APPENDIX H SOIL SURVEY

MACQUARIE GEOTECH

Geotechnical Engineers & Engineering Geologists
NATA Accredited Laboratories for Asphalt, Aggregate, Coal, Concrete, Environmental, Soil & Rock
Geotechnical & Environmental Drilling

Desk Study and Preliminary Soil Survey for Beryl Solar Farm, Beryl

First Solar

14 March 2017

Ref: 17-096

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1 INTRODUCTION

At the request of Tom Best from First Solar, Macquarie Geotechnical has carried out a Desk study and preliminary site investigation for the proposed Beryl Solar Farm, Beryl.

The objectives of this desk study were to describe the existing geology, geomorphology, groundwater information, description of soil types and properties including erosion potential and chemical properties.

2 METHOD OF INVESTIGATION

A desk study was undertaken using readily available geological and geotechnical information and included the following:

- Dubbo 1:250,000 Geological Sheet SI/55-4
- Dubbo 1:250,000 Geological Sheet SI/55-4 Explanatory Notes
- Dubbo 1:250,000 Soil Landscape Series Sheet
- ASRIS/CSIRO
- ESPADE/Salis
- NSW Office of Water – Water Resources and Management
- NSW Office of Water – Borehole search
- Australian Standard 1726 – 2007 Geotechnical Site Investigations

The assessment involved review of the geological setting of the slope, strength of soils, slope gradient, existing erosion and potential erosion risk, salinity risk, and the topographic setting of the site. In addition drainage paths, extent of possible waterlogging during wet periods and site vegetation were also considered.

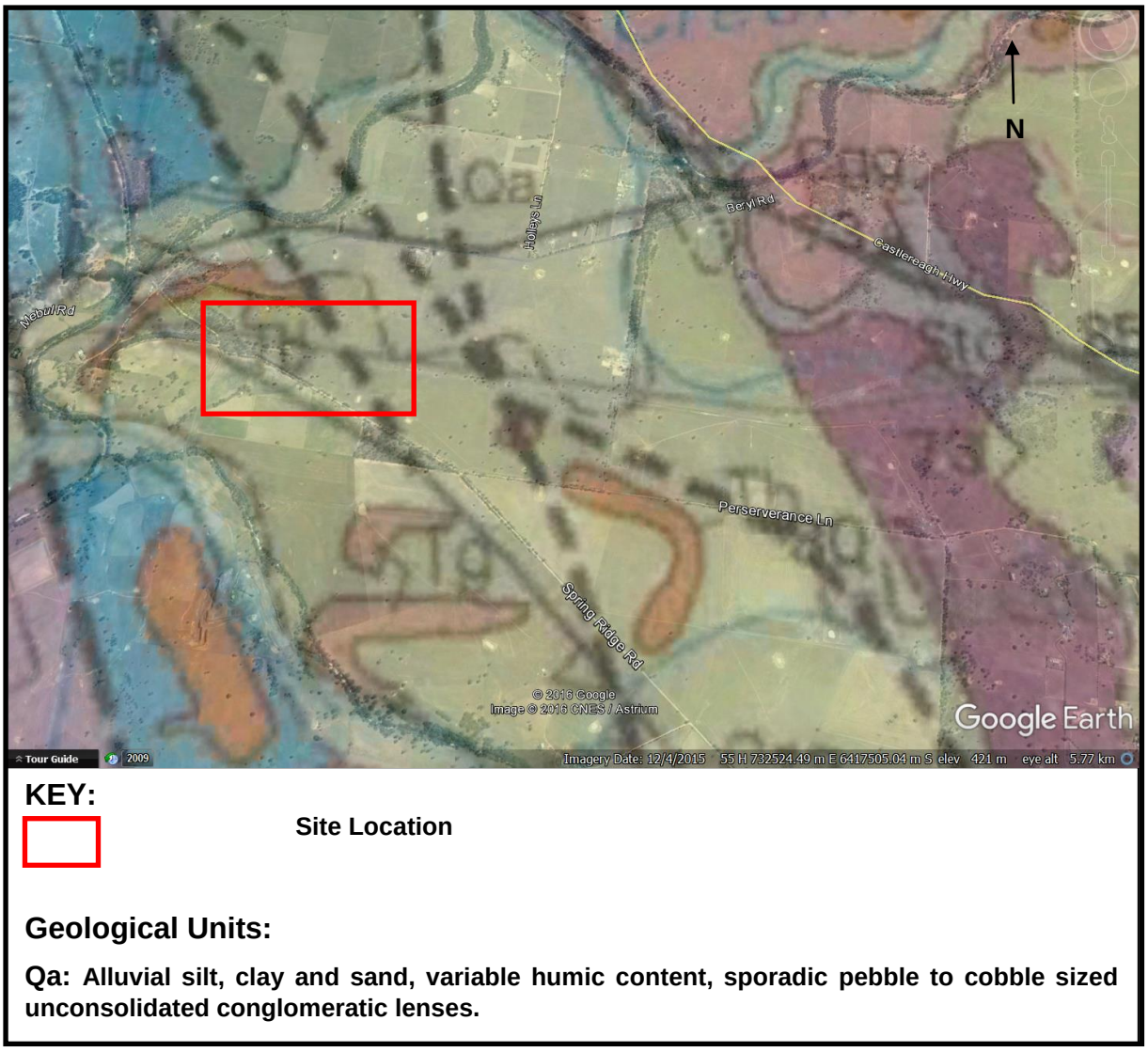
As part of the desk study reference has been made to the preliminary geotechnical investigation undertaken within the proposed site footprint. A site visit was also undertaken by an Engineering Geologist from our Bathurst office.

3 SITE DESCRIPTION

The site is located adjacent to Beryl Substation, Beryl. The site is located on gently undulating grassed areas that is currently used for cropping and grazing.. The site is bound to the south by Spring Ridge Rd and Perseverance Lane and grassed paddocks all other directions. The north western section of the site is bound by Beryl Road and Beryl substation

3.1 Regional Geology

Reference to the Dubbo Geological map (1:250'000 SI/55-4) indicates that the geology underlying the site consists of the following;



KEY:

Site Location

Geological Units:

Qa: Alluvial silt, clay and sand, variable humic content, sporadic pebble to cobble sized unconsolidated conglomeratic lenses.

Figure 1: Solid Geology of the Area

The site is generally underlain by the following geological sequences:

- Qa (Alluvial Deposits) – Alluvial silt, clay and sand, variable humic content, sporadic pebble to cobble sized unconsolidated conglomeratic lenses.

The 1:250000 "Dubbo" Soil Landscape Series Sheet indicates that the site is located within the following soil landscape groups:

The "Home Rule" Soil Group

The "Membul" Soil Group

The "Craigmore" Soil Group

The site predominantly falls into the Home Rule soil group and is described as follows:

- These soils are found on undulating low rises ranging in elevation between 420 and 500m above sea level.
- Slopes are gently inclined 4 – 8%.
- The landscape consists of siliceous sands, bleached sands and earthy sands overlying yellow sodic soils.
- Erosion hazard is high especially in areas with minimal ground cover and drainage depressions are susceptible to gully erosion.

Extract summary from Dubbo Soil Landscapes is provided below:

Table 1: Dubbo Soil Landscape – Home Rule

SUMMARY TABLE FOR THE MAIN SOILS OF HOME RULE SOIL LANDSCAPE		
	Siliceous Sands	**Yellow Solodic Soils**
Dominance	Co-dominant	Co-dominant
Landform element	Crests, mid to upper slopes	Lower slopes
Surface condition	Loose	Hardsetting
Drainage	Excessively well-drained	Imperfectly drained
Soil permeability	High	Slow
Watertable depth	>150 cm	>150 cm
Available waterholding capacity	Low	Moderate to low
Depth to bedrock	100 - 300 cm	150+ cm
Flood hazard	Nil	Low
pH (topsoil)	Slightly acidic	Slightly acidic to neutral
Fertility (chemical)	Low	Low
Expected nutrient deficiencies	N, P	N, P
Soil salinity	Low	Low to moderate
Erodibility (topsoil)	Moderate	High
Erodibility (subsoil)	Moderate	High
Erosion hazard	High	High to very high
Structural degradation hazard	Low	High
Land capability classification	III, VI	IV, V, VI
USCS (subsoil)	CL, SM, SP, SW	CL, SC
Shrink-swell potential	Low	Moderate
Mass movement hazard	Low	Low

The Membul soil group and is described as follows:

- These soils are found on undulating low hills ranging in elevation between 400 and 540m above sea level.
- Slopes range from 2 –15%.
- The landscape consists of choclate soils and euchozerms.
- Erosion hazard is high especially in areas with minimal ground cover.

Extract summary from Dubbo Soil Landscapes is provided in Table 2.

Table 2: Dubbo Soil Landscape – Membul

SUMMARY TABLE FOR MAIN SOILS OF MEBUL SOIL LANDSCAPE			
	Chocolate Soils	**Euchrozems**	**Non-calcic Brown Soils**
Dominance	Dominant	Minor	Minor
Landform element	Mid and upper slopes	Mid to lower slopes	Upper slopes and crests
Surface condition	Friable	Friable	Hardsetting
Drainage	Well-drained	Well-drained	Well-drained
Soil permeability	Moderate	Moderate to rapid	Moderate
Watertable depth	>300 cm	>300 cm	>300 cm
Available waterholding capacity	Moderate to high	Moderate to high	Moderate
Depth to bedrock	>100 cm	>100 cm	>100 cm to 60 cm
Flood hazard	Nil	Nil	Nil
pH (topsoil)	Neutral	Neutral	Slightly acidic
Fertility (chemical)	Moderate	Moderate to high	Moderate
Expected nutrient deficiencies	N, P	N, P	N, P
Soil salinity	Low	Low	Low
Erodibility (topsoil)	Low	Low	Moderate
Erodibility (subsoil)	Low	Low	Low
Erosion hazard	Moderate	Moderate	Moderate
Structural degradation hazard	Moderate	Moderate to low	High
Land capability classification	III, IV	III, IV	III, IV
USCS (subsoil)	CL, CH	CL, CH	CL, CH
Shrink-swell potential	Moderate to high	Moderate to high	Moderate to high

The Craigmore soil group and is described as follows:

- These soils are found on high terrace ranging in elevation between 460 and 475m above sea level.
- The landscape consists of non-calcic soils and red earths.
- Erosion hazard is low unless in areas with minimal ground cover.

Extract summary from Dubbo Soil Landscapes is provided in Table 3.

Table 3: Dubbo Soil Landscape – Craigmore

SUMMARY TABLE FOR THE MAIN SOILS OF CRAIGMORE SOIL LANDSCAPE		
	Red Earths	**Non-calcic Brown Soils**
Dominance	Co-dominant	Co-dominant
Landform element	Alluvial terrace	Alluvial terrace
Surface condition	Hardsetting	Hardsetting
Drainage	Moderately well drained	Moderately well drained
Soil permeability	Permeable	Permeable
Watertable depth	>100 cm	>100 cm
Available waterholding capacity	Moderate to high	Moderate to high
Depth to bedrock	Very deep	Very deep
Flood hazard	High terrace above modern flood level	High terrace above modern flood level
pH (topsoil)	Slightly acidic	Slightly acidic
Fertility (chemical)	Moderate to high	Moderate to high
Expected nutrient deficiencies	N, P	N, P
Soil salinity	Low	Low
Erodibility (topsoil)	Low	Low
Erodibility (subsoil)	Low	Low
Erosion hazard	Low	Low
Structural degradation hazard	High	High
Land capability classification	II, III, IV	II, III, IV
USCS (subsoil)	ML, SM	CL
Shrink-swell potential	Low	Low to moderate
Mass movement hazard	Nil	Nil

3.2 Existing Borehole Data

As part of the deskstudy a bore hole search was undertaken using the NSW Groundwater data, the borehole search predominatly provides information to groundwater, however they do provide basic information on geology. Only one borehole with information is noted with 1km of the eastern boundary of the site.

Table 4: Geological Summary of Borehole data – GW803647

Depth (m)	Strata
0.00-0.30	TOPSOIL
0.30-5.00	CLAY
5.00-7.40	SAND, GRAVEL & CLAY
7.40-9.50	CLAY
9.50-25.00	SAND & GRAVEL
25.00-33.50	CLAY
33.50-35.00	BASALT
35.00-54.00	SHALE

3.3 Acid Sulphate Soils

A review of the Acid Sulphate risk maps has been undertaken and presented below:

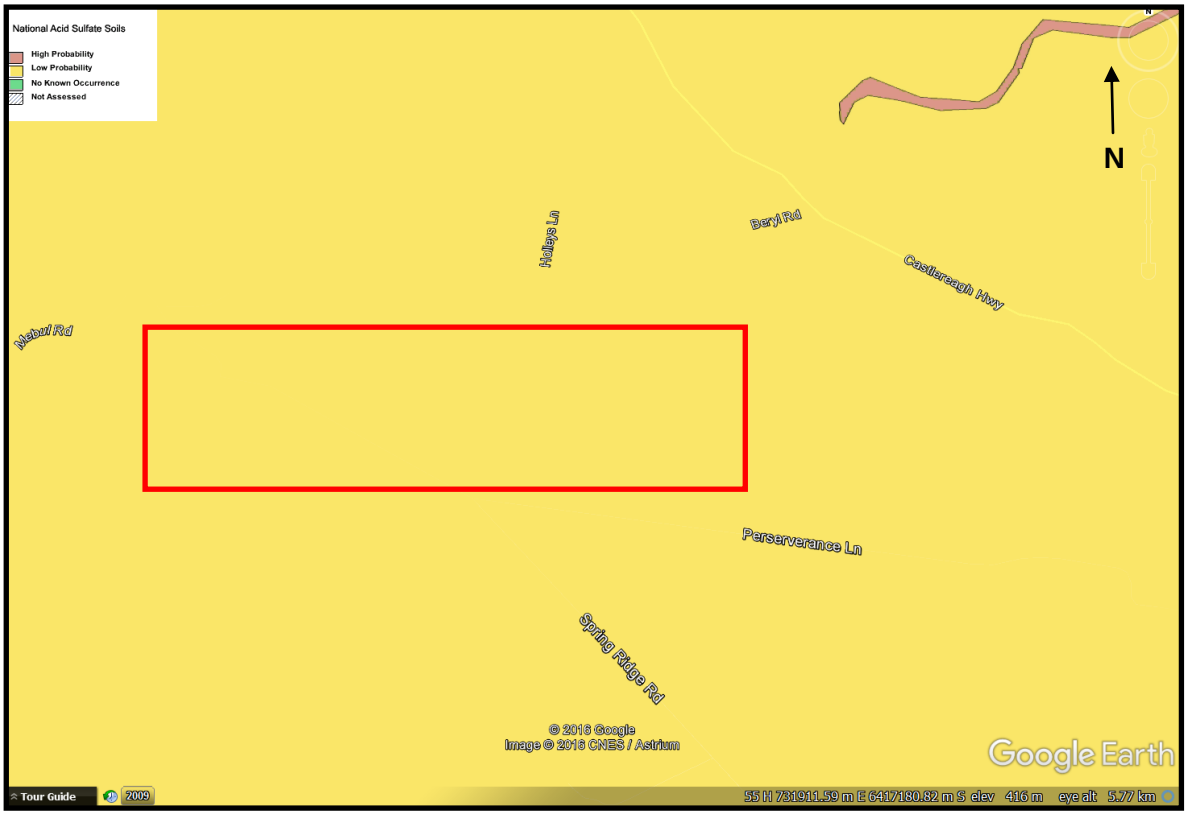


Figure 2: Acid Sulphate Soils

The acid sulphate risk map shows that the investigation area is located within an area no known occurrence.

3.4 Geotechnical Investigation

Fieldwork was undertaken on the 20th of February 2017 by an Engineering Geologist from our Bathurst office.

The fieldwork was undertaken in accordance with AS1726 - "Geotechnical Site Investigations" and our proposal dated 09th February 2017.

The fieldwork comprised six shallow boreholes to depths of up to 0.5m for dispersion testing.

The boreholes were drilled using a 4wd mounted Innovative Sampla 24LT. The boreholes were identified as BH-01 to BH-06 inclusive.

The subsurface investigation indicates that the following:

Table 5: Borehole Summary

Borehole	BH01	BH02	BH03	BH04	BH05	BH06
	Depth (m)					
Silty SAND – loose (TOPSOIL)	0.00–0.30	0.00–0.50	0.00-0.45	0.00-0.40	0.00-0.50	0.00-0.50
Sandy CLAY – stiff (ALLUVIAL)	0.30-0.50	-	0.45-0.50	0.40-0.50	-	-
Termination Depth (m)	0.50	0.50	0.50	0.50	0.50	0.50
Groundwater Encountered	No	No	No	No	No	No

A number of rocky outcrops were noted at borehole BH06 within the north eastern section of the site.

Samples were taken from all of the boreholes and returned to our NATA accredited laboratory in Bathurst for Emerson Crumb Testing in accordance with AS1289 3.8.1. The results of the testing are presented in the table below:

Table 6: Emerson Crumb Results

Depth (m)	Emerson Crumb Result
0.45 – 0.50	2
0.45 – 0.50	1
0.45 – 0.50	1
0.45 – 0.50	1
0.45 – 0.50	1
0.45 – 0.50	1

4 DISCUSSIONS

Based on the results of the desk study, geotechnical investigation for Beryl Solar Farm and the site inspection and our experience with similar soils, the main geotechnical properties of the underlying soils are as follows;

- Site soils fall predominantly into the Home Rule Soil Group and consisted of silty sands underlain by clays.
- The emerson crumb results range between 1 to 2 and indicate that the site soils are dispersive.
- The erosion risk of the area is high based especially in areas with no or minimal ground cover. It is noted that the majority of the site investigated is protected from erosion by existing groundcover.
- Erosion on site can be managed and controlled by implementation of erosion and sedimentation management plans.
- The probability of acid sulphate soils in the area is generally low.

5 CONCLUSION

The findings of our report were based on our fieldwork, in-situ testing, laboratory testing, technical assessment and local knowledge for this site. We trust the foregoing is sufficient for your present purposes, and if you have any questions please contact either of the undersigned.

Yours sincerely

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BSc (Hons) Affil MIE Aust

LIMITATIONS OF GEOTECHNICAL SITE INVESTIGATION

Scope of Services

This report has been prepared for the Client in accordance with the Services Engagement Form (SEF), between the Client and Macquarie Geotechnical.

Reliance on Data

Macquarie Geotechnical has relied upon data and other information provided by the Client and other individuals. Macquarie Geotechnical has not verified the accuracy or completeness of the data, except as otherwise stated in the report. Recommendations in the report are based on the data.

Macquarie Geotechnical will not be liable in relation to incorrect recommendations should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

Geotechnical Investigation

Findings of Geotechnical Investigations are based extensively on judgment and experience. Geotechnical reports are prepared to meet the specific needs of individual clients. This report was prepared expressly for the Client and expressly for the Clients purposes.

This report is based on a subsurface investigation, which was designed for project-specific factors. Unless further geotechnical advice is obtained this report cannot be applied to an adjacent site nor can it be used when the nature of any proposed development is changed.

Limitations of Site investigation

As a result of the limited number of sub-surface excavations or boreholes there is the possibility that variations may occur between test locations. The investigation undertaken is an estimate of the general profile of the subsurface conditions. The data derived from the investigation and laboratory testing are extrapolated across the site to form a geological model. This geological model infers the subsurface conditions and their likely behavior with regard to the proposed development.

The actual conditions at the site might differ from those inferred to exist.

No subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

Time Dependence

This report is based on conditions, which existed at the time of subsurface exploration. Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report.

Macquarie Geotechnical should be kept appraised of any such events, and should be consulted for further geotechnical advice if any changes are noted.

Avoid Misinterpretation

A geotechnical engineer or engineering geologist should be retained to work with other design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

No part of this report should be separated from the Final Report.

Sub-surface Logs

Sub-surface logs are developed by geoscientific professionals based upon their interpretation of field logs and laboratory evaluation of field samples. These logs should not under any circumstances be redrawn for inclusion in any drawings.

Geotechnical Involvement During Construction

During construction, excavation frequently exposes subsurface conditions. Geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendations and should make their own enquiries and obtain independent advice in relation to such matters

Macquarie Geotechnical assumes no responsibility and will not be liable to any other person or organisations for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisations arising from matters dealt with or conclusions expressed in the report.

Other limitations

Macquarie Geotechnical will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Other Information

For further information reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, 1987.