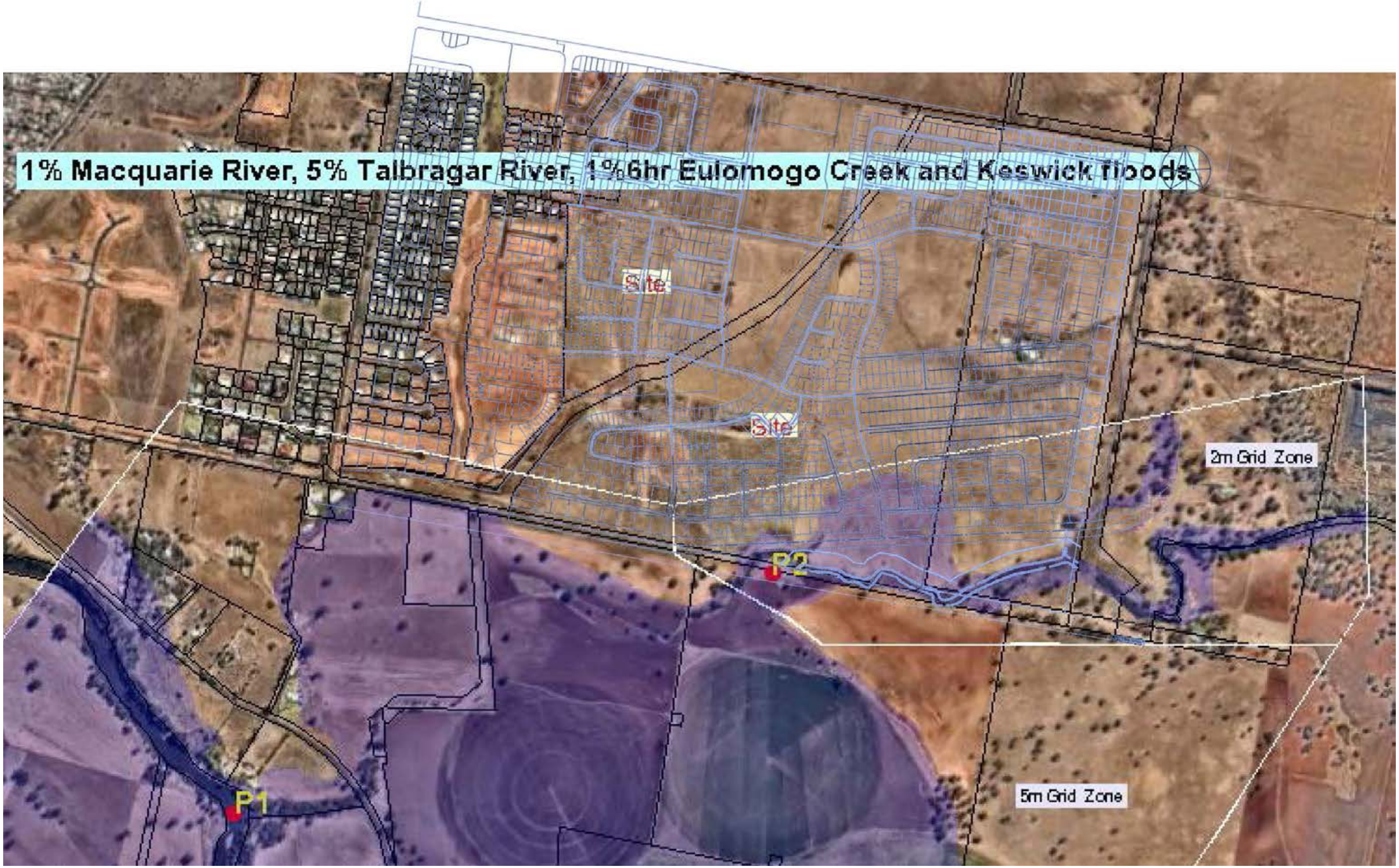


Figure 17 Proposed Development Layout overlaid on 100 yr ARI Flood Extent

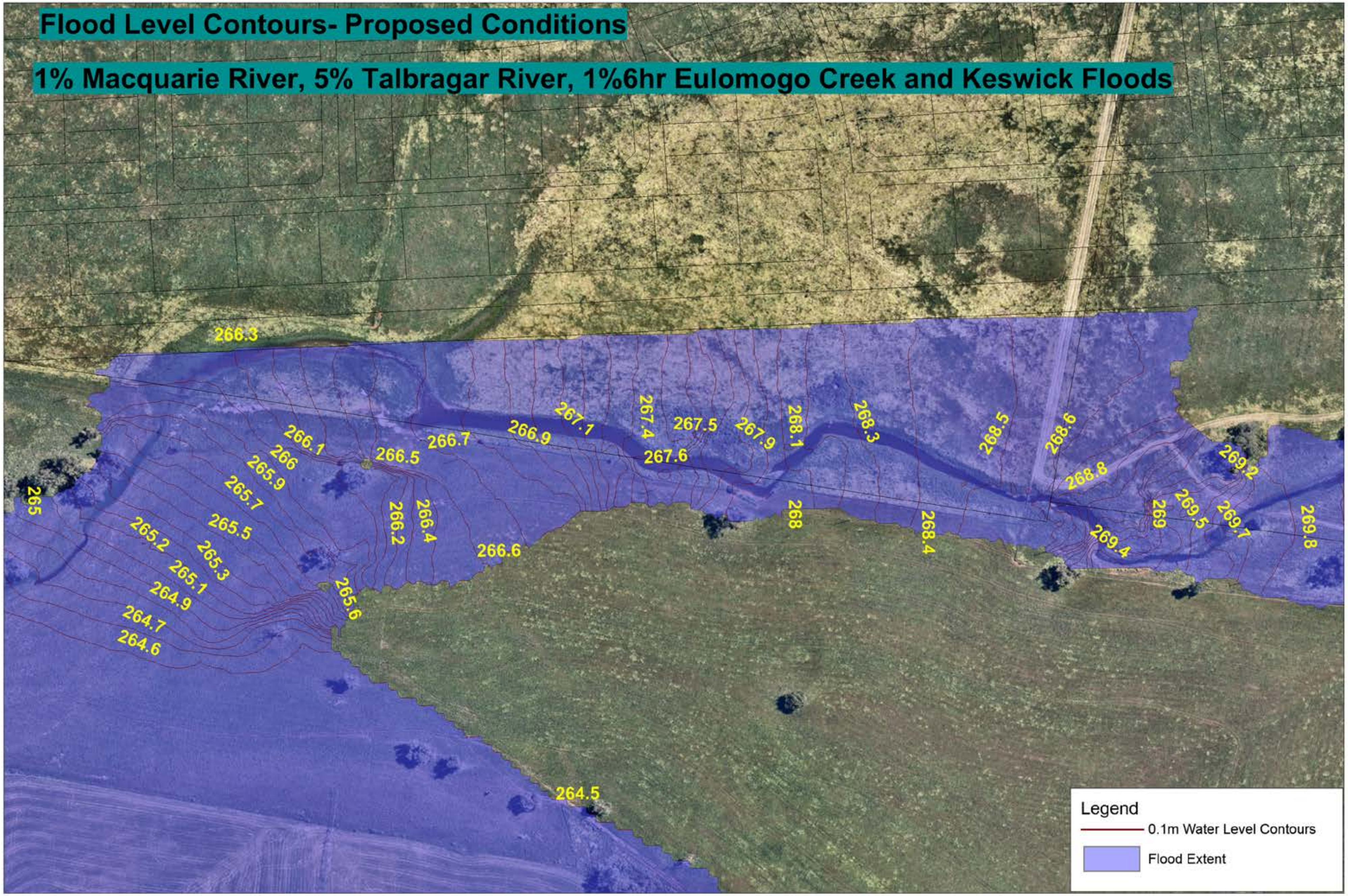


Figure 18 100 yr ARI Flood Levels – Hillview – Post-Development Conditions

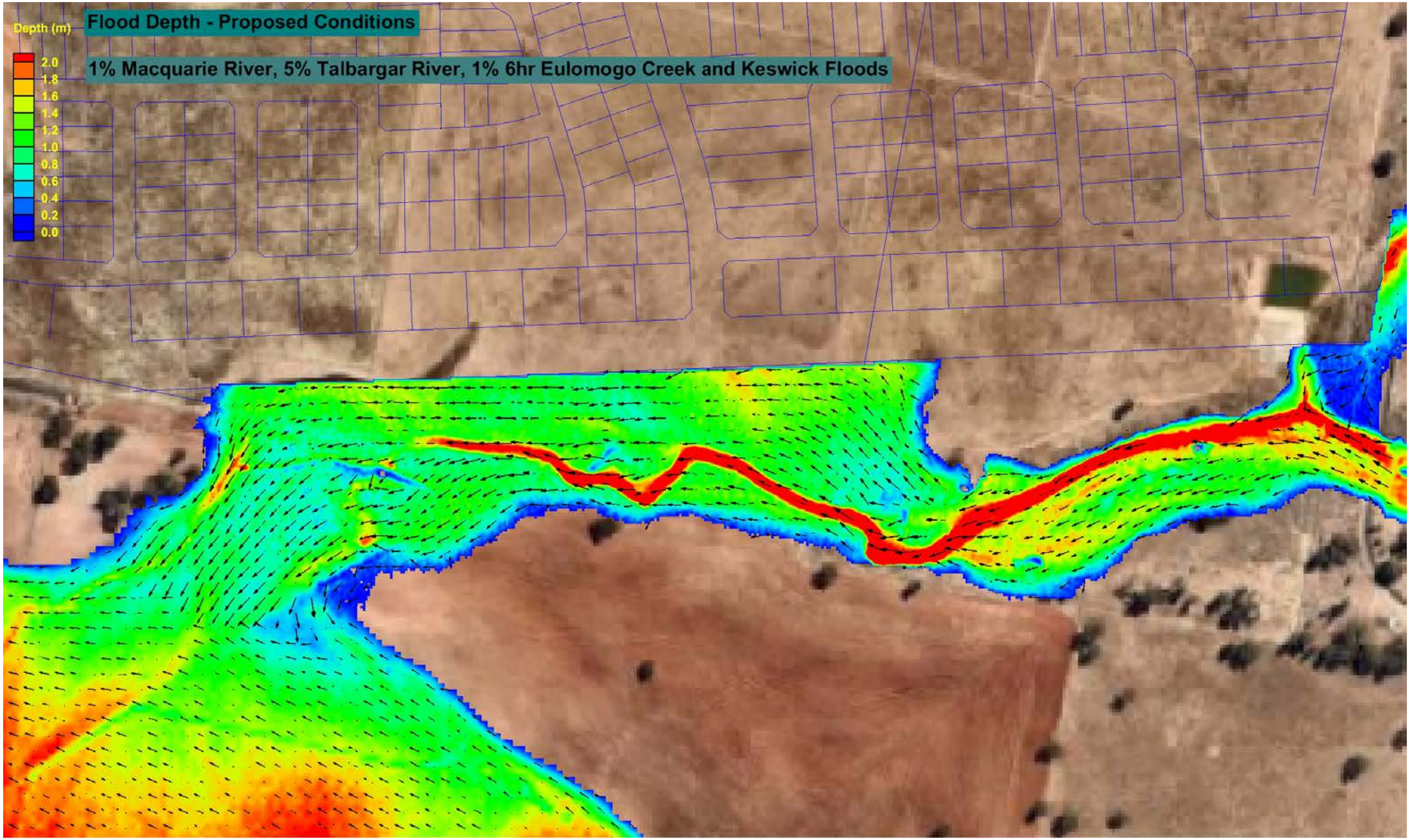


Figure 19 100 yr ARI Flood Depths – Hillview – Post-Development Conditions

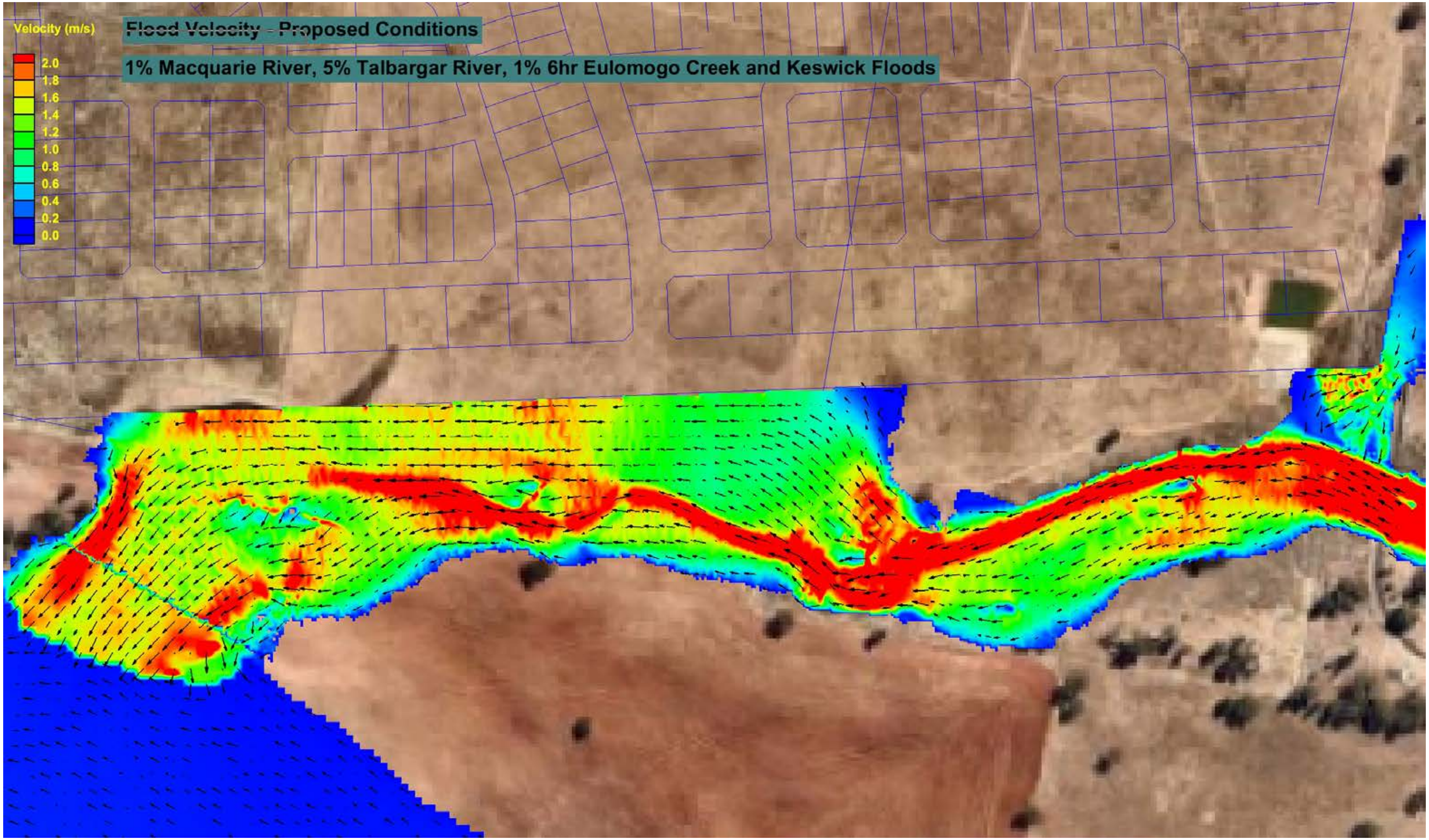


Figure 20 100 yr ARI Flood Velocities – Hillview – Post-Development Conditions

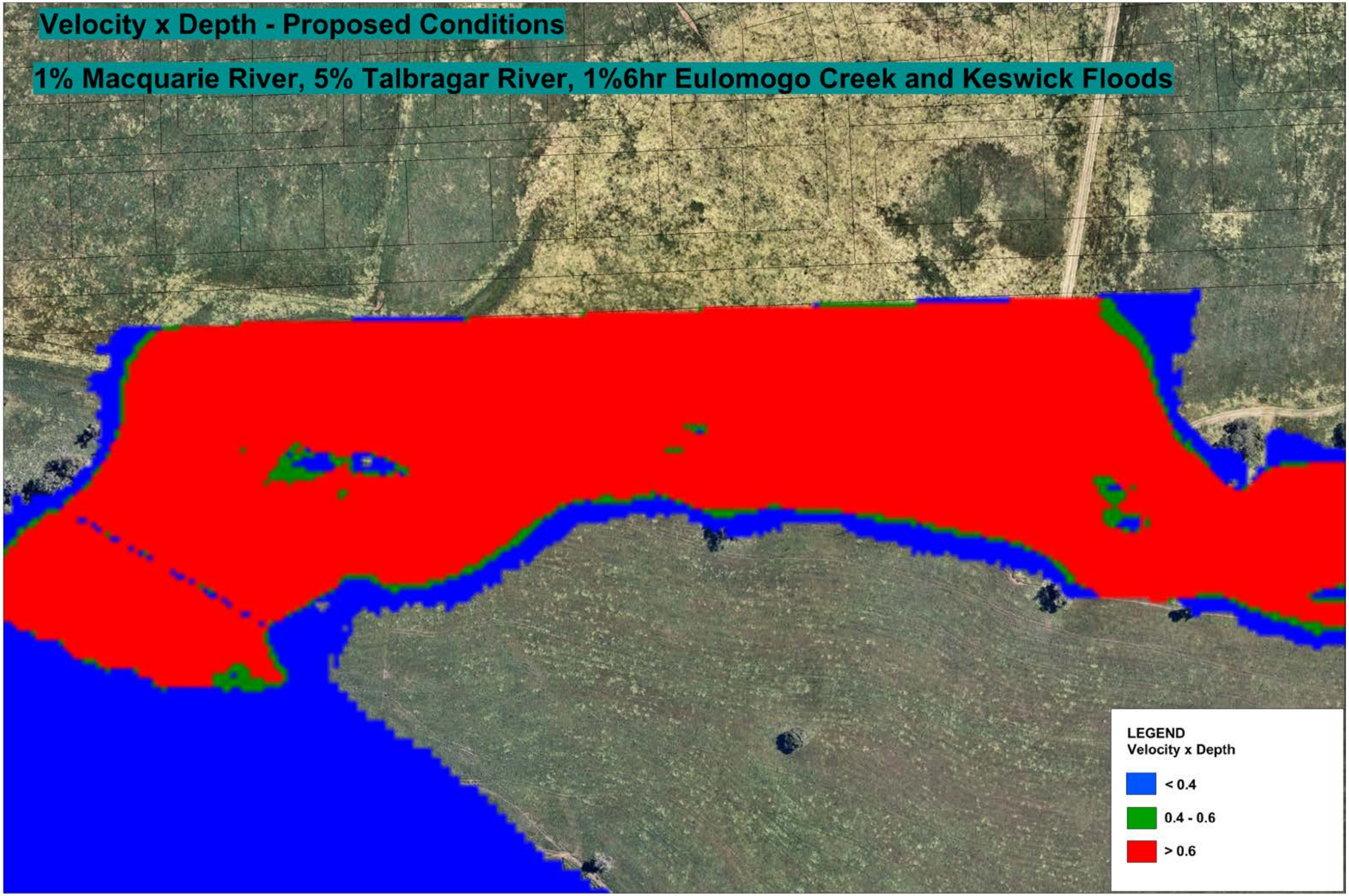


Figure 21 100 yr ARI Flood Velocity x Depth – Hillview – Post-Development Conditions

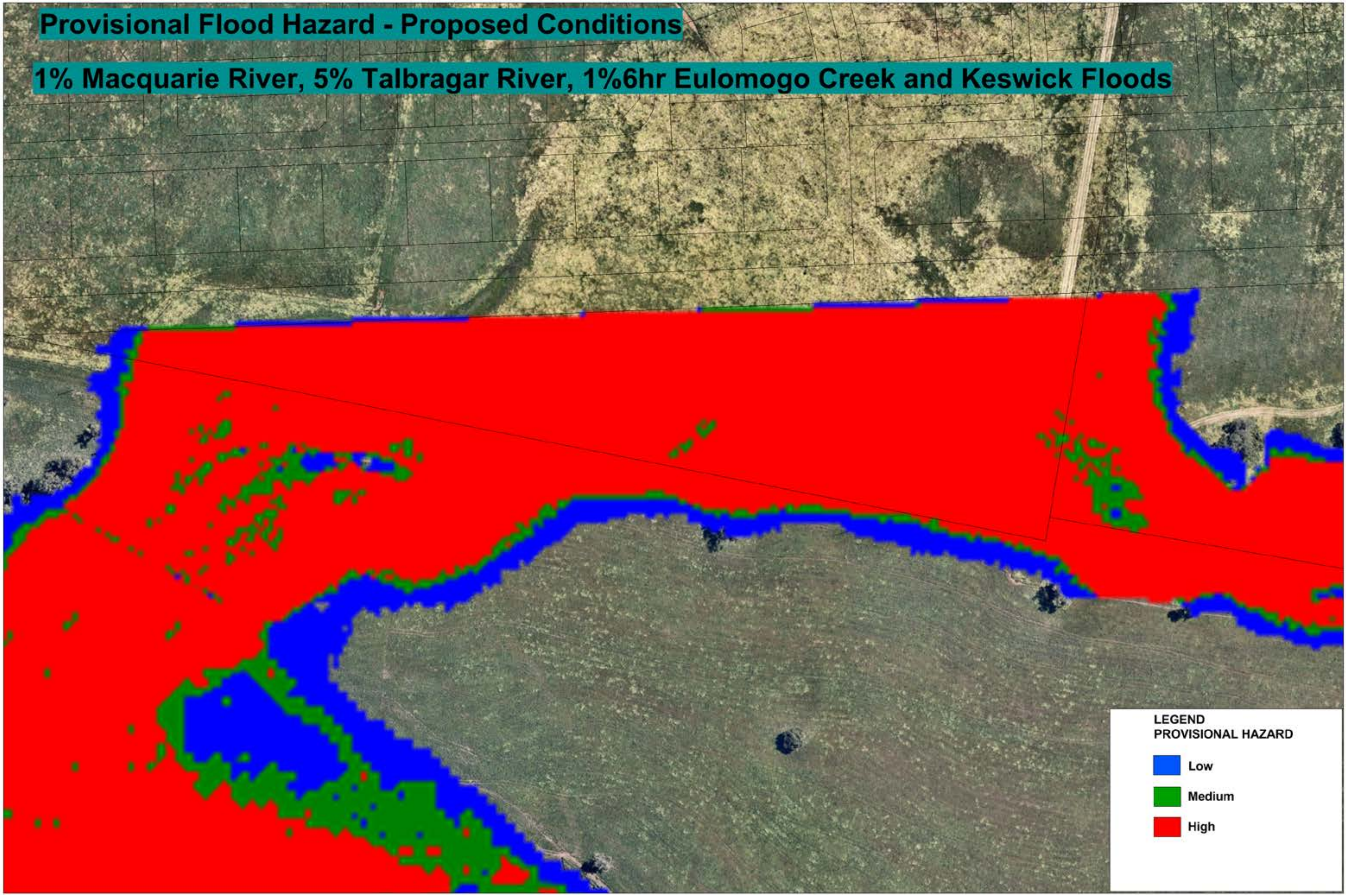


Figure 22 100 yr ARI Flood Hazards – Hillview – Post-Development Conditions

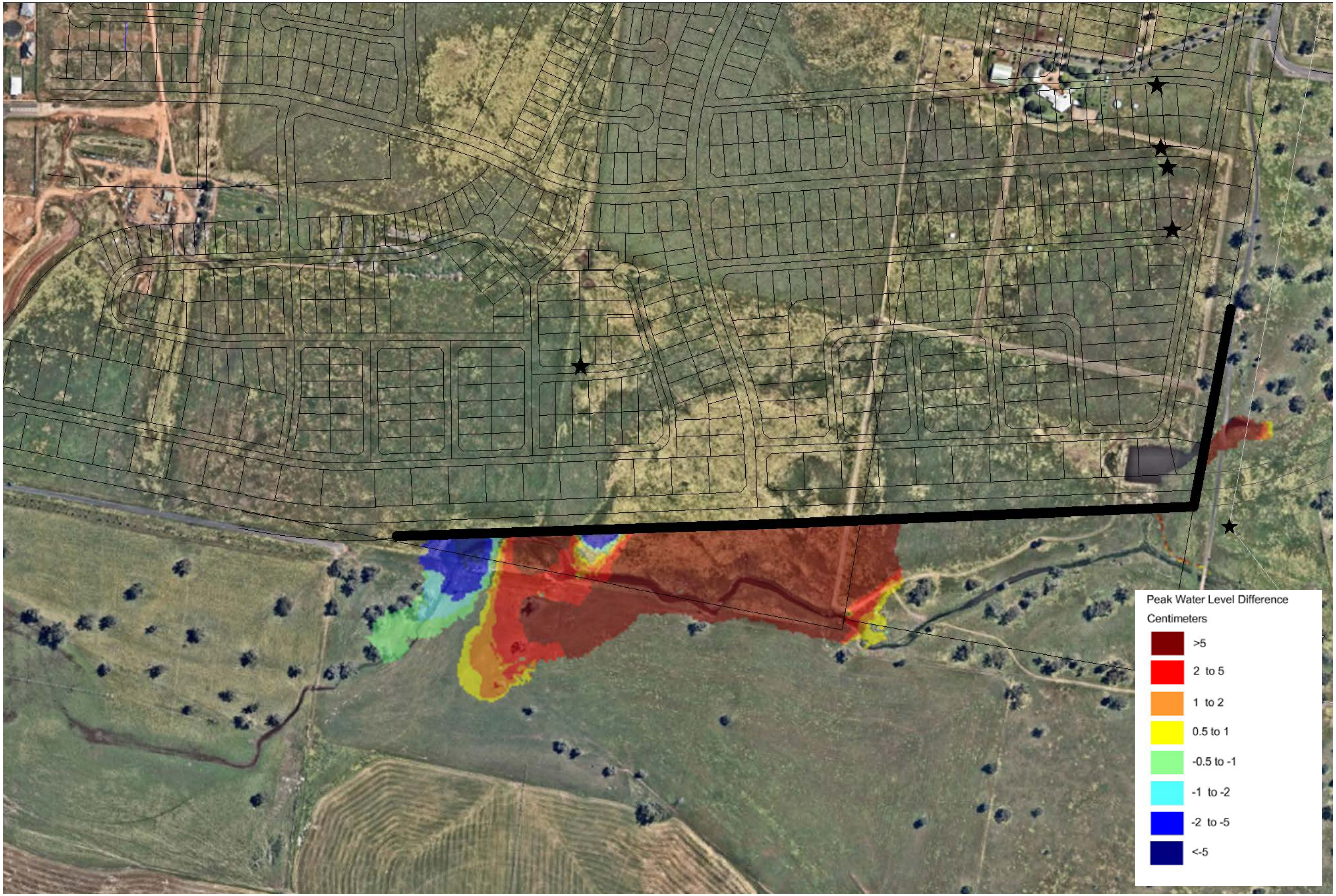


Figure 23 100 yr ARI Flood Level Differences – Hillview – Post-Development Conditions minus Existing Conditions

Appendix F

CONTAMINATION INVESTIGATION STUDY

Prepared by Envirowest Consulting Pty Ltd

March 2017

Preliminary contamination investigation

Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW

Ref: R7891c1
Date: 10 March 2017

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Assessor:	Ashleigh Pickering BSc Environmental Scientist
Checked by:	Leah Desborough BNatRes (Hons) Senior Environmental Scientist
Authorising Officer:	Greg Madafiglio PhD Senior Environmental Scientist
Interested authorities:	Dubbo City Council
Report number:	R7891c1
Date:	10 March 2017

Executive summary

Background

A residential subdivision is proposed for Lot 2 DP880413 Sheraton Road, Dubbo NSW. The site has an agricultural land-use history of grazing. An investigation of the site is required to determine the soil contamination status and suitability for residential and recreational land-use.

Objectives of the investigation

A preliminary site investigation was conducted in accordance with the contaminated land management planning guidelines State Environmental Planning Policy No. 55 (SEPP 55) to determine the soil contamination status of Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

Investigation and conclusions

An inspection of the site was made on 10 and 11 January 2017. The site is located in a developing residential area on the south eastern fringes of Dubbo and has an area of approximately 50 hectares.

The site has an agricultural land-use history of grazing. Several structures were identified on the site including a dwelling, machinery shed, cattle yards and two above ground storage tanks. There is no evidence of orchards, mines, sheep dips, mixing sheds or contaminating industrial activities on the site from the review of site history or site walkover. The use of agricultural pesticides over the area in the past is expected to be low.

The contamination status of the site was assessed from a soil sampling and laboratory analysis program. One hundred and four discrete soil samples were collected over the paddock areas from the 0 to 100mm soil depth. The discrete samples were combined to form twenty six composite samples for analysis. The soil samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel and zinc. Five discrete soil samples from within the paddocks were analysed for organochlorine pesticides (OCP). Seven discrete samples were collected from around the shed and historic cattle yards and were analysed for arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, organochlorine pesticides (OCP), total recoverable hydrocarbons (TRH) (C6-C40), benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN) and polycyclic aromatic hydrocarbons (PAH).

Two cottages were identified in aerial photographs (2006-2010) south of the machinery shed and had been removed at the time of the site inspection. The cottages were west of the dwelling. Asbestos containing fragments were identified in the area of the old cottages. Several small mounds containing soil, timber and bitumen were identified in this area. Asbestos containing fragments were excavated during investigations of the extent of asbestos impacted material. The asbestos fragments were generally spread across the surface with some buried up to 500mm in depth. The impacted area was approximately 600m^2 in size. The impacted material was removed landfill licensed to accept asbestos waste. A visual clearance was undertaken following excavation and removal of asbestos impacted material. Four surface samples were collected across the area of the historic cottages and analysed for heavy metals, OCP, TRH, BTEXN and PAH. The levels of all metals, OCPs, TRH, BTEXN and PAH analysed in the cottage soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds.

The levels of all metals and OCPs analysed in the machinery shed and yard area soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds. One soil sample from near the diesel above ground storage tank contained levels of TRH (>C16-C34) above the health screening levels for residential land use. Two soil samples collected from within the area of above ground storage tanks were above the adopted ecological screening levels for TRH (>C16-C34) for residential land use. Further investigations into the depth of hydrocarbon impacted material identified the impacted material was contained within the top 100mm of soil. The impacted material was excavated and removed during the investigations to determine the depth. The area was less than $10m^2$ in size. Three additional discrete samples were collected from the base of excavations and TRH was reported as not detected in all three samples. Hydrocarbon impacted material was removed to a licensed landfill.

The soil sampling program did not detect elevated levels of the analysed metals or OCP within the paddock areas. The levels of all substances evaluated were below the EPA investigation threshold for residential land-use with access to soil.

Recommendations

The site is suitable for the proposed residential and recreational activities.

If additional asbestos fragments or other hazardous materials are encountered then the unexpected finds protocol (Appendix 5) should be implemented which would include ceasing works and the identified impacted asbestos material removed in accordance with SafeWork methods “How to safely remove asbestos” prior to site works commencing.

Contents

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1. Introduction

A residential subdivision is proposed for Lot 2 DP880413 Sheraton Road, Dubbo NSW. The site has an agricultural land-use history of grazing. An investigation of the site is required to determine the soil contamination status and suitability for residential and recreational land-use.

A desktop study and a review of the available history were undertaken of the site. A walkover and site inspection for evidence of contamination from past activities was conducted on 10 and 11 January 2017. Soil samples were collected and analysed for metals, persistent pesticides and hydrocarbons.

2. Scope of work

Envirowest Consulting Pty Ltd was commissioned by Maas Group Properties Pty Ltd to undertake a preliminary contamination investigation, in accordance with the contaminated land management planning guidelines, from the *Contaminated Land Management Act 1997* and the *State Environmental Policy No. 55 (SEPP 55)*, of Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW. The objective was to identify past potentially contaminating activities, identify potential contamination types, discuss the site condition, provide a preliminary assessment of site contamination and assess the need for further investigation or suitability for residential land-use.

3. Site identification

Address	24R Sheraton Road Dubbo NSW
Client	Maas Group Properties Pty Ltd
Deposited plans	Lot 2 DP880413
Locality map	Figure 1
Site plan	Figure 2
Photographs	Figure 5
Area	Approximately 50ha

4. Site history

4.1 Zoning

The site is zoned R5 Large Lot Residential under the Dubbo Local Environmental Plan (2011).

4.2 Land-use

The site is currently used for grazing of livestock and horses on improved pastures. The site is located in a developing residential area on the south eastern fringes of the city of Dubbo. A dwelling is located on the property and is currently occupied. A machinery shed is located west of the dwelling along with farm machinery identified inside.

4.3 Summary of council records

None expected

4.4 Sources of information

Site inspection 10 and 11 January 2017 by Leah Desborough and Ashleigh Pickering
NSW EPA records of public notices under the CLM Act 1997
Soil and geological maps
Historical aerial photographs
Dubbo LEP 2011

4.5 Chronological list of site uses

The 1986 topographic map developed off the 1980 aerial photograph does not indicate any buildings or infrastructure on the site. A drainage line is located in the south eastern section of the site.

Aerial photography of the site indicated few changes between 1965 to 2016.

Year	Visual observations on site	Surrounding area
1965	The land appears predominantly cleared with remnant trees remaining. No buildings or dwellings are visible on the site. A drainage line is present in the southern section of the site.	The surrounding land appears to be used for grazing of stock. Land to the west of the site appears to have been cultivated.
1980	The site appears to have been split into two paddocks. The site remains free of buildings and dwellings.	Some trees have been removed to the east of the site. No other changes are evident to the surrounding land.
1995	The site remains split into two paddocks. A dwelling is visible in the central area of the lot with farm sheds.	No changes are evident to the surrounding land
2006	A dwelling, farm sheds and two cottages are visible. The paddocks have been divided into approximately five paddocks. A dam is located on the eastern boundary of the site. An area of stockpiles and disturbed soil is visible to the east of the cottages.	Agricultural grazing land remains surrounding the site on all sides. A quarry is evident approximately 1km to the east of the site. An increase in residential development is visible to the west of the site.
2010	The eastern cottage has been removed with demolition material evident. All other buildings remain. The stockpiles and disturbed soil is still evident.	No changes are evident to the surrounding land
2012	The western cottage has been removed and no demolition material is visible. The paddocks have been further divided and horse husbandry structures are visible in each paddock. The large machinery shed to the west of the dwelling has been expanded. The stockpiles and disturbed material is no longer visible.	Continued residential development is visible to the west.
2016	The dam on the eastern boundary of the property has been expanded. No other changes are visible to the site.	The residential developments to the west are expanding further east towards to site. The predominant land use surrounding the site remains agricultural grazing.

No orchards, mines, sheep dips or contaminating industrial activities are known to have been located on the site from the site inspection and site history.

4.6 Buildings and infrastructure

A dwelling, garage and large machinery shed were located in the central area of the site at the time of site inspection. Farming machinery including a sprayer and quadbike were identified inside the machinery shed.

Two above ground storage tanks (AST) were located north west of the large machinery shed. One AST was identified as unleaded petrol (ULP) with approximately 1000L capacity and the other AST was identified as diesel with approximately 2000L capacity.

House footings were identified from the two previous cottages located on site. Horse shelters were identified in each paddock.

4.7 Contaminant sources

No known contaminants have been applied to the site. The historic agricultural land-use may have resulted in application of pesticides.

The machinery shed is suspected to have been used for the storage of machinery and chemicals. Contamination may have occurred from leaking chemical and fuel storage containers.

The cottages may have been constructed using asbestos containing materials.

4.8 Contaminants of concern

Based on historical activities and site inspection the contaminants of concern are:

4.8.1 Paddocks

- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc)
- Organochlorine pesticides (OCP)

4.8.2 Machinery shed and yards

- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury)
- OCP
- Total Recoverable Hydrocarbons (TRH C6-C40)
- Polycyclic Aromatic hydrocarbons

4.8.3 Former cottage site

- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury)
- OCP
- Asbestos

4.9 Relevant complaint history

Nil

4.10 Contaminated site register

The investigation area is not listed on the NSW EPA register of contaminated sites.

4.11 Previous investigations

No previous investigations are known to have been undertaken on the site.

4.12 Neighbouring land-use

North – Rural
South – Rural
East – Rural with quarry beyond
West – Rural with residential development beyond

Historical and present neighbouring land-uses not expected to impact of the site.

4.13 Integrity assessment

The site history was obtained from a site inspection and history review. The information is consistent with the current site condition and to the best of the assessor's knowledge is accurate.

5. Site condition and environment

5.1 Surface cover

Surface cover on the site consisted of improved pasture including paspalum, lucerne, wild oats and wild sage and weed species include Paterson's curse, cat head, clover, saffron thistle and khaki weed. The site has been predominately cleared of native tree species. Eucalypts and cyprus pines occur within the south eastern section of the site.

5.2 Topography

The site is a mid-slope with a gentle inclination of less than 5% and a predominant southerly aspect. The site has several raised outcrops with scattered rocks located in the north eastern section of the site. The site drops off in the south eastern corner of the site to Eulomogo Creek. Eulomogo Creek traverses the southern section of the site.

5.3 Soils and geology

The site is within the Bunglegumbie and Wongarbon Soil Landscape (Murphy *et al.* 1998). Soil in the Bunglegumbie landscape consists of red-brown earths comprises dark brown sandy loam topsoil with bleached silty loam to reddish brown medium clay subsoil. Red earths comprise dark reddish brown loamy sands over a reddish brown fine sandy clay loam. The soil has a moderate fertility and generally low erodibility.

Soil in the Wongarbon Soil Landscape (Muphy et al. 1998) consists of Euchrozems and red and brown crack clays. The soil has a moderate to high fertility and a moderate to high erodibility

The site is underlain by Ballimore formation which comprises quartz sandstone, lithic sandstone, conglomerate, ferruginous sandstone, siltstone and undifferentiated olivine basalt and dolerite (Murphy *et al.* 1998).

5.4 Water

5.4.1 Surface water

The Eulomogo Creek traverses the southern section of the site. The drainage line empties into the Macquarie River approximately 2km west of the site. One dam has been formed within the site and fed by the natural slope of the site.

Surface water over the remainder of the site predominantly flows south and into the Eulomogo Creek.

5.4.2 Groundwater

Eight bores have been constructed across the site to depths from 29m to 149m. One bore is licensed for stock supplies and had water bearing zones from 57m in consolidated sandstone. No details are provided for the other bores and it is expected they did not intercept groundwater and were not cased.

5.5 Evidence of contamination checklist

Site layout showing industrial processes	None present
Sewer and service plans	None known
Manufacturing processes	None known
Underground tanks	None known
Product spills and loss history	Pesticide mixing or storage of chemicals may have occurred in the machinery shed. Small amounts of diesel and ULP may have been spilled during refuelling on site.
Discharges to land, water and air	None known
Disposal locations, presence of drums, wastes and fill materials	Two small mounds of soil were identified near the location of the previous cottages. The mounds of soil contained rock, soil, timber and bitumen. Asbestos cement fragments were identified to the west of the mounds within the historical cottages location.
Soil staining	Nil
Visible signs of plant stress, bare areas	Nil
Odours	Nil
Ruins	Footings of the former cottage
Other	Nil

6. Conceptual site model

Potential contamination sources, exposure pathways and receptors are presented below.

Contamination source	Potential exposure pathways	Receptors
Hydrocarbon spills Pesticides ACM fragments	Direct contact (ingestion and absorption) Wind blown	*On-site* Residential Site workers Terrestrial environment *Off-site* Residential Rural

7. Data quality objectives (DQO)

7.1 State the problem

A change of land-use is proposed from rural to low density residential including recreational areas. The property has historically been used for grazing stock on improved pastures and associated machinery is expected to have been used. A dwelling is located in the central section of the site. The site requires investigation to ensure suitability for the proposed land-use.

7.2 Identify the decision

The land-use proposed is low density residential and the levels of contaminants should be less than the thresholds listed in Section 10. The decision problem is, do the levels of potential contaminants exceed the assessment criteria listed in Section 10.

7.3 Identify the inputs decision

Investigations of the paddocks, the machinery shed and yards and the old cottage area is required to identify any potential contaminants from historical land use.

7.4 Define the boundaries of the study

The investigation area is Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

7.5 Develop a decision rule

The initial guidelines for soil were the health investigation levels for residential and recreational land-use (NEPC 1999).

If soil contamination was identified then the contaminant source and extent of contamination was determined.

7.6 Specify acceptable limits on the decision errors.

The 95% upper confidence limit of average levels of samples collected are less than the threshold levels.

7.7 Optimize the design for obtaining data

Soil samples were collected from the paddocks on an approximate 70m and combined to form composite samples. Discrete soil samples were collected from the machinery area in potential hot spot areas. Analytes to be evaluated include heavy metals, OCP, TRH (C6-C40), BTEXN and PAH. Discrete soil samples were collected from the old cottage area and the AST area following additional investigations.

8. Sampling analysis plan and sampling methodology

8.1 Sampling strategy

The main land-use was identified as grazing on agricultural paddocks with associated machinery use.

8.1.1 Sampling design

8.1.1.1 Paddocks

A systematic sampling pattern was adopted to assess the probable location of contamination in the paddocks. Uniform management practices are expected to have occurred on the site. The site has been historically managed as part of a single unit and is expected to have been treated similarly.

8.1.1.2 Machinery shed and yards

A judgmental sampling pattern was adopted to assess the probably location of contamination in the machinery shed and yards area. Potential hotspot locations were identified in the machinery shed and yards area and discrete samples were taken. Discrete soil samples were collected following additional investigations to determine the extent of hydrocarbon impacted material.

8.1.1.3 Old cottages area

A systematic sampling pattern was adopted to assess the probable location of contamination within the old cottages area.

8.1.2 Sampling locations

8.1.2.1 Paddocks

Discrete soil samples were collected from the site on an approximate 70m grid pattern across the paddocks. Four discrete samples were combined to form a composite soil sample. A total of 104 discrete soil samples were collected and combined to form 26 composite samples for analysis. The sampling locations are described in Figure 2.

A visual inspection of the site for asbestos was undertaken.

8.1.2.2 Machinery shed and yard area

Seven discrete soil samples were collected from the machinery shed and yard area. Three additional samples were collected from the above ground storage area to confirm the hydrocarbon impacted materials had been removed.

The sampling locations are described in Figure 2.

8.1.2.3 Old cottages area

Four discrete soil samples were collected from the old cottages area on an approximate 15m grid pattern. The sampling locations are described in Figure 2.

A visual inspection of the old cottage area for asbestos was undertaken following excavation of asbestos impacted material.

8.1.3 Sampling density

8.1.3.1 Paddocks

The sampling density can detect a potential hot spot with a radius of 41m at a 95% level of confidence. Uniform management practices have been undertaken on the site and the soil sampling and laboratory analysis is considered indicative of the site as a whole. The sampling frequency is less than the minimum recommended by EPA (1995) but justified due to the uniform management of the site.

The surface was visually inspected for asbestos. One cement sheeting sample was submitted for analysis from an area to the east of the cottages.

8.1.3.2 Machinery shed and yard area

Potential hot spot areas were identified within the machinery shed and yard area. The sampling frequency is considered adequate for the area.

8.1.3.3 Old cottages area

The sampling density can detect a potential hot spot with a radius of 8.8m at a 95% level of confidence. Uniform management practices have been undertaken on the site and the soil sampling and laboratory analysis is considered indicative of the site as a whole. The sampling frequency is less than the minimum recommended by EPA (1995) but justified due to the uniform management of the area.

8.1.4 Sampling depth

Any heavy metals or persistent pesticides present are generally immobile and expected to be contained in the 0-100mm soil layer which was the target sampling depth as soil disturbance has not occurred.

The investigation area was also visually inspected for asbestos.

8.2 Analytes

8.2.1 Paddocks

The paddock composite soil samples were evaluated for OCP, arsenic, cadmium, chromium, copper, lead, nickel and zinc as these were identified as the contaminants of concern possibly present as a result of previous activities.

One sample of cement sheeting fragment was analysed for asbestos identification.

8.2.2 Machinery shed and yard area

The machinery and yard discrete soil samples were evaluated for OCP, arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, TRH, BTEXN and PAH as these were identified as the contaminants of concern possibly present as a result of previous activities (Table 1). Additional samples were analysed for TRH (C6-C40) as these were identified as the contaminants present.

8.2.3 Old cottages area

The old cottage area discrete soil samples were evaluated for arsenic, cadmium, chromium, copper, lead, nickel, zinc and OCP as these were identified as the contaminants of concern possibly present as a result of previous activities (Table 1).

8.3 Sampling methods

Soil samples were taken using a stainless steel soil push corer. Soil was taken at each individual sampling location below the vegetated and detrital layer.

The soil was transferred to a stainless steel bucket, mixed and transferred to a solvent rinsed glass jar with a Teflon lid. Combining 4 discrete samples made a composite sample for chemical analysis. Discrete soil samples were transferred directly to a solvent rinsed glass jar with a Teflon lid.

Tools were decontaminated between sampling locations to prevent cross contamination by: brushing to remove caked or encrusted material, washing in detergent and tap water, rinsing in an organic solvent, rinsing with clean tap water and allowing to air dry or using a clean towel.

A visual inspection was undertaken to determine the presence of asbestos across the site. One fragment of cement sheeting was submitted for analysis.

Table 1. Schedule of samples and analyses

Sample ID	Discrete sample ID (Figure 2)	Location	Depth	Analysis undertaken
SR1	11, 12, 13, 14	Paddock	0-100mm	Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn)
SR2	21, 22, 23, 24	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR3	31, 32, 33, 34	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR4	41, 42, 43, 44	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR5	51, 52, 53, 54	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR6	61, 62, 63, 64	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR7	71, 72, 73, 74	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR8	81, 82, 83, 84	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR9	91, 92, 93, 94	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR10	101, 102, 103, 104	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR11	111, 112, 113, 114	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR12	121, 122, 123, 124	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR13	131, 132, 133, 134	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR14	141, 142, 143, 144	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR15	151, 152, 153, 154	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR16	161, 162, 163, 164	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR17	171, 172, 173, 174	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR18	181, 182, 183, 184	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR19	191, 192, 193, 194	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR20	201, 202, 203, 204	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR21	211, 212, 213, 214	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR22	221, 222, 223, 224	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR23	231, 232, 233, 234	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR24	241, 242, 243, 244	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR25	251, 252, 253, 254	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR26	261, 262, 263, 264	Paddock	0-100mm	As, Cd, Cr, Cu, Pb, Ni, Zn
SR27	SR27	Cattle yard	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Total Recoverable Hydrocarbons (C6-C40) (TRH), Polycyclic Aromatic Hydrocarbon (PAH), Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalene (BTEXN)
SR28	SR28	ULP AST	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Mercury (Hg), TRH , PAH, BTEXN
SR29	SR29	Diesel AST	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR30	SR30	Behind machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR31	SR31	Behind machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR32	SR32	Inside machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN

Table 1 cont. Schedule of samples and analyses

Sample ID	Discrete sample ID	Location	Depth	Analysis undertaken
SR33	SR33	Inside machinery shed	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, TRH, PAH, BTEXN
SR73	SR73	Paddock	0-100mm	OCP
SR91	SR91	Paddock	0-100mm	OCP
SR113	SR113	Paddock	0-100mm	OCP
SR184	SR184	Paddock	0-100mm	OCP
SR224	SR224	Paddock	0-100mm	OCP
SR201	SR201	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SR202	SR202	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SR203	SR20	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SR204	SR204	Old cottage area	0-100mm	OCP, As, Cd, Cr, Cu, Pb, Ni, Zn, Hg
SRV301	SRV301	AST area	0-100mm	TRH
SRV302	SRV302	AST area	0-100mm	TRH
SRV303	SRV303	AST area	0-100mm	TRH

9. Quality assurance and quality control

9.1 Sampling design

The sampling program is intended to provide data as to the presence and levels of contaminants.

Discrete soil samples were collected on a systematic pattern across the paddocks on an approximate grid pattern of 70 metres. This sampling density will enable the detection of an area with an elevated concentration on a radius of 41 metres with a 95% confidence level. Five discrete soil samples were analysed from within the paddocks for OCP.

Seven discrete samples were collected from the machinery shed and yard area. The samples were taken in potential hotspot areas and the frequency is considered adequate.

The number of sampling locations is less than the recommended density in the EPA sampling guidelines but justified due to the uniform management practices on the site. No “hot spots” smaller than the sampled grid are expected over the site.

One cement sheeting fragment from the surface of the old cottage area was collected and submitted for asbestos identification.

9.2 Field

The collection of samples was undertaken in accordance with accepted standard protocols (NEPC 1999). Composite sampling was undertaken to reduce the cost of chemical analysis. Combining equal amounts from four discrete samples created the composite samples. A composite sample represents the average concentration of the sub-sample.

The rules for composite sampling were observed (EPA 1995). All composite samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel and zinc.

Sampling equipment was decontaminated between each sampling event. The appropriate storage conditions and duration were observed between sampling and analysis. A chain of custody form accompanied the samples to the laboratory (Appendix 2).

A single sampler was used to collect the samples using standard methods. Soil collected was a fresh sample from a hand shovel. After collection the samples were immediately placed in new glass sampling jars and placed in a cooler.

Two duplicate samples were collected. No field blank, rinsate, trip blank or matrix spikes were submitted for analysis. Some samples from all batches did not contain contaminants which confirm the absence of cross contamination during transport and storage. A field sampling log is presented in Appendix 3.

9.3 Laboratory

9.3.1 Soil

Chemical analysis was conducted by SGS Laboratories, Alexandria, which is NATA accredited for the tests undertaken. The laboratories have quality assurance and quality control programs in place, which include internal replication and analysis of spike samples and recoveries.

Method blanks, matrix duplicates and laboratory control samples were within acceptance criteria. The quality assurance and quality control report is presented together with the laboratory report as Appendix 2.

9.3.2 Asbestos cement sheeting

Asbestos identification was undertaken at Greencap, South Australia, which is NATA accredited for the test undertaken.

9.4 Data evaluation

The laboratory quality control report indicates the data variability is within acceptable industry limits. The data is considered representative and usable for the purposes of the investigation. Data quality indicators are presented in Appendix 1.

10. Assessment criteria

10.1 Soil

The proposed land use is low density and large lot residential. The laboratory results were assessed against the proposed land-use of residential (*HIL A*) and recreational (*HIL C*). The health-based investigation levels of contaminants in the soil for residential and recreational sites, for the substances for which criteria are available, are listed in Table 2, as recommended in the NEPC (1999).

The NEPC (1999) also provides health screening levels (HSL) for hydrocarbons in soil. The HSLs have been developed to be protective of human health for soil types, depths below surface and apply to exposure to hydrocarbons through the predominant vapour exposure pathway. The appropriate HSL for the site is listed in Table 2. TRH>16 have physical properties which make the TRH fractions non-volatiles and therefore these TRH fractions are not applicable for vapour intrusion.

Ecological investigation levels (EIL) have been developed for the protection of terrestrial ecosystems for selected metals and organic substances in the soil in the guideline (NEPC 1999). Ecological screening levels (ESL) assess the risk to terrestrial ecosystems from petroleum hydrocarbons in the soil. The EILs and ESLs consider the properties of the soil and contaminants and the capacity of the local ecosystem to accommodate increases in contaminant levels.

EILs vary with land-use and apply to contaminants up to 2m depth below the surface. The EILs for residential and recreational land-use are listed in Table 2.

ESLs are dependent on land-use, soil types and are applicable to contaminants up to 2m below the surface. The appropriate ESL for the site is residential in fine soil as listed in Table 2.

Management limits have been developed to assess petroleum hydrocarbons following evaluation of human health and ecological risks (NEPC 1999). Management limits are applicable as screening levels after consideration of relevant ESLs and HSLs. The appropriate management limit for the site is listed in Table 3.

The investigation threshold was adjusted to enable the detection of an individual location being diluted in the composting process (EPA 1995). For composite sampling, the analyte result was divided against the number of discrete samples making up the composite. This is based on a worst-case scenario in which one sample has a high concentration whilst other discrete samples have zero concentration. This is a conservative approach.

Chromium is analysed as total chromium which is the sum of chromium (III) and chromium (VI). Chromium (VI) is a potential contaminant from industrial processes including ferrochrome production, electroplating, pigment production and tanning (WHO 1998) and is not expected to occur in agricultural sites. Chromium (VI) is reduced to chromium (III) when it comes into contact with organic matter in biota, soil and water. No threshold has been set for total chromium on agricultural sites as it is ubiquitous in the environment and is almost always present in the trivalent state (WHO 1998). Chromium (III) is poorly absorbed by any route therefore toxicity of chromium is mainly attributable to chromium (VI) (ATSDR 2013).

10.2 Asbestos

One pieces of cement sheeting was sent to Greencap for asbestos identification by Polarised Light Microscopy including Dispersion Staining (AS4964-2004). The requirement for the soil surface to be free of asbestos is applicable.

Table 2. Soil assessment criteria metals and OCPs (mg/kg)

Analyte	Residential land-use with access to soil threshold (NEPC 1999)		Public open space- HIL C Recreational (NEPC 1999)		EIL – Urban residential and public open space	
	Discrete Samples (mg/kg)	Composite Samples (mg/kg)	Discrete Samples (mg/kg)	Composite Samples (mg/kg)	Discrete Samples (mg/kg)	Composite Samples (mg/kg)
Arsenic	100	25	300	75	100	25
Cadmium	20	5	90	22.5	-	-
Chromium (total)	-*	-*	-*	-*	-	-
Copper	6,000	1,500	17,000	4,250	-	-
Lead	300	75	600	150	1100	275
Nickel	400	100	1,200	300	170	42.5
Zinc	7,400	1,850	30,000	7,500	-	-
Mercury	40	10	80	20	-	-
OCP	-	-	-	-	180	45
DD's	240	60	-	-		

* Not applicable due to low human toxicity of Cr(III) and non-industrial site

Table 2. Soil assessment criteria hydrocarbons (mg/kg)

Analyte	HSL Residential / clay soil				HSL Recreational / clay soil				ESL Residential/ recreational- fine soil	Management limits for TRH in soil – residential/ recreational
	0m to <1m	1m to <2m	2m to <4m	>4m	0m to <1m	1m to <2m	2m to <4m	>4m		
TRH (C6-C10) (F1)	50	90	150	290	NL	NL	NL	NL	180	800
TRH (>C10-C16) (F2)	280	NL	NL	NL	NL	NL	NL	NL	120	1,000
TRH (>C16-C34)	NA	NA	NA	NA	NL	NL	NL	NL	1,300	3,500
TRH (>C34-C40)	NA	NA	NA	NA	NL	NL	NL	NL	5,600	10,000
Benzene	0.7	1	2	3	NL	NL	NL	NL	65	-
Toluene	480	NL	NL	NL	NL	NL	NL	NL	105	-
Ethylbenzene	NL	NL	NL	NL	NL	NL	NL	NL	125	-
Xylenes	110	310	NL	NL	NL	NL	NL	NL	45	-
Naphthalene	5	NL	NL	NL	NL	NL	NL	NL	-	-
Benzo(a)pyrene	-	-	-	-	-	-	-	-	0.7	-

HSL – health screening level, ESL – ecological screening level, NL – non limiting, NA – not applicable

11. Results and discussion

11.1 Paddocks

Surface cover on the site consisted of improved pasture including native and introduced pasture species with weeds. The site has been predominately cleared of native tree species. Pasture species include paspalum, lucerne, wild oats, wild sage. The weed species include Paterson's curse, cat head, clover, saffron thistle, couch grass, and khaki weed. Eucalypts and Cyprus pines occur within the south eastern section of the site.

The levels of all metals and OCPs analysed in the paddock soil samples (Table 4) were not detected or at environmental background levels and below the residential and recreational land-use thresholds (NEPC 1999).

11.2 Machinery shed and yard area

A machinery shed and yard area was located in the central section of the site. The area has been used to store machinery and refuelling from above ground storage tanks. Cattle yards were also located within this area.

The levels of all metals and OCPs analysed in the machinery shed and yard area soil samples (Table 5) were not detected or at environmental background levels and below the residential and recreational land-use thresholds (NEPC 1999).

One sample (SR29) contained levels of TRH (>C10-C16) above the health screening levels for residential and recreational land use. Two samples (SR28 and SR29) were above the adopted ecological screening levels for residential and recreational land in fine soil. The levels of all other hydrocarbons analysed in the machinery and yard area soil samples (Table 6) were below the residential and recreational land-use thresholds (NEPC 1999). Additional investigations were undertaken to determine the extent hydrocarbon impacted material. Approximately 1.3m^3 of hydrocarbon impacted material was removed from the AST area (6m x 2m x 0.1m). No hydrocarbon material remained following the investigations to determine the extent of the hydrocarbon impacted material. Disposal dockets of the hydrocarbon impacted material are provided in Appendix 4.

10.3 Old cottage area

Small mounds containing soil, timber and bitumen were located to the east of the historical cottages.

Asbestos containing fragments were identified on the soil surface in the area of the historical cottages. The asbestos containing fragments were assessed as being in poor condition with moderate accessibility. Small fragments less than 7mm were observed therefore classing the fragments as friable asbestos. The risk rating of exposure has been assessed as moderate to high.

Additional investigations were undertaken to determine the depth and extent of asbestos impacted material. The asbestos fragments were generally spread across the surface with some buried up to 500mm in depth. The impacted area was approximately 600m^2 in size. The asbestos impacted material was removed during the additional investigations. Disposal dockets are provided in Appendix 4.

Table 4. Analytical results and threshold concentrations (mg/kg)

Sample ID	Sample type	Location	Arsenic	Cadmium	Chromium (total)	Copper	Lead	Nickel	Zinc	OCP
SR1	Composite	Paddock	ND	ND	19	7	5	10	14	-
SR2	Composite	Paddock	ND	ND	18	6	6	9	18	-
SR3	Composite	Paddock	ND	ND	20	6	5	9	13	-
SR4	Composite	Paddock	ND	ND	11	4	4	5	10	-
SR5	Composite	Paddock	ND	ND	18	7	6	8	13	-
SR6	Composite	Paddock	ND	ND	19	8	6	10	15	-
SR7	Composite	Paddock	ND	ND	11	5	5	5	12	-
SR8	Composite	Paddock	ND	ND	23	7	6	10	14	-
SR9	Composite	Paddock	ND	ND	36	7	8	14	22	-
SR10	Composite	Paddock	ND	ND	10	3	4	3	6	-
SR11	Composite	Paddock	ND	ND	9	4	5	4	7	-
SR12	Composite	Paddock	ND	ND	11	5	5	7	9	-
SR13	Composite	Paddock	ND	ND	16	7	6	11	14	-
SR14	Composite	Paddock	ND	ND	58	18	9	41	45	-
SR15	Composite	Paddock	ND	ND	50	17	9	34	31	-
SR16	Composite	Paddock	ND	ND	41	14	8	25	23	-
SR17	Composite	Paddock	ND	ND	36	13	11	20	21	-
SR18	Composite	Paddock	ND	ND	36	12	8	17	22	-
SR19	Composite	Paddock	ND	ND	24	11	8	16	24	-
SR20	Composite	Paddock	ND	ND	27	11	7	16	22	-
SR21	Composite	Paddock	ND	ND	41	13	7	24	25	-
SR22	Composite	Paddock	ND	0.3	65	18	9	42	35	-
SR23	Composite	Paddock	ND	0.4	59	20	9	52	41	-
SR24	Composite	Paddock	ND	0.4	63	20	9	50	40	-
SR25	Composite	Paddock	ND	ND	40	15	9	32	29	-
SR26	Composite	Paddock	ND	0.4	67	10	10	52	59	-
SR73	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR91	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR113	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR184	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR224	Discrete	Paddock	-	-	-	-	-	-	-	ND
SR201	Discrete	Old cottage area	3	0.4	47	21	17	42	55	ND
SR202	Discrete	Old cottage area	3	0.4	51	22	19	38	80	ND
SR203	Discrete	Old cottage area	3	0.4	60	20	13	49	23	ND
SR204	Discrete	Old cottage area	3	0.4	52	15	16	31	48	ND
Health Investigation Levels – Residential land-use threshold (NEPC 1999)										
Discrete			*100*	*20*	*-**	*6,000*	*300*	*400*	*7,400*	-
Composite			*25*	*5*	*-**	*1,500*	*75*	*100*	*1,850*	-
Health Investigation Levels – Recreational land-use threshold (NEPC 1999)										
Discrete			*300*	*90*	*-**	*17,000*	*600*	1,200	*30,000*	-
Composite			*75*	*21.5*	*-**	*4,250*	*150*	300	*7,500*	-
Ecological Investigation Levels – Urban residential and public open space (NEPC 1999)										
Discrete			*100*	-	-	-	*1100*	170	-	*180*
Composite			*25*	-	-	-	*275*	42.5	-	*45*

ND = not detected at the detection limit, * Not applicable due to low human toxicity of Cr(III) and non-industrial site

Table 5. Analytical results and threshold concentrations (mg/kg)

Sample ID	Sample type	Location	Arsenic	Cadmium	Chromium (total)	Copper	Lead	Nickel	Zinc	OCP DD's
SR27	Discrete	Cattle yard	ND	0.4	58	23	11	62	64	ND
SR28	Discrete	ULP AST	ND	0.3	50	19	10	40	58	ND
SR29	Discrete	Diesel AST	ND	0.4	63	26	8	83	50	ND
SR30	Discrete	Behind machinery shed	ND	0.3	64	22	9	48	49	ND
SR31	Discrete	Behind machinery shed	ND	ND	49	21	10	41	58	ND
SR32	Discrete	Inside machinery shed	ND	0.3	53	22	10	50	40	ND
SR33	Discrete	Inside machinery shed	ND	0.3	59	22	10	48	44	ND
Health Investigation Levels – Residential land-use threshold (NEPC 1999)										
			100	*20*	*-**	*6,000*	*300*	*400*	*7,400*	*3,600*
Health Investigation Levels – Recreational land-use threshold (NEPC 1999)										
			300	*90*	*-**	*300*	*17,000*	*600*	*1,200*	*-*
Ecological Investigation Levels – Urban residential and public open space (NEPC 1999)										
			100	*-*	*-*	*-*	*1,100*	*170*	*-*	*180*

ND = not detected at the detection limit, * Not applicable due to low human toxicity of Cr(III) and non-industrial site

Table 6. Analytical results and threshold concentrations for hydrocarbons (mg/kg)

Sample id.	Sample type	Location	TRH (C6-C10)	TRH (>C10-C16)	TRH (>C16-C34)	TRH (>C34-C40)	Benzene	Toluene	Ethylbenzene	Xylenes	Naphthalene
SR27	Discrete	Cattle yard	ND	ND	ND	ND	ND	ND	ND	ND	ND
SR28	Discrete	ULP AST	ND	ND	930	ND	ND	ND	ND	ND	ND
SR29	Discrete	Diesel AST	ND	450	3,100	ND	ND	ND	ND	ND	ND
SR30	Discrete	Behind machinery shed	ND	ND	ND	ND	ND	ND	ND	ND	ND
SR31	Discrete	Behind machinery shed	ND	ND	ND	ND	ND	ND	ND	ND	ND
SR32	Discrete	Inside machinery shed	ND	ND	170	ND	ND	ND	ND	ND	ND
SR33	Discrete	Inside machinery shed	ND	ND	ND	ND	ND	ND	ND	ND	ND
SRV301	Discrete	AST area	ND	ND	130	ND	-	-	-	-	-
SRV302	Discrete	AST area	ND	26	210	ND	-	-	-	-	-
SRV303	Discrete	AST area	ND	53	540	ND	-	-	-	-	-
HSL A– Residential/recreational clay soil		0m to <1m	*50*	*280*	*NA*	*NA*	*0.7*	*480*	*NL*	*110*	*NL*
EIL – residential/recreational			-	-	-	-	-	-	-	-	*170*
ESL – residential/ recreational / fine soil			*180*	*120*	*1,300*	*5,600*	*65*	*105*	*125*	*45*	-
Management limits for TRH fractions in soil / residential/recreational			*800*	*1,000*	*5,000*	*10,000*	-	-	-	-	-

ND = not detected at the detection limit

12. Site characterisation

12.1 Environmental contamination

No soil contamination remained on site.

12.2 Chemical degradation production

No soil contamination remained on site.

12.3 Exposed population

No soil contamination remained on site.

13. Conclusions and recommendations

13.1 Summary

An inspection of the site was made on 10 and 11 January 2017. The site is located in a developing residential area on the south eastern fringes of Dubbo and has an area of approximately 50ha.

The site has an agricultural land-use history of grazing. Several buildings were identified on the site including a dwelling, machinery shed, cattle yards and two above ground storage tanks. There is no evidence of orchards, mines, sheep dips, mixing sheds or contaminating industrial activities on the site from the review of site history or site walkover. The use of agricultural pesticides over the area in the past is expected to be low.

The contamination status of the site was assessed from a soil sampling and laboratory analysis program. One hundred and four discrete soil samples were collected over the paddock areas from the 0 to 100mm soil depth. The discrete samples were combined to form twenty six composite samples for analysis. The soil samples were analysed for arsenic, cadmium, chromium, copper, lead, nickel and zinc. Five discrete soil samples from within the paddocks were analysed for organochlorine pesticides (OCP). Seven discrete samples were collected from around the shed and historic cattle yards and were analysed for arsenic, cadmium, chromium, copper, lead, nickel, zinc, mercury, organochlorine pesticides (OCP), total recoverable hydrocarbons (TRH) (C6-C40), benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN) and polycyclic aromatic hydrocarbons (PAH).

Two cottages were identified in aerial photographs (2006-2010) south of the machinery shed and had been removed at the time of the site inspection. The cottages were located west of the dwelling. Asbestos containing fragments were identified in the area of the old cottages. Several small mounds containing soil, timber and bitumen were identified in this area. Asbestos containing fragments were excavated during investigations of the extent of asbestos impacted material. The asbestos fragments were generally spread across the surface with some buried up to 500mm in depth. The impacted area was approximately 600m^2 in size. The impacted material was removed landfill licensed to accept asbestos waste. A visual clearance was undertaken following excavation and removal of asbestos impacted material. Four surface samples were collected across the area of the historic cottages and analysed for heavy metals, OCP, TRH, BTEXN and PAH. The levels of all metals, OCPs, TRH, BTEXN and PAH analysed in the cottage soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds.

The levels of all metals and OCPs analysed in the machinery shed and yard area soil samples were not detected or at environmental background levels and below the residential and recreational land-use thresholds. One soil sample from near the diesel above ground storage tank contained levels of TRH (>C16-C34) above the health screening levels for residential land use. Two soil samples collected from within the area of above ground storage tanks were above the adopted ecological screening levels for TRH (>C16-C34) for residential land use. Further investigations into the depth of hydrocarbon impacted material identified the impacted material was contained within the top 100mm of soil. The impacted material was excavated and removed during the investigations to determine the depth. The area was less than $10m^2$ in size. Three additional discrete samples were collected from the base of excavations and TRH was reported as not detected in all three samples. Hydrocarbon impacted material was removed to a licensed landfill.

The soil sampling program did not detect elevated levels of the analysed metals or OCP within the paddock areas. The levels of all substances evaluated were below the EPA investigation threshold for residential land-use with access to soil.

13.2 Assumptions in reaching the conclusions

It is assumed the sampling sites are representative of the site. An accurate history has been obtained and typical past farming practices were adopted.

13.3 Extent of uncertainties

The analytical data relate only to the locations sampled. Soil conditions can vary both laterally and vertically and it cannot be excluded that unidentified contaminants may be present. The sampling density was designed to detect a ‘hot spot’ in the field area within a radius of approximately 41 metres and with a 95% level of confidence.

13.4 Suitability for proposed use of the site

The site requires additional investigations in the area of the old cottages. A remediation action plan is required for the hydrocarbon and asbestos impacted material.

13.5 Limitations and constraints on the use of the site

The assessed areas are suitable for the proposed land use of residential and recreational. Additional investigations are required in the area of the old cottages.

13.6 Recommendation for further work

The site is suitable for the proposed residential activities.

If additional asbestos fragments or other hazardous materials are encountered then the unexpected finds protocol (Appendix 5) should be followed which would include ceasing works and the identified impacted asbestos material removed in accordance with SafeWork methods “How to safely remove asbestos” prior to site works commencing.

14. Report limitations and intellectual property

This report has been prepared for the use of the client to achieve the objectives given the clients requirements. The level of confidence of the conclusion reached is governed by the scope of the investigation and the availability and quality of existing data. Where limitations or uncertainties are known, they are identified in the report. No liability can be accepted for failure to identify conditions or issues which arise in the future and which could not reasonably have been predicted using the scope of the investigation and the information obtained.

The investigation identifies the actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing is interpreted by geologists, engineers or scientists who then render an opinion about overall subsurface conditions, the nature and extent of the contamination, it's likely impact on the proposed development and appropriate remediation measures. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, and no sub-surface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock or time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. It is thus important to understand the limitations of the investigation and recognise that we are not responsible for these limitations.

This report, including data contained and its findings and conclusions, remains the intellectual property of Envirowest Consulting Pty Ltd. A licence to use the report for the specific purpose identified is granted for the persons identified in that section after full payment for the services involved in preparation of the report. This report should not be used by persons or for purposes other than those stated and should not be reproduced without the permission of Envirowest Consulting Pty Ltd.

15. References

DEC (2006) *Contaminated Sites: Guidelines for the NSW Site Auditors Scheme* (NSW Department of Environment and Conservation, Chatswood)

Environment Protection Authority (1995) *Contaminated sites: Sampling Design Guidelines* (NSW Environment Protection Authority, Chatswood)

Murphy BW and Lawrie, JW (1990) *Soil Landscapes of the Dubbo 1:250,000 Sheet* (Soil Conservation Service of NSW, Sydney)

NEPC (1999 revised 2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999* (National Environment Protection Council Service Corporation, Adelaide)

Figures

Figure 1: Locality map		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

Approximate Scale 1: 6,000

0 60 120 240m

Legend

⊗ Sampling location

Lot boundary

Dam

Fence

Figure 2: Site plan		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

Legend

⊗ Sampling location

Lot boundary

Fence

Slope

Approximate Scale 1: 6,000

0 60 120 240m

Figure 3: Sampling locations		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

Legend

⊗ Sampling location

— · — Fence

Approximate Scale 1: 1,500

0 15 30 60m

Figure 4: Sampling locations in machinery shed and yard		
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW		
	Envirowest Consulting Pty Ltd	
Job: R7891c	Drawn by: AP	Date: 31/01/2017

Legend

⊗ Sampling location

— · — Fence

Figure 5: Sampling locations in old cottage and AST area	
Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW	
	Envirowest Consulting Pty Ltd
Job: R7891c	Drawn by: AP — Date: 31/01/2017

Figure 6. Photographs of the site

Looking west across paddocks

Looking south west across paddocks

Looking south across paddocks

Cottage area requiring following investigations

AST area

AST area

Appendices

Appendix 1. Sample analysis, quality assurance and quality control (QAQC) report
Appendix 2. Soil analysis results –

SGS report number SE160957 and chain of custody form
Greencap report number 21782 and chain of custody form

Appendix 3. Field sampling log

Appendix 1. Sample analysis, quality assurance and quality control (QAQC) report

1. Data quality indicators (DQI) requirements

1.1 Completeness

A measure of the amount of usable data for a data collection activity. Greater than 95% of the data must be reliable based on the quality objectives. Where greater than two quality objectives have less reliability than the acceptance criterion the data may be considered with uncertainty.

1.1.1 Field

Consideration	Requirement
Locations and depths to be sampled	Described in the sampling plan. The acceptance criterion is 95% data retrieved compared with proposed. Acceptance criterion is 100% in crucial areas.
SOP appropriate and compiled	Described in the sampling plan.
Experienced sampler	Sampler or supervisor
Documentation correct	Sampling log and chain of custody completed

1.1.2 Laboratory

Consideration	Requirement
Samples analysed	Number according to sampling and quality plan
Analytes	Number according to sampling and quality plan
Methods	EPA or other recognised methods with suitable PQL
Sample documentation	Complete including chain of custody and sample description
Sample holding times	Metals 6 months, OCP, PAH, TPH, PCB 14 days

1.2 Comparability

The confidence that data may be considered to be equivalent for each sampling and analytical event. The data must show little or no inconsistencies with results and field observations.

1.2.1 Field

Consideration	Requirement
SOP	Same sampling procedures to be used
Experienced sampler	Sampler or supervisor
Climatic conditions	Described as may influence results
Samples collected	Sample medium, size, preparation, storage, transport

1.2.2 Laboratory

Consideration	Requirement
Analytical methods	Same methods, approved methods
PQL	Same
Same laboratory	Justify if different
Same units	Justify if different

1.3 Representativeness

The confidence (expressed qualitatively) that data are representative of each media present on the site.

1.3.1 Field

Consideration	Requirement
Appropriate media sampled	Sampled according to sampling and quality plan or in accordance with the EPA (1995) sampling guidelines.
All media identified	Sampling media identified in the sampling and quality plan. Where surface water bodies on the site sampled.

1.3.2 Laboratory

Consideration	Requirement
Samples analysed	Blanks

1.4 Precision

A quantitative measure of the variability (or reproduced of the data). Is measured by standard deviation or relative percent difference (RPD). A RPD analysis is calculated and compared to the practical quantitation limit (PQL) or absolute difference AD.

- Levels greater than 10 times the PQL the RPD is 50%
- Levels between 5 and 10 times the PQL the RPD is 75%
- Levels between 2 and 5 times the PQL the RPD is 100%
- Levels less than 2 times the PQL, the AD is less than 2.5 times the PQL

Data not conforming to the acceptance criterion will be examined for determination of suitability for the purpose of site characterisation.

1.4.1 Field

Consideration	Requirement
Field duplicates	Frequency of 5%, results to be within RPD or discussion required indicate the appropriateness of SOP

1.4.2 Laboratory

Consideration	Requirement
Laboratory and inter lab duplicates	Frequency of 5%, results to be within RPD or discussion required. Inter laboratory duplicates will be one sample per batch.
Field duplicates	Frequency of 5%, results to be within RPD or discussion required
Laboratory prepared volatile trip spikes	One per sampling batch, results to be within RPD or discussion required

1.5 Accuracy

A quantitative measure of the closeness of the reported data to the true value.

1.5.1 Field

Consideration	Requirement
SOP	Complied
Inter laboratory duplicates	Frequency of 5%. Analysis criterion 60% RPD for levels greater than 10 times the PQL 85% RPD for levels between 5 to 10 times the PQL 100% RPD at levels between 2 to 5 times the PQL Absolute difference, 3.5 times the PQL where levels are, 2 times PQL

1.5.2 Laboratory

Recovery data (surrogates, laboratory control samples and matrix spikes) data subject to the following control limits:

- 60 to 140% acceptable data
- 20-60% discussion required, may be considered acceptable
- 10-20% data should considered as estimates
- 10% data should be rejected

Consideration	Requirement
Field blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Rinsate blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Method blanks	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Matrix spikes	Frequency of 5%, results to be within +/-40% or discussion required
Matrix duplicates	Sample injected with a known concentration of contaminants with tested. Frequency of 5%, results to be within +/-40% or discussion required
Surrogate spikes	QC monitoring spikes to be added to samples at the extraction process in the laboratory where applicable. Surrogates are closely related to the organic target analyte and not normally found in the natural environment. Frequency of 5%, results to be within +/-40% or discussion required
Laboratory control samples	Externally prepared reference material containing representative analytes under investigation. These will be undertaken at one per batch. It is to be within +/-40% or discussion required
Laboratory prepared spikes	Frequency of 5%, results to be within +/-40% or discussion required

2. Laboratory analysis summary

One analysis batch was undertaken over the preliminary investigation program. Samples were collected on 22 and 23 April 2015. A total of thirty four samples were submitted for analytical testing. The samples were collected in the field by an environmental scientist from Envirowest Consulting Pty Ltd, placed into laboratory prepared receptacles as recommended in NEPC (1999). The samples preservation and storage was undertaken using standard industry practices (NEPC 1999). A chain of custody form accompanied transport of the samples to the laboratory.

The samples were analysed at the laboratories of SGS, Alexandria, NSW which is National Association of Testing Authorities (NATA) accredited for the tests undertaken. The analyses undertaken, number of samples tested and methods are presented in the following tables:

Laboratory analysis schedule

Sample id. (sampling location)	Number of samples	Duplicate	Analyses	Date collected	Substrate	Laboratory report
SR1, SR2, SR3, SR4, SR5, SR6, SR7, SR8, SR9, SR10, SR11, SR12, SR13, SR14, SR15, SR16, SR17, SR18, SR19, SR20, SR21, SR22, SR23, SR24, SR25, SR26, SR27	27	2	As, Cd, Cr (total), Cu, Pb, Ni, Zn	11/01/2017	Soil	SE160957
SR28, SR29, SR30, SR31, SR32, SR33	2	0	As, Cd, Cr, Pb, Ni, Zn, OCP, TRH (C6-C40), BTEXN, PAH	11/01/2017 12/01/2017	Soil	SE160957
SR73, SR91, SR113, SR184, , SR224	5	0	OCP	11/01/2017	Soil	SE160957
SR201, SR202, SR203, SR204	4	0	As, Cd, Cr (total), Cu, Pb, Ni, Zn, OCP	22/02/2017	Soil	SE162373
SRV301, SRV302, SRV303	3	0	TRH (C6-C40)	22/02/2017	Soil	SE162373A

Analytical methods

Analyte	Extraction	Laboratory methods
Metals	USEPA 200.2 Mod	APHA USEPA SW846-6010
Chromium (III)	-	APHA 3500 CR-A&B & 3120 and USEPA SW846-3060A
Chromium (VI)	USEPA SW846-3060A	USEPA SW846-3060A
Mercury	USEPA 200.2 Mod	APHA 3112
TRH(C6-C9)	USPEA SW846-5030A	USPEA SW 846-8260B
TRH(C10-C36), PAH	Tumbler extraction of solids	USEPA SW 846-8270B
PCB	Tumbler extraction of solids	USEPA SW 846-8270B
OC Pesticides	Tumbler extraction of solids	USEPA SW 846-8270B
BTEX	Tumbler extraction of solids	USEPA SW 846-8260B

3. Field quality assurance and quality control

Two intra laboratory duplicate samples were collected for the investigation. The frequency was slightly less than the recommended frequency of 5%. Table A5.1 outlines the samples collected and differences in replicate analyses. Relative differences were deemed to pass if they were within the acceptance limits of +/- 40% for replicate analyses or less than 5 times the detection limit.

Field duplicate frequency

Sample id.	Number of samples	Duplicate	Frequency (%)	Date collected	Substrate	Laboratory report
SR1, SR2, SR3, SR4, SR5, SR6, SR7, SR8, SR9, SR10, SR11, SR12, SR13, SR14, SR15, SR16, SR17, SR18, SR19, SR20, SR21, SR22, SR23, SR24, SR25, SR26, SR27, SR28, SR29, SR30, SR31, SR32, SR33, SR73, SR91, SR113	36	2	5.5	11/01/2017 12/01/2017	Soil	SE160957
SR201, SR202, SR203, SR204	4	0	0	22/02/2017	Soil	SE162373
SRV301, SRV302, SRV303	3	0	0	22/02/2017	Soil	SE162373A

Table A5.1. Relative differences for intra laboratory duplicates

	SR2, SRA		SR10, SRB	
	Relative difference (%)	Pass/Fail	Relative difference (%)	Pass/Fail
Arsenic	NA	-	NA	-
Cadmium	NA	-	NA	-
Chromium	15	Pass	0	Pass
Copper	0	Pass	0	Pass
Lead	18	Pass	0	Pass
Nickel	0	Pass	0	Pass
Zinc	6	Pass	18	Pass

NA – relative difference unable to be calculated as results are less than laboratory detection limit

No trip blanks or spikes were submitted for analysis. This is not considered to create significant uncertainty in the analysis results because of the following rationale:

- The fieldwork was completed within a short time period and consistent methods were used for soil sampling.

- Soil samples were placed in insulated cooled containers after sampling to ensure preservation during transport and storage.

- The samples were placed in single use jars using clean sampling tools and disposable gloves from material not in contact with other samples. This reduces the likelihood of cross contamination.

- Samples in the analysis batch contain analytes below the level of detection. It is considered unlikely that contamination has occurred as a result of transport and handling.

4. Laboratory quality assurance and quality control

Sample holding times are recommended in NEPC (1999). The time between collection and extraction for all samples was less than the criteria listed below:

Analyte	Maximum holding time
Metals, cyanide	6 months
OCP, TPH, PCB, BTEX, PAH	14 days

The laboratory interpretative reports are presented with individual laboratory report. Assessment is made of holding time, frequency of control samples and quality control samples. No significant outliers exist for the sampling batches. The laboratory report also contains a detailed description of preparation methods and analytical methods.

The results, quality report, interpretative report and chain of custody are presented in the attached appendices. The quality report contains the laboratory duplicates, spikes, laboratory control samples, blanks and where appropriate matrix spike recovery (surrogate).

5. Data quality indicators (DQI) analysis

5.1 Completeness

A measure of the amount of usable data for a data collection activity (total to be greater than 95%).

The data set was found to be complete based on the scope of work. No critical areas of contamination were omitted from the data set.

5.1.1 Field

Consideration	Accepted	Comment
Locations to be sampled	Yes	In accordance with sampling methodology, described in the report. Sampling locations described in figures.
Depth to be sampled	Yes	In accordance with sampling methodology
SOP appropriate and compiled	Yes	In accordance with sampling methodology Sampled with stainless steel spade into lab prepared containers, decontamination between samples, latex gloves worn by sampler
Experienced sampler	Yes	Same soil sampler, environmental scientist

Documentation correct	Yes	Sampling log completed Chain of custody completed

5.1.2 Laboratory

Consideration	Accepted	Comment
Samples analysed	Yes	All critical samples analysed in accordance with chain of custody and analysis plan
Analytes	Yes	All analytes in accordance with chain of custody and analysis plan
Methods	Yes	Analysed in NATA accredited laboratory with recognised methods and suitable PQL
Sample documentation	Yes	Completed including chain of custody and sample results and quality results report for each batch
Sample holding times	Yes	Metals less than 6 months. OCP, TPH, PCB, BTEX less than 14 days

5.2 Comparability

The confidence that data may be considered to be equivalent for each sampling and analytical event.

The data sets were found to be acceptable.

5.2.1 Field

Consideration	Accepted	Comment
SOP	Yes	Same sampling procedures used and sampled on one date
Experienced sampler	Yes	Experienced scientist
Climatic conditions	Yes	Described in field sampling log
Samples collected	Yes	Suitable size, storage and transport

5.2.2 Laboratory

Consideration	Accepted	Comment
Analytical methods	Yes	Same methods all samples, in accordance with NEPC(1999) or USEPA
PQL	Yes	Suitable for analytes
Same laboratory	Yes	ALS Environmental is NATA accredited for the test
Same units	Yes	-

5.3 Representativeness

The confidence (expressed qualitatively) that data are representative of each media present on the site.

The data sets were found to be acceptable.

5.3.1 Field

Consideration	Accepted	Comment
Appropriate media sampled	Yes	Sampled according to sampling and quality plan
All media identified	Yes	Soil Sampling media identified in the sampling and quality plan

5.3.2 Laboratory

Consideration	Accepted	Comment
Samples analysed	Yes	Undertaken in NATA accredited laboratory. No blanks analysed. Samples in the analysis batch contain analytes below the level of detection. It is considered unlikely that contamination has occurred as a result of transport and handling.

5.4 Precision

A quantitative measure of the variability (or reproduced of the data).
The data sets were found to be acceptable.

5.4.1 Field

Consideration	Accepted	Comment
SOP	Yes	Complied
Field duplicates	Yes	Collected.

5.4.2 Laboratory

Consideration	Accepted	Comment
Laboratory and inter lab duplicates	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Field duplicates	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory prepared volatile trip spikes	NA	Not collected due to the preliminary nature of the investigation

5.5 Accuracy

A quantitative measure of the closeness of the reported data to the true value.

The data sets were found to be acceptable.

5.5.1 Field

Consideration	Accepted	Comment
SOP	Yes	Complied
Field blanks	NA	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Rinsate blanks	NA	Frequency of 5%, <5 times the PQL, PQL may be adjusted

5.5.2 Laboratory

Consideration	Accepted	Comment
Method blanks	Yes	Frequency of 5%, <5 times the PQL, PQL may be adjusted
Matrix spikes	Yes	Frequency of 5%, results to be within +/-40% or discussion required.
Matrix duplicates	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Surrogate spikes	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory control samples	Yes	Frequency of 5%, results to be within +/-40% or discussion required
Laboratory prepared spikes	Yes	Frequency of 5%, results to be within +/-40% or discussion required

No trip blanks, field spikes or sample rinsates were submitted for analysis. This is not considered to create significant uncertainty in the analysis results because of the following rationale:

- The fieldwork methods used for soil sampling were consistent throughout the project with all in situ samples collected from material which had not been subject to exposure.
- The fieldwork was completed within a short time period and consistent methods were used for soil sampling.
- Soil samples were placed in insulated cooled containers as quickly as possible, with the containers filled to minimize headspace. The sample containers were sealed immediately after the sample was collected and chilled in an esky containing ice.
- The samples were stored in a refrigerator and transported with ice bricks to ensure preservation during transport and storage.
- The samples were placed in single use jars using clean sampling tools and disposable gloves from material not in contact with other samples. This reduces the likelihood of cross contamination.
- Samples in the analysis batches contained analytes below the level of detection. It is considered unlikely that contamination has occurred as a result of transport and handling.

6. Conclusion

All media appropriate to the objectives of this investigation have been adequately analysed and no area of significant uncertainty exist. It is concluded the data is usable for the purposes of the investigation.

Appendix 2. Soil analysis results – SGS report number SE160957 and chain of custody form
– SGS report number SE162373 and chain of custody form
– SGS report number SE162373A and chain of custody form
– Greencap report number 21782 and chain of custody form

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Ashleigh Pickering	Manager	Huong Crawford
Client	ENVIROWEST CONSULTING PTY LIMITED	Laboratory	SGS Alexandria Environmental
Address	PO BOX 8158 ORANGE NSW 2800	Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	61 2 63614954	Telephone	+61 2 8594 0400
Facsimile	(Not specified)	Facsimile	+61 2 8594 0499
Email	ashleigh@envirowest.net.au	Email	au.environmental.sydney@sgs.com
Project	**7891**	SGS Reference	**SE160957 R0**
Order Number	(Not specified)	Date Received	17/1/2017
Samples	42	Date Reported	24/1/2017

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

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VOC's in Soil [AN433] Tested: 19/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Benzene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
m/p-xylene	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o-xylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Xylenes*	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Total BTEX	mg/kg	0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Benzene	mg/kg	0.1	<0.1	<0.1
Toluene	mg/kg	0.1	<0.1	<0.1
Ethylbenzene	mg/kg	0.1	<0.1	<0.1
m/p-xylene	mg/kg	0.2	<0.2	<0.2
o-xylene	mg/kg	0.1	<0.1	<0.1
Total Xylenes*	mg/kg	0.3	<0.3	<0.3
Total BTEX	mg/kg	0.6	<0.6	<0.6
Naphthalene	mg/kg	0.1	<0.1	<0.1

Volatile Petroleum Hydrocarbons in Soil [AN433] Tested: 19/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
TRH C6-C9	mg/kg	20	<20	<20	<20	<20	<20
Benzene (F0)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
TRH C6-C10	mg/kg	25	<25	<25	<25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	<25	<25	<25

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
TRH C6-C9	mg/kg	20	<20	<20
Benzene (F0)	mg/kg	0.1	<0.1	<0.1
TRH C6-C10	mg/kg	25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25

TRH (Total Recoverable Hydrocarbons) in Soil [AN403] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
TRH C10-C14	mg/kg	20	<20	<20	120	<20	<20
TRH C15-C28	mg/kg	45	<45	910	3400	<45	<45
TRH C29-C36	mg/kg	45	<45	52	<45	<45	<45
TRH C37-C40	mg/kg	100	<100	<100	<100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	<25	450	<25	<25
TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	450	<25	<25
TRH >C16-C34 (F3)	mg/kg	90	<90	930	3100	<90	<90
TRH >C34-C40 (F4)	mg/kg	120	<120	<120	<120	<120	<120
TRH C10-C36 Total	mg/kg	110	<110	960	3500	<110	<110
TRH C10-C40 Total	mg/kg	210	<210	960	3500	<210	<210

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
TRH C10-C14	mg/kg	20	<20	<20
TRH C15-C28	mg/kg	45	140	<45
TRH C29-C36	mg/kg	45	51	<45
TRH C37-C40	mg/kg	100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	<25
TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25
TRH >C16-C34 (F3)	mg/kg	90	170	<90
TRH >C34-C40 (F4)	mg/kg	120	<120	<120
TRH C10-C36 Total	mg/kg	110	190	<110
TRH C10-C40 Total	mg/kg	210	<210	<210

PAH (Polynuclear Aromatic Hydrocarbons) in Soil [AN420] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Naphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Total PAH (18)	mg/kg	0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Total PAH (NEPM/WHO 16)	mg/kg	0.8	<0.8	<0.8	<0.8	<0.8	<0.8

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Naphthalene	mg/kg	0.1	<0.1	<0.1
2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1
1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1
Acenaphthylene	mg/kg	0.1	<0.1	<0.1
Acenaphthene	mg/kg	0.1	<0.1	<0.1
Fluorene	mg/kg	0.1	<0.1	<0.1
Phenanthrene	mg/kg	0.1	<0.1	<0.1
Anthracene	mg/kg	0.1	<0.1	<0.1
Fluoranthene	mg/kg	0.1	<0.1	<0.1
Pyrene	mg/kg	0.1	<0.1	<0.1
Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1
Chrysene	mg/kg	0.1	<0.1	<0.1
Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1
Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1
Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1
Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1
Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1
Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	<0.2	<0.2
Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3
Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2
Total PAH (18)	mg/kg	0.8	<0.8	<0.8
Total PAH (NEPM/WHO 16)	mg/kg	0.8	<0.8	<0.8

OC Pesticides in Soil [AN420] Tested: 18/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 18/1/2017 (continued)

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SR73 SOIL - 11/1/2017 SE160957.034	SR91 SOIL - 11/1/2017 SE160957.035	SR113 SOIL - 11/1/2017 SE160957.036
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 18/1/2017 (continued)

PARAMETER	UOM	LOR	SR184 SOIL - 11/1/2017 SE160957.037	SR224 SOIL - 11/1/2017 SE160957.038
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR) [AN122] Tested: 23/1/2017

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
Exchangeable Sodium, Na	mg/kg	2	17	530
Exchangeable Sodium, Na	meq/100g	0.01	0.07	2.3
Exchangeable Sodium Percentage*	%	0.1	3.3	36.5

Soluble Anions (1:5) in Soil by Ion Chromatography [AN245] Tested: 19/1/2017

			BH16-100	BH16-1500
			SOIL	SOIL
			-	-
			11/1/2017	11/1/2017
PARAMETER	UOM	LOR	SE160957.041	SE160957.042
Chloride	mg/kg	0.25	7.6	50

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017

PARAMETER	UOM	LOR	SR1 SOIL - 11/1/2017 SE160957.001	SR2 SOIL - 11/1/2017 SE160957.002	SR3 SOIL - 11/1/2017 SE160957.003	SR4 SOIL - 11/1/2017 SE160957.004	SR5 SOIL - 11/1/2017 SE160957.005
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	19	18	20	11	18
Copper, Cu	mg/kg	0.5	6.7	6.0	5.5	4.2	6.8
Lead, Pb	mg/kg	1	5	6	5	4	6
Nickel, Ni	mg/kg	0.5	9.8	8.5	8.5	5.1	7.6
Zinc, Zn	mg/kg	0.5	14	18	13	9.6	13
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR6 SOIL - 11/1/2017 SE160957.006	SR7 SOIL - 11/1/2017 SE160957.007	SR8 SOIL - 11/1/2017 SE160957.008	SR9 SOIL - 11/1/2017 SE160957.009	SR10 SOIL - 11/1/2017 SE160957.010
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	19	11	23	36	9.9
Copper, Cu	mg/kg	0.5	7.5	5.1	7.3	7.1	3.2
Lead, Pb	mg/kg	1	6	5	6	8	4
Nickel, Ni	mg/kg	0.5	10	4.6	9.5	14	3.1
Zinc, Zn	mg/kg	0.5	15	12	14	22	6.2
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR11 SOIL - 11/1/2017 SE160957.011	SR12 SOIL - 11/1/2017 SE160957.012	SR13 SOIL - 11/1/2017 SE160957.013	SR14 SOIL - 11/1/2017 SE160957.014	SR15 SOIL - 11/1/2017 SE160957.015
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	9.2	11	16	58	50
Copper, Cu	mg/kg	0.5	3.9	4.8	6.5	18	17
Lead, Pb	mg/kg	1	5	5	6	9	9
Nickel, Ni	mg/kg	0.5	4.4	7.0	11	41	34
Zinc, Zn	mg/kg	0.5	7.4	8.9	14	45	31
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017 (continued)

PARAMETER	UOM	LOR	SR16 SOIL - 11/1/2017 SE160957.016	SR17 SOIL - 11/1/2017 SE160957.017	SR18 SOIL - 11/1/2017 SE160957.018	SR19 SOIL - 11/1/2017 SE160957.019	SR20 SOIL - 11/1/2017 SE160957.020
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	41	36	36	24	27
Copper, Cu	mg/kg	0.5	14	13	12	11	11
Lead, Pb	mg/kg	1	8	11	8	8	7
Nickel, Ni	mg/kg	0.5	25	20	17	16	16
Zinc, Zn	mg/kg	0.5	23	21	22	24	22
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR21 SOIL - 11/1/2017 SE160957.021	SR22 SOIL - 11/1/2017 SE160957.022	SR23 SOIL - 11/1/2017 SE160957.023	SR24 SOIL - 11/1/2017 SE160957.024	SR25 SOIL - 11/1/2017 SE160957.025
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	0.3	0.4	0.4	<0.3
Chromium, Cr	mg/kg	0.3	41	65	59	63	40
Copper, Cu	mg/kg	0.5	13	18	20	20	15
Lead, Pb	mg/kg	1	7	9	9	9	9
Nickel, Ni	mg/kg	0.5	24	42	52	50	32
Zinc, Zn	mg/kg	0.5	25	35	41	40	29
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	SR26 SOIL - 11/1/2017 SE160957.026	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	0.4	0.4	0.3	0.4	0.3
Chromium, Cr	mg/kg	0.3	67	58	50	63	64
Copper, Cu	mg/kg	0.5	22	23	19	26	22
Lead, Pb	mg/kg	1	10	11	10	8	9
Nickel, Ni	mg/kg	0.5	52	62	40	83	48
Zinc, Zn	mg/kg	0.5	59	64	58	50	49
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320] Tested: 23/1/2017 (continued)

PARAMETER	UOM	LOR	SR31 SOIL - 11/1/2017 SE160957.031	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SRA SOIL - 11/1/2017 SE160957.039	SRB SOIL - 11/1/2017 SE160957.040
Arsenic, As	mg/kg	3	<3	<3	<3	<3	<3
Cadmium, Cd	mg/kg	0.3	<0.3	0.3	0.3	<0.3	<0.3
Chromium, Cr	mg/kg	0.3	49	53	59	21	9.7
Copper, Cu	mg/kg	0.5	21	22	22	6.0	3.4
Lead, Pb	mg/kg	1	10	10	10	5	4
Nickel, Ni	mg/kg	0.5	41	50	48	8.3	2.9
Zinc, Zn	mg/kg	0.5	58	40	44	17	5.1
Calcium, Ca	mg/kg	5	-	-	-	-	-
Magnesium, Mg	mg/kg	5	-	-	-	-	-
Sodium, Na	mg/kg	5	-	-	-	-	-
Potassium, K	mg/kg	10	-	-	-	-	-

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
Arsenic, As	mg/kg	3	-	-
Cadmium, Cd	mg/kg	0.3	-	-
Chromium, Cr	mg/kg	0.3	-	-
Copper, Cu	mg/kg	0.5	-	-
Lead, Pb	mg/kg	1	-	-
Nickel, Ni	mg/kg	0.5	-	-
Zinc, Zn	mg/kg	0.5	-	-
Calcium, Ca	mg/kg	5	180	230
Magnesium, Mg	mg/kg	5	190	590
Sodium, Na	mg/kg	5	22	450
Potassium, K	mg/kg	10	590	360

Mercury in Soil [AN312] Tested: 20/1/2017

PARAMETER	UOM	LOR	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030	SR31 SOIL - 11/1/2017 SE160957.031
Mercury	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	<0.05

PARAMETER	UOM	LOR	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033
Mercury	mg/kg	0.05	<0.05	<0.05

Moisture Content [AN002] Tested: 20/1/2017

PARAMETER	UOM	LOR	SR1 SOIL - 11/1/2017 SE160957.001	SR2 SOIL - 11/1/2017 SE160957.002	SR3 SOIL - 11/1/2017 SE160957.003	SR4 SOIL - 11/1/2017 SE160957.004	SR5 SOIL - 11/1/2017 SE160957.005
% Moisture	%w/w	0.5	8.7	4.9	4.0	9.1	5.6

PARAMETER	UOM	LOR	SR6 SOIL - 11/1/2017 SE160957.006	SR7 SOIL - 11/1/2017 SE160957.007	SR8 SOIL - 11/1/2017 SE160957.008	SR9 SOIL - 11/1/2017 SE160957.009	SR10 SOIL - 11/1/2017 SE160957.010
% Moisture	%w/w	0.5	7.7	3.5	6.5	3.5	2.0

PARAMETER	UOM	LOR	SR11 SOIL - 11/1/2017 SE160957.011	SR12 SOIL - 11/1/2017 SE160957.012	SR13 SOIL - 11/1/2017 SE160957.013	SR14 SOIL - 11/1/2017 SE160957.014	SR15 SOIL - 11/1/2017 SE160957.015
% Moisture	%w/w	0.5	5.3	3.6	3.2	7.7	8.1

PARAMETER	UOM	LOR	SR16 SOIL - 11/1/2017 SE160957.016	SR17 SOIL - 11/1/2017 SE160957.017	SR18 SOIL - 11/1/2017 SE160957.018	SR19 SOIL - 11/1/2017 SE160957.019	SR20 SOIL - 11/1/2017 SE160957.020
% Moisture	%w/w	0.5	7.1	8.3	6.7	6.3	6.2

PARAMETER	UOM	LOR	SR21 SOIL - 11/1/2017 SE160957.021	SR22 SOIL - 11/1/2017 SE160957.022	SR23 SOIL - 11/1/2017 SE160957.023	SR24 SOIL - 11/1/2017 SE160957.024	SR25 SOIL - 11/1/2017 SE160957.025
% Moisture	%w/w	0.5	5.8	12	7.4	6.4	4.8

PARAMETER	UOM	LOR	SR26 SOIL - 11/1/2017 SE160957.026	SR27 SOIL - 11/1/2017 SE160957.027	SR28 SOIL - 11/1/2017 SE160957.028	SR29 SOIL - 11/1/2017 SE160957.029	SR30 SOIL - 11/1/2017 SE160957.030
% Moisture	%w/w	0.5	8.5	6.3	6.3	4.8	5.7

PARAMETER	UOM	LOR	SR31 SOIL - 11/1/2017 SE160957.031	SR32 SOIL - 12/1/2017 SE160957.032	SR33 SOIL - 12/1/2017 SE160957.033	SR73 SOIL - 11/1/2017 SE160957.034	SR91 SOIL - 11/1/2017 SE160957.035
% Moisture	%w/w	0.5	4.3	5.3	5.7	1.3	5.5

Moisture Content [AN002] Tested: 20/1/2017 (continued)

PARAMETER	UOM	LOR	SR113 SOIL - 11/1/2017 SE160957.036	SR184 SOIL - 11/1/2017 SE160957.037	SR224 SOIL - 11/1/2017 SE160957.038	SRA SOIL - 11/1/2017 SE160957.039	SRB SOIL - 11/1/2017 SE160957.040
% Moisture	%w/w	0.5	2.2	7.9	7.6	5.2	2.2

PARAMETER	UOM	LOR	BH16-100 SOIL - 11/1/2017 SE160957.041	BH16-1500 SOIL - 11/1/2017 SE160957.042
% Moisture	%w/w	0.5	6.3	10

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN040/AN320	A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.
AN040	A portion of sample is digested with Nitric acid to decompose organic matter and Hydrochloric acid to complete the digestion of metals and then filtered for analysis by ASS or ICP as per USEPA Method 200.8.
AN122	Exchangeable Cations, CEC and ESP: Soil sample is extracted in 1M Ammonium Acetate at pH=7 (or 1M Ammonium Chloride at pH=7) with cations (Na, K, Ca & Mg) then determined by ICP OES/ICP MS and reported as Exchangeable Cations. For saline soils, these results can be corrected for water soluble cations and reported as Exchangeable cations in meq/100g or soil can be pre-treated (aqueous ethanol/aqueous glycerol) prior to extraction. Cation Exchange Capacity (CEC) is the sum of the exchangeable cations in meq/100g.
AN122	The Exchangeable Sodium Percentage (ESP) is calculated as the exchangeable sodium divided by the CEC (all in meq/100g) times 100. ESP can be used to categorise the sodicity of the soil as below: ESP < 6% non-sodic ESP 6-15% sodic ESP >15% strongly sodic Method is refernced to Rayment and Higginson, 1992, sections 15D3 and 15N1.-
AN245	Anions by Ion Chromatography: A water sample is injected into an eluent stream that passes through the ion chromatographic system where the anions of interest ie Br, Cl, NO2, NO3 and SO4 are separated on their relative affinities for the active sites on the column packing material. Changes to the conductivity and the UV-visible absorbance of the eluent enable identification and quantitation of the anions based on their retention time and peak height or area. APHA 4110 B
AN312	Mercury by Cold Vapour AAS in Soils: After digestion with nitric acid, hydrogen peroxide and hydrochloric acid, mercury ions are reduced by stannous chloride reagent in acidic solution to elemental mercury. This mercury vapour is purged by nitrogen into a cold cell in an atomic absorption spectrometer or mercury analyser. Quantification is made by comparing absorbances to those of the calibration standards. Reference APHA 3112/3500
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is reported directly and also corrected by subtracting Naphthalene (from VOC method AN433) where available.
AN403	Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents.
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN420	(SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols (etc) in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN420	SVOC Compounds: Semi-Volatile Organic Compounds (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).
AN433	VOCs and C6-C9 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
		IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/en/terms-and-conditions. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

STATEMENT OF QA/QC PERFORMANCE

SE160957 R0

CLIENT DETAILS

Contact	Ashleigh Pickering
Client	ENVIROWEST CONSULTING PTY LIMITED
Address	PO BOX 8158 ORANGE NSW 2800
Telephone	61 2 63614954
Facsimile	(Not specified)
Email	ashleigh@envirowest.net.au
Project	**7891**
Order Number	(Not specified)
Samples	42

LABORATORY DETAILS

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Laboratory	SGS Alexandria Environmental
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Email	au.environmental.sydney@sgs.com
SGS Reference	**SE160957 R0**
Date Received	17 Jan 2017
Date Reported	25 Jan 2017

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Matrix Spike	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	1 item
	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	3 items

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	42 Soil
Date documentation received	17/1/2017	Type of documentation received	COC
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	21.5°C	Sufficient sample for analysis	Yes
Turnaround time requested	Standard		

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH16-100	SE160957.041	LB117341	11 Jan 2017	17 Jan 2017	08 Feb 2017	23 Jan 2017	08 Feb 2017	23 Jan 2017
BH16-1500	SE160957.042	LB117341	11 Jan 2017	17 Jan 2017	08 Feb 2017	23 Jan 2017	08 Feb 2017	23 Jan 2017

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117281	11 Jan 2017	17 Jan 2017	08 Feb 2017	20 Jan 2017	08 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117281	12 Jan 2017	17 Jan 2017	09 Feb 2017	20 Jan 2017	09 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117281	12 Jan 2017	17 Jan 2017	09 Feb 2017	20 Jan 2017	09 Feb 2017	24 Jan 2017

Moisture Content

Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR1	SE160957.001	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR2	SE160957.002	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR3	SE160957.003	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR4	SE160957.004	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR5	SE160957.005	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR6	SE160957.006	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR7	SE160957.007	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR8	SE160957.008	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR9	SE160957.009	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR10	SE160957.010	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR11	SE160957.011	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR12	SE160957.012	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR13	SE160957.013	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR14	SE160957.014	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR15	SE160957.015	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR16	SE160957.016	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR17	SE160957.017	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR18	SE160957.018	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR19	SE160957.019	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR20	SE160957.020	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR21	SE160957.021	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR22	SE160957.022	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR23	SE160957.023	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR24	SE160957.024	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR25	SE160957.025	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR26	SE160957.026	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR27	SE160957.027	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR28	SE160957.028	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR29	SE160957.029	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR30	SE160957.030	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR31	SE160957.031	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR32	SE160957.032	LB117208	12 Jan 2017	17 Jan 2017	26 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR33	SE160957.033	LB117208	12 Jan 2017	17 Jan 2017	26 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR73	SE160957.034	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR91	SE160957.035	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR113	SE160957.036	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR184	SE160957.037	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SR224	SE160957.038	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SRA	SE160957.039	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
SRB	SE160957.040	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
BH16-100	SE160957.041	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017
BH16-1500	SE160957.042	LB117208	11 Jan 2017	17 Jan 2017	25 Jan 2017	20 Jan 2017	25 Jan 2017	23 Jan 2017

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref

HOLDING TIME SUMMARY

SE160957 R0

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

OC Pesticides in Soil (continued)

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
BH16-100	SE160957.041	LB117119	11 Jan 2017	17 Jan 2017	18 Jan 2017	18 Jan 2017	15 Feb 2017	18 Jan 2017
BH16-1500	SE160957.042	LB117119	11 Jan 2017	17 Jan 2017	18 Jan 2017	18 Jan 2017	15 Feb 2017	18 Jan 2017

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR1	SE160957.001	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR2	SE160957.002	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR3	SE160957.003	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR4	SE160957.004	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR5	SE160957.005	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR6	SE160957.006	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR7	SE160957.007	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR8	SE160957.008	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR9	SE160957.009	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR10	SE160957.010	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR11	SE160957.011	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR12	SE160957.012	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR13	SE160957.013	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR14	SE160957.014	LB117335	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR15	SE160957.015	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR16	SE160957.016	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR17	SE160957.017	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR18	SE160957.018	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR19	SE160957.019	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR20	SE160957.020	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR21	SE160957.021	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR22	SE160957.022	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR23	SE160957.023	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR24	SE160957.024	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR25	SE160957.025	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR26	SE160957.026	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS “Field Sampling Guide for Containers and Holding Time” (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued) — Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR28	SE160957.028	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR29	SE160957.029	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR30	SE160957.030	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR31	SE160957.031	LB117336	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SR32	SE160957.032	LB117336	12 Jan 2017	17 Jan 2017	11 Jul 2017	23 Jan 2017	11 Jul 2017	24 Jan 2017
SR33	SE160957.033	LB117336	12 Jan 2017	17 Jan 2017	11 Jul 2017	23 Jan 2017	11 Jul 2017	24 Jan 2017
SRA	SE160957.039	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
SRB	SE160957.040	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
BH16-100	SE160957.041	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017
BH16-1500	SE160957.042	LB117337	11 Jan 2017	17 Jan 2017	10 Jul 2017	23 Jan 2017	10 Jul 2017	24 Jan 2017

TRH (Total Recoverable Hydrocarbons) in Soil — Method: ME-(AU)-[ENV]AN403

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117067	12 Jan 2017	17 Jan 2017	26 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR73	SE160957.034	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR91	SE160957.035	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR113	SE160957.036	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR184	SE160957.037	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017
SR224	SE160957.038	LB117067	11 Jan 2017	17 Jan 2017	25 Jan 2017	18 Jan 2017	27 Feb 2017	24 Jan 2017

VOC's in Soil — Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR27	SE160957.027	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR28	SE160957.028	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR29	SE160957.029	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR30	SE160957.030	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR31	SE160957.031	LB117101	11 Jan 2017	17 Jan 2017	25 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR32	SE160957.032	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017
SR33	SE160957.033	LB117101	12 Jan 2017	17 Jan 2017	26 Jan 2017	19 Jan 2017	28 Feb 2017	24 Jan 2017

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Tetrachloro-m-xylene (TCMX) (Surrogate)	SR27	SE160957.027	%	60 - 130%	109
	SR28	SE160957.028	%	60 - 130%	115
	SR29	SE160957.029	%	60 - 130%	80
	SR30	SE160957.030	%	60 - 130%	109
	SR31	SE160957.031	%	60 - 130%	105
	SR32	SE160957.032	%	60 - 130%	100
	SR33	SE160957.033	%	60 - 130%	105
	SR73	SE160957.034	%	60 - 130%	105
	SR91	SE160957.035	%	60 - 130%	108
	SR113	SE160957.036	%	60 - 130%	107
	SR184	SE160957.037	%	60 - 130%	107
	SR224	SE160957.038	%	60 - 130%	109

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
2-fluorobiphenyl (Surrogate)	SR27	SE160957.027	%	70 - 130%	100
	SR28	SE160957.028	%	70 - 130%	78
	SR29	SE160957.029	%	70 - 130%	110
	SR30	SE160957.030	%	70 - 130%	78
	SR31	SE160957.031	%	70 - 130%	110
	SR32	SE160957.032	%	70 - 130%	80
	SR33	SE160957.033	%	70 - 130%	80
d14-p-terphenyl (Surrogate)	SR27	SE160957.027	%	70 - 130%	92
	SR28	SE160957.028	%	70 - 130%	86
	SR29	SE160957.029	%	70 - 130%	112
	SR30	SE160957.030	%	70 - 130%	78
	SR31	SE160957.031	%	70 - 130%	112
	SR32	SE160957.032	%	70 - 130%	76
	SR33	SE160957.033	%	70 - 130%	94
d5-nitrobenzene (Surrogate)	SR27	SE160957.027	%	70 - 130%	90
	SR28	SE160957.028	%	70 - 130%	74
	SR29	SE160957.029	%	70 - 130%	110
	SR30	SE160957.030	%	70 - 130%	84
	SR31	SE160957.031	%	70 - 130%	112
	SR32	SE160957.032	%	70 - 130%	80
	SR33	SE160957.033	%	70 - 130%	88

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SR27	SE160957.027	%	60 - 130%	72
	SR28	SE160957.028	%	60 - 130%	71
	SR29	SE160957.029	%	60 - 130%	94
	SR30	SE160957.030	%	60 - 130%	75
	SR31	SE160957.031	%	60 - 130%	77
	SR32	SE160957.032	%	60 - 130%	71
	SR33	SE160957.033	%	60 - 130%	71
d4-1,2-dichloroethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	110
	SR28	SE160957.028	%	60 - 130%	109
	SR29	SE160957.029	%	60 - 130%	104
	SR30	SE160957.030	%	60 - 130%	112
	SR31	SE160957.031	%	60 - 130%	109
	SR32	SE160957.032	%	60 - 130%	109
	SR33	SE160957.033	%	60 - 130%	112
d8-toluene (Surrogate)	SR27	SE160957.027	%	60 - 130%	79
	SR28	SE160957.028	%	60 - 130%	80
	SR29	SE160957.029	%	60 - 130%	75
	SR30	SE160957.030	%	60 - 130%	81
	SR31	SE160957.031	%	60 - 130%	78
	SR32	SE160957.032	%	60 - 130%	76
	SR33	SE160957.033	%	60 - 130%	79
Dibromofluoromethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	96
	SR28	SE160957.028	%	60 - 130%	95

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

VOC's in Soil (continued) — Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Dibromofluoromethane (Surrogate)	SR29	SE160957.029	%	60 - 130%	92
	SR30	SE160957.030	%	60 - 130%	98
	SR31	SE160957.031	%	60 - 130%	98
	SR32	SE160957.032	%	60 - 130%	98
	SR33	SE160957.033	%	60 - 130%	100

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SR27	SE160957.027	%	60 - 130%	72
	SR28	SE160957.028	%	60 - 130%	71
	SR29	SE160957.029	%	60 - 130%	94
	SR30	SE160957.030	%	60 - 130%	75
	SR31	SE160957.031	%	60 - 130%	77
	SR32	SE160957.032	%	60 - 130%	71
	SR33	SE160957.033	%	60 - 130%	71
d4-1,2-dichloroethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	110
	SR28	SE160957.028	%	60 - 130%	109
	SR29	SE160957.029	%	60 - 130%	104
	SR30	SE160957.030	%	60 - 130%	112
	SR31	SE160957.031	%	60 - 130%	109
	SR32	SE160957.032	%	60 - 130%	109
	SR33	SE160957.033	%	60 - 130%	112
d8-toluene (Surrogate)	SR27	SE160957.027	%	60 - 130%	79
	SR28	SE160957.028	%	60 - 130%	80
	SR29	SE160957.029	%	60 - 130%	75
	SR30	SE160957.030	%	60 - 130%	81
	SR31	SE160957.031	%	60 - 130%	78
	SR32	SE160957.032	%	60 - 130%	76
	SR33	SE160957.033	%	60 - 130%	79
Dibromofluoromethane (Surrogate)	SR27	SE160957.027	%	60 - 130%	96
	SR28	SE160957.028	%	60 - 130%	95
	SR29	SE160957.029	%	60 - 130%	92
	SR30	SE160957.030	%	60 - 130%	98
	SR31	SE160957.031	%	60 - 130%	98
	SR32	SE160957.032	%	60 - 130%	98
	SR33	SE160957.033	%	60 - 130%	100

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number	Parameter	Units	LOR

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Number	Parameter	Units	LOR	Result
LB117281.001	Mercury	mg/kg	0.05	<0.05

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB117067.001		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1
		Alpha BHC	mg/kg	0.1	<0.1
		Lindane	mg/kg	0.1	<0.1
		Heptachlor	mg/kg	0.1	<0.1
		Aldrin	mg/kg	0.1	<0.1
		Beta BHC	mg/kg	0.1	<0.1
		Delta BHC	mg/kg	0.1	<0.1
		Heptachlor epoxide	mg/kg	0.1	<0.1
		Alpha Endosulfan	mg/kg	0.2	<0.2
		Gamma Chlordane	mg/kg	0.1	<0.1
		Alpha Chlordane	mg/kg	0.1	<0.1
		p,p'-DDE	mg/kg	0.1	<0.1
		Dieldrin	mg/kg	0.2	<0.2
		Endrin	mg/kg	0.2	<0.2
		Beta Endosulfan	mg/kg	0.2	<0.2
		p,p'-DDD	mg/kg	0.1	<0.1
		p,p'-DDT	mg/kg	0.1	<0.1
		Endosulfan sulphate	mg/kg	0.1	<0.1
		Endrin Aldehyde	mg/kg	0.1	<0.1
		Methoxychlor	mg/kg	0.1	<0.1
		Endrin Ketone	mg/kg	0.1	<0.1
		Isodrin	mg/kg	0.1	<0.1
		Mirex	mg/kg	0.1	<0.1
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	%	-	99

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB117067.001		Naphthalene	mg/kg	0.1	<0.1
		2-methylnaphthalene	mg/kg	0.1	<0.1
		1-methylnaphthalene	mg/kg	0.1	<0.1
		Acenaphthylene	mg/kg	0.1	<0.1
		Acenaphthene	mg/kg	0.1	<0.1
		Fluorene	mg/kg	0.1	<0.1
		Phenanthrene	mg/kg	0.1	<0.1
		Anthracene	mg/kg	0.1	<0.1
		Fluoranthene	mg/kg	0.1	<0.1
		Pyrene	mg/kg	0.1	<0.1
		Benzo(a)anthracene	mg/kg	0.1	<0.1
		Chrysene	mg/kg	0.1	<0.1
		Benzo(a)pyrene	mg/kg	0.1	<0.1
		Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1
		Dibenzo(ah)anthracene	mg/kg	0.1	<0.1
		Benzo(ghi)perylene	mg/kg	0.1	<0.1
		Total PAH (18)	mg/kg	0.8	<0.8
	Surrogates	d5-nitrobenzene (Surrogate)	%	-	82
		2-fluorobiphenyl (Surrogate)	%	-	84
		d14-p-terphenyl (Surrogate)	%	-	76

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Soluble Anions (1:5) in Soil by Ion Chromatography (continued)

Method: ME-(AU)-[ENV]AN245

Sample Number	Parameter	Units	LOR	Result
LB117119.001	Chloride	mg/kg	0.25	<0.25

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number	Parameter	Units	LOR	Result
LB117335.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
LB117336.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
LB117337.001	Arsenic, As	mg/kg	3	<3
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.3	<0.3
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	0.5	<0.5
	Calcium, Ca	mg/kg	5	<5
	Magnesium, Mg	mg/kg	5	<5
	Sodium, Na	mg/kg	5	<5
	Potassium, K	mg/kg	10	<10

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR	Result
LB117067.001	TRH C10-C14	mg/kg	20	<20
	TRH C15-C28	mg/kg	45	<45
	TRH C29-C36	mg/kg	45	<45
	TRH C37-C40	mg/kg	100	<100
	TRH C10-C36 Total	mg/kg	110	<110

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB117101.001	Monocyclic Aromatic Hydrocarbons	Benzene	mg/kg	0.1	<0.1
		Toluene	mg/kg	0.1	<0.1
		Ethylbenzene	mg/kg	0.1	<0.1
		m/p-xylene	mg/kg	0.2	<0.2
		o-xylene	mg/kg	0.1	<0.1
	Polycyclic VOCs	Naphthalene	mg/kg	0.1	<0.1
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	96
		d4-1,2-dichloroethane (Surrogate)	%	-	109
		d8-toluene (Surrogate)	%	-	75
		Bromofluorobenzene (Surrogate)	%	-	70
	Totals	Total BTEX	mg/kg	0.6	<0.6

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB117101.001		TRH C6-C9	mg/kg	20	<20
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	96
		d4-1,2-dichloroethane (Surrogate)	%	-	109
		d8-toluene (Surrogate)	%	-	75

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.031	LB117281.014		Mercury	mg/kg	0.05	<0.05	<0.05	200	0
SE160960.007	LB117281.024		Mercury	mg/kg	0.05	<0.05	<0.05	200	0

Moisture Content

Method: ME-(AU)-[ENV]AN002

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160956.011	LB117208.011		% Moisture	%w/w	0.5	<0.5	<0.5	200	0
SE160957.010	LB117208.022		% Moisture	%w/w	0.5	2.0	1.8	82	13
SE160957.020	LB117208.033		% Moisture	%w/w	0.5	6.2	6.6	46	7
SE160957.030	LB117208.044		% Moisture	%w/w	0.5	5.7	5.8	47	3
SE160957.040	LB117208.055		% Moisture	%w/w	0.5	2.2	1.8	80	22
SE160957.042	LB117208.058		% Moisture	%w/w	0.5	10	10	40	1

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.036	LB117067.034		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Lindane	mg/kg	0.1	<0.1	<0.1	200	0
			Heptachlor	mg/kg	0.1	<0.1	<0.1	200	0
			Aldrin	mg/kg	0.1	<0.1	<0.1	200	0
			Beta BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Delta BHC	mg/kg	0.1	<0.1	<0.1	200	0
			Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	200	0
			o,p'-DDE	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	200	0
			Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	200	0
			Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	200	0
			trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	200	0
			p,p'-DDE	mg/kg	0.1	<0.1	<0.1	200	0
			Dieldrin	mg/kg	0.2	<0.2	<0.2	200	0
			Endrin	mg/kg	0.2	<0.2	<0.2	200	0
			o,p'-DDD	mg/kg	0.1	<0.1	<0.1	200	0
			o,p'-DDT	mg/kg	0.1	<0.1	<0.1	200	0
			Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	200	0
			p,p'-DDD	mg/kg	0.1	<0.1	<0.1	200	0
			p,p'-DDT	mg/kg	0.1	<0.1	<0.1	200	0
			Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	200	0
			Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	200	0
			Methoxychlor	mg/kg	0.1	<0.1	<0.1	200	0
			Endrin Ketone	mg/kg	0.1	<0.1	<0.1	200	0
			Isodrin	mg/kg	0.1	<0.1	<0.1	200	0
			Mirex	mg/kg	0.1	<0.1	<0.1	200	0
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.16	0.16	30	1

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthylene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluorene	mg/kg	0.1	<0.1	<0.1	200	0
			Phenanthrene	mg/kg	0.1	<0.1	<0.1	200	0
			Anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Chrysene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

PAH (Polynuclear Aromatic Hydrocarbons) in Soil (continued) — Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ (mg/kg)	0.2	<0.2	<0.2	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	134	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	175	0
			Total PAH (18)	mg/kg	0.8	<0.8	<0.8	200	0
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.5	30	9
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.6	30	10
			d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.5	30	10
SE160957.033	LB117067.032		Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthylene	mg/kg	0.1	<0.1	<0.1	200	0
			Acenaphthene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluorene	mg/kg	0.1	<0.1	<0.1	200	0
			Phenanthrene	mg/kg	0.1	<0.1	<0.1	200	0
			Anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Chrysene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(a)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	200	0
			Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	200	0
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ (mg/kg)	0.2	<0.2	<0.2	200	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	<0.3	<0.3	134	0
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	<0.2	<0.2	175	0
			Total PAH (18)	mg/kg	0.8	<0.8	<0.8	200	0
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.4	0.4	30	7
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.4	0.4	30	5
			d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.4	30	11

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.005	LB117335.014	Arsenic, As	mg/kg	3	<3	<3	94	11
		Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	200	0
		Chromium, Cr	mg/kg	0.3	18	18	33	2
		Copper, Cu	mg/kg	0.5	6.8	6.4	38	5
		Lead, Pb	mg/kg	1	6	5	48	4
		Nickel, Ni	mg/kg	0.5	7.6	7.2	37	5
		Zinc, Zn	mg/kg	0.5	13	13	45	0
SE160957.014	LB117335.024	Arsenic, As	mg/kg	3	<3	<3	86	28
		Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	138	0
		Chromium, Cr	mg/kg	0.3	58	57	31	1
		Copper, Cu	mg/kg	0.5	18	19	33	3
		Lead, Pb	mg/kg	1	9	9	41	2
		Nickel, Ni	mg/kg	0.5	41	41	31	0
		Zinc, Zn	mg/kg	0.5	45	44	35	1
SE160957.024	LB117336.014	Arsenic, As	mg/kg	3	<3	<3	81	7
		Cadmium, Cd	mg/kg	0.3	0.4	0.4	113	1
		Chromium, Cr	mg/kg	0.3	63	65	31	2
		Copper, Cu	mg/kg	0.5	20	21	32	7
		Lead, Pb	mg/kg	1	9	9	41	4
		Nickel, Ni	mg/kg	0.5	50	57	31	13
		Zinc, Zn	mg/kg	0.5	40	41	35	2
SE160957.033	LB117336.024	Arsenic, As	mg/kg	3	<3	<3	70	6
		Cadmium, Cd	mg/kg	0.3	0.3	0.3	121	11
		Chromium, Cr	mg/kg	0.3	59	59	31	1

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued)

Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.033	LB117336.024		Copper, Cu	mg/kg	0.5	22	23	32	3
			Lead, Pb	mg/kg	1	10	10	40	1
			Nickel, Ni	mg/kg	0.5	48	49	31	1
			Zinc, Zn	mg/kg	0.5	44	45	35	4
SE160960.006	LB117337.014		Arsenic, As	mg/kg	3	4	<3	61	23
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	143	0
			Chromium, Cr	mg/kg	0.3	43	36	31	18
			Copper, Cu	mg/kg	0.5	15	15	33	1
			Lead, Pb	mg/kg	1	13	13	38	4
			Nickel, Ni	mg/kg	0.5	33	29	32	13
			Zinc, Zn	mg/kg	0.5	14	15	44	3
SE160960.015	LB117337.024		Arsenic, As	mg/kg	3	<3	<3	70	13
			Cadmium, Cd	mg/kg	0.3	<0.3	<0.3	178	0
			Chromium, Cr	mg/kg	0.3	16	15	33	11
			Copper, Cu	mg/kg	0.5	12	13	34	5
			Lead, Pb	mg/kg	1	19	16	36	17
			Nickel, Ni	mg/kg	0.5	19	19	33	4
			Zinc, Zn	mg/kg	0.5	32	32	36	2

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160957.027	LB117067.014		TRH C10-C14	mg/kg	20	<20	<20	200	0
			TRH C15-C28	mg/kg	45	<45	<45	200	0
			TRH C29-C36	mg/kg	45	<45	<45	200	0
			TRH C37-C40	mg/kg	100	<100	<100	200	0
			TRH C10-C36 Total	mg/kg	110	<110	<110	200	0
			TRH C10-C40 Total	mg/kg	210	<210	<210	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	<25	<25	200	0
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	200	0
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	200	0
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	200	0
SE160957.033	LB117067.031		TRH C10-C14	mg/kg	20	<20	<20	200	0
			TRH C15-C28	mg/kg	45	<45	<45	200	0
			TRH C29-C36	mg/kg	45	<45	<45	200	0
			TRH C37-C40	mg/kg	100	<100	<100	200	0
			TRH C10-C36 Total	mg/kg	110	<110	<110	200	0
			TRH C10-C40 Total	mg/kg	210	<210	<210	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	<25	<25	200	0
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	<25	<25	200	0
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	200	0
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	200	0

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.003	LB117101.014	Monocyclic Aromatic	Benzene	mg/kg	0.1	<0.1	<0.1	200	0
			Toluene	mg/kg	0.1	<0.1	<0.1	200	0
			Ethylbenzene	mg/kg	0.1	<0.1	<0.1	200	0
			m/p-xylene	mg/kg	0.2	<0.2	<0.2	200	0
			o-xylene	mg/kg	0.1	<0.1	<0.1	200	0
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.9	4.9	50	0
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.5	5.6	50	2
			d8-toluene (Surrogate)	mg/kg	-	3.8	3.9	50	2
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.6	3.6	50	0
		Totals	Total Xylenes*	mg/kg	0.3	<0.3	<0.3	200	0
			Total BTEX	mg/kg	0.6	<0.6	<0.6	200	0
SE160960.013	LB117101.025	Monocyclic Aromatic	Benzene	mg/kg	0.1	<0.1	<0.1	200	0
			Toluene	mg/kg	0.1	<0.1	<0.1	200	0
			Ethylbenzene	mg/kg	0.1	<0.1	<0.1	200	0
			m/p-xylene	mg/kg	0.2	<0.2	<0.2	200	0
			o-xylene	mg/kg	0.1	<0.1	<0.1	200	0
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

VOC's in Soil (continued) — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.013	LB117101.025	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.6	50	7
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.9	5.3	50	9
			d8-toluene (Surrogate)	mg/kg	-	4.0	3.6	50	9
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	3.7	50	3
		Totals	Total Xylenes*	mg/kg	0.3	<0.3	<0.3	200	0
			Total BTEX	mg/kg	0.6	<0.6	<0.6	200	0

Volatile Petroleum Hydrocarbons in Soil — Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE160960.003	LB117101.014		TRH C6-C10	mg/kg	25	<25	<25	200	0
			TRH C6-C9	mg/kg	20	<20	<20	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.9	4.9	30	0
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.5	5.6	30	2
			d8-toluene (Surrogate)	mg/kg	-	3.8	3.9	30	2
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.6	3.6	30	0
		VPH F Bands	Benzene (F0)	mg/kg	0.1	<0.1	<0.1	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	200	0
SE160960.013	LB117101.025		TRH C6-C10	mg/kg	25	<25	<25	200	0
			TRH C6-C9	mg/kg	20	<20	<20	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.6	30	7
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.9	5.3	30	9
			d8-toluene (Surrogate)	mg/kg	-	4.0	3.6	30	9
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	3.7	30	3
		VPH F Bands	Benzene (F0)	mg/kg	0.1	<0.1	<0.1	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	200	0

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Exchangeable Cations and Cation Exchange Capacity (CEC/ESP/SAR)

Method: ME-(AU)-[ENV]AN122

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117341.002		Exchangeable Sodium, Na	mg/kg	2	NA	390	80 - 120	118

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117281.002		Mercury	mg/kg	0.05	0.22	0.2	70 - 130	110

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		Heptachlor	mg/kg	0.1	0.2	0.2	60 - 140	102
		Aldrin	mg/kg	0.1	0.2	0.2	60 - 140	98
		Delta BHC	mg/kg	0.1	0.2	0.2	60 - 140	108
		Dieldrin	mg/kg	0.2	<0.2	0.2	60 - 140	92
		Endrin	mg/kg	0.2	0.2	0.2	60 - 140	112
		p,p'-DDT	mg/kg	0.1	0.2	0.2	60 - 140	124
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.15	0.15	40 - 130	97

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		Naphthalene	mg/kg	0.1	4.4	4	60 - 140	109
		Acenaphthylene	mg/kg	0.1	4.3	4	60 - 140	108
		Acenaphthene	mg/kg	0.1	4.2	4	60 - 140	104
		Phenanthrene	mg/kg	0.1	4.1	4	60 - 140	103
		Anthracene	mg/kg	0.1	3.9	4	60 - 140	96
		Fluoranthene	mg/kg	0.1	4.2	4	60 - 140	106
		Pyrene	mg/kg	0.1	3.5	4	60 - 140	88
		Benzo(a)pyrene	mg/kg	0.1	5.0	4	60 - 140	125
	Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	96
		2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	100
		d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.5	40 - 130	96

Soluble Anions (1:5) in Soil by Ion Chromatography

Method: ME-(AU)-[ENV]AN245

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117119.002		Chloride	mg/kg	0.25	97	100	70 - 130	97

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117335.002		Arsenic, As	mg/kg	3	49	50	80 - 120	98
		Cadmium, Cd	mg/kg	0.3	51	50	80 - 120	102
		Chromium, Cr	mg/kg	0.3	48	50	80 - 120	95
		Copper, Cu	mg/kg	0.5	47	50	80 - 120	93
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	50	50	80 - 120	101
		Zinc, Zn	mg/kg	0.5	48	50	80 - 120	96
LB117336.002		Arsenic, As	mg/kg	3	49	50	80 - 120	97
		Cadmium, Cd	mg/kg	0.3	51	50	80 - 120	101
		Chromium, Cr	mg/kg	0.3	47	50	80 - 120	94
		Copper, Cu	mg/kg	0.5	46	50	80 - 120	93
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	50	50	80 - 120	99
		Zinc, Zn	mg/kg	0.5	47	50	80 - 120	95
LB117337.002		Arsenic, As	mg/kg	3	48	50	80 - 120	96
		Cadmium, Cd	mg/kg	0.3	48	50	80 - 120	97
		Chromium, Cr	mg/kg	0.3	47	50	80 - 120	95
		Copper, Cu	mg/kg	0.5	47	50	80 - 120	95
		Lead, Pb	mg/kg	1	48	50	80 - 120	96
		Nickel, Ni	mg/kg	0.5	48	50	80 - 120	97
		Zinc, Zn	mg/kg	0.5	48	50	80 - 120	96

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES (continued) Method: ME-(AU)-[ENV]AN040/AN320

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117337.002		Calcium, Ca	mg/kg	5	49	50	80 - 120	98
		Magnesium, Mg	mg/kg	5	48	50	80 - 120	95
		Sodium, Na	mg/kg	5	48	50	80 - 120	97
		Potassium, K	mg/kg	10	480	500	80 - 120	95

TRH (Total Recoverable Hydrocarbons) in Soil Method: ME-(AU)-[ENV]AN403

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117067.002		TRH C10-C14	mg/kg	20	31	40	60 - 140	78
		TRH C15-C28	mg/kg	45	<45	40	60 - 140	85
		TRH C29-C36	mg/kg	45	<45	40	60 - 140	90
	TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	32	40	60 - 140	80
		TRH >C16-C34 (F3)	mg/kg	90	<90	40	60 - 140	98
		TRH >C34-C40 (F4)	mg/kg	120	<120	20	60 - 140	80

VOC's in Soil Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117101.002	Monocyclic Aromatic	Benzene	mg/kg	0.1	2.1	2.9	60 - 140	72
		Toluene	mg/kg	0.1	1.8	2.9	60 - 140	62
		Ethylbenzene	mg/kg	0.1	1.9	2.9	60 - 140	67
		m/p-xylene	mg/kg	0.2	4.7	5.8	60 - 140	82
		o-xylene	mg/kg	0.1	2.1	2.9	60 - 140	72
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.6	5	60 - 140	92
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.2	5	60 - 140	104
		d8-toluene (Surrogate)	mg/kg	-	3.8	5	60 - 140	75
		Bromofluorobenzene (Surrogate)	mg/kg	-	5.2	5	60 - 140	103

Volatile Petroleum Hydrocarbons in Soil Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB117101.002		TRH C6-C10	mg/kg	25	<25	24.65	60 - 140	88
		TRH C6-C9	mg/kg	20	<20	23.2	60 - 140	79
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.6	5	60 - 140	92
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.2	5	60 - 140	104
		d8-toluene (Surrogate)	mg/kg	-	3.8	5	60 - 140	75
		Bromofluorobenzene (Surrogate)	mg/kg	-	5.2	5	60 - 140	103
	VPH F Bands	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	7.25	60 - 140	123

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Mercury in Soil

Method: ME-(AU)-[ENV]AN312

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.005	LB117281.004		Mercury	mg/kg	0.05	0.21	<0.05	0.2	98

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.028	LB117067.033		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha BHC	mg/kg	0.1	<0.1	<0.1	-	-
			Lindane	mg/kg	0.1	<0.1	<0.1	-	-
			Heptachlor	mg/kg	0.1	0.2	<0.1	0.2	81
			Aldrin	mg/kg	0.1	0.2	<0.1	0.2	75
			Beta BHC	mg/kg	0.1	<0.1	<0.1	-	-
			Delta BHC	mg/kg	0.1	0.2	<0.1	0.2	83
			Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	-	-
			o,p'-DDE	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	-	-
			Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	-	-
			Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	-	-
			trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	-	-
			p,p'-DDE	mg/kg	0.1	<0.1	<0.1	-	-
			Dieldrin	mg/kg	0.2	<0.2	<0.2	0.2	76
			Endrin	mg/kg	0.2	<0.2	<0.2	0.2	100
			o,p'-DDD	mg/kg	0.1	<0.1	<0.1	-	-
			o,p'-DDT	mg/kg	0.1	<0.1	<0.1	-	-
			Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	-	-
			p,p'-DDD	mg/kg	0.1	<0.1	<0.1	-	-
			p,p'-DDT	mg/kg	0.1	0.2	<0.1	0.2	124
			Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	-	-
			Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	-	-
			Methoxychlor	mg/kg	0.1	<0.1	<0.1	-	-
			Endrin Ketone	mg/kg	0.1	<0.1	<0.1	-	-
			Isodrin	mg/kg	0.1	<0.1	<0.1	-	-
			Mirex	mg/kg	0.1	<0.1	<0.1	-	-
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.16	0.17	-	106

PAH (Polynuclear Aromatic Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.031		Naphthalene	mg/kg	0.1	3.9	<0.1	4	98
			2-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	-	-
			1-methylnaphthalene	mg/kg	0.1	<0.1	<0.1	-	-
			Acenaphthylene	mg/kg	0.1	3.9	<0.1	4	98
			Acenaphthene	mg/kg	0.1	4.2	<0.1	4	104
			Fluorene	mg/kg	0.1	<0.1	<0.1	-	-
			Phenanthrene	mg/kg	0.1	3.9	<0.1	4	97
			Anthracene	mg/kg	0.1	3.6	<0.1	4	90
			Fluoranthene	mg/kg	0.1	4.0	<0.1	4	100
			Pyrene	mg/kg	0.1	3.7	<0.1	4	92
			Benzo(a)anthracene	mg/kg	0.1	<0.1	<0.1	-	-
			Chrysene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(b&j)fluoranthene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(k)fluoranthene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(a)pyrene	mg/kg	0.1	4.8	<0.1	4	121
			Indeno(1,2,3-cd)pyrene	mg/kg	0.1	<0.1	<0.1	-	-
			Dibenzo(ah)anthracene	mg/kg	0.1	<0.1	<0.1	-	-
			Benzo(ghi)perylene	mg/kg	0.1	<0.1	<0.1	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=0	TEQ	0.2	4.8	<0.2	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=LOR	TEQ (mg/kg)	0.3	5.0	<0.3	-	-
			Carcinogenic PAHs, BaP TEQ <LOR=LOR/2	TEQ (mg/kg)	0.2	4.9	<0.2	-	-
			Total PAH (18)	mg/kg	0.8	32	<0.8	-	-
		Surrogates	d5-nitrobenzene (Surrogate)	mg/kg	-	0.5	0.4	-	90
			2-fluorobiphenyl (Surrogate)	mg/kg	-	0.5	0.4	-	90

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub-sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

PAH (Polynuclear Aromatic Hydrocarbons) in Soil (continued)

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.031	Surrogates	d14-p-terphenyl (Surrogate)	mg/kg	-	0.5	0.4	-	94

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.005	LB117335.004		Arsenic, As	mg/kg	3	42	<3	50	78
			Cadmium, Cd	mg/kg	0.3	42	<0.3	50	85
			Chromium, Cr	mg/kg	0.3	45	6.6	50	77
			Copper, Cu	mg/kg	0.5	57	19	50	76
			Lead, Pb	mg/kg	1	54	20	50	69 ⑨
			Nickel, Ni	mg/kg	0.5	43	4.9	50	77
			Zinc, Zn	mg/kg	0.5	51	15	50	72
SE160957.015	LB117336.004		Arsenic, As	mg/kg	3	30	<3	50	55 ⑨
			Cadmium, Cd	mg/kg	0.3	39	<0.3	50	77
			Chromium, Cr	mg/kg	0.3	84	50	50	67 ⑨
			Copper, Cu	mg/kg	0.5	55	17	50	76
			Lead, Pb	mg/kg	1	44	9	50	69 ⑨
			Nickel, Ni	mg/kg	0.5	70	34	50	73
			Zinc, Zn	mg/kg	0.5	69	31	50	76
SE160957.039	LB117337.004		Arsenic, As	mg/kg	3	44	<3	50	84
			Cadmium, Cd	mg/kg	0.3	44	<0.3	50	88
			Chromium, Cr	mg/kg	0.3	63	21	50	84
			Copper, Cu	mg/kg	0.5	52	6.0	50	92
			Lead, Pb	mg/kg	1	49	5	50	87
			Nickel, Ni	mg/kg	0.5	53	8.3	50	89
			Zinc, Zn	mg/kg	0.5	64	17	50	95

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160956.001	LB117067.032		TRH C10-C14	mg/kg	20	39	<20	40	98
			TRH C15-C28	mg/kg	45	<45	<45	40	110
			TRH C29-C36	mg/kg	45	<45	<45	40	98
			TRH C37-C40	mg/kg	100	<100	<100	-	-
			TRH C10-C36 Total	mg/kg	110	120	<110	-	-
			TRH C10-C40 Total	mg/kg	210	<210	<210	-	-
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	40	<25	40	100
			TRH >C10-C16 (F2) - Naphthalene	mg/kg	25	40	<25	-	-
			TRH >C16-C34 (F3)	mg/kg	90	<90	<90	40	113
			TRH >C34-C40 (F4)	mg/kg	120	<120	<120	-	-

VOC's in Soil

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004	Monocyclic Aromatic	Benzene	mg/kg	0.1	2.1	<0.1	2.9	72
			Toluene	mg/kg	0.1	1.9	<0.1	2.9	66
			Ethylbenzene	mg/kg	0.1	1.9	<0.1	2.9	64
			m/p-xylene	mg/kg	0.2	4.7	<0.2	5.8	80
			o-xylene	mg/kg	0.1	2.1	<0.1	2.9	71
		Polycyclic	Naphthalene	mg/kg	0.1	<0.1	<0.1	-	-
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.8	-	86
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	5.5	-	100
			d8-toluene (Surrogate)	mg/kg	-	3.7	4.0	-	73
			Bromofluorobenzene (Surrogate)	mg/kg	-	5.0	3.6	-	101
		Totals	Total Xylenes*	mg/kg	0.3	6.8	<0.3	-	-
			Total BTEX	mg/kg	0.6	13	<0.6	-	-

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004		TRH C6-C10	mg/kg	25	<25	<25	24.65	85
			TRH C6-C9	mg/kg	20	<20	<20	23.2	79
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	4.8	-	86
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	5.5	-	100
			d8-toluene (Surrogate)	mg/kg	-	3.7	4.0	-	73
			Bromofluorobenzene (Surrogate)	mg/kg	-	5.0	3.6	-	101
		VPH F	Benzene (F0)	mg/kg	0.1	2.1	<0.1	-	-

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Volatile Petroleum Hydrocarbons in Soil (continued)

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE160957.027	LB117101.004	VPH F	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	7.25	117

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service .
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

Chain of Custody Form – Ref 7891

Ref: 7891
Investigator: Envirowest Consulting
9 Cameron Place
PO Box 8158
ORANGE NSW 2800
Telephone: (02) 6361 4954
Facsimile: (02) 6360 3960
Email: ashleigh@envirowest.net.au
Contact Person: Ashleigh Pickering
Invoice: accounts@envirowest.net.au

Laboratory: SGS SYDNEY
16/33 Maddox Street
ALEXANDRIA NSW 2015

Quotation #:
Courier/CN:

Sample ID	Container*	Sampling Date/Time	Sample matrix: Water	Soil	Sludge	Sample preservation: Cool	HNO3/HCl	Unpre-served	Analysis (SGS Method Code): CL1 7 Metals	OC Pesticides	CL10 TRH/BTEXN/PAH/ 8 metals		
SR1	A	11/01/2017		X		X		X	X				
SR2	A	11/01/2017		X		X		X	X				
SR3	A	11/01/2017		X		X		X	X				
SR4	A	11/01/2017		X		X		X	X				
SR5	A	11/01/2017		X		X		X	X				
SR6	A	11/01/2017		X		X		X	X				
SR7	A	11/01/2017		X		X		X	X				
SR8	A	11/01/2017		X		X		X	X				
SR9	A	11/01/2017		X		X		X	X				
SR10	A	11/01/2017		X		X		X	X				
SR11	A	11/01/2017		X		X		X	X				
SR12	A	11/01/2017		X		X		X	X				
SR13	A	11/01/2017		X		X		X	X				
SR14	A	11/01/2017		X		X		X	X				
SR15	A	11/01/2017		X		X		X	X				

SGS EHS Alexandria Laboratory
SE160957 COC
Received: 17 – Jan – 2017

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.

Sampler name: Ashleigh Pickering
Date : 11 & 12/01/2017 Time:

Relinquished by: (print and signature) Ashleigh Pickering Date 16/01/2017 Time 17:00

Received by: (print and signature) Date 17/01/17 Time @ 11.40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

Chain of Custody Form – Ref 7891

Ref: **7891**
Investigator: Envirowest Consulting
9 Cameron Place
PO Box 8158
ORANGE NSW 2800
Telephone: (02) 6361 4954
Facsimile: (02) 6360 3960
Email: ashleigh@envirowest.net.au
Contact Person: Ashleigh Pickering
Invoice: accounts@envirowest.net.au

Laboratory: SGS SYDNEY
16/33 Maddox Street
ALEXANDRIA NSW 2015

Quotation #:
Courier/CN:

			Sample matrix			**Sample preservation**			**Analysis**				
									SGS Method Code				
									CL1		**CL10**		
Sample ID	**Container***	**Sampling Date/Time**	Water	Soil	Sludge	Cool	HNO3/HCl	Unpre-served	7 Metals	OC Pesticides	TRH/BTEXN/PAH/ 8 metals		
SR16	A	11/01/2017		X		X		X	X				
SR17	A	11/01/2017		X		X		X	X				
SR18	A	11/01/2017		X		X		X	X				
SR19	A	11/01/2017		X		X		X	X				
SR20	A	11/01/2017		X		X		X	X				
SR21	A	11/01/2017		X		X		X	X				
SR22	A	11/01/2017		X		X		X	X				
SR23	A	11/01/2017		X		X		X	X				
SR24	A	11/01/2017		X		X		X	X				
SR25	A	11/01/2017		X		X		X	X				
SR26	A	11/01/2017		X		X		X	X				
SR27	A	11/01/2017		X		X		X		X	X		
SR28	A	11/01/2017		X		X		X		X	X		
SR29	A	11/01/2017		X		X		X		X	X		
SR30	A	11/01/2017		X		X		X		X	X		

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.

Sampler name: Ashleigh Pickering
Date : 11 & 12/01/2017 Time:

Relinquished by: (print and signature) Ashleigh Pickering [signature] Date 16/01/2017 Time 17:00

Received by: (print and signature) [signature] Date 17/1/17 Time 11:40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

Chain of Custody Form – Ref 7891

Ref: 7891

Investigator: Envirowest Consulting
9 Cameron Place
PO Box 8158
ORANGE NSW 2800
Telephone: (02) 6361 4954
Facsimile: (02) 6360 3960
Email: ashleigh@envirowest.net.au
Contact Person: Ashleigh Pickering
Invoice: accounts@envirowest.net.au

Laboratory: SGS SYDNEY
16/33 Maddox Street
ALEXANDRIA NSW 2015

Quotation #:
Courier/CN:

			Sample matrix			Sample preservation			Analysis					
									SGS Method Code					
									CL1		CL10			
Sample ID	**Container***	**Sampling Date/Time**	Water	Soil	Sludge	Cool	HNO3/HCl	Unpre-served	7 Metals	OC Pesticides	TRH/BTEXN/PAH/ 8 metals	Chlorides	Cations	Exchangeable sodium percentage
SR31	A	11/01/2017		X		X		X		X	X			
SR32	A	12/02/2017		X		X		X		X	X			
SR33	A	12/02/2017		X		X		X		X	X			
SR73	A	11/01/2017		X		X		X		X				
SR91	A	11/01/2017		X		X		X		X				
SR113	A	11/01/2017		X		X		X		X				
SR184	A	11/01/2017		X		X		X		X				
SR224	A	11/01/2017		X		X		X		X				
SRA	A	11/01/2017		X		X		X	X					
SRB	A	11/01/2017		X		X		X	X					
BH16-100	A	11/01/2017		X		X		X				X	X	X
BH16-1500	A	11/01/2017		X		X		X				X	X	X

Investigator: I attest that the proper field sampling procedures were used during the collection of these samples.

Sampler name: Ashleigh Pickering
Date : 11 & 12/01/2017 Time:

Relinquished by: (print and signature) Ashleigh Pickering [signature] Date 16/01/2017 Time 17:00

Received by: (print and signature) [signature] Date 17/1/17 Time 11:40

Please return completed form to Envirowest Consulting, *A = Solvent rinsed glass jar with Teflon lined lid and orange label

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Ashleigh Pickering
Client	ENVIROWEST CONSULTING PTY LIMITED
Address	PO BOX 8158 ORANGE NSW 2800
Telephone	61 2 63614954
Facsimile	(Not specified)
Email	ashleigh@envirowest.net.au
Project	**7891-1**
Order Number	(Not specified)
Samples	7

LABORATORY DETAILS

Manager	Huong Crawford
Laboratory	SGS Alexandria Environmental
Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	+61 2 8594 0400
Facsimile	+61 2 8594 0499
Email	au.environmental.sydney@sgs.com
SGS Reference	**SE162373 R0**
Date Received	24/2/2017
Date Reported	3/3/2017

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Bennet Lo
Senior Organic Chemist/Metals Chemist

Ly Kim Ha
Organic Section Head

OC Pesticides in Soil [AN420]   Tested: 27/2/2017

PARAMETER	UOM	LOR	SR201 SOIL - 22/2/2017 SE162373.001	SR202 SOIL - 22/2/2017 SE162373.002	SR203 SOIL - 22/2/2017 SE162373.003	SR204 SOIL - 22/2/2017 SE162373.004	SRV301 SOIL - 22/2/2017 SE162373.005
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1	<0.1	<0.1	<0.1

OC Pesticides in Soil [AN420] Tested: 27/2/2017 (continued)

			SRV302	SRV303
			SOIL	SOIL
			-	-
			22/2/2017	22/2/2017
PARAMETER	UOM	LOR	SE162373.006	SE162373.007
Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	<0.1
Alpha BHC	mg/kg	0.1	<0.1	<0.1
Lindane	mg/kg	0.1	<0.1	<0.1
Heptachlor	mg/kg	0.1	<0.1	<0.1
Aldrin	mg/kg	0.1	<0.1	<0.1
Beta BHC	mg/kg	0.1	<0.1	<0.1
Delta BHC	mg/kg	0.1	<0.1	<0.1
Heptachlor epoxide	mg/kg	0.1	<0.1	<0.1
o,p'-DDE	mg/kg	0.1	<0.1	<0.1
Alpha Endosulfan	mg/kg	0.2	<0.2	<0.2
Gamma Chlordane	mg/kg	0.1	<0.1	<0.1
Alpha Chlordane	mg/kg	0.1	<0.1	<0.1
trans-Nonachlor	mg/kg	0.1	<0.1	<0.1
p,p'-DDE	mg/kg	0.1	<0.1	<0.1
Dieldrin	mg/kg	0.2	<0.2	<0.2
Endrin	mg/kg	0.2	<0.2	<0.2
o,p'-DDD	mg/kg	0.1	<0.1	<0.1
o,p'-DDT	mg/kg	0.1	<0.1	<0.1
Beta Endosulfan	mg/kg	0.2	<0.2	<0.2
p,p'-DDD	mg/kg	0.1	<0.1	<0.1
p,p'-DDT	mg/kg	0.1	<0.1	<0.1
Endosulfan sulphate	mg/kg	0.1	<0.1	<0.1
Endrin Aldehyde	mg/kg	0.1	<0.1	<0.1
Methoxychlor	mg/kg	0.1	<0.1	<0.1
Endrin Ketone	mg/kg	0.1	<0.1	<0.1
Isodrin	mg/kg	0.1	<0.1	<0.1
Mirex	mg/kg	0.1	<0.1	<0.1

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES [AN040/AN320]   Tested: 2/3/2017

PARAMETER	UOM	LOR	SR201 SOIL - 22/2/2017 SE162373.001	SR202 SOIL - 22/2/2017 SE162373.002	SR203 SOIL - 22/2/2017 SE162373.003	SR204 SOIL - 22/2/2017 SE162373.004	SRV301 SOIL - 22/2/2017 SE162373.005
Arsenic, As	mg/kg	1	3	3	3	3	3
Cadmium, Cd	mg/kg	0.3	0.4	0.4	0.4	0.4	0.5
Chromium, Cr	mg/kg	0.5	47	51	60	52	75
Copper, Cu	mg/kg	0.5	21	22	20	15	25
Lead, Pb	mg/kg	1	17	19	13	16	11
Nickel, Ni	mg/kg	0.5	42	38	49	31	55
Zinc, Zn	mg/kg	2	55	80	23	48	51

PARAMETER	UOM	LOR	SRV302 SOIL - 22/2/2017 SE162373.006	SRV303 SOIL - 22/2/2017 SE162373.007
Arsenic, As	mg/kg	1	3	3
Cadmium, Cd	mg/kg	0.3	0.5	0.5
Chromium, Cr	mg/kg	0.5	77	76
Copper, Cu	mg/kg	0.5	25	26
Lead, Pb	mg/kg	1	11	11
Nickel, Ni	mg/kg	0.5	55	57
Zinc, Zn	mg/kg	2	49	53

Moisture Content [AN002] Tested: 27/2/2017

PARAMETER	UOM	LOR	SR201 SOIL - 22/2/2017 SE162373.001	SR202 SOIL - 22/2/2017 SE162373.002	SR203 SOIL - 22/2/2017 SE162373.003	SR204 SOIL - 22/2/2017 SE162373.004	SRV301 SOIL - 22/2/2017 SE162373.005
% Moisture	%w/w	1	2.4	7.9	4.6	2.5	7.1
% Total Solids	%w/w	1	97.6	92.1	95.4	97.5	92.9

PARAMETER	UOM	LOR	SRV302 SOIL - 22/2/2017 SE162373.006	SRV303 SOIL - 22/2/2017 SE162373.007
% Moisture	%w/w	1	7.3	7.5
% Total Solids	%w/w	1	92.7	92.5

METHOD	METHODOLOGY SUMMARY
AN002	The test is carried out by drying (at either 40°C or 105°C) a known mass of sample in a weighed evaporating basin. After fully dry the sample is re-weighed. Samples such as sludge and sediment having high percentages of moisture will take some time in a drying oven for complete removal of water.
AN040/AN320	A portion of sample is digested with nitric acid to decompose organic matter and hydrochloric acid to complete the digestion of metals. The digest is then analysed by ICP OES with metals results reported on the dried sample basis. Based on USEPA method 200.8 and 6010C.
AN040	A portion of sample is digested with Nitric acid to decompose organic matter and Hydrochloric acid to complete the digestion of metals and then filtered for analysis by ASS or ICP as per USEPA Method 200.8.
AN420	SVOC Compounds: Semi-Volatile Organic Compounds (SVOCs) including OC, OP, PCB, Herbicides, PAH, Phthalates and Speciated Phenols in soils, sediments and waters are determined by GCMS/ECD technique following appropriate solvent extraction process (Based on USEPA 3500C and 8270D).

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
		IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

STATEMENT OF QA/QC PERFORMANCE

SE162373 R0

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Ashleigh Pickering	Manager	Huong Crawford
Client	ENVIROWEST CONSULTING PTY LIMITED	Laboratory	SGS Alexandria Environmental
Address	PO BOX 8158 ORANGE NSW 2800	Address	Unit 16, 33 Maddox St Alexandria NSW 2015
Telephone	61 2 63614954	Telephone	+61 2 8594 0400
Facsimile	(Not specified)	Facsimile	+61 2 8594 0499
Email	ashleigh@envirowest.net.au	Email	au.environmental.sydney@sgs.com
Project	**7891-1**	SGS Reference	**SE162373 R0**
Order Number	(Not specified)	Date Received	24 Feb 2017
Samples	7	Date Reported	03 Mar 2017

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Matrix Spike	Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES	1 item

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	7 Soil
Date documentation received	24/2/2017	Type of documentation received	COC
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	16.1°C	Sufficient sample for analysis	Yes
Turnaround time requested	Standard		

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Moisture Content — Method: ME-(AU)-[ENV]AN002

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR201	SE162373.001	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SR202	SE162373.002	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SR203	SE162373.003	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SR204	SE162373.004	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SRV301	SE162373.005	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SRV302	SE162373.006	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017
SRV303	SE162373.007	LB119431	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	04 Mar 2017	28 Feb 2017

OC Pesticides in Soil — Method: ME-(AU)-[ENV]AN420

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR201	SE162373.001	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	01 Mar 2017
SR202	SE162373.002	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	01 Mar 2017
SR203	SE162373.003	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SR204	SE162373.004	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SRV301	SE162373.005	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SRV302	SE162373.006	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017
SRV303	SE162373.007	LB119368	22 Feb 2017	24 Feb 2017	08 Mar 2017	27 Feb 2017	08 Apr 2017	02 Mar 2017

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SR201	SE162373.001	LB119680	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SR202	SE162373.002	LB119680	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SR203	SE162373.003	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SR204	SE162373.004	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SRV301	SE162373.005	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SRV302	SE162373.006	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017
SRV303	SE162373.007	LB119681	22 Feb 2017	24 Feb 2017	21 Aug 2017	02 Mar 2017	21 Aug 2017	03 Mar 2017

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Tetrachloro-m-xylene (TCMX) (Surrogate)	SR201	SE162373.001	%	60 - 130%	73
	SR202	SE162373.002	%	60 - 130%	73
	SR203	SE162373.003	%	60 - 130%	79
	SR204	SE162373.004	%	60 - 130%	73
	SRV301	SE162373.005	%	60 - 130%	77
	SRV302	SE162373.006	%	60 - 130%	77
	SRV303	SE162373.007	%	60 - 130%	75

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result
LB119368.001		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1
		Alpha BHC	mg/kg	0.1	<0.1
		Lindane	mg/kg	0.1	<0.1
		Heptachlor	mg/kg	0.1	<0.1
		Aldrin	mg/kg	0.1	<0.1
		Beta BHC	mg/kg	0.1	<0.1
		Delta BHC	mg/kg	0.1	<0.1
		Heptachlor epoxide	mg/kg	0.1	<0.1
		Alpha Endosulfan	mg/kg	0.2	<0.2
		Gamma Chlordane	mg/kg	0.1	<0.1
		Alpha Chlordane	mg/kg	0.1	<0.1
		p,p'-DDE	mg/kg	0.1	<0.1
		Dieldrin	mg/kg	0.2	<0.2
		Endrin	mg/kg	0.2	<0.2
		Beta Endosulfan	mg/kg	0.2	<0.2
		p,p'-DDD	mg/kg	0.1	<0.1
		p,p'-DDT	mg/kg	0.1	<0.1
		Endosulfan sulphate	mg/kg	0.1	<0.1
		Endrin Aldehyde	mg/kg	0.1	<0.1
		Methoxychlor	mg/kg	0.1	<0.1
		Endrin Ketone	mg/kg	0.1	<0.1
		Isodrin	mg/kg	0.1	<0.1
		Mirex	mg/kg	0.1	<0.1
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	%	-	72

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number	Parameter	Units	LOR	Result
LB119680.001	Arsenic, As	mg/kg	1	<1
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.5	<0.5
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	2	<2
LB119681.001	Arsenic, As	mg/kg	1	<1
	Cadmium, Cd	mg/kg	0.3	<0.3
	Chromium, Cr	mg/kg	0.5	<0.5
	Copper, Cu	mg/kg	0.5	<0.5
	Lead, Pb	mg/kg	1	<1
	Nickel, Ni	mg/kg	0.5	<0.5
	Zinc, Zn	mg/kg	2	<2

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Moisture Content

Method: ME-(AU)-[ENV]AN002

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162369.003	LB119431.011		% Moisture	%w/w	1	3.2670454545	3.1645569620	61	3
SE162373.003	LB119431.022		% Moisture	%w/w	1	4.6	4.5	52	1
SE162375.003	LB119431.033		% Moisture	%w/w	1	4.9	4.2	52	17
SE162383.003	LB119431.044		% Moisture	%w/w	1	11	12	39	3
SE162383.012	LB119431.054		% Moisture	%w/w	1	8.4	8.9	42	5

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162373.006	LB119368.025		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	0	200	0
			Alpha BHC	mg/kg	0.1	<0.1	0	200	0
			Lindane	mg/kg	0.1	<0.1	0	200	0
			Heptachlor	mg/kg	0.1	<0.1	0	200	0
			Aldrin	mg/kg	0.1	<0.1	0	200	0
			Beta BHC	mg/kg	0.1	<0.1	0	200	0
			Delta BHC	mg/kg	0.1	<0.1	0	200	0
			Heptachlor epoxide	mg/kg	0.1	<0.1	0	200	0
			o,p'-DDE	mg/kg	0.1	<0.1	0	200	0
			Alpha Endosulfan	mg/kg	0.2	<0.2	0	200	0
			Gamma Chlordane	mg/kg	0.1	<0.1	0	200	0
			Alpha Chlordane	mg/kg	0.1	<0.1	0	200	0
			trans-Nonachlor	mg/kg	0.1	<0.1	0	200	0
			p,p'-DDE	mg/kg	0.1	<0.1	0	200	0
			Dieldrin	mg/kg	0.2	<0.2	0	200	0
			Endrin	mg/kg	0.2	<0.2	0	200	0
			o,p'-DDD	mg/kg	0.1	<0.1	0	200	0
			o,p'-DDT	mg/kg	0.1	<0.1	0	200	0
			Beta Endosulfan	mg/kg	0.2	<0.2	0	200	0
			p,p'-DDD	mg/kg	0.1	<0.1	0	200	0
			p,p'-DDT	mg/kg	0.1	<0.1	0	200	0
			Endosulfan sulphate	mg/kg	0.1	<0.1	0	200	0
			Endrin Aldehyde	mg/kg	0.1	<0.1	0	200	0
			Methoxychlor	mg/kg	0.1	<0.1	0	200	0
			Endrin Ketone	mg/kg	0.1	<0.1	0	200	0
			Isodrin	mg/kg	0.1	<0.1	0	200	0
			Mirex	mg/kg	0.1	<0.1	0	200	0
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.12	0.112	30	3
SE162376.005	LB119368.023		Hexachlorobenzene (HCB)	mg/kg	0.1	0	0	200	0
			Alpha BHC	mg/kg	0.1	0	0	200	0
			Lindane	mg/kg	0.1	0	0	200	0
			Heptachlor	mg/kg	0.1	0	0	200	0
			Aldrin	mg/kg	0.1	0	0	200	0
			Beta BHC	mg/kg	0.1	0	0	200	0
			Delta BHC	mg/kg	0.1	0	0	200	0
			Heptachlor epoxide	mg/kg	0.1	0	0	200	0
			o,p'-DDE	mg/kg	0.1	0	0	200	0
			Alpha Endosulfan	mg/kg	0.2	0	0	200	0
			Gamma Chlordane	mg/kg	0.1	0	0	200	0
			Alpha Chlordane	mg/kg	0.1	0	0	200	0
			trans-Nonachlor	mg/kg	0.1	0	0	200	0
			p,p'-DDE	mg/kg	0.1	0	0	200	0
			Dieldrin	mg/kg	0.2	0	0	200	0
			Endrin	mg/kg	0.2	0	0	200	0
			o,p'-DDD	mg/kg	0.1	0	0	200	0
			o,p'-DDT	mg/kg	0.1	0	0	200	0
			Beta Endosulfan	mg/kg	0.2	0	0	200	0
			p,p'-DDD	mg/kg	0.1	0	0	200	0
			p,p'-DDT	mg/kg	0.1	0	0	200	0
			Endosulfan sulphate	mg/kg	0.1	0	0	200	0
			Endrin Aldehyde	mg/kg	0.1	0	0	200	0
			Methoxychlor	mg/kg	0.1	0	0	200	0
			Endrin Ketone	mg/kg	0.1	0	0	200	0

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil (continued) — Method: ME-(AU)-[ENV]AN420

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162376.005	LB119368.023		Isodrin	mg/kg	0.1	0	0	200	0
			Mirex	mg/kg	0.1	0	0	200	0
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.106	0.107	30	1

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES — Method: ME-(AU)-[ENV]AN040/AN320

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162369.006	LB119680.014	Arsenic, As	mg/kg	1	1.9479789778	1.8356576075	83	6
		Cadmium, Cd	mg/kg	0.3	0.0797130935	0.0612904053	200	0
		Chromium, Cr	mg/kg	0.5	7.2505849609	7.1270739715	37	2
		Copper, Cu	mg/kg	0.5	1.4538406949	1.6052042123	63	10
		Lead, Pb	mg/kg	1	12.857089866	12.418085194	38	3
		Nickel, Ni	mg/kg	0.5	0.5466566184	0.4729970578	128	9
		Zinc, Zn	mg/kg	2	14.002721526	15.251488379	44	9
SE162373.002	LB119680.024	Arsenic, As	mg/kg	1	3	3	67	2
		Cadmium, Cd	mg/kg	0.3	0.4	0.4	108	1
		Chromium, Cr	mg/kg	0.5	51	52	31	0
		Copper, Cu	mg/kg	0.5	22	22	32	0
		Lead, Pb	mg/kg	1	19	23	35	19
		Nickel, Ni	mg/kg	0.5	38	38	31	2
		Zinc, Zn	mg/kg	2	80	87	32	9
SE162376.002	LB119681.014	Arsenic, As	mg/kg	1	41.389563866	55.769132292	31	10
		Cadmium, Cd	mg/kg	0.3	0.3066875989	0.3340051512	124	9
		Chromium, Cr	mg/kg	0.5	18.083155266	21.195453521	33	16
		Copper, Cu	mg/kg	0.5	14.016823812	14.678378058	33	5
		Lead, Pb	mg/kg	1	16.806985474	14.963020282	36	12
		Nickel, Ni	mg/kg	0.5	4.5032652213	5.2877047609	40	16
		Zinc, Zn	mg/kg	2	47.978228726	54.323254926	31	3
SE162384.004	LB119681.024	Arsenic, As	mg/kg	1	6.5267983716	7.2692989215	44	11
		Cadmium, Cd	mg/kg	0.3	0.1948775383	0.2013926581	181	0
		Chromium, Cr	mg/kg	0.5	11.090823754	10.281914049	35	8
		Copper, Cu	mg/kg	0.5	20.230833333	26.231228725	32	26
		Lead, Pb	mg/kg	1	54.060416666	64.638415196	32	18
		Nickel, Ni	mg/kg	0.5	7.1853232758	6.6524281127	37	8
		Zinc, Zn	mg/kg	2	69.618726053	70.666109264	33	1

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119368.002		Heptachlor	mg/kg	0.1	0.2	0.2	60 - 140	91
		Aldrin	mg/kg	0.1	0.2	0.2	60 - 140	83
		Delta BHC	mg/kg	0.1	0.2	0.2	60 - 140	81
		Dieldrin	mg/kg	0.2	<0.2	0.2	60 - 140	80
		Endrin	mg/kg	0.2	<0.2	0.2	60 - 140	81
		p,p'-DDT	mg/kg	0.1	0.2	0.2	60 - 140	99
	Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.11	0.15	40 - 130	74

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119680.002	Arsenic, As	mg/kg	1	50	50	80 - 120	100
	Cadmium, Cd	mg/kg	0.3	49	50	80 - 120	98
	Chromium, Cr	mg/kg	0.5	50	50	80 - 120	101
	Copper, Cu	mg/kg	0.5	53	50	80 - 120	105
	Lead, Pb	mg/kg	1	50	50	80 - 120	99
	Nickel, Ni	mg/kg	0.5	51	50	80 - 120	102
	Zinc, Zn	mg/kg	2	51	50	80 - 120	101
LB119681.002	Arsenic, As	mg/kg	1	49	50	80 - 120	98
	Cadmium, Cd	mg/kg	0.3	49	50	80 - 120	97
	Chromium, Cr	mg/kg	0.5	50	50	80 - 120	100
	Copper, Cu	mg/kg	0.5	51	50	80 - 120	102
	Lead, Pb	mg/kg	1	49	50	80 - 120	98
	Nickel, Ni	mg/kg	0.5	51	50	80 - 120	102
	Zinc, Zn	mg/kg	2	50	50	80 - 120	100

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub-sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

OC Pesticides in Soil

Method: ME-(AU)-[ENV]AN420

QC Sample	Sample Number		Parameter	Units	LOR	Original	Spike	Recovery%
SE162373.003	LB119368.024		Hexachlorobenzene (HCB)	mg/kg	0.1	<0.1	-	-
			Alpha BHC	mg/kg	0.1	<0.1	-	-
			Lindane	mg/kg	0.1	<0.1	-	-
			Heptachlor	mg/kg	0.1	<0.1	0.2	95
			Aldrin	mg/kg	0.1	<0.1	0.2	86
			Beta BHC	mg/kg	0.1	<0.1	-	-
			Delta BHC	mg/kg	0.1	<0.1	0.2	85
			Heptachlor epoxide	mg/kg	0.1	<0.1	-	-
			o,p'-DDE	mg/kg	0.1	<0.1	-	-
			Alpha Endosulfan	mg/kg	0.2	<0.2	-	-
			Gamma Chlordane	mg/kg	0.1	<0.1	-	-
			Alpha Chlordane	mg/kg	0.1	<0.1	-	-
			trans-Nonachlor	mg/kg	0.1	<0.1	-	-
			p,p'-DDE	mg/kg	0.1	<0.1	-	-
			Dieldrin	mg/kg	0.2	<0.2	0.2	82
			Endrin	mg/kg	0.2	<0.2	0.2	80
			o,p'-DDD	mg/kg	0.1	<0.1	-	-
			o,p'-DDT	mg/kg	0.1	<0.1	-	-
			Beta Endosulfan	mg/kg	0.2	<0.2	-	-
			p,p'-DDD	mg/kg	0.1	<0.1	-	-
			p,p'-DDT	mg/kg	0.1	<0.1	0.2	107
			Endosulfan sulphate	mg/kg	0.1	<0.1	-	-
			Endrin Aldehyde	mg/kg	0.1	<0.1	-	-
			Methoxychlor	mg/kg	0.1	<0.1	-	-
			Endrin Ketone	mg/kg	0.1	<0.1	-	-
			Isodrin	mg/kg	0.1	<0.1	-	-
			Mirex	mg/kg	0.1	<0.1	-	-
		Surrogates	Tetrachloro-m-xylene (TCMX) (Surrogate)	mg/kg	-	0.12	-	76

Total Recoverable Metals in Soil/Waste Solids/Materials by ICPOES

Method: ME-(AU)-[ENV]AN040/AN320

QC Sample	Sample Number	Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE162373.003	LB119681.004	Arsenic, As	mg/kg	1	37	3	50	69 ⑨
		Cadmium, Cd	mg/kg	0.3	41	0.4	50	81
		Chromium, Cr	mg/kg	0.5	99	60	50	77
		Copper, Cu	mg/kg	0.5	67	20	50	94
		Lead, Pb	mg/kg	1	50	13	50	74
		Nickel, Ni	mg/kg	0.5	87	49	50	77
		Zinc, Zn	mg/kg	2	68	23	50	91

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service .
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

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Project	**7891-1 - Additional**
Order Number	(Not specified)
Samples	7

LABORATORY DETAILS

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SGS Reference	**SE162373A R0**
Date Received	7/3/2017
Date Reported	9/3/2017

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(4354).

SIGNATORIES

Ly Kim Ha
Organic Section Head

Volatile Petroleum Hydrocarbons in Soil [AN433] Tested: 7/3/2017

PARAMETER	UOM	LOR	SRV301 SOIL - 22/2/2017 SE162373A.005	SRV302 SOIL - 22/2/2017 SE162373A.006	SRV303 SOIL - 22/2/2017 SE162373A.007
Benzene (F0)	mg/kg	0.1	<0.1	<0.1	<0.1
TRH C6-C9	mg/kg	20	<20	<20	<20
TRH C6-C10	mg/kg	25	<25	<25	<25
TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	<25

TRH (Total Recoverable Hydrocarbons) in Soil [AN403] Tested: 8/3/2017

PARAMETER	UOM	LOR	SRV301 SOIL - 22/2/2017 SE162373A.005	SRV302 SOIL - 22/2/2017 SE162373A.006	SRV303 SOIL - 22/2/2017 SE162373A.007
TRH C10-C14	mg/kg	20	<20	<20	<20
TRH C15-C28	mg/kg	45	67	230	600
TRH C29-C36	mg/kg	45	89	<45	<45
TRH C37-C40	mg/kg	100	<100	<100	<100
TRH >C10-C16 (F2)	mg/kg	25	<25	26	53
TRH >C16-C34 (F3)	mg/kg	90	130	210	540
TRH >C34-C40 (F4)	mg/kg	120	<120	<120	<120
TRH C10-C36 Total	mg/kg	110	160	230	600
TRH C10-C40 Total	mg/kg	210	<210	240	590

METHOD	METHODOLOGY SUMMARY
AN403	Total Recoverable Hydrocarbons: Determination of Hydrocarbons by gas chromatography after a solvent extraction. Detection is by flame ionisation detector (FID) that produces an electronic signal in proportion to the combustible matter passing through it. Total Recoverable Hydrocarbons (TRH) are routinely reported as four alkane groupings based on the carbon chain length of the compounds: C6-C9, C10-C14, C15-C28 and C29-C36 and in recognition of the NEPM 1999 (2013), >C10-C16 (F2), >C16-C34 (F3) and >C34-C40 (F4). F2 is reported directly and also corrected by subtracting Naphthalene (from VOC method AN433) where available.
AN403	Additionally, the volatile C6-C9 fraction may be determined by a purge and trap technique and GC/MS because of the potential for volatiles loss. Total Petroleum Hydrocarbons (TPH) follows the same method of analysis after silica gel cleanup of the solvent extract. Aliphatic/Aromatic Speciation follows the same method of analysis after fractionation of the solvent extract over silica with differential polarity of the eluent solvents .
AN403	The GC/FID method is not well suited to the analysis of refined high boiling point materials (ie lubricating oils or greases) but is particularly suited for measuring diesel, kerosene and petrol if care to control volatility is taken. This method will detect naturally occurring hydrocarbons, lipids, animal fats, phenols and PAHs if they are present at sufficient levels, dependent on the use of specific cleanup/fractionation techniques. Reference USEPA 3510B, 8015B.
AN433	VOCs and C6-C9/C6-C10 Hydrocarbons by GC-MS P&T: VOC`s are volatile organic compounds. The sample is presented to a gas chromatograph via a purge and trap (P&T) concentrator and autosampler and is detected with a Mass Spectrometer (MSD). Solid samples are initially extracted with methanol whilst liquid samples are processed directly. References: USEPA 5030B, 8020A, 8260.

FOOTNOTES

*	NATA accreditation does not cover the performance of this service.	-	Not analysed.	UOM	Unit of Measure.
**	Indicative data, theoretical holding time exceeded.	NVL	Not validated.	LOR	Limit of Reporting.
		IS	Insufficient sample for analysis.	↑↓	Raised/lowered Limit of Reporting.
		LNR	Sample listed, but not received.		

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calculated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:

a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

STATEMENT OF QA/QC PERFORMANCE

SE162373A R0

CLIENT DETAILS

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Email	ashleigh@envirowest.net.au
Project	**7891-1 - Additional**
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LABORATORY DETAILS

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SGS Reference	**SE162373A R0**
Date Received	07 Mar 2017
Date Reported	09 Mar 2017

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met (within the SGS Alexandria Environmental laboratory).

SAMPLE SUMMARY

Samples clearly labelled	Yes	Complete documentation received	Yes
Sample container provider	SGS	Sample cooling method	Ice Bricks
Samples received in correct containers	Yes	Sample counts by matrix	3 Soil
Date documentation received	7/3/17@9.40am	Type of documentation received	Email
Samples received in good order	Yes	Samples received without headspace	Yes
Sample temperature upon receipt	16.1°C	Sufficient sample for analysis	Yes
Turnaround time requested	Three Days		

HOLDING TIME SUMMARY

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SRV301	SE162373A.005	LB119976	22 Feb 2017	07 Mar 2017	08 Mar 2017	08 Mar 2017	17 Apr 2017	09 Mar 2017
SRV302	SE162373A.006	LB119976	22 Feb 2017	07 Mar 2017	08 Mar 2017	08 Mar 2017	17 Apr 2017	09 Mar 2017
SRV303	SE162373A.007	LB119976	22 Feb 2017	07 Mar 2017	08 Mar 2017	08 Mar 2017	17 Apr 2017	09 Mar 2017

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
SRV301	SE162373A.005	LB119969	22 Feb 2017	07 Mar 2017	08 Mar 2017	07 Mar 2017	16 Apr 2017	09 Mar 2017
SRV302	SE162373A.006	LB119969	22 Feb 2017	07 Mar 2017	08 Mar 2017	07 Mar 2017	16 Apr 2017	09 Mar 2017
SRV303	SE162373A.007	LB119969	22 Feb 2017	07 Mar 2017	08 Mar 2017	07 Mar 2017	16 Apr 2017	09 Mar 2017

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA/QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Parameter	Sample Name	Sample Number	Units	Criteria	Recovery %
Bromofluorobenzene (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	83
	SRV302	SE162373A.006	%	60 - 130%	79
	SRV303	SE162373A.007	%	60 - 130%	83
d4-1,2-dichloroethane (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	94
	SRV302	SE162373A.006	%	60 - 130%	98
	SRV303	SE162373A.007	%	60 - 130%	94
d8-toluene (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	87
	SRV302	SE162373A.006	%	60 - 130%	90
	SRV303	SE162373A.007	%	60 - 130%	86
Dibromofluoromethane (Surrogate)	SRV301	SE162373A.005	%	60 - 130%	88
	SRV302	SE162373A.006	%	60 - 130%	88
	SRV303	SE162373A.007	%	60 - 130%	80

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number	Parameter	Units	LOR	Result
LB119976.001	TRH C10-C14	mg/kg	20	<20
	TRH C15-C28	mg/kg	45	<45
	TRH C29-C36	mg/kg	45	<45
	TRH C37-C40	mg/kg	100	<100
	TRH C10-C36 Total	mg/kg	110	<110

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result
LB119969.001		TRH C6-C9	mg/kg	20	<20
	Surrogates	Dibromofluoromethane (Surrogate)	%	-	94
		d4-1,2-dichloroethane (Surrogate)	%	-	96
		d8-toluene (Surrogate)	%	-	84

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162730.002	LB119976.026		TRH C10-C14	mg/kg	20	0	0	200	0
			TRH C15-C28	mg/kg	45	0	0	200	0
			TRH C29-C36	mg/kg	45	0	0	200	0
			TRH C37-C40	mg/kg	100	0	0	200	0
			TRH C10-C36 Total	mg/kg	110	0	0	200	0
			TRH C10-C40 Total	mg/kg	210	0	0	200	0
		TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	0	0	200	0
			TRH >C16-C34 (F3)	mg/kg	90	0	0	200	0
			TRH >C34-C40 (F4)	mg/kg	120	0	0	200	0

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Original	Duplicate		Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
SE162730.006	LB119969.014		TRH C6-C10	mg/kg	25	0	0	200	0
			TRH C6-C9	mg/kg	20	0.49	0.14	200	0
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	3.7	3.78	30	2
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.42	4.52	30	2
			d8-toluene (Surrogate)	mg/kg	-	3.84	3.89	30	1
			Bromofluorobenzene (Surrogate)	mg/kg	-	3.86	3.84	30	1
		VPH F Bands	Benzene (F0)	mg/kg	0.1	0	0	200	0
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	-0.07	-0.07	200	0

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

TRH (Total Recoverable Hydrocarbons) in Soil

Method: ME-(AU)-[ENV]AN403

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119976.002		TRH C10-C14	mg/kg	20	35	40	60 - 140	88
		TRH C15-C28	mg/kg	45	<45	40	60 - 140	95
		TRH C29-C36	mg/kg	45	<45	40	60 - 140	83
	TRH F Bands	TRH >C10-C16 (F2)	mg/kg	25	35	40	60 - 140	88
		TRH >C16-C34 (F3)	mg/kg	90	<90	40	60 - 140	98
		TRH >C34-C40 (F4)	mg/kg	120	<120	20	60 - 140	75

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

Sample Number		Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB119969.002		TRH C6-C10	mg/kg	25	<25	24.65	60 - 140	90
		TRH C6-C9	mg/kg	20	<20	23.2	60 - 140	79
	Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.3	5	60 - 140	86
		d4-1,2-dichloroethane (Surrogate)	mg/kg	-	4.7	5	60 - 140	94
		d8-toluene (Surrogate)	mg/kg	-	4.2	5	60 - 140	83
		Bromofluorobenzene (Surrogate)	mg/kg	-	3.8	5	60 - 140	76
	VPH F Bands	TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	7.25	60 - 140	86

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub -sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Volatile Petroleum Hydrocarbons in Soil

Method: ME-(AU)-[ENV]AN433

QC Sample	Sample Number		Parameter	Units	LOR	Result	Original	Spike	Recovery%
SE162373A.005	LB119969.004		TRH C6-C10	mg/kg	25	<25	<25	24.65	96
			TRH C6-C9	mg/kg	20	<20	<20	23.2	77
		Surrogates	Dibromofluoromethane (Surrogate)	mg/kg	-	4.4	4.4	-	88
			d4-1,2-dichloroethane (Surrogate)	mg/kg	-	5.0	4.7	-	100
			d8-toluene (Surrogate)	mg/kg	-	4.6	4.4	-	91
			Bromofluorobenzene (Surrogate)	mg/kg	-	4.5	4.1	-	89
		VPH F Bands	Benzene (F0)	mg/kg	0.1	2.3	<0.1	-	-
			TRH C6-C10 minus BTEX (F1)	mg/kg	25	<25	<25	7.25	108

MATRIX SPIKE DUPLICATES

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No matrix spike duplicates were required for this job.

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Recovery failed acceptance criteria due to sample heterogeneity.
⑩	LOR was raised due to high conductivity of the sample (required dilution).
†	Refer to Analytical Report comments for further information.

Appendix 3. Field sampling log

Sampling log

Client	Maas Property Group Pty Ltd
Contact	Steven Guy
Job number	R7891
Location	Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW
Date	10 and 11 January 2017
Investigator(s)	Leah Desborough and Ashleigh Pickering
Weather conditions	Fine

Sample id	Matrix	Date	Analysis required	Observations/comments
SR1	Soil	11/01/2017	Arsenic (As), cadmium (Ca), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), zinc (Zn)	Composite comprising 11, 12, 13, 14
SR2	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 21, 22, 23, 24
SR3	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 31, 32, 33, 34
SR4	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 41, 42, 43, 44
SR5	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 51, 52, 53, 54
SR6	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 61, 62, 63, 64
SR7	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 71, 72, 73, 74
SR8	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 81, 82, 83, 84
SR9	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 91, 92, 93, 94
SR10	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 101, 102, 103, 104
SR11	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 111, 112, 113, 114
SR12	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 121, 122, 123, 124
SR13	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 131, 132, 133, 134
SR14	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 141, 142, 143, 144
SR15	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 151, 152, 153, 154
SR16	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 161, 162, 163, 164
SR17	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 171, 172, 173, 174
SR18	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 181, 182, 183, 184
SR19	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 191, 192, 193, 194
SR20	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 201, 202, 203, 204
SR21	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 211, 212, 213, 214
SR22	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 221, 222, 223, 224
SR23	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 231, 232, 233, 234
SR24	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 241, 242, 243, 244
SR25	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 251, 252, 253, 254
SR26	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 261, 262, 263, 264
SR27	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Composite comprising 271, 272, 273, 274
SR28	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, Total Recoverable Hydrocabons (TRH), Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalene (BTEXN), Organochlorine pesticides (OCP), Polycyclic Aromatic Hydrocarbons (PAH)	Discrete sample
SR29	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR30	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR31	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR32	Soil	12/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR33	Soil	12/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP, PAH, TRH, BTEXN	Discrete sample
SR73	Soil	11/01/2017	OCP	Discrete sample
SR91	Soil	11/01/2017	OCP	Discrete sample
SR113	Soil	11/01/2017	OCP	Discrete sample
SR184	Soil	11/01/2017	OCP	Discrete sample
SR224	Soil	11/01/2017	OCP	Discrete sample
SRA	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Duplicate of SR2
SRB	Soil	11/01/2017	As, Ca, Cr, Cu, Pb, Ni, Zn	Duplicate of SR20
2S	Asbestos	11/01/2017	Asbestos identification	Fragments from within cottage area

Sampling log

Client	Maas Property Group Pty Ltd
Contact	Steven Guy
Job number	R7891-1
Location	Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW
Date	22 February 2017
Investigator(s)	Ashleigh Pickering
Weather conditions	Fine

Sample id	Matrix	Date	Analysis required	Observations/comments
SR201	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SR202	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SR203	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SR204	Soil	22/2/2017	As, Ca, Cr, Cu, Pb, Ni, Zn, OCP	Old cottage area
SRV301	Soil	22/2/2017	TRH	AST area
SRV302	Soil	22/2/2017	TRH	AST area
SRV303	Soil	22/2/2017	TRH	AST area

Appendix 4. Waste Disposal Dockets

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHYLANDRA WASTE & RECYCLING CENTRE
COOBA ROAD
DUBBO NSW 2830

TAX INVOICE

Docket: WI71881\1
Date: 23/02/2017 8:18
Printed: 23/02/2017 8:18
Operator: RJW

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

ASBESTOS	OVER 1 TONNE	
7380kg @ $228.00/t		$1682.64
Subtotal		$1529.67
GST		$152.97
Total Including GST		$1682.64

Gross	13680	kg
Tare	6300	kg
Net	7380	kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund $1682.64
Paid By Account
Ref No 4295014539

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHYLANDRA WASTE & RECYCLING CENTRE
COOBA ROAD
DUBBO NSW 2830

TAX INVOICE

Docket: WI71868\1
Date: 22/02/2017 3:23
Printed: 22/02/2017 3:23
Operator: MS

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

ASBESTOS	OVER 1 TONNE	
6160kg @ $228.00/t		$1404.48
Subtotal		$1276.80
GST		$127.68
Total Including GST		$1404.48

Gross	12400	kg
Tare	6240	kg
Net	6160	kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund $1404.48
Paid By Account
Ref No 4295014533

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHYLANDRA WASTE & RECYCLING CENTRE
COOBA ROAD
DUBBO NSW 2830

TAX INVOICE

Docket: WI71924\1
Date: 23/02/2017 12:18
Printed: 23/02/2017 12:18
Operator: MS

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

CONTAMINATED SO WEIGHED
1860kg @ $75.00/t $139.50

Subtotal	$126.82
GST	$12.68
Total Including GST	$139.50

Gross	8460 kg
Tare	6600 kg
Net	1860 kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund $139.50
Paid By Account
Ref No 4295014568

Whylandra
DUBBO REGIONAL COUNCIL
ABN 53 539 070 9

WHY... WASTE & RECYCLING CENTRE
...OOBA ROAD
...UBBO NSW 2830

TAX INVOICE

Docket: WI71873\1
Date: 22/02/2017 4:32
Printed: 22/02/2017 4:32
Operator: RJW

Customer: Maas Civil Pty Ltd
Vehicle: 2219A
Order No:

ASBESTOS OVER 1 TONNE
7340kg @ $228.00/t $1673.52

Subtotal	$1521.38
GST	$152.14
Total Including GST	$1673.52

Gross	15540 kg
Tare	8200 kg
Net	7340 kg

For payment options contact council's customer service centre phone on 6801 4000.

Payment/Refund $1673.52
Paid By Account
Ref No 4295014535

Appendix 4. Unexpected finds protocol

1. Introduction

Investigations have been undertaken including boreholes, soil sampling and analysis to evaluate the contamination status of Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

A procedure is required describing the actions if potential contamination or hazards are encountered during excavation/construction activities.

2. Scope

Prepare a procedure to enable the identification and management of unexpected hazards identified during excavation works and/or construction activities.

3. Site identification

Lot 2 DP880413, 24R Sheraton Road, Dubbo NSW.

4. Responsible person

The landowner is responsible for implementation of the unexpected finds protocol. The land owner will appoint an environmental scientist to induct and provide information on hazard identification and responses to earthwork supervisors and personnel which may uncover unexpected hazards.

5. Identification of unexpected hazards

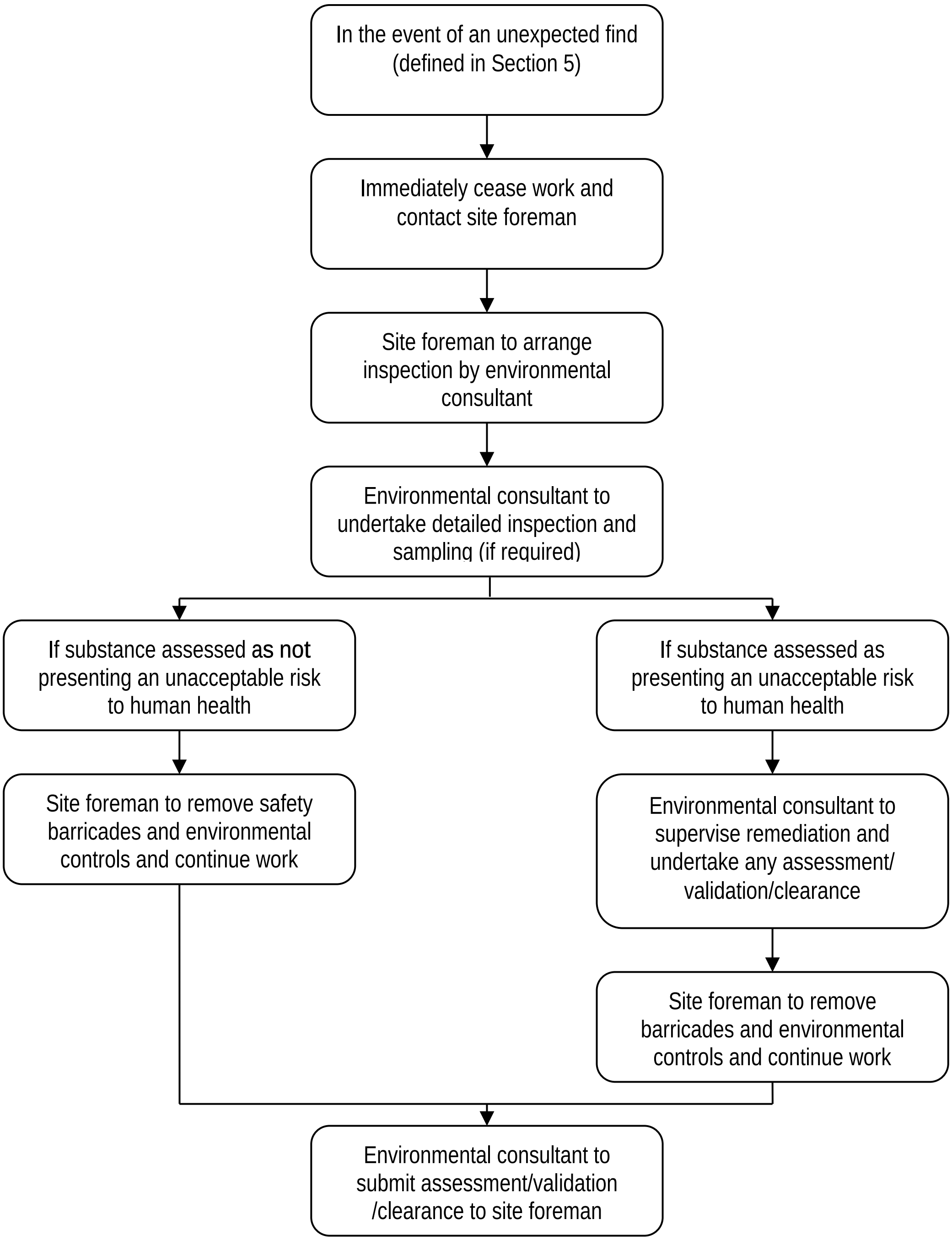
Potential hazards will be identified by appearance and odour and include:

- A filled pit or gully
- Demolition waste
- Discoloured soil
- Oil/diesel/tar
- Sheens on water
- An offensive odour
- Asbestos cement sheeting
- Ash or slag
- Underground storage tank

6. Training and induction

All excavation/construction personnel are to be inducted on the identification of potential hazards. The induction can be undertaken at the time of general site induction and toolbox meetings. The training will include display of the poster below to alert worker of potential hazards.

7. Procedure



8. Recommencement of works

The potential hazards will be assessed by the environmental scientist and a report prepared describing:

- Preliminary assessment of the contamination and need for cleanup
- Preparation of a remediation action plan
- All works to be undertaken in accordance with contaminated site regulations and guidelines
- Remediation works
- Validation of the remediation
- Works can commence on the potentially hazardous area after the environmental scientist has provided a clearance.

BE AWARE

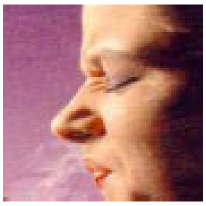
UNEXPECTED HAZARDS MAY BE PRESENT

drums

asbestos

chemical bottles

blood stains



odour

ash / slag

demolition waste

if you <u>SEE</u> or <u>SMELL</u> anything unusual

<u>STOP WORK</u> & contact the Site Foreman

do not restart working before the area has been investigated and cleared by an Environmental Consultant

Appendix G

ABORIGINAL ARCHAEOLOGICAL ASSESSMENT

Prepared by Ozark Environmental & Heritage Management Pty Ltd

March 2017

Overview of the north bank of Eulomogo Creek, facing west.

Environmental and
Heritage Management P/L

ABORIGINAL DUE DILIGENCE ARCHAEOLOGICAL ASSESSMENT

Subdivision of Lot 2 DP880413

Sheraton Road, Dubbo NSW

Dubbo Regional LGA

March 2017

Report Prepared by

OzArk Environmental & Heritage Management Pty Ltd

For

MAAS Group Properties

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DOCUMENT CONTROLS

<table>
<tr><td>Proponent</td><td colspan="3">MAAS Group Properties</td></tr>
<tr><td>Client</td><td colspan="3">MAAS Group Properties</td></tr>
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<tr><td>Document Description</td><td colspan="3">Aboriginal Due Diligence Archaeological Assessment: Subdivision of Lot 2 DP880413, Dubbo NSW, Dubbo Regional LGA</td></tr>
<tr><td></td><td>Name</td><td>Signed</td><td>Date</td></tr>
<tr><td>Clients Reviewing Officer</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Clients Representative Managing this Document</td><td colspan="2">OzArk Person(s) Managing this Document</td></tr>
<tr><td colspan="2"></td><td colspan="2">Dr Chris Lovell</td></tr>
<tr><td colspan="2">Location</td><td colspan="2">OzArk Job No.</td></tr>
<tr><td colspan="2">OzArk EHM Data ►Clients ►MAAS ►Lot 2 DP880413</td><td colspan="2">#1545</td></tr>
<tr><td colspan="2">Document Status FINAL</td><td colspan="2">Date: 8 March 2017</td></tr>
<tr><td colspan="2">Draft V1.1 Author to Editor OzArk 1st Internal (Series V1._ = OzArk internal edits)</td><td colspan="2">V1.0 CL draft to BC 9/2/2017
V1.1 BC edit 10/2/2017</td></tr>
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(Series V2._ = OzArk and Client edits)</td><td colspan="2">V2.0 CL to client 10/2/2017
V2.1 CL update with updated design 8/3/2017</td></tr>
<tr><td colspan="2">FINAL V3._once latest version of draft approved by client</td><td colspan="2">V3.0 Final draft issued to client 31/3/2017</td></tr>
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</table>

Acknowledgement

OzArk acknowledge Traditional Owners of the area on which this assessment took place and pay respect to their beliefs, cultural heritage and continuing connection with the land. We also acknowledge and pay respect to the post-contact experiences of Aboriginal people with attachment to the area and to the elders, past and present, as the next generation of role models and vessels for memories, traditions, culture and hopes of local Aboriginal people.

EXECUTIVE SUMMARY

OzArk Environmental & Heritage Management was engaged by MAAS Group Properties to complete an Aboriginal Due Diligence archaeological assessment for the proposed subdivision of Lot 2 DP880413 at 24R Sheraton Road, Dubbo NSW. Lot 2 DP880413 was previously assessed by Kelton (1995) who recorded two Aboriginal sites in the southern portion of the Study Area and one Aboriginal site 20 metres south of the Study Area adjacent to Eulomogo Creek.

A visual inspection of the Study Area was undertaken by OzArk Senior Archaeologist, Dr Chris Lovell, on Thursday 19 January 2017. One new site was recorded during the inspection (Hillview-IF1) and the three Aboriginal sites previously recorded by Kelton (1995) were assessed. No artefacts were identified at the previously recorded site locations; however, this was due to low ground surface visibility and the artefacts are likely to exist at the site locations. Two of the site locations (AHIMS ##36-1-0186 and #36-1-0188) were confirmed as being within the Study Area and one site location (AHIMS #36-1-0187) was confirmed as being 20 metres south of the Study Area southern boundary. An area of potential archaeological sensitivity (PAS) was identified in the southern portion of the Study Area, encompassing the Eulomogo Creek banks, the banks of an unnamed drainage line in the vicinity of #36-1-0188, and the creek flat to the south of Eulomogo Creek.

The Due Diligence archaeological assessment concluded that Aboriginal objects or intact archaeological deposits are likely to be harmed by the Proposal. This moves the Proposal to the following outcome: 'further investigation and impact assessment' of the Study Area must be undertaken. To ensure that the Aboriginal cultural heritage values of the Study Area are protected, the following recommendations are made:

1. Further investigation and impact assessment of the Study Area must be undertaken, including the preparation of an Aboriginal Cultural Heritage Assessment Report (ACHAR), following the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010a) and adhering to the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b; Code of Practice). If this assessment concludes that harm to Aboriginal objects will occur, then an Aboriginal Heritage Impact Permit (AHIP) application must be made.
2. Ground disturbing activities must not occur within the riparian zone or within the Study Area boundaries south of Eulomogo Creek. This will avoid harm to AHIMS #36-1-0186 and most of the area of PAS (**Figure 3-8**). Due to the close proximity to the Study Area, management of AHIMS #36-1-0187 may also be required during the proposed work to avoid inadvertently harming the site.
3. The establishment of a riparian zone has not avoided ground disturbing activities within the updated AHIMS #36-1-0188 site extent and potential archaeological deposit (PAD)

area (**Figure 3-6**) or within the northeast portion of the area of PAS (**Figure 3-8**). If ground disturbing work cannot be avoided in this area, test excavations in accordance with the Code of Practice will be required to establish whether an archaeological deposit exists in this area, with the results reported in an Archaeological Assessment Report or included in the ACHAR. Surface salvage of previously recorded artefacts and, possibly, salvage excavations will subsequently be required under an AHIP.

4. Harm to Hillview-IF1 has not been avoided and therefore surface collection of the artefact will be required under an AHIP.

CONTENTS

FIGURES

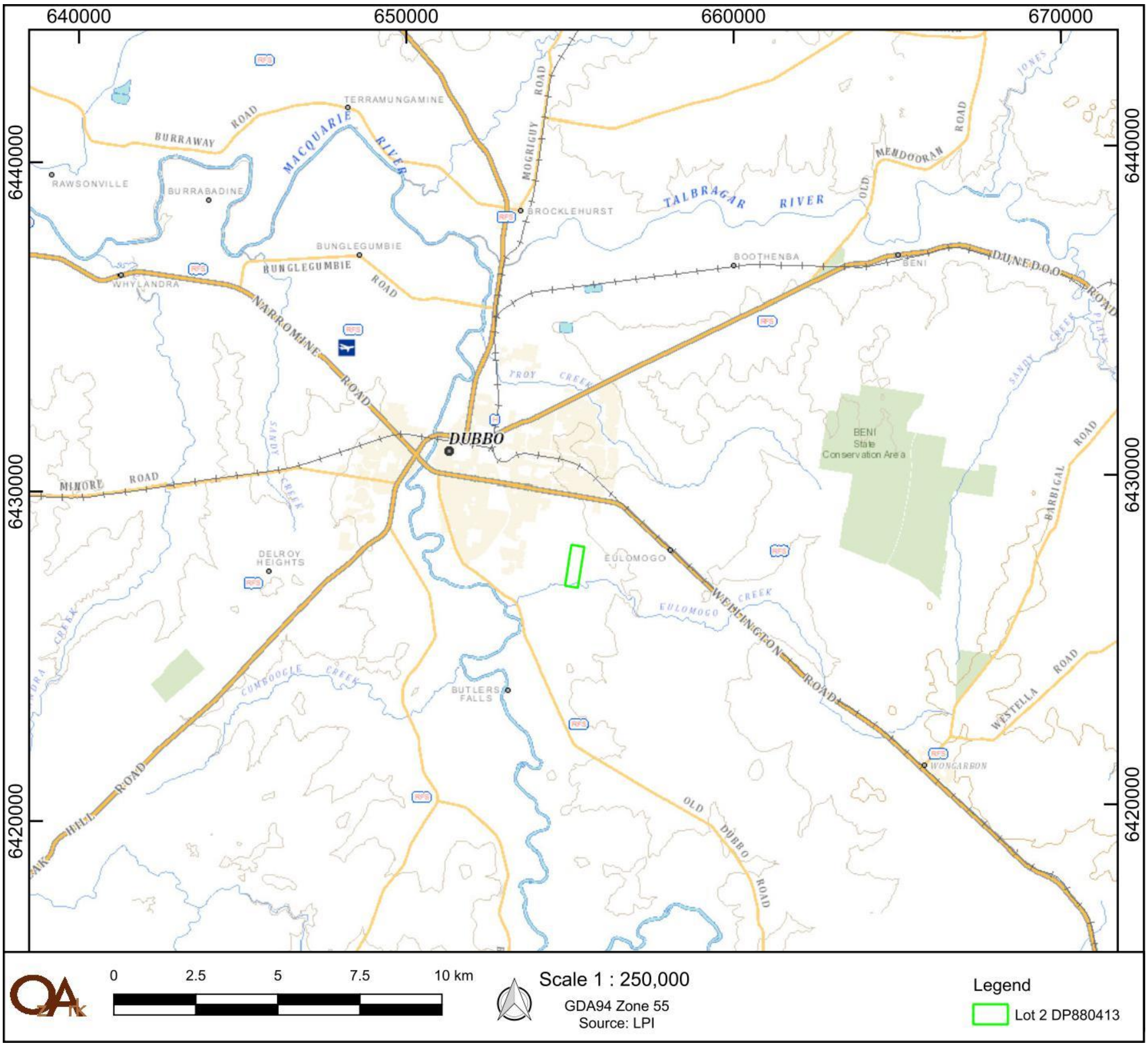
TABLES

1 INTRODUCTION

1.1 BRIEF DESCRIPTION OF THE PROPOSAL

OzArk Environmental & Heritage Management (OzArk) has been engaged by MAAS Group Properties (the Proponent) to complete an Aboriginal Due Diligence archaeological assessment for the proposed subdivision of Lot 2 DP880413 at 24R Sheraton Road, Dubbo NSW. This report examines proposed works associated with the subdivision of Lot 2 DP880413 (the Proposal). The Proposal is situated within the Dubbo Regional Local Government Area (LGA) (**Figure 1-1**).

Figure 1-1: Map showing the location of the Proposal in the region.



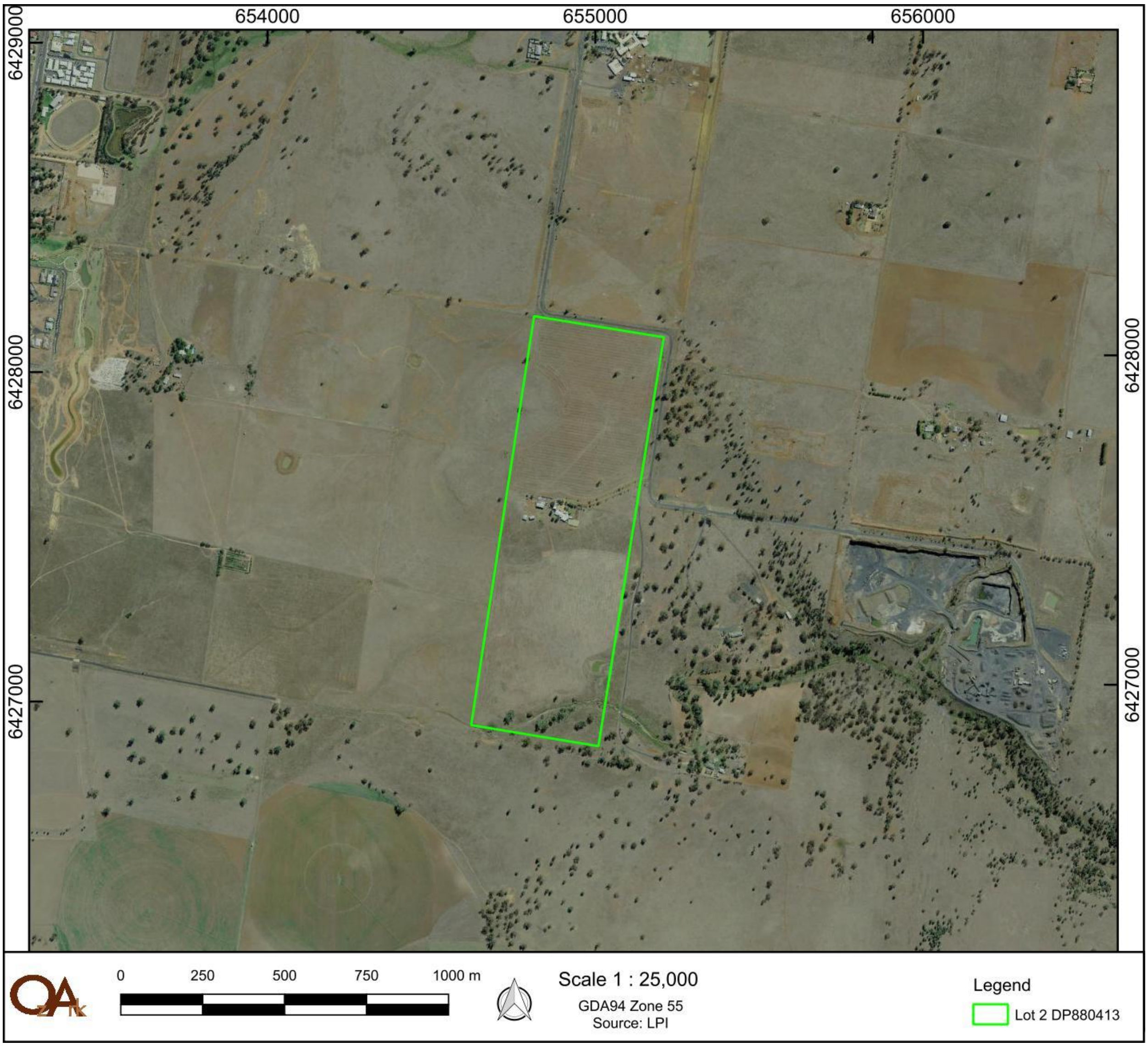
1.2 BACKGROUND

Lot 2 DP880413 was assessed by Kelton (1995) for the proposed 'Keswick' housing subdivision of 415 hectares of rural land located southeast of Dubbo and encompassing Lot 2 DP880413. The assessment included some consultation with Aboriginal community representatives, which included requests for information regarding the cultural significance of the development area and briefings at the end of each field survey day. Discussions with Aboriginal community representatives did not suggest that the development area contained areas of Aboriginal cultural significance, except that parts of the area were located close to the Macquarie River. Lot 2 DP880413 is located at the eastern boundary of the Kelton (1995) development area, approximately two kilometres northeast of the Macquarie River. Seven sites were recorded by Kelton (1995) within the development area, two of which are located within Lot 2 DP880413. The results of the Kelton (1995) assessment and relevance to the current project are outlined in **Section 2.3.3** and **Section 3.2**.

1.3 STUDY AREA

The Study Area includes Lot 2 DP880413, encompassing approximately 51 hectares of land, located approximately 4.7 kilometres southeast of the Dubbo CBD at 24R Sheraton Road (**Figure 1-2**).

Figure 1-2: Map showing satellite imagery of the Study Area (Lot 2 DP880413).



1.4 ASSESSMENT APPROACH

The desktop and visual inspection component for the Study Area follows the *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales* (Due Diligence; DECCW 2010c).

2 DUE DILIGENCE ASSESSMENT

2.1 INTRODUCTION

The National Parks and Wildlife Regulation 2009 (NPW Regulation) made under the *National Parks and Wildlife Act 1974* advocates a Due Diligence process to determining likely impacts on Aboriginal objects. Carrying out Due Diligence provides a defence to the offence of harming Aboriginal objects and is an important step in satisfying Aboriginal heritage obligations in NSW.

2.2 DEFENCES UNDER THE NPW REGULATION 2009

2.2.1 Low Impact Activities

The first step before application of the Due Diligence process itself is to determine whether the proposed activity is a "low impact activity" for which there is a defence in the NPW Regulation. The exemptions are listed in Section 80B (1) of the NPW Regulation (DECCW 2010c: 6).

The activities of MAAS Group Properties are not an except 'low impact activity' listed in the NPW Regulation. Furthermore, this defence does not apply to situations where there is reason to suspect that an Aboriginal object may be present. The proposed work includes landforms that contain previously recorded Aboriginal sites (Kelton 1995), therefore the Due Diligence process must be applied.

2.2.2 Disturbed Lands

Relevant to this process is the assessed levels of previous land-use disturbance.

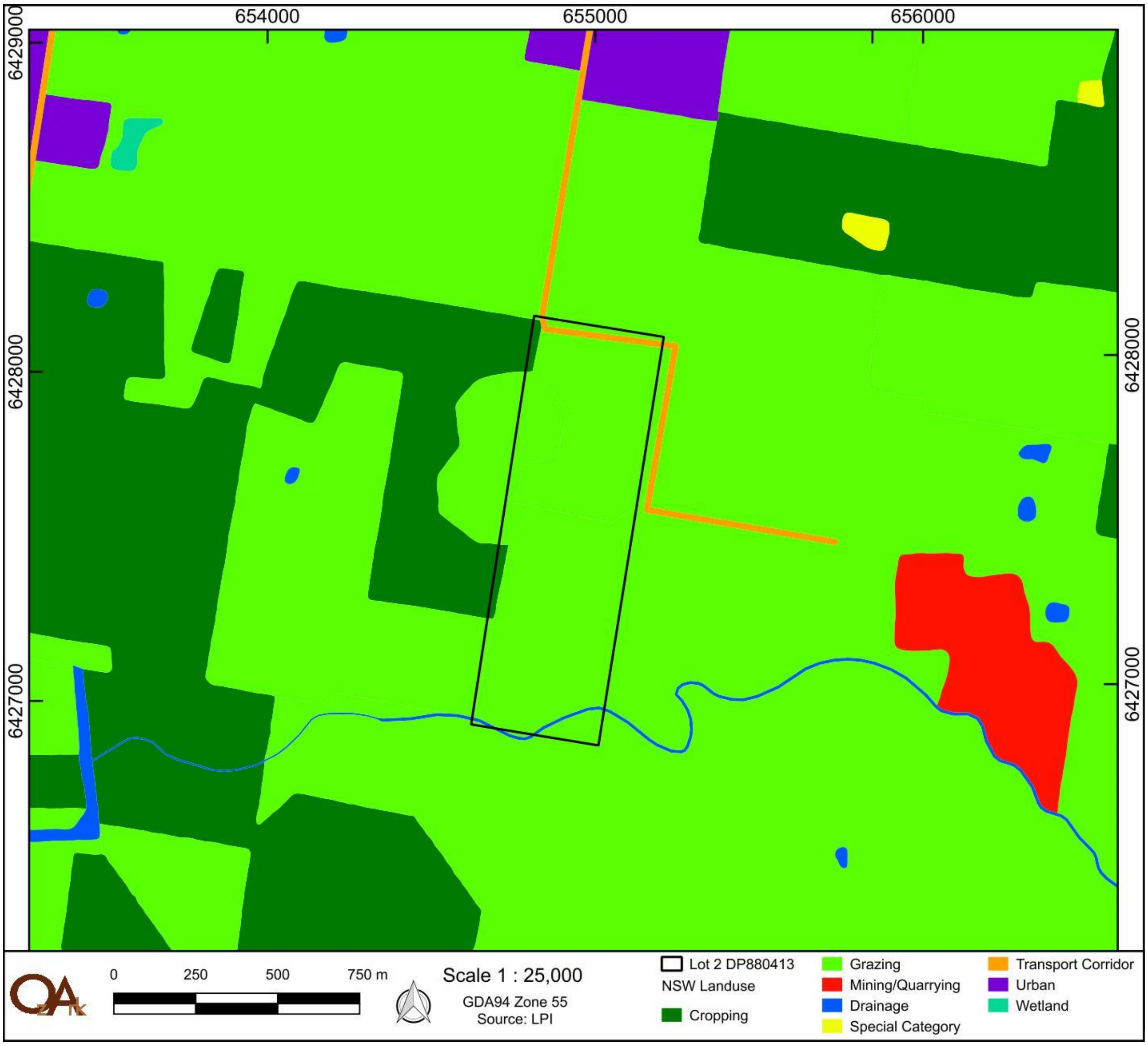
The NPW Regulation Section 80B (4) (DECCW 2010c: 18) define disturbed land as follows:

> *Land is disturbed if it has been the subject of a human activity that has changed the land's surface, being changes that remain clear and observable.*
>
> *Examples include ploughing, construction of rural infrastructure (such as dams and fences), construction of roads, trails and tracks (including fire trails and tracks and walking tracks), clearing vegetation, construction of buildings and the erection of other structures, construction or installation of utilities and other similar services (such as above or below ground electrical infrastructure, water or sewerage pipelines, stormwater drainage and other similar infrastructure) and construction of earthworks.*

Figure 2-1 shows land use in the vicinity of the Study Area. Examination of satellite imagery (**Figure 1-2**) and visual inspection of the Study Area confirmed that the area has been cleared of vegetation, although some remnant trees exist in the southern and south-eastern portion, adjacent to Eulomogo Creek. House, shed and driveway construction has occurred in the central parts of the Study Area (**Plate 9**). The Study

Area is composed of several fenced paddocks that have undergone prolonged grazing. Visual inspection confirmed that the large northern (**Plate 10**) and southern paddocks (**Plate 11**) have been ploughed. Two low voltage powerlines and an earthen dam have been constructed in the southeast corner of the Study Area. Most of the Study Area therefore falls under the NPW Regulation definition of 'disturbed land', with the exception perhaps of: a low hill along the north western boundary; some areas to the east and west of the house and sheds; and the south eastern parts of the Study Area in the vicinity of Eulomogo Creek. As such, some portions of the Study Area cannot be considered 'disturbed land' and therefore the Due Diligence process must be applied.

Figure 2-1: Map showing land use in the Study Area.



2.3 APPLICATION OF THE DUE DILIGENCE CODE OF PRACTICE TO THE PROPOSAL

To follow the generic Due Diligence process, a series of steps in a question/answer flowchart format (DECCW 2010c: 10) are applied to the proposed impacts and the Study Area, and the responses documented.

2.3.1 Step 1

Will the activity disturb the ground surface or any culturally modified trees?

Yes. The Proposal involves the subdivision of Lot 2 DP880413 in preparation for a future housing development (**Figure 2-2**). The subdivision of land is a local government administrative procedure that does not involve surface ground disturbance and will not affect any culturally modified trees. However, a housing development is proposed to occur after the subdivision is complete and this development will disturb the ground surface and could affect culturally modified trees, if present. This assessment takes into consideration the impacts of the subsequent housing development. A riparian zone has been established in the southern portion of the Study Area, including a 40 metre vegetated riparian buffer either side of Eulomogo Creek. No ground disturbing work is proposed in this area or south of Eulomogo Creek. A freight way is proposed to the north of the riparian zone (**Figure 2-2** and **Figure 2-3**).

Figure 2-2: Map showing the lot layout for the proposed subdivision within the Study Area (green dashed line).

Figure 2-3: Map showing the overall site plan within the Study Area (dashed green line) including the limits of the riparian zone along Eulomogo Creek and the proposed freight way.

2.3.2 Step 2 a)

Are there any relevant confirmed site records or other associated landscape feature information on AHIMS?

Yes. A search of the Office of Environment and Heritage (OEH) administered Aboriginal Heritage Information Management System (AHIMS) database was conducted on 12 January 2017. The search encompassed a five kilometre by five kilometre area, centred on the Study Area. The AHIMS search returned 26 Aboriginal sites within the search area (**Appendix 1**). The results are summarised in **Table 2-1** and site types and site locations and types are plotted in **Figure 2-4** in relation to the Study Area. Two sites are located in the southeast portion of the Study Area (AHIMS #36-1-0186 and #36-1-0188) and two sites are located in close proximity to the Study Area (AHIMS #36-1-0187 and #36-1-0246) as shown in **Figure 2-5**. The site extents shown in **Figure 2-5** are approximate and were reconstructed on the basis of information contained on the AHIMS site cards.

Table 2-1: AHIMS site types and frequencies.

Site Type	Number	% Frequency
Artefact	12	46
Modified tree (carved or scarred)	12	46
Grinding groove	2	8
TOTAL	**26**	**100**

Artefact scatters and isolated artefacts comprise almost half of the AHIMS search results. None of the AHIMS sites are registered as being associated with a potential archaeological deposit (PAD). Most of the artefact sites are located within 200 metres of a watercourse, particularly Eulomogo Creek. As such, it is possible that other unrecorded stone artefact scatters and isolated stone artefacts could be located within the Study Area, particularly within 200 metres of Eulomogo Creek. Isolated finds could be located anywhere within the Study Area. Two axe grinding groove sites are located on the bank and creek flat adjacent to Eulomogo Creek (AHIMS #36-1-0253 and #36-1-0254) on exposed sandstone outcrops several hundred metres east of the Study Area. The site cards note that there is potential for additional grinding grooves to be present beneath accumulated silt deposits. Likewise, unrecorded axe grinding grooves could exist in the Study Area on outcropping sandstone within 50 metres of Eulomogo Creek, although they could have been covered by silty sediments deposited during flood events and therefore be undetectable. Modified trees also comprise close to half the AHIMS search results. Most of these trees are located within several hundred metres of the Macquarie River, Eulomogo Creek and other ephemeral drainage lines, although several are located more than a kilometre from water. As such, culturally modified trees could exist in the Study Area where remnant mature trees of sufficient age exist – i.e. in the southeast portion of the Study Area adjacent to Eulomogo Creek.

Figure 2-4: Map showing the location of previously recorded AHIMS sites (including site types) in the vicinity of the Study Area.

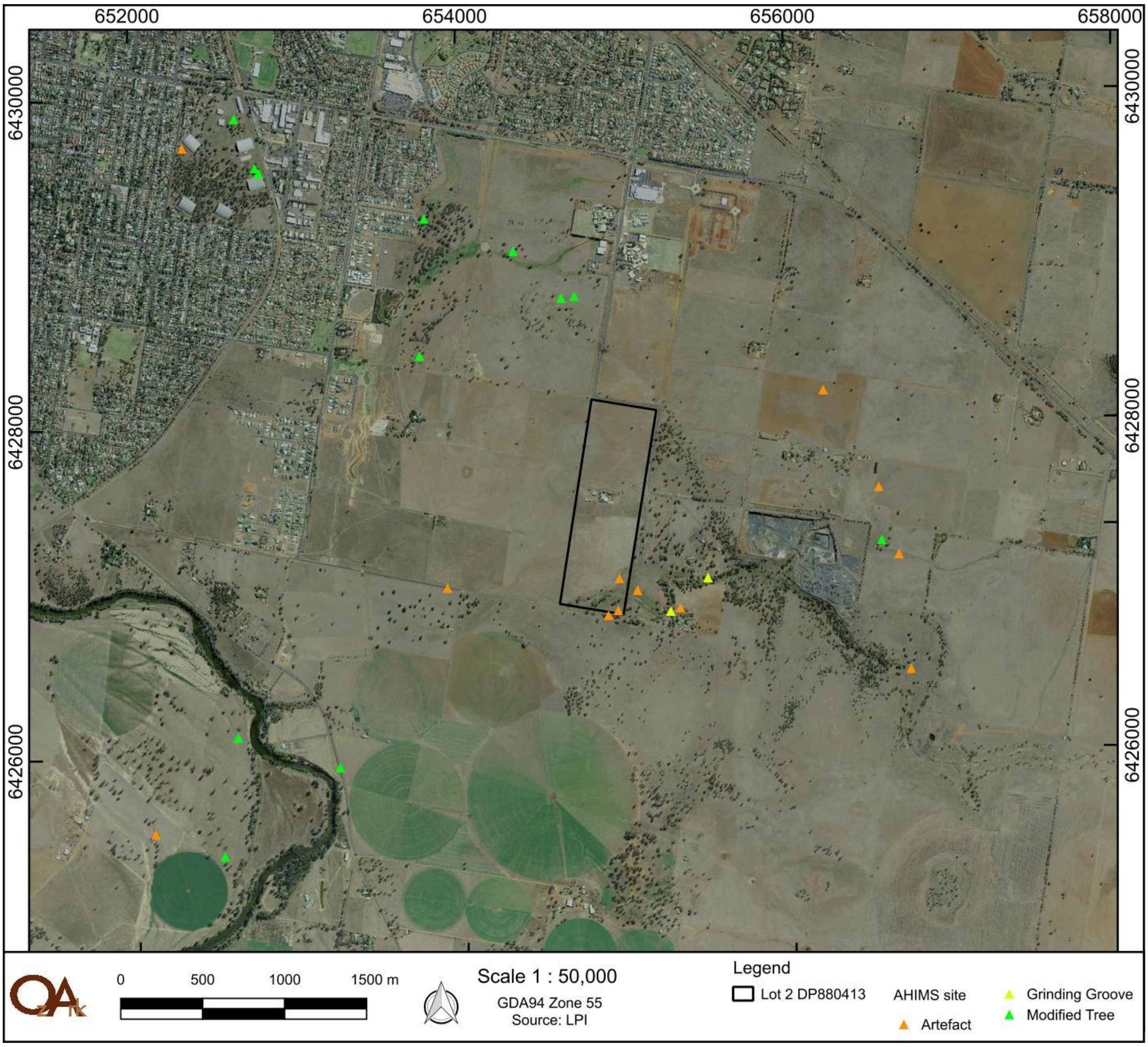


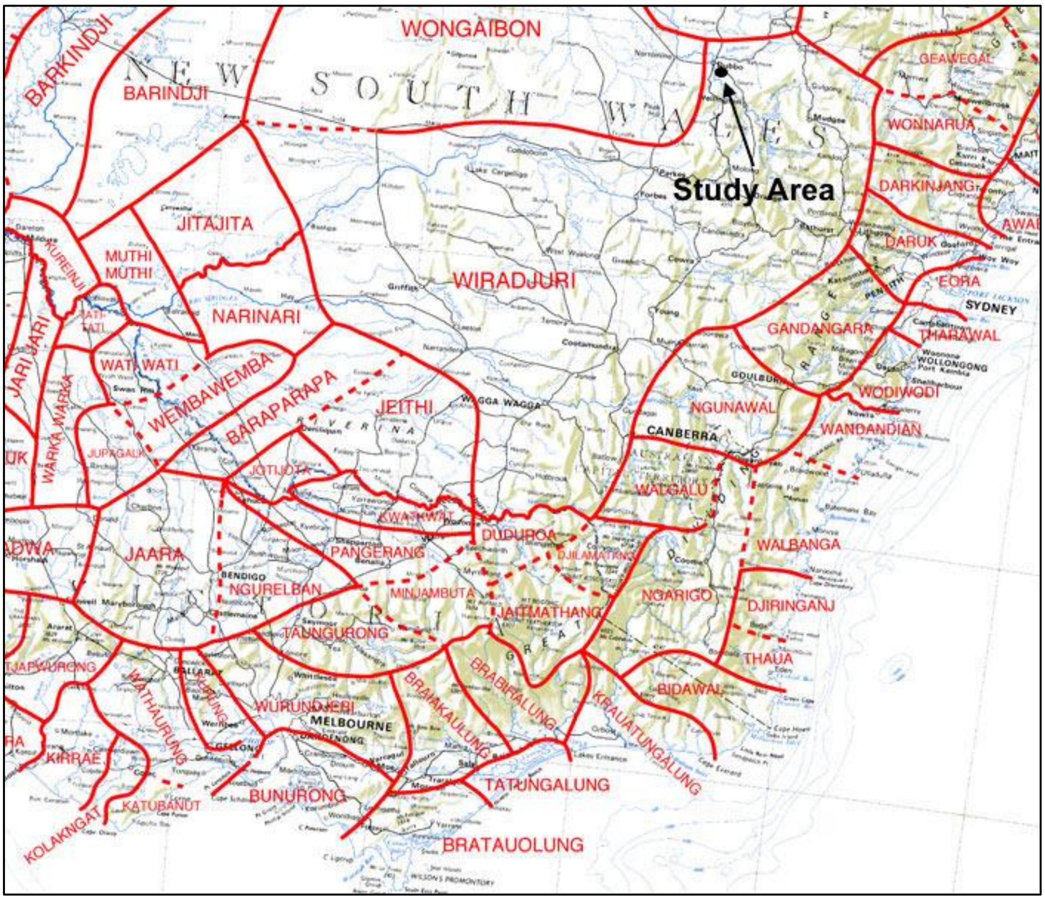
Figure 2-5: Map showing the location of previously recorded AHIMS sites (site types, AHIMS numbers and reconstructed site extents) and watercourses in the southeast of the Study Area.

2.3.3 Step 2 b)

Are there any other sources of information of which a person is already aware?

Yes. According to Tindale's (1974) and Horton's (1994) maps of tribal boundaries, the Dubbo area falls within the northern limits of the Wiradjuri 'tribal' or ethno-linguistic group (**Figure 2-6**). The Wiradjuri are typically described as a large language group or tribal nation extending over a considerable area of New South Wales, comprising numerous sub-groups. Use of the term 'tribe' and the delineation of 'tribal boundaries' on maps is considered problematic, although distinctive ethno-linguistic groups are known to exist. Two group names are used within the Dubbo region: Wiradjuri and Tubba-Gah. The Tubba-Gah comprise a local sub-group, 'clan' or mob within the larger Wirajuri entity and are historically linked to the locality encompassing the Study Area (Kelton 1995:7-8; Koettig 1985:21-22). The territory thought to have been traversed by the Tubba-Gah lies to the east of the Macquarie River, south of the Talbragar River and north of Eulomogo creek.

Figure 2-6: A portion of Tindale's (1974) map showing the location of the Wiradjuri ethno-linguistic group in relation to the Study Area.



Little recorded information survives concerning the life of Aboriginal people in the Dubbo area following European settlement (Koettig 1985:19). The most important historical resources are the oral histories passed from parent to child by local Indigenous inhabitants. The current caretakers of this knowledge are involved in a project to record that information. When it becomes available, this resource stands to replace existing documents as the most valuable written resource describing Aboriginal cultural practices at the time of European settlement.

Early accounts of contact between European and Aboriginal people in the Macquarie River area were provided by Oxley (1820) and Sturt (1834) and later by Garnsey (1942) who was born in Dubbo in 1874. Garnsey's interest in Aboriginal cultures led him to record information gleaned from his father and from Aboriginal elders in the Dubbo area. His work remains a useful account of everyday life and religious/ceremonial practices.

According to early accounts, Tubba-Gah territory was rich in animal and plant food resources (Koettig 1985). Garnsey's (1942:6) description of camp life suggests that many activities were performed communally, for the benefit of the mob. Campsites comprised a series of bark or bush shelters arranged in a semi-circle opening to the east, arranged around a central fire, with men occupying shelters to the north, women in the centre, and children to the south. Camps moved frequently over short distances due to alterations in social relations and weather, and in response to hygiene concerns, among other factors. Longer distance movements tended to be linked to participation in large-scale gatherings (e.g. ceremony or warfare) or alterations in resource availability. Garnsey (1942:16–23) also provides detailed descriptions of ceremonial practices related to alterations in social status and passages from infancy to adulthood. These descriptions of are a composite of various verbal accounts, the accuracy of which is difficult to ascertain. Garnsey (1942:14) suggests that the 'mob' structure began to break down during the 1890s when only older men appeared to retain the tribal markings and knowledge associated with ceremonial practice. Oral histories of traditional custodians are likely to elaborate upon and refute aspects of these early accounts.

Prior to 1985, no systematic archaeological studies had been undertaken in the Dubbo region. During the late nineteenth and early twentieth centuries, interested locals and amateurs, including Milne and Gresser and to a lesser extent Garnsey, recorded a number of sites and collected artefacts, contributing to the body of archaeological data available to researchers today. A number of archaeological studies have since been conducted within the Dubbo region (Balme 1986; Koettig 1985; OzArk 2006; Pearson 1981; Purcell 2000). These provide baseline data for placing past Aboriginal sites within a regional landscape context.

Pearson (1981) worked primarily in the Upper Macquarie region. The proximity of this area to the current study area and general topographic similarities render the findings relevant to the Dubbo region. Pearson divided the archaeological sites he recorded into two main categories: occupation sites and non-occupation sites (including grinding grooves, scarred or carved trees, ceremonial and burial sites). Analysis of site locations produced a site prediction model with occupation occurring in areas with: access to water, good drainage, level ground, adequate fuel and appropriate localised weather patterns for summer or winter occupation. Occupation sites were most frequently located on low ridge tops, creek banks, gently undulating hills and river flats and usually in open woodland vegetation (Pearson 1981:101). The location of non-occupation sites was dependent upon a variety of factors relating to site function. For instance, grinding grooves were found where appropriate outcropping sandstone occurred close to occupation sites. The location of scarred trees displayed no obvious patterning, other than proximity to watercourses. Pearson suggested that these patterns would differ on the drier plains to the west, towards Dubbo and beyond, where dependence upon larger, more permanent water supplies was greater.

Koettig (1985:81–82) examined evidence of Aboriginal occupation within five kilometres of Dubbo's city limits. She concluded that sites existed throughout all landscape units surveyed; artefact scatters, scarred trees and grinding grooves were the most frequently occurring site types; and that site location and size were determined by various environmental and social factors. Of the environmental factors, proximity to water, geological formation and availability of food resources were most important. As such, her site prediction model suggested that: all site types would occur along watercourses; stone arrangements would occur most frequently on knolls or prominent landscape features; larger campsites would occur most frequently along permanent watercourses, near springs or wetlands; small campsites could occur anywhere; scarred trees could occur anywhere, but particularly in remnant native woodland communities; campsites would be smaller and more sporadic near the headwaters of creeks; grinding grooves could occur where appropriate sandstone existed; quarries could occur wherever there were suitable stone sources; and shell middens could occur only along the Macquarie River.

The North-Central Rivers study undertaken by Balme (1986) examined site location in terms of site preservation. Balme (1986:182) found that, other than historic impacts, site distribution was most affected by geomorphic processes affecting site preservation and leading to site exposure. In addition, there was little scope for the assessment of site chronologies as few datable contexts had been located. Balme also concluded that sites recorded on AHIMS from ethnographic accounts were unlikely to be relocated.

In an assessment of the Pilliga and Goonoo State Forests, Purcell (2000) recorded 47 and 106 Aboriginal sites respectively. Purcell (2000:31) found that sites were more frequently located within alluvium landforms including creeks, swamps and chains of ponds surrounded by floodplains and terraces, and that 91.5 per cent of sites were recorded within 200 to 300 meters of water.

OzArk (2006) assessed Indigenous heritage resources within the former Dubbo LGA (now part of the Dubbo Regional LGA) to assist Dubbo City Council with planning. This study aimed to: consolidate previous surveys and assessments of Indigenous heritage; set a baseline for further study; and survey areas zoned for future expansion. Approximately 1,120 hectares of land was surveyed within five study areas surrounding the city of Dubbo, including two areas located within three kilometres west of the Study Area. During the survey, 26 new Aboriginal sites were recorded and eight out of 12 previously recorded sites were relocated. Proportions of newly located sites by type were similar to those found in previous studies. Fewer scarred trees were found than expected, likely due to intensive agricultural practices and associated tree clearance around Dubbo city compared to the broader Dubbo LGA. No new grinding groove sites were found, which was likely, given that this site type comprised only 3.6 per cent of previously located sites within the Dubbo LGA. Scarred tree distribution adhered to the predictive model, exclusively following waterways and fence-lines, although this probably reflected land clearing practices more than Indigenous site patterning. Isolated finds and open sites followed a similar pattern, largely limited to watercourse edges and elevated terraces within 500 meters of the Macquarie River and other permanent to semi-permanent waterways. No significant patterning emerged in terms of site size or quality, perhaps because surface manifestations often do not adequately reflect site size or complexity.

OzArk (2014) undertook an archaeological assessment of Lot 710 DP 1041906 comprising approximately 15 hectares located 1.5 kilometres west of the Study Area. One new open site comprising two silcrete artefacts and an associated PAD was recorded on a gentle south trending slope, approximately 300 metres north of the Macquarie River.

Kelton (1995) undertook an archaeological survey for the proposed 'Keswick' housing subdivision of 415 hectares of rural land encompassing the Study Area and several adjoining lots. Seven Aboriginal sites comprising four artefact scatters, two isolated artefacts and one culturally modified tree (scarred) were recorded in the area. All recorded sites were located within several hundred metres of Eulomogo Creek and the Macquarie River on elevated floodplains (above the one-in-a-hundred-year flood zone) and the banks and elevated banks of Eulomogo Creek. Flaked stone artefacts were composed of chert, mudstone, quartzite, quartz and basalt; and grinding stone fragments were composed of mudstone and sandstone.

During the Kelton (1995) survey two sites were recorded in the southeast corner of the Study Area and one site just outside of the Study Area. An extensive artefact scatter was recorded in the Study Area on the north bank of Eulomogo Creek (AHIMS #36-1-0188); an isolated artefact was recorded on the southern bank of Eulomogo Creek in the Study Area (#36-1-0186); and an artefact scatter was recorded on the southern bank of Eulomogo Creek about 20 metres south of the Study Area (#36-1-0187) (**Figure 2-5**). As such, Kelton (1995:36) assessed the entire south bank of Eulomogo Creek (within the area surveyed, including the southeast portion of the Study Area and AHIMS #36-1-0186) as being as being archaeologically sensitive with potential to contain relatively undisturbed subsurface archaeological deposits. Kelton recommended that no further disturbance occur in this area, particularly in relation to any future development. Kelton (1995:39) assessed the area in the vicinity of AHIMS #36-1-0188 north of Eulomogo Creek in the Study Area as having potential to contain an extensive subsurface archaeological deposit in areas of minimal ground surface disturbance. As such, Kelton (1995:48) provides three management options for the southeast corner of the Study Area: (1) that the entire south-eastern corner of the Study Area be set aside as an ‘archaeological conservation zone’; or (2) that no ground surface disturbance occur within the #36-1-0188 site boundaries, including a 50 metre buffer around the site; or (3) that text excavations occur to characterise #36-1-0188.

OzArk (2015) undertook a Due Diligence assessment of neighbouring Lot 399 DP1199356 and Lot 503 DP1152321 west of the Study Area, previously surveyed by Kelton (1995). No new sites were recorded during the field inspection and AHIMS #36-1-0189, previously recorded by Kelton (1995), was unable to be located, probably due to low ground surface visibility (GSV). AHIMS #36-1-0189 is an artefact scatter located approximately 700 metres west of the Study Area, 100 metres northwest of Eulomogo Creek, comprising an approximately 1.2 hectare open artefact scatter containing 50 to 100 stone artefacts including: a bifacially knapped basalt axe blank, three ‘multipurpose hammerstones’ and quartzite and chert flakes and flaked pieces.

Heritage database searches were undertaken to identify any previously recorded Aboriginal sites and places in the Study Area. The database search results are summarised in **Table 2-2**.

Table 2-2: Aboriginal heritage: summary of desktop-database search results.

Name of Database Searched	Date of Search	Type of Search	Comment
Australian Heritage Database	7/2/2017	Dubbo Regional LGA	No places listed are near the Study Area
NSW Heritage Office State Heritage Register and State Heritage Inventory	7/2/2017	Dubbo Regional LGA	No places listed are near the Study Area
National Native Title Claims Search	7/2/2017	Dubbo Regional LGA	No Native Title Claims cover the Study Area
OEH AHIMS	12/1/2017	5 km x 5km area centred on the Study Area	26 sites are located within the search area
Local Environment Plan (LEP)	7/2/2017	Dubbo LEP 2011	No places listed are near the Study Area

Previous archaeological studies and the results of heritage databases searches indicate that two previously recorded Aboriginal sites exist in the Study Area (AHIMS #36-1-0186 and #36-1-0188) and one previously recorded site is located close to the southern boundary of the Study Area (AHIMS #36-1-0187). There are no other known Aboriginal cultural values associated with the Study Area, although it is noted that Aboriginal community representatives did not accompany the current visual inspection. The results of the desktop assessment suggest that unidentified Aboriginal sites could exist in the Study Area, particularly on landforms with Aboriginal archaeological potential, including the southeast portion of the Study Area adjacent to Eulomogo Creek.

2.3.4 Step 2 c)

Are there any landscape features that are likely to indicate presence of Aboriginal objects?

Yes. The Study Area is located in the Brigalow Belt South bioregion (Talbragar subregion) (NPWS 2003: 131-137). At the time of European settlement, vegetation in the vicinity of the Study Area would have comprised eucalypt and cyprus pine woodland, with some river oak (*Casuarina cunninghamiana*) along Eulomogo Creek. These plant communities would have supported a variety of native fauna and provided Aboriginal people with access to a range of plant and animal resources.

Characteristic landforms of the Talbragar subregion include residual rocky hills, undulating long slopes and wash plains, and wide valley floors with sandy streams. Thin stony loams and texture contrast soils cover most of the landscape with deeper sands and brown earths on valley floors. The Study Area includes three Mitchell (2002) landscape units (**Figure 2-7**): (1) Macquarie Alluvial Plains (southwest corner); (2) Goonoo Slopes (south-central parts); and (3) Dubbo Basalts (northern parts). The Macquarie Alluvial Plain landscape unit is a plain associated with the Macquarie River main alluvial fan and distributary stream system with local relief of one to three metres. The Goonoo Slopes landscape unit includes undulating to stepped low hills with long slopes; and the Dubbo Basalts landscape unit includes slightly elevated plains and low hills on flat lying Tertiary basalt and trachyte flows, roughly parallel to the present course of the Macquarie River, with local relief to 10 metres.

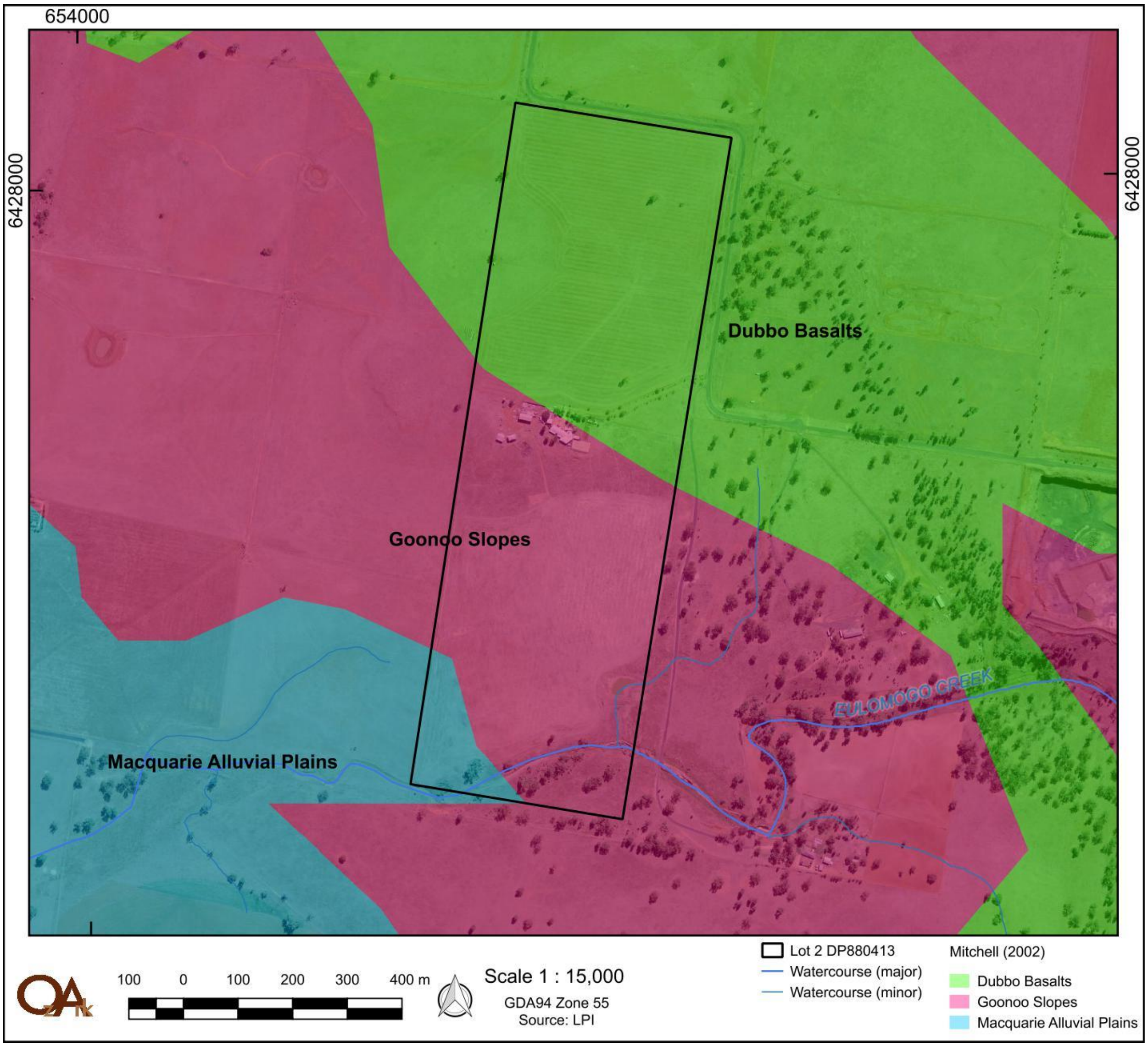
In terms of hydrology, the Study Area is located approximately two kilometres northeast of the Macquarie River, the region's major waterway. Eulomogo Creek is an intermittent tributary of the Macquarie River that flows southwest through the southern portion of the Study Area. An ephemeral drainage line also enters the southeast corner of the Study Area, flowing south into Eulomogo Creek (**Figure 2-5** and **Figure 2-7**).

In summary, artefact scatters and culturally modified trees are the most likely site types to be encountered in the Study Area. Artefacts are likely to have been manufactured from chert, mudstone, quartzite, quartz and volcanic materials. Artefact scatters are likely to be located adjacent to Eulomogo Creek and the ephemeral drainage line, particularly on flat alluvial rises and gentle slopes, as well as on the gentle upper slopes and crests of nearby hills. Aboriginal scarred trees could also exist in the Study Area where mature trees of sufficient age to contain Aboriginal scarring exist. Axe grinding grooves could be located on outcropping sandstone within 50 metres of Eulomogo Creek including the creek bed, particularly adjacent to artefact scatters and open camp sites. Quarries for the procurement of raw materials for the manufacture of stone tools are possible where suitable sources of outcropping stone occur.

Aboriginal archaeological deposits are likely to have been harmed or destroyed by a variety of land use activities and disturbances within the Study Area, particularly: vegetation clearing;

ploughing; powerline construction; construction of farm buildings, fences and water management infrastructure (e.g. pipelines and an earthen dam); and erosion (e.g. wind, sheet wash, rill, gully and streambank erosion). Nevertheless, two known Aboriginal sites exist in the Study Area and landforms with potential to contain unidentified Aboriginal sites exist. As such, visual inspection of the Study Area is required.

Figure 2-7: Map showing the Michell (2002) landscape units of the Study Area.



2.3.5 Step 3

<u>Can harm to Aboriginal objects listed on AHIMS or identified by other sources of information and/or can the carrying out of the activity at the relevant landscape features be avoided?</u>

No. The Proposal includes landscape features that contain, or have potential to contain, Aboriginal objects and sites, and these landscape features have not been avoided.

2.3.6 Step 4

Does a desktop assessment and visual inspection confirm that there are Aboriginal objects or that they are likely?

Yes. The visual inspection of the Study Area was undertaken by OzArk Senior Archaeologist, Dr Chris Lovell, on Thursday 19 January 2017. One new site was recorded during the survey (Hillview-IF1; isolated artefact) and three previously recorded Aboriginal sites were assessed, including two that were confirmed as being located within the Study Area (**Section 3**).

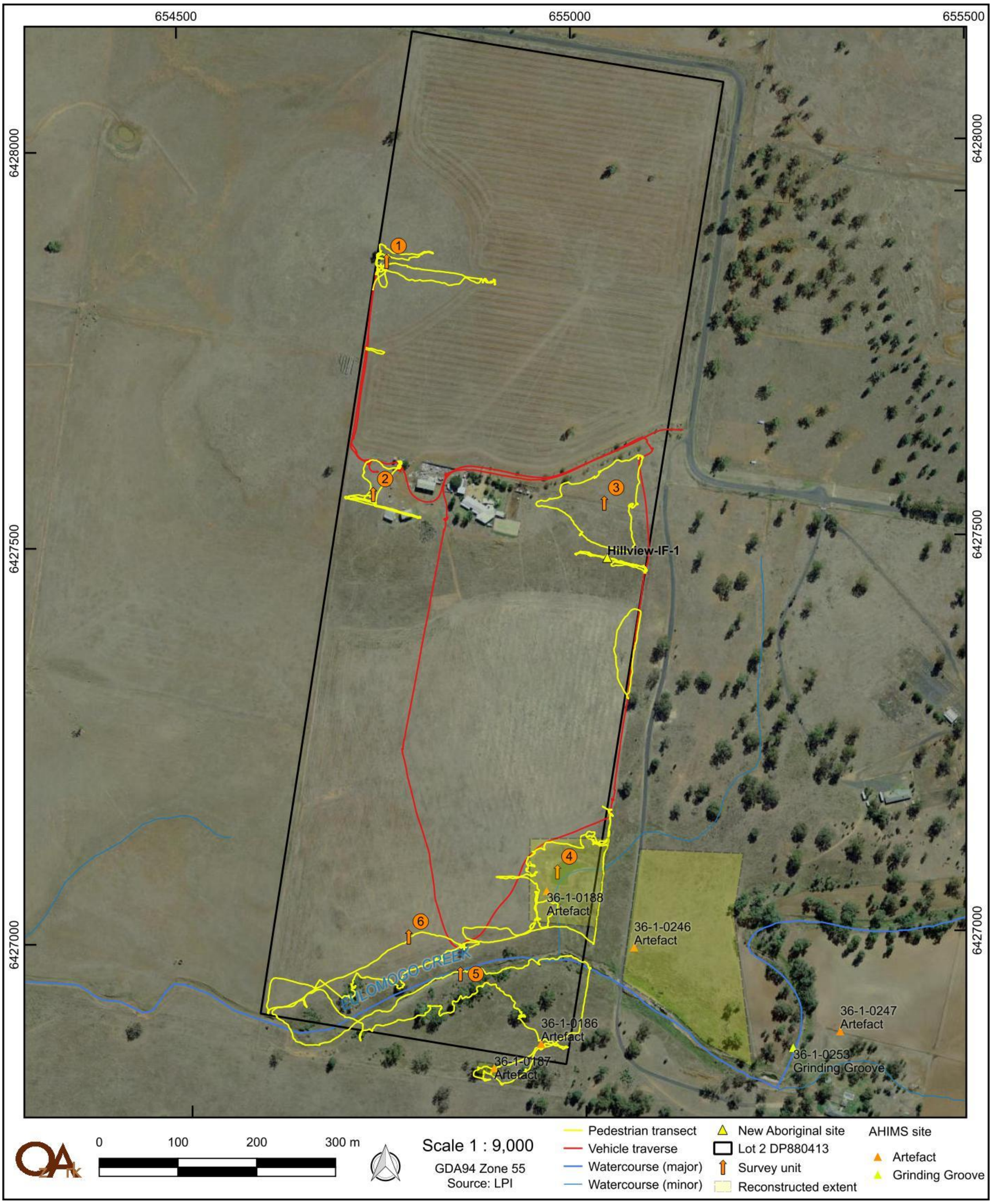
Standard archaeological field survey and recording methods were employed (Burke and Smith 2004). A combination of vehicle traverses and pedestrian transects were used to assess the Study Area. Emphasis was placed upon areas with minimal ground surface disturbance and landforms identified as having Aboriginal archaeological potential. These areas include: the crest of a low hill on the western boundary to the north (survey unit 1; **Plate 1**); central areas to the west (survey unit 2; **Plate 2**) and east (survey unit 3; **Plate 3**) of the house and sheds; an area to the north of Eulomogo Creek in the vicinity of AHIMS #36-1-0188 (survey unit 4; **Plate 4**); areas along the northern and southern banks and bed of Eulomogo Creek (survey unit 5; **Plates 5** to **7**); and the crest of a low hill overlooking Eulomogo Creek (survey unit 6; **Plate 8**). Survey data for each survey unit is summarised in **Table 2-3**.

Table 2-3: Survey data

Survey unit	Landform	Exposure	GSV	Note	Disturbance
1	Crest and gentle to moderate upper slope	20	10	Low GSV due to grass/forb cover	Cleared, grazed, fence, vehicle track, trampled, sheet wash, wind erosion, water tank
2	Flat to gentle bench and mid-slope	30	20	Low GSV due to grass/forb cover	Cleared, grazed, fence, vehicle track, trampled, sheet wash, wind erosion, machinery cut
3	Gentle mid-slope	30	20	Low GSV due to grass/forb cover	Cleared, grazed, fence, trampled, sheet wash, wind erosion, machinery cut, possibly ploughed
4	Stream bank	30	10	Low GSV due to grass/forb cover	Cleared, grazed, fence, dam, vehicle track, trampled, sheet wash, machinery cut
5	Stream bank, flat and bed	40	10	Low GSV due to grass/forb cover	Cleared, grazed, vehicle track, trampled, sheet wash, streambank, wind erosion, powerline
6	Crest of low hill	30	0	Low GSV due to grass/forb cover	Cleared, grazed, trampled, sheet wash, wind erosion

All trees with potential to contain Aboriginal cultural scarring or carving were inspected and no Aboriginal modified trees were identified. The Eulomogo Creek bed and banks were inspected for axe grinding grooves and none were identified. Vehicle and pedestrian track data, survey unit locations and the new site location were captured via handheld GPS as shown in **Figure 2-8**. Representative photographs of the survey units are shown in **Plates 1** to **8**. Exposure within the survey units ranged from 20 to 40 per cent, which is considered sufficient to reveal archaeological material; however, GSV was generally low to very low (ranging from zero to 20 per cent) due to extensive grass and forb cover attributable to recent prevailing wet weather. Nevertheless, GSV and exposure combined with background research identifying previously recorded and predicted Aboriginal site locations was considered sufficient to assess the locations of previously recorded sites as well as the archaeological potential of all landforms within the Study Area.

Figure 2-8: Map showing survey coverage (survey units, vehicle traverses and pedestrian transects), AHIMS sites and the newly recorded Aboriginal site in the Study Area.



A 'yes' answer to Step 4 requires that 'further investigation and impact assessment' of the Study Area be undertaken. Integral to the preparation of an Aboriginal Cultural Heritage Assessment Report (ACHAR) is the requirement to follow the OEH *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW 2010a; ACHCRs).

If, after this detailed investigation and impact assessment, it is decided that harm will occur to Aboriginal objects then an Aboriginal Heritage Impact Permit (AHIP) application must be made. The NPW Act is complemented by the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010b; Code of Practice) that sets out the requirements for archaeological investigation in NSW where an application for an AHIP is likely to be made.

3 ABORIGINAL SITES RECORDED AND ASSESSED

One new Aboriginal site was recorded during the visual inspection (Hillview-IF1) and three previously recorded Aboriginal sites were assessed (AHIMS #36-1-0186, #36-1-0187 and #36-1-0188). Details of these sites are summarised in **Table 3-1** and their locations and reconstructed site extents are shown in **Figure 2-8**.

Table 3-1: Summary of Aboriginal sites recorded and assessed.

Site Name	AHIMS ID	Coordinates (GDA94 Zone 55, centre point)	Site type	Artefact Count	Site Dimensions (m)
Hillview-IF1	36-1-0707	655038E 6427478N	Isolated find	1	1 x 1
K-IF-2	36-1-0186	654944E 6426865N	Isolated find	1	1 x 1
K-OS-2	36-1-0187	654884E 6426835N	Artefact scatter	6	10 x 2
K-OS-3	36-1-0188	654954E 6427058N	Artefact scatter	37	85 x 110

3.1 NEWLY RECORDED ABORIGINAL SITE

Hillview-IF1

AHIMS ID: 36-1-0707

Site Type: Isolated find

Location of Site: Hillview-IF1 is approximately 5.5 kilometres southeast of the Dubbo CBD; 510 metres north of Eulomogo Creek; 185 metres south southwest of the property entrance gates off Sheraton Road; 150 metres east south east of a residential house; and one metre south of a paddock fence (**Figure 2-8** and **Figure 3-2**).

Description of Site: Hillview-IF1 is a newly recorded isolated stone artefact (**Figure 3-1**): a mudstone multidirectional core with at least five flake removal scars at a secondary stage of reduction (approximately 25 per cent cortex remaining). The core is possibly opportunistic, with flakes perhaps removed to test the cobble. The site is located on a gentle mid-slope landform in a cleared, grazed and possibly ploughed paddock, beside a paddock fence, below a large bench that contains the property's residence and sheds (**Figure 3-2**). No other artefacts were visible in the vicinity of the site, although exposure was good (40 per cent) but GSV was poor (10 per cent). As such, other Aboriginal objects could exist in the vicinity of the site. However, the potential for subsurface archaeological deposits was assessed as being low-moderate due to distance from water (500 metres to Eulomogo Creek, and 200 metres from an ephemeral drainage line), the gentle sloping landform, and levels of ground disturbance (fence construction, machinery cut, vegetation clearing, grazing, trampling and possibly ploughing). Soils comprised brown medium sand and vegetation included grasses and forbs.

Figure 3-1: Photographs showing an overview of Hillview-IF1 and the artefact.

1. View west to Hillview-IF1 (pink flag) beside fence.

2. View east to Hillview-IF1 (pink flag) beside fence

3. View of mudstone core showing flake removal scars.

3. View of mudstone core showing flake removal scars.

Figure 3-2: Map showing Hillview-IF1 in relation to the Study Area.

3.2 Previously Recorded Aboriginal Sites

K-IF-2 (#36-1-0186)

AHIMS ID: 36-1-0186

Site Type: Isolated find

Location of Site: According to the site card, K-IF-2 is located approximately 5.7 kilometres southeast of the Dubbo CBD; 800 metres south of the property entrance gates off Sheraton Road; 100 metres west of a north-south to east-west bend in Sheraton Road; 100 metres south of Eulomogo Creek; and 30 metres west of a low voltage powerline pole (number: 6287-820) (**Figure 2-8** and **Figure 3-4**).

Description of Site: According to Kelton (1995) and the site card, K-IF-2 is a yellow/tan broken sandstone grinding stone (millstone) with unifacial use wear (silica gloss, barely visible on one side) located on a creek flat landform adjacent to Eulomogo Creek. The artefact measures approximately 22 by 19 by 3.2 centimetres. A large freshwater mussel fragment of uncertain provenance was found 10 to 20 metres west of the grinding stone.

During the visual inspection, an attempt was made to locate the artefact using a GPS receiver (**Figure 3-3**). AHIMS site coordinates were verified against the site card maps and location description (**Figure 3-4**). The artefact was unable to be located, probably due to extensive grass cover obscuring GSV (close to zero). It is considered likely that the artefact is present at the location and would be visible under conditions of greater GSV.

Figure 3-3: Photograph from Kelton (1995) and current overview of the K-IF-2 site location.

	
1. Photograph taken by Kelton (1995) showing the site location and grinding stone fragment (foreground, in front of peg).	2. Current photograph of the K-IF-2 site location, facing west, showing limited GSV and intensive grass cover. The photograph appears to show a similar location and orientation to photograph 1. The shrub in the foreground appears to have been removed.

Figure 3-4: Map showing the K-IF-2 (#36-1-0186) and K-OS-2 (#36-1-0187) AHIMS site locations and reconstructed site extents in relation to the Study Area.

K-OS-2 (#36-1-0187)

AHIMS ID: 36-1-0187

Site Type: Open site (artefact scatter, area of potential archaeological sensitivity [PAS])

Location of Site: According to the site card, K-OS-2 is located approximately 5.7 kilometres southeast of the Dubbo CBD; 840 metres south of the property entrance gates off Sheraton Road; 160 metres west southwest of a north-south to east-west bend in Sheraton Road; 130 metres south of Eulomogo Creek; and 20 metres north northwest of a low voltage powerline pole (number: 6289-820) (**Figure 2-8**).

Description of Site: According to Kelton (1995) and the site card, K-OS-2 is a small artefact scatter located on an unformed vehicle track on a creek flat landform adjacent to Eulomogo Creek. Kelton (1995) recorded six artefacts (quartz and quartzite flakes, cores and debitage) in an approximately 10 by two metre area. Kelton (1995) assessed the entire southern bank and creek flat of Eulomogo Creek in the Study Area as being an area of PAS, with potential to contain subsurface archaeological deposits, due to the high potential landform and proximity to the high significance site: K-OS-3 (see below).

During the visual inspection, an attempt was made to locate the artefact scatter using a GPS receiver. Site location coordinates were provided by AHIMS and verified against the site card maps and location description (**Figure 3-4**). An approximate site extent was reconstructed on the basis of the site card map. The artefacts were unable to be located, probably due to intensive grass cover obscuring GSV (close to zero) in the vicinity of the site location. It is considered likely that the artefacts are present at the site location and would be visible under conditions of greater GSV.

It was confirmed that the site location and reconstructed site extent are not located in the Study Area, but are about 20 metres south of the Lot 2 DP880413 southern cadastral boundary. It was noted that the southern paddock boundary fence does not follow the Lot 2 DP880413 cadastral boundary, but is located approximately 40 metres to the south.

Figure 3-5: Photographs from Kelton (1995) and a current overview of the K-OS-2 site location.

	
1. Photograph taken by Kelton (1995) showing an overview of the site location, facing west.	2. Photograph of the K-OS-2 site location taken during the visual inspection, facing west, showing limited GSV and intensive grass cover. This photograph appears to have been taken in a similar location and orientation to photograph 1. The shrub in the foreground (left) of photograph 1 appears to have been removed and the vehicle track that contains the site rerouted to follow the fence line.

K-OS-3 (#36-1-0188)

AHIMS ID: 36-1-0188

Site Type: Open site (artefact scatter, PAD)

Location of Site: According to the site card, K-OS-3 is located approximately 5.5 kilometres southeast of the Dubbo CBD; 600 metres south of the property entrance gates off Sheraton Road; 200 metres north northwest of a north-south to east-west bend in Sheraton Road and 80 metres north of Eulomogo Creek. The site extent contains a low voltage powerline pole (number: 6284-820) in the northeast corner and an ephemeral drainage line and earthen dam in the central parts (**Figure 2-8**).

Description of Site: According to Kelton (1995) and the site card, K-OS-3 is an extensive low-density artefact scatter located on a slightly elevated, gently sloping landform northwest of the confluence of Eulomogo Creek and an unnamed ephemeral drainage line. On the basis of visible surface artefacts, Kelton (1995: 38) determined that the site extent was roughly crescent-shaped, extending from the northern elevated bank of Eulomogo Creek in a northern and northeast direction, along the elevated northern and western banks and shoulders of the unnamed drainage line, within an approximately 90 by 90 metre area (**Figure 3-6**).

Kelton observed 37 stone artefacts and recorded 22 of them in five different areas of exposure. Artefacts included quartz, quartzite, chert and silcrete flakes, cores and debitage and a grinding stone (millstone) fragment. Kelton (1995) assessed the site as having potential to contain an extensive subsurface archaeological deposit in areas of minimal disturbance due to the high potential archaeological sensitivity of the landform and presence of surface archaeological material.

During the visual inspection, an attempt was made to locate the artefact scatter using a GPS receiver and focusing on the five areas where Kelton recorded artefacts. Site location coordinates were provided by AHIMS and verified against the site card maps and location description. The artefacts were unable to be located, probably due to intensive grass cover obscuring GSV (close to zero) in the vicinity of the site location. An earthen dam has been constructed within the site extent since the site was recorded (**Figure 3-7**) and has likely destroyed part of the site, including at least one area where Kelton recorded artefacts. It is nevertheless considered likely that artefacts are present within the remaining intact portions of the site and would be visible under conditions of greater GSV.

An updated site extent was delineated on the basis of Kelton's (1995) site description, landform potential and currently observed levels of site disturbance, including the construction of the earthen dam (**Figure 3-7**). The updated site extent is assessed as being a PAD on the basis of landform potential, levels of disturbance and presence of previously recorded artefacts.

Figure 3-6: Map showing the K-OS-3 (#36-1-0188) AHIMS site location and updated reconstructed site extent in relation to the Study Area.

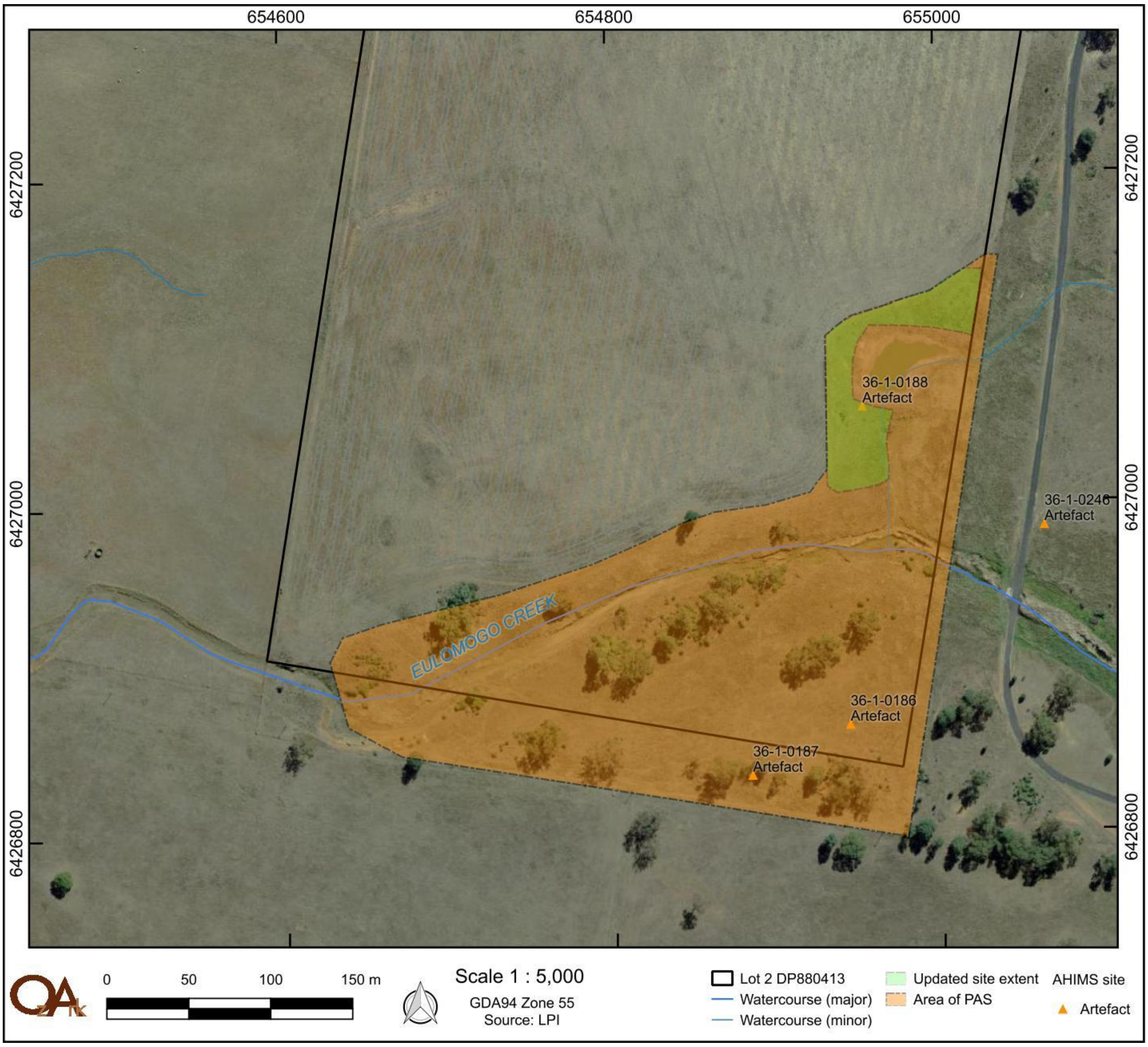
Figure 3-7: Photographs from Kelton (1995) and current views of the K-OS-3 site location.

	
1. Photograph taken by Kelton (1995) showing an overview of the site location, facing east.	2. Photograph taken by Kelton (1995) showing an overview of the site location, facing north.
	
3. Current photograph of the K-OS-3 site location in the northern part of the site, facing south, showing the earthen dam and nil GSV due to grass cover. This is one of the areas Kelton recorded artefacts.	4. Current photograph of the K-OS-3 site location in the southern part of the site, facing northeast, showing the earthen dam, dumped construction waste and limited GSV due to grass cover.
	
5. Current photograph of the K-OS-3 site location in the western part of the site, facing west, showing an area of exposure where Kelton recorded artefacts, with limited GSV due to grass cover.	6. Current photograph of the K-OS-3 site location in the southern part of the site, facing northwest, showing nil GSV due to grass cover.

3.3 AREA OF POTENTIAL ARCHAEOLOGICAL SENSITIVITY

In accordance with Kelton's (1995) assessment of the southern bank of Eulomogo Creek and creek flat, and an updated assessment of archaeological potential of the northern bank and associated gently sloping landforms, an area of PAS has been delineated as shown in **Figure 3-8**. This area is delineated on the basis of landform potential and the presence of previously recorded Aboriginal objects, sites and PAD. The area of PAS is delineated by: an approximately 30 metre buffer north of the Eulomogo Creek northern bank; the #36-1-0188 updated site extent; and the eastern and southern paddock fence lines. The area of PAS likely extends further east and south of the fence lines, but these areas are not within the Study Area and were therefore not assessed.

Figure 3-8: Map showing the Area of PAS in relation to the Study Area.



There is a moderate to high likelihood that additional Aboriginal objects and archaeological deposits exist in the area of PAS. If the area of PAS is to be impacted, a detailed archaeological investigation would be required to establish whether additional Aboriginal objects, sites and PADs exist – i.e. in addition to the objects, sites and PAD identified at AHIMS #36-1-0186, #36-1-0187 and #36-1-0188. Ideally, survey would be conducted when there is significantly more GSV than existed during the current visual inspection.

4 MANAGEMENT RECOMMENDATIONS

The Due Diligence archaeological assessment has taken into consideration the impacts of a proposed housing development that will disturb the ground surface. Two previously recorded AHIMS sites, one newly recorded Aboriginal site and an area of PAS have been identified and assessed within the Study Area. The assessment has concluded that Aboriginal objects or intact archaeological deposits are likely to be harmed by the Proposal. This moves the Proposal to the following outcome: 'further investigation and impact assessment' of the Study Area must be undertaken.

To ensure that the Aboriginal cultural heritage values of the Study Area are protected, the following recommendations are made:

1. Further investigation and impact assessment of the Study Area must be undertaken, including the preparation of an ACHAR, following the ACHCRs and adhering to the Code of Practice. If this assessment concludes that harm to Aboriginal objects will occur, then an AHIP application must be made.
2. Ground disturbing activities must not occur within the riparian zone or within the Study Area boundaries south of Eulomogo Creek. This will avoid harm to AHIMS #36-1-0186 and most of the area of PAS (**Figure 3-8**). Due to the close proximity to the Study Area, management of AHIMS #36-1-0187 may also be required during the proposed work to avoid inadvertently harming the site.
3. The establishment of a riparian zone around Eulomogo Creek has not avoided ground disturbing activities within the updated AHIMS #36-1-0188 site extent and PAD area (**Figure 3-6**) or within the northeast portion of the area of PAS (**Figure 3-8**). If ground disturbing work cannot be avoided in this area, test excavations in accordance with the Code of Practice will be required to establish whether an archaeological deposit exists in this area, with the results reported in an Archaeological Assessment Report or included in the ACHAR. Surface salvage of previously recorded artefacts and, possibly, salvage excavations will subsequently be required under an AHIP.
4. Harm to Hillview-IF1 has not been avoided and therefore surface collection of the artefact will be required under an AHIP.

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PLATES

Plate 1: View of survey unit 1 (crest of low hill on eastern boundary, northern paddock) facing north, showing disturbance around a water tank, gate and fence.

Plate 2: View of survey unit 2 (central area, flat bench, west of house and sheds) facing south, showing limited GSV and disturbance due to the installation of farming infrastructure.

Plate 3: View of survey unit 3 (gentle mid slope, east of house and sheds) facing west, showing good GSV and disturbance due to water tank installation, fencing and house construction.

Plate 4: View of survey unit 4 (northern bank of Eulomogo Creek and unnamed drainage line encompassing AHIMS #36-1-0188) showing very limited GSV due to grass cover.

Plate 5: View of survey unit 5 showing the northern bank of Eulomogo Creek, facing west, with very limited GSV due to grass cover.

Plate 6: View of survey unit 5 showing the southern bank and creek flat of Eulomogo Creek, facing southeast, with very limited GSV due to grass cover.

Plate 7: View of survey unit 5 showing the Eulomogo Creek bed, facing west.

Plate 8: View of survey unit 6 (crest of low hill overlooking Eulomogo Creek) facing east, showing very limited GSV.

Plate 9: View of the central Study Area facing east, showing disturbance around the house and sheds.

Plate 10: View of ploughed paddock in the northern portion of the Study Area, facing south.

Plate 11: View of ploughed paddock in the southern portion of the Study Area, north of Eulomogo Creek, facing southwest.

APPENDIX 1: AHIMS SEARCH RESULTS

Office of Environment & Heritage — NSW Government

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1545 Lot2DP880413#1

Client Service ID : 262045

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
36-1-0246	EC-OS-1;Eulomogo Creek;	AGD	55	654950	6426800	Open site	Valid	Artefact : -	Open Camp Site	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**	1276,1277	
36-1-0247	EC-OS-2;Eulomogo Creek;	AGD	55	655210	6426690	Open site	Valid	Artefact : -	Open Camp Site	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**	1276,1277	
36-1-0248	Eulomogo Creek (EC-OS-3)	GDA	55	656544	6427593	Open site	Valid	Artefact : -	Open Camp Site	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd,OzArk Environmental ar					**Permits**	1276,1277	
36-1-0249	EC-OS-4;Keswick South (Eulomogo);	AGD	55	656100	6428000	Open site	Valid	Artefact : -	Open Camp Site	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**	1276,1277	
36-1-0250	EC-OS-5; Keswick South (Eulomogo)	GDA	55	656662	6427183	Open site	Valid	Artefact : -	Open Camp Site	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd,OzArk Environmental ar					**Permits**	1276,1277	
36-1-0251	EC-OS-6; Keswick South (Eulomogo)	GDA	55	656726	6426485	Open site	Valid	Artefact : -	Open Camp Site	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd,OzArk Environmental ar					**Permits**	1276,1277	
36-1-0252	EC-ST-1; Keswick South (Eulomogo)	GDA	55	656559	6427271	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd,OzArk Environmental ar					**Permits**	1276,1277	
36-1-0253	EC-AG-2;Eulomogo Creek;	AGD	55	655150	6426670	Open site	Valid	Grinding Groove : -	Axe Grinding Groove	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**	1276,1277	
36-1-0254	EC-AG-1;Eulomogo Creek;	AGD	55	655380	6426870	Open site	Valid	Grinding Groove : -	Axe Grinding Groove	4378
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**	1276,1277	
36-1-0154	Old Dubbo Rd	AGD	55	653120	6425750	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders**	Katrina Geering					**Permits**		
36-1-0213	K-ST-6	AGD	55	653640	6428240	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	3350
	Contact	**Recorders**	Jim Kelton					**Permits**		
36-1-0179	Keswick-Scarred Tree-5 (K-ST-5)	GDA	55	653794	6429259	Open site	Destroyed	Modified Tree (Carved or Scarred) : -	Scarred Tree	3350
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd,OzArk Environmental ar					**Permits**	3873	
36-1-0180	K-ST-4	AGD	55	654590	6428590	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	3350
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**		

Report generated by AHIMS Web Service on 12/01/2017 for Chris Lovell for the following area at Datum :GDA, Zone : 55, Eastings : 652000 - 657000, Northings : 6425000 - 6430000 with a Buffer of 0 meters. Additional Info : Due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 26

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1545 Lot2DP880413#1

Client Service ID : 262045

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
36-1-0181	K-ST-3	AGD	55	654510	6428580	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	3350
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**		
36-1-0182	K-ST-2	AGD	55	654220	6428870	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	3350
	Contact	**Recorders**	Central West Archaeological and Heritage Services Pty Ltd					**Permits**		
36-1-0186	K-IF-2;	AGD	55	654830	6426680	Open site	Valid	Artefact : -	Isolated Find	3348
	Contact	**Recorders**	Jim Kelton					**Permits**		
36-1-0187	K-OS-2;	AGD	55	654770	6426650	Open site	Valid	Artefact : -	Open Camp Site	3348
	Contact	**Recorders**	Jim Kelton					**Permits**		
36-1-0188	K-OS-3;	AGD	55	654840	6426873	Open site	Valid	Artefact : -	Open Camp Site	3348,102800
	Contact	**Recorders**	Jim Kelton					**Permits**		
36-1-0189	K-OS-4;	AGD	55	653790	6426830	Open site	Valid	Artefact : -	Open Camp Site	3348
	Contact	**Recorders**	Jim Kelton					**Permits**		
36-1-0109	M16 Dubbo	AGD	55	652500	6425940	Open site	Valid	Modified Tree (Carved or Scarred) : 1	Scarred Tree	1065
	Contact	**Recorders**	N Franklin,Margrit Koettig,Rex Silcox					**Permits**		
36-1-0110	M17 Dubbo	AGD	55	652410	6425220	Open site	Valid	Modified Tree (Carved or Scarred) : 1	Scarred Tree	1065
	Contact	**Recorders**	N Franklin,Margrit Koettig,Rex Silcox					**Permits**		
36-1-0111	M18 Dubbo	AGD	55	651990	6425360	Open site	Valid	Artefact : 1000	Open Camp Site	1065
	Contact	**Recorders**	N Franklin,Margrit Koettig,Rex Silcox					**Permits**		
36-1-0665	DSD1 (RAAF-OS1)	GDA	55	652323	6429705	Open site	Valid	Artefact : 1		
	Contact	**Recorders**	Ms.Morgan Wilcox					**Permits**		
36-1-0666	RAAF-ST3	GDA	55	652764	6429580	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders**	Ms.Morgan Wilcox					**Permits**		
36-1-0667	Scarred Tree 1 (RAAF-ST1)	GDA	55	652642	6429881	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders**	Ms.Morgan Wilcox					**Permits**		

Report generated by AHIMS Web Service on 12/01/2017 for Chris Lovell for the following area at Datum :GDA, Zone : 55, Eastings : 652000 - 657000, Northings : 6425000 - 6430000 with a Buffer of 0 meters. Additional Info : Due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 26

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AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 1545 Lot2DP880413#1

Client Service ID : 262045

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
36-1-0668	Scarred Tree (RAAF-ST2)	GDA	55	652788	6429549	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders**	Ms.Morgan Wilcox					**Permits**		

Report generated by AHIMS Web Service on 12/01/2017 for Chris Lovell for the following area at Datum :GDA, Zone : 55, Eastings : 652000 - 657000, Northings : 6425000 - 6430000 with a Buffer of 0 meters. Additional Info : Due diligence assessment. Number of Aboriginal sites and Aboriginal objects found is 26

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Appendix H

ACOUSTIC REVIEW

Prepared By Muller Acoustic Consulting

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2 March 2018

MAC160254LR1

Attention: Steve Guy
Maas Group Properties
PO Box 404
Dubbo NSW 2830

Dear Steve,

Acoustic Technical Review of Cumulative Noise

Proposed South Keswick Quarry and Proposed Southern Distributor, Dubbo, NSW.

1 Introduction

Muller Acoustic Consulting Pty Ltd (MAC) has been commissioned by Maas Group Properties to prepare an Acoustic Technical Review (ATR) of cumulative noise emissions to the proposed Southlake Estate residential subdivision (the 'subdivision'). The cumulative noise assessment includes emissions from the proposed South Keswick Quarry (the 'quarry') and road traffic noise emissions from the proposed Southern Distributor (the 'distributor').

This letter report should be read in conjunction with historic reports prepared for both sites and include:

- *Noise and Vibration Impact Assessment, Proposed South Keswick Quarry Project, Environmental Impact Statement (Muller Acoustic Consulting Pty Ltd, 2016);* and
- Road Traffic Noise Assessment, Proposed Southlakes Estate, Dubbo NSW *(Muller Acoustic Consulting Pty Ltd, 2017).*

The letter report has been prepared to address a request from Dubbo Regional Council to show an acoustic impact map from both the quarry and the distributor operations.

2 Methodology

A computer model was developed to determine the acoustic impact of cumulative quarry and road noise emissions to future residential lots within the proposed subdivision. Brüel and Kjær Predictor Type 7810 (Version 11.10) noise modelling software was used to assess potential noise impacts associated with the quarry. A three-dimensional digital terrain map giving all relevant topographic information was used in the modelling process.

Additionally, the model uses relevant noise source data, ground type, shielding such as barriers and/or adjacent buildings and atmospheric information to predict noise levels at the nearest potentially affected receivers.

The model calculation method used to predict noise levels was in accordance with ISO 9613-1 'Acoustics - Attenuation of sound during propagation outdoors. Part 1: Calculation of the absorption of sound by the atmosphere' and ISO 9613-2 'Acoustics - Attenuation of sound during propagation outdoors. Part 2: General method of calculation'. As the road noise assessment metrics differ from industrial noise (ie quarry noise), a correction factor of -3dB was applied to road noise predictions. The correction factor is consistent with the approach taken in the recently released Noise Policy for Industry (EPA, 2017) for converting period noise levels to a fifteen-minute period. For this assessment the worst-case day assessment period noise levels have been reviewed.

Technical Note: Road noise is assessed as an $LA_{eq(15hr)}$ or $LA_{eq(9hr)}$ metric, while operational noise is assessed as an $LA_{eq(15min)}$.

Criteria for both noise sources also vary. Operational noise criteria from the quarry is 35dBA $LA_{eq(15min)}$, while the road noise criteria are 60dBA $LA_{eq(15hr)}$. The key reasons for the difference in criteria is outside the scope for this assessment, although are essentially governed by policy and take into account community expectations and tolerance of industrial noise compared to road noise.

3 Results and Discussion

The results of the cumulative noise model are shown in **Figure 1**. The figure shows quarry and distributor noise in isolation along with the cumulative noise from both sources. The results also show the noise contours for a mitigated scenario (ie a 2.8m barrier along the distributor boundary).

In summary, the noise levels for the subdivision are controlled by road traffic noise from the distributor, with only a negligible increase (<1dB) experienced adjacent to the distributor catchment when both sources are considered (ie logarithmic addition of the two sources). In general terms, once both projects are operational, road noise would mask quarry operations at these receivers.

It should be noted that the distributor road noise predictions are typical for this type of development and are generally mitigated by barriers or building treatments that focus on achieving internal design criteria. Conversely, the criteria for industry is based on external noise and is less reliant on achieving internal noise criteria.

4 Conclusion

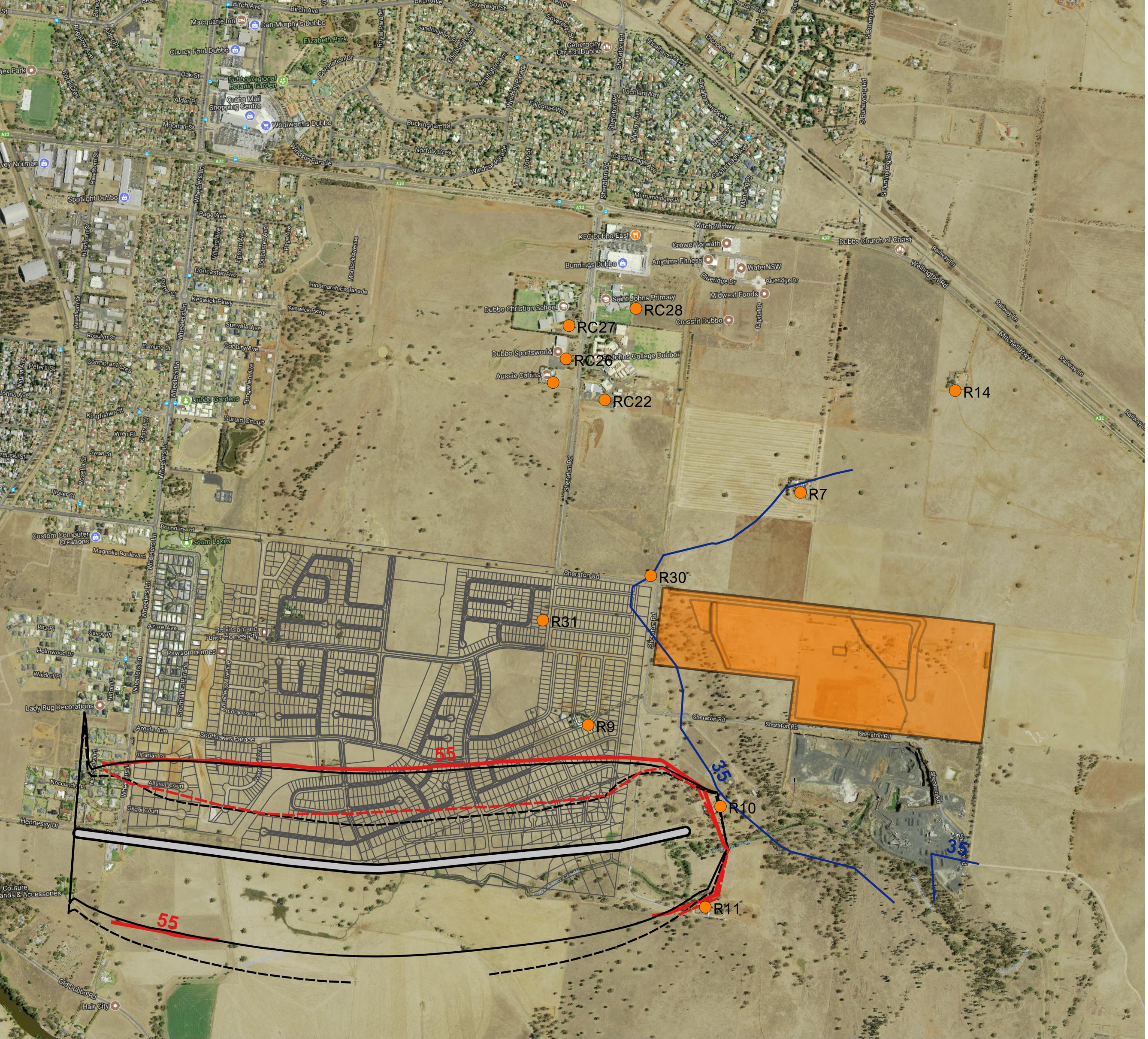
Muller Acoustic Consulting Pty Ltd (MAC) has completed an Acoustic Technical Review (ATR) of cumulative noise levels from South Keswick Quarry and road noise emissions from the proposed Southern Distributor.

The findings for the review identifies that the distributor is the acoustically dominant source of noise and the overall increase with both sites operating is less than 1dB. Generally, this would not be perceptible by residents and quarry noise would be masked by road noise from the distributor, and potentially inaudible.

We trust the above information is satisfactory and if you have any further questions regarding the review, please contact the undersigned.

Yours sincerely

Oliver Muller
Principal Acoustic Scientist
BSc(REM & HGeog)|MAAS
omuller@mulleracoustic.com



MAC
Muller Acoustic Consulting

FIGURE 1

PREDICTED CUMULATIVE NOISE LEVELS

REF: MAC160254

Legend

- Receivers
- Cumulative LAeq DAY
- Quarry LAeq DAY
- Sth Distributor LAeq DAY
- Cumulative LAeq DAY w/Barrier
- Sth Distributor LAeq DAY w/Barrier
- Southern Distrbutor
- Quarry

N

0 50 100 150 200 250 300 350 400 450 500 m

Appendix I

AIR QUALITY ASSESSMENT

Prepared by Pacific Environment Pty Ltd

Steve Guy
Maas Group Family Properties
SteveGuy@mgfp.com.au

8 March 2018

Dear Mr Guy,

South Keswick residential sub-division, – air quality assessment

Pacific Environment has been requested by Mr Steve Guy of Maas Group Family Properties (hereafter referred to as the Proponent) to provide an air quality assessment report for the proposed residential development at Sheraton Road, South Keswick, New South Wales (NSW).

We trust that this letter is adequate to meet your needs. Please do not hesitate to contact me should you require any further information.

Yours sincerely

Francine Manansala
Senior Consultant – Air Quality

Pacific Environment Pty Ltd – An ERM Company
309 Kent Street
Sydney, NSW, 2000
www.pacific-environment.com
Ph: +61 8584 8888

1 Background

The Proponent is seeking to complete a residential development (hereafter referred to as 'the Project') under a Development Application (DA) at Sheraton Road, South Keswick, NSW (see **Figure 1**). It is proposed that the Project would have a minimum lot size of 2,000 m^2.

The land use in the area surrounding the Project site is primarily rural with flat terrain. The Central Business District (CBD) of Dubbo is located approximately 4.2 km northwest of the Project site. The currently operating Holcim quarry is located approximately 500 m to the east of the Project. The most western boundary of the proposed South Keswick Quarry is located within 50 m of the Project.

The Proponent has requested that Pacific Environment prepare an Air Quality Impact Assessment (AQIA) to determine the potential for dust at the Project site. The main sources of dust in the area will be from the two aforementioned quarry operations as well as existing background levels (i.e. sources not generated from the quarries).

This report therefore assesses the potential dust impacts at the Project site.

Figure 1: Location of the Project site and nearby quarry operations

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1.1 AQIA for the South Keswick Quarry

Pacific Environment completed an AQIA for the proposed South Keswick Quarry in September 2017 (**Pacific Environment, 2017**).The study included emissions estimation and dispersion modelling of dust from the quarry in isolation and also a cumulative assessment which included dust generated by the Holcim quarry and other sources (i.e. background levels). Information such as production levels and activity data for the South Keswick Quarry was provided by the Proponent for modelling. The maximum extraction rate for the Holcim Quarry was taken from the Environmental Protection Licence (EPL) and used for modelling.

It was established that air quality on and surrounding the South Keswick Quarry was likely to be similar to other rural areas in NSW. As such, data from the Office of Environment and Heritage (OEH) stations at Tamworth, Bathurst, Albury and Wagga Wagga North for 2015 were used to determine background levels of particulate matter for the cumulative assessment. Background levels of TSP and dust deposition were determined using historical data collected at Toongi.

The study assessed the local meteorology surrounding the quarry. Meteorological data from the Bureau of Meteorology's (BoM) for 2015 was used in the modelling.

The AQIA also provided a semi-quantitative construction dust assessment. The assessment also outlined the proposed dust control measures for the quarry.

The South Keswick Quarry AQIA used dispersion modelling to assess two future operational scenarios – 'Scenario 1' and 'Scenario 2'. These scenarios were considered to be representative of worst case operations as they included maximum production levels and locations where operations were located closest to sensitive receivers. Concentrations of total suspended particulates (TSP), PM_{10} (particulate matter 10 micrometres or less in diameter) and $PM_{2.5}$ (particulate matter 2.5 micrometres or less in diameter) were predicted for both scenarios. Dust deposition levels were also predicted. The assessment included contour plots and predictions made at sensitive locations (e.g. residences) surrounding the quarries. Of the 32 receptors assessed, one was applicant-owned, one was a proposed photovoltaic power plant and four were receptors proposed for the future. These receptors are shown below on Figure 2. Receptor R9 and future or 'potential' receptor P23 represent locations at the Project.

The modelling results from the South Keswick Quarry AQIA will form the basis of discussion for the Project.

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Figure 2: Sensitive receptors assessed in the South Keswick Quarry AQIA

2 Assessment of impacts

2.1 Introduction

Dispersion model predictions made for Scenarios 1 and 2 of the South Keswick Quarry AQIA and are presented in the sections below. The location of the Project has been overlayed on the contour plots for reference. Cumulative results (i.e. South Keswick Quarry, Holcim Quarry and background) have been shown here only. Tabulated results at sensitive receptors from the South Keswick Quarry AQIA have been replicated here.

2.2 Annual average TSP

Figure 3 and **Figure 4** present the predicted annual average TSP concentrations from the cumulative sources in South Keswick Quarry's AQIA Scenarios 1 and 2. **Table 1** presents the cumulative TSP results at sensitive receptor locations assessed in the South Keswick Quarry AQIA. As discussed previously, receptors in locations representing the Project are R9 and P23.

The results show that predicted annual average TSP concentrations at the Project site are below the impact assessment criterion of 90 µg/m^3 in Scenarios 1 and 2.

Table 1: Annual average TSP concentrations from cumulative sources (µg/m^3)

Receiver ID	South Keswick Quarry AQIA Scenario 1 - Proposal and other sources	South Keswick Quarry AQIA Scenario 2 - Proposal and other sources
	Annual average TSP (µg/m^3)	
	Assessment criterion = 90 µg/m^3	
R1*	29	23
R3	19	19
R4	19	19
R7	20	20
P8a	20	21
P8b	21	21
P8c	20	20
R9	20	20
R10	21	21
R11	20	20
R14	19	19
R15	19	19
R18	19	19
R19	19	19
R20	19	19
R22	20	20
P23	20	20
R24	19	19
R26	19	19
R27	19	19
R28	19	19
R32	25	22

* Applicant-owned property

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Species: TSP	Location: South Keswick	Scenario: South Keswick Quarry AQIA Scenario 1	Percentile: N/A	Averaging Time: Annual
Model Used: AERMOD v9.1	**Units:** µg/m³	**Criterion:** 90 µg/m³	**Met Data:** 2015	**Plot:** F. Manansala

Figure 3: Predicted annual average TSP concentrations from the cumulative sources – South Keswick Quarry AQIA Scenario 1

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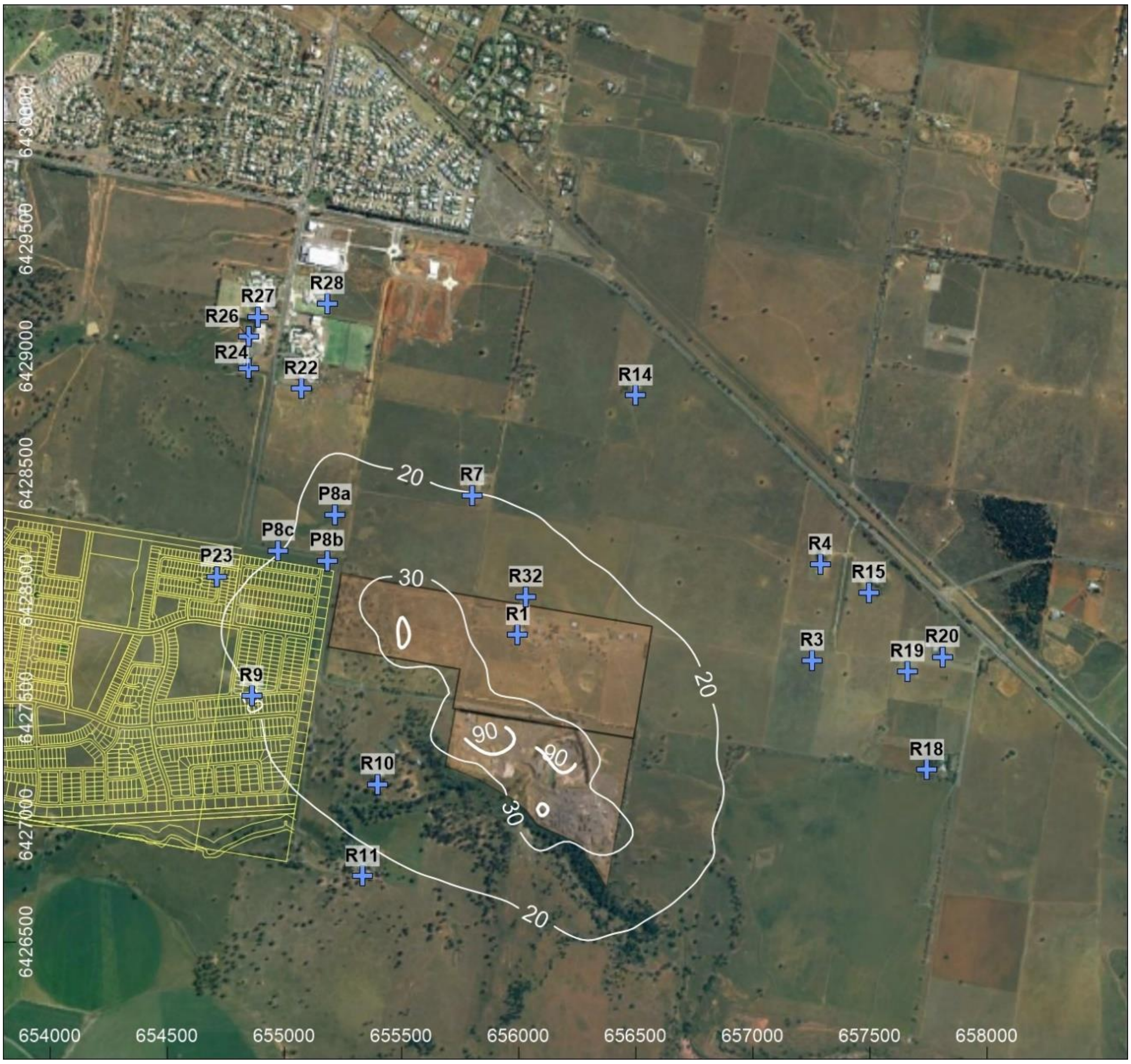

Species: TSP	**Location:** South Keswick	**Scenario:** South Keswick Quarry AQIA Scenario 2	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: AERMOD v9.1	**Units:** µg/m³	**Criterion:** 90 µg/m³	**Met Data:** 2015	**Plot:** F. Manansala

Figure 4: Predicted annual average TSP concentrations from the cumulative sources – South Keswick Quarry AQIA Scenario 2

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2.3 Annual average PM_{10}

Figure 5 and **Figure 6** present the predicted annual average PM_{10} concentrations from the cumulative sources in South Keswick Quarry's AQIA Scenarios 1 and 2. **Table 2** presents the cumulative PM_{10} results at sensitive receptor locations assessed in the South Keswick Quarry AQIA. Receptors in locations representing the Project are R9 and P23.

The results show that predicted annual average PM_{10} concentrations at the Project site are below the impact assessment criterion of 25 µg/m³ in Scenarios 1 and 2.

Table 2: Annual average PM_{10} concentrations from cumulative sources (µg/m³)

Receiver ID	South Keswick Quarry AQIA Scenario 1 - Proposal and other sources	South Keswick Quarry AQIA Scenario 2 - Proposal and other sources
	Annual average PM_{10} (µg/m³)	
	Assessment criterion = 25 µg/m³	
R1*	23	20
R3	17	17
R4	17	17
R7	18	18
P8a	18	18
P8b	19	19
P8c	18	18
R9	18	18
R10	18	19
R11	18	18
R14	17	17
R15	17	17
R18	17	17
R19	17	17
R20	17	17
R22	18	18
P23	18	18
R24	17	18
R26	17	17
R27	17	17
R28	17	17
R32	21	20

* Applicant-owned property

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Species:	Location:	Scenario:	Percentile:	Averaging Time:
PM_{10}	South Keswick	South Keswick Quarry AQIA Scenario 1	N/A	Annual
Model Used:	**Units:**	**Criterion:**	**Met Data:**	**Plot:**
AERMOD v9.1	μg/m^3	25 μg/m^3	2015	F. Manansala

Figure 5: Predicted annual average PM_{10} concentrations from the cumulative sources – South Keswick Quarry AQIA Scenario 1

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Species: PM10	Location: South Keswick	Scenario: South Keswick Quarry AQIA Scenario 2	Percentile: N/A	Averaging Time: Annual
Model Used: AERMOD v9.1	**Units:** µg/m³	**Criterion:** 25 µg/m³	**Met Data:** 2015	**Plot:** F. Manansala

Figure 6: Predicted annual average PM_{10} concentrations from the cumulative sources – South Keswick Quarry AQIA Scenario 2

2.4 Annual average $PM_{2.5}$

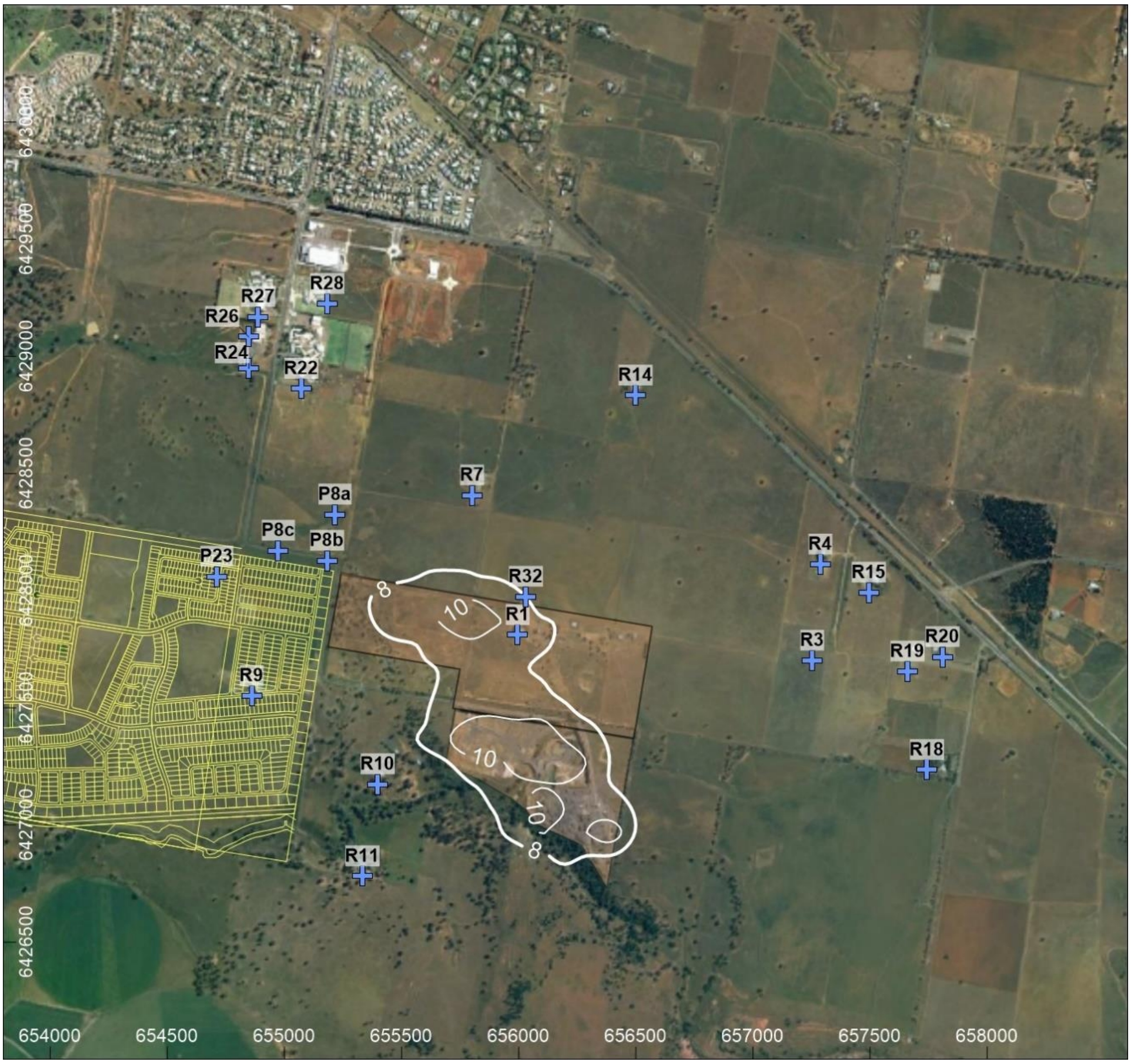
Figure 7 and **Figure 8** present the predicted annual average $PM_{2.5}$ concentrations from the cumulative sources in South Keswick Quarry's AQIA Scenarios 1 and 2. **Table 3** presents the cumulative $PM_{2.5}$ results at sensitive receptor locations assessed in the South Keswick Quarry AQIA. Receptors in locations representing the Project are R9 and P23.

The results show that predicted annual average $PM_{2.5}$ concentrations at the Project site are below the impact assessment criterion of 8 µg/m³ in Scenarios 1 and 2.

Table 3: Annual average $PM_{2.5}$ concentrations from cumulative sources (µg/m³)

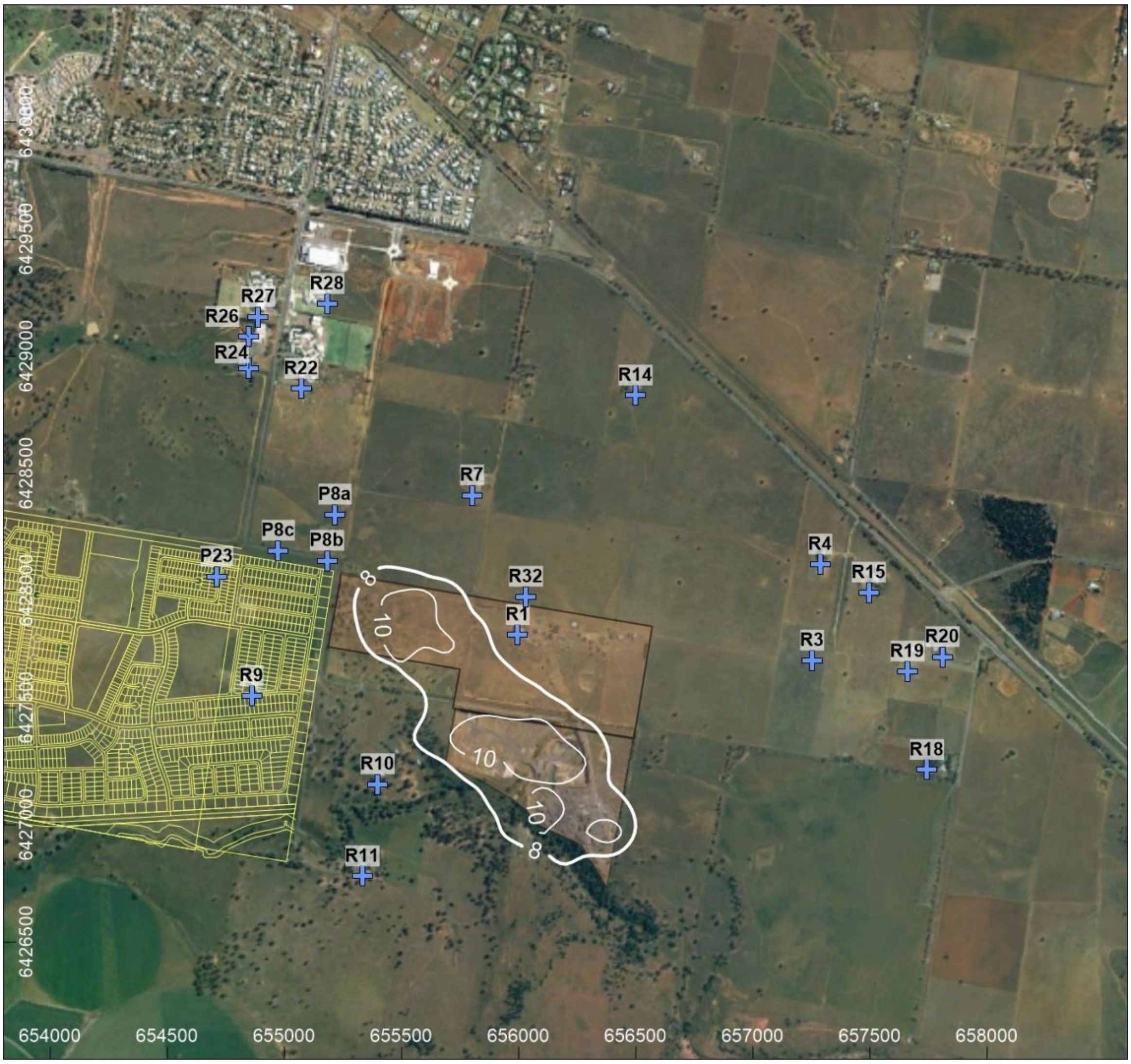
Receiver ID	South Keswick Quarry AQIA Scenario 1 - Proposal and other sources	South Keswick Quarry AQIA Scenario 2 - Proposal and other sources
	Annual average $PM_{2.5}$ (µg/m³)	
	Assessment criterion = 8 µg/m³	
R1*	8	8
R3	7	7
R4	7	7
R7	7	7
P8a	7	7
P8b	7	7
P8c	7	7
R9	7	7
R10	7	7
R11	7	7
R14	7	7
R15	7	7
R18	7	7
R19	7	7
R20	7	7
R22	7	7
P23	7	7
R24	7	7
R26	7	7
R27	7	7
R28	7	7
R32	8	7

* Applicant-owned property



Species: PM$_{2.5}$	Location: South Keswick	Scenario: South Keswick Quarry AQIA Scenario 1	Percentile: N/A	Averaging Time: Annual
Model Used: AERMOD v9.1	**Units:** µg/m^3	**Criterion:** 8 µg/m^3	**Met Data:** 2015	**Plot:** F. Manansala

Figure 7: Predicted annual average PM$_{2.5}$ concentrations from the cumulative sources – South Keswick Quarry AQIA Scenario 1



Species: $PM_{2.5}$	**Location:** South Keswick	**Scenario:** South Keswick Quarry AQIA Scenario 2	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: AERMOD v9.1	**Units:** µg/m³	**Criterion:** 8 µg/m³	**Met Data:** 2015	**Plot:** F. Manansala

Figure 8: Predicted annual average $PM_{2.5}$ concentrations from the cumulative sources – South Keswick Quarry AQIA Scenario 2

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2.5 Annual average dust deposition

Figure 9 and **Figure 10** present the predicted annual average dust deposition levels from the cumulative sources in South Keswick Quarry's AQIA Scenarios 1 and 2. **Table 4** presents the cumulative dust deposition results at sensitive receptor locations assessed in the South Keswick Quarry AQIA. Receptors in locations representing the Project are R9 and P23.

The results show that predicted annual average dust deposition levels at the Project site are below the impact assessment criterion of 4 $g/m^2/month$ in Scenarios 1 and 2.

Table 4: Annual average dust deposition levels from cumulative sources ($g/m^2/month$)

Receiver ID	South Keswick Quarry AQIA Scenario 1 - Proposal and other sources	South Keswick Quarry AQIA Scenario 2 - Proposal and other sources
	Annual average dust deposition ($g/m^2/month$)	
	Assessment criterion = 4 $g/m^2/month$	
R1*	3.4	2.6
R3	2.0	2.0
R4	2.0	2.0
R7	2.1	2.1
P8a	2.1	2.2
P8b	2.2	2.2
P8c	2.1	2.1
R9	2.1	2.1
R10	2.2	2.2
R11	2.1	2.1
R14	2.0	2.0
R15	2.0	2.0
R18	2.0	2.0
R19	2.0	2.0
R20	2.0	2.0
R22	2.1	2.1
P23	2.1	2.1
R24	2.0	2.0
R26	2.0	2.0
R27	2.0	2.0
R28	2.0	2.0
R32	3.0	2.4

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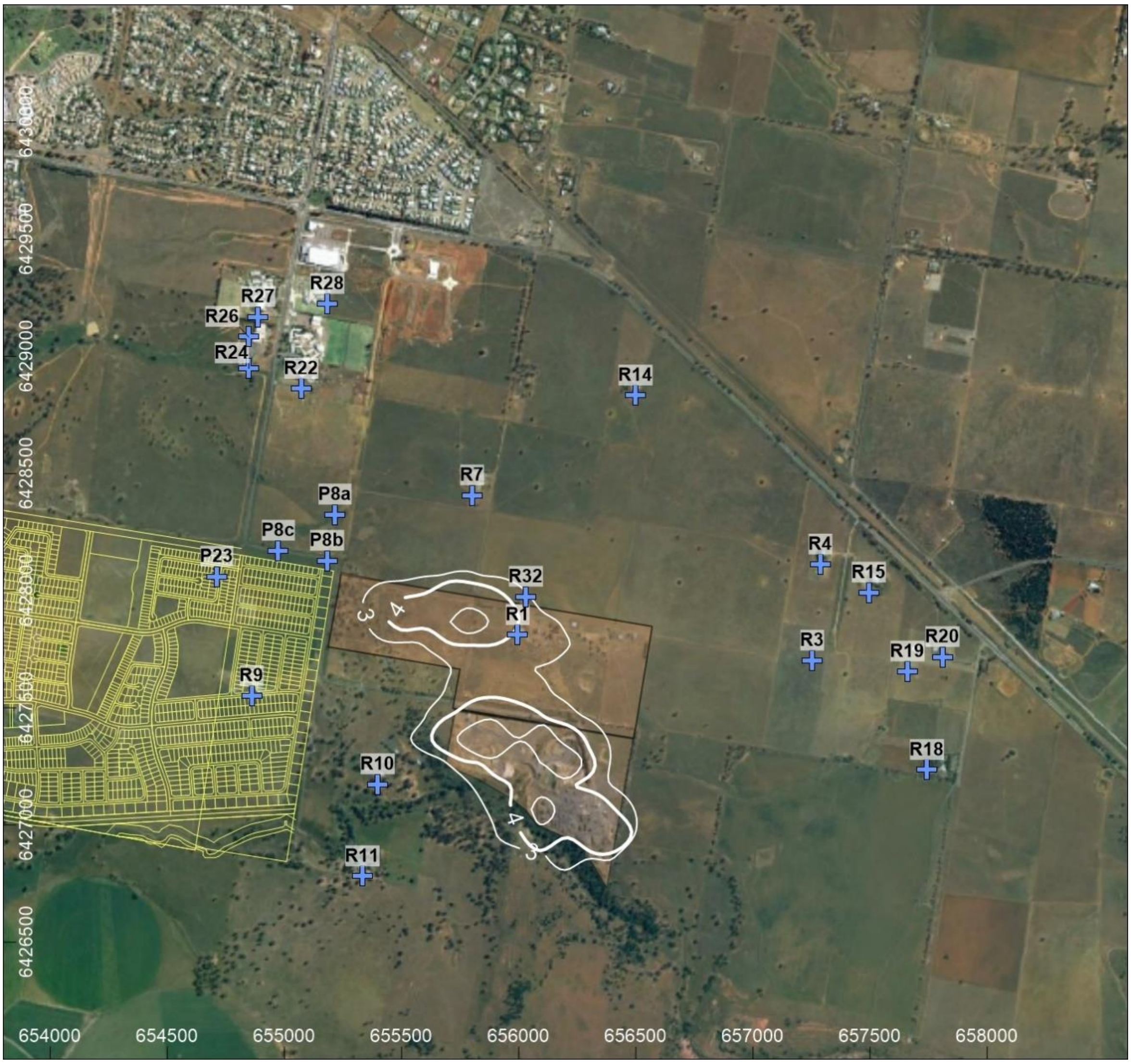
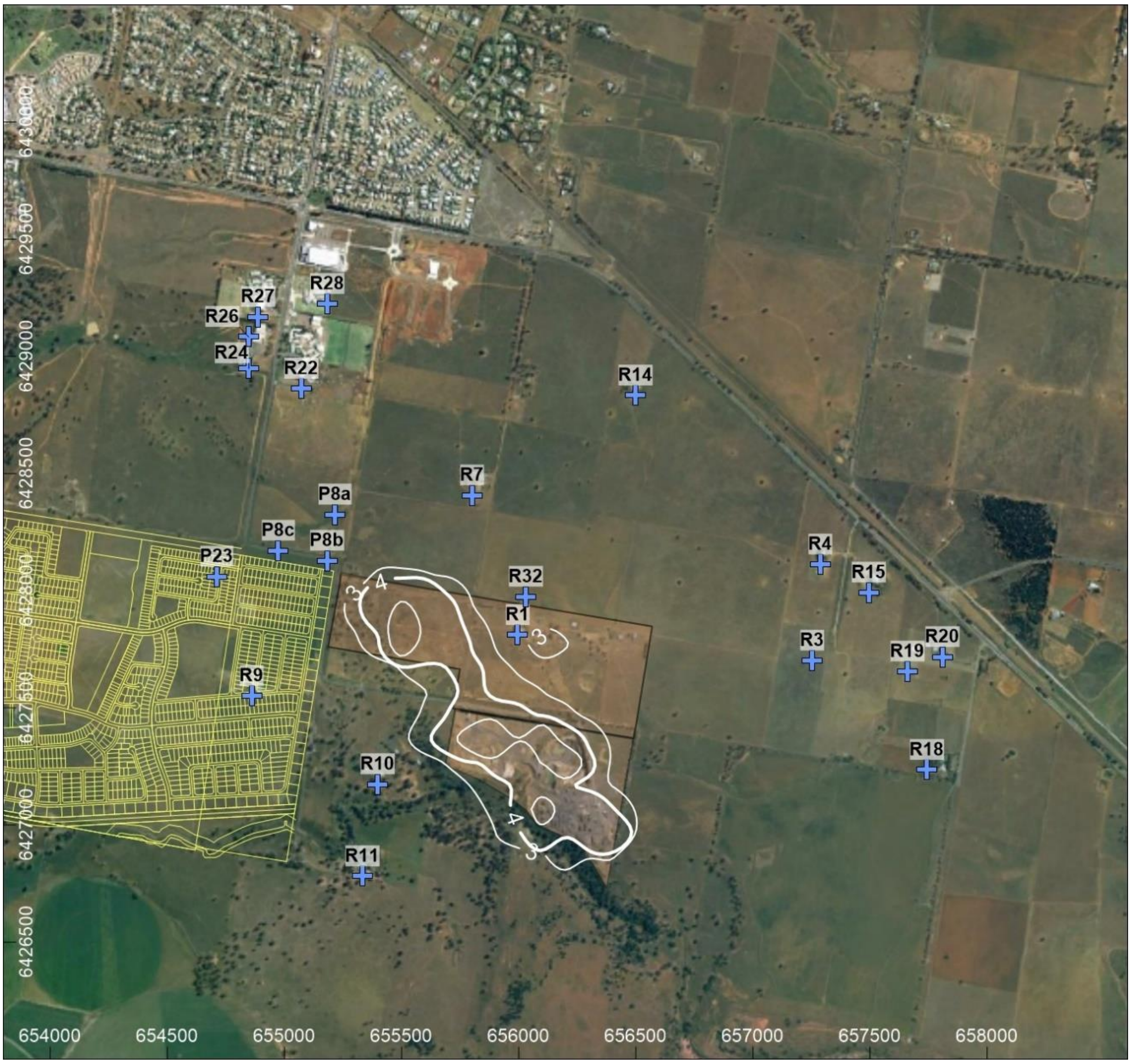


Species: Dust deposition	**Location:** South Keswick	**Scenario:** South Keswick Quarry AQIA Scenario 1	**Percentile:** N/A	**Averaging Time:** Annual
Model Used: AERMOD v9.1	**Units:** $g/m^2/month$	**Criterion:** $4\ g/m^2/month$	**Met Data:** 2015	**Plot:** F. Manansala

Figure 9: Predicted annual average dust deposition levels from the cumulative sources – South Keswick Quarry AQIA Scenario 1



Species: Dust deposition	Location: South Keswick	Scenario: South Keswick Quarry AQIA Scenario 2	Percentile: N/A	Averaging Time: Annual
Model Used: AERMOD v9.1	**Units:** g/m²/month	**Criterion:** 4 g/m²/month	**Met Data:** 2015	**Plot:** F. Manansala

Figure 10: Predicted annual average dust deposition levels from the cumulative sources – South Keswick Quarry AQIA Scenario 2

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2.6 Maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations

Table 5 and **Table 6** presents the cumulative maximum 24-hour average PM_{10} and $PM_{2.5}$ results respectively at sensitive receptor locations assessed in the South Keswick Quarry AQIA. Receptors in locations representing the Project are R9 and P23.

The results show that predicted maximum 24-hour average PM_{10} concentrations at the Project site are below the impact assessment criterion of 50 µg/m³ in Scenarios 1 and 2.

The predicted maximum 24-hour average $PM_{2.5}$ concentrations at the Project site are also below the impact assessment criterion of 25 µg/m³ in Scenarios 1 and 2.

Table 5: Maximum cumulative 24-hour average PM_{10} concentrations (µg/m³)

Receiver ID	South Keswick Quarry AQIA Scenario 1 - Proposal and other sources	South Keswick Quarry AQIA Scenario 2 - Proposal and other sources
	Maximum 24-hour average PM_{10} (µg/m³)	
	Assessment criterion = 50 µg/m³	
R1*	41	41
R3	39	39
R4	39	39
R7	39	40
P8a	39	39
P8b	39	39
P8c	39	39
R9	39	39
R10	39	39
R11	39	39
R14	40	39
R15	39	39
R18	39	39
R19	39	39
R20	39	39
R22	39	39
P23	39	39
R24	39	39
R26	39	39
R27	39	39
R28	39	39
R32	45	41

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Table 6: Maximum cumulative 24-hour average $PM_{2.5}$ concentrations (µg/m^3)

Receiver ID	South Keswick Quarry AQIA Scenario 1 - Proposal and other sources	South Keswick Quarry AQIA Scenario 2 - Proposal and other sources
	Maximum 24-hour average $PM_{2.5}$ (µg/m^3)	
	Assessment criterion = 25 µg/m^3	
R1*	19	19
R3	18	18
R4	18	18
R7	18	19
P8a	18	18
P8b	18	18
P8c	18	18
R9	18	18
R10	18	18
R11	18	18
R14	18	18
R15	18	18
R18	18	18
R19	18	18
R20	18	18
R22	18	18
P23	18	18
R24	18	18
R26	18	18
R27	18	18
R28	18	18
R32	20	19

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3 Conclusion

Pacific Environment has completed an air quality assessment for the proposed South Keswick Quarry residential sub-division located at Sheraton Road, South Keswick, NSW. The main sources of dust in the area will be from the proposed South Keswick Quarry and the existing Holcim quarry as well as existing background levels.

Pacific Environment completed an AQIA for the proposed South Keswick Quarry in September 2017 (**Pacific Environment, 2017**).The study included emissions estimation and dispersion modelling of dust from the quarry in isolation and also a cumulative assessment which included dust generated by the Holcim quarry and background sources. The South Keswick AQIA presented results as contour plots and at discrete sensitive receptor locations some of which are located at the Project site. The dispersion modelling results from the South Keswick AQIA have been used to determine potential air quality impacts on the Project site.

The results of the dispersion modelling indicate that the cumulative predicted annual average PM_{10}, TSP and dust deposition at the Project site are all predicted to comply with the impact assessment criteria.

The cumulative 24-hour assessment also showed that there were no receptors expected to experience maximum 24-hour cumulative PM_{10} and $PM_{2.5}$ concentrations above the impact assessment criteria.

References

Pacific Environment (2017)
South Keswick Quarry – Air Quality Assessment. Prepared for RW Corkery & Co Pty Ltd. September 2017.

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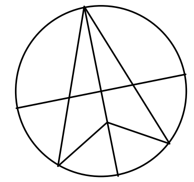

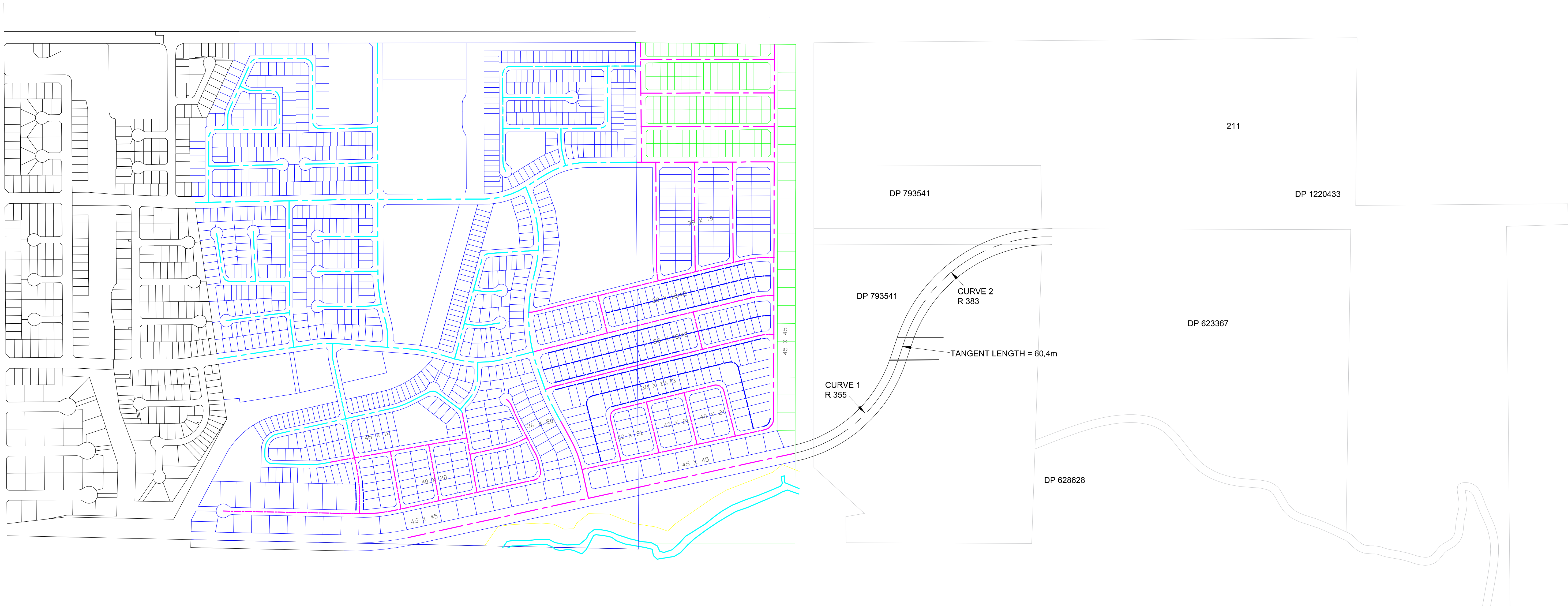

NOTE :

- AUSTROADS GUIDE TO ROAD DESIGN PART 3 : GEOMETRIC DESIGN HAS BEEN FOLLOWED FOR RADIUS OF CURVES, TANGENT LENGTH,SUPERELEVATION AND SIDE FRICTION .
- THE RADIUS OF CURVE HAS BEEN CROSS-CHECKED WITH FIGURE 7.9, PAGE 172 OF AUSTROADS 2016.
- ACCORDONG TO TABLE 7.6 ,PAGE 167 OF AUSTROADS GUIDE TO ROAD DESIGN, MINIMUM RADIUS OF CURVE FOR URBAN ROADS IS 354m WHEN SUPERELEVATION IS 5% AND DESIGN SPEED IS 90km/hr.
- MAXIMUM SUPERELEVATION , e_{max}= 5% (AS PER TABLE 7.6 , AUSTROADS 2016) HAS BEEN CONSIDERED.
- OPERATING SPEED =90 km/hr (AS PER TABLE 7.6 AUSTROADS 2016) HAS BEEN CONSIDERED.
- f_{max} HAS BEEN TAKEN FROM TABLE 7.5, PAGE 167 AUSTROADS 2016.
- EQUATION 5, PAGE 157 AUSTROADS 2016 HAS BEEN USED FOR CALCULATION.
- SECTION 7.5.3 OF AUSTROADS HAS BEEN CONSIDERED FOR TANGENT LENGH.
- AS PER FIGURE 7.3, PAGE 160 0F AUSTROADS , MINIMUM TANGENT LENGTH BETWEEN TWO REVERSE CURVE IS 54m WHEN VEHICLE TRAVELING AT 90km/hr.
- ACCORDING TO SECTION 7.5.3 OF AUSTROADS , REVERSE TRANSITION CURVE CONNECTED WITH TANGENT HAS BEEN CONSIDERED.

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NO	DATE	CHECKED	PM	DETAILS
A			DW	PLANNING PROPOSAL
B				
C				
D				

SCALE 1:125 (A1)

0 10 20 30 40 50

SCALE 1:250 (A3)

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DRAWINGS

PROPOSED FREIGHT WAY ALIGNMENT

PROJECT NUMBER	DRAWING NUMBER	SIZE
114135	114135_C1	A3
SURVEY MARK	RL	DATUM A.H.D.
STATUS : P.P. SUBMISSION	SHEET: C01 0F C01	REVISION: 0

LANDSCAPE MASTER PLAN

* ALL DIMENSIONS ARE TO BE CONFIRMED BY THE BUILDER PRIOR TO CONSTRUCTION.
DO NOT SCALE FROM DRAWINGS.
BUILDING SET OUT & SITE BOUNDARY DETAILS TO BE CONFIRMED BY A REGISTERED SURVEYOR.
ALL WORK TO BE CARRIED OUT TO RELEVANT STANDARDS AND BUILDING CODES.

DATE: 31/03/17	SCALE: N.T.S.	DRAWN: AS	DRAWING: SOUTHLAKES MASTERPLAN
SHEET 01 OF 1	DRAWING 150317	ISSUE: C	

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