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Project 82750.02
13 May 2016
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GS:sj

Dear Sirs

Geotechnical Verification
Residential Subdivision Montego Hills Stage 4
97 Upper Ormeau Road, Kingsholme

1. Introduction

As requested by Morton Urban Solutions Pty Ltd on behalf of Villawood Properties Pty Ltd, Douglas Partners Pty Ltd (DP) have carried out a quantitative landslip risk assessment, reviewed the previous geotechnical report for the site, produced by Cardno Bowler, (see below) and global stability checks of selected bulk earthwork sections within the proposed residential development, Montego Hills, Stage 4, 97 Upper Ormeau Road, Kingsholme.

This report is specific to the area nominated as Stage 4 as shown on Drawing 1 attached.

This report was compiled in response to Councils Information Request (IR) Ref:- PN118080/03/DA6 dated 18 September 2015, Conditions 8, 9 and 12(a), as detailed below:

8. Certification of low risk of slope instability

The applicant must submit to Council, with any future development application for operational work (works for infrastructure or change to ground level), certification from a Registered Professional Engineer of Queensland (RPEQ) specialising in geotechnical engineering confirming that 'each' of the proposed lots/building envelopes, access roads and effluent disposal areas will achieve a slope instability hazard risk of 'low' or 'better'.

9. Certification of engineering drawings consistency with geotechnical report

The applicant must submit to Council, with any future development application for operational work (works for infrastructure or change to ground level), certification from a Registered Professional Engineer of Queensland (RPEQ) specialising in geotechnical engineering confirming that the proposed engineering drawings are in all respects consistent with the advice and recommendations of the geotechnical report "Amendment A, Geotechnical Investigation and Slope Stability Assessment, Proposed Residential Development, 97 Upper Ormeau Road, Kingsholme, prepared by Cardno Bowler Pty Ltd, Job No. 7221gs-B,11, dated 9 November 2011.

12(a). Certification of retaining structures/batters long-term factor of safety

With any future development application for operational work (works for infrastructure or change to ground level), the applicant must submit to Council;

A certification from a Registered Professional Engineer of Queensland (RPEQ) specialising in geotechnical engineering stating that 'all cut/fill batters and retaining structures (if any) associated with the proposed bulk earthworks, access roads and building pads development have been adequately designed based on existing geotechnical conditions of the site, taking into account all predicted surcharge loadings; and they will achieve a long-term factor of safety greater than 1.5 against geotechnical instabilities'

This report is specific to conditions that relate to the assessment of the landslip risk hazard assessment, the theoretical factor of safety of the proposed bulk earthworks and confirming the proposed bulk earthworks drawings are consistent with the advice provided in the previous geotechnical investigation.

Conditions that relate to verification of satisfactory earthworks program being carried out and suitability of completed cut/fill batters will be carried out by DP at the completion of the earthworks.

A site walkover was carried out by DP on 7 December 2015 and the following geotechnical report was used to confirm design requirements and provide geotechnical data for this assessment:

- Cardno Bowler Pty Ltd (CB), Job No. 7221gs-B.11 dated 9 November 2011 *'Amendment A, Geotechnical Investigation and Slope Stability Assessment, Proposed Residential Development, 97 Upper Ormeau Road, Kingsholme'*.

To assist DP in undertaking the global stability analyses, the following proposed set out and cross sections have been provided Morton Urban Solutions Pty Ltd:

- Drawing No's – 19610-04-050 to 052, Rev A.

This report must be read on conjunction with the attached notes '*About this Report'*.

2. Landslip Hazard Assessment for Proposed Lots

An indicative quantitate hazard rating has been calculated for the lots across the site for both pre and post earthworks based on likely *'worse case scenario'* conditions as encountered during the field work using two methods from the Australian Geomechanics Society (AGS). The assessments were based on the existing and proposed final slope angles as provided by Morton Urban Solutions Pty Ltd. From the supplied slope angle plans, only minimal earthworks are expected to create building lots.

The following parameters, as shown in Table 1 below, were used for the AGS *'A Method of Zoning Landslip Hazard'* method of analysis above.

Table 1: Slope Instability Risk Assessment using AGS *'A Method of Zoning Landslip Hazard'*

Category	Description		Level of Risk		Factor	
	Pre Bulk Earthworks	Post Bulk Earthworks	Pre Bulk Earthworks	Post Bulk Earthworks	Pre Bulk Earthworks	Post Bulk Earthworks
Slope Angle	Between 15º and 30º	Between 15° and 30°	Medium	Medium	0.8	0.8
Slope Shape	Planar	Planar	Low	Low	0.9	0.9
Site Geology	Low grade metamorphic rock	Low grade metamorphic rock	Medium	Medium	1	1
Material Strength	Residual soil >3m deep	Residual Soil >3m deep(ii)	High	High	1.5	1.5
Concentration of surface water	Lower slope	Lower slope	High	High	1.5	1.5
Evidence of groundwater	None apparent	None apparent	Low	Low	0.7	0.7
Evidence of instability	No sign of instability	No signs of instability	Low	Low	0.5	0.5
Relative Frequency					**0.57**	**0.57**

Note i) Includes controlled filling where it is assumed controlled filling will behave similar to that of a residual soil.
(ii) All controlled filling placement is to be carried out under Level 1 requirements by DP.

The result of this assessment provided relative frequency value 0.57 for both pre and post bulk earthworks which indicates the site has a *'low'* likelihood of instability in both instances (refer to Table 2).

Tables 2 and 3 below indicate typical implications with respect to site *'risk'* level and the correlation between relative frequency and likelihood rating.

Table 2: Risk Level Implications

Risk Level		Example Implications[1]
VH	Very High	Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical.
H	High Risk	Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable levels.
L	Low Risk	Tolerable provided treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of treatment options.
VL	Very Low	Acceptable. Manage by normal slope maintenance procedures.

Notes: 1. The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide.

2. Judicious use of dual descriptors for Likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.

Table 3 - Correlation between Relative Frequency and Likelihood Rating

Relative Frequency	Likelihood Rating
<0.2	Very low
0.2-0.6	Low
0.6-2.0	Moderate
2.0-6.0	High
>6.0	Very High

Parameters were determined and assigned, as shown in Table 4 below, for the AGS quantitative landslip assessment, as per ASG *'Landslide Task Force, Landslip Practice Note Working Group'.*

Table 4 – Slope Instability Risk Assessment for Properties using AGS *'Landslide Task Force, Landslip Practice Note Working Group' for both pre and post Bulk Earthworks*

Hazard	Likelihood	Consequence to proposed Development	Risk to proposed Development
Creep of natural residual soils	Rare	Insignificant to major	Very low to low
Deep seated instability within the site	Barely Credible	Major to Catastrophic	Very low to low

For this landslip risk assessment method, *'very low to low'* risk of instability was determined.

For both quantitative landslip risk methods, it can be concluded that a *'very low to low'* risk of instability could be expected for the proposed development.

The above analysis assumes that all the recommendations made in the CB report and this report will be adhered to, that DP will undertake any required additional detailed assessments, earthwork compaction control and inspections of cut/fill batter verification, as required, and that a suitable stormwater management plan will be designed, implemented and verified by a duly qualified hydraulics engineer.

In relation to effluent systems, their effect on stability will be a function of the adequacy of design given subsurface and setback requirements, location of the system in relation to structures, adequacy of installation and effectiveness of the system to perform to an acceptable standard over the life of the dwelling built. Detailed individual assessments will be required to assess the most appropriate systems and application areas at each site once details are known on the size of each dwelling, the proposed dwelling location and location of any ancillary structures i.e. pool, and the earthworks associated with the development of each lot.

3. Drainage

Adequate drainage and controlled removal of run-off from any sloping site is a crucial element of good hillside development practices. In this respect, it is recommended that any flows of water onto the slopes should be minimised, in order to reduce the potential for saturation, possible instability and scour.

All stormwater flows collected from the roofs of buildings, other impermeable areas, surface drains and retaining walls should be collected by a stormwater drainage system and discharged via pipes with flexible joints or lined channels to the street stormwater drainage system.

General guidelines for good building practices or sloping blocks are shown attached.

4. Global Stability Analysis - Proposed Bulk Earthworks

Global stability analysis were also carried out for selected proposed bulk earthworks cross sections for the proposed residential development, as referenced above.

This analysis is specific to conditions that relate to the assessment of the theoretical factor of safety of the proposed bulk earthworks and confirming the proposed bulk earthwork drawings are consistent with the advice provided in the previous CB geotechnical investigation.

Conditions that relate to verification of satisfactory earthworks program being carried out and suitability of completed cut/fill batters, Condition 12(b), as previously discussed, will be carried out by DP at the satisfactory completion of the bulk earthworks.

Global stability analyses was undertaken using the subsurface conditions encountered during the above referenced CB investigation, and from the cross sections provided for the proposed bulk earthworks. In the area under assessment, generally the subsurface conditions comprised a layer of medium dense silty sand over stiff or stronger residual clay over shale (metasiltstone). The shale (metasiltstone) was described generally as being extremely weathered.

The proposed bulk earthworks will require cut/fill operations. The drawings indicate that the cut of up to 10 m and fill of up to 5 m are expected. The batters assessed predominantly comprise filling batters which will be constructed using a mix of clay and metasiltstone excavated from site placed under Level 1 inspection by DP in accordance with the requirements of AS 3798-2007. The cut batters will predominantly be in residual soils and extremely weathered shale (metasiltstone).

The global stability analyses consisted of global stability checks using the Slope/W 2007 Version 7.14 software (Geo-Studio International, Ltd) using the Bishops method for two selected cross sections considered typical for the proposed works.

The geotechnical parameters used for the analysis were inferred from the previous investigation results using published information and local experience and are as listed in Table 5 below.

Table 5: Summary of Geotechnical Material Properties

Material	c' (kPa)	Φ' (°)	γ (kN/m^3)
Controlled bulk filling	5	26	19
Residual soils	5	26	19

The analysis assumed a 10 kPa surcharge load placed not within 1 m of the crest of any batter. The analyses also allowed for groundwater seepage through the filling.

Based on the results of the analyses, the proposed bulk earthworks analysed for global stability indicated for the typical cases analysed, the theoretical factor of safety (FOS) against failure is at least 1.5, as required.

As discussed the above, the analysis results assumes that all the filling will be placed under Level 1 inspection and testing by DP and further that an appropriate stormwater management plan is designed adopted and verified by a suitably qualified engineer. It is also assumed that appropriate erosion protection, such as erosion matts and quick growing native plants, be installed, upon completion of the earthworks to minimise the effects of erosion.

All cut/fill batters will need to be inspected by DP during and at the completion of the earthworks operation to confirm suitability in relation to long term stability and confirmation that the batters comply with sealed plans and design requirements and DP recommendations.

5. Verifications

Based on the results of the investigation, in respect of Condition 8, it can be verified that the proposed lots/building envelope access roads and effluent disposal areas will achieve a slope instability hazard risk of 'very low' to 'low'.

The above assumes that all the recommendations made in the above referred report will be adhered to, that DP will undertake any required additional detailed assessments, earthwork compaction control and inspections of cut/fill batter verification, as required, and that a suitable stormwater management plan will be designed, implemented and verified by a duly qualified hydraulics engineer.

In relation to effluent systems, their effect on stability will be a function of the adequacy of design given subsurface and setback requirements, location of the system in relation to structures, adequacy of installation and effectiveness of the system to perform to an acceptable standard over the life of the dwelling built. Detailed individual assessments will be required to assess the most appropriate systems and application areas at each site once details are known on the size of each dwelling, the proposed dwelling location and location of any ancillary structures i.e. pool, and the earthworks associated with the development of each lot.

In respect of Condition 9, it is verified that the provided drawings, with respect to recommended cut/fill batter angles, were consistent with the recommendations in the report *'Amendment A, Geotechnical Investigation and Slope Stability Assessment, Proposed Residential Development, 97 Upper Ormeau Road, Kingsholme'* prepared by Cardno Bowler Pty Ltd, Job No. 7221gs-B.11 dated 9 November 2011.

If respect of Condition 12 (a), it is verified that the proposed cut/fill batters associated with the proposed bulk earthworks will achieve a long term factor of safety against instability of 1.5 or greater subject to the recommendations of the above referenced report being adhered to.

6. Limitations

This report is provided for the exclusive use of Morton Urban Solutions Pty Ltd or their client for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the sub-surface conditions as detailed in the above referenced Cardno Bowler report at the specific sampling and testing locations, and then only to the depths investigated and at the time the work was carried out. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's field testing has been completed.

DP's advice is based upon the conditions encountered during this investigation. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions

across the site between and beyond the sampling and testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction of all works (not just geotechnical components) and the controls required to mitigate risk. DP should be contacted to provide specific advice with respect to a Safety Report where it is to be prepared.

We trust that the above advice meets your requirements. If you have any queries or require additional information, please contact us.

Please contact the undersigned if you have any questions on this matter.

Yours faithfully
Douglas Partners Pty Ltd

Gary Samuels
Associate/Branch Manager

Reviewed by

Andrew Middleton
Principal RPEQ 4366

Attachments: About this Report
Site Drawing

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

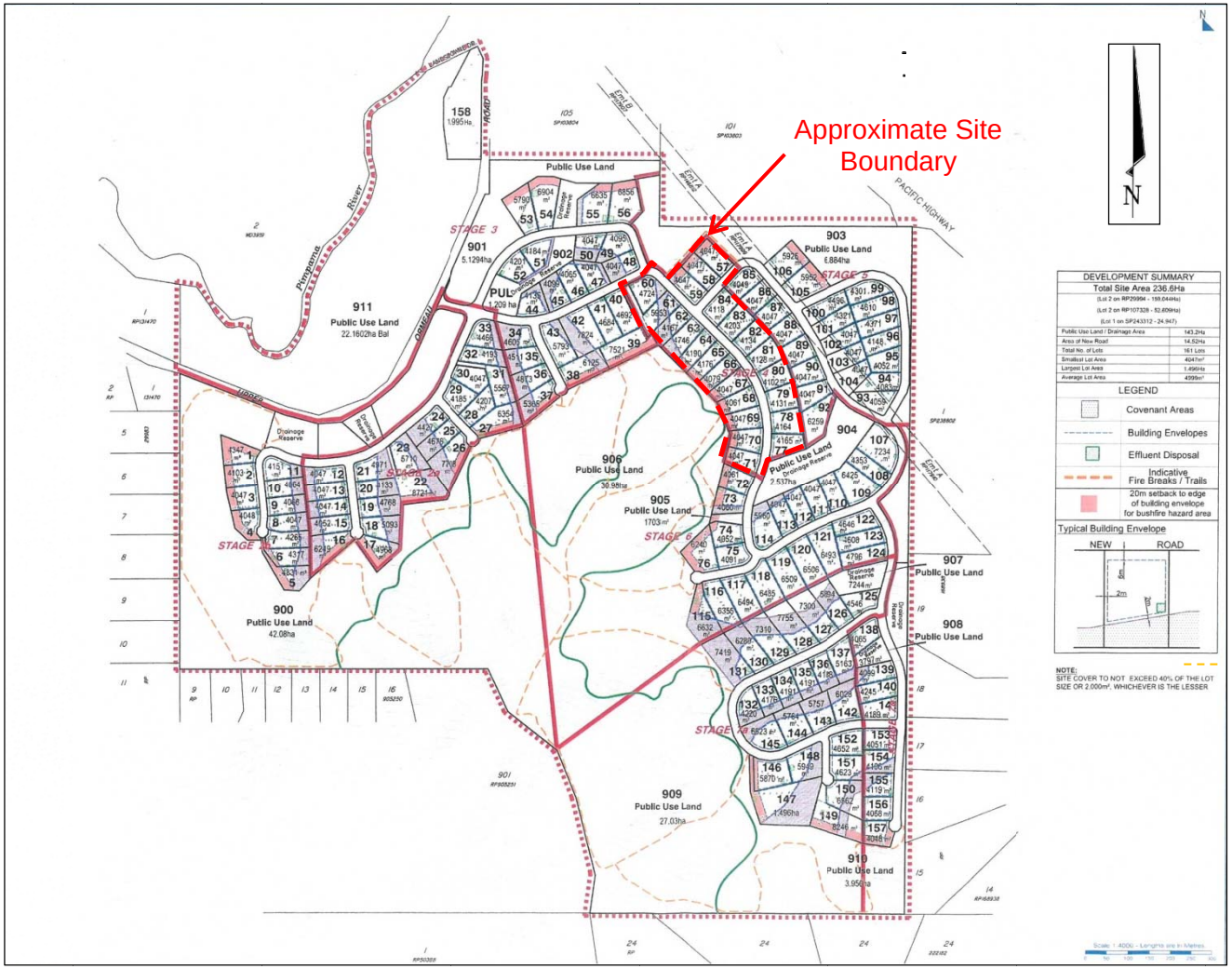
In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.



Notes:.

1. Drawing adapted from Development Perspectives drawing title, Proposed Stage Reconfiguration of a lot Plan, drawing number, 5543 P ROL 12J

Douglas Partners Geotechnics / Environment / Groundwater	CLIENT:	Villawood Properties Pty Ltd	**Site Location Plan**	PROJECT No: 82750.02
	OFFICE:	Gold Coast	**Proposed Residential Development Montego Hills, Stage 4**	DRAWING No: 1
	DATE:	May 2016	**97 Upper Ormeau Road, Kingsholme**	REVISION: 0