SOIL SURVEY REPORT

YANCO SOLAR FARM

FEBRUARY 2019

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February 2019

Project brief

At the request of Sarah Hillis of NGH Environmental Pty Ltd, soil sampling, analysis and reporting was carried out to assess the site for a proposed solar farm on 7 and 8 November 2018. The document provides information about the site and soil conditions from field observations and laboratory analysis.

Site identification

Address: 385 Toorak Rd Leeton 2705; 249 Toorak Rd Leeton 2705.
Real property description: Lots 287, 142, 145, 146, 147, 148, 149, 150, 151 152 & 572 DP751745; Lot 6650 DP 197165.
Centre co-ordinate: 443422E 6172635N MGA GDA z55
Property size: 180 ha approximately
Owner: c/o NGH Environmental Pty Ltd
Local Council Area: Leeton Shire Council
Present use: Horticulture and viticulture
Development Application Reference: not known
Report identification: 5474

Certification

Name	Signed	Date	Revision Number
David McMahon CEnvP BAppSc SA GradDip WRM MEnvMgmt		28/02/19	00

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1.0 Introduction

The report presents the results of a soil survey carried out by DM McMahon Pty Ltd (McMahon) for the proposed Yanco Solar Farm near Yanco, NSW.

The soil and land survey was commissioned by Sarah Hillis of NGH Environmental Pty Ltd and was undertaken in general accordance with the scope of works in an email dated 27 August 2018. Alice Debney of DM McMahon Pty Ltd conducted a free soil survey on 7 and 8 November using standard soil surveying techniques. The survey was carried out utilising a backhoe to excavate soil pits for evaluation to a depth of approximately 1.2 metres. Sampling and classification of in situ soils was carried out as per the Australian Soil and Land Survey Field book (2009) and The Australian Soil Classification (ASC) (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.

2.0 Site characteristics

A 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 situated over the Topographic map sheet Leeton 1:25,000 8128-1N. The site is located at an elevation of approximately 138m AHD. The landform is flat with a slope class of level.

2.2 Vegetation

The site is currently used for horticulture and viticulture production. The majority of paddocks contain mature vines and orange trees, with one paddock in the middle of the site ploughed and cow manure from a local feedlot incorporated into the topsoil. There is no natural vegetation on the property.

2.3 Weather

The mean rainfall for the Yanco Agricultural Institution weather station (4 km away) is approximately 397.9 mm per annum. The wettest months are May, August and October; however, the rainfall is spread relatively evenly throughout the year. Mean maximum temperatures range from 14.5 ºC in July to 34.0 ºC in January and mean minimum temperatures range from 4.9 ºC in July to 18.9 ºC in January. Historical records obtained from Yanco Agricultural Institution weather station 74037 (www.bom.gov.au).

2.4 Hydrology

The site is located within the Murrumbidgee River catchment area. The nearest waterway is the Main Canal, located 3.5 km to the east of the site.

2.5 Soil & Landform

The site lies within the mapping units **Oc3** from the Digital Atlas of Australian Soils (CSIRO, 1991).

"**Oc3**"

"Plains with domes, lunettes, and swampy depressions, and divided by continuous or discontinuous low river ridges associated with prior stream systems--the whole traversed by present stream valleys; layered soil or sedimentary materials common at fairly shallow depths: chief soils are hard alkaline red soils (Dr2.33), grey and brown cracking clays, commonly (Ug5.24) and (Ug5.35), and other (D) soils in a complex soil pattern with the following general features: (i) well-drained to moderately drained plains of (Dr2.33) with (Db1.33 and Db1.43), often with thin A horizons (<4 in. thick); (ii) moderately to poorly drained gilgai plains subject to some seasonal flooding of (Ug5.3), (Dr2.33), (Db1.43), (Dy2.33 and Dy2.43), and (Ug5.2) soils; (iii) poorly drained gilgai plains subject to frequent seasonal flooding of (Ug5.2), (Ug5.3), (Db1.43), (Dy2.43), (Dd1.33 and Dd1.43), and (Ug5.4) soils; (iv) swampy depressions of (Dd1.33 and Dd1.43), (Db1.43), (Dy2.43), (Dy3.43), and (Ug5) soils; (v) domes and/or lu. Occurs on sheet(s): 3".

2.6 Geology & Lithology

The site geology and lithology are distributed over one unit: Cainozoic alluvium.

2.7 Hydrogeology

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

3.0 Investigation scope of works

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

Table 1: *Scope of works*

Item	Description	Description
1.	Where available, review provided plans and other general related documents to gain a comprehensive understanding of the proposed project.	-
2.	Undertake a desktop study of local landform, geological, lithological & hydrogeological conditions.	-
3.	Conduct Dial Before You Dig search.	-
4.	Carry out field investigations by reference to Guidelines for Surveying Soil and Land Resources (2008) & AS1726:1993 Geotechnical Site Investigations.	12 excavation pits in total. Samples of topsoils, B, B/C and C horizons taken where present to adequately classify soils as per ASC 1996.

5.	Analyse soils in situ and at NATA accredited laboratory to AS/RMS methods.	5 x Representative samples for topsoil analysis – pH, EC, nutrient and cation status. 8 x representative samples for subsoil analysis – pH, EC, dispersion.
6.	Generate laboratory reports and review results.	-
7.	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.	-
8.	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**.

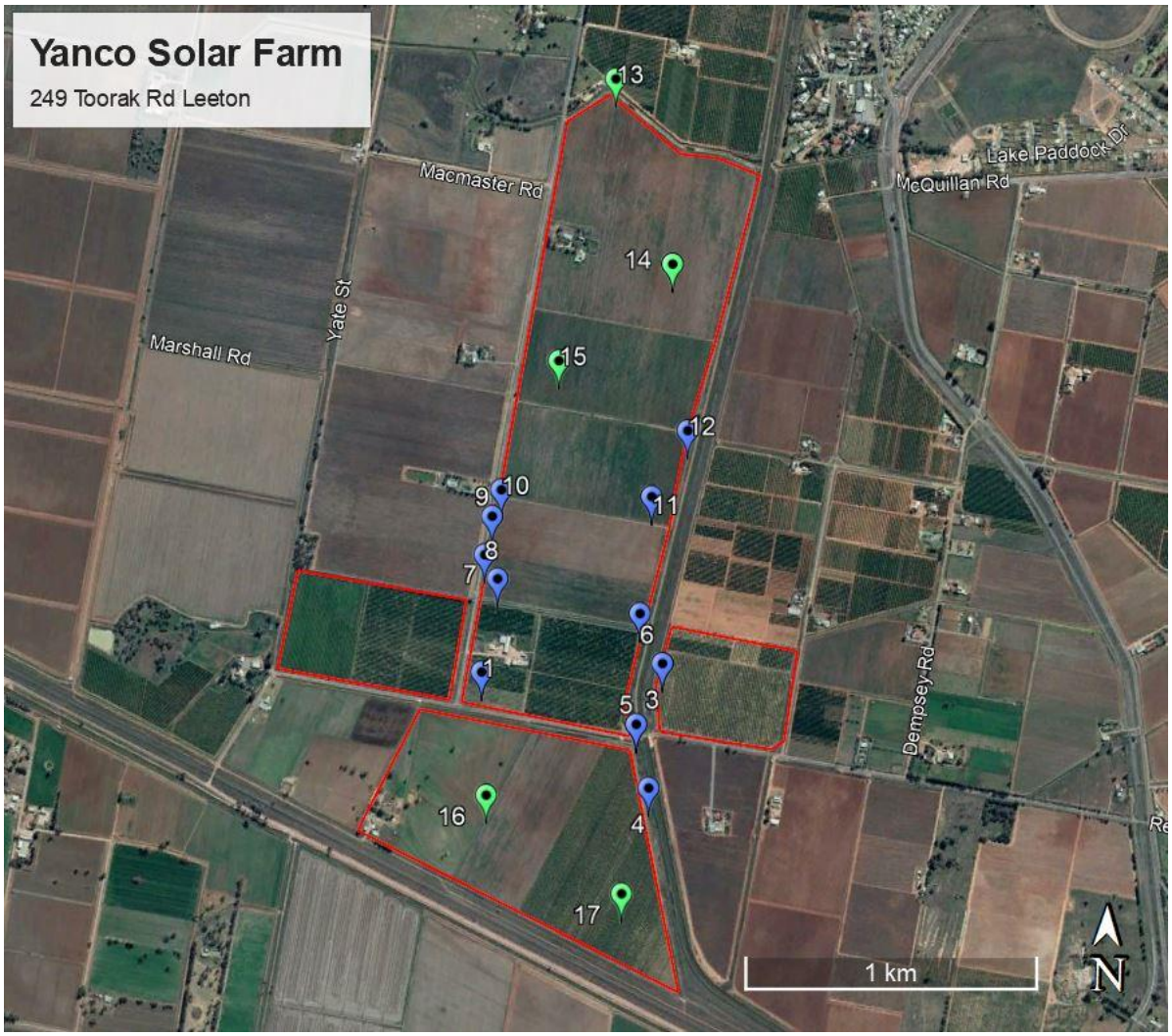

Figure 1: *Soil survey investigation locations*

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 parent formations, drainage plains and the complex soil sequences that are associated with such. Soil moisture content varied between soil types. Due to recent heavy rain at the time the survey was conducted, all topsoil was found to be moist. Subsoils ranged from dry to moist at depth, with heavier clays holding more moisture. Free groundwater was not encountered to the investigated depth.

4.2 Typical soil profiles

Soils can be classified into a typical soil profile across the site as per the Australian Soil Classification (ASC) system (Isbell, 1996). 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. Description of the typical soil type encountered, Chromosols, can be seen as follows.

4.2.1 Chromosols

Chromosols have a strong texture contrast between A and B horizons (however, on this site the topsoil layer providing a strong texture contrast between the horizons had been removed). There is a clear or abrupt textural B horizon in which the upper portion of the horizon (0.2m) is not strongly acid and not sodic. These soils are the most commonly encountered soils under agricultural use in Australia.

Topsoil

Brown sandy clay loams, moderately well-structured to well-structured with sub-angular blocky peds. pH (1:5 soil/water) 4.8 to 7.1 in the A horizon; to 20-40cm depth. Clear boundary to-

Subsoils

Weakly to moderately structured with sub-angular blocky peds. Hues vary from reddish-brown to brownish-red in B horizon and brownish-yellow in B2 and C horizon (where present). Light to medium clays in B horizon and extremely weathered rock in C horizon.

In some locations, soft nodules of calcium carbonate begin to appear at about 90cm depth. pH (1:5 soil/water) 5.6 to 7.5.

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

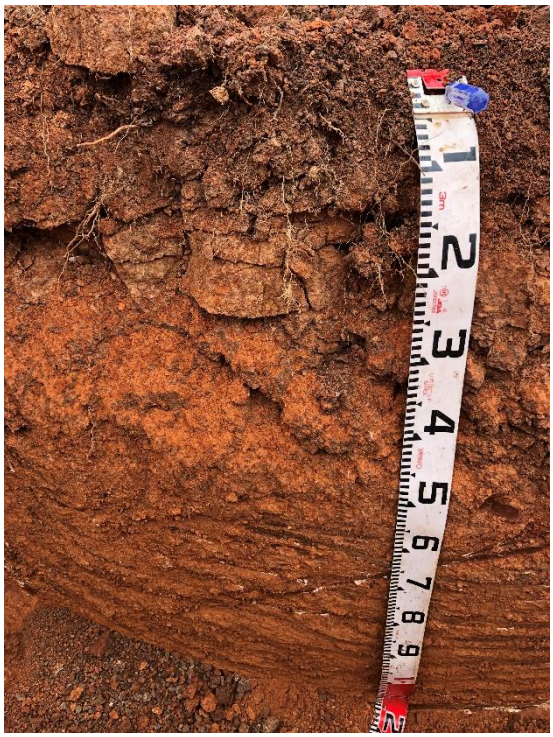

Figure 2: *Typical soil profile with A and B horizons, showing carbonate in the B Horizon.*

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

4.3 Laboratory analysis

Five representative topsoil samples were obtained and analysed at a NATA accredited laboratory for the establishment of baseline soil data that may be referred to and used in preparation of a site decommissioning plan. Laboratory results can be found in the attachments and topsoil soil parameters can be seen summarised in **Table 2**. Eight subsoil samples were also analysed for pH and EC, and tested for dispersion, **Table 3**.

4.3.1 Topsoil analysis

4.3.1.1 pH & Electrical Conductivity

Topsoil pH (1:5 soil/water) ranged from 6.2 to 7.9 and can be classed as ‘slightly acid’ to ‘moderately alkaline’ (Bruce & Rayment, 1982). Electrical Conductivity (EC) ranged from 0.09 to 0.22 dS/m and therefore the salinity rating was ‘very low’ (Agriculture Victoria, 2011).

4.3.1.2 Cation Exchange Capacity, Exchangeable Sodium Percentage & Dispersion

Cation Exchange Capacity (CEC) ranges from 11.9 to 19.3 cmol(+)/kg. CEC of the soils is rated by Hazelton and Murphy (2007), as ‘low’ (6 - 12) to ‘moderate’ (12 - 25). Exchangeable Sodium Percentage (ESP) ranges from 0.78% to 3.6%. Soils are classified as ‘non-sodic’ when the ESP is <6% (Hazelton & Murphy, 2007). Field determination of dispersion was partial in three of the topsoil samples, with some slaking in one of the samples tested and nil in the remainder.

4.3.1.3 Colwell Phosphorus and Phosphorus Buffering Index

Colwell P (plant available phosphorus) ranges from 12 to 110mg/kg, which is classed as 'low' to 'high' (Hazelton and Murphy, 2007). Phosphorus Buffering Index (PBI) ranged from 64 to 90 and is classed from 'very low' (36 - 70) to 'low' (71 – 140) (Agriculture Victoria, 2011).

4.3.1.4 Calcium: Magnesium Ratio

Ca:Mg ratio should be at least 2:1. Higher calcium contents are acceptable however higher magnesium content may result in soil dispersion. Ca:Mg determined for topsoils returned results ranging from 1.5 to 3.1, indicating that there is low potential for dispersion of topsoils upon wetting.

4.3.2 Subsoil analysis

4.3.2.1 pH & Electrical Conductivity

Subsoil pH (1:5 soil/water) ranged from 6.3 to 8.8 and can be classed as 'Slightly Acid' to 'Strongly Alkaline' (Bruce & Rayment, 1982). EC ranged from <0.156 to 0.313 dS/m and therefore the salinity rating was 'very low' (Agriculture Victoria, 2011).

4.3.2.2 Dispersion

Field determination of dispersion showed partial dispersion at one of the eight investigated subsoil samples, and nil dispersion in the remainder. The partially dispersive B horizon was found in the eastern most investigation point. These results indicate that most soils on the property are unlikely to be sodic (Hazelton & Murphy, 2007).

5.0 Summary of test results

Table 2: *Topsoil - Results of laboratory testing*

Pit/Sample	Dispersion+	pH (1:5 Water)	pH (1:5 CaCl2)	Electrical Conductivity	Chloride	Nitrate Nitrogen	Ammonium Nitrogen	Colwell P	PBI	Sulphur – KCl40	CEC	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	%	%	%	%	%	-
2/1	P	7.7	6.7	0.13	14	12	2	85	90	24	19.3	11.0	6.3	0.69	1.60	630	<0.1	<1.0	55.0	33.0	3.60	8.30	1.7
7/1	*	6.2	5.6	0.22	46	43	3	110	74	33	17.9	11.0	4.5	0.16	2.20	860	<0.1	<1.0	62.0	25.0	0.87	12.0	2.4
12/1	N	7.9	7.1	0.14	22	14	1	12	69	9	19.1	13.0	4.1	0.10	1.70	670	<1.0	<1.0	69.0	22.0	0.50	8.90	3.2
13/1	P	6.9	6.1	0.11	<10	28	3	29	70	10	14.6	8.0	5.4	0.43	0.76	300	<0.1	<1.0	55.0	37.0	2.90	5.20	1.5
17/1	P	6.8	5.8	0.09	12	5	1	60	64	11	11.9	7.0	3.2	0.09	1.60	640	<0.1	<1.0	59.0	27.0	0.78	14.0	2.2

+*Dispersion testing results were rated N, P or C being Nil, Partial or Complete dispersion.*

** Denotes slaking but no dispersion.*

Table 3: *Subsoil – Results of field testing*

Pit/ Sample	Horizon	pH (1:5 soil/water)	Electrical Conductivity	Dispersion[+]
Units	-	-	µS/cm	-
2/2	B1	8.1	156	*
3/2	B1	8.7	156	P
7/2	B2	8.8	<100	*
10/2	B2	8.4	313	*
11/2	B	8.2	<100	*
12/2	A2	8.6	<100	N
15/2	B1	6.5	156	N
17/2	B1	6.3	<100	*

[+]*Dispersion testing results were rated N, P or C being Nil, Partial or Complete dispersion.*

* *Denotes slaking but no dispersion.*

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 4**.

Table 4: *Potential landscape limitation assessment.*

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

As follows is the soil landscape map (Digital Atlas of Australian Soils) that has been generally validated by the soil survey through laboratory and field techniques. As such, management practices can be grouped into management classes of Australian Soil Classification (ASC) units with Chromosols being represented across the majority of the property in the Oc3 soil landscape, **Figure 4**. This report identifies management practices for ASC units in Section 6.5 below.

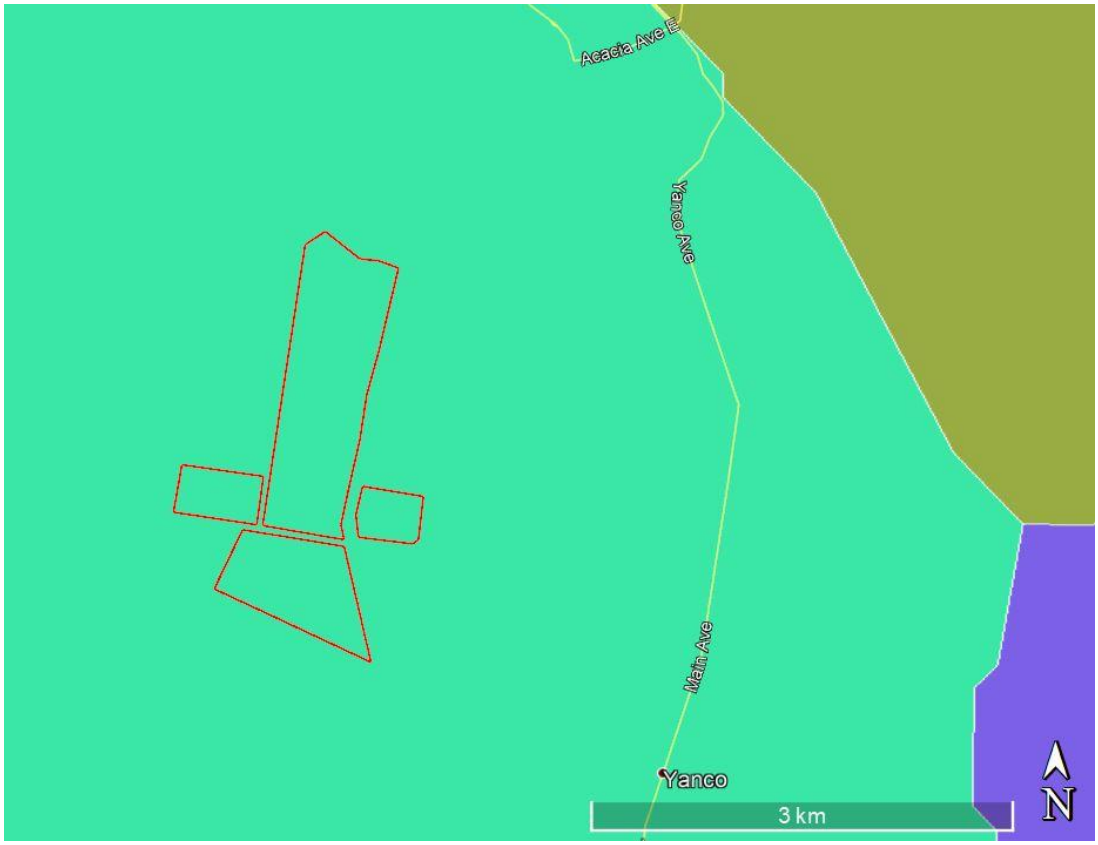

Figure 2: *Digital Atlas of Australian Soils mapping units with site overlay* (**Oc3**, **Oc5** *and* **Qb9**).

6.2 Erosion control

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 low due to the low relief and generally low salinity and sodicity of topsoils and subsoils. 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 of an Erosion and Sediment Control Plan (ESCP).

6.3 Acid sulphate 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 sulphuric 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 Potential impacts on salinity, groundwater resources and hydrology

Current operational procedures include drip irrigated horticulture and viticulture crops. Associated water features across the investigated area include irrigation channels. There are two registered groundwater bores within 500 metres of the site boundary, details of which can be found in **Table 5**. Given the majority of soils on site are classified as 'non-sodic' and are of low salinity, the risk of salt build-up in discharge areas is low. However, changing direction of surface waters and any run-on should be avoided as local changes in the water regime are likely to mobilise any salts stores, however low, in the soil. Deep rooted vegetation should be maintained where present and established where absent, and ground clearing should be minimised.

Table 5: *Registered groundwater bores in the locale (Water NSW, 2018).*

Bore ID	Drilled depth (m)	Water bearing zone (m)	Standing water level (m)	AHD (m)	Salinity	Purpose
GW058303	10.40	6.00 – 6.50 8.50 – 10.40	2.10	140	Good	Stock, Domestic
GW0405004	7.00	No data	No data	No data	No data	Stock, Domestic

As can be seen in **Table 5** above, the grounderwater bores near the site are for stock and/or domestic use. The groundwater is likely to be in alluvial layers and be responisve to rainfall and recharge events in terms of standing water level and salinity. From a review of the current and proposed site operations the potential impacts on salinity, groundwater and hydrology are thought to be low.

6.5 Soil characteristics and management responses

6.5.1 Chromosols

Table 6: *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 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 and 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.

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 a visual and tactile assessment with consideration given to 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. Bore logs	3 pages
B. Laboratory reports 5474	10 pages

McMahon EARTH SCIENCE

DOCUMENT ATTACHMENTS

REPORT 2019

DM McMahon Pty Ltd
6 Jones Street, (PO Box 6118)
Wagga Wagga NSW 2650

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Attachment A : *Bore logs*

McMahon EARTH SCIENCE

SOIL SURVEY FIELD SHEET

Job No: 5474
Project: Yanco Solar Farm
Site: 385 Toorak Rd Leeton

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Layer	Layer Top (m)	Layer Bottom (m)	Horizon	Boundary	Colour	Munsell Code	Texture	Moisture	Consistence	Mottles	Mottle Type	Structure	Coarse Fragments	Fragment Size (mm)	Fragment (%)	Comments
1	1	0443091 6172502		0.0	0.25	A		+B		LC	M	3	N	-	SAB	Nil	-	-	Roots to ~0.2m. Black nodules in B Horizon. Carbonates.
	2			0.25	1.2	B	C	RB		MC	M	6	Y	Black	SAB	Nil	-	-	
2	1	0442653 6172633		0.0	0.25	A		+B		LC	M	4	N	-	SAB	Nil	-	-	Carbonate in B Horizon.
	2			0.3	0.5	B1	A	RB		MC	M	3	Y	Black	SAB	Nil	-	-	
	3			0.5	1.2	B2	C	YB/BY		MC	M	2	Y	Red	SAB	Nil	-	-	
3	1	0443708 6172553		0.0	0.1	A		+B		LC	M	1	N	-	SAB	Nil	-	-	Roots to 0.1m. Carbonate in B Horizon.
	2			0.1	0.7	B1	C	RB		MC	M	2	N	-	SAB	Nil	-	-	
	3			0.7	1.2	B2	D	BR		HC	M	2	Y	Black	Massive	Nil	-	-	
4	1	0443676 6172128		0.0	0.05	A1		+B		ZSCL	M	2	N	-	SAB	Nil	-	-	Ash throughout profile due to fire remants above. Carbonate in B Horizon.
	2			0.05	0.5	A2	C	-B		CL	D	4	Y	Black	SAB	Nil	-	-	
				0.5	1.2	B	D	RB		CL	D	4	Y	Black	Massive	Nil	-	-	
5	1	0443626 6172343		0.0	0.2	A		+B		SCL	M	3	N	-	SAB	Nil	-	-	Carbonate in B Horizon.
				0.2	0.4	B1	C	RB		CL	D	6	Y	Black	SAB	Nil	-	-	
	2			0.4	1.2	B2	D	BR		CL	D	6	N	-	SAB	Nil	-	-	
6	1	0443625 6172720		0.0	0.1	A		+B		SCL	M	1	N	-	SAB	Nil	-	-	Black nodules in B1 Horizon.
				0.1	0.6	B1	C	RB		LC	T	5	N	-	SAB	Nil	-	-	
	2			0.6	1.4	B2	D	BR		LC	T	3	N	-	SAB	Nil	-	-	

SOIL SURVEY FIELD SHEET

Job No: 5474
Project: Yanco Solar Farm
Site: 385 Toorak Rd Leeton

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Layer	Layer Top (m)	Layer Bottom (m)	Horizon	Boundary	Colour	Munsell Code	Texture	Moisture	Consistence	Mottles	Mottle Type	Structure	Coarse Fragments	Fragment Size (mm)	Fragment (%)	Comments
7	1	0443626 6172343		0.0	0.1	A		+B		LC	M	2	N	-	SAB	Nil	-	-	Carbonate in B Horizon.
				0.1	0.7	B1	C	RB		MC	M	4	Y	Black	SAB	Nil	-	-	
	2			0.70	1.1	B2	D	RB		MC	M	5	Y	Black	SAB	Nil	-	-	
8	1	0443087 6172901		0.0	0.1	A		+B		LMC	M	2	N	-	SAB	Nil	-	-	Carbonate in B Horizon.
	2			0.1	0.7	A2	C	B		MC	D	4	Y	Black	SAB	Nil	-	-	
				0.7	1.2	B	D	RY		M-HC	D	6	Y	Black	SAB	Nil	-	-	
9	1	0443108 6173033		0.0	0.1	A		+B		LMC	M	2	N	-	SAB	Nil	-	-	Carbonate in B Horizon.
	2			0.1	0.7	B1	C	RB		MC	D	4	N	-	SAB	Nil	-	-	
				0.7	1.2	B2	D	BY		M-HC	D	6	N	-	SAB	Nil	-	-	
10	1	0443108 6173033		0.0	0.45	A		B		CL	M	2	N	-	Structureless	Nil	-	-	Paddock ploughed. Cow manure incorporated. Carbonate present B Horizon.
				0.45	0.8	B1	D	RB		LMC	T	4	Y	Black	SAB	Nil	-	-	
	2			0.8	1.2	B2	D	BY		MC	T	3	Y	Black	SAB	Nil	-	-	
11	1	0443651 6173119		0.0	0.75	A		B		CL	M	4	Y	Red	Structureless	Nil	-	-	Ploughed. A and B Horizons mixed. Some red mottling in low A Horizon.
	2			0.75	1.2	B	C	R		LMC	D-T	3	N	-	SAB	Nil	-	-	
12	1	0443766 6173348		0.0	0.15	A1		+B		SCL	M	2	N	-	SAB	Nil	-	-	Deep rooted grass (near irrigation channel). Carbonate in B Horizon.
	2			0.15	0.8	A2	C	RB		LC	D	5	Y	Black	SAB	Nil	-	-	
				0.8	1.0	B	D	BR		LMC	D	3	N	-	SAB	Nil	-	-	

McMahon EARTH SCIENCE

SOIL SURVEY FIELD SHEET

Job No:	5474
Project:	Yanco Solar Farm
Site:	385 Toorak Rd Leeton

Site Identity	Sample	Co-ordinates MGA GDA94 z55	Layer	Layer Top (m)	Layer Bottom (m)	Horizon	Boundary	Colour	Munsell Code	Texture	Moisture	Consistence	Mottles	Mottle Type	Structure	Coarse Fragments	Fragment Size (mm)	Fragment (%)	Comments
13	1	0443477		0.0	0.1	A		+B		MC	T-M	2	N	-		Nil			Carbonate in B Horizon.
		6174536		0.1	1.0	B	C	B		MC	D-T	2	N	-		Nil			
14	1	0443694		0.0	0.25	A		+B		LC	T	3	N	-		Nil	-	-	Carbonate in B Horizon.
		6173912		0.3	1.0	B	C	B		MC	D-T	2	N	-		Nil	-	-	
15	1	0443317		0.0	0.1	A	-	+B/RB		LC	T	1	N	-		Nil	-	-	Carbonate in B Horizon.
	2	6173570		0.1	1.0	B	C	RB		HC	M	5	Y	Black		Nil	-	-	
16	1	0443121		0.0	0.1	A	-	-B		CL	T-M	2	N	-		Nil	-	-	Carbonate in B Horizon.
	2	6712084		0.1	1.0	B1	C	YB		LC	D	2	N	-		Nil	-	-	
17	1	0443596		0.0	0.1	A		+B		CL	T	2	N	-		Nil	-	-	Carbonate in B Horizon.
	2	6171765		0.1	1.00	B1	C	YB		LC	D-T	2	N	-		Nil	-	-	

Attachment B : *Laboratory reports 5474*

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Nutrient Advantage Advice® Nutrient Report

DM McMahon Ptv Ltd
PO BOX 6118

WAGGA WAGGA
NSW 2650

Report Print Date: 16/11/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: DM MCMAHON

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019396
Paddock Name: 2/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 7/11/2018

Analyte / Assay	Units	Value
pH (1:5 Water)		7.7
pH (1:5 CaCl2)		6.7
Electrical Conductivity (1:5 water)	dS/m	0.13
Chloride	mg/kg	14
Nitrate Nitrogen	mg/kg	12
Ammonium Nitrogen	mg/kg	2
Phosphorus (Colwell)	mg/kg	85
Phosphorus Buffer Index		90
Sulphur (KCl40)	mg/kg	24
Cation Exch. Cap. (CEC)	cmol(+)/kg	19.3
Calcium (Amm-acet.)	cmol(+)/kg	11.0
Magnesium (Amm-acet.)	cmol(+)/kg	6.3
Sodium (Amm-acet.)	cmol(+)/kg	0.69
Potassium (Amm-acet.)	cmol(+)/kg	1.60
Available Potassium	mg/kg	630
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	55.0
Magnesium % of Cations	%	33.0
Sodium % of Cations (ESP)	%	3.60
Potassium % of Cations	%	8.30
Calcium/Magnesium Ratio		1.7

Analyses conducted by **Nutrient Advantage Laboratory Services**
8 South Road, Werribee VIC 3030
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Email: lab.feedback@incitecpivot.com.au

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Nutrient Advantage Advice® Nutrient Report

Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019396	**Test Code:**	E11
Paddock Name:	2/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	7/11/2018
Sample Depth (cm):	0 **To** 10		

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.

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Report Print Date: 16/11/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: DM MCMAHON

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019397
Paddock Name: 7/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 7/11/2018

Analyte / Assay	Units	Value
pH (1:5 Water)		6.2
pH (1:5 CaCl2)		5.6
Electrical Conductivity (1:5 water)	dS/m	0.22
Chloride	mg/kg	46
Nitrate Nitrogen	mg/kg	43
Ammonium Nitrogen	mg/kg	3
Phosphorus (Colwell)	mg/kg	110
Phosphorus Buffer Index		74
Sulphur (KCl40)	mg/kg	33
Cation Exch. Cap. (CEC)	cmol(+)/kg	17.9
Calcium (Amm-acet.)	cmol(+)/kg	11.0
Magnesium (Amm-acet.)	cmol(+)/kg	4.5
Sodium (Amm-acet.)	cmol(+)/kg	0.16
Potassium (Amm-acet.)	cmol(+)/kg	2.20
Available Potassium	mg/kg	860
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	62.0
Magnesium % of Cations	%	25.0
Sodium % of Cations (ESP)	%	0.87
Potassium % of Cations	%	12.00
Calcium/Magnesium Ratio		2.4

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019397	**Test Code:**	E11
Paddock Name:	7/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	7/11/2018
Sample Depth (cm):	0 **To** 10		

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Report Print Date: 16/11/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: DM MCMAHON

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019398
Paddock Name: 12/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 7/11/2018

Analyte / Assay	Units	Value
pH (1:5 Water)		7.9
pH (1:5 CaCl2)		7.1
Electrical Conductivity (1:5 water)	dS/m	0.14
Chloride	mg/kg	22
Nitrate Nitrogen	mg/kg	14
Ammonium Nitrogen	mg/kg	1
Phosphorus (Colwell)	mg/kg	12
Phosphorus Buffer Index		69
Sulphur (KCl40)	mg/kg	9
Cation Exch. Cap. (CEC)	cmol(+)/kg	19.1
Calcium (Amm-acet.)	cmol(+)/kg	13.0
Magnesium (Amm-acet.)	cmol(+)/kg	4.1
Sodium (Amm-acet.)	cmol(+)/kg	0.10
Potassium (Amm-acet.)	cmol(+)/kg	1.70
Available Potassium	mg/kg	670
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	69.0
Magnesium % of Cations	%	22.0
Sodium % of Cations (ESP)	%	0.50
Potassium % of Cations	%	8.90
Calcium/Magnesium Ratio		3.2

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019398	**Test Code:**	E11
Paddock Name:	12/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	7/11/2018
Sample Depth (cm):	0 **To** 10		

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NSW 2650

Report Print Date: 16/11/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: DM MCMAHON

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019399
Paddock Name: 13/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 7/11/2018

Analyte / Assay	Units	Value
pH (1:5 Water)		6.9
pH (1:5 CaCl2)		6.1
Electrical Conductivity (1:5 water)	dS/m	0.11
Chloride	mg/kg	<10
Nitrate Nitrogen	mg/kg	28
Ammonium Nitrogen	mg/kg	3
Phosphorus (Colwell)	mg/kg	29
Phosphorus Buffer Index		70
Sulphur (KCl40)	mg/kg	10
Cation Exch. Cap. (CEC)	cmol(+)/kg	14.6
Calcium (Amm-acet.)	cmol(+)/kg	8.0
Magnesium (Amm-acet.)	cmol(+)/kg	5.4
Sodium (Amm-acet.)	cmol(+)/kg	0.43
Potassium (Amm-acet.)	cmol(+)/kg	0.76
Available Potassium	mg/kg	300
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	55.0
Magnesium % of Cations	%	37.0
Sodium % of Cations (ESP)	%	2.90
Potassium % of Cations	%	5.20
Calcium/Magnesium Ratio		1.5

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Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019399	**Test Code:**	E11
Paddock Name:	13/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	7/11/2018
Sample Depth (cm):	0 **To** 10		

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NSW 2650

Report Print Date: 16/11/2018
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: DM MCMAHON

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019400
Paddock Name: 17/1
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 7/11/2018

Analyte / Assay	Units	Value
pH (1:5 Water)		6.8
pH (1:5 CaCl2)		5.8
Electrical Conductivity (1:5 water)	dS/m	0.09
Chloride	mg/kg	12
Nitrate Nitrogen	mg/kg	5
Ammonium Nitrogen	mg/kg	1
Phosphorus (Colwell)	mg/kg	60
Phosphorus Buffer Index		64
Sulphur (KCl40)	mg/kg	11
Cation Exch. Cap. (CEC)	cmol(+)/kg	11.9
Calcium (Amm-acet.)	cmol(+)/kg	7.0
Magnesium (Amm-acet.)	cmol(+)/kg	3.2
Sodium (Amm-acet.)	cmol(+)/kg	0.09
Potassium (Amm-acet.)	cmol(+)/kg	1.60
Available Potassium	mg/kg	640
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	59.0
Magnesium % of Cations	%	27.0
Sodium % of Cations (ESP)	%	0.78
Potassium % of Cations	%	14.00
Calcium/Magnesium Ratio		2.2

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Nutrient Advantage Advice® Nutrient Report

Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019400	**Test Code:**	E11
Paddock Name:	17/1	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	7/11/2018
Sample Depth (cm):	0 **To** 10		

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)
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