SOIL SURVEY REPORT

JINDERA SOLAR FARM

FEBRUARY 2019

DM McMahon Pty Ltd
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East Wagga Wagga NSW 2650
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SOIL SURVEY REPORT

JINDERA SOLAR FARM

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 in January 2019 for a proposed solar farm. The document provides information about the site and soil conditions from field observations and laboratory analysis.

Site identification

Address: 1866 Urana Road, Jindera NSW 2642; 1466 Walla Walla Jindera Road, Jindera NSW 2642; 140 Ortlipp Road, Jindera NSW 2642.
Real property description: Lots 70, 134, 136, 139, 147, 153, 154 & 155 DP 753342; Lot 2 DP213465; Lot 3 DP1080215; Lot 1 DP588720.
Centre co-ordinate: 489064E 6025962N MGA GDA z55
Property size: (investigated area) 360 ha approximately
Owner: c/o NGH Environmental Pty Ltd
Local Council Area: Great Hume Shire Council
Present use: Mixed Agriculture
Development Application Reference: N/A
Report identification: 5473

Certification

Name	Signed	Date	Revision Number
David McMahon CEnvP BAppSc GradDip WRM MEnvMgmt		12/02/19	0

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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 Jindera Solar Farm near Jindera, 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. David McMahon and Zach Bradley of DM McMahon Pty Ltd conducted a free soil survey on 30 January 2019 using standard soil surveying techniques. The survey was carried out utilising a coring rig to excavate the soil profile to a depth of approximately 1.5 metres. 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 (ASC) (Isbell, 1996). Density of investigation boreholes 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 located over the Howlong 1:50,000 Topographic Map (Sheet 8226-S) at an elevation range of approximately 220m to 265m AHD. The landform of the site consists of low gently to moderately undulating hills to the west running to level to very gently inclined drainage plains to the east. Two widely spaced shallow ephemeral drainages traverse the site, Kilnacroft Creek and Dead Horse Creek, that lie in the upper catchment of the Murray River associated with the Oak Hill range to the west.

2.2 Vegetation

The site is currently used for broad acre agriculture, predominantly grazing and cropping. At the time of the soil survey, the majority of the site was dry pasture being grazed by cattle or sheep and some paddocks on the higher ground had been cropped and with canola stubble present. Some broadleaf weed species such as thistles were present on site but were not prevalent. There are established eucalypt trees scattered throughout the property, mostly in clumps and along the drainages or property boundaries. A more detailed assessment of vegetation present can be seen in the NGH Environmental Scoping Report for the site.

2.3 Weather

The mean rainfall for the Walla Walla Post Office weather station (15 km away) is approximately 632.2 mm per annum. The wettest months are July, August and October; however, the rainfall is spread relatively evenly throughout the year. At the Albury Airport AWS Weather Station (18.5 km away), mean maximum temperatures range from 13.1 ºC in July to 32.3 ºC in January and mean minimum temperatures range from 3.1 ºC in July to 16.3 ºC in February. Historical records obtained from Walla Walla Post Office 74117 and the Albury Airport AWS 072160 weather stations, respectively (www.bom.gov.au).

2.4 Hydrology

The site is located within the Murray River catchment. The Kilnacroft Creek and Dead Horse Creek run westerly through the property and are both first and second order streams, Strahler

(1952). Both these creeks run into Bowna Creek which drains to the south east into the northern end of Lake Hume. Lake Hume is a major dam across the Murray River.

2.5 Soil & Landform

The site lies within the mapping units **Va14** from the Digital Atlas of Australian Soils (CSIRO, 1991).

"Va14"

"Plains of hard alkaline and neutral yellow mottled soils (Dy3.43 and Dy3.42). Associated are various earths (Gn2.2 and Gn2.9) with other undescribed soils. Data are limited. Occurs on sheet(s): 3"

2.6 Geology & Lithology

The site geology is distributed over two units: Cainozoic alluvium and Granitoids. The lithology groups on the site are Cainozoic colluvial surfaces and Silurian Devonian granites. The Cainozoic alluvium lies is associated with the drainage plains in the east of the site while the granites lie in the west of the site on the low undulating hills.

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 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.	21 boreholes in total. Samples of topsoils (A1), A2, B, B/C and C horizons taken when present to adequately classify soils as per ASC 1996.
5.	Analyse soils in situ and at NATA accredited laboratory to AS/RMS methods.	4 x Representative samples for topsoil analysis – pH, EC, nutrient and cation status. 10 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 borehole locations, **Figure 1**.

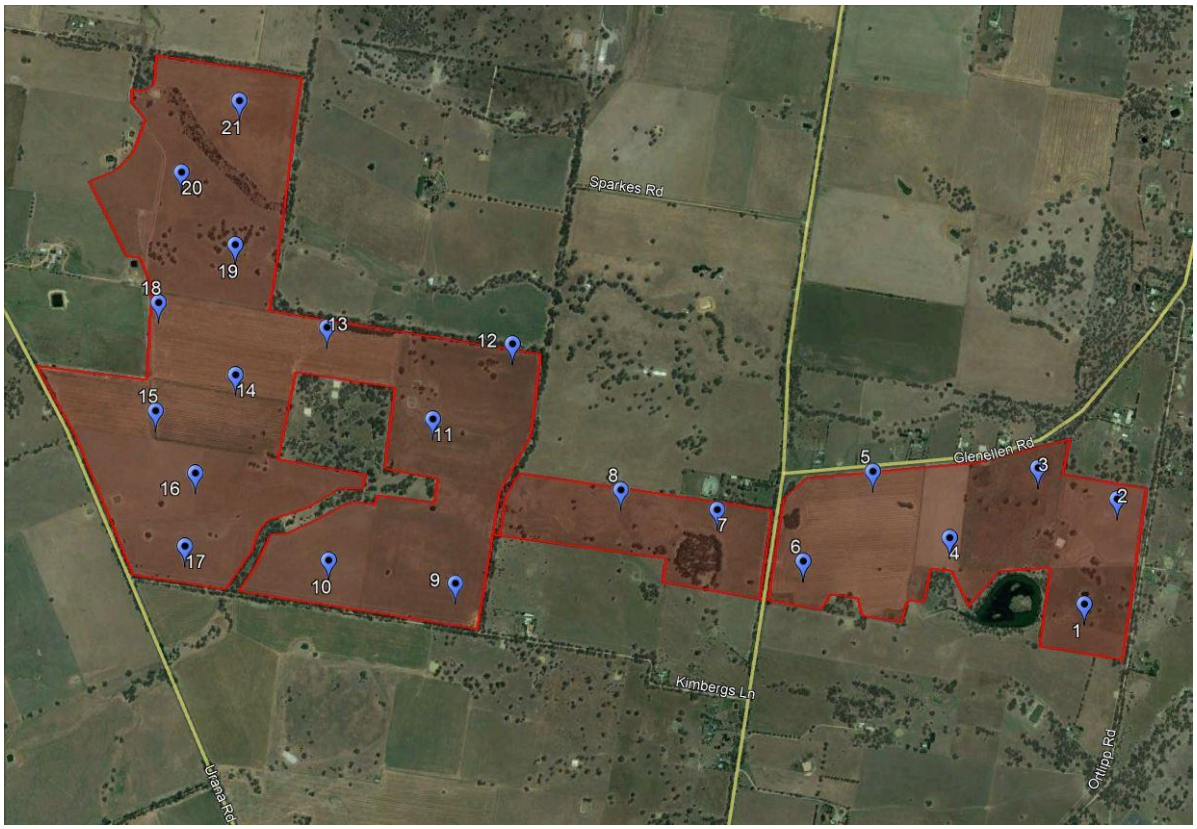

Figure 1: *Soil survey investigation borehole locations.*

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 boreholes 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 contents varied between soil types but were generally found to be dry in the topsoil and at depth. 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 boreholes 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. 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

Light brown silty loams and white silts, moderately granular. pH (1:5 soil/water) 5.4 – 6.0 in the A horizon; to 20-60cm depth. Pronounced A2 horizon on the lower lying areas. Clear boundary to-

Subsoils

Weakly to moderately massive structure. Hues vary from yellowish-brown to brownish-red in B horizon and brownish-red to yellowish red in C horizon (where encountered). Light to medium clays in B horizon and sandy silty clays in C horizon.

4.3 Laboratory analysis

4 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 COA's can be found in the attachments and topsoil soil parameters can be seen summarised in **Table 2**. 8 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 6.1 to 6.5 and can be classed as 'slightly acid' (Bruce & Rayment, 1982). Electrical Conductivity (EC) ranged from 0.13 to 0.19 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 6.9 to 8.7 cmol(+)/kg. CEC of the soils is rated by Hazelton and Murphy (2007), as 'low' (6 – 12). Exchangeable Sodium Percentage (ESP) ranges from <1% to 1.4%. Soils are classified as 'non-sodic' when the ESP is <6%.

Dispersion was consistent across topsoil samples with the majority showing signs of slaking but no dispersion.

4.3.1.3 Colwell Phosphorus and Phosphorus Buffering Index

Colwell P (plant available phosphorus) ranges from 36 to 66mg/kg, which is classed as 'very high' (Hazelton and Murphy, 2007). Phosphorus Buffering Index (PBI) ranged from 41 to 49 and is classed as 'very low' (36 - 70), (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 6.5 to 28.

4.3.1.5 Soil infiltration rates and water holding capacity

Water holding capacity for topsoils is determined as high based on soil type as a result of high available water by percentage (25-30%) and moderate permanent wilting point (~20%). Water holding capacity for subsoils is lower due to a higher clay content which has a lower available water percentage (12-13%) and higher permanent wilting point (24-29%), (Hazleton & Murphy 2007).

Topsoil infiltration based on texture and degree of structure for loam and clay loams with evident peds is inferred to be around 50-90mm/h. This is given a moderate to high rating for saturated hydraulic conductivity with rare and occasional runoff (Hazleton & Murphy 2007). Infiltration in subsoils is considered to be very slow with a permeability of less than 5mm per hour. Subsoils are liable to waterlogging where there is a limited topsoil horizon due to the very slow infiltration rates (Hunt & Gilkes 1992).

5.0 Summary of Test Results

Table 2: *Topsoil - Results of laboratory testing*

Parameters	Units	Composite borehole sample ID			
		Samples 1 - 6	Samples 7 & 8	Samples 9,10,11, 12,17	Samples 13,14,15,16, 18,19,20,21
pH (1:5 Water)		6.3	6.1	6.4	6.5
pH (1:5 CaCl2)		5.8	5.4	5.8	6
Electrical Conductivity	dS/m	0.14	0.16	0.19	0.13
Chloride	mg/kg	<10	<10	19	12
Nitrate Nitrogen	mg/kg	35	34	47	32
Ammonium Nitrogen	mg/kg	18	37	22	5
Phosphorus (Colwell)	mg/kg	36	66	57	51
Phosphorus Buffer Index		47	41	42	49
Sulphur (KCl40)	mg/kg	12	14	15	14
Cation Exch. Cap. (CEC)	cmol(+)/kg	7.1	8.2	8.7	6.9
Calcium (Amm-acet.)	cmol(+)/kg	6.1	5.8	7.2	6.1
Magnesium (Amm-acet.)	cmol(+)/kg	0.3	0.9	0.5	0.2
Sodium (Amm-acet.)	cmol(+)/kg	<0.02	0.07	0.12	0.05
Potassium (Amm-acet.)	cmol(+)/kg	0.71	1.4	0.74	0.55
Available Potassium	mg/kg	280	550	290	220
Aluminium (KCl)	cmol(+)/kg	<0.1	<0.1	<0.1	<0.1
Aluminium % of Cations	%	<1.0	<1.0	<1.0	<1.0
Calcium % of Cations	%	86	71	84	88
Magnesium % of Cations	%	4.4	11	6.2	3.3
Sodium % of Cations (ESP)	%	<1.00	0.85	1.4	0.68
Potassium % of Cations	%	10	17	8.6	8
Calcium/Magnesium Ratio		20	6.5	13	28

Table 3: *Subsoil – Results of laboratory testing.*

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

Pit/Sample	Horizon	pH (1:5 soil/water)	Electrical Conductivity	Dispersion[+]
Units	**-**	**-**	**µS/cm**	**-**
2/2	B	6.0	0.02	*
4/3	B	5.8	0.03	*
6/3	B	5.3	0.05	*
7/3	B	5.4	0.04	*
10/3	B	5.8	0.04	N
12/3	B	6.3	0.04	P
15/3	C	6.2	0.04	*
17/3	B	5.8	0.02	*
19/3	B	6.2	0.08	P
21/2	B	5.2	0.05	*

** 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	YES	LOW	NO	LOW

As follows is the soil landscape map (eSpade, 2018) which 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 Va14 soil type, **Figure 4**. This report identifies management practices for ASC units in Section 6.5 below.

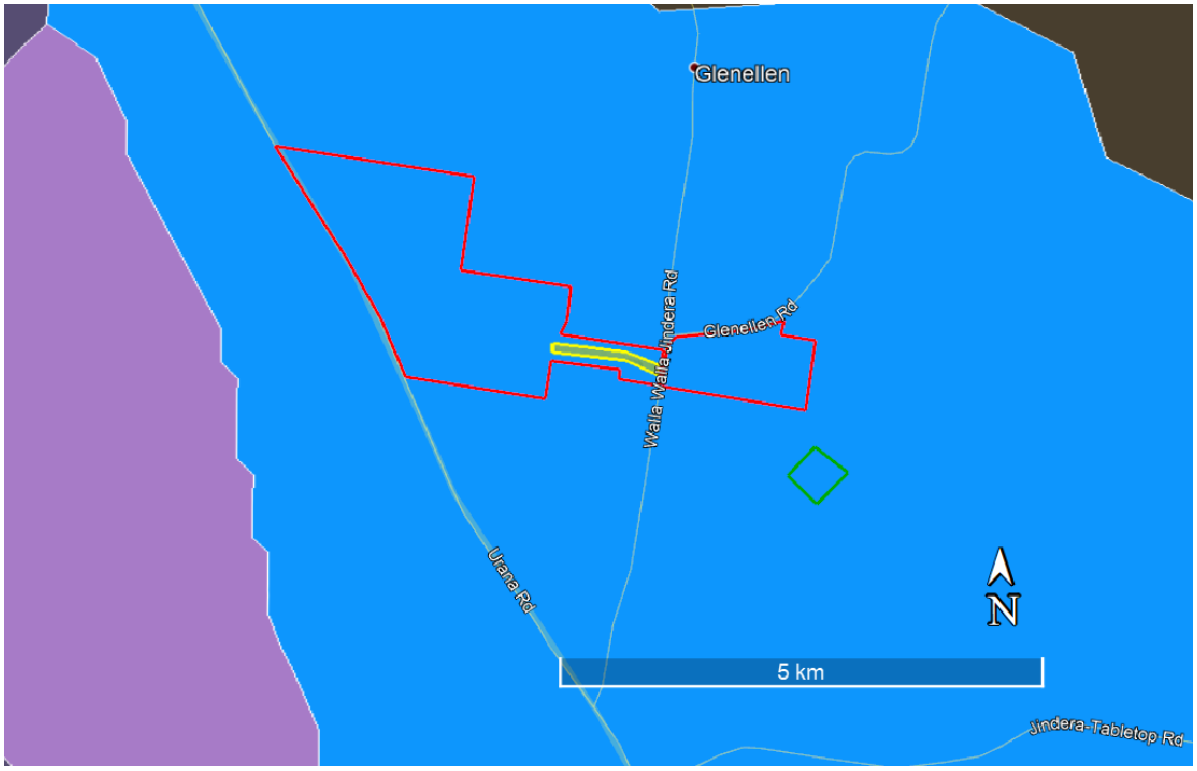

Figure 2: *Digital Atlas of Australian Soils mapping units with site overlay (**Pb4**, **Va14** and **My10**).*

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 dryland cropping and grazing. Associated water features across the investigated area include 28 dams. There are no registered groundwater bores within 500 metres of the site boundary. Most of the paddocks on the higher ground to the west had maintained stubble at the time of the investigation. 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, ground clearing should be minimised.

6.5 Soil characteristics and management responses

6.5.1 Chromosols

Table 5: *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 borehole 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. Log sheets	4 pages
B. Laboratory reports	8 pages

McMahon EARTH SCIENCE

DOCUMENT ATTACHMENTS

REPORT 2019

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Attachment A : *Log sheets*

McMahon EARTH SCIENCE

SOIL SURVEY FIELD SHEET

Job No:	5473
Project:	Jindera Solar Farm/ NGH Enviornmental
Site:	1866 Urana Road, Jindera

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	1/1	491509	1	0.0	0.01	A1	-	-B	-	SILTY LOAM	D	1	Y	R	GRANULAR	-	-	-	Flat Level Ground
	1/2	6025170	2	0.01	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	1/3		3	0.40	1.50	B	D	YB	-	LIGHT CLAY	D	4	Y	R	MASSIVE	-	-	-	
2	2/1	491646	1	0.0	0.30	A	-	B	-	SILTY LOAM	D	2	-	-	GRANULAR	-	-	-	
	2/2	6025608	2	0.30	1.50	B	D	YB	-	MEDIUM CLAY	D	4	Y	OB	MASSIVE	-	-	-	
3	3/1	491314	1	0.00	0.20	A1	-	-B	-	SILTY LOAM	D	1	-	-	GRANULAR	-	-	-	
	3/2	6025738	2	0.2	0.4	A2	C	B	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	3/3		3	0.4	1.5	B	D	BR	-	LIGHT CLAY	T	4	Y	R	MASSIVE	-	-	-	
4	4/1	490944	1	0.0	0.01	A1	-	-B	-	SILTY LOAM	D	1	Y	R	GRANULAR	-	-	-	
	4/2	6025466	2	0.01	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	4/3		3	0.40	1.50	B	D	YB	-	LIGHT CLAY	D	4	Y	R	MASSIVE	-	-	-	
5	5/1	490622	1	0.0	0.01	A1	-	-B	-	SILTY LOAM	D	1	Y	R	GRANULAR	-	-	-	
	5/2	6025722	2	0.01	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	5/3		3	0.40	1.50	B	D	YB	-	LIGHT CLAY	D	4	Y	R	MASSIVE	-	-	-	
6	6/1	490331	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	1	-	-	GRANULAR	-	-	-	
	6/2	6025348	2	0.05	0.30	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	6/3		3	0.30	1.50	B	D	YB	-	MEDIUM CLAY	D	4	Y	OB	MASSIVE	-	-	-	

McMahon EARTH SCIENCE

SOIL SURVEY FIELD SHEET

Job No: 5473
Project: Jindera Solar Farm/ NGH Enviornmental
Site: 1866 Urana Road, Jindera

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	7/1	489971	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	1	-	-	GRANULAR	-	-	-	
	7/2	6025562	2	0.05	0.60	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	7/3		3	0.60	1.50	B	D	YB	-	MEDIUM CLAY	D	5	Y	R	MASSIVE	-	-	-	
8	8/1	489568	1	0.00	0.05	A1	-	-B	-	SILTY LOAM	D	2	-	-	GRANULAR	-	-	-	In a 1m depression
	8/2	6025644	2	0.05	0.5	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	8/3		3	0.5	0.8	B	D	-B	-	LIGHT CLAY	D	4	Y	R	MASSIVE	-	-	-	
	8/4		4	0.8	1.5	C	D	-B	-	SANDY CLAY	D	2	-	-	GRANULAR	-	-	-	
9	9/1	488878	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	2	-	-	GRANULAR	-	-	-	
	9/2	6025255	2	0.05	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	9/3		3	0.40	1.50	B	D	O	-	LIGHT CLAY	D	4	Y	RB	MASSIVE	-	-	-	
10	10/1	488350	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	2	-	-	GRANULAR	-	-	-	
	10/2	6025351	2	0.05	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	10/3		3	0.40	1.50	B	D	O	-	LIGHT CLAY	D	4	Y	RB	MASSIVE	-	-	-	
11	11/1	488783	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	2	-	-	GRANULAR	-	-	-	Better drainage, higher elev.
	11/2	6025938	2	0.05	0.30	A2	C	-B/W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	11/3		3	0.30	1.50	B	D	Y	-	SA-SILTY CLAY	D	3	-	-	SUBANGULAR	-	-	-	
12	12/1	489115	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	2	-	-	GRANULAR	-	-	-	
	12/2	6026251	2	0.05	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	12/3		3	0.40	1.50	B	D	BY	-	MEDIUM CLAY	D	4	Y	RB	MASSIVE	-	-	-	

Job No: 5473
Project: Jindera Solar Farm/ NGH Enviornmental
Site: 1866 Urana Road, Jindera

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	13/1	488342	1	0.0	0.30	A1	-	B	-	SA-CLAY LOAM	D	2	-	-	GRANULAR	-	-	-	Mid slope, east aspect, gutsy
	13/2	6026318	2	0.30	0.50	A2	C	-B	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	13/3		3	0.50	1.50	B	D	YB	-	MEDIUM CLAY	T	4	Y	RB	MASSIVE	-	-	-	
14	14/1	487963	1	0.00	0.30	A	-	+B	-	F-SA-CLAY LOAM	D	2	-	-	GRANULAR/SUB.A.	-	-	-	Mid slope
	14/2	6026120	2	0.30	0.5	B	C	RB	-	CLAY LOAM	D	1	-	-	SUBANGULAR	-	-	-	
	14/3		3	0.5	1.5	C	C	BR	-	LIGHT CLAY	T	4	Y	R	MASSIVE	-	-	-	
15	15/1	487634	1	0.0	0.30	A	-	+B	-	F-SA-CLAY LOAM	D	2	-	-	GRANULAR/SUB.A.	-	-	-	Top of Slope
	15/2	6025970	2	0.30	0.50	B	C	BO	-	CLAY LOAM	D	2	-	-	SUBANGULAR	-	-	-	
	15/3		3	0.50	1.50	C	D	O	-	SA-SILTY CLAY	D	4	Y	R	MASSIVE	-	-	-	
16	16/1	487795	1	0.0	0.10	A1	-	--B	-	SA-CLAY LOAM	D	1	-	-	GRANULAR	-	-	-	
	16/2	6025712	2	0.10	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	16/3		3	0.40	1.50	B	D	--B	-	MEDIUM CLAY	D	4	Y	O	MASSIVE	-	-	-	
17	17/1	487752	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	2	-	-	GRANULAR	-	-	-	
	17/2	6025409	2	0.05	0.40	A2	C	W	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	17/3		3	0.40	1.50	B	D	O	-	LIGHT CLAY	D	4	Y	RB	MASSIVE	-	-	-	
18	18/1	487640	1	0.0	0.20	A1	-	-B	-	SILTY LOAM	D	1	-	-	GRANULAR	-	-	-	Drainage Plain, Prairie soil
	18/2	6026420	2	0.20	0.30	A2	C	B	-	SILTY CLAY	D	2	-	-	GRANULAR	-	-	-	
	18/3		3	0.30	1.50	B	D	O	-	SA-SILTY CLAY	D	4	Y	O	MASSIVE	-	-	-	

McMahon EARTH SCIENCE

SOIL SURVEY FIELD SHEET

Job No: 5473
Project: Jindera Solar Farm/ NGH Enviornmental
Site: 1866 Urana Road, Jindera

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
19	19/1	487957	1	0.0	0.05	A1	-	-B	-	SILTY LOAM	D	1	-	-	GRANULAR	-	-	-	
	19/2	6026662	2	0.05	0.20	A2	C	WB	-	SILT	D	1	-	-	GRANULAR	-	-	-	
	19/3		3	0.20	1.40	B	D	++B	-	LIGHT CLAY	D	5	Y	BRO	SUBANGULAR	-	-	-	
	19/4		4	1.4	1.5	C	D	OB	-	SANDY CLAY	D	5	Y	O	MASSIVE	-	-	-	
20	20/1	487734	1	0.0	0.20	A1	-	-B	-	SILTY LOAM	D	1	-	-	GRANULAR	-	-	-	
	20/2	6026962	2	0.20	0.40	A2	C	OB	-	SA-SILTY CLAY	D	2	Y	O	GRANULAR	-	-	-	
	20/3		3	0.40	1.50	B	D	BO	-	SA-SILTY CLAY	D	4	Y	BRO	MASSIVE	-	-	-	
21	21/1	487977	1	0.0	0.30	A	-	BO	-	F-SA-CLAY LOAM	D	2	-	-	GRANULAR	-	-	-	
	21/2	6027258	2	0.30	1.50	B	D	O	-	LIGHT CLAY	D	5	Y	RG	MASSIVE	-	-	-	

Attachment B : *Laboratory reports*

Nutrient Advantage®

Nutrient Advantage Advice® Nutrient Report

DM McMahon Ptv Ltd
PO BOX 6118

WAGGA WAGGA
NSW 2650

Report Print Date: 08/02/2019
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5473

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019547
Paddock Name: SAMPLES 1-6
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 6/02/2019

Analyte / Assay	Units	Value
pH (1:5 Water)		6.3
pH (1:5 CaCl2)		5.8
Electrical Conductivity (1:5 water)	dS/m	0.14
Chloride	mg/kg	<10
Nitrate Nitrogen	mg/kg	35
Ammonium Nitrogen	mg/kg	18
Phosphorus (Colwell)	mg/kg	36
Phosphorus Buffer Index		47
Sulphur (KCl40)	mg/kg	12
Cation Exch. Cap. (CEC)	cmol(+)/kg	7.1
Calcium (Amm-acet.)	cmol(+)/kg	6.1
Magnesium (Amm-acet.)	cmol(+)/kg	0.3
Sodium (Amm-acet.)	cmol(+)/kg	<0.02
Potassium (Amm-acet.)	cmol(+)/kg	0.71
Available Potassium	mg/kg	280
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	86.0
Magnesium % of Cations	%	4.4
Sodium % of Cations (ESP)	%	<1.00
Potassium % of Cations	%	10.00
Calcium/Magnesium Ratio		20.0

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

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Nutrient Advantage Advice® Nutrient Report

Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019547	**Test Code:**	E11
Paddock Name:	SAMPLES 1-6	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	6/02/2019
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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Nutrient Advantage Advice® Nutrient Report

DM McMahon Ptv Ltd
PO BOX 6118

WAGGA WAGGA
NSW 2650

Report Print Date: 08/02/2019
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5473

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019548
Paddock Name: SAMPLES 7 AND 8
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 6/02/2019

Analyte / Assay	Units	Value
pH (1:5 Water)		6.1
pH (1:5 CaCl2)		5.4
Electrical Conductivity (1:5 water)	dS/m	0.16
Chloride	mg/kg	<10
Nitrate Nitrogen	mg/kg	34
Ammonium Nitrogen	mg/kg	37
Phosphorus (Colwell)	mg/kg	66
Phosphorus Buffer Index		41
Sulphur (KCl40)	mg/kg	14
Cation Exch. Cap. (CEC)	cmol(+)/kg	8.2
Calcium (Amm-acet.)	cmol(+)/kg	5.8
Magnesium (Amm-acet.)	cmol(+)/kg	0.9
Sodium (Amm-acet.)	cmol(+)/kg	0.07
Potassium (Amm-acet.)	cmol(+)/kg	1.40
Available Potassium	mg/kg	550
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	71.0
Magnesium % of Cations	%	11.0
Sodium % of Cations (ESP)	%	0.85
Potassium % of Cations	%	17.00
Calcium/Magnesium Ratio		6.5

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Nutrient Advantage Advice® Nutrient Report

Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019548	**Test Code:**	E11
Paddock Name:	SAMPLES 7 AND 8	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	6/02/2019
Sample Depth (cm):	0 **To** 10		

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Nutrient Advantage Advice® Nutrient Report

DM McMahon Ptv Ltd
PO BOX 6118

WAGGA WAGGA
NSW 2650

Report Print Date: 08/02/2019
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5473

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019549
Paddock Name: SAMPLES 9-12 AND 17
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 6/02/2019

Analyte / Assay	Units	Value
pH (1:5 Water)		6.4
pH (1:5 CaCl2)		5.8
Electrical Conductivity (1:5 water)	dS/m	0.19
Chloride	mg/kg	19
Nitrate Nitrogen	mg/kg	47
Ammonium Nitrogen	mg/kg	22
Phosphorus (Colwell)	mg/kg	57
Phosphorus Buffer Index		42
Sulphur (KCl40)	mg/kg	15
Cation Exch. Cap. (CEC)	cmol(+)/kg	8.7
Calcium (Amm-acet.)	cmol(+)/kg	7.2
Magnesium (Amm-acet.)	cmol(+)/kg	0.5
Sodium (Amm-acet.)	cmol(+)/kg	0.12
Potassium (Amm-acet.)	cmol(+)/kg	0.74
Available Potassium	mg/kg	290
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	84.0
Magnesium % of Cations	%	6.2
Sodium % of Cations (ESP)	%	1.40
Potassium % of Cations	%	8.60
Calcium/Magnesium Ratio		13.0

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Nutrient Advantage Advice® Nutrient Report

Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019549	**Test Code:**	E11
Paddock Name:	SAMPLES 9-12 AND 17	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	6/02/2019
Sample Depth (cm):	0 **To** 10		

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Nutrient Advantage Advice® Nutrient Report

DM McMahon Ptv Ltd
PO BOX 6118

WAGGA WAGGA
NSW 2650

Report Print Date: 08/02/2019
Agent/Dealer:
Advisor/Contact: D M MCMAHON PTY LTD
Phone: 02 6931 0510
Purchase Order No: 5473

Grower Name : D M MCMAHON PTY LTD
Sample No: 022019550
Paddock Name: SAMPLES 13-16 AND 18-21
Sample Name:
Sample Depth (cm): 0 **To** 10

Nearest Town: WAGGA NORTH
Test Code: E11
Sample Type: Soil
Sampling Date: 6/02/2019

Analyte / Assay	Units	Value
pH (1:5 Water)		6.5
pH (1:5 CaCl2)		6.0
Electrical Conductivity (1:5 water)	dS/m	0.13
Chloride	mg/kg	12
Nitrate Nitrogen	mg/kg	32
Ammonium Nitrogen	mg/kg	5
Phosphorus (Colwell)	mg/kg	51
Phosphorus Buffer Index		49
Sulphur (KCl40)	mg/kg	14
Cation Exch. Cap. (CEC)	cmol(+)/kg	6.9
Calcium (Amm-acet.)	cmol(+)/kg	6.1
Magnesium (Amm-acet.)	cmol(+)/kg	0.2
Sodium (Amm-acet.)	cmol(+)/kg	0.05
Potassium (Amm-acet.)	cmol(+)/kg	0.55
Available Potassium	mg/kg	220
Aluminium (KCl)	cmol(+)/kg	<0.1
Aluminium % of Cations	%	<1.0
Calcium % of Cations	%	88.0
Magnesium % of Cations	%	3.3
Sodium % of Cations (ESP)	%	0.68
Potassium % of Cations	%	8.00
Calcium/Magnesium Ratio		28.0

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Nutrient Advantage Advice® Nutrient Report

Grower Name :	D M MCMAHON PTY LTD	**Nearest Town:**	WAGGA NORTH
Sample No:	022019550	**Test Code:**	E11
Paddock Name:	SAMPLES 13-16 AND 18-21	**Sample Type:**	Soil
Sample Name:		**Sampling Date:**	6/02/2019
Sample Depth (cm):	0 **To** 10		

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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.