JOB NO DE16/258 **SEPTEMBER, 2016**

YARRANLEA SOLAR PTY LTD

PRELIMINARY BROADSCALE GEOTECHNICAL INVESTIGATION

PROPOSED SOLAR FARM

538 & 752 YARRANLEA ROAD

YARRANLEA

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 **P** (07) 3279 0900 **F** (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Job No: DE16/258
Ref No: 21249
Author: Davor Dragun

15th September, 2016

Yarranlea Solar Pty Ltd
C/-: i3 Consulting Pty Ltd
Suite 2/39 Sherwood Road
Toowong QLD 4066

ATTENTION: MR NICK CANTO
Email: nick.canto@icubed.com.au

Dear Sir,

RE: PRELIMINARY BROADSCALE GEOTECHNICAL INVESTIGATION – PROPOSED SOLAR FARM, 538 AND 752 YARRANLEA ROAD, YARRANLEA

1.0 INTRODUCTION

This report presents the results of a preliminary broadscale geotechnical investigation carried out for the proposed solar farm at the above site.

The work was commissioned by Mr. Nick Canto from i3 Consulting Pty Ltd, on behalf of Yarranlea Solar Pty Ltd (the "Client").

From the information provided, it is understood that the proposed development will involve the construction of a solar farm and will also include a substation in the south western corner of the site. It is understood that the preferred footing system for the solar panels are screw piles with the substation to be supported by a high level raft slab. It is proposed to remove and replace upper materials in the area of the substation subgrade with non - reactive fill due to the expected reactivity of the in-situ soils.

Earthworks operations are unknown but are expected to comprise cut and fill to create the required platform.

Our preliminary broadscale report contains the results of fieldwork and laboratory testing, together with comments and recommendations relating to the following:

- Description of subsurface materials in the depth range of the boreholes in accordance with AS1726;
- Groundwater depths, if encountered;
- Laboratory test results;
- Earthworks recommendations including excavability;
- Soil reactivity and characteristic ground surface movements for normal moisture conditions only;
- Alternative foundation types and allowable bearing capacities;

The recommendations made in this preliminary report are for use in preliminary design and their adoption for final design is contingent upon confirmation of the design parameters across the entire development footprint by further investigation and laboratory testing.

2.0 SITE DESCRIPTION

The proposed development site is located at 538 and 752 Yarranlea Road, Yarranlea.

At the time of the field investigation, most of the site was vacant, undeveloped and used for crop farming.

Field observations indicate that the ground surface was relatively level.

Refer to site photographs below for typical site conditions at the time of field work.

Site Photo 1

Site Photo 2

3.0 METHODOLOGY

The geotechnical investigation comprised the auger drilling of seven boreholes to depths of between 2.7m and 5.6m (drilling rig refusal) at the locations scattered across the site and where access permitted. All boreholes were drilled using a utility mounted Jehyco Digga drilling rig. Dynamic Cone Penetrometer (DCP) tests were performed adjacent to each borehole. Undisturbed and disturbed samples were collected at selected locations from the boreholes for laboratory testing.

The subsurface conditions encountered in the depth range of the boreholes were logged and visually classified in accordance with AS1726-1993 by a geotechnical engineer from the Morrison Geotechnic Darra office.

The samples collected during the field investigation were tested in Morrison Geotechnic's soil laboratory at Darra and included Shrink-Swell Index and Quality of Material tests.

Testing was carried out in accordance with the relevant Australian Standards.

The approximate locations of the boreholes are shown on the site plan in Appendix A. The logs of the boreholes are contained in Appendix B of this report. Results of the laboratory tests are presented in Appendix C.

4.0 GEOLOGY

The local geology and groundwater conditions are described in Section 4.1 and Section 4.2 respectively.

4.1 Local Geology

The local geology generally consists of natural clay soils and rock to the borehole termination depths. The subsurface profiles are discussed below and are described in more detail in the engineering borehole logs attached in Appendix B.

Natural Soils

Natural materials were encountered in all boreholes and generally comprised of stiff to hard, medium and high plasticity sandy/silty clay and gravelly sandy/gravelly clay. All boreholes were terminated within the natural clays with the exception of borehole BH1. Drilling rig refusal, maximum 'TC' bit was reached in boreholes BH6 and BH7 in gravels or cobbles within the clays. The possibility exists that weathered rock may also be present at the refusal depths.

Weathered Rock

Extremely weathered and extremely to distinctly weathered, extremely low and very low strength basalt was encountered only in borehole BH1 at depth of 4.0m to 4.5m and 5.2m to 5.6m. Drilling rig refusal, maximum 'TC' bit was reached at a depth of 5.6m. The possibility exists that stronger rock may be present below the drilling refusal depth.

A summary of the subsurface profile encountered in the boreholes is shown in Table 1.

Table 1 – Geotechnical Summary of the Subsurface Profile

Borehole No.	Depth Range (m)		
	Natural Clays (m)	Extremely Weathered Basalt (m)	Termination Depth (m)
BH1	0.0 – 4.0 4.5 – 5.2	4.0 – 4.5 5.2 – TD	5.6 3.)
BH2	0.00 – TD	NE	4.5
BH3	0.00 – TD	NE	4.5
BH4	0.00 – TD	NE	4.5
BH5	0.00 – TD	NE	4.5
BH6	0.00 – TD	NE	2.7 4.)
BH7	0.00 – TD	NE	3.1 4.)

NOTES
1. TD – Termination Depth; NE – Not Encountered;
2. All depth below existing ground surface level as at the time of field work on 29th August, 2016.
3. TC bit refusal within weathered rock.
4. TC bit refusal within gravels/cobbles.

4.2 Groundwater

No groundwater or groundwater seepages were observed in the boreholes. However, seepages can be expected within the natural soil/rock interface, especially following periods of extended heavy rainfall.

The presence and depth to groundwater is dependent on rainfall, subsurface material and permeability, integrity of in-ground services, proximity to existing waterways and water bodies and the proximity to, type and density of vegetation.

5.0 LABORATORY TEST RESULTS

The laboratory test results are contained in Appendix C to this report and are summarised below.

The results of the Particle Size Distribution/Atterberg Limits (Quality of Materials) tests are summarised in Table 2.

Table 2 – Quality of Materials

Borehole Number	Depth (m)	Soil Fraction			Liquid Limit (%)	Plasticity Index	Linear Shrinkage	Material
		Clay/Silt (%)	Sand (%)	Gravel (%)				
BH1	1.5 – 1.8	71	28	1	68	49	16.5	Natural Silty Clay (CH)
BH3	0.9 – 2.9	91	7	2	56	37	14.5	Natural Silty Clay (CH)
BH4	2.5 – 2.75	65	17	18	72	52	18.5	Natural Silty Clay (CH)
BH5	2.5 – 2.75	69	29	2	63	43	19	Natural Sandy Clay (CH)
BH7	1.5 – 1.7	40	25	35	64	43	19	Natural Clayey Gravel (GC)1.)

Notes:
1. Based on the visual assessment during drilling, this material appears to be gravelly clay.

Laboratory testing was carried out on representative undisturbed (U50) soil samples recovered from the field investigation programme and are as follows:-

- Shrink/Swell Index (Iss) – To assess the volume change potential (reactivity) of the subsurface material.

The results of the laboratory testing are summarised in Table 3.

Table 3 – Shrink/Swell Index Test Results

Borehole Number	Depth (m)	Shrink (%)	Swell (%)	Shrink Swell Index (I_{ss} %)
BH1	1.5	5.0	4.6	4.0
BH2	2.5	4.6	3.7	3.6
BH4	2.5	2.9	4.1	2.7
BH5	2.5	2.2	6.5	3.0
BH7	1.5	1.4	2.4	1.4

6.0 EARTHWORKS

All earthworks procedures should be carried out in a responsible manner in accordance with AS.3798-2007 “Guidelines on Earthworks for Commercial and Residential Developments”. The earthworks contractor should make himself familiar with the site conditions.

Earthworks operations are unknown but are expected to comprise some cut and fill to create required platforms. Removal and replacement works are expected in the area of the proposed substation structure. Following general comments are made.

The following earthworks procedures are recommended:-

- Clearing and stripping should be carried out across the building areas.

- Temporary cut batters in material encountered on site should generally not exceed 45^0, subject to inspection by an experienced geotechnical engineer or engineering geologist.

- Depressions formed by the removal of vegetation, underground elements, etc. should have all disturbed and weakened soil removed.

- After stripping, the exposed competent natural clay ground surface should be proof rolled under the supervision of Morrison Geotechnic using a static vehicle with a tare of at least 15 tonnes and then compacted to 98% Standard Maximum Dry Density (SMDD). Areas demonstrating excessive movement should be treated (dried and recompacted) or removed and replaced with compacted fill. Treatment should be to a standard sufficient so that the subgrade passes proof rolling and that compaction can be achieved in the first layer of fill.

- Provided the placement moisture content of any imported fill or select insitu material approximates the Optimum Moisture Content for compaction, suitable compaction should be achievable using typical compaction machinery. The fill materials should be compacted in layers not exceeding 200mm loose thickness. However, layer thicknesses will be dependent on the compaction plant type and size, use of vibration, material type and condition. Final maximum placement layer thicknesses will need to be determined when compaction plant, as well as material type and conditions, are known.

- The insitu soils obtained from site cuttings, where free of organic and deleterious material, may be used for structural fill provided the moisture content of the soils on placement approximates the Optimum Moisture Content required for compaction. This may require conditioning to bring the soils to OMC. However, it should be noted that the high plasticity clay soils could be expected to present difficulties in handling, placement and compaction if the appropriate moisture content cannot be achieved, particularly if the clays are overly moist.

- With use of reactive clay soils, close control of moisture content during placement and compaction is required so as to minimise the potential for swelling and shrinkage movement. Moisture content within the range of OMC (Standard Optimum Moisture Content) to OMC +2% is recommended. Foundation design must reflect the use of the potentially reactive clays if they are used as structural fill.

- Based on the laboratory testing, the natural clay materials tested were generally high to extremely high reactive in terms of volume change potential and under the normal soil moisture conditions as defined in Section 1.3.2 of AS2870-2011, Table 2.1 and Table 2.3 of AS2870-2011. The designer should consider the effect of earthworks using the natural clay soils as controlled fill.

- Imported select fill material, if required, should be a good quality select fill material with a soaked CBR of at least 10%, a maximum aggregate size of 50mm and have a maximum Shrink/Swell Index of 1.0%.

- All fill placed to raise the ground surface should be compacted in 200mm thick layers to a density not less than 98% SMDD in accordance with AS.1290 5.1.1 (Standard Compaction). Where pavements are to be constructed, fill compaction and compaction of the natural soil subgrade to 100% SMDD is required.

- Pavement gravels should comply with D.O.T. quality specification for base, sub – base and blanket materials (DOT MRS11.05 Base Type 2.1, Sub – Base – Type 2.3 and Blanket – Type 2.5).

- Field density testing should be carried out in each fill lift placed to check the standard of compaction achieved and the placement moisture content if applicable. The frequency and extent of testing should be as per guidelines in AS.3798-2007, Section 8.0.

- The natural soils encountered on site (to borehole depths) should be within the excavation limits of a small dozer (eg. Cat D4 or similar) in bulk earthworks and a medium sized backhoe (eg. Case 580 or similar) in trench excavations. However, for the earthworks below the 'TC' bit limit, larger excavators (30 tonne) with the ripper attachments, compressor driven pneumatic tools or hydraulic rock breakers would be required for efficient excavation.

6.1 Earthworks Supervision

It is recommended that all earthworks operations be supervised under Level 1 engineering supervision by Morrison Geotechnic.

Engineering certification should be provided by a registered professional engineer (RPEQ).

7.0 SOIL REACTIVITY AND CHARACTERISTIC GROUND SURFACE MOVEMENT

In accordance with AS.2870 "Residential Slabs and Footings – Construction", the site classification relates to residential type construction and may not be directly applicable for this development. However, it is a valuable method of site assessment.

Classification of sites where ground movements are predominantly due to soil reactivity under normal soil moisture conditions, as defined in Section 1.3.2 of AS2870-2011, can be based on Table 2.1 and Table 2.3 of AS2870-2011. If "normal" soil conditions prevail, a characteristic ground surface movement, y_s in range of 65mm to 85mm for the natural clay soils would be expected based on the laboratory test results.

The design of new footings must take account of the calculated characteristic ground surface movement, y_s, and the potential surface movement resulting from tree induced suction changes, y_t, calculated as described in Appendix H of AS2870-2011.

Potential ground surface movements due to the effects of trees (y_t) can be assessed using the parameters in Table 4.

Table 4 – Ground Surface Movements Due to Effects of Trees

Design Suction Change Depth H_s (m)	Single Tree		Tree Group	
	Maximum Extra Suction Change (pF)	Maximum Design Drying Depth H_t (m)	Maximum Extra Suction Change (pF)	Maximum Design Drying Depth (H_t)
3.0	0.38	3.4	0.46	4.1

The characteristic ground surface movements may change where:

- Earthworks or additional earthworks are carried out;
- Abnormal soil moisture conditions exist on site or are allowed to develop; and
- Tree planting is carried out on site or trees are removed on or adjacent to the site.

At this site, abnormal soil moisture conditions may prevail in the short to medium term due to the construction of the new development. Examples of abnormal soil moisture conditions are described in Section 1.3.3 of AS2870-2011. On this basis, ground movements are likely to be affected by the expected abnormal soil moisture conditions and therefore the site may be classified as a Class 'P' site in accordance with AS.2870-2011. Class 'P' does not signify any particular severity of potential problems but rather that the site is disqualified from the other classes and therefore requires special consideration using engineering principles.

The designer should consider the effect of further earthworks on site classification. The use of excavated insitu clay soils as additional controlled fill may potentially result in a ground surface movement (ys) of 130mm based on the laboratory test results.

All footings and slab systems should be designed to accommodate the expected ground surface movements for the conditions existing after completion of the earthworks, including the additional suction effects of trees, both present and pre – existing, if applicable.

8.0 FOUNDATIONS

8.1 High Level Footings

The natural clay soils are assessed to be highly to extremely highly reactive in relation to moisture content variations. The foundation system for the proposed development should be designed and constructed to accommodate the potential ground movement resulting from the volume instability of the reactive clay and any new fill materials.

Strip and pad footings and the ground beams of stiffened on-grade raft slabs can be adopted for the proposed substation structure. These footings must be founded in controlled structural fill or natural stiff or stronger clay soils or weathered rock and be designed for the conditions existing now or after completion of any further earthworks.

The design of high level strip and pad footings and the thickened sections of stiffened rafts forming strip and pad footings should consider the allowable bearing pressures presented in Table 5.

TABLE 5 – ALLOWABLE BEARING PRESSURE FOR HIGH LEVEL FOOTINGS

Material[2]		**Allowable Bearing Pressure (kPa)**	
		Strip Footings	**Pad Footings**
Controlled Fill		100	100
Natural Clays	Stiff	100	100
	Very Stiff	175	200
	Hard	250	300
Weathered Basalt (XW/DW)	Extremely Low to Very Low Strength	350	400

Notes:

(1) NR – Not recommended.

(2) All founding material should be verified by a suitably qualified geotechnical engineer or engineering geologist during construction.

(3) Subject to inspection to confirm these values.

The total long term load related settlement of strip and pad footings designed in accordance with Table 5 should be limited to less than 25mm.

Footings and floors founding in the different strata (ie. controlled fill or natural clay soils or weathered rock), may result in potential differential settlements across the building footprints. The anticipated differential settlements equal to 50% of the predicted settlements are expected. If these settlements are excessive, all footings should be founded within consistent strata, preferably either in controlled fill or natural clay soils.

Where required, footings may be made up of mass concrete poured to the underside of the footing, or alternatively, footings may be constructed over mass concrete filled, backhoe excavated pedestals, founding in the deeper stronger soils.

If footings cannot be poured on the same day as the excavations, a concrete blinding layer of at least 50mm thickness is recommended.

8.2 Reduction of Ground Surface Movements

As noted above, the foundation system for the proposed development must be designed and constructed to accommodate the potential ground seasonal movements resulting from the volume instability of the reactive clay soils. If the potential ground surface movement is considered excessive, then an earthworks operation can be undertaken to reduce the seasonal ground surface movements. The placement of imported selected compacted fill (refer Section 6.0) over the natural silty clay soils will be required to reduce the expected seasonal ground surface movements.

With the placement of approximately 2.5m thickness of non-reactive, imported select fill material, the ground surface movements are expected to be reduced to about 35mm (ie. Class ‘M’ conditions). For this case, the imported select fill material will need to extend across the entire building area and at least 2.0m beyond the perimeter of the building layout.

Earthworks procedures should be carried out in accordance with AS 3798 – 2007 and recommendations contained in Section 6.0. The non-reactive imported select fill material should conform to quality requirement outlined in Section 6.0. Adequate quality testing prior to delivery to site is recommended to confirm fill quality and the low reactivity characteristics;

Engineering supervision of the earthworks operations is recommended as described in Section 6.0.

It is emphasised that the success of the above-described reduction in ground surface movement measures is greatly dependent on strict site maintenance over the life of the structure (refer Section 9.0).

8.3 Deep Foundations

If high levels footing founding depths are considered to be excessive, wall or column loads are high or ground surface movements cannot be tolerated, a deep foundation system may be considered.

Given the materials encountered on site, bored piles or grout injected bored piles are considered the most suitable systems for footings at this site.

Screw piles can also be considered. Specialist contractors should be consulted for their assessment of pile capacity.

It is recommended that all piles be socketed at least 4 diameters into the very stiff or stronger natural clays or weathered rock. Bored or Grout injected piles can be designed using the ultimate compressive geotechnical pressures presented in Table 6 below.

Table 6 – Ultimate Compressive Design Parameters for Bored or Grout Injected Piles

Material		**Ultimate Geotechnical Shaft Adhesion (kPa)**	**Ultimate Geotechnical End Bearing Pressure (kPa)**	
			L ≤ 4D	**L ≥ 4D**
Controlled Fill		15	NR	NR
Natural Clay Based Soil	Stiff	30	NR	NR
	Very Stiff	45	900	1350
	Hard	60	1200	1800
Weathered Basalt (XW/DW)	Extremely Low to Very Low Strength	75	1500	2250

Notes:

(1) NC – Not considered; NR – Not recommended.
(2) L – Pile socket length; D – Pile diameter.
(3) Upward ultimate geotechnical shaft adhesion resistance and ultimate end bearing pressure should only be considered below a depth of 3.0m due to moisture variations of the clay strata.
(4) It has been assumed that the founding materials extend at least 3 diameters below the termination depth of pile.
(5) Higher values may be available in weathered rock material where TC bit refusal was achieved. However, further assessment must be carried out to determine rock strength. It is recommended that inspection is carried out by geotechnical engineer/engineering geologist during bored pier drilling to confirm the above values given or any other materials that may be encountered.

For uplift loading the shaft friction values shown in Table 6 should be factored by 0.7.

A suitable geotechnical strength reduction factor (Φg) should be adopted using the methodology presented in *AS2159-2009.* Refer to AS2159 Section 4.3 for further advice regarding Φg.

The ultimate design geotechnical pressures presented in Table 6, in conjunction with the strength reduction factor recommended above, are used to assess the "design geotechnical strength" (R_{dg}) of the pile, as defined in *AS2159-2009 Piling – Design and Installation* by considering the shaft and base areas. The design geotechnical strength must be greater than the "design action effect" (E_d).

The bases and sides of bored pile holes must be thoroughly cleaned of all loose soil debris using a proper cleaning tool. The practice of adding water and spinning the auger is not acceptable. If there is any doubt as to the effectiveness of the base cleaning, the base resistance must be ignored.

No groundwater was encountered in the depth range of the boreholes. If seepage or groundwater is encountered, the holes will need to be lined with steel liners which will have to be socketed into low permeability material to achieve an impermeable seal against any water charged soils above. These groundwater seepages may be controllable by pumping, otherwise requiring the piles to be constructed under water or bentonite using tremie methods. Shaft adhesion must be ignored for the portion of the pile that is permanently lined.

Drilling piles is not only dependent on the subsurface material characteristics but also the type (power and size) of the bored pile drilling rig, drilling teeth, size of pile, etc. It is recommended that a specialist drilling contractor be consulted to be able to manage the above conditions and materials encountered.

During construction, all bored piles must be inspected by an experienced geotechnical engineer or engineering geologist to confirm the geotechnical strength parameters presented in Table 5 and to check the capacity of the piles.

The total long term settlements of bored piles designed in accordance with the information given in this section should be limited to 15mm. Differential settlements should not exceed 50% of the total settlements.

9.0 CONSTRUCTION & SITE MANAGEMENT RECOMMENDATIONS

The following recommendations are made in regard to construction management:

- Subgrades should be compacted to achieve the minimum density ratios recommended in Section 6.0.
- It is recommended that inspection and testing be carried out following general earthworks to confirm sub grade conditions.

In order to minimize foundation movement, it is important that proper site management methods are observed both during construction and throughout the life of the development. These include:-

- The site needs to be well drained. The ground around the building should slope away at 1 in 20 for a minimum of 2.0 metres then fall to the stormwater system to prevent water ponding adjacent to the buildings.
- Footings should be placed with a minimal delay after excavation to avoid desiccation or wetting of the founding soils. If footings cannot be poured on same day as excavation a 50mm blinding layer should be poured. Piers should be poured immediately after excavation.
- Downpipes should not be allowed to saturate founding soils.
- Service trenches under buildings should be kept to a minimum.
- Any service pipes that pass through the foundation structure should use flexible joints allowing both horizontal and vertical movement.
- Any leaking or blocked drains should be fixed promptly.

- Future trees and shrubs should be planted a distance at least 1.5 to their mature height away from the buildings to avoid shrinkage movement in expansive founding soils. Existing trees that may encroach this restriction should be removed as early as possible prior to building construction to enable soil moisture to reach equilibrium.

10.0 LIMITS OF INVESTIGATION

This Preliminary Broadscale Report has been prepared by Morrison Geotechnic Pty Ltd (**Morrison Geotechnic**), and may include contributions from Morrison Geotechnic's officers and employees, sub-contractors, sub-consultants or agents (**Contributors**).

This Preliminary Broadscale Report is for the sole benefit and use of Yarranlea Solar Pty Ltd (**Client**) and approved parties for the sole purpose of providing geotechnical advice and recommendations in respect of the Proposed Yarranlea Solar Farm at 538 and 752 Yarranlea Road, Yarranlea **(Project)**. The Report is only intended to address those issues expressly described in the scope of work in the Proposal Letter and this Preliminary Broadscale Report.

This Preliminary Broadscale Report should not be used or relied upon for any other purpose without Morrison Geotechnic's prior written consent. Morrison Geotechnic and the Contributors do not accept any responsibility or liability in any way whatsoever for the use or reliance of this Preliminary Broadscale Report by anyone other than the Client or by anyone for any purpose other than that for which it has been prepared.

Except with Morrison Geotechnic's prior written consent, this Preliminary Broadscale Report may not be:

(a) released to any other party, whether in whole or in part (other than to the Client's officers, employees and advisers);

(b) used or relied upon by any other party; or

(c) filed with any Governmental agency or other person or quoted or referred to in any public document.

Morrison Geotechnic and the Contributors, do not accept any liability or responsibility whatsoever for, or in respect of, any use or reliance upon this Preliminary Broadscale Report by any third party. Morrison Geotechnic is not obliged to enter into discussions with any third party in respect of this Report.

The information (including technical information and information obtained through discussions) on which this Preliminary Broadscale Report is based has been provided by the Client and third parties. Morrison Geotechnic and the Contributors:

(a) have relied upon and presumed the accuracy of this information;
(b) have not verified the accuracy or reliability of this information (other than as expressly stated in this Preliminary Broadscale Report);
(c) have not made any independent investigations or enquiries in respect of those matters of which it has no actual knowledge at the time of giving this Preliminary Broadscale Report to the Client; and
(d) make no warranty or guarantee, expressed or implied, as to the accuracy or reliability of this information.

Morrison Geotechnic and the Contributors do not accept responsibility or liability for any incorrect assumptions related to this Preliminary Broadscale Report. For the avoidance of doubt, this Report:

(a) cannot predict the ground conditions encountered at any untested location because the ground conditions surrounding a test sampling location (or between any two test sampling locations) may be different from the test samples we have obtained;

(b) is not an environmental, contamination or hazardous materials assessment; may be invalid, incomplete or inaccurate (including errors in the scope of work, investigation methodology, observations, opinions and advice) where the information provided to Morrison Geotechnic was invalid, incomplete or inaccurate;

(c) is limited to observations of those parts of the site that were accessible at the time of the field investigation and is not based on observations about areas of the site which were inaccessible to the investigation equipment (including slopes, heavily vegetated areas or service corridors); and

(d) is not a comprehensive representation of the actual site conditions and may only show a reasonable interpretation of conditions encountered at discrete test locations along with general site observations.

No warranty or guarantee, whether express or implied, is made in respect of the geotechnical data, information, advice, opinions and recommendations present in this Preliminary Broadscale Report. In recognition of the limited use to be made by the Client of this Preliminary Broadscale Report, the Client agrees that, to the maximum extent permitted by law, Morrison Geotechnic and the Contributors shall not be liable for any losses, claims, costs, expenses, damages (whether in statute, in contract or tort for negligence or otherwise) suffered or incurred by the Client or any third party as a result of or in connection with the information, findings, opinions, estimates, recommendations and conclusions provided in the course of this Preliminary Broadscale Report.

If further information becomes available, or additional assumptions need to be made, Morrison Geotechnic reserves its right to amend this Preliminary Broadscale Report.

Please note that further investigation and laboratory testing must be carried out in order to confirm the actual founding conditions and that the preliminary recommendations in this report are applicable for the entire site.

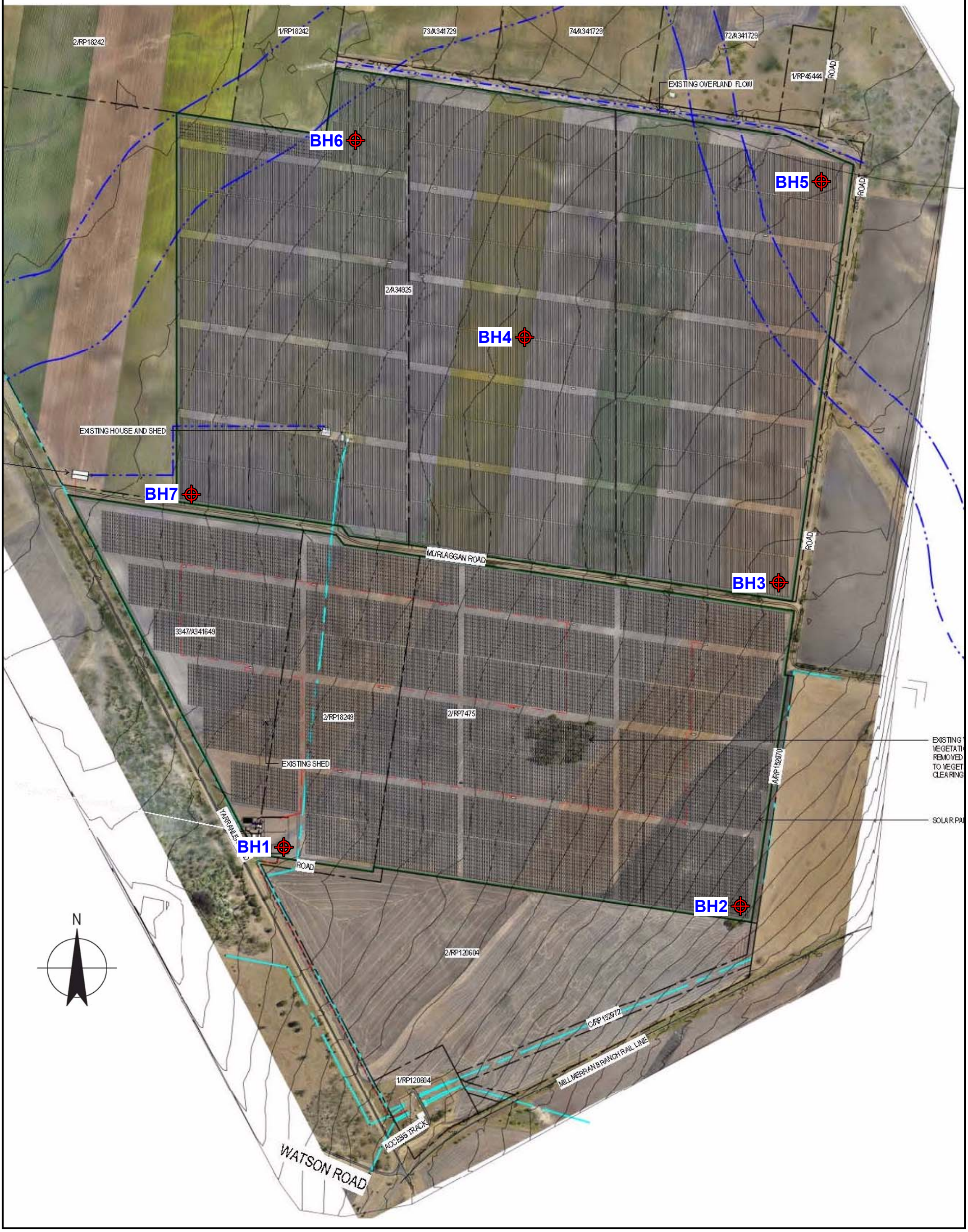
Yours faithfully,

D DRAGUN (RPEQ 16310)
For and on behalf of
MORRISON GEOTECHNIC PTY LIMITED

Encl Appendix A – Borehole Site Plan
Appendix B – Borehole Log Sheets
Appendix C – Laboratory Test Results
Important Information about your Geotechnical Engineering Report

A P P E N D I X A

BOREHOLE SITE PLAN



MORRISON GEOTECHNIC PTY LTD

ABN: 51 009 878 899

Unit 1/ 35 Limestone St, Darra 4076 *Ph: 3279 0900*
Email: brisbanelab@morrisongeo.com.au *Fax: 3279 0955*

Engineers: D.Riley, J. Daly
D.Dragun, S.Wynne &
D.Vanderhor
Geologists: L.Bexley & R.Howchin
Laboratory: M.Morrison

Map Description :	**BOREHOLE TEST LOCATIONS (Approximate Only)**
Client :	YARRANLEA SOLAR PTY LTD; C/ I^3 CONSULTING
Project :	**BROADSCALE GEOTECHNICAL INVESTIGATION** **PROPOSED YARRANLEA SOLAR FARM, WATSON RD, YARRANLEA**
LEGEND :	Borehole Locations

Project No :	DE16/258	Drawing No :	DE16/258 - 01	Scale :	Not to Scale

A P P E N D I X B

BOREHOLE LOG SHEETS

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH1

Job Number: DE16/258
Client: Yarranlea Solar Pty Ltd; C/ I³ Consulting
Project: Proposed Yarranlea Solar Farm
Location: Watson Road, Yarranlea

Easting: 354897.00
Northing: 6933318.00
RL:
Total Depth: 5.60
Drilling Rig: Jehyco Digga
Driller: Morrison Geotechnic
Logged By: D.Vanderhor
Date: 29/08/2016

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
100mm Solid Flight Auger			0.6	Natural		CH	**Silty CLAY**: Stiff, high plasticity, dark brown black, trace of fine grained sand, moist		M	St	1 1 1 2 1 2	0.1	PP	155kPa
			1.0 1.2			CH	**Silty CLAY**: As above but very stiff		M	VSt	3 2 2 4 7 8	0.6 1.2	PP	260kPa
			1.8			CH	**Silty CLAY**: As above but hard, dark grey		M	H	7 8 10 7 8 7	1.5 1.8	PP D U50 PP	420kPa PP: 500kPa 500kPa
			2.0			CH	**Silty CLAY**: As above but mottled white black		M	H	6 7 6 7 6 6 7 6	2	PP	500kPa
			3.0 3			CH	**Silty CLAY**: As above but grey mottled orange brown		M	H		3	PP	500kPa
			3.7			CH	**Sandy CLAY**: Hard, high plasticity, grey mottled orange brown, fine to coarse grained sand, moist		M	H		3.7	PP	500kPa
			4.0 4	Rock		BAS	**BASALT**: Extremely weathered, extremely low strength, brown	XW		ELS				
			4.5	Residual		CI-CH	**Silty CLAY**: Very stiff to hard, medium to high plasticity, brown, with fine to coarse grained sand, moist		M	VSt-H		4.5	PP	400kPa
			5.0 5.2	Rock		BAS	**BASALT**: Extremely weathered to distinctly weathered, extremely low to very low strength, brown	XW-DW		ELS-VLS				
			5.6				**5.60m: BOREHOLE TERMINATED AT TC BIT REFUSAL**							
			6.0											

Comments:

Authorised by: ……

Date: ……..……..……

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH2

Job Number: DE16/258
Client: Yarranlea Solar Pty Ltd; C/ I³ Consulting
Project: Proposed Yarranlea Solar Farm
Location: Watson Road, Yarranlea

Easting: 355941.00
Northing: 6933185.00
RL:
Total Depth: 4.50
Drilling Rig: Jehyco Digga
Driller: Morrison Geotechnic
Logged By: D.Vanderhor
Date: 29/08/2016

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
100mm Solid Flight Auger			0.6	Natural		CH	**Silty CLAY**: Very stiff, high plasticity, dark brown black, moist		M	VSt	1 2 2 1 1 3	0.1	PP	250kPa
			1.0			CH	**Silty CLAY**: As above but hard, grey brown mottled white, trace of fine grained sand, moist		M	H	3 3 5 5 6 5 5 4 4 4 4 6 7 6	0.6 1.5	PP PP	500kPa 540kPa
			2.0 2			CH	**Silty CLAY**: As above but grey mottled orange brown		M	H	5 7 6 8 8 7	2 2.5	PP D U50	500kPa PP: 550kPa
			3.0 3.5			CH	**Silty CLAY**: As above but white grey mottled orange, no sand		M	H		3.5	PP	420kPa
			4.0 4 4.5			CI	**Silty CLAY**: As above but medium plasticity, grey white, moist to dry		M-D	H				
							4.50m: BOREHOLE TERMINATED							
			5.0											
			6.0											

Comments:

Authorised by: ……

Date: ……..……..……

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH3

Job Number: DE16/258
Client: Yarranlea Solar Pty Ltd; C/ I³ Consulting
Project: Proposed Yarranlea Solar Farm
Location: Watson Road, Yarranlea

Easting: 356028.00
Northing: 6933925.00
RL:
Total Depth: 4.50
Drilling Rig: Jehyco Digga
Driller: Morrison Geotechnic
Logged By: D.Vanderhor
Date: 29/08/2016

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
100mm Solid Flight Auger			0.0	Natural		CH	**Silty CLAY**: Stiff to very stiff, high plasticity, dark brown black, moist		M	St-VSt	1 1 1 2 4	0.1	PP	200kPa
			0.5			CH	**Silty CLAY**: As above but hard, brown mottled grey white, trace of fine grained sand, moist		M	H	4 6 7 8	0.5	PP	410kPa
			1.0	0.9		CH	**Silty CLAY**: Hard, high plasticity, grey mottled orange brown, trace of fine to medium grained sand, with fine to medium sized gravel, and clayey sand layering, moist to dry		M-D	H	14 17 25/80mm	0.9	D	
			2.0											
			3.0	2.9		CH	**Silty CLAY**: As above but orange brown		M-D	H				
			4.0											
			4.2			CH	**Silty CLAY**: Very stiff, high plasticity, grey mottled white, moist		M	VSt		4.2	PP	310kPa
			4.5				**4.50m: BOREHOLE TERMINATED**							
			5.0											
			6.0											

Comments:

Authorised by: ……

Date: ……..…..……..

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH4

Job Number: DE16/258
Client: Yarranlea Solar Pty Ltd; C/ I³ Consulting
Project: Proposed Yarranlea Solar Farm
Location: Watson Road, Yarranlea

Easting: 355447.00
Northing: 6934485.00
RL:
Total Depth: 4.50
Drilling Rig: Jehyco Digga
Driller: Morrison Geotechnic
Logged By: D.Vanderhor
Date: 29/08/2016

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
100mm Solid Flight Auger			0.5	Natural		CH	**Silty CLAY**: Stiff, high plasticity, dark brown mottled black, moist		M	St	1 1 1 6 6	0.1	PP	160kPa
			1.0 0.9			CH	**Silty CLAY**: As above but very stiff to hard, brown		M	VSt-H	5 5 5 7	0.5	PP	400kPa
			2.0 2			CI-CH	**Gravelly Sandy CLAY**: Hard, medium to high plasticity, grey mottled orange brown, fine to medium grained sand, fine sized gravel moist to dry		M-D	H	4 5 6 10 9 11 25/50mm	0.9	PP	450kPa
			3.0 3			CH	**Silty CLAY**: Hard, high plasticity, grey mottled white with fine sized gravel, trace of fine grained sand, moist to dry		M-D	H		2.5 2.75	D U50 PP	PP: >600kPa >600kPa
			3.6			CH	**Silty CLAY**: As above but very stiff, brown mottled orange grey trace of fine sized gravel, trace of fine to coarse grained sand, moist		M	VSt		3	PP	300kPa
			4.0 4.5			CI-CH	**Silty CLAY**: As above but hard, medium to high plasticity grey mottled orange, with fine sized gravel, and with fine to coarse grained sand, moist to dry		M-D	H				
			5.0				**4.50m: BOREHOLE TERMINATED**							
			6.0											

Comments:

Authorised by: ……

Date: ……..……..……

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH5

Job Number: DE16/258
Client: Yarranlea Solar Pty Ltd; C/ I³ Consulting
Project: Proposed Yarranlea Solar Farm
Location: Watson Road, Yarranlea

Easting: 356125.00
Northing: 6934842.00
RL:
Total Depth: 4.50
Drilling Rig: Jehyco Digga
Driller: Morrison Geotechnic
Logged By: D.Vanderhor
Date: 29/08/2016

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
100mm Solid Flight Auger			0.5	Natural		CH	**Silty CLAY**: Hard, high plasticity, dark brown, moist		M	H	1 2 2 2 3	0.1	PP	>600kPa
			1.0			CH	**Silty CLAY**: As above but brown		M	H	4 5 4 4 4 4 4 4	0.5	PP	460kPa
			1.3			CI	**Silty CLAY**: As above but very stiff to hard, medium plasticity, grey brown white, trace of fine grained sand, moist to dry		M-D	VSt-H	4 4	1.3	PP	400kPa
			1.5			CH	**Sandy CLAY**: Hard, high plasticity, brown mottled grey, fine grained sand, moist		M	H	5 5 7 6 8	1.5	PP	470kPa
			2.0 2			CH	**Sandy CLAY**: As above but trace of fine sized gravel		M	H	7 7 10 8 8 7	2	PP	500kPa
			3.0 3			CI	**Silty CLAY**: Hard, medium plasticity, grey mottled orange brown, with fine grained sand, moist to dry		M-D	H		2.5	D U50	PP: >600kPa
			4.0 4.5									3	PP	550kPa
							4.50m: BOREHOLE TERMINATED							
			5.0											
			6.0											

Comments:

Authorised by: ……

Date: ……..…..……..

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH6

Job Number: DE16/258
Client: Yarranlea Solar Pty Ltd; C/ I³ Consulting
Project: Proposed Yarranlea Solar Farm
Location: Watson Road, Yarranlea

Easting: 355060.00
Northing: 6934934.50
RL:
Total Depth: 2.70
Drilling Rig: Jehyco Digga
Driller: Morrison Geotechnic
Logged By: D.Vanderhor
Date: 29/08/2016

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
100mm Solid Flight Auger			0.1	Natural		CH	**Silty CLAY**: Stiff, high plasticity, dark brown black, dry		D	St	2	0.05	PP	150kPa
						CH	**Silty CLAY**: As above but hard, moist		M	H	11	0.1	PP	>600kPa
											12			
											8			
											9			
			0.6								8			
						CH	**Silty CLAY**: As above but brown		M	H	7	0.6	PP	>600kPa
			1.0								6			
											5			
											7			
											8			
											13			
											15			
			1.5								20			
						CI-CH	**Gravelly Sandy CLAY**: Estimated Hard, medium to high plasticity, grey brown, fine to coarse grained sand, fine to coarse sized gravel, trace of cobbles, moist to dry		M-D	H				
			2.0											
			2.7											
			3.0				**2.70m: BOREHOLE TERMINATED AT TC BIT REFUSAL ON COBBLES**							
			4.0											
			5.0											
			6.0											

Comments:

Authorised by: ……

Date: ……..…..……..

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

Morrison Geotechnic Pty Ltd
A.B.N. 051 009 878 899
PO Box 3063, Darra, QLD 4076
Phone: (07) 3279 0900 Fax: (07) 3279 0955

Engineering Log - Borehole

Borehole No.: BH7

Job Number: DE16/258
Client: Yarranlea Solar Pty Ltd; C/ I³ Consulting
Project: Proposed Yarranlea Solar Farm
Location: Watson Road, Yarranlea

Easting: 354685.00
Northing: 6934124.00
RL:
Total Depth: 3.10
Drilling Rig: Jehyco Digga
Driller: Morrison Geotechnic
Logged By: D.Vanderhor
Date: 29/08/2016

Drilling Information				Material Description							Test Samples			
Drill Method	Water	RL	Hole Depth (m)	Soil Origin	Graphic Log	Classification Code	Description	Weathering	Moisture	Consistency - Density - Strength	DC Test Results	Test Depth	Tests	Sample/Result
100mm Solid Flight Auger			0.6	Natural		CH	**Silty CLAY**: Very stiff to hard, high plasticity, dark brown black, moist		M	VSt-H	1 1 2 3 3 3	0.1	PP	400kPa
			1.0			CH	**Silty CLAY**: As above but brown		M	VSt-H	3 4 4 3	0.6	PP	400kPa
			1			CI-CH	**Silty CLAY**: As above but medium to high plasticity, white grey, trace of fine grained sand		M	VSt-H	3 4	1	PP	400kPa
			1.2			CH	**Gravelly CLAY**: Hard, high plasticity, grey brown, fine sized gravel, with fine to coarse grained sand, trace of cobbles, moist to dry		M-D	H	5 5 9 7 5 18 16	1.2 1.5	PP D U50	>600kPa PP: >600kPa
			2.0 1.9			CH	**Gravelly CLAY**: As above but fine to medium sized gravel, with cobbles		M-D	H	22			
			3.0 3.1				**3.10m: BOREHOLE TERMINATED AT TC BIT REFUSAL ON COBBLES**							
			4.0											
			5.0											
			6.0											

Comments:

Authorised by: ……

Date: ……..…..……..

Water
- Water level on date shown
- Water inflow
- Water outflow

Weathering
- RS Residual soil
- XW Extremely weathered
- DW Distinctly weathered
- SW Slightly weathered
- FR Fresh

Consistency
- VS Very soft
- S Soft
- F Firm
- St Stiff
- VSt Very stiff
- H Hard

Moisture
D Dry M Moist W Wet

Density
- VL Very loose
- L Loose
- MD Medium dense
- D Dense
- VD Very dense

Rock Strength
- ELS Extremely low
- VLS Very low
- LS Low
- MS Medium
- HS High
- VHS Very high
- EHS Extremely high

Tests & Results
- U50 Undisturbed 50mm diam tube.
- D Disturbed sample.
- SPT Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
- PP Hand penetrometer estimate of unconfined compressive strength, kPa.
- S Vane shear value kPa
- DC Dynamic Cone test, 9.09kg hammer, fall 508mm, driving 20mm, 30 deg taper cone fitted to rods of smaller section. From AS1289-1993 Methods of Testing Soils for Engineering Purposes

A P P E N D I X C

LABORATORY TEST RESULTS

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Quality of Materials Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 1**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**8/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.3.6.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**		**Page 1 of 1**

Sample Number :	218008
Sampling Method :	-
Sampled By :	Declan Vanderhor
Date Sampled :	29/08/2016
Date Tested :	1/09/2016
Material Type :	-
Material Source :	Insitu
Remarks :	-

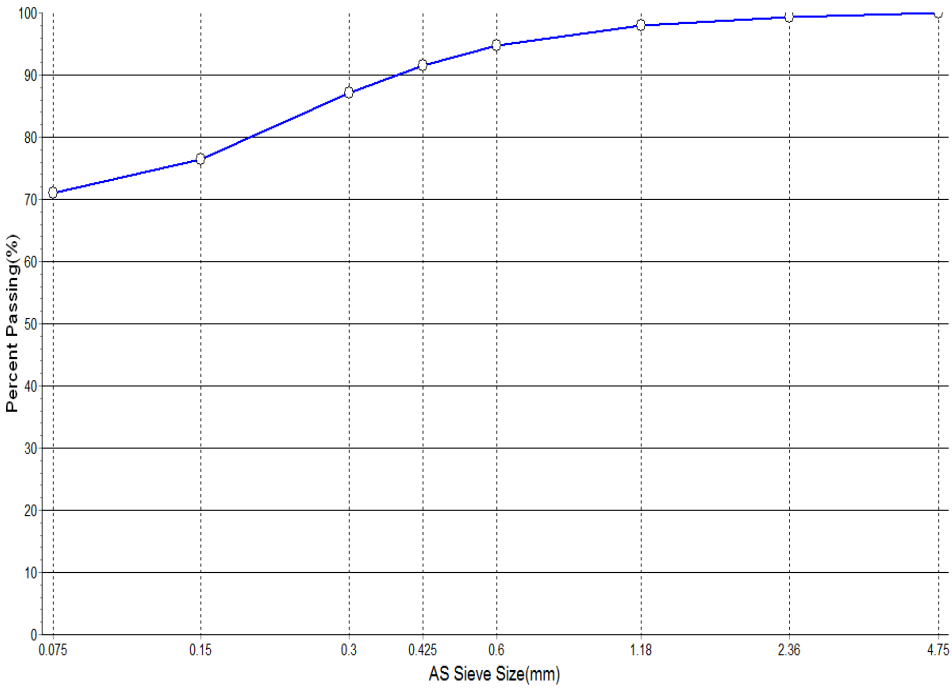
SAMPLE LOCATION

Borehole BH1

Depth 1.50m - 1.80m

Test Number :	**-**
Lot Number :	**-**
Specification Number :	

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0		
16.0		
13.2		
9.5		
6.7		
4.75	**100**	
2.36	**99**	
1.18	**98**	
0.600	**95**	
0.425	**92**	
0.300	**87**	
0.150	**76**	
0.075	**71**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1**	**68**	Shrinkage Comments :	**Cracking - NO, Curling - YES**
Plastic Limit (%) :		**AS1289.3.2.1**	**19**	Mould Length (mm) :	**250.1**
Plasticity Index (%) :		**AS1289.3.3.1**	**49**	Sample History	**Oven Dried**
Linear Shrinkage (%) :		**AS1289.3.4.1**	**16.5**		
Soil Description :					

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Liam Mcdowall (Brisbane) - Branch Manager
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Quality of Materials Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 2**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**8/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.3.6.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**		**Page 1 of 1**

Sample Number :	218009
Sampling Method :	-
Sampled By :	Declan Vanderhor
Date Sampled :	29/08/2016
Date Tested :	31/08/2016
Material Type :	-
Material Source :	Insitu
Remarks :	-

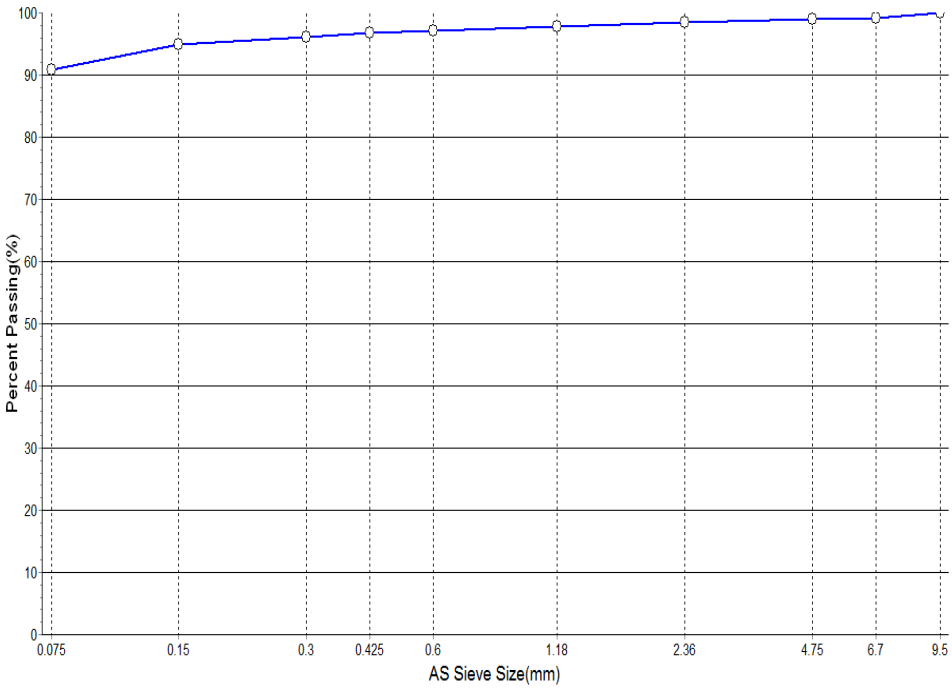
SAMPLE LOCATION

Borehole BH3

Depth 0.90m - 2.90m

Test Number :	**-**
Lot Number :	**-**
Specification Number :	

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0		
16.0		
13.2		
9.5	**100**	
6.7	**99**	
4.75	**99**	
2.36	**98**	
1.18	**98**	
0.600	**97**	
0.425	**97**	
0.300	**96**	
0.150	**95**	
0.075	**91**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1**	**56**	Shrinkage Comments :	**Cracking And Curling Occurred**
Plastic Limit (%) :		**AS1289.3.2.1**	**19**	Mould Length (mm) :	**250.2**
Plasticity Index (%) :		**AS1289.3.3.1**	**37**	Sample History	**Oven Dried**
Linear Shrinkage (%) :		**AS1289.3.4.1**	**14.5**		
Soil Description :					

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Liam Mcdowall (Brisbane) - Branch Manager
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Quality of Materials Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 3**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**8/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.3.6.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**		**Page 1 of 1**

Sample Number :	218010
Sampling Method :	-
Sampled By :	Declan Vanderhor
Date Sampled :	29/08/2016
Date Tested :	31/08/2016
Material Type :	-
Material Source :	Insitu
Remarks :	-

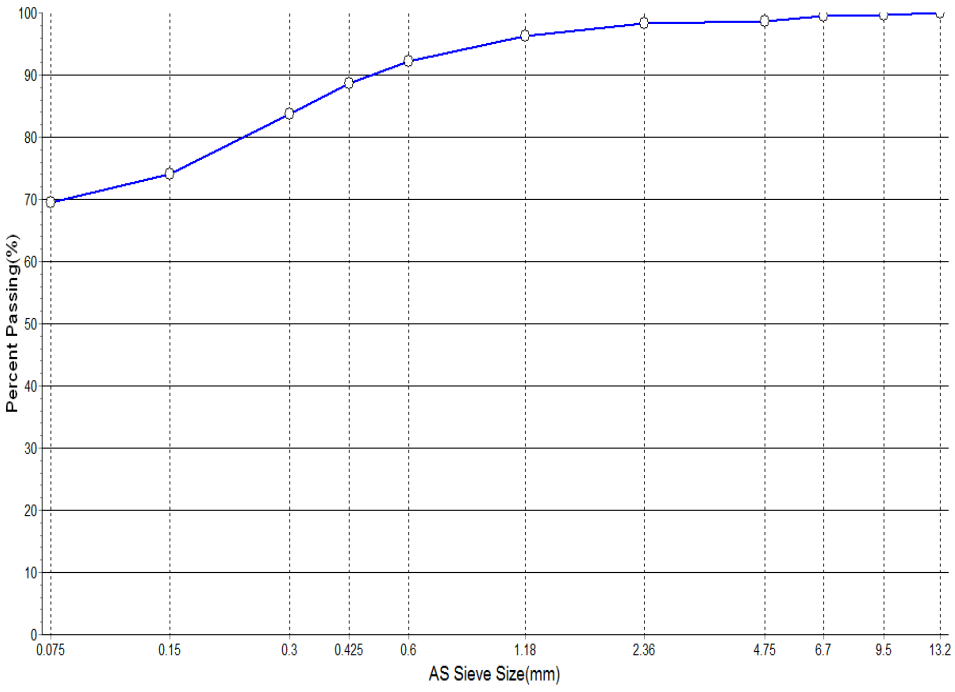
SAMPLE LOCATION

Borehole BH5

Depth 2.50m - 2.75m

Test Number :	**-**
Lot Number :	**-**
Specification Number :	

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0		
16.0		
13.2	**100**	
9.5	**100**	
6.7	**100**	
4.75	**99**	
2.36	**98**	
1.18	**96**	
0.600	**92**	
0.425	**89**	
0.300	**84**	
0.150	**74**	
0.075	**69**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1**	**63**	Shrinkage Comments :	**Cracking And Curling Occurred**
Plastic Limit (%) :		**AS1289.3.2.1**	**20**	Mould Length (mm) :	**250.1**
Plasticity Index (%) :		**AS1289.3.3.1**	**43**	Sample History	**Oven Dried**
Linear Shrinkage (%) :		**AS1289.3.4.1**	**19**		
Soil Description :					

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Liam Mcdowall (Brisbane) - Branch Manager
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Quality of Materials Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 4**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**8/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.3.6.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**		**Page 1 of 1**

Sample Number :	218011
Sampling Method :	-
Sampled By :	Declan Vanderhor
Date Sampled :	29/08/2016
Date Tested :	31/08/2016
Material Type :	-
Material Source :	Insitu
Remarks :	-

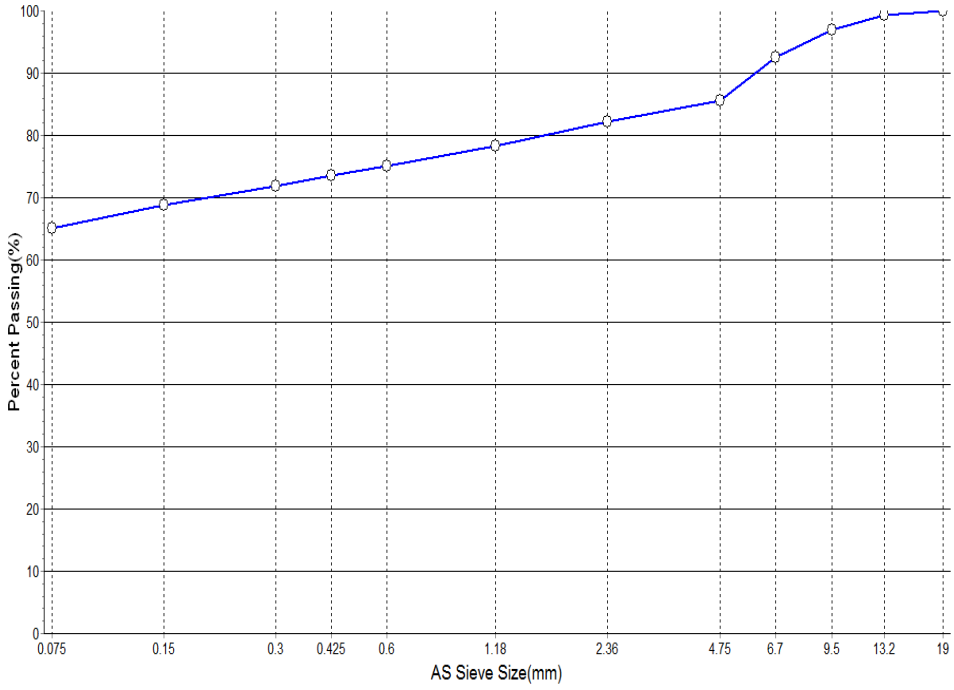
SAMPLE LOCATION

Borehole BH4

Depth 2.50m - 2.75m

Test Number :	**-**
Lot Number :	**-**
Specification Number :	

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0	**100**	
16.0	**-**	
13.2	**99**	
9.5	**97**	
6.7	**93**	
4.75	**86**	
2.36	**82**	
1.18	**78**	
0.600	**75**	
0.425	**74**	
0.300	**72**	
0.150	**69**	
0.075	**65**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1**	**72**	Shrinkage Comments :	**Cracking And Curling Occurred**
Plastic Limit (%) :		**AS1289.3.2.1**	**20**	Mould Length (mm) :	**253.9**
Plasticity Index (%) :		**AS1289.3.3.1**	**52**	Sample History	**Oven Dried**
Linear Shrinkage (%) :		**AS1289.3.4.1**	**18.5**		
Soil Description :					

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Liam Mcdowall (Brisbane) - Branch Manager
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Quality of Materials Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 5**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**8/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.3.6.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**		**Page 1 of 1**

Sample Number :	218012
Sampling Method :	-
Sampled By :	Declan Vanderhor
Date Sampled :	29/08/2016
Date Tested :	31/08/2016
Material Type :	-
Material Source :	Insitu
Remarks :	-

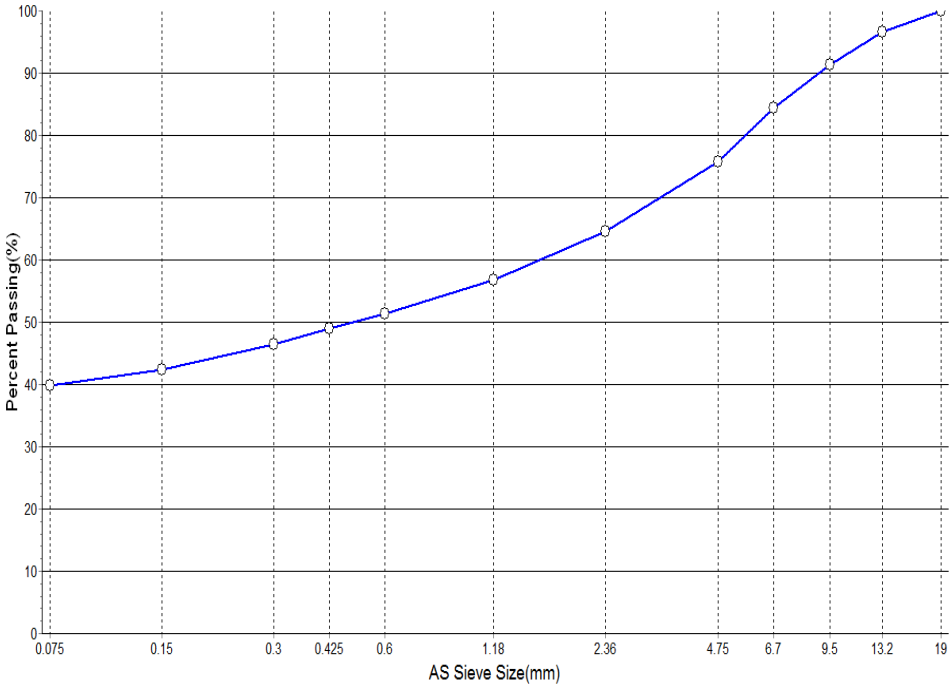
SAMPLE LOCATION

Borehole BH7

Depth 1.50m - 1.70m

Test Number :	**-**
Lot Number :	**-**
Specification Number :	

AS Sieve Size(mm)	Percent Passing	Specification Limits
100		
75.0		
63.0		
53.0		
37.5		
26.5		
19.0	**100**	
16.0	**-**	
13.2	**97**	
9.5	**91**	
6.7	**84**	
4.75	**76**	
2.36	**65**	
1.18	**57**	
0.600	**51**	
0.425	**49**	
0.300	**46**	
0.150	**42**	
0.075	**40**	



		Test Method	Results		
Liquid Limit (%) :		**AS1289.3.1.1**	**64**	Shrinkage Comments :	**Cracking And Curling Occurred**
Plastic Limit (%) :		**AS1289.3.2.1**	**21**	Mould Length (mm) :	**250.2**
Plasticity Index (%) :		**AS1289.3.3.1**	**43**	Sample History	**Oven Dried**
Linear Shrinkage (%) :		**AS1289.3.4.1**	**19**		
Soil Description :					

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Liam Mcdowall (Brisbane) - Branch Manager
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Shrink Swell Index Report

Client :	**YARRANLEA SOLAR PTY LTD c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Number:	**DE16/258 - 6**
Address :		Report Date :	**9/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.7.1.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**	**Page 1 of 1**	

Sample Number :	218003			
Test Number :	-			
Sampling Method :	-			
Sampled By :	Declan Vanderhor			
Date Sampled :	29/08/2016			
Date Tested :	31/08/2016			
Material Type :	**-**			
Material Source :	**Insitu**			
Sample Location :	Borehole BH1 Depth 1.50m			
Inert Material Estimate (%) :	-			
PP before (kPa) :	500			
PP after (kPa) :	230			
Shrinkage Moisture Content (%) :	22.5			
Shrinkage (%) :	**5**			
Swell Moisture Content Before (%) :	22.3			
Swell Moisture Content After (%) :	27.8			
Swell (%) :	**4.6**			
Unit Weight (t/m³) :	2			
Shrink Swell Index Iss (%) :	**4**			
Visual Classification :	NATURAL Silty CLAY (CH) high plasticity, dark grey.			
Cracking :	Yes			
Crumbling :	No			
Remarks :	-			

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Mick Morrison (Brisbane) - Director
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 **P** (07) 3279 0900 **F** (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Shrink Swell Index Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 7**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**9/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.7.1.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**	**Page 1 of 1**	

Sample Number :	218004			
Test Number :	-			
Sampling Method :	-			
Sampled By :	Declan Vanderhor			
Date Sampled :	29/08/2016			
Date Tested :	31/08/2016			
Material Type :	**-**			
Material Source :	**Insitu**			
Sample Location :	Borehole BH2 Depth 2.50m			
Inert Material Estimate (%) :	-			
PP before (kPa) :	550			
PP after (kPa) :	290			
Shrinkage Moisture Content (%) :	23.8			
Shrinkage (%) :	**4.6**			
Swell Moisture Content Before (%) :	23			
Swell Moisture Content After (%) :	26.2			
Swell (%) :	**3.7**			
Unit Weight (t/m³) :	2.01			
Shrink Swell Index Iss (%) :	**3.6**			
Visual Classification :	NATURAL Silty CLAY (CH) high plasticity, grey mottled orange brown.			
Cracking :	Yes			
Crumbling :	No			
Remarks :	-			

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Mick Morrison (Brisbane) - Director
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Shrink Swell Index Report

Client :	**YARRANLEA SOLAR PTY LTD c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Number:	**DE16/258 - 8**
Address :		Report Date :	**9/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.7.1.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**	**Page 1 of 1**	

Sample Number :	218005			
Test Number :	-			
Sampling Method :	-			
Sampled By :	Declan Vanderhor			
Date Sampled :	29/08/2016			
Date Tested :	31/08/2016			
Material Type :	**-**			
Material Source :	**Insitu**			
Sample Location :	Borehole BH4 Depth 2.50m			
Inert Material Estimate (%) :	-			
PP before (kPa) :	>600			
PP after (kPa) :	380			
Shrinkage Moisture Content (%) :	18.8			
Shrinkage (%) :	**2.9**			
Swell Moisture Content Before (%) :	18.1			
Swell Moisture Content After (%) :	24.6			
Swell (%) :	**4.1**			
Unit Weight (t/m³) :	2.02			
Shrink Swell Index Iss (%) :	**2.7**			
Visual Classification :	NATURAL Silty CLAY (CH) high plasticity, grey mottled white.			
Cracking :	Yes			
Crumbling :	Yes			
Remarks :	-			

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Mick Morrison (Brisbane) - Director
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Shrink Swell Index Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 9**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**9/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.7.1.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**	**Page 1 of 1**	

Sample Number :	218006			
Test Number :	-			
Sampling Method :	-			
Sampled By :	Declan Vanderhor			
Date Sampled :	29/08/2016			
Date Tested :	31/08/2016			
Material Type :	**-**			
Material Source :	**Insitu**			
Sample Location :	Borehole BH5 Depth 2.50m			
Inert Material Estimate (%) :	-			
PP before (kPa) :	>600			
PP after (kPa) :	190			
Shrinkage Moisture Content (%) :	16.7			
Shrinkage (%) :	**2.2**			
Swell Moisture Content Before (%) :	16.4			
Swell Moisture Content After (%) :	22.4			
Swell (%) :	**6.5**			
Unit Weight (t/m³) :	2.08			
Shrink Swell Index Iss (%) :	**3**			
Visual Classification :	NATURAL Sandy CLAY (CH) high plasticity, brown mottled grey.			
Cracking :	Yes			
Crumbling :	No			
Remarks :	-			

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Mick Morrison (Brisbane) - Director
NATA Accreditation Number
1162 / 1169

MORRISON GEOTECHNIC

Brisbane | Gold Coast | Brendale | Maroochydore
Unit 1, 35 Limestone Street (PO Box 3063), Darra Q 4076 P (07) 3279 0900 F (07) 3279 0955
ABN 51 009 878 899
www.morrisongeo.com.au

Shrink Swell Index Report

Client :	**YARRANLEA SOLAR PTY LTD**	Report Number:	**DE16/258 - 10**
Address :	**c/- I CUBED CONSULTING P/L - P O BOX 878, TOOWONG, QLD, 4066**	Report Date :	**9/09/2016**
Project Name :	**PROPOSED SOLAR FARM**	Order Number :	**-**
Project Number :	**DE16/258**	Test Method :	**AS1289.7.1.1**
Location:	**538 & 752 YARRANLEA ROAD , YARRANLEA**	**Page 1 of 1**	

Sample Number :	218007			
Test Number :	-			
Sampling Method :	-			
Sampled By :	Declan Vanderhor			
Date Sampled :	29/08/2016			
Date Tested :	31/08/2016			
Material Type :	**-**			
Material Source :	**Insitu**			
Sample Location :	Borehole BH7 Depth 1.50m			
Inert Material Estimate (%) :	-			
PP before (kPa) :	>600			
PP after (kPa) :	350			
Shrinkage Moisture Content (%) :	16.1			
Shrinkage (%) :	**1.4**			
Swell Moisture Content Before (%) :	16.1			
Swell Moisture Content After (%) :	24			
Swell (%) :	**2.4**			
Unit Weight (t/m³) :	1.92			
Shrink Swell Index Iss (%) :	**1.4**			
Visual Classification :	NATURAL Gravelly CLAY (CH) high plasticity, grey brown.			
Cracking :	Yes			
Crumbling :	Yes			
Remarks :	-			

NATA WORLD RECOGNISED ACCREDITATION

Accredited for compliance with ISO/IEC 17025.

APPROVED SIGNATORY

Mick Morrison (Brisbane) - Director
NATA Accreditation Number
1162 / 1169

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

IIGER06085.0MRP