SLOPE STABILITY ASSESSMENT REPORT UPDATE
PROPOSED RESIDENTIAL SUBDIVISION
LOT 1 ON DP167380, LOT 1 ON DP134787 & LOT 2 ON DP961928
WALMSLEYS ROAD
BILAMBIL - NSW

For

Mr Peter Walmsley

MAY 2009
Job No. JU/04/810-2009

Maiden Geotechnics

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UPDATE REPORT ON SLOPE STABILITY ASSESSMENT PROPOSED RESIDENTIAL SUBDIVISION LOT 1 ON DP167380, LOT 1 ON DP134787 & LOT 2 ON DP961928 WALMSLEYS ROAD BILAMBIL HEIGHTS

1.0 INTRODUCTION

Presented, herein, is an update report on geotechnical assessment for proposed residential subdivision on the following properties in Bilambil Heights: Lot 1 on DP167380, Lot 1 on DP134787 and Lot 2 on DP961928. A previous report on the subject matter, issued by Maiden Geotechnics on July 2004 (Job No. JU/04/810) is referenced.

2.0 SITE DESCRIPTION

2.1 Location and Topography

The properties extend in the east-west directions, between Scott Street (cul-de-sac) and Walmsley Road.

Lot 1 on DP167380 covers an area of 3.23ha. It stretches eastward from a proposed Scott Street extension to Walmsley Road. The rectangularly shaped block measures 125.2 by 258.2 metres. The ground surface has a steep slope towards the east boundary. A gently sloping patch occurs along the east boundary, approximately 170m from the north end.

Lot 1 on DP134787 forms the proposed access road reserve. It covers an area of 0.26ha, and measures 10.06 by 258.2 metres in plan. The ground surface is approximately level to gently sloping within the proposed road reserve.

Lot 2 on DP961928 extends westwards from the proposed Scott Street extension. It covers an area of 5.69ha, and measures approximately 156 by 348.8 metres in plan. The ground surface is approximately level to gently sloping within 40 metres from the road reserve, but steeply sloping thereafter towards the southwest.

2.2 Surface Features

Low-cut grass covers the slopes. A line of dense and matured trees extend along the northern boundary. Dense forest also covers the area immediately beyond the limit of the proposed development at the western side. The topography is extremely steep at this section. Large sections of the road reserve are currently un-vegetated.

A gully originates at the northeast corner of Lot 2 DP961928, and runs in the southwest direction into the dense forest outside the limit of the proposed development. The gully section within the proposed subdivision is packed with uncontrolled fill. A stockpile of garden debris and other materials also occurs above the gully.

3.0 SCOPE OF WORK

3.1 Earlier Investigation

A copy of the earlier geotechnical investigation report is included as appendix to this report. It details the extent and scope of work conducted at the time. Detailed discussions on the ground conditions and their impact on the proposed development are presented. The report also contains ground improvement measures for the maintenance of the slope stability.

3.2 Update Assessment

The current update assessment extends the previous work to cover Lot 1 DP134787 and Lot 2 DP961928. Additional tests, in the form of test pitting and dynamic cone penetrometer (DCP) tests, were conducted at the areas of Lot 2 DP961928.

Seven (7) test pits were excavated with an 8-tonne Kato hydraulic excavator. Most of the test pits were advanced to depths ranging from 1.5 to 2.4 metres. A limited number terminated on boulders at approximate depths of 1.0m or thereabout. The test pits and the DCP tests were located within the proposed subdivision allotment building pads.

Mr Peter Walmsley assisted with the identification of the subdivision allotment boundaries and the locations of the building pads. Experienced

geotechnical engineer supervised the fieldwork. A site plan contained in the appendix depicts the test pits and the DCP tests locations.

4.0 GROUND CONDITIONS

4.1 Regional Geology

A reference to the Geological Survey of New South Wales, 1:250000 Tweed Heads Series (Sheet SH56.3), indicates that, the geology of the region comprises the meta-sedimentary Neranleigh-Fernvale Beds and the tertiary aged Lamington Volcanics. The Neranleigh-Fernvale Beds appear to dominate the subject site.

4.2 Geotechnical Characteristics

4.2.1 Lot 1 DP167380

The geotechnical characteristics within Lot 1 DP167380 are adequately covered in the earlier investigation report attached. Following are extracts of the discussions on the ground conditions. The original site plan (copy in the appendix) is referred.

Eastern Depression (Refer Test Pit 1)

A deposit of colluvium, comprising loose aggregate of cobbles, boulders and high plasticity silty clay, extends an approximate depth of 2.3m. 0.3m of hard residual cay underlies the colluvium. Decomposed shale (bedrock) underlies the residual soil at depths. No ground water seepage was observed within the formation.

Previous Dam Site (Refer Test Pit 4, 5 & 6)

Up to 3.8m of stiff or medium dense silty/gravelly clay fill overlies soft silty (organic) clay. Rotten timbers and other organic materials were contained in the soft clay layer. Stiff residual clay underlies the organic layer.

The Southern Steep Slope (Refer Test Pit 7)

The areas of proposed subdivision lots 1,2,3,10,11 and 12 are referred to, herein, as the southern steep slope. Medium to high plasticity silty clay extends to depths in excess of 2.4 metres.

The soil profile is stiff and very stiff to approximate depths of 1.0 and 2.0 metres, respectively. Hard, silty clay extends thereon. Decomposed shale (bedrock) is envisaged within a few metres below the depth reached with the excavator.

4.2.2 Lot 1 DP134787 & Lot 2 DP961928

At the areas of the proposed road reserve (Lot 1 DP134787) and along the westward trending ridge to the west of Scott Street cul-de-sac, the subsurface profile is characterised by stiff to very stiff and hard clays and weathered siltstone. Depths to the bedrock ranges from 1.4 to over 3.6 metres.

Closely packed cobbles and boulders, in a mixture with silty clay (fill) occur along the gully, extending up to the area of the proposed subdivision Lot 41. The following subdivision allotments are believed to be within the fill: 37, 38, 39, 40, 41, & 42.

Across the surrounding overlooking slopes, up to 1.0m of fill was identified on Lot 33. Strongly bonded matrix of the clays and boulders were revealed within Lots 37 and 39.

Further away from the gully, the slopes are dominated by medium plasticity, stiff residual clay. Depths of the stiff clay range between 2.0 and 2.6 metres, grading to extremely weathered shale, thereafter. Groundwater seepage was not observed in any of the test pits.

5.0 STABILITY ASSESSMENT

5.1 General

Presence of colluvium on steep slopes generally signifies potential slope instability. For shallow-seated colluvium with strongly bonded matrix, however, potential for slope instability is significantly reduced. Such sites can be engineered to reduce risk of long-term slope failure to acceptable level for development.

For the present site, the risk of long-term slope instability varies between the various from sections. The following discussions examine the risks of instabilities of the main identified sections of the site.

5.2 Stability Assessment: The Southern Steep Slope

For the sub-surface characteristics revealed at this section, the naturally occurring surface gradient is considered as being excessive for long-term stability. Though no obvious signs of potential slope instability could be identified due to lack of trees and other features that are sensitivity to minor ground movements.

5.3 Stability Assessment: The Ridge Crest and Adjacent Slopes

This section includes the access road reserve and the western trending ridge along the northern boundary, west of Scott Street. The sub-surface stratification consist, mostly of stiff residual clay to depths of 2.0 to 2.6 metres, grading to weathered shale thereafter. No obvious signs of potential instability were noted at the time of the investigation.

Existing colluvium (up to 1.0m thick) immediately above the eastern depression can pose potential instability to building foundations. These materials must be removed from the building envelopes prior to foundation construction. Such excavations should be conducted under engineering supervision.

5.4 Stability Assessment: The Eastern Depression

The eastern depression contains significant depths of colluvium, which are unsuitable for use as structural foundation. The deposits are not, however, expected to affect or worsen the stability of the adjacent slope. Some ground improvement measures are recommended for this area.

5.5 Stability Assessment: The Previous Dam Site

The earlier investigation identified significant amount of fill at a previous dam site. It was noted that the fill overlaid soft organic clays, and could undergo significant settlement with time. It was, however, noted that majority of the area was to be developed into a recreational park and could accommodate minor settlements.

The proposed road alignment may extend over sections of the poor formation. Any section within the road alignment should be excavated to the natural and competent formation, and the excavated area backfill with suitable material.

5.6 Stability Assessment: The Gully

Proposed subdivision Lots 37 to 42 are located within inadequately compacted fill along the gully. The long-term stability of the area is currently doubtful due to the presence of fill. The area can, however, be engineered to improve the long-term stability.

6.0 CONCLUSIONS & RECOMMENDATIONS

It can be concluded from the foregoing discussions that, while the site is generally suitable for the proposed development, special measures are required at certain areas to improve on their long-term stability. These areas and the specific measures required are discussed in the following sections.

6.1 Ground Improvement Techniques: Eastern Depressions

It is recommended that existing colluvium over the area identified as the "eastern depression" should be removed. The material may be excavated and discarded or stockpiled for re-use, following removal of the boulders, cobbles, and oversize materials.

The backfill shall be placed in layers not exceeding 0.5m (uncompacted), and compacted to at least 100% standard dry density ratio. Bulk earthworks, including road works, are to be conducted under engineering supervision by this office.

Preparation of the proposed access road subgrade should include an excavation of, at least, 1.0m of the existing formation. The subgrade replacement shall comply with Tweed Shire Council specification. The material shall be placed and compacted to, at least, 100% standard dry density ratio.

6.1.1 Ground Improvement Techniques: The Southern Slopes

Buildings over the designated Southern Slopes should be limited to lightweight pole homes. Foundations should be either steel posts or reinforced concrete

piers. They should extend at least 1.0 metre past the toe of the slope and be socketed into bedrock. The rock socket length shall not be less than 1.0m

6.1.2 Ground Improvement Techniques: The Filled Gully

The existing sections of the site situated within the gully are considered unsuitable for residential building construction due to presence of fill. The proposed subdivision allotments 37 to 42 are mostly affected. The area can, however, be engineered to improve on the stability and, consequently, its suitability for residential development.

As part of the re-engineering exercise, existing fill should be removed, and the area presented for re-assessment. It is unlikely that existing fill shall be suitably for re-use as structural fill. The excavated material may, however, be stockpiled for further assessment. Certification of the suitability of the re-engineered site for residential development by an experienced geotechnical engineer should be required, prior to the issue of a subdivision certificate.

6.1.3 Ground Improvement Techniques: Ridge-tops & Adjacent Slopes

The ridges and adjacent slopes are adequately stable for normal residential development. Footings for these buildings should be adequately socketed into bedrock. Each subdivision allotment should be independently engineered for the intended structure. Full geotechnical investigation should be insisted. Routine “soil test” for the classification of the site, as defined in AS2870-1996, may be inadequate.

7.0 CLOSURE

This report has been prepared for the sole use of Mr Peter Walmsley for the subdivision application with Tweed Shire Council. It is not intended for any other use without written approval from this office. Queries, and requirements for clarification or additional information pertaining to any aspect of the report should be directed to this office.

Please note that Maiden Geotechnics cannot take responsible for geotechnical testing or inspected relating to the proposed development that may be undertaken by other organisations.

The attention of readers and users of this report is drawn to the document "Important information about your geotechnical Engineering Report". A copy is provided in the appendix. The document is intended to advise on realistic expectations from the geotechnical report, and to ensure that all parties who may rely on this report become aware of their responsibilities.

For and on behalf of Maiden Geotechnics

Ohene K. Yeboah (C.P.Eng.)
M.I.E.Aust., M.ASCE, R.P.E.Q.
B.Sc.(Hons. Civil), M.Eng.Sc.(Melb.),
Grad.Dip.Comp.(Monash)
Director

APPENDIX


STOTT STREET
COMMUNITY PROPERTY
PUBLIC RESERVE
MAIDEN GEOTECHNICS TEST PITS 10 - 16 AS INDICATED & NUMBERED
DCP TEST LOCATIONS

MAIDEN GEOTECHNICS

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Postal Address: PO Box 2079 Nerang East, Qld 4211, Australia Email: gmaiden@winshop.com.au

TEST PIT LOG

CLIENT	Mr Peter Walmsley	**Job No.**JU/04/810-2008
PROJECT	Slope Stability Assessment	**Test Pit No:** 10
LOCATION	Walmsleys Road, Bilambil Heights	**Test Pit RL:**
Lot 1 (DP167380), Lot 1 DP 134787 & Lot 2 DP 961928		**Page 1 of 1**
Logged By: O.K.Y.	**Date:** 24/10/08	**Checked By:** O.K.Y.

DEPTH (m)	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.0	**FILL - Silty CLAY (CH)** with gravel, dark brown, firm, high plasticity, moist	Firm			
1.0					
1.2	End of test pit excavation @ 1.2m				
	Closely packed boulders				
7.0					

DRILL TYPE: **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

"V" Bit Refusal - Maximum Depth of Penetration by "V" Bit
"T/C" Bit Refusal - Maximum Depth of Penetration by "T/C" Bit
PS = Piston Sample

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TEST PIT LOG

CLIENT	Mr Peter Walmsley	**Job No.** JU/04/810-2008
PROJECT	Slope Stability Assessment	**Test Pit No:** 11
LOCATION	Walmsleys Road, Bilambil Heights	**Test Pit RL:**
Lot 1 DP167380. Lot 1 DP1341787 & Lot 2 DP 961928		**Page 1 of 1**
Logged By: O.K.Y.	**Date:** 24/10/08	**Checked By:** O.K.Y.

DEPTH (m)	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.0	**Residual - Silty CLAY (CI)** brown, medium plasticity, stiff, moist	Stiff			
1.0					
1.4	**Residual - CLAY (CI)** orange dark brown, medium plasticity, very stiff to hard, moist	Very stiff to hard			
2.0					
2.4	**Total Depth = 2.4m**				

DRILL TYPE: 8-tonne Komatsu Hydraulic Excavator Groundwater: Nil

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

"V" Bit Refusal - Maximum Depth of Penetration by "V" Bit
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TEST PIT LOG

CLIENT Mr Peter Walmsley	**Job No.**JU/04/810-2008
PROJECT Slope Stability Assessment	**Test Pit No:** 12
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit RL:**
Lot 1 DP167380. Lot 1 DP1341787 & Lot 2	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 24/10/08 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.0		**FILL - Clayey SILT (CI)** dark reddish brown, medium plasticity, moist. Boulders encountered within top 0.3m				
0.5						
1.0		**RESIDUAL - CLAY (CI)** orange brown/red, medium plasticity, hard, moist	Hard			
1.5		**Total depth = 1.5m**				
2.0						
2.5						
3.0						
3.5						
4.0						
4.5						
5.0						

DRILL TYPE: 8-tonne Komatsu hydraulic excavator **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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TEST PIT LOG

CLIENT	Mr Peter Walmsley	**Job No.**JU/04/810-2008
PROJECT	Slope Stability Assessment	**Test Pit No:** 13
LOCATION	Walmsleys Road, Bilambil Heights	**Test Pit RL:**
Lot 1 DP167380. Lot 1 DP1341787 & Lot 2		**Page 1 of 1**

Logged By: O.K.Y. **Date:** 24/10/08 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.0		**FILL - clayey SILT(CI)** dark brown, medium plasticity, moist	Stiff			
0.4						
0.5		**RESIDUAL - CLAY (CI-CH)** pale grey, medium to high plasticity, dry	Very stiff to hard			
1.0		**RESIDUAL - CLAY (CI)** pale grey /brown, medium plasticity, hard, dry. (Extremely weathered shale)	Hard			
1.5						
2.0		**Total depth = 2.0m**				

DRILL TYPE: 8-tonne Komatsu hydraulic excavator **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
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PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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TEST PIT LOG

CLIENT Mr Peter Walmsley	**Job No.**JU/04/810-2008
PROJECT Slope Stability Assessment	**Test Pit No:** 14
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit RL:**
Lot 1 DP167380. Lot 1 DP1341787 & Lot 2	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 24/10/08 **Checked By:** O.K.Y.

DEPTH (m)	USCS	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.0		**Clayey SILT (CI),** dark/ reddish brown, medium plasticity, stiff, moist	Stiff			
0.4		**RESIDUAL - Silty CLAY (CI)** reddish brown/ mottley grey, medium plasticity, very stiff, moist	Very stiff			
1.0						
1.5		**RESIDUAL - Silty CLAY (CI)** dark brown, medium to high plasticity, hard, moist	Hard			
1.8		**Total depth = 1.8m**				

DRILL TYPE: 8-tonne Komatsu hydraulic excavator. **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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PS = Piston Sample

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TEST PIT LOG

CLIENT	Mr Peter Walmsley	**Job No.** JU/04/810-2008
PROJECT	Slope Stability Assessment	**Test Pit No:** 15
LOCATION	Walmsleys Road, Bilambil Heights	**Test Pit RL:**
Lot 1 DP167380. Lot 1 DP1341787 & Lot 2		**Page 1 of 1**

Logged By: O.K.Y. **Date:** 24/10/08 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.0		**FILL - clayey SILT (CI)**, dark brown, medium plasticity, dry	Firm/ loose			
0.5		**CLAY & COBBLES & BOULDERS** dark/ reddish brown, low plasticity, medium dense, dry	Medium dense			
1.0		**Test pit terminated at 1.0m**				

DRILL TYPE: Komatsu 8-tonne hydraulic excavator **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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PS = Piston Sample

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TEST PIT LOG

CLIENT Mr Peter Walmsley	**Job No.** JU/04/810-2008
PROJECT Slope Stability Assessment	**Test Pit No:** 16
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit RL:**
Lot 1 DP167380. Lot 1 DP1341787 & Lot 2	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 24/10/08 **Checked By:** O.K.Y.

DEPTH (m)	USCS	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.0		**FILL - Gravelly CLAY (CI)**, dark brown, medium plasticity, firm, moist	Firm			
0.5						
1.0						
1.5						
1.6		**Residual - CLAY (CI),** orange/reddish brown, low to medium plasticity, dry	Hard			
2.0		Total Depth = 2.0m				

DRILL TYPE: 8-tonne, Kumatsu hydraulic excavator Groundwater: NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

"V" Bit Refusal - Maximum Depth of Penetration by "V" Bit
"T/C" Bit Refusal - Maximum Depth of Penetration by "T/C" Bit
PS = Piston Sample

OKY/al
Our Ref: JU/04/810
29 July, 2004

Mr Peter Walmsley
C/- Martin Findlater & Associates Pty. Ltd.
PO Box 6389
TWEED HEADS SOUTH NSW 2486

Dear Sir,

RE: REPORT SLOPE STABILITY ASSESSMENT
PROPOSED RESIDENTIAL SUBDIVISION
LOT 1 (DP167380) WALMSLEYS ROAD
BILAMBIL HEIGHTS

1.0 INTRODUCTION

Maiden Geotechnics is pleased to present, herein, a report on the geotechnical assessment of the site's slope stability at Lot 1 (DP 167380) Walmsley Road, Bilambil Heights.

The assessment followed the acceptance of Maiden Geotechnics fee proposal of 22 June, 2004 (ref. Q-JU/04/534) on the subject matter by Blueland Engineers.

It is understood the site is to be subdivided for residential development. Soil Survey Engineering Pty. Limited has previously investigated the subject site. The objectives of the present investigation are as follows:

- To review the previous investigation findings, particular on the areas of reported landslide, and provide a second opinion on the matter.
- To provide mitigation measures for areas where the existing ground conditions are likely to pose some problems to intended development.

2.0 THE SITE

2.1 Location and Topography

The subject site extends over the area between the southern end (cul-de-sac) of Stott Street and Walmsleys Road. Current access are via Stott Street at the northern end, and a continuation of Walmsleys Road at the southern end.

The proposed subdivision layout extends over the crest of a north-south bending ridge and adjoining side slopes gradients are typically 5 to 10, and 10 to 20 degrees, respectively.

It is understood the site had previously be used for banana plantation and other cash crop farming activities. No signs of the farming activities existed at the time of the investigation.

Grass covered the ridge crest and the adjacent slopes. The northern and part of the eastern boundaries had lines of planted and matured trees. A deep gully exists to the south-west side of the access road. The areas along the south-west boundaries and below the slopes at the western end were covered by weed species.

The following topographical features are identified for review and discussion in this report.

- An existing depression along sections of the eastern boundary. This area has been retained by a rock wall and backfilled against the main slope. This area shall be referred to as eastern depression for the remaining section of this report.

- A deep gully at the southwest corner, which grades into a gentle slope towards the western extremities. Boulders and clayey silt/silty clay soils cover this area. Stockpile of fill is located at the top of the gully. This area shall be referred to as southwest depression for the remainder of this report.

- A previous dam site at the southeast corner, which has been backfilled, is also identified. This section extends between the eastern

depression and a naturally occurring steep slope along the southern boundary. For the remainder of this report, this area shall be referred to as "the previous dam site".

2.2 Regional Geology

A reference to the Geological Survey of New South Wales, 1:250000 Tweed Heads Series (Sheet SH56.3), indicates that, the geology of the region is dominated by the meta-sedimentary, Neranleigh-Fernvale Beds and the tertiary aged Lamington Volcanics.

The Neranleigh-Fernvale Beds appear to dominate the subject site. However, some occurance of the Lamington Volcanics are expected.

3.0 BACKGROUND INFORMATION

Soil Survey Engineering Pty. Ltd has previously investigated the subject site. The investigation involved site inspection by an experienced geotechnical engineer and engineering geologist, and subsurface exploration with test pits.

The test pits extended to maximum depth of 2.9m. Copies of the test pits logs are provided in the appendix of this report.

4.0 METHOD OF INVESTIGATION

The previous investigation by Soil Survey Engineering Pty. Limited raised some concerns about the stability of the eastern depression, the deep gully and the steep slope overlooking the previous dam site.

The present investigation concentrated at these areas. Eight (8) test pits were excavated with a 20-tonne Kato hydraulic excavator. The test pits were advanced to maximum depth of 5.5 metres at the previous dam site, and to refusal at depths of between 1.4 and 2.5 metres at the other locations.

Dynamic cone penetrometer (DCP) test was conducted through the existing fill at the previous dam site. The test was advanced to 5.7m below the existing ground surface.

A site plan contained in the appendix shows the test pits and the DCP test locations. An experienced geotechnical engineer from this office supervised the fieldwork.

5.0 GROUND CONDITIONS

5.1 Eastern Depression (Refer Test Pit 1)

A deposit of colluvium, comprising loose aggregate of cobbles, boulders and high plasticity silty clay, extends to an approximate depth of 2.3m. 0.3m of hard residual cay underlies the colluvium. Decomposed shale (bedrock) underlies the residual soil at depths. No ground water seepage was observed within the formation.

5.2 Previous Dam Site (Refer Test Pit 4, 5 & 6)

Up to 3.8m of stiff or medium dense silty/gravelly clay fill overlies soft silty (organic) clay. Rotten timbers and other organic materials were contained in the soft clay layer. Stiff residual clay underlies the organic layer.

5.3 Bottom of Deep Gully (Refer Pits 8 & 9)

Cobbles, boulders and silty clay fill (colluvium) occur at the bottom of the gully. The colluvial deposits extend to depths typically in the vicinity of 2.0m in the test pit, but may be deeper at some other locations. The overlooking natural slope formation (refer test pit 7) consists of 2.4m or more of stiff to hard silty clay.

5.4 Top of Eastern Depression (Refer Test Pits 2 & 3)

At the top of the eastern depression slope, some 0.6m of top soil predominantly clay, and up to 0.8m of colluvium, overlies the bedrock. The colluvium was revealed mostly along the eastern boundary.

5.5 The Southern Steep Slope (Refer Test Pit 7)

Medium to high plasticity silty clay extends to depths in excess of 2.4 metres. The profile is stiff and very stiff to approximate depths of 1.0 and 2.0 metres, respectively. Hard silty clay extends thereon. Decomposed shale (bedrock) is envisaged within a few metres below the depth reached with the excavator.

5.6 Other Sections

At the other sections of the site, soil survey test pits Nos. 13, 14, 15, 16, and 17 indicates that, the subsurface profile is characterised by stiff to very stiff and hard clays and weathered siltstone. Depths to the bedrock ranges from 1.4 to over 3.6 metres.

5.7 Groundwater Conditions

The test pits revealed no ground water seepage. Wet conditions were noted in the organic layer revealed at the previous dam site.

6.0 STABILITY ASSESSMENT

6.1 General

Presence of colluvium on steep slopes generally signifies potential slope instability. However, where depths of the colluvium is shallow or where the deposits are highly "consolidated" to form strong matrix, the area can be engineered to ensure adequate stability for development processes.

Similarly, historical landslide may not necessarily imply potential instability. In some cases, landslides only eradicate hazardous strata, leaving behind stable formation.

6.2 The Southern Steep Slope

The topography of the naturally occurring southern slope can be regarded as being "excessive" for the subsurface strata. No potential threat to stability of the slope is indicated.

6.3 The Ridge Crest and Adjacent Slopes

These sections show no sections of slope instability. The subsurface stratification include stiff to hard, silty clays/clayey silt, which are adequately stable.

The area along the edges to the eastern depression contains some colluvium, generally up to 1.0 metre. These areas would have to be specifically engineered if the long-term stability is to be maintained.

6.4 The Eastern Depression

The eastern depression contains significant depths of colluvium, which are unsuitable for use as structural foundation. The deposits would not, however, affect or worsen the stability of the adjacent slope. Some ground improvement measures are recommended for this area. Details of the ground improvement techniques are discussed at a later section of this report.

6.5 The Previous Dam Site

The existing fill at the previous dam site is established over soft organic clays, and could undergo significant settlement with time. It is believed the majority of the area shall be re-developed into a recreational park and therefore minor settlements can be accommodated.

However, the proposed road alignment may extend to some sections. Any section within the road alignment should be excavated to the natural, competent formation, and the excavated area backfill with suitable material.

6.6 The Deep Gully

This area is currently dominated by colluvium depth of which may exceed 2.0 metres at some locations. The area can be reclaimed by backfilling with suitable material. Proper engineering supervision is recommended for the backfilling operations.

7.0 DISCUSSIONS & RECOMMENDATIONS

7.1 Ground Improvement Techniques – eastern depressions

The existing ground conditions at this area can be rectified as follows:

- Excavate the colluvium and stockpile the material.
- Remove cobbles, boulders and oversize rocks from the stockpile.
- Backfill with sorted material (less the oversize rocks, cobbles and boulders).

The backfill shall be placed in layers not exceeding 0.5m (uncompacted) and compacted to at least 100% standard dry density ratio.

Each layer should be tested. Full-time supervision of the earthworks operation is strongly recommended.

Along the top of the slope, the construction of the proposed road should involve removal of the colluvium. The new pavement should be established over the bedrock.

7.2 The Southern Slopes

Buildings should be limited to lightweight pole homes. Foundations should be either steel posts or reinforced concrete piers. They should extend at least 1.0 metre past the toe of the slope, or be socketed into bedrock. The rock socket length shall not be less than 50% of the total post or pier length.

7.3 The Deep Gully Area

The existing colluvium at the deep gully should be removed. The area may be backfilled with suitable material to the design formation level. The fill shall be placed at slopes of not steeper than 1 in 2.5, and compacted to standard dry ratio of at least 100%.

7.4 Other Areas

The ridge crest and adjacent slopes are adequately stable for normal residential development. Independent soils tests and site classifications are recommended for the individual allotments.

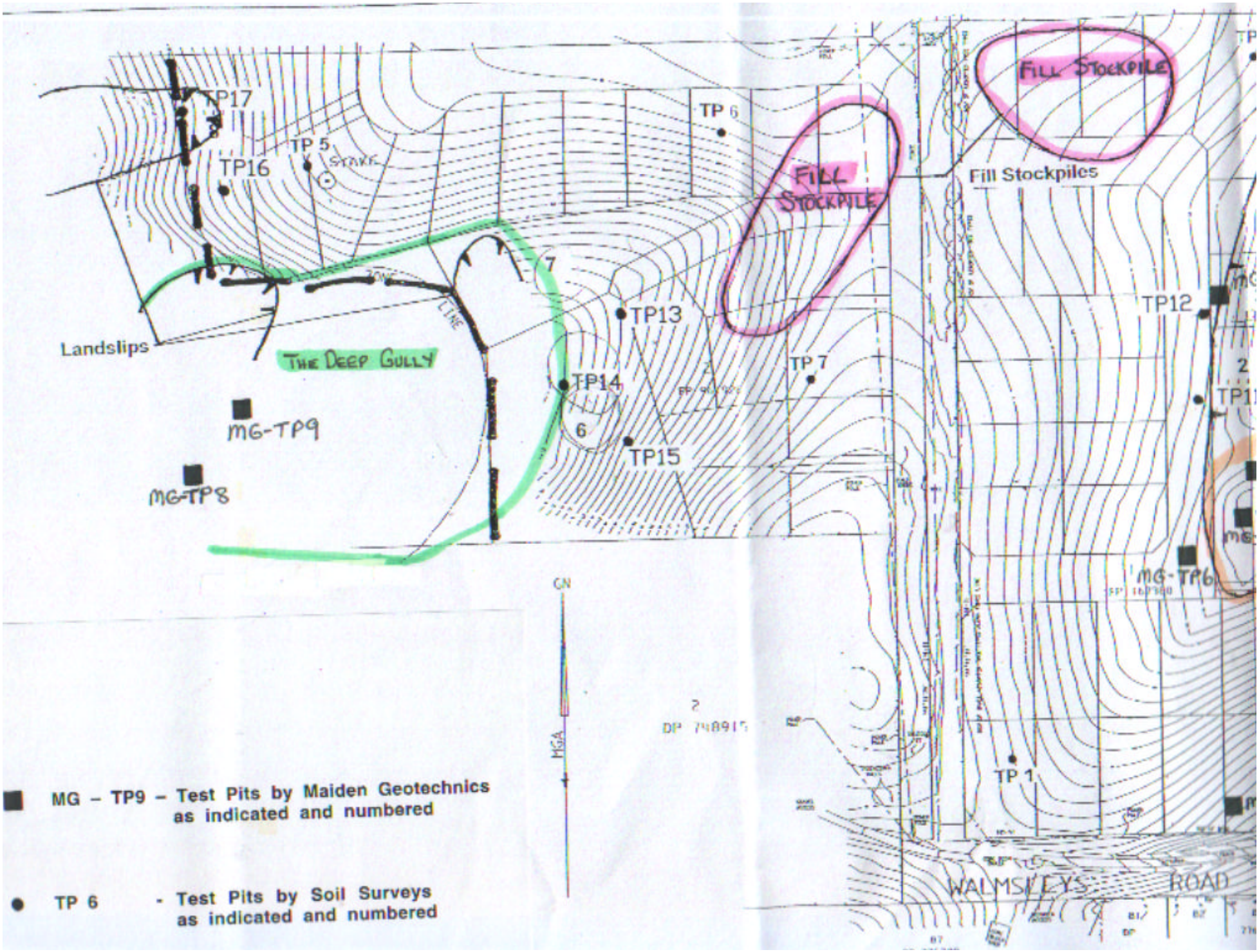
It is believe the information contained, herein, are adequate for the proposed development. However, should you have any queries or require any additional information, do not hesitate to contact this office.

Please note that Maiden Geotechnics cannot take responsible for geotechnical testing or inspected relating to the proposed development that may be undertaken by other organisations.

For and on behalf of Maiden Geotechnics

Ohene K. Yeboah (C.P.Eng.)
M.I.E.Aust., M.ASCE, R.P.E.Q.
B.Sc.(Hons. Civil), M.Eng.Sc.(Melb.),
Grad.Dip.Comp.(Monash)
Director

APPENDIX II



■ MG – TP9 – Test Pits by Maiden Geotechnics as indicated and numbered

● TP 6 - Test Pits by Soil Surveys as indicated and numbered

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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 1
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	USCS	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.5		**COLLUVIUM - Silty CLAY (CH)** with cobbles and boulders, dark brown, medium to high plasticity, dry.				
1.0						
1.5						
2.0						
2.3						
2.5		**RESIDUAL - Silty CLAY (CH)**, pale grey mottling red, high plasticity, hard, dry	hard			
2.7						
3.0		**DECOMPOSED SHALE**				
3.5						
4.0						
		Total depth = 4.0m				
4.5						
5.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

"V" Bit Refusal - Maximum Depth of Penetration by "V" Bit
"T/C" Bit Refusal - Maximum Depth of Penetration by "T/C" Bit
PS = Piston Sample

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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 2
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.5		**TOPSOIL - Silty CLAY (CH),** dark brown, medium plasticity, stiff, dry.	stiff			
0.6		**BEDROCK**				
1.0						
1.5		**Excavator refusal at 1.5m**				
2.0						
2.5						
3.0						
3.5						
4.0						
4.5						
5.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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"T/C" Bit Refusal - Maximum Depth of Penetration by "T/C" Bit
PS = Piston Sample

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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 3
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.5		**COLLUVIUM - CLAY (CH),** dark brown, high plasticity, stiff, dry. Cobbles and boulders up to 600mm	stiff			
0.8						
1.0		**BEDROCK**				
1.4						
1.5		**Excavator refusal at 1.4m**				
2.0						
2.5						
3.0						
3.5						
4.0						
4.5						
5.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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"T/C" Bit Refusal - Maximum Depth of Penetration by "T/C" Bit
PS = Piston Sample

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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 4
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.5		**FILL - Silty CLAY (CH),** dark brown, medium plasticity, stiff, moist.	stiff			
0.8						
1.0						
1.5						
1.6		**FILL - Gravelly CLAY (CI),** greenish mottling grey, medium plasticity, stiff, moist.	stiff			
2.0						
3.0						
3.8						
4.0		**TOPSOIL - Silty CLAY (CH),** dark brown, high plasticity, soft, wet.	soft			
5.0						
5.5		**Total depth = 5.5m**				
6.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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"T/C" Bit Refusal - Maximum Depth of Penetration by "T/C" Bit
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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 5
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.5		**FILL - Silty CLAY (CI) with gravel,** dark brown, medium plasticity, stiff, moist. Contains some cobbles and minor boulders.	stiff			
0.8						
1.0						
1.5						
1.6		**Silty CLAY (CI),** brown, medium plasticity, very stiff, dry.	very stiff			
2.0						
3.0						
3.4		**BEDROCK** intercepted at 3.4m				
3.5						
4.0		**Excavator refusal at 3.5m**				
5.0						
5.5						
6.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
PP = Pocket Penetrometer Reading (kPa)
PT = Penetration Test

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"T/C" Bit Refusal - Maximum Depth of Penetration by "T/C" Bit
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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 6
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.5	**FILL - Silty CLAY (CI) with gravel,** brown, medium plasticity, very stiff, dry.	very stiff			
1.0					
1.5					
2.0	**FILL - Silty CLAY (OH) and rotten timber,** dark grey,high plasticity, soft, wet.	soft			
3.0					
4.0	**Total depth = 4.0m**				
5.0					
5.5					
6.0					

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
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D = Disturbed Sample
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PT = Penetration Test

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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 7
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.2		**TOPSOIL - CLAY (CI) ,** dark brown, medium plasticity, hard, dry.	hard			
0.5		**Silty CLAY (CI)**, reddish brown, medium plasticity, stiff to very stiff, moist.	stiff to very stiff			
1.0		**Silty CLAY (CI)**, greenish, medium plasticity, very stiff.	very stiff			
1.5						
2.0		**Silty CLAY (CI),** grey mottling red, high plasticity, hard, moist.	hard			
2.4		**Total depth = 2.4m**				
3.0						
4.0						
5.0						
5.5						
6.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 8
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.2		**FILL - Silty CLAY (CI) ,** dark brown, medium plasticity, loose, dry. With cobbles and boulders. Contains root matter.	loose			
0.5						
0.6		**Silty CLAY (CI)**, dark brown, medium plasticity, stiff to very stiff, moist.	stiff to very stiff			
1.0						
1.5						
2.0		**Silty CLAY (CH),** grey mottling red, high plasticity, very stiff to hard, moist.	very stiff to hard			
2.5						
3.0		**Total depth = 2.5m**				
4.0						
5.0						
5.5						
6.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
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TEST PIT LOG

CLIENT Mr Peter Walmsley c/- Martin Findlater & Associates Pty Ltd	**Job No.** JU/04/810
PROJECT Slope Stability Assessment - Lot 1 (DP167380)	**Test Pit No:** 9
LOCATION Walmsleys Road, Bilambil Heights	**Test Pit Incl.**
TEST PIT LOCATION R.L. -	**Page 1 of 1**

Logged By: O.K.Y. **Date:** 8/7/2004 **Checked By:** O.K.Y.

DEPTH (m)	GRAPHIC LOG	PROFILE DESCRIPTION	CONSISTENCY	INSITU TESTING Depth(m)	INSITU TESTING Results	COMMENTS
0.2		**TOPSOIL - Silty CLAY (CI) ,** dark brown, medium plasticity, loose, dry. With cobbles and boulders sizes up to 0.8m.	loose			
0.5						
0.6		**COLLUVIUM - Silty CLAY (CI)**, dark brown, mediumplasticity, stiff, moist.	stiff			
1.0						
1.5						
2.0		**Excavator refusal on large bouler at 2.0m**				
2.5						
3.0						
4.0						
5.0						
5.5						
6.0						

DRILL TYPE: HD-5 20 tonne Kato **Groundwater:** NIL

U50 = Undisturbed 50mm diameter Tube Sample
SPT = Standard Penetration Test
D = Disturbed Sample
S = Vane Shear Value (kPa)
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DYNAMIC CONE PENETROMETER TEST

CLIENT	Mr Peter Walmsleyc/- Martin Findlater & Associates Pty Ltd	**JOB NO:**	JU/04/810
PROJECT	Slope Stability Assessment - Lot 1 (DP167380)		7/7/04
LOCATION	Walmsleys Road, Bilambil Heights	**PAGE NO:**	1 of 1
Tested By:	V.V.	**Checked By:**	O.K.Y.

TEST NUMBER	**DCP-1**				
TEST LOCATION	TP4				
DEPTH (m)	**BLOWS**	**BLOWS**	**BLOWS**		
0.1	16	**3.2**	8		
0.2	15	**3.3**	6		
0.3	11	**3.4**	5		
0.4	11	**3.5**	5		
0.5	13	**3.6**	4		
0.6	10	**3.7**	2		
0.7	7	**3.8**	5		
0.8	9	**3.9**	2		
0.9	10	**4.0**	5		
1.0	10	**4.1**	3		
1.1	8	**4.2**	6		
1.2	6	**4.3**	6		
1.3	6	**4.4**	6		
1.4	7	**4.5**	4		
1.5	6	**4.6**	3		
1.6	4	**4.7**	5		
1.7	4	**4.8**	4		
1.8	4	**4.9**	5		
1.9	11	**5.0**	4		
2.0	7	**5.1**	4		
2.1	6	**5.2**	3		
2.2	5	**5.3**	5		
2.3	4	**5.4**	4		
2.4	2	**5.5**	5		
2.5	3	**5.6**	5		
2.6	6	**5.7**	5		
2.7	8				
2.8	6				
2.9	5				
3.0	5				
3.1	6				

SOIL DESCRIPTION: REFER BOREHOLE LOGS