



# **Douglas Partners**

*Geotechnics | Environment | Groundwater*

Report on  
Preliminary Geotechnical Assessment

Proposed Residential Subdivision,  
Lots 99 and 100 D.P. 1243071, Gurner Avenue,  
Austral, NSW

Prepared for  
Landcom

Project 94562.00  
November 2019

Integrated Practical Solutions



## Document History

### Document details

Project No.	94562.00	Document No.	R.001.Rev1
Document title	Report on Preliminary Geotechnical Assessment Proposed Residential Subdivision		
Site address	Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW		
Report prepared for	Landcom		
File name	94562.01.R.001.Rev1		

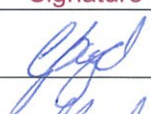

### Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	Gavin Boyd	Michael J Thom	13 November 2019
Revision 1	Gavin Boyd	Michael J Thom	22 November 2019

### Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Rosemary Hooper, Landcom
Revision 1	1	0	Rosemary Hooper, Landcom

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

Signature	Date
Author 	22 November 2019
Reviewer  MJT	22 November 2019



FS 604853

Douglas Partners Pty Ltd  
 ABN 75 053 980 117  
[www.douglaspartners.com.au](http://www.douglaspartners.com.au)  
 43 Hobart Street  
 Riverstone NSW 2765  
 PO Box 267  
 Riverstone NSW 2765  
 Phone (02) 4666 0450

## Executive Summary

This report presents the results of a preliminary geotechnical assessment undertaken by Douglas Partners Pty Ltd (DP) for Landcom at Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW.

DP understands that Landcom requires the preliminary geotechnical assessment to inform due diligence, planning and design of the proposed redevelopment of the site. DP also understands that the development will provide a mixture of low density residential and apartment buildings and is intended to improve the supply of affordable, innovative and diverse housing in the area. This may change, therefore, and to provide Landcom with flexibility, this assessment assumes that a general low density residential redevelopment is proposed and basement car parking may be included.

The study included a review of previous geotechnical investigations undertaken by DP near the subject site, published geological maps, and a site walkover. A summary of the findings from the desktop review and site walkover are provided in this report, together with preliminary comments relating to design and construction issues. No intrusive sampling or testing was conducted so the advice given is limited to experience in the area.

Based on available information, a site walkover and geological mapping, the interpreted geotechnical model for the site is likely to comprise a topsoil layer overlying fill and natural soils. Natural soils are expected to be moderately to highly reactive alluvial and residual clays to depths ranging from 1 m to 4 m with the depth increasing with proximity to the creeks. Bedrock is expected to be shale and progressively increase in strength with depth.

Groundwater seepage is expected at the soil/rock interface and along bedding planes and joints within the rock. Groundwater levels could change with variations in climatic conditions. Based on the local topography, groundwater is anticipated to flow downslope towards the creeks.

The report includes comments on excavation conditions, earthworks, foundations, pavements and salinity. The following preliminary comments are provided on some significant comments provided below:

- Excavation to depths of up to say 1.5 m, is expected to be within fill soils, natural soils soil and possibly very low to low strength rock which should generally be achievable using conventional earthmoving equipment.
- It is generally expected that the excavation will need to be supported by a retaining structure both during construction and as part of the final structure.
- Recommendations on site preparation measures and earthworks are provided for site development and placement of controlled fill.
- Site Classifications in accordance with AS2870 "Residential Slabs and Footings" (2011) have been provided. It is expected that where natural clay soils are within 1 m of the surface that site classifications of Class M to H1 will be appropriate. In deeper clay soil areas site classifications of Class H1 and H2 will probably be appropriate. Investigation will be required both prior to and following bulk earthworks to confirm lot classifications.
- It is likely that most footings could be founded in stiff to very stiff natural clays with an allowable base bearing pressure of 150 kPa. Where shale is exposed at founding level or piles are drilled then footings could be proportioned for an allowable base bearing pressure of at least 500 kPa.

- Pavements in the area with a compacted clay soil subgrade, are generally designed with a California bearing ratio (CBR) in the range of 2 % to 5 %.
- The site is located in an area known to include saline soils, highly sodic soils and dispersive or erodible soils. The 'bare soils' evident on-site may be evidence of these saline or sodic conditions. Saline or sodic soils are not considered significant impediments to the proposed development but will require appropriate remediation or management techniques. Typical management techniques have been provided.



## Table of Contents

	Page
1. Introduction.....	1
2. Site Description .....	1
3. Geological Mapping .....	2
3.1 Geology.....	2
3.2 Soil Landscape .....	2
3.3 Hydrology and Hydrogeology .....	3
3.4 Acid Sulfate Soils .....	3
3.5 Salinity Potential .....	4
4. Site History .....	5
4.1 Aerial Photographs .....	5
4.2 Previous Investigation.....	6
5. Site Walkover .....	7
6. Geotechnical Model .....	8
7. Proposed Development.....	8
8. Comments .....	8
8.1 General .....	8
8.2 Site Preparation and Earthworks .....	9
8.2.1 Excavation Conditions .....	9
8.2.2 Subgrade Preparation .....	9
8.3 Excavation Support.....	10
8.4 Foundations .....	10
8.5 Pavements .....	11
8.6 Salinity .....	11
8.7 Geotechnical Investigation.....	12
<b>9. Limitations .....</b>	<b>12</b>
 Appendix A: About This Report	
Appendix B: Drawings	
Appendix C: Site Photographs	

# **Report on Preliminary Geotechnical Assessment**

## **Proposed Residential Subdivision**

### **Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW**

---

## **1. Introduction**

Douglas Partners Pty Ltd (DP) was commissioned by Landcom to undertake a preliminary geotechnical assessment to inform the proposed residential redevelopment of Lots 99 and 100 Deposited Plan (D.P.) 1243071, Gurner Avenue, Austral, NSW (the site). The site location and layout is shown on Drawing 1 (Appendix B).

DP understands that Landcom requires the preliminary geotechnical assessment to inform due diligence, planning and design of the proposed redevelopment of the site. DP also understands that the development will provide apartment buildings and is intended to improve the supply of affordable, innovative and diverse housing in the area. This may change, therefore, and to provide Landcom with flexibility, this assessment assumes that a general low density residential redevelopment is proposed and basement car parking may be included.

The study included a review of previous geotechnical investigations undertaken by DP near the subject site, published geological maps, and a site walkover. A summary of the findings from the desktop review and site walkover are provided in this report, together with preliminary comments relating to design and construction issues. No intrusive sampling or testing was conducted so the advice given is limited to experience in the area.

This report was carried out concurrently with a Preliminary Site (Contamination) Investigation (Project 94562.00.R.001) which has been reported separately.

## **2. Site Description**

The site is approximately 50.9 hectares (ha) and is located within the Local Government Area of Liverpool City Council. The site is formally registered as Lots 99 and 100 on Deposited Plan (D.P.) 1243071. The site layout and lot boundaries are shown on Drawing 1, Appendix B.

The site is an irregular shaped parcel of land located on the northern site of Gurner Avenue with a narrow strip fronting Gurner Avenue in the south. A Transgrid substation is located immediately north west of the site and electrical metal pylons traverse north east – south west across the western portion of the site. A Sydney Water wastewater pump station (pump reference SP1190) is located in the north central portion of the site and is excluded from the assessment area. A Jemena gas substation is located near the south east corner of the site (within the site area).

The site within a largely rural setting, adjacent to residential and agricultural properties and generally comprises bushland and open fields. A creek traverses across the eastern portion of the site and flows towards the north-west and ultimately flows into South Creek (further discussed in Section 2.6).

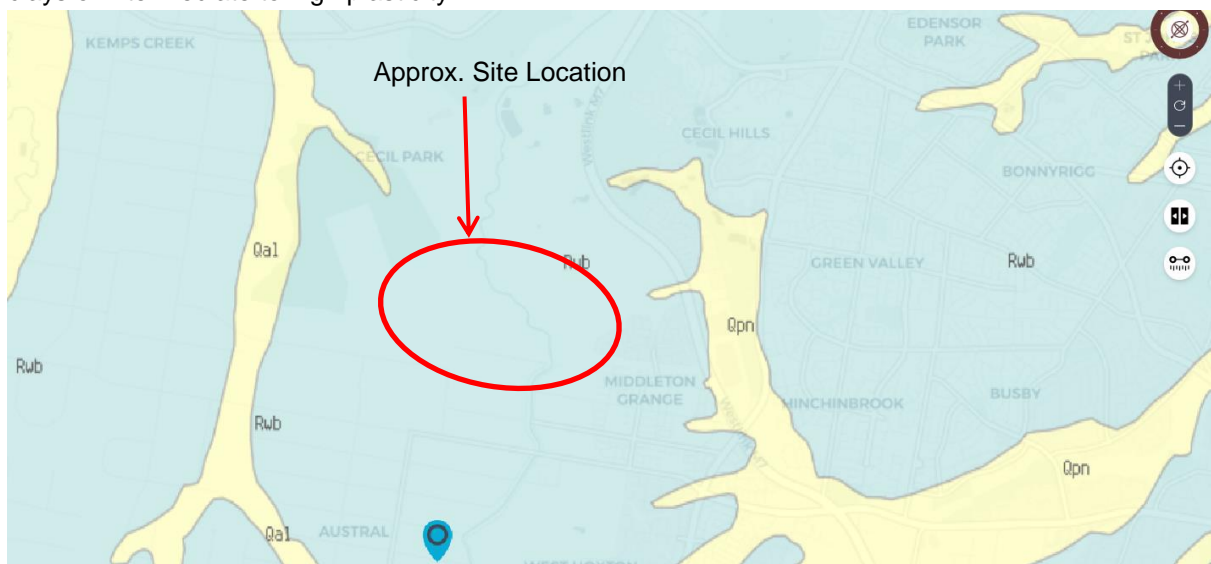
DP understands that the riparian corridor associated with the creek is to be retained as part of the development.

Regional topographic data indicates that the site topography ranges from 72 m relative to Australian Height Datum (AHD) in the eastern side of the site to 62 m AHD in the northern centre of the site, with the general topography of the site sloping towards the north east, with the exception of the far western corner which sloped towards the north-west and the eastern portion which slopes towards the west.

### 3. Geological Mapping

#### 3.1 Geology

Reference to the Geological Survey of New South Wales *Penrith 1:100 000 scale Geological Series Sheet 9030*, 1<sup>st</sup> Edition 1991 indicates that the site is underlain by Bringelly Shale of the Wianamatta Group of Triassic age. This formation typically comprises shale, carbonaceous claystone, claystone, laminite, fine to medium-grained lithic sandstone, rare coal and tuff which typically weather to form clays of intermediate to high plasticity.



**Figure 1: Excerpt of the Penrith 1:100 000 Geological Series**

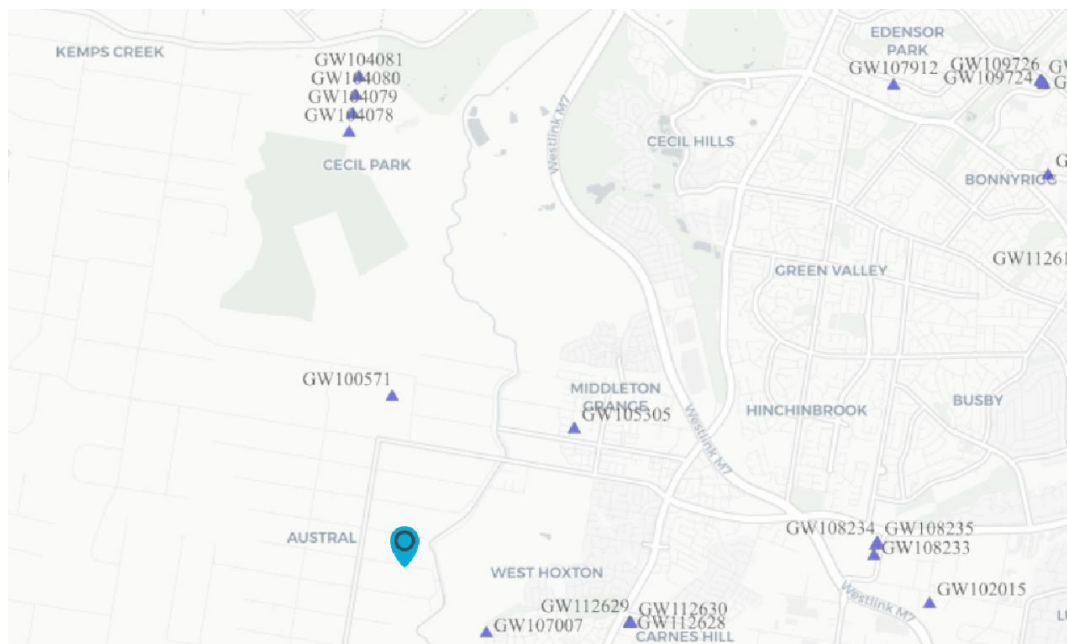
#### 3.2 Soil Landscape

Reference to the Soil Conservation Service of NSW, *Soil Landscapes of the Penrith 1:100 000 Sheet*, 1990 indicates that the site is located within the Blacktown soil landscape group. Blacktown soils comprise shallow to moderately deep red and brown podzolic soils on crests, upper slopes and well drained areas and deep yellow podzolic soils and soloths on lower slopes and in areas of poor drainage. Such soils are generally moderately reactive highly plastic subsoil, low soil fertility with poor soil drainage.

### 3.3 Hydrology and Hydrogeology

Two unnamed creeks are located on the site, one in the eastern portion of the site and the other in the western portion of the site. Both creeks flow towards the north west and ultimately into Kemps Creek 1.8 km north west of the site. Given the general topography of the site and the presence of on-site creeks, surface water is expected to flow towards both on-site creeks and towards the west (in the western portion) and the north west (in the centre and east). Upper Canal which flows between the Upper Nepean dams located south/south east of the site, from the south east towards the north west is located approximately 400 m east of the site.

A search for registered groundwater bores within 1 km radius from the site was undertaken and one bore was identified. The groundwater bore (GW100571) is indicated to be located 550 m south-east of the site and was drilled to 271 m below ground level with no details have been provided regarding well construction or water bearing zones. The bore was previously registered for farming purposes, however the licence for the well has been cancelled and subdivision work conducted on the location of the bore and therefore is most likely no longer present.



**Figure 3: Location of Registered Groundwater Wells**

The shale terrain of much of Western Sydney is known for saline groundwater, resulting either from the release of connate salt in shales of marine origin or from the accumulation of windblown sea salt. Seasonal groundwater level changes of 1.0 m to 2.0 m can occur in a shallow regolith aquifer or a deeper shale aquifer due to natural influences.

### 3.4 Acid Sulfate Soils

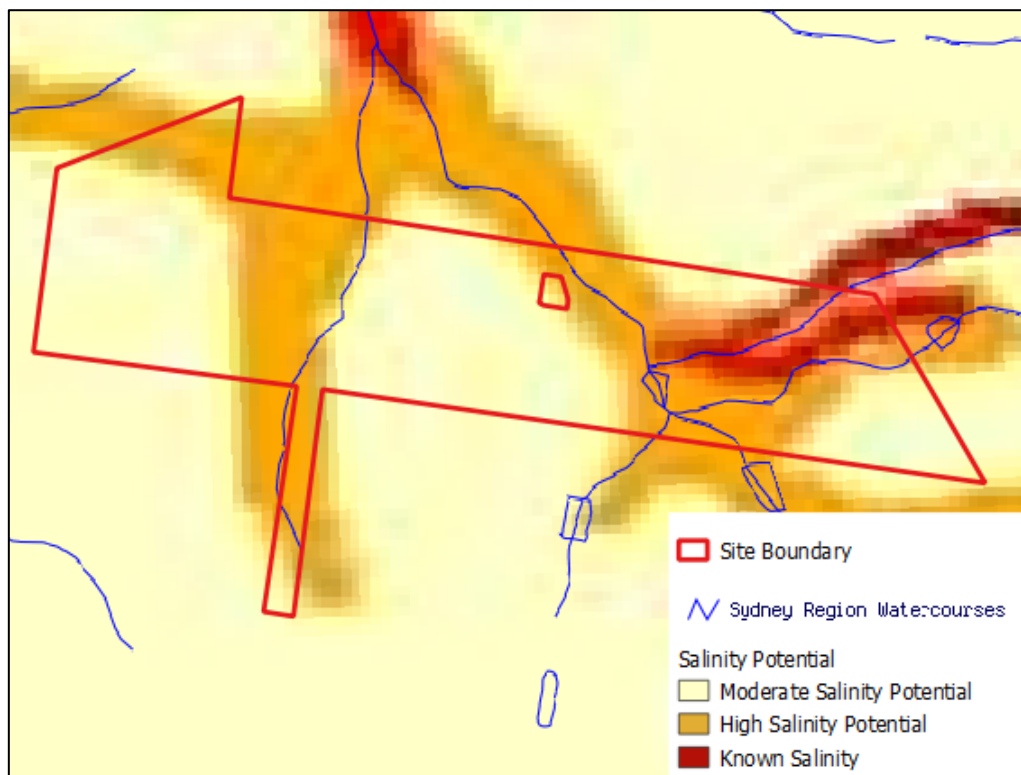
Reference to the Acid Sulfate Soil (ASS) mapping for the area indicates that the site is in an area of no known occurrence of ASS.

The NSW Acid Sulfate Soils Manual 1998 published by the Acid Sulfate Soils Advisory Committee (ASSMAC) indicates that ASS (and Potential Acid Sulfate Soils – PASS) normally occur in alluvial or estuarine soils below RL 5 m AHD although occasionally are encountered up to RL 12 m AHD. Considering the ASS mapping and given that the site soils are at site elevations above RL 62 m AHD, it is considered unlikely that ASS is present at the site.

### 3.5 Salinity Potential

Reference to the *Map of Salinity Potential in Western Sydney*, indicates that soil along the creeks on the site are mapped as having high salinity potential (orange areas) and known salinity (red areas). The salinity potential for the remainder of the site is mapped as having moderate salinity potential, i.e. saline soils may be present but have not yet been assessed.

These classifications are based on regional hydrology and landform geology and it is noted that due to the resolution at the scale of the mapping, it is not possible to delineate the zone boundaries with precision.



**Figure 2: Salinity potential based on regional mapping**

## 4. Site History

### 4.1 Aerial Photographs

Aerial photographs were from 1957, 1961, 1970, 1982, 1991 and 2002 were sourced from Spatial Services, NSW and reviewed to assist in identifying the history of the site and the surrounding area. Additionally, recent images from August 2015 and July 2019 were sourced from Nearmap<sup>1</sup>. The aerial photographs are shown on Drawings 2 to 10 (Appendix B) with a summary of the review provided in Table 1 below. Map Reference Points (MRP) discussed in Table 1 are shown on relevant drawings.

**Table 1: Summary of Aerial Photograph Review:**

Year of Aerial Photograph	Description of Site and Surrounding Area
1957 Drawing 2	<p>The site is vacant and mainly cleared of vegetation. Evidence of cultivation is visible in the north east portion of the site.</p> <p>The land surrounding the site is generally cleared of vegetation to the north, east and west, with sporadic patches of vegetation to the south, intermitted within cleared land for rural residential properties and low density farming and market gardens. Upper Canal and associated service roads are evident to the east.</p>
1961 Drawing 3	<p>The aerial photograph for 1961 shows the eastern two thirds of the site, but the westernmost part of the site is not included.</p> <p>The site has remained relatively unchanged with the exception of an increase of bush cover next to the creek in the eastern portion of the site. Smaller creeks are visible in the eastern portion of the site, likely flowing towards the creek (i.e. towards the west).</p> <p>The surrounding land generally remained unchanged with the exception of additional building structures and possible horticultural areas to the south.</p>
1970 Drawing 4	<p>The site appears to be relatively unchanged.</p> <p>Further vegetation clearing, market gardens, horticultural areas, a horse training track and additional structures are apparent to the south of the site.</p>
1982 Drawing 5	<p>The westernmost portion of the site is not shown on the available aerial photos for this period. Electrical metal pylons (MRP1 - high voltage 330 kV) are now evident on site in the same alignment as the present day. Associated service/construction roads (MRP2) are present on site along the north, east and western boundary of the site and following the same general alignment as current. The current access road to the Transgrid substation has been constructed running north-south on the western portion of the site. Potential ground disturbances and structures are noted in the south eastern portion of the site, likely associated with the current Jemena gas substation.</p> <p>Transgrid Kemps Creek Transmission Substation appears to be under construction to the north-west of the site. Further vegetation clearing and rural residential development is evident to the south of the site.</p>
1991	<p>Further electrical pylons / transmission towers are evident in the aerial photograph, but were most likely constructed prior to the prior 1982 aerial photograph as these are shown</p>

<sup>1</sup> <http://maps.au.nearmap.com/>. Last accessed 18 October 2019.



Year of Aerial Photograph	Description of Site and Surrounding Area
Drawing 6	in the portion of the site where photography was not available for 1982. Overall, the site and surrounding land appears relatively unchanged.
2002 Drawing 7	<p>The site has remained relatively unchanged, with the exception of a small structure and associated unpaved tracks running towards the north west and east in the eastern portion of the site.</p> <p>The surrounding land has remained relatively unchanged, however, some lots have had greenhouse areas constructed since the previous aerial photograph, likely used for horticultural purposes.</p>
2009 Drawing 8	The site and surrounding land appears to be relatively unchanged.
2015 Drawing 9	<p>The following site features are noted:</p> <ul style="list-style-type: none"> <li>• Ground disturbances/earth works and road construction were undergoing in associated with construction of the sewerage pump station on Lot 2 D.P. 1223501 (not included in the site boundary) in the centre of the site.</li> <li>• An additional structure is noted on the eastern boundary</li> <li>• A stockpile on the south-west corner.</li> <li>• Ground disturbance.</li> </ul> <p>The surrounding land appears relatively unchanged with the exception with the construction of Al-Faisal College to the south of the site.</p>
2019 Drawing 10	<p>The construction of the pump station on Lot 2 D.P. 1223501 has been completed. An additional service road is evident in the centre of the site. There are ground disturbances associated with subdivision earthworks to the south to the site.</p> <p>Land to the south east of the site has been cleared and appears to be in the progress of bulk earthworks for residential development. Al Faisal College has been constructed south west of the site.</p>

## 4.2 Previous Investigation

A previous geotechnical report has been carried out of a broader regional area which includes the subject site has been carried out by SMEC. The report titled “*Austral and Leppington North – Design of Water Management Infrastructure: Geotechnical Interpretive Report*” dated 24 January 2019 (Project No. 30011388).

Four test boreholes were carried out within the subject site as part of this investigation. These boreholes were drilled to 2.5 m depth at areas around the creek alignments which are considered typical of alluvial depositional environments. The results of the investigation indicated the following subsurface profile:

- Topsoil – 200 mm to 600 mm of silty clay.
- Alluvium – firm to still silty clay to depths of 1.1 m to 2.1 m.

- Residual clays – firm to very stiff to the limit of investigation at 2.5 m depth. One borehole noted the clay was extremely weathered shale from 2.2 m depth.

No free groundwater was observed during the investigation.

The following additional comments were provided in SMEC's report:

- Clay soils reactivity expected to be moderate to high.
- Soil aggressivity indicates that the soils are mostly non-aggressive to mildly aggressive to buried steel and concrete.
- Soil salinity is highly variable and ranges from non-saline to moderately saline.
- Soil dispersivity is generally high.
- Soil sodicity is generally moderate to high.

## 5. Site Walkover

A site walkover was carried out by a DP Senior Scientist, Ms Emily McGinty, on 24 September 2019 and key findings are outlined below:

- The site is predominantly used for agricultural purposes.
- The grass covering was variable in thickness but several areas had significant thickness (e.g. knee high) obscuring inspection in these areas.
- The riparian area next to the creeks were covered with thick low lying shrubbery. Fly tipping was visible in portions of the shrubbery, including discarded white goods, construction and demolition materials and domestic materials. Clay soils were exposed on the batter slopes of this creek and some minor erosion was evident where the clay was exposed
- Stockpiles and fly-tipping were observed at several locations across the site. Reference should be made to DP's PSI report for further details.
- Hummocky ground, often with associated longer grass, at several areas across the site.
- Cracking in the clay soils in the few areas where bare soils in the unformed dirt roads were exposed in unformed pavements. These soils are suspected to have been susceptible to progressive cycles of water saturation and drying with changing climatic conditions.
- Unformed dirt roads had evidence of wheel rutting at a few locations.
- No signs of efflorescence.
- The lower elevation areas do not appear to have efficient run-off areas and may be subject to water logging or saturation.
- No evidence of slope instability, however, localised areas of minor instability may be evident around creek sidewalls.

Select photographs are provided in Appendix C

## 6. Geotechnical Model

Based on available information, a site walkover and geological mapping, the interpreted geotechnical model for the site is likely to comprise:

- Topsoil: clayey soils containing roots and vegetation to variable depths but generally up 0.2 m;
- Fill: generally clay soils to depths of up to 0.5 m with localised deeper/thicker fill in the vicinity of the creek alignments, stockpiles and building areas assuming some cut and fill was required to form a near-level founding surface. It is also possible that the hummocky ground is associated with previous ploughing or other agricultural activities; overlying,
- Natural Soils: typically stiff to hard alluvial and residual clays, with some localised softer layers, to depths ranging from 1 m to 4 m, possibly deeper towards the lower elevations adjacent to the creeks. Soils around the creeks may also include sands and possibly gravels. Clay soils in the area are typically of medium to high plasticity and moderately to highly reactive, resulting in shrink or swell when the moisture content of the soil changes. Clay soils immediately above the bedrock are expected to be extremely weathered shale; overlying,
- Bedrock: initially very low to low strength weathered shale, possibly with some sandstone laminations, progressively increasing in strength and becoming less weathered with depth.

Groundwater seepage is expected at the soil/rock interface and along bedding planes and joints within the rock. Groundwater levels could change with variations in climatic conditions. Based on the local topography, groundwater is anticipated to flow downslope towards the creeks.

## 7. Proposed Development

It is understood that the site is being considered for the construction of a proposed residential subdivision proposed to predominantly include one to two storey buildings, pavements, recreational areas and associated landscaping and earthworks will be required.

## 8. Comments

### 8.1 General

Development across the site, from a geotechnical perspective, is considered feasible. There are some areas of the site, however, that are more likely to require stiffer and or deeper footing systems (e.g. a higher lot classification or engineer designed pile footings) for buildings and infrastructure than others due to the depth and type of soils present. These areas are generally expected to be present at lower elevations of the site, adjacent to the creeks. Furthermore, soils in closer proximity to the creek are expected to have higher salinity levels, requiring more extensive salinity management systems.

## 8.2 Site Preparation and Earthworks

### 8.2.1 Excavation Conditions

It is expected that there will be some form of excavation works on site due to the sloping nature of the site. Excavation to depths of up to say 1.5 m, is expected to be within fill soils, natural soils and possibly very low to low strength rock which should generally be achievable using conventional earthmoving equipment.

Deeper excavation within any medium strength (or stronger) rock will likely require hydraulic rock breakers in conjunction with heavy ripping for effective removal of this material. If deep excavation in bedrock materials is proposed then core drilling of the rock is recommended in order to quantify the strength of rock for and for contractors to more accurately assess rippability and hence excavation costs.

All excavated materials disposed off-site will need to be classified in accordance with the provisions of the current legislation and guidelines including the *Waste Classification Guidelines* (EPA, 2014). This includes Fill and natural materials that may be removed from the site.

### 8.2.2 Subgrade Preparation

For planning purposes, the following site preparation measures are recommended for subgrade preparation and any site platform fill placement for the development:

- remove any deleterious, soft, wet or highly compressible material or material rich in organics or root matter;
- test roll the exposed surface with at least six passes of a minimum 12 tonne deadweight smooth drum roller, with a final test roll pass accompanied by careful visual inspection to ensure that any deleterious materials such as soft, wet or highly compressible soil and any organics are identified and removed;
- place approved fill, where required, in layers not exceeding 300 mm loose thickness, with each layer compacted to a minimum dry density ratio of 98% Standard within 2% of optimum moisture content (OMC); new fill should be free of oversize particles (>75mm) and deleterious material;
- moisture conditioning of clay soils may be required if soils are saturated. Moisture conditioning would involve drying in 'sunny and windy' weather, blending with other drier materials or lime stabilisation;
- promptly cover any exposed clay at subgrade level with a minimum 150 mm of select granular fill (minimum CBR 15%) to reduce potential wetting and drying and trafficability problems; and
- new fill required to achieve design levels for support of any on-ground slabs and/or structural loads will need to be carried out under Level 1 testing conditions as defined in AS 3798–2007 "Guidelines on Earthworks for Commercial and Residential Developments". Level 2 testing is recommended for filling materials beneath pavements, recreational and landscaping areas.

The above procedures will require geotechnical inspection and testing services to be employed during construction.

### 8.3 Excavation Support

Excavation for the proposed buildings and pavement area are assumed to predominantly be within filling, residual clays and possibly very low to low strength shale bedrock.

The soils exposed in cut will not be able to stand vertically without support in the longer term. Where space permits, it will be possible to batter the sides of the excavation and in these conditions, it is suggested to allow for temporary side slopes of 1H:1V in the clays.

A maximum batter slope of 2H:1V is recommended for permanent slopes in the clays, provided that the slopes are protected against surface erosion and local slumping. Where the slopes are to be vegetated to prevent erosion, a maximum batter slope of 6H:1V is recommended.

Retaining walls could be designed to support fill or cut slopes in accordance with engineering principles.

### 8.4 Foundations

DP's experience in the area is that a range of lot classifications will probably be appropriate for the site in accordance with AS2870 "Residential Slabs and Footings" (2011). The probable range of classifications, outlined in Table 1 below, is broadly dependent on the reactivity of natural clay and controlled fill materials together with the depth of these reactive soils. These classifications could be adversely affected by the presence and/or removal of trees near the footprints of proposed buildings.

**Table 1: Preliminary Lot Classification Scenarios**

Scenario	Description	Probable Lot Classification
1	Rock is exposed at, or near, the bulk excavation.	A
2	Clay or fill soils. Rock is exposed at a depth of less than 1m below the surface.	M to H1
3	Natural clay soils and/or controlled clay filling <sup>1</sup> to at least 1.8 m depth below the proposed ground surface.	H1 to H2
4	Uncontrolled filling.	P

Note: 1. Controlled filling is defined as fill placed under Level 1 testing conditions (refer Section 8.2.2)

Investigation will be required both prior to and following bulk earthworks to confirm lot classifications.

All foundations should be designed and constructed in accordance with AS2870, with consideration to the site classifications. Footings with a "P" classification will design to be carried out in accordance with engineering principles.

Founding systems will need to be located outside the zone of influence (defined by a 45° line of influence from the toe of the trenches) of any underground services or trench fill associated with the backfill of underground services. This is particularly relevant on the northern and southern

boundaries, where historical aerial photographs suggest that significant trenches were excavated to install the associated underground services and were subsequently backfilled, presumably under uncontrolled testing conditions.

It is likely that most footings could be founded in stiff to very stiff natural clays with an allowable base bearing pressure of 150 kPa. Where shale is exposed at founding level or piles are drilled then footings could be proportioned for an allowable base bearing pressure of at least 500 kPa. If weathered rock is encountered during footing excavation, then all footings for the structure must be founded in rock in order to provide uniform founding conditions.

Footings should be inspected by a suitably qualified engineer prior to steel and concrete placement to confirm the adequacy of the founding stratum for the adopted design pressure. Care must be exercised to ensure that DA Consent conditions are satisfied with respect to footing inspections, and the engineering discipline to undertake the inspections is appropriate (for example, a structural engineer cannot be used as a substitute for a geotechnical engineer).

## 8.5 Pavements

Pavements in the area with a compacted clay soil subgrade, are generally designed with a California bearing ratio (CBR) in the range of 2 % to 5 %. If bedrock is exposed at the subgrade, then a higher CBR value may be possible. Laboratory testing will be required to confirm the CBR of the material for detailed design and planning.

Flexible pavements for similar developments in the area have ranged from 300 mm to 550 mm in thickness, comprising asphaltic concrete surfacing over granular roadbase materials. Pavement thicknesses are dependent on the subgrade CBR value, pavement materials used and traffic loading applied.

## 8.6 Salinity

The site is located in an area known to include saline soils, highly sodic soils and dispersive or erodible soils. The 'bare soils' evident on-site may be evidence of these saline or sodic conditions. Saline or sodic soils are not considered significant impediments to the proposed development but will require appropriate remediation or management techniques. Typical management techniques include the following:

- Strategic design and construction of efficient drainage systems and detention ponds so that they collect water and dispose of surface water effectively, prevent water saturation and avoid water collecting in low lying areas, in depressions, pavements, retaining walls or filled areas. These drainage systems will need to be well maintained during both construction and in the long-term.
- Sourcing of non-saline or slightly saline soils for use beneath roads.
- Imported fill materials to comprise only non-saline or slightly saline natural soils.
- Selection of concrete strengths and covers to reinforcement appropriate to the aggressivity of site soils. Sulphate resistant concretes may need to be adopted.



- Underground services to comprise appropriate materials for site conditions (e.g. sufficient corrosion protection).
- Implementation of erosion control measures across the site during construction and in the long-term.
- Reference should be made to an experienced landscape planner or agronomist for management and treatment of sodic soils. It is likely that this management will include;
  - Capping of sodic soils.
  - Maintaining vegetation and planting salt tolerant species in sodic soils.
  - Addition of gypsum to saline and sodic soils.
  - Efficient drainage systems as described above.
- Development of a water quality monitoring plan and appropriate treatment, such as the adjustment of pH levels prior to discharge to the surrounding environment.

## 8.7 Geotechnical Investigation

Geotechnical investigations will be required to assess the subsurface conditions at the site prior to detailed design and construction. Further, geotechnical review and advice will be required once the investigation has been completed.

## 9. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report (or services) for this project at Lots 99 and 100 Deposited Plan (D.P.) 1243071, Gurner Avenue, Austral, NSW in accordance with DP's proposal NWS190074 dated 31 May 2019. The work was carried out under agreed contract terms with Landcom. This report is provided for the exclusive use of Landcom for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions on the site only at the specific sampling and/or testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached notes and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The scope for work for this investigation/report did not include the assessment of surface or sub-surface materials or groundwater for contaminants, within or adjacent to the site. Should evidence of filling of unknown origin be noted in the report, and in particular the presence of building demolition materials, it should be recognised that there may be some risk that such filling may contain contaminants and hazardous building materials.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

---

**Douglas Partners Pty Ltd**

---

## Appendix A

---

About This Report

# About this Report

# Douglas Partners



## Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

## Copyright

This report is the property of Douglas Partners Pty Ltd. The report may only be used for the purpose for which it was commissioned and in accordance with the Conditions of Engagement for the commission supplied at the time of proposal. Unauthorised use of this report in any form whatsoever is prohibited.

## Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

## Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

## Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

# *About this Report*

## **Site Anomalies**

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

## **Information for Contractual Purposes**

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

## **Site Inspection**

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

---


## Appendix B

---

Drawings





Legend  
 Site Boundary



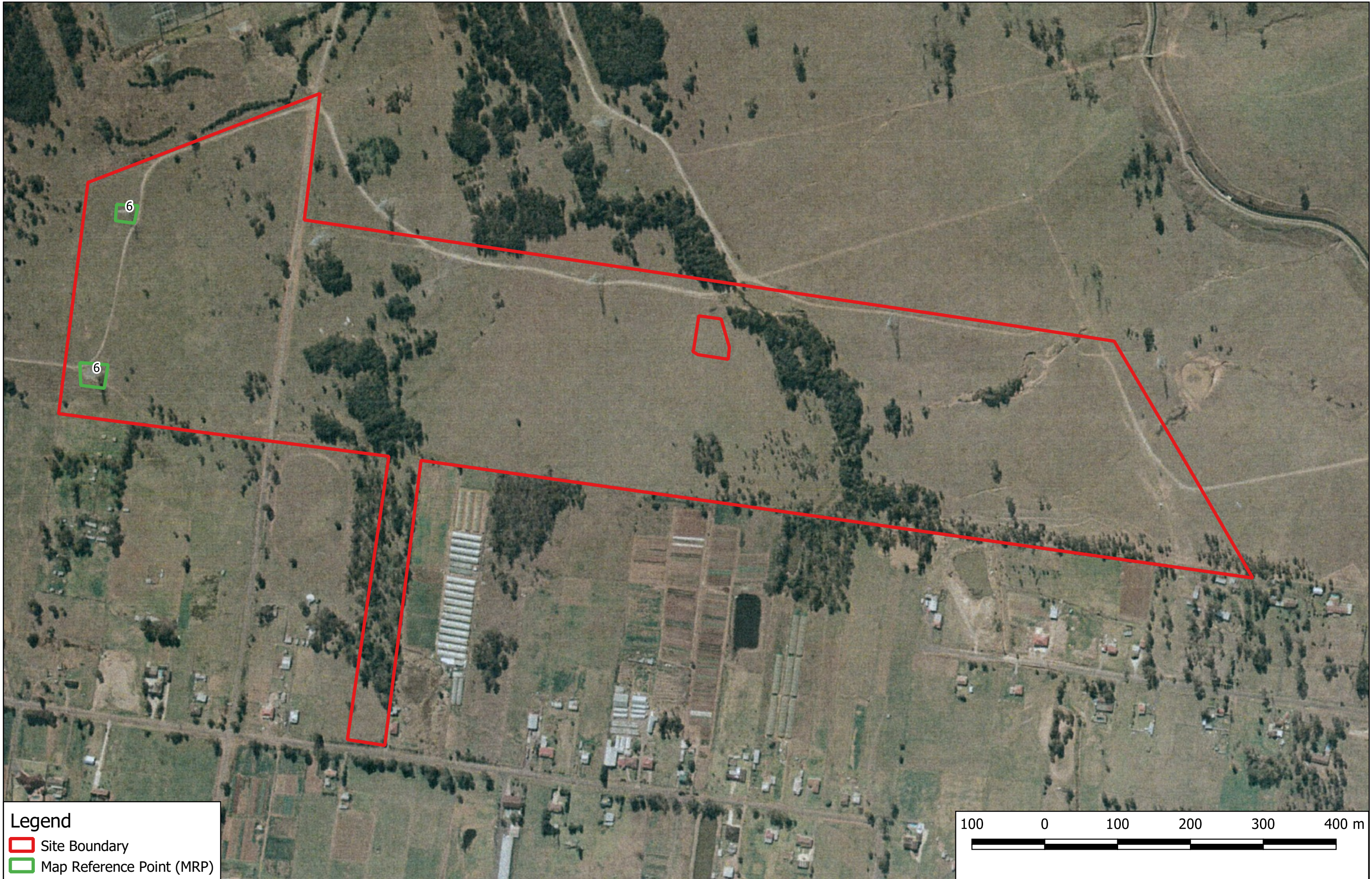
CLIENT: Landcom	
OFFICE: Macarthur	DRAWN BY: LOC
SCALE: As shown	DATE: 14.08.2019

TITLE: Historical Aerial - 2009  
Due Diligence Investigation  
Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW



PROJ. #: 94562.00.R.002
DRAWING No: 8
REVISION: 0







**Legend**

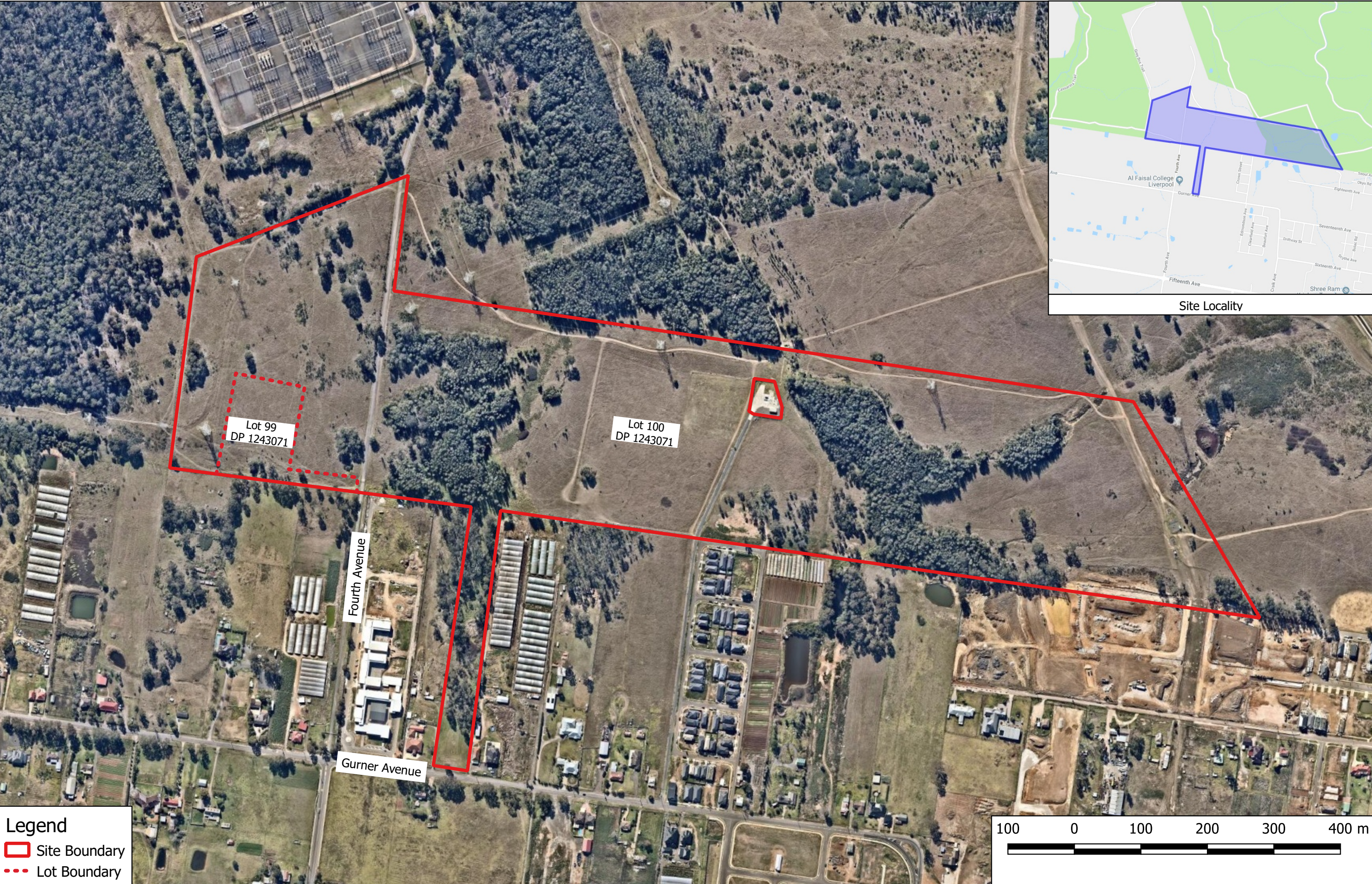
▭ Site Boundary

▭ Map Reference Point (MRP)



 <b>Douglas Partners</b> <i>Geotechnics   Environment   Groundwater</i>	CLIENT: Landcom		TITLE: Historical Aerial - 1991 Due Diligence Investigation Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW	 MGA	PROJ. #: 94562.00.R.002
	OFFICE: Macarthur	DRAWN BY: LOC			DRAWING No: 6
	SCALE: As shown	DATE: 14.08.2019			REVISION: 0





**Legend**

Site Boundary

Lot Boundary







**Legend**

▭ Site Boundary

▭ Map Reference Point (MRP)



 <b>Douglas Partners</b> <i>Geotechnics   Environment   Groundwater</i>	CLIENT: Landcom		TITLE: Historical Aerial - 2015 Due Diligence Investigation Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW	 MGA	PROJ. #: 94562.00.R.002
	OFFICE: Macarthur	DRAWN BY: LOC			DRAWING No: 9
	SCALE: As shown	DATE: 14.08.2019			REVISION: 0







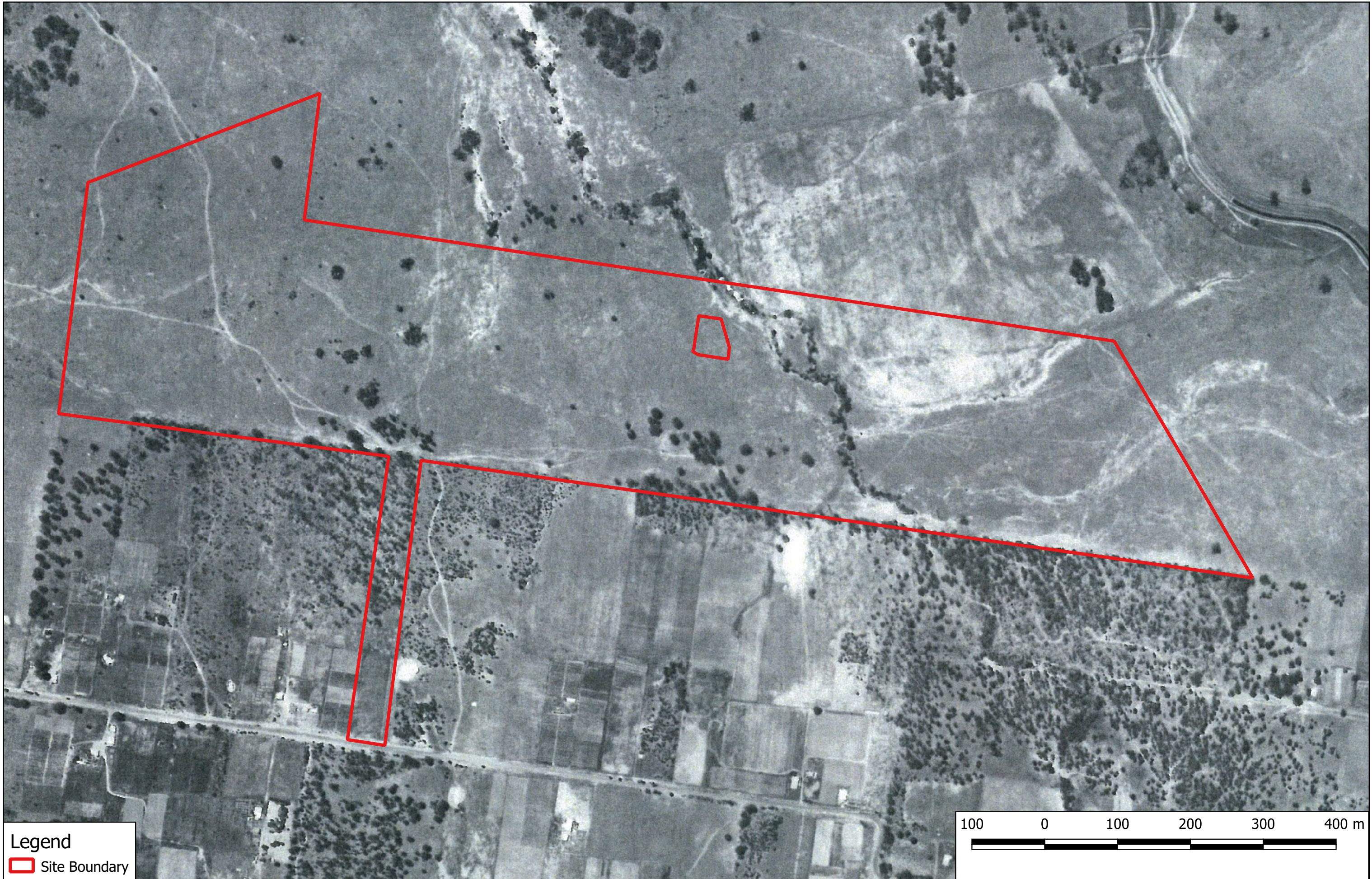
**Legend**


▭ Site Boundary

▭ Map Reference Point (MRP)



 <b>Douglas Partners</b> <i>Geotechnics   Environment   Groundwater</i>	CLIENT: Landcom		TITLE: Historical Aerial - 2019 Due Diligence Investigation Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW		 MGA	PROJ. #: 94562.00.R.002	
	OFFICE: Macarthur	DRAWN BY: LOC				DRAWING No:	10
	SCALE: As shown	DATE: 14.08.2019				REVISION:	0



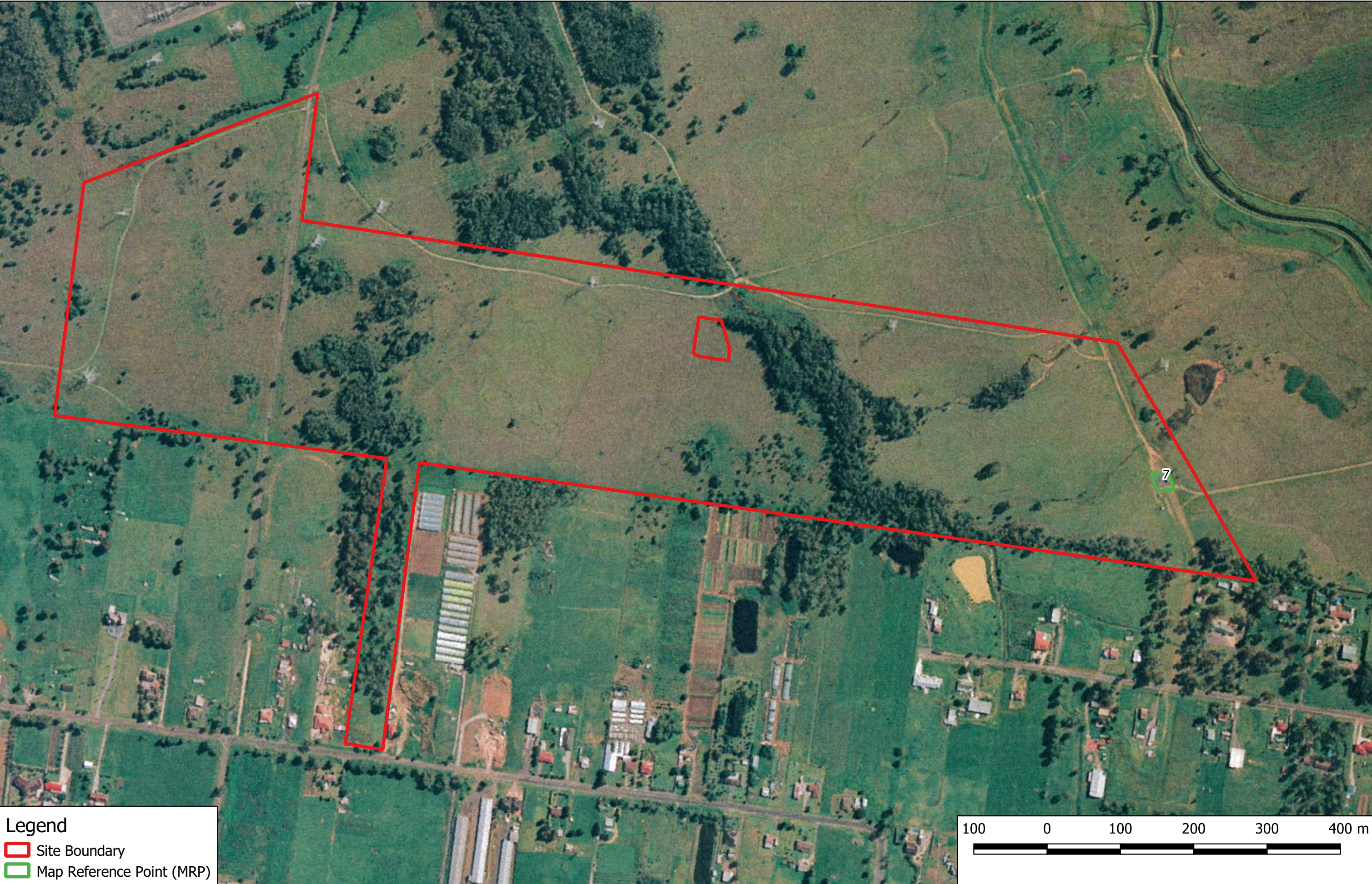


**Legend**  
 Site Boundary



 <b>Douglas Partners</b> <i>Geotechnics   Environment   Groundwater</i>	CLIENT: Landcom		TITLE: Historical Aerial - 1957 Due Diligence Investigation Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW	 MGA	PROJ. #: 94562.00.R.002
	OFFICE: Macarthur	DRAWN BY: LOC			DRAWING No: 2
	SCALE: As shown	DATE: 14.08.2019			REVISION: 0







**Legend**

▭ Site Boundary

▭ Map Reference Point (MRP)





 <b>Douglas Partners</b> <i>Geotechnics   Environment   Groundwater</i>	CLIENT: Landcom		TITLE: Historical Aerial - 2002 Due Diligence Investigation Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW	 MGA	PROJ. #: 94562.00.R.002
	OFFICE: Macarthur	DRAWN BY: LOC			DRAWING No: 7
	SCALE: As shown	DATE: 14.08.2019			REVISION: 0






Legend

 Site Boundary

 <b>Douglas Partners</b> <i>Geotechnics   Environment   Groundwater</i>	CLIENT: Landcom		TITLE: Historical Aerial - 1961 Due Diligence Investigation Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW	 MGA	PROJ. #: 94562.00.R.002
	OFFICE: Macarthur	DRAWN BY: LOC			DRAWING No: 3
	SCALE: As shown	DATE: 14.08.2019			REVISION: 0





Legend  
 Site Boundary



**Douglas Partners**  
Geotechnics | Environment | Groundwater

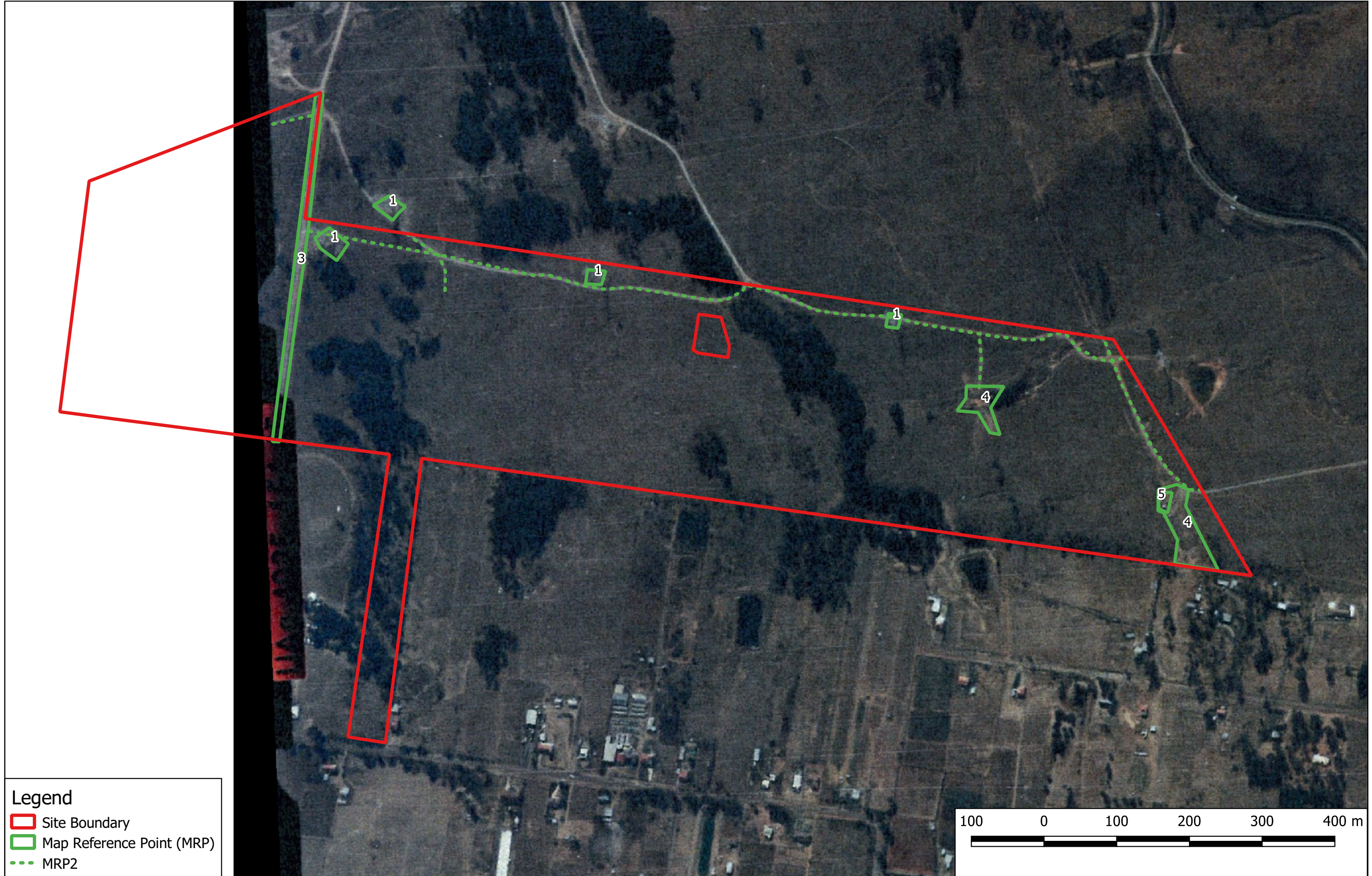
CLIENT: Landcom	
OFFICE: Macarthur	DRAWN BY: LOC
SCALE: As shown	DATE: 14.08.2019

TITLE: Historical Aerial - 1970  
Due Diligence Investigation  
Lots 99 and 100 D.P. 1243071, Gurner Avenue, Austral, NSW



PROJ. #: 94562.00.R.002
DRAWING No: 4
REVISION: 0





**Legend**

- Site Boundary
- Map Reference Point (MRP)
- MRP2





Photo 1 - General Site View



Photo 2 - Discarded white goods next to creek





Photo 3 - Discarded wheelie bin in riparian corridor



Photo 4 - High turbidity noted in creek throughout the site





Photo 5 - Puddling next to residential subdivision being constructed immediately south west of the site



Photo 6 - Tyres and scrap metal on ground surface in north west portion of the site





Photo 7 - Stockpile of construction and demolition materials in south west portion of the site



Photo 8 - Stockpile of scrap metal and timber in south west portion of the site





Photo 9 - Overgrown stockpile of timber and metal in south west portion of the site



Photo 10 - Loose timber in field





Photo 11 - Loose railway track on ground surface in south west portion of the site



Photo 12 - Discarded polystyrene boxed in field in southern portion of the site





Photo 13 - Stockpile of construction and demolition material partially covered in grass, in south west portion of the site



Photo 14 - Soil mound mostly covered with grass containing construction and demolition materials

---

## **Appendix C**

---

Site Photographs