ENVIRONMENTAL ASSESSMENT REPORT

Proposed Piggery

553 Dick Knobels Rd MUNYABLA NSW 2658

August 2018

DM McMahon Pty Ltd

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Project brief

At the request of Robyn Tucker of Livestock Environmental and Planning (LEAP), soil sampling, analysis and reporting was carried out to assess the site for a proposed piggery development on 28 August 2018. The document provides information about the site and soil conditions from field observations and laboratory analysis.

Site identification

Address: 533 Dick Knobels Road, Munyabla NSW 2658
Real property description: Lot 1 DP 1211821 and Lot 2 DP 373967
Centre co-ordinate: 491101 6080100 MGA GDA z55
Property size: approx. 360 ha
Owner: c/o Robyn Tucker LEAP
Local Council Area: Lockhart Shire Council
Present use: Agriculture
Development Application Reference: not known
Report identification: 5407

Certification

Name	Signed	Date	Revision Number
David McMahon CEnvP BAppSc SA GradDip WRM		17/09/18	0

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1.0 Introduction

The report presents the results of an environmental assessment carried out by DM McMahon Pty Ltd (McMahon) for a proposed piggery complex near Yerong Creek, NSW.

The soil and land survey work was commissioned by Robyn Tucker of LEAP Consulting and was undertaken in general accordance with an email dated 23 July. The survey was carried out utilising a backhoe to excavate soil pits for evaluation to a depth of approximately 1.2m. Alice Debney of DM McMahon Pty Ltd conducted a free soil survey on 28 August 2018 using standard soil surveying techniques. Sampling and classification of in situ soils was carried out as per the Australian Soil and Land Survey Field Handbook (2009) and The Australian Soil Classification (Isbell, 1996). Density of investigation pits was determined via Guidelines for Surveying Soil and Land Resources, McKenzie et al (2008) where selection of a 'Moderately High (Detailed)' intensity level was deemed appropriate for satisfying the objectives.

2.0 Site Characteristics

A brief desktop review and investigation of the topography, hydrology, soil, lithology, geology and hydrogeology of the site has been undertaken and are as follows:

2.1 Topography

The site is located within the Pleasant Hills 1:50,000 Topographic Map sheet (8227-S). The site is located at an elevation range of approximately 200m AHD. The site slope is classed as level and the landform is classed as flat.

2.2 Vegetation

The site is used for agricultural production and is predominantly sown to winter cereal crops. Paddy melon weeds and desiccated thistles are present.

2.3 Weather

The mean rainfall for Yerong Creek is approximately 542.0mm per annum. The wettest months are June, July and October, however the rainfall is spread relatively evenly throughout the year. Mean maximum monthly temperatures range from 15.1 ºC in July to 35.8 ºC in January and mean minimum monthly temperatures range from 10.8 ºC in July to 27.5 ºC in January. Historical records obtained from Yerong Creek (Fertilizer Depot) NSW AWS 074126 and Wagga Wagga AMO NSW AWS 072150, respectively (www.bom.gov.au).

2.4 Hydrology

The site is located on the drainage plains of the Murrumbidgee River catchment. The Mittagong Creek, an ephemeral drainage, runs through the property, along with the associated first and second order ephemeral tributaries of the Mittagong Creek. The channel is defined in the Mittagong Creek while the firsts and second order tributaries are likely to have more linkage to the drainage plain. Due to the relative incline of the site and relatively permeable soils, rainfall is likely to both run off and infiltrate into soil at the site.

2.5 Soil & Landform

The site lies within the mapping unit **Va17** from the Digital Atlas of Australian Soils (CSIRO, 1991).

The map unit **Va17** is described as:

"Va17"

"Flat to gently undulating country with some swamps and broken by an occasional low gravelly or stony ridge or hillock: chief soils are hard alkaline yellow mottled soils (Dy3.43) and (Dr2.33), both containing ironstone gravel and sometimes forming soil complexes. Associated are: ridges and hillocks of (Dr2.32, Dr2.42) and (Um4.1) soils similar to unit Qc3; small flat areas of (Dr2.23); and various undescribed soils in local situations, e.g. subjacent to swamps and on stream terraces. Data are limited. Occurs on sheet(s): 3"

2.6 Geology

The site geology is distributed over two units: Cainozoic colluvium and Early Palaeozoic metasedimentary rocks.

2.7 Hydrogeology

From the Geoscience Australia hydrogeology dataset, the groundwaters beneath the site are described as fractured or fissured, extensive aquifers of low to moderate productivity.

3.0 Investigation Scope of Work

The specifications for the site investigation and soil survey are as follows, **Table 1**:

Table 1: *Scope of work*

Item	Description	Description
1.	Where available, review plans and other general related documents provided to us to gain a comprehensive understanding of the proposed project.	-
2.	Undertake a desktop study of local landform, geological, lithological & hydrogeological conditions.	-
3.	Carry out field investigations by reference to Guidelines for Surveying Soil and Land Resources (2008) & AS1726:1993 Geotechnical Site Investigations.	20 pits in total. Samples of topsoils, B, B/C and C horizons taken where present to adequately classify soils as per ASC 1996.
4.	Analyse soils in situ and at our NATA accredited laboratory to AS/RMS methods.	Composite testing of pH, EC, OC, dispersion/aggregate stability, N, PBI, ESP, Colwell P, K & Ca:Mg (E12 x 10).
5.	Generate laboratory reports and review results.	-
6.	Compile results in report detailing methodology, desktop study, physical conditions, field work results, test locations, bore logs, in-situ test results, laboratory results and discussion.	-

7.	Recommendations for erosion control and prevention measures and management recommendations for earthworks.	-

As follows is a map of the investigated site and investigation pit locations, **Figure 1**.

Figure 1: *Soil survey investigation pit locations*

4.0 Results

4.1 Field Survey

A free soil survey was conducted using standard soil surveying techniques. Sampling and classification of in situ soils was carried out as per the Australian Soil and Land Survey Field Handbook (2009) and The Australian Soil Classification (Isbell, 1996). Density of investigation pits was determined via Guidelines for Surveying Soil and Land Resources (2008) where selection of a 'Moderately High (Detailed)' intensity level was deemed appropriate for satisfying the objectives for detailed project planning. Soils encountered were typical of the locale, generally falling into reconnaissance survey classes. Slight variations in profiles exist due to remnant channels and the complex soil sequences that are associated with such. Soil moisture contents varied considerably between soil types but were generally found to be dry to moderately moist at depth. Free groundwater was not encountered to the investigated depths.

4.2 Typical Soil Profiles

Soils can be classified into two typical soil profiles across the site as per the Australian Soil Classification system (Isbell, 1996) and the Great Soil Groups (Stace *et al.,* 1968). Representative photographs from profiles examined on site can be seen below with a brief description of the profile characteristics. All soil pits investigated were located on managed agricultural lands. Field soil log sheets can be seen attached.

4.2.1 Chromosols

The soils belonging to the **Chromosol** soil classification are defined as having strong texture contrast between the A and B horizons and with a not strongly acid and not sodic B horizon. The site has both mesotrophic and eutrophic red chromosols. Chromosols are also classified as **Non-calcic brown soils** and a range of **podzolic soils** and some **red-brown earths**. They are derived from Cainozoic alluvial clay (with minor sand) sequences.

The profiles mainly consist of two horizons:

1. A darker clay loam organic surface layer (A horizon);

2. A clayey structured subsurface horizon that is not strongly acid and not sodic (B horizons).

Figures 2 and **3** represent typical soil profiles on site.

The soil is moderately deep, friable in the topsoil and becoming harder with depth, porous and non-cracking that is currently well-drained and aerated. Field tests showed that the soils do not swell or disperse, but the subsoils are generally low in organic matter. In general, a combination of soil depth, slope, low salinity, open porosity, fine friable subsoil structure, physically unrestricted roots and water penetration, large water holding capacity, moderate drainage, aeration, water and heat transmission, workability and trafficability, are some of the many advantages of these soils. These favourable properties make them suitable for the intended use. Soil pit log sheets can be seen in the **Attachments**.

Figure 3: *Typical profile with A and B horizons*

Figure 2: *Soil profile with bleached elluvial A2 horizon*

4.2.2 Sodosols

The soils belonging to the **Sodosol** soil classification are defined as having strong texture contrast between the A and B horizons and with a not strongly acid and a sodic B horizon. Sodosols are also classified as **solodized solontez** and **solodic soils**, some **soloths, red-brown earths** and **desert loams**. They are derived from Cainozoic alluvial clay (with minor sand) sequences.

The profiles mainly consist of two horizons:

1. A darker clay loam organic surface layer (A horizon);
2. A clayey structured subsurface horizon that is not strongly acid and is sodic (B horizons).

Figures 4 and **5** represent typical soil profiles on site.

The soil is moderately deep, friable in the topsoil and becoming harder with depth, porous and non-cracking that is currently well-drained and aerated. Field tests showed that the soils do not swell and the topsoils do not disperse, but the subsoils are generally low in organic matter and dispersion testing indicated they may be sodic. In general, a combination of soil depth, slope, low salinity, porosity, fine friable subsoil structure, physically unrestricted roots and water penetration, moderate water holding capacity, fair drainage, aeration, water and heat transmission, workability and trafficability, are some of the many advantages of these soils. These favourable properties make them suitable for the intended use. Soil pit log sheets can be seen in the **Attachments**.

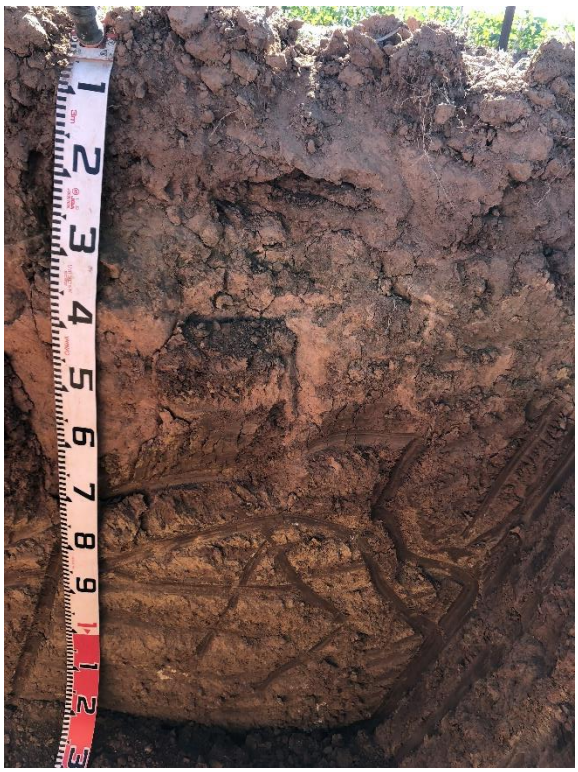

Figure 5: *Typical soil profile with A and B horizon*

Figure 4: *Soil profile with bleached elluvial A2 horizon*

4.4 Laboratory Analysis

Ten representative samples were obtained and analysed at a NATA accredited laboratory for the establishment of baseline soil data. Laboratory certificates of analysis (COA's) can be found in the attachments and soil parameters can be seen summarised in **Table 5** and **Table 6**. A summary of the laboratory results is as follows.

4.4.1 Topsoil Analysis

4.4.1.1 pH & Electrical Conductivity

Topsoil pH (1:5 soil/water) ranged from 5.5 to 6.0 and can be classed as 'strongly acid' to 'moderately acid', Bruce & Rayment (1982). Saturated Extract Electrical Conductivity (ECe) ranged from 0.3 to 1.4 dS/m and can be classed as non-saline, Hazelton and Murphy (2007).

4.4.1.2 Cation Exchange Capacity, Exchangeable Sodium Percentage & Dispersion

Cation Exchange Capacity (CEC) ranged from 4.8 to 7.9 cmol(+)/kg. CEC of the soils is rated by Hazelton and Murphy (2007), as 'very low' (<6) to 'low' (6 - 12). Exchangeable Sodium Percentage (ESP) ranges from 0.6% to 10.0%, which indicates that the soil ranges from 'non-sodic' to 'marginally sodic', Pope and Abbot (1989). Field determination of dispersion was nil in all topsoil samples, with some slaking in two of the samples. Therefore, structural limitations in the topsoil are low.

4.4.1.3 Colwell Phosphorus and Phosphorus Buffering Index

Colwell P (plant available phosphorus) was generally 'very low', from 9 to 23 mg/kg, with one 'high' reading of 150 mg/kg, AWI (2008). Phosphorus Buffering Index (PBI) ranged from 44 to 130 and is classed from 'very, very low' (15 - 30) to 'low' (71 – 140), Agriculture Victoria, (2011).

4.4.1.4 Calcium:Magnesium Ratio

Ca:Mg ratio for topsoils returned results ranging from 1.7 to 4.1, indicating at the higher end that there is potential for dispersion of topsoils upon wetting.

4.4.1.5 Saturated Hydraulic Conductivity

Indicative permeability can be inferred from textures determined in the field, which in the topsoil were structured loams and clay loams. The indicative permeability of these topsoils is 20 to 60 mm/h indicating moderate infiltration, Charman and Murphy (1991).

4.4.2 Subsoil Analysis

4.4.2.1 pH & Electrical Conductivity

Subsoil pH (1:5 soil/water) ranged from 6.9 to 8.9 and can be classed as 'Neutral' to 'Strongly Alkaline' (Bruce & Rayment, 1982). Saturated Extract Electrical Conductivity (ECe) ranged from 0.4 to 3.3 dS/m and can be classed as non to slightly saline, Hazelton and Murphy (2007).

4.4.2.2 Dispersion

Field determination of dispersion indicated that all subsoils are likely to be sodic. Partial and complete dispersion was observed in five of the samples, while slaking was observed in the remaining three (Hazelton & Murphy, 2007). Therefore, some structural limitations in the subsoil would be expected.

4.4.2.3 Saturated Hydraulic Conductivity

Indicative permeability can be inferred from textures determined in the field, which in the subsoil were structured clay loams and light clays. The indicative permeability of these topsoils is 20 to 60 mm/h indicating slow to moderate infiltration, Charman and Murphy (1991).

4.4.3 National Environmental Guidelines for Rotational Outdoor Piggeries

The range of topsoil and subsoil results have been compared against the recommended soil analysis parameters from table 17.1 of the National Environmental Guidelines for Rotational Outdoor Piggeries, Australian Pork Ltd (2013), **Table 2**. The results demonstrate that there is a degree of limitation in regard to topsoil pH and subsoil sodicity but overall the soil is fit for purpose. The topsoil pH and subsoil sodicity limitations are inherent to the locale and can be improved by amelioration. Management controls around such should be implemented as part of the development as outlined in **Section 6**.

Table 2: *Soil test parameters for the National Environmental Guidelines for Rotational Outdoor Piggeries*

Soil test parameter	Depth	Range	Justification
pH (1:5 soil:water)	Topsoil	Strongly Acid to Moderately Acid	Influences nutrient availability.
	Subsoil	Neutral to Strongly Alkaline	
EC_e	Topsoil	Very Low	Measure of soil salinity. The soil is non-saline.
	Subsoil	Very Low to Low	
Nitrate-nitrogen	Topsoil	3 to 78 mg/kg	Measure of nitrogen available for plant uptake.
	Subsoil	4 to 18 mg/kg	
Available phosphorus (Colwell)	Topsoil	9 to 150mg/kg	Measure of phosphorus available for plant uptake.
	Subsoil	<5 to 15 mg/kg	
Potassium	Topsoil	0.40 to 1.90 cmol(+)/kg	Measure of potassium available for plant uptake.
	Subsoil	0.26 to 1.30 cmol(+)/kg	
Organic carbon	Topsoil	0.8 to 2.5%	Influences soil stability and consequently soil erosion (preferred level is >2%).
ESP (Exchangeable sodium percentage)	Topsoil	0.6 to 10.0%	Implications for soil structure.
	Subsoil	3.9 to 32.0%	
EKP (Exchangeable potassium percentage)	Topsoil	8.4% to 24.0%	Implications for soil structure.
	Subsoil	4.3% to 4.6%	
Ca:Mg ratio	Topsoil	1.7**:**1 to 4.1**:**1	Implications for soil structure.
	Subsoil	0.2**:**1 to 1.9**:**1	
(CEC) Cation Exchange Capacity	Topsoil	4.8 to 7.9 cmol(+)/kg	Implications for soil structure.
	Subsoil	6.1 to 21.0 cmol(+)/kg	

The NSW DEC offer soil test parameter characteristics limitations for use of effluent by irrigation, NSW DEC (2004), **Table 3**. The range of topsoil and subsoil results have been compared against the soil properties, **Table 4**. The results show that the only moderate limitation was an acidic topsoil pH and some instances of a relatively low CEC which is inherent to the locale and can be improved by soil amelioration. Management controls around such should be implemented as part of the development as outlined in **Section 6**.

4.4.4 Use of Effluent by Irrigation

Table 3: *Soil test parameters for typical soil characteristics for effluent irrigation systems*

Property	Limitation			Restrictive Feature
	Nil or Slight	Moderate	Severe	
Exchangeable sodium percentage (0–40 cm)	0–5	5–10	> 10	Structural degradation and waterlogging
Exchangeable sodium percentage (40–100 cm)	< 10	>10	_	Structural degradation and waterlogging
Salinity measured as electrical conductivity (ECe) (dS/m at 0–70 cm)	< 2	2–4	> 4	Excess salt may restrict plant growth
Salinity measured as electrical conductivity (ECe) (dS/m at 70–100 cm)	< 4	4–8	> 8	Excess salt may restrict plant growth, potential seasonal groundwater rise
Depth to top of seasonal high water table (metres)	> 3	0.5–3	< 0.5	Poor aeration, restricts plant growth, risk to groundwater
Depth to bedrock or hardpan (metres)	> 1	0.5–1	< 0.5	Restricts plant growth, excess runoff, waterlogging
Saturated hydraulic conductivity (Ks, mm/h, 0-100 cm)	20–80	5–20 or >80	<5	Excess runoff, waterlogging, poor infiltration
Available water capacity (AWC, mm/m)	> 100	< 100	–	Little plant-available water in reserve, risk to groundwater
Soil pHCaCl2 (surface layer)	> 6–7.5	3.5–6.0 > 7.5	< 3.5	Reduces optimum plant growth
Effective cation exchange capacity (ECEC, cmol (+)/kg, average 0–40 cm)	> 15	3–15	< 3	Unable to hold plant nutrients
Emerson aggregate test (0–100cm)	4, 5, 6, 7, 8	2, 3	1	Poor structure
Phosphorus (P) sorption (kg/ha at total 0–100 cm)	High	Moderate	Low	Unable to immobilise any excess phosphorus

Table 4: *Site suitability in relation to the use of effluent by irrigation guidelines*

Property	Comments
Exchangeable sodium percentage (0–40 cm)	Exchangeable sodium percentage in the topsoil was classed as a nil or slight to moderate limitation.
Exchangeable sodium percentage (40–100 cm)	Exchangeable sodium percentage in the subsoil was classed as a nil or slight to severe limitation.
Salinity measured as electrical conductivity (EC) (dS/m at 0–70 cm)	Salinity measured as EC_{se} in the topsoil was classed as a nil or slight limitation.
Salinity measured as electrical conductivity (EC) (dS/m at 70–100 cm)	Salinity measured as EC_{se} in the subsoil was classed as a nil or slight limitation.
Depth to top of seasonal high water table (metres)	No free groundwater was encountered during excavation to 1.2m depth.
Depth to bedrock or hardpan (metres)	No bedrock or hardpans were experienced during excavation to 1.2m depth.
Saturated hydraulic conductivity (Ks, mm/h, 0-100 cm)	The indicative permeability of these soils is 2.5 to 125 mm/h, falling into the 'nil or slight' to 'moderate' limitation categories, and careful irrigation scheduling and good irrigation practices will be required to maintain site sustainability.
Available water capacity (AWC, mm/m)	AWC is calculated to be generally ~183 to 175 mm/m which is highly suitable for irrigation.
Soil pH$CaCl_2$ (surface layer)	Laboratory testing indicated moderate acidity which is a moderate limitation. Topsoils with lower pH are considered typical to the locale and can be ameliorated by the addition of lime.
Effective cation exchange capacity (ECEC, cmol (+)/kg, average 0–40 cm)	CEC for the topsoil and subsoil raged from 4.8 to 21.0 indicting nil-slight to moderate limitations.
Emerson aggregate test (0–100cm)	Samples returned results that have nil or slight limitations in the topsoil and moderate to severe limitations in the subsoil.
Phosphorus (P) sorption (kg/ha at total 0–100 cm)	Not tested.

5.0 Summary of Test Results

Table 5: *Topsoil - Results of laboratory testing.*

Pit/Sample	Dispersion	pH (1:5 Water)	pH (1:5 $CaCl_2$)	Electrical Conductivity$_{se}$	Organic Carbon	Chloride	Nitrate Nitrogen	Ammonium Nitrogen	Colwell P	Phosphorus Buffer Index	Sulphur – KCl40	Cation Exchange Capacity	Calcium	Magnesium	Sodium	Potassium	Available Potassium	Aluminium	Aluminium % of Cations	Calcium % of Cations	Magnesium % of Cations	Sodium % of Cations	Potassium % of Cations	Ca/Mg Ratio
Units	-	-	-	dS/m	%	mg/kg	mg/kg	mg/kg	mg/kg	-	mg/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	mg/kg	cmol(+)/kg	%	%	%	%	%	-
1/1	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/1	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/1	N*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1	N	6.0	4.7	0.5	1.5	16	12	2	9	82	10	4.8	2.2	1.3	0.49	0.40	160	0.4	7.7	46.0	27.0	10.0	8.40	1.7
11/1	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13/1	N	5.7	4.8	0.5	0.8	<10	12	3	16	44	6	5.0	3.3	0.8	0.03	0.64	250	0.1	2.7	68.0	16.0	0.60	13.00	4.1
15/1	N*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18/1	N	5.6	4.9	1.4	2.5	18	78	14	150	89	19	7.9	4.0	1.7	0.24	1.90	740	0.2	1.8	50.0	21.0	3.00	24.00	2.4
1+6/1	-	6.0	4.8	0.3	1.1	<10	3	3	10	96	4	4.9	2.6	2.6	1.1	0.70	270	0.4	7.1	53.0	23.0	3.40	14.00	2.4
11+15/11	-	5.5	4.6	0.9	1.0	60	42	3	23	130	5	6.3	3.2	1.8	0.31	0.67	260	0.3	5.3	51.0	28.0	4.90	11.00	1.8

Table 6: *Subsoil - Results of laboratory testing*

Pit/Sample	Dispersion	pH (1:5 Water)	pH (1:5 $CaCl_2$)	Electrical Conductivity$_{se}$	Organic Carbon	Chloride	Nitrate Nitrogen	Ammonium Nitrogen	Colwell P	Phosphorus Buffer Index	Sulphur – KCl40	Cation Exchange Capacity	Calcium	Magnesium	Sodium	Potassium	Available Potassium	Aluminium	Aluminium % of Cations	Calcium % of Cations	Magnesium % of Cations	Sodium % of Cations	Potassium % of Cations	Ca/Mg Ratio
Units	-	-	-	dS/m	%	mg/kg	mg/kg	mg/kg	mg/kg	-	mg/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	mg/kg	cmol(+)/kg	%	%	%	%	%	-
1/2	N*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/2	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/2	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/2	P/C	8.9	7.9	3.3	<0.2	310	5	1	7	97	100	21.0	3.5	10.0	6.40	0.82	320	<0.1	<1.0	17.0	49.0	30.00	3.90	0.4
11/2	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13/2	N*	8.1	7.0	0.4	<0.2	<10	7	1	9	84	2	17.1	8.1	7.0	0.67	1.30	520	<0.1	<1.0	47.0	41.0	3.9	7.8	1.2
15/2	P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18/2	N*	8.8	7.8	3.3	<0.2	360	18	2	15	92	74	19.3	2.4	9.9	6.10	0.89	350	<0.1	<1.0	13.0	51.0	32.00	4.60	0.2
1+6/2	-	8.6	7.9	2.9	<0.2	230	11	1	<5	100	26	20.2	11.0	5.9	2.70	0.67	260	<0.1	<1.0	54.0	29.0	13.00	3.30	1.9
11+15/2	-	6.9	5.5	0.6	0.2	58	4	1	6	51	4	6.1	1.9	2.6	1.30	0.26	100	<0.1	<1.0	31.0	43.0	22.00	4.3	0.7

- *Dispersion testing results were rated N, P or C being Nil, Partial or Complete dispersion. An "*" denotes slaking.*

6.0 Comments and Recommendations

The discussion and recommendations provided below are based on field observations and testing at discrete locations.

6.1 Potential Limitations

Potential landscape limitations have been summarised below, **Table 7**.

Table 7: *Potential landscape limitation assessment*

Soil Type	Erosion Hazard	Salinity Risk	Acid Soil	Waterlogging Risk	Acid Sulfate Soils	Infrastructure
Chromosol	MODERATE	LOW	YES	LOW	NO	LOW
Sodosol	MODERATE	LOW	YES	LOW	NO	LOW

As follows is the Digital Atlas of Australian Soils map (CSIRO, 1991) that has been generally validated by the soil survey through laboratory and field techniques, **Figure 6**. As such, management practices can be grouped into management classes of either soil landscape units or Australian Soil Classification (ASC) units. This report identifies management practices for ASC units in section 6.5 below.

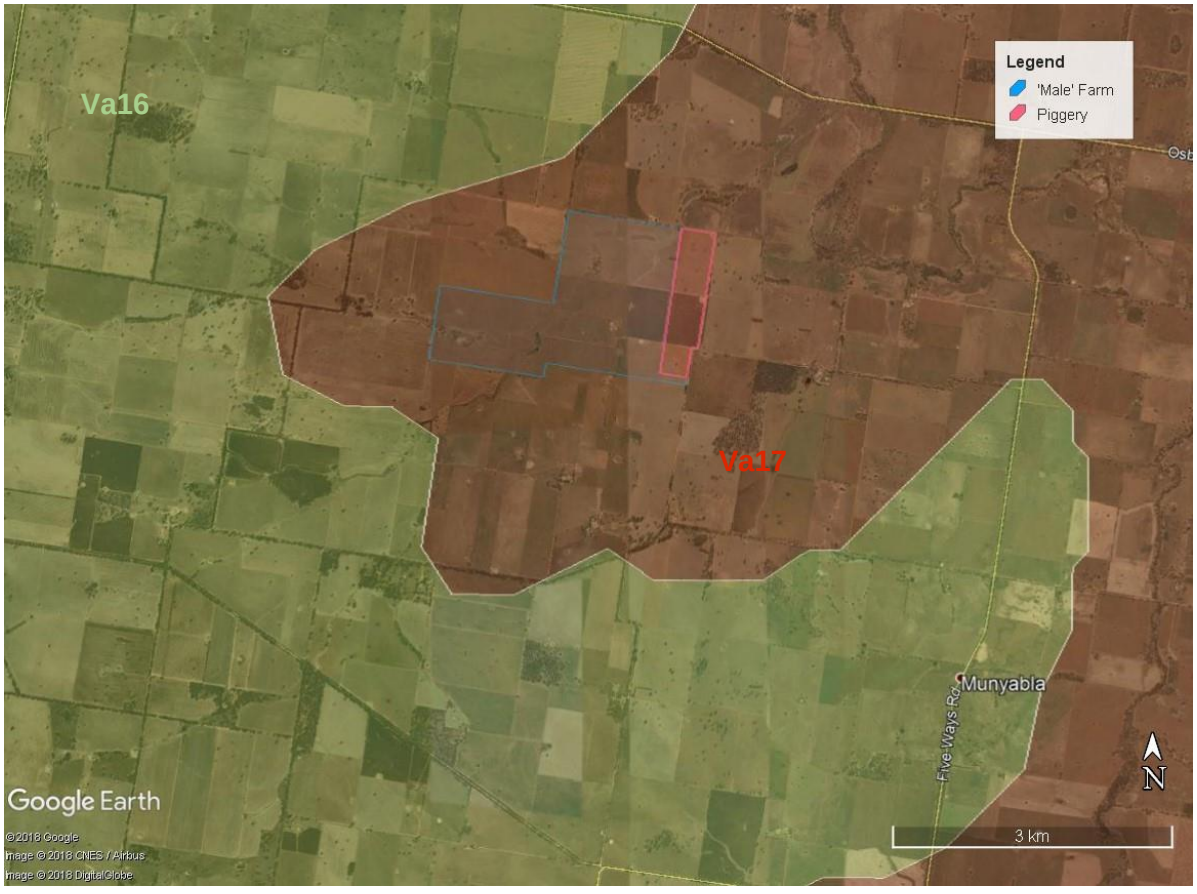

Figure 6: *Digital Atlas of Australian Soils with site overlay.*

6.2 Erosion Control

In order to mitigate the occurrence of erosion the following primary principles should be adhered to, particularly throughout the construction period of the project. Best Management Practices (BMPs) should be employed where applicable to further reduce the risk of potential erosion and sediment control.

- Integrate project design with any site constraints.
- Preserve and stabilise drainageways.
- Minimise the extent and duration of disturbance.
- Control stormwater flows onto, through and from the site in stable drainage structures.
- Install perimeter controls.
- Stabilise disturbed areas promptly.
- Protect steep slopes.
- Employ the use of sediment control measures to prevent off and on-site damage.
- Protect inlets, storm drain outlets and culverts.
- Provide access and general construction controls.
- Inspect and maintain sediment and erosion control measures regularly.

The risk of erosion on site due to construction activities is considered moderate due to the very low relief and generally low salinity of topsoils and subsoils, however dispersion testing indicated some subsoils may be sodic.

Excavation of subsoils should be limited where possible, and excavated subsoils should be stockpiled and contained to avoid potential dispersion and sediment transfer. Ground cover around the structures should be maintained where possible. Maintenance of ground cover will also aid in the prevention of topsoil losses from wind erosion. Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2A & 2C (DECC, 2008) should be consulted further in the development an Erosion and Sediment Control Plan (ESCP).

6.3 Acid Sulfate Soils

Acid sulphate soils is the common name given to naturally occurring soils containing iron sulphides. Exposure of the sulphides present in these soils to oxygen from drainage or excavation will lead to the generation of sulfuric acid. Field pH of these soils in their undisturbed state is generally pH 4 or less.

Landscape characteristics such as; the dominance of mangroves, reeds, rushes and other marine/estuarine or swamp-tolerant vegetation, low lying areas, back swamps or scalded areas of coastal estuaries and floodplains and sulphurous smell following rain after prolonged dry periods (Stone *et al*, 1998) after soil disturbance were not observed. There was no evidence of a jarositic horizon or jarosite precipitates or coatings on any root channels or cracks in the soil.

From the soil survey conducted, it has been deduced that acid sulfate soils are not present on site.

6.4 Soil Characteristics and Management Responses

6.4.1 Chromosols

Table 8: *Chromosol characteristics and management responses*

Soil Property	Behaviour of soil to activity or environment	Management responses/measures
Soil Surface		
These soils generally have weak structure in the surface with a firm to hard setting surface condition.	A firm to hard setting surface will generally have poor initial infiltration resulting in a large proportion of water running off causing erosion.	Surface infiltration rate can be increased through the incorporation of composted organic matter and by maintaining vegetative cover.
	A hard setting surface will also cause poor germination and seedling emergence.	Soil structure and moisture holding capacity can be improved through the incorporation of composted organic matter leading to better seedling establishment.
	A sandy to loamy surface with poor structure can have low soil strength causing trafficability issues.	Trafficability of these soils may be difficult when wet, however the use of gravel road surfaces may improve site access.
	If sandy to loamy surface soil with poor structure and low soil strength is overworked or excessively trafficked there is a high potential to generate dust.	Limit traffic and do not disturb unless necessary to avoid destruction of the limited soil structure. Construct gravel roads on the site and limit access off these roads. Consider the use of stabilisation products.
Expansive Clays		
These soils contain little to no expansive clays.		
Clay Subsoils		
These soils contain non-sodic, slightly acidic to slightly alkaline clay subsoils that may be mottled.	These soils have imperfect drainage and lower landscape positions can stay wet for extended periods of time. Subsoil permeability is moderate.	Subsoil material is unsuitable for use on the soil surface and should be adequately covered with topsoil. Appropriate drainage design and materials (i.e. sand and gravel) can improve site access for construction. Depending on subsoil structure, plant roots are generally able to extend into the subsoil material without restriction. Gypsum additions can be used to assist structure improvement where required.

Soil Property	Behaviour of soil to activity or environment	Management responses/measures
Dispersion		
These soils are generally non-dispersive; however, testing will be needed to confirm.	Although not generally dispersive, these soils are still susceptible to rill, sheet and stream bank erosion.	Maintain cover to reduce sheet and rill erosion. Stream bank erosion managed by maintaining vegetative cover and encouraging plants with fibrous root systems. Do not concentrate water flow unless using appropriate erosion and sediment control treatments. Erosion and sediment controls may need to be installed to manage drainage, erosion and prevent movement of sediment off-site.
Salinity		
These soils can have high salt levels (depending on parent material and landscape practices) particularly on lower slopes.	High salt levels will affect plant growth and will also impact water quality if leached or washed off.	If irrigating salty soils, maintain a leaching profile to reduce salt levels (salinity management handbook (DERM 2011) contains thresholds for different plants). Treat salty soils as dispersive soils, even if field testing results are negative, because salt can mask dispersion.
	Salt can cause scalding, erosion and damage to infrastructure.	Discharge salinity expressions can be managed by reducing water inputs and by increasing soil water use at the site or upslope if possible. Soil amelioration with gypsum and planting salt tolerant species may assist scald areas.
Fertility		
These soils generally have a low to moderate fertility.	The sandy surface and pale subsurface layers (where present) generally mean that nutrient content is low in these soils, as is their ability to hold onto nutrients.	Fertiliser additions may improve plant growth, particularly nitrogen, phosphorus, and potassium. To limit leaching/loss of nutrients, specific fertiliser rates should be divided up into regular smaller applications during the growing season, rather than one single application. Increasing organic matter content with composted organics will improve the fertility and assist nutrient retention in these soils.

Soil Property	Behaviour of soil to activity or environment	Management responses/measures
Revegetation		
These soils are poorly to imperfectly drained with low to moderate fertility, highly alkaline subsoils and low plant available water holding capacity.	Plant species need be selected that are adapted to these conditions.	Addition of gypsum may be required to alleviate dispersion risk. Increasing organic matter content with composted organics will improve fertility, assist nutrient retention and improve moisture holding capacity of these soils. Relieve any compaction present and ensure adequate fertility for quick establishment. These soils will require frequent, low volume watering due to the dense subsoils. Protect surface with mulch material to reduce raindrop induced crusted or hard setting surface. Fertiliser additions should be divided up into regular smaller applications during the growing season to limit leaching of nutrients. Dense subsoil material significantly restricts plant root extension into the subsoil. Stabilisation and revegetation targets and timeframes should be in accordance with IECA (2008) guidelines
Soil Handling		
Some of these soils have very salty and/ or dispersive subsoils and potentially dusty topsoil.	The objective of soil handling is to minimise off site impacts and maximise the productive capacity of the soil on site consistent with the intended use.	Topsoil stripping should maximise available reserves and should avoid mixing with alkaline, salty and/or sodic subsoils – a simple survey of the site is recommended. Topsoil and subsoil stockpiles should be kept separate. Reinstate soil in the order they were removed (i.e. deeper subsoil below upper subsoil). Final placement of dispersive materials should be covered with adequate topsoil material to protect from erosion. Installation of erosion and sediment control structures may be required where soil is exposed. Trafficability of these soils may be difficult when wet, the use of gravel road surfaces may improve site access. Minimise the handling of topsoil material and ensure traffic is concentrated on constructed road surfaces.

6.4.2 Sodosols

Table 9: *Sodosol characteristics and management responses*

Soil Property	Behaviour of soil to activity or environment	Management responses/measures
Soil Surface		
These soils generally have weak structure in the surface with a firm to hardsetting surface condition.	A sandy to loamy surface with poor structure can have low soil strength causing trafficability issues. If sandy to loamy surface soil with poor structure and low soil strength is overworked or excessively trafficked there is a high potential to generate dust.	Trafficability of these soils may be difficult when wet, however the use of gravel road surfaces may improve site access. Limit traffic and do not disturb unless necessary to avoid destruction of the soil structure. Construct gravel roads on the site and limit access off these roads. Consider the use of soil stabilisation products (i.e. polymer sprays).
Expansive Clays		
These soils contain little to no expansive clays.		
Clay Subsoils		
These soils contain dense sodic, alkaline clay subsoils that are commonly mottled.	Depending on landscape position these soils can stay wet for long periods of time.	Appropriate drainage design and materials (e.g. sand and gravel) can improve site access for construction. Water diversion or vegetation may limit waterlogging at some locations.
Dispersion		
These soils are sometimes dispersive in the subsoil.	Dispersive soils have a high erosion risk and tunnel and gully erosion can occur.	Do not expose dispersive subsoil or at least minimise exposure (e.g. by staging construction disturbance, topsoil replacement and rehabilitation immediately following construction, installation of pipes and culverts for drains and other general earthworks). Gypsum can be used to ameliorate dispersive soils and assist with improving drainage and soil structure. Avoid ponding water on dispersive soils. To avoid an increased risk of tunnel erosion, ensure reinstated subsoil material is compacted similar to that of surrounding subsoil. Do not concentrate water flow unless using appropriate erosion and sediment control treatments. Erosion and sediment controls may need to be installed to manage drainage, erosion and prevent movement of sediment off-site.

Soil Property	Behaviour of soil to activity or environment	Management responses/measures
Salinity		
These soils can have high salt levels (depending on parent material and landscape practices) particularly on lower slopes.	High salt levels will affect plant growth and will also impact water quality if leached or washed off.	If irrigating salty soils, maintain a leaching profile (i.e.. increase irrigation) to reduce salt levels (the salinity management handbook (DERM 2011) contains thresholds for different plants). Treat salty soils as dispersive soils, even if field testing results are negative, because salt can mask dispersion.
	Salt can cause scalding, erosion and damage to infrastructure.	Discharge salinity expressions can be managed by reducing water inputs (e.g. reducing irrigation, water diversions) and by increasing soil water use at the site or upslope if possible. Soil amelioration with gypsum and planting salt tolerant species may assist scald areas.
Fertility		
These soils generally have low to moderate fertility**.**	The sandy surface and pale subsurface layers generally mean that nutrient content is low in these soils as is their ability to retain nutrient.	Fertiliser additions will improve plant growth, particularly nitrogen, phosphorus, and potassium. To limit leaching/loss of nutrients, specific fertiliser rates should be divided up into regular smaller applications during the growing season, rather than one single application. Increasing organic matter content with composted organics will improve the fertility of these soils.
Revegetation		
These soils are poorly to imperfectly drained with low to moderate fertility, highly alkaline subsoils and low plant available water holding capacity.	Plant species need be selected that are adapted to these conditions.	Addition of gypsum may be required to alleviate dispersion risk. Increasing organic matter content with composted organics will improve fertility, assist nutrient retention and improve moisture holding capacity of these soils. Relieve any compaction present and ensure adequate fertility for quick establishment (testing required). These soils may require frequent, low volume watering due to the dense subsoils. Protect surface with mulch material to reduce raindrop induced crusted or hardsetting surface. Fertiliser additions should be divided up into regular smaller applications during the growing season to limit leaching of nutrients. Dense subsoil material significantly restricts plant root extension into the subsoil. Stabilisation and revegetation targets and timeframes should be in accordance with IECA (2008) guidelines.

Soil Property	Behaviour of soil to activity or environment	Management responses/measures
Soil handling		
Some of these soils have very salty and/or dispersive subsoils and potentially dusty topsoil.	The objective of soil handling is to minimise off site impacts and maximise the productive capacity of the soil on site consistent with the intended use.	Topsoil stripping should maximise available reserves and should avoid mixing with alkaline, salty and/or sodic subsoils – a simple survey of the site is recommended. Topsoil and subsoil stockpiles should be kept separate. Reinstate soil in the order they were removed (i.e. deeper subsoil below upper subsoil). Final placement of dispersive materials should be covered with adequate topsoil material to protect from erosion (subsoil amelioration with gypsum may also be needed). Install erosion and sediment control structures where soil is exposed (i.e.. clean water diversions upslope, sediment fences around stockpiles, sediment control structures downslope). Trafficability of these soils may be difficult when wet, the use of gravel road surfaces may improve site access. Minimise the handling of topsoil material and ensure traffic is concentrated on constructed road surfaces (reduce soil degradation and dust generation).

7.0 Notes relating to results

Groundwater

No Free groundwater was encountered during the investigation. A groundwater table or seepage may be present at other times and fluctuations in groundwater levels and seepage could occur due to rainfall, changes in temperature and other factors.

Bore hole / test pit logging

The information supplied in the log sheets is based on visual and tactile assessment based on field conditions at the time of testing. The log sheets can include inferred data based on the experience of the geotechnician as well as factual data from in situ testing.

Samples

D Disturbed sample

B Bulk or composite sample

U Undisturbed sample

Moisture Condition	
D	Dry – runs freely through the fingers
T	Moderately moist – does not run freely and is difficult to form
M	Moist – does not run freely but is able to be formed
W	Wet – free water visible on the soil surface

Consistency (Cohesive Soils)	
Description	Unconfined Compressive Strength (UCS)
Very soft	<25kPa
Soft	25-50kPa
Firm	50-100kPa
Stiff	100-200kPa
Very Stiff	200-400kPa
Hard	>400kPa

Relative Density (Cohesionless Soils)			
Description	N Value	Density Index	Soil Friction
	blows per 300mm	Range%	Angle (degrees)
Very Loose	0-4	<15	<30
Loose	4-10	15-35	30-35
Medium	10-30	35-65	35-40
Dense	30-50	65-85	40-45
Very Dense	>50	>85	<45

8.0 Disclaimer

The information contained in this report has been extracted from field and laboratory sources believed to be reliable and accurate. DM McMahon Pty Ltd will not assume any responsibility for the misinterpretation of information supplied in this report. The accuracy and reliability of recommendations identified in this report need to be evaluated with due care according to individual circumstances. It should be noted that the recommendations and findings in this report are based solely upon the said site location and the ground level conditions at the time of testing. The results of the said investigations undertaken are an overall representation of the conditions encountered. The properties of the soil within the location may change due to variations in ground conditions outside of the tested area. The author has no control or liability over site variability that may warrant further investigation that may lead to significant design changes.

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10.0 Attachments

Attachment	Details
A. Field soil logs	4 pages
B. Laboratory results	20 pages

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DOCUMENT ATTACHMENTS

REPORT 2018

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Attachment A : *Field soil logs*

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SOIL SURVEY FIELD SHEET

Job No: 5407
Project: LEAP Consulting
Site: Munyabla

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Layer Top (m)	Layer Bottom (m)	Horizon	Boundary	Colour	Texture	Moisture	Consistence	Mottles	Mottle Type	Structure	Coarse Fragments	Fragment Size (mm)	Fragment (%)	Comments
1	1	490406 6080429	0.0	0.2	A		B	CL	T	3	N	-	SAB	Nil	-	-	Manganese nodules.
			0.2	0.6	B1	C	-YB	LC	D	5	Y	R	SAB	Nil	-	-	
	2		0.6	1.1	B2	D	BY	LC	D	5	Y	R	SAB	Nil	-	-	
2	1	489815 6080408	0.0	0.3	A		B	CL	D	3	N	-	SAB	Nil	-	-	Roots to ~0.40m. Carbonate present in B2 Horizon. Manganese accretions.
	2		0.3	0.6	B1	D	YB	LC	T/D	4	Y	Black	SAB	Nil	-	-	
			0.6	1.2	B2	D	BY	LC	D	6	Y	Black	SAB	Y	5 to 10	<5	
3	1	0489932 6080844	0.0	0.4	A		-B	CL	D	3	N	-	SAB	Nil	-	-	Manganese nodules in B Horizon.
	2		0.4	1.2	B	D	YB	LC	T/D	6	Y	Red	SAB	Nil	-	-	
4	1	4899089 6080328	0.0	0.3	A		-B	CL	T	3	N	-	SAB	Nil	-	-	Manganese nodules and carbonate present in B1 and B2 Horizons.
	2		0.3	0.7	B1	C	YB	LC	T	5	Y	Red	SAB	Nil	-	-	
			0.7	1.3	B2	D	RYB	LMC	T	6	Y	Red	SAB	Nil	-	-	
5	1	489065 6080771	0.0	0.4	A		+B	CL	T	5	Nil	-	SAB	Nil	-	-	
	2		0.4	0.6	B1	D	B	LC	T	4	Nil	-	SAB	Nil	-	-	
			0.6	1.1	B2	C	YB	LC	T	4	Y	Bl&B	SAB	Nil	-	-	
6	1	488038 6080491	0.0	0.4	A		B	CL	D	4	Nil	-	SAB	Nil	-	-	Manganese nodules in B1 Horizon. Carbonate present in B2 Horizon.
			0.4	0.7	B1	D	YB	LC	D	6	Y	Red	SAB	Nil	-	-	
	2		0.7	1.3	B2	D	BY	LC	D	6	Y	Red	SAB	Nil	-	-	

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Site Identity	Sample	Co-ordinates MGA GDA94 z55	Layer Top (m)	Layer Bottom (m)	Horizon	Boundary	Colour	Texture	Moisture	Consistence	Mottles	Mottle Type	Structure	Coarse Fragments	Fragment Size (mm)	Fragment (%)	Comments
7	1	487989 6081285	0.0	0.20	A1		+B	CL	T	3	N	-	SAB	Nil	-	-	Manganese nodules present in B Horizon.
			0.20	0.60	A2	D	-B	CL	D	3	N	-	SAB	Nil	-	-	
	2		0.60	1.20	B	C	BY	LC	D	5	Y	Red	SAB	Nil	-	-	
8	1	488464 6080710	0.0	0.10	A1		+B	CL	D	4	N	-	SAB	Nil	-	-	Manganese accretions in B1 and B2 Horizons.
			0.10	0.50	A2	C	B	CL	D	5	N	-	SAB	Nil	-	-	
	2		0.50	0.80	B1	D	BY	LC	D	5	Y	Black	SAB	Nil	-	-	
			0.80	1.10	B2	C	YB	LC	D	5	Y	Black	SAB	Nil	-	-	
9	1	488806 6081170	0.0	0.1	A1		B	CL	T	2	N	-	SAB	Nil	-	-	Manganese nodules in B1 Horizon. A small amount of carbonate present in B1 and B2 Horizons.
			0.1	0.4	A2	D	B	CL	T	4	N	-	SAB	Nil	-	-	
	2		0.4	0.7	B1	C	YB	LC	T	6	N	-	SAB	Nil	-	-	
			0.7	1.2	B2	C	BY	LC	T	6	Y	Red	SAB	Nil	-	-	
10	1	489228 6081256	0.0	0.5	A		+B	CL	D	3	N	-	SAB	Nil	-	-	Manganese accretions and lots of carbonate present in B Horizon.
	2		0.5	1.2	B	C	B	LC	D-T	6	Y	Black	SAB	Nil	-	-	
11	1	489605 6081386	0.0	0.3	A1		B	CL	D-T	2	N	-	w.d. SAB	Nil	-	-	Bleached A2 Horizon (near a drainage line). Manganese nodules present in B Horizon.
	2		0.3	0.7	A2	C	--B	CL	D	6	N	-	SAB	Nil	-	-	
	3		0.7	1.1	B	C	YB	LC	D	6	Y	+Red	SAB	Nil	-	-	

SOIL SURVEY FIELD SHEET

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Project: LEAP Consulting
Site: Munyabla

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Layer Top (m)	Layer Bottom (m)	Horizon	Boundary	Colour	Texture	Moisture	Consistence	Mottles	Mottle Type	Structure	Coarse Fragments	Fragment Size (mm)	Fragment (%)	Comments
12	1	489281 6081622	0.0	0.20	A1		B	CL	D-T	2	N	-	SAB	Nil	-	-	Slightly bleached A2 Horizon.
			0.20	0.40	A2	C	--B	CL	D	3	N	-	SAB	Nil	-	-	
			0.40	0.70	B1	D	YB	LC	D	4	Y	Black	SAB	Nil	-	-	
	2		0.70	1.30	B2	D	BY	LMC	D	5	N	-	SAB	Nil	-	-	
13	1	489371 6082093	0.00	0.30	A1		--B	ZSCL	D	2	N		SAB	Nil	-	-	Manganese nodules present in B1 and B2 Horizons.
	2		0.30	0.60	B1	C	YB	LC	D	4	Y	Red	SAB	Nil	-	-	
			0.60	1.20	B2	C	BY	LC	D	6	Y	Red	SAB	Nil	-	-	
14	1	489855 6082015	0.0	0.15	A1		B	ZSCL	D	3	N	-	SAB	Nil	-	-	Bleached A2 Horizon. Manganese nodules and carbonate present in B1 and B2 Horizon.
			0.15	0.3	A2	A	--B	CL	D	4	N	-	SAB	Nil	-	-	
	2		0.3	0.7	B1	D	RB	LC	D-T	4	N	-	SAB	Nil	-	-	
			0.7	1.2	B2	D	RB	LC	D-T	5	Y	Red	SAB	Nil	-	-	
15	1	489872 6081758	0.0	0.2	A1		+B	ZCL	D	3	N		SAB	Nil	-	-	Less clay and bleached in A2 Horizon (near drainage line).
	2		0.2	0.6	A2	A	--B	ZCL	D-T	2	N		SAB	Nil	-	-	
	3		0.6	1.1	B	D	YRB	LC	D	5	Y	Black	SAB	Nil	-	-	
16	1	490528 6081893	0.0	0.2	A1		-B	CL	D	3	N		w.d. SAB	Nil	-	-	Bleached A2 Horizon. Manganese nodules in B1 Horizon.
			0.2	0.4	A2	D	-YB	CL	D	3	N		SAB	Nil	-	-	
	3		0.4	1.2	B1	D	BY	LC	D	5	Y	Red	SAB	Nil	-	-	

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SOIL SURVEY FIELD SHEET

Job No: 5407
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Site: Munyabla

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Layer Top (m)	Layer Bottom (m)	Horizon	Boundary	Colour	Texture	Moisture	Consistence	Mottles	Mottle Type	Structure	Coarse Fragments	Fragment Size (mm)	Fragment (%)	Comments
17	1	0490872 6081774	0.0	0.10	A1		-B	L	T	3	N	-	SAB	Nil	-	-	
			0.10	0.40	A2	D	+B	CL	D	5	N	-	SAB	Nil	-	-	
	2		0.40	1.20	B1	D	YB	CL	D	4	Y	Red	SAB	Nil	-	-	
18	1	490589 6081107	0.0	0.05	A1		B	L	T	2	N	-	SAB	Nil	-	-	Carbonate and manganese nodules present in B Horizon.
			0.05	0.30	A2	C	--B	L	T-D	4	N	-	SAB	Nil	-	-	
	2		0.30	1.20	B	D	BY	LC	D	5	Y	Red	SAB	Nil	-	-	
19	1	490822 6081107	0.0	0.1	A1		-B	CL	D	3	N	-	w.d. SAB	Nil	-	-	Manganese nodules present in B Horizon.
			0.1	0.4	A2	D	--B	CL	D	4	N	-	w.d. SAB	Nil	-	-	
	2		0.4	1.2	B	D	RB	LC	D-T	5	Y	Red	w.d. SAB	Nil	-	-	
20	1	490279 6081552	0.0	0.1	A1		-B	CL	D	3	N	-	w.d. SAB	Nil	-	-	Manganese nodules present in B Horizon.
			0.1	0.4	A2	D	--B	CL	D	4	N	-	w.d. SAB	Nil	-	-	
	2		0.4	1.2	B	D	RB	LC	D-T	5	Y	Red	w.d. SAB	Nil	-	-	

Attachment B : *Laboratory results*

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Grower Name : D M MCMAHON PTY LTD
Sample No: 022018940
Paddock Name: 18/2
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Brown
Soil Texture		Clay
pH (1:5 Water)		8.8
pH (1:5 CaCl2)		7.8
Electrical Conductivity (1:5 water)	dS/m	0.54
Electrical Conductivity (Sat. Ext.)	dS/m	3.3
Chloride	mg/kg	360
Organic Carbon (W&B)	%	<0.2
Nitrate Nitrogen	mg/kg	18
Ammonium Nitrogen	mg/kg	2
Phosphorus (Colwell)	mg/kg	15
Phosphorus Buffer Index		92
Sulphur (KCl40)	mg/kg	74
Cation Exch. Cap. (CEC)	cmol(+)/kg	19.3
Calcium (Amm-acet.)	cmol(+)/kg	2.4
Magnesium (Amm-acet.)	cmol(+)/kg	9.9
Sodium (Amm-acet.)	cmol(+)/kg	6.10
Potassium (Amm-acet.)	cmol(+)/kg	0.89
Available Potassium	mg/kg	350
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	13.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018940	**Test Code:**	E12
Paddock Name:	18/2	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	51.0
Sodium % of Cations (ESP)	%	32.00
Potassium % of Cations	%	4.60
Calcium/Magnesium Ratio		0.2

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Report Print Date: 07/09/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018941
Paddock Name: 18/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Brown
Soil Texture		Clay
pH (1:5 Water)		5.6
pH (1:5 CaCl2)		4.9
Electrical Conductivity (1:5 water)	dS/m	0.23
Electrical Conductivity (Sat. Ext.)	dS/m	1.4
Chloride	mg/kg	18
Organic Carbon (W&B)	%	2.5
Nitrate Nitrogen	mg/kg	78
Ammonium Nitrogen	mg/kg	14
Phosphorus (Colwell)	mg/kg	150
Phosphorus Buffer Index		89
Sulphur (KCl40)	mg/kg	19
Cation Exch. Cap. (CEC)	cmol(+)/kg	7.9
Calcium (Amm-acet.)	cmol(+)/kg	4.0
Magnesium (Amm-acet.)	cmol(+)/kg	1.7
Sodium (Amm-acet.)	cmol(+)/kg	0.24
Potassium (Amm-acet.)	cmol(+)/kg	1.90
Available Potassium	mg/kg	740
Aluminium (KCl)	cmol(+)/kg	0.2
Aluminium % of Cations	%	1.8
Calcium % of Cations	%	50.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018941	**Test Code:**	E12
Paddock Name:	18/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	21.0
Sodium % of Cations (ESP)	%	3.00
Potassium % of Cations	%	24.00
Calcium/Magnesium Ratio		2.4

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Report Print Date: 07/09/2018
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Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018942
Paddock Name: 13/2
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Orange/Yellow
Soil Texture		Clay
pH (1:5 Water)		8.1
pH (1:5 CaCl2)		7.0
Electrical Conductivity (1:5 water)	dS/m	0.07
Electrical Conductivity (Sat. Ext.)	dS/m	0.4
Chloride	mg/kg	<10
Organic Carbon (W&B)	%	<0.2
Nitrate Nitrogen	mg/kg	7
Ammonium Nitrogen	mg/kg	1
Phosphorus (Colwell)	mg/kg	9
Phosphorus Buffer Index		84
Sulphur (KCl40)	mg/kg	2
Cation Exch. Cap. (CEC)	cmol(+)/kg	17.1
Calcium (Amm-acet.)	cmol(+)/kg	8.1
Magnesium (Amm-acet.)	cmol(+)/kg	7.0
Sodium (Amm-acet.)	cmol(+)/kg	0.67
Potassium (Amm-acet.)	cmol(+)/kg	1.30
Available Potassium	mg/kg	520
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	47.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018942	**Test Code:**	E12
Paddock Name:	13/2	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	41.0
Sodium % of Cations (ESP)	%	3.90
Potassium % of Cations	%	7.80
Calcium/Magnesium Ratio		1.2

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Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018943
Paddock Name: 13/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Brown
Soil Texture		Clay Loam
pH (1:5 Water)		5.7
pH (1:5 CaCl2)		4.8
Electrical Conductivity (1:5 water)	dS/m	0.06
Electrical Conductivity (Sat. Ext.)	dS/m	0.5
Chloride	mg/kg	<10
Organic Carbon (W&B)	%	1.5
Nitrate Nitrogen	mg/kg	12
Ammonium Nitrogen	mg/kg	3
Phosphorus (Colwell)	mg/kg	16
Phosphorus Buffer Index		44
Sulphur (KCl40)	mg/kg	6
Cation Exch. Cap. (CEC)	cmol(+)/kg	5.0
Calcium (Amm-acet.)	cmol(+)/kg	3.3
Magnesium (Amm-acet.)	cmol(+)/kg	0.8
Sodium (Amm-acet.)	cmol(+)/kg	0.03
Potassium (Amm-acet.)	cmol(+)/kg	0.64
Available Potassium	mg/kg	250
Aluminium (KCl)	cmol(+)/kg	0.1
Aluminium % of Cations	%	2.7
Calcium % of Cations	%	68.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018943	**Test Code:**	E12
Paddock Name:	13/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	16.0
Sodium % of Cations (ESP)	%	0.60
Potassium % of Cations	%	13.00
Calcium/Magnesium Ratio		4.1

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Phone: 02 6931 0510
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Grower Name : D M MCMAHON PTY LTD
Sample No: 022018944
Paddock Name: 9/2
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Orange/Yellow
Soil Texture		Clay
pH (1:5 Water)		8.9
pH (1:5 CaCl2)		7.9
Electrical Conductivity (1:5 water)	dS/m	0.54
Electrical Conductivity (Sat. Ext.)	dS/m	3.3
Chloride	mg/kg	310
Organic Carbon (W&B)	%	<0.2
Nitrate Nitrogen	mg/kg	5
Ammonium Nitrogen	mg/kg	1
Phosphorus (Colwell)	mg/kg	7
Phosphorus Buffer Index		97
Sulphur (KCl40)	mg/kg	100
Cation Exch. Cap. (CEC)	cmol(+)/kg	21.0
Calcium (Amm-acet.)	cmol(+)/kg	3.5
Magnesium (Amm-acet.)	cmol(+)/kg	10.0
Sodium (Amm-acet.)	cmol(+)/kg	6.40
Potassium (Amm-acet.)	cmol(+)/kg	0.82
Available Potassium	mg/kg	320
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	17.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018944	**Test Code:**	E12
Paddock Name:	9/2	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	49.0
Sodium % of Cations (ESP)	%	30.00
Potassium % of Cations	%	3.90
Calcium/Magnesium Ratio		0.4

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Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018945
Paddock Name: 9/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Brown
Soil Texture		Clay
pH (1:5 Water)		6.0
pH (1:5 CaCl2)		4.7
Electrical Conductivity (1:5 water)	dS/m	0.08
Electrical Conductivity (Sat. Ext.)	dS/m	0.5
Chloride	mg/kg	16
Organic Carbon (W&B)	%	0.8
Nitrate Nitrogen	mg/kg	12
Ammonium Nitrogen	mg/kg	2
Phosphorus (Colwell)	mg/kg	9
Phosphorus Buffer Index		82
Sulphur (KCl40)	mg/kg	10
Cation Exch. Cap. (CEC)	cmol(+)/kg	4.8
Calcium (Amm-acet.)	cmol(+)/kg	2.2
Magnesium (Amm-acet.)	cmol(+)/kg	1.3
Sodium (Amm-acet.)	cmol(+)/kg	0.49
Potassium (Amm-acet.)	cmol(+)/kg	0.40
Available Potassium	mg/kg	160
Aluminium (KCl)	cmol(+)/kg	0.4
Aluminium % of Cations	%	7.7
Calcium % of Cations	%	46.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018945	**Test Code:**	E12
Paddock Name:	9/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	27.0
Sodium % of Cations (ESP)	%	10.00
Potassium % of Cations	%	8.40
Calcium/Magnesium Ratio		1.7

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Report Print Date: 07/09/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018946
Paddock Name: 1+6/2
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Orange/Yellow
Soil Texture		Clay
pH (1:5 Water)		8.6
pH (1:5 CaCl2)		7.9
Electrical Conductivity (1:5 water)	dS/m	0.46
Electrical Conductivity (Sat. Ext.)	dS/m	2.9
Chloride	mg/kg	230
Organic Carbon (W&B)	%	<0.2
Nitrate Nitrogen	mg/kg	11
Ammonium Nitrogen	mg/kg	1
Phosphorus (Colwell)	mg/kg	<5
Phosphorus Buffer Index		100
Sulphur (KCl40)	mg/kg	26
Cation Exch. Cap. (CEC)	cmol(+)/kg	20.2
Calcium (Amm-acet.)	cmol(+)/kg	11.0
Magnesium (Amm-acet.)	cmol(+)/kg	5.9
Sodium (Amm-acet.)	cmol(+)/kg	2.70
Potassium (Amm-acet.)	cmol(+)/kg	0.67
Available Potassium	mg/kg	260
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	54.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018946	**Test Code:**	E12
Paddock Name:	1+6/2	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	29.0
Sodium % of Cations (ESP)	%	13.00
Potassium % of Cations	%	3.30
Calcium/Magnesium Ratio		1.9

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Report Print Date: 07/09/2018
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Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018947
Paddock Name: 1+6/2
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Brown
Soil Texture		Clay
pH (1:5 Water)		6.0
pH (1:5 CaCl2)		4.8
Electrical Conductivity (1:5 water)	dS/m	0.05
Electrical Conductivity (Sat. Ext.)	dS/m	0.3
Chloride	mg/kg	<10
Organic Carbon (W&B)	%	1.1
Nitrate Nitrogen	mg/kg	3
Ammonium Nitrogen	mg/kg	3
Phosphorus (Colwell)	mg/kg	10
Phosphorus Buffer Index		96
Sulphur (KCl40)	mg/kg	4
Cation Exch. Cap. (CEC)	cmol(+)/kg	4.9
Calcium (Amm-acet.)	cmol(+)/kg	2.6
Magnesium (Amm-acet.)	cmol(+)/kg	1.1
Sodium (Amm-acet.)	cmol(+)/kg	0.17
Potassium (Amm-acet.)	cmol(+)/kg	0.70
Available Potassium	mg/kg	270
Aluminium (KCl)	cmol(+)/kg	0.4
Aluminium % of Cations	%	7.1
Calcium % of Cations	%	53.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018947	**Test Code:**	E12
Paddock Name:	1+6/2	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	23.0
Sodium % of Cations (ESP)	%	3.40
Potassium % of Cations	%	14.00
Calcium/Magnesium Ratio		2.4

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Report Print Date: 07/09/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018948
Paddock Name: 11+15/2
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Brown
Soil Texture		Clay
pH (1:5 Water)		6.9
pH (1:5 CaCl2)		5.5
Electrical Conductivity (1:5 water)	dS/m	0.09
Electrical Conductivity (Sat. Ext.)	dS/m	0.6
Chloride	mg/kg	58
Organic Carbon (W&B)	%	0.2
Nitrate Nitrogen	mg/kg	4
Ammonium Nitrogen	mg/kg	1
Phosphorus (Colwell)	mg/kg	6
Phosphorus Buffer Index		51
Sulphur (KCl40)	mg/kg	4
Cation Exch. Cap. (CEC)	cmol(+)/kg	6.1
Calcium (Amm-acet.)	cmol(+)/kg	1.9
Magnesium (Amm-acet.)	cmol(+)/kg	2.6
Sodium (Amm-acet.)	cmol(+)/kg	1.30
Potassium (Amm-acet.)	cmol(+)/kg	0.26
Available Potassium	mg/kg	100
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	31.0

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018948	**Test Code:**	E12
Paddock Name:	11+15/2	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	43.0
Sodium % of Cations (ESP)	%	22.00
Potassium % of Cations	%	4.30
Calcium/Magnesium Ratio		0.7

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Agent/Dealer:
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Phone: 02 6931 0510
Purchase Order No: 5407

Grower Name : D M MCMAHON PTY LTD
Sample No: 022018949
Paddock Name: 11+15/11
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E12
Sample Type: Soil
Sampling Date: 29/08/2018

Analyte / Assay	Units	Value
Soil Colour		Brown
Soil Texture		Clay
pH (1:5 Water)		5.5
pH (1:5 CaCl2)		4.6
Electrical Conductivity (1:5 water)	dS/m	0.14
Electrical Conductivity (Sat. Ext.)	dS/m	0.9
Chloride	mg/kg	60
Organic Carbon (W&B)	%	1.0
Nitrate Nitrogen	mg/kg	42
Ammonium Nitrogen	mg/kg	3
Phosphorus (Colwell)	mg/kg	23
Phosphorus Buffer Index		130
Sulphur (KCl40)	mg/kg	5
Cation Exch. Cap. (CEC)	cmol(+)/kg	6.3
Calcium (Amm-acet.)	cmol(+)/kg	3.2
Magnesium (Amm-acet.)	cmol(+)/kg	1.8
Sodium (Amm-acet.)	cmol(+)/kg	0.31
Potassium (Amm-acet.)	cmol(+)/kg	0.67
Available Potassium	mg/kg	260
Aluminium (KCl)	cmol(+)/kg	0.3
Aluminium % of Cations	%	5.3
Calcium % of Cations	%	51.0

Analyses conducted by **Nutrient Advantage Laboratory Services**
8 South Road, Werribee VIC 3030
NATA Accreditation No: 11958
Tel: 1800 803 453
Certificate of Analysis is available upon request.
Email: lab.feedback@incitecpivot.com.au

Nutrient Advantage®

Nutrient Advantage Advice® Nutrient Report

Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022018949	**Test Code:**	E12
Paddock Name:	11+15/11	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	29/08/2018
Sample Depth (cm):	0 **To** 10		

Analyte / Assay	Units	Value
Magnesium % of Cations	%	28.0
Sodium % of Cations (ESP)	%	4.90
Potassium % of Cations	%	11.00
Calcium/Magnesium Ratio		1.8

The results reported pertain only to the sample submitted.
Analyses performed on soil dried at 40 degrees Celsius and ground to <2mm (excluding moisture assay)
* One or more components of this test are below their detection limit. The value used is indicative only.