EASTMANS GREEN SUBDIVISION
NEWSTEAD

GEOTECHNICAL NOTES

TO ACCOMPANY AS2870 ("SOIL TEST") REPORTS
FOR INDIVIDUAL LOTS

eastmans green
take the first step

Newstead, Tasmania

Introduction

William C Cromer Pty Ltd has been engaged by Ecoast Homes Pty Ltd to prepare separate site classification ("soil test") reports for about 50 lots in the Eastmans Green Subdivision at Newstead.

The assessments are being done in accordance with Australian Standard 2870:2011 *Residential slabs and footings*, and draft Tasmanian guidelines[1] relating to the draft Tasmanian Landslide Code.

Individual AS2870 soil test reports have been or are being prepared for each unsold lot in the subdivision. These separate reports (each is called PART 1) contain geotechnical information specific to the lot in question. The reports for each lot completed so far are freely available at http://eastmansgreen.com.au/

Important geotechnical information is common to all lots in the subdivision. Rather than repeat this information in each individual report, it was thought preferable to provide it as this single separate document (PART 2), freely available at http://eastmansgreen.com.au/ and http://www.williamccromer.com/

This current document therefore forms an important part of each individual report, and should be read in conjunction with it.

Refer to this report as

> Cromer, W. C. (2014). *Geotechnical Notes to accompany AS2870 ("soil test") reports for individual lots, Eastmans Green Subdivision, Newstead.* Unpublished report for Ecoast Homes Pty Ltd by William C. Cromer Pty. Ltd., 20 August 2014.

People using this document should check that it has not been superseded by a later version.

Implications for AS2870 reports from the draft Tasmanian Landslide Code and guidelines

There are state-wide implications for AS2870 site classifications if the draft Tasmanian Landslide Code[2] is adopted in its current form:

- All residential lots in the Medium landslide hazard band[3] will automatically be classified as Class P unless otherwise classified by a suitably qualified practitioner. Footings for Class P sites require certification by a suitably experienced engineer.

- In the Medium landslide hazard band, new buildings (or new extensions to an existing building) which result in a total final floor area greater than 200m^2 will require a Landslide Risk Management (LRM) report.

Most of the Eastmans Green Subdivision is in the Medium landslide hazard band (Attachment 1). Anticipating that the draft Tasmanian Landslide Code will be adopted, a general LRM has been completed for the subdivision (Attachment 4). Where appropriate, automatic Class P classifications for lots in the Medium landslide band in this subdivision have been amended in individual PART 1 reports.

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[1] Cromer, W. C. (2014). *Building for landslide: Geotechnical guidance for regulators and practitioners using the Tasmanian Landslide Code*. Report for the Tasmanian Department of Premier and Cabinet by William C. Cromer Pty. Ltd., June 2014).

[2] Available at http://www.planning.tas.gov.au/__data/assets/pdf_file/0009/168948/Draft_Planning_Directive_-_Statewide_Codes.pdf

[3] See Attachment 1 of *Geotechnical Notes to accompany AS2870 ("soil test") reports for individual lots, Eastmans Green Subdivision, Newstead*

Dissemination of information is important

New geotechnical information is contained in this report. The information may be useful to regulators and other geotechnical practitioners. Dissemination of such knowledge is important.

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William C Cromer Pty Ltd may submit hard or electronic copies of this report to Mineral Resources Tasmania to enhance the geotechnical database of Tasmania.

Background information

William C Cromer Pty Ltd produced detailed geotechnical (including landslide risk management, LRM) reports for Ecoast Homes Pty Ltd for the original Eastmans Green subdivision:

- Cromer, W. C. (2009). *Geotechnical assessment, 76 – lot subdivision, Penquite Road, Newstead.* (Unpublished report for ECoast Homes Pty Ltd by William C. Cromer Pty. Ltd., 7 April 2009; 137 pages), and

- Cromer, W. C. (2011). *Geotechnical Assessment Addendum Report, Eastman's Green subdivision, Penquite Road, Newstead.* (Unpublished report for ECoast Homes Pty Ltd by William C. Cromer Pty. Ltd., 22 May 2011; 33 pages)

Both are available at http://eastmansgreen.com.au/ and http://www.williamccromer.com/

Notes about how Tasmanian practitioners should prepare AS2870 soil test reports for houses are available at http://www.williamccromer.com/soil-testing-for-houses/

WARNING
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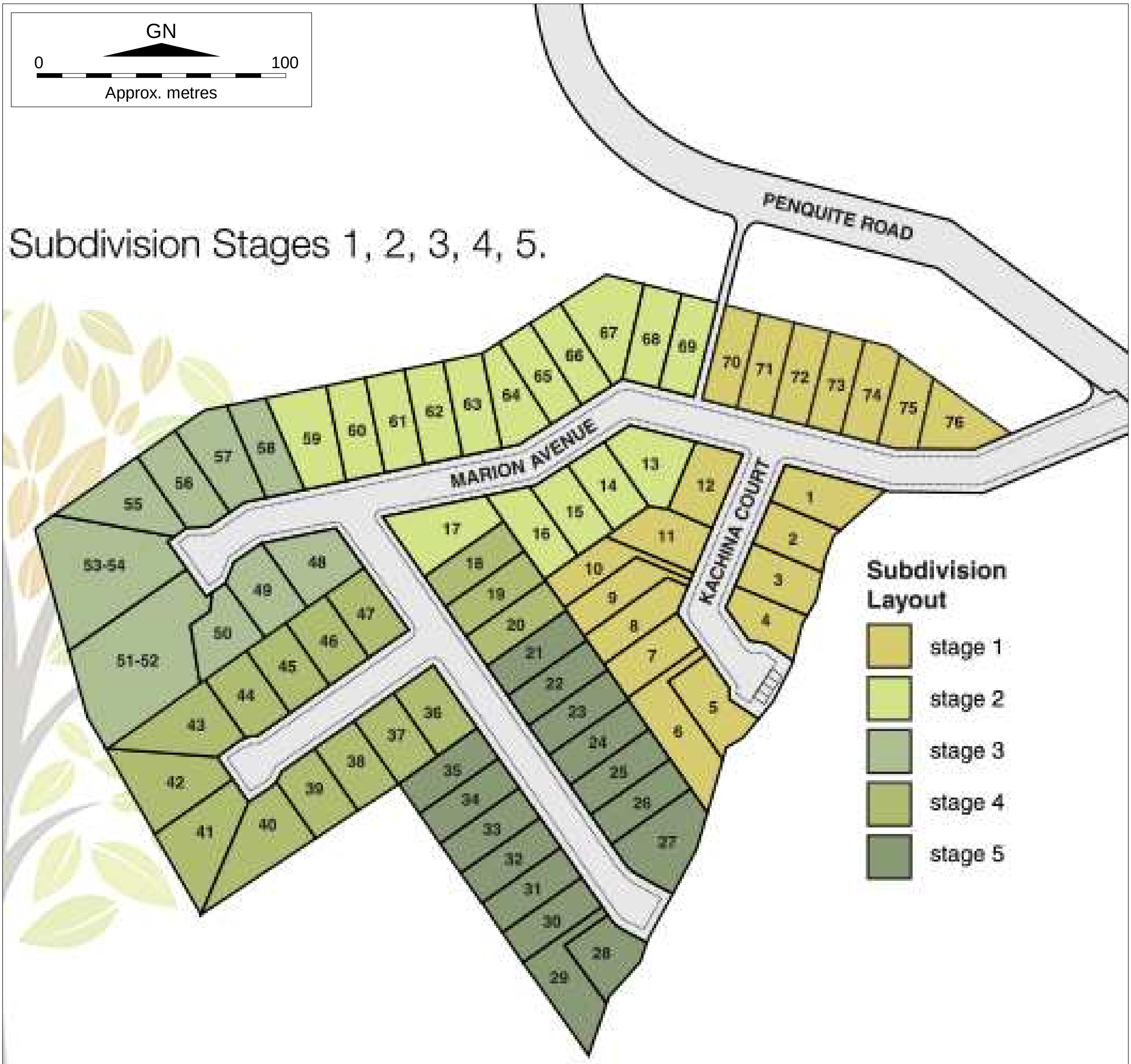
W. C. Cromer

Principal
20 August 2014

This report is and shall remain accompanied by the following Attachments:

Attachment 1.	Location, satellite imagery, published geology and landslide hazard bands (2 pages)
Attachment 2.	Launceston Landslide Hazard Maps in relation to Eastmans Green (4 pages)
Attachment 3.	Technical Notes (9 pages)
Attachment 4.	Landslide Risk Management (LRM; 6 pages)
Attachment 5.	Good and poor hillside construction practices (4 pages)
Attachment 6.	AGS Geoguide LR11 Record Keeping (1 page)

The Eastmans Green Subdivision and its 5 stages



Source: http://www.eastmansgreen.com.au/layout-and-pricing/stage-1/

Geotechnical notes to accompany AS2870 ("soil test") reports for individual lots Eastmans Green Subdivision

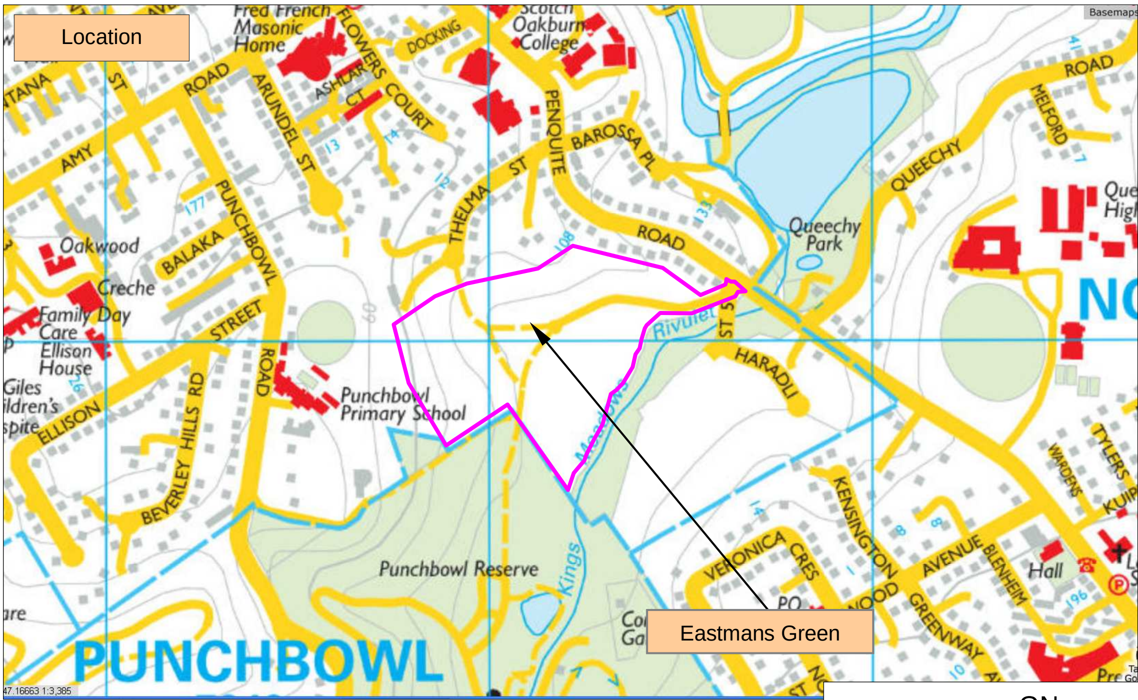
WARNING
These Notes form PART 2 of the AS2870 ("soil test") report (PART 1) for each lot in the subdivision, and should be read in conjunction with it.

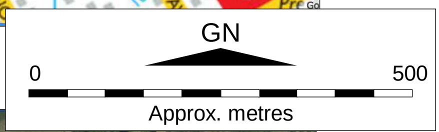
Attachment 1

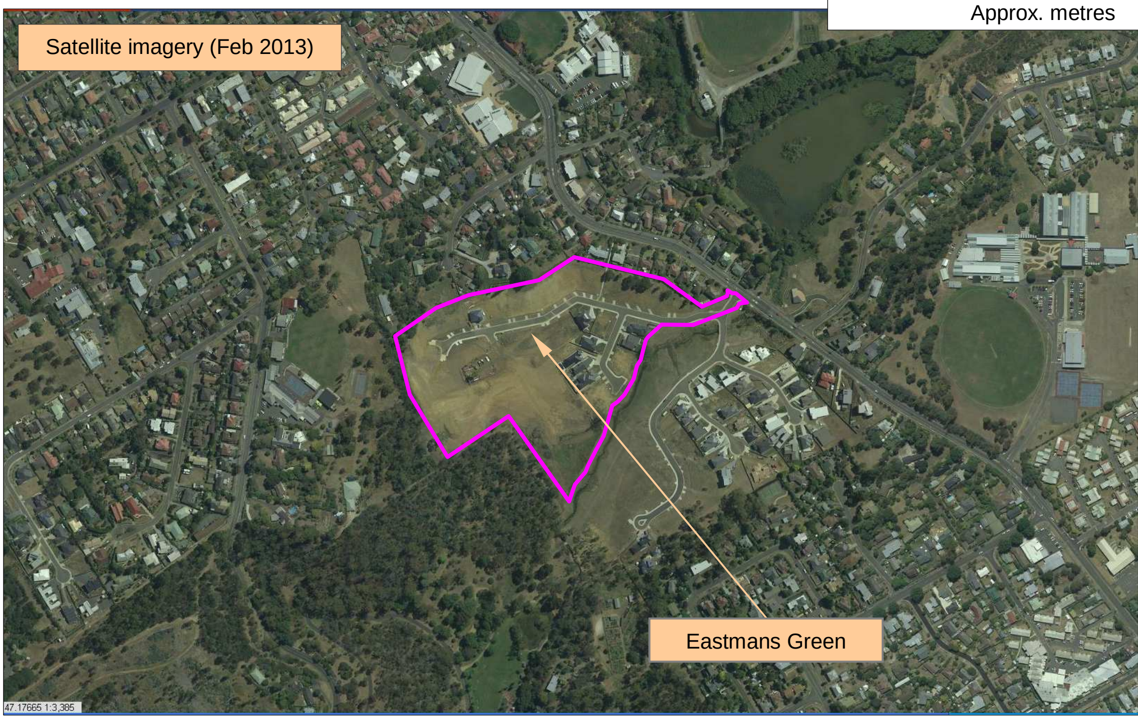
(2 pages)

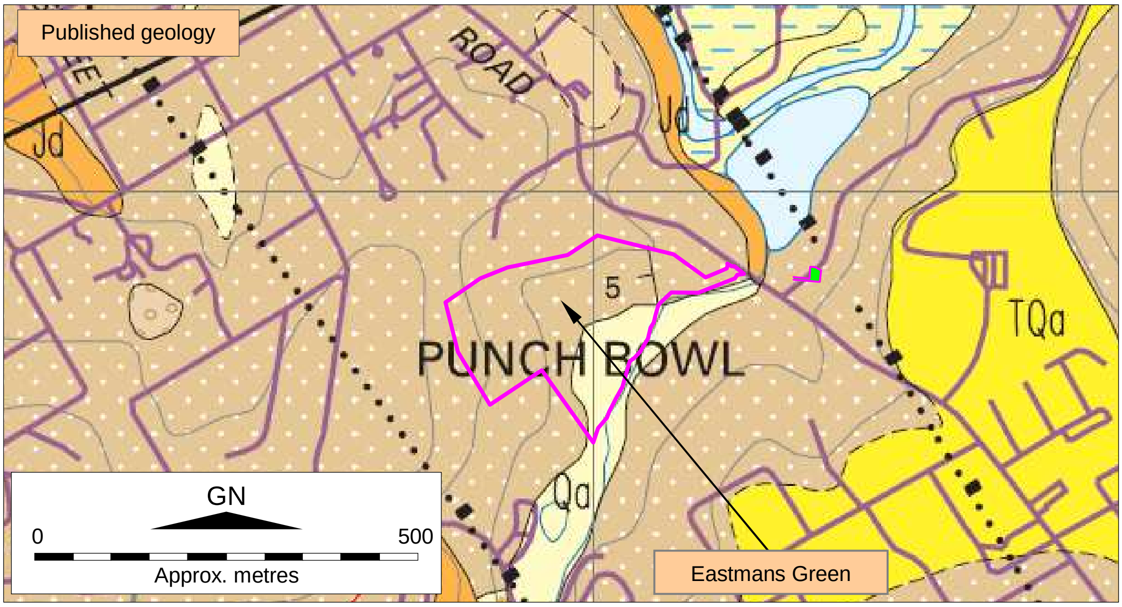
Location, satellite imagery, published geology and landslide hazard bands

Sources www.thelist.tas.gov.au, Mineral Resources Tasmania

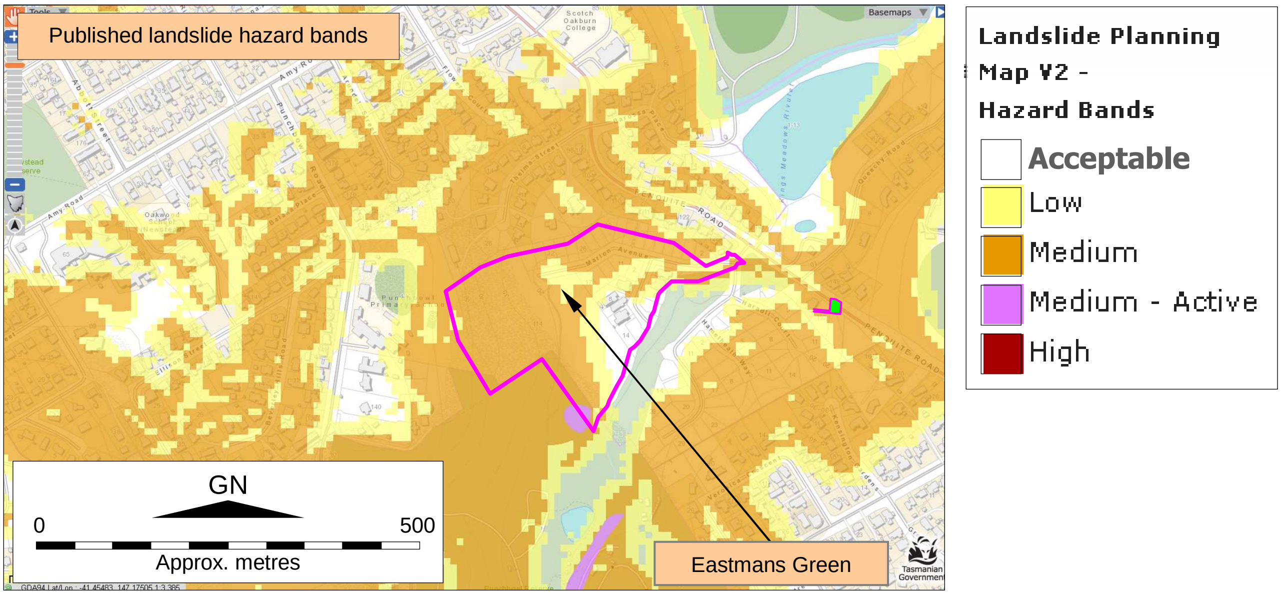








Source for geology: Calver, C. R. and Forsyth, S. M. F. (compilers) 2005. Map 3, Launceston – Geology. Tasmanian Landslide Hazard Series. Mineral Resources Tasmania.
Key to rock colours:
Orange = Jurassic-age dolerite; Brown stippled with white = Tertiary-age weakly consolidated sedimentary rocks (the "Launceston Beds"); bright yellow = Late Tertiary-age terrace deposits of gravel and sand; light yellow = Quaternary-age estuarine sediments.



Acceptable band
A landslide is a rare event based on current understanding of the hazard, but it may occur in some exceptional circumstances.

Low band
The area may include landslide features but their activity is unknown, and they have been judged by MRT to rank of lesser risk than those in higher bands.

Medium band
The area has known landslide features, or is within a landslide susceptibility zone, or has legislated controls to limit disturbance of adjacent unstable areas.

Medium-active band
The area has known recently active landslide features.

High band
The site is within a declared Landslip A area.

Attachment 2

(4 pages)

Launceston Landslide Hazard Maps in relation to Eastmans Green

Notes

This Attachment shows Eastmans Green and surrounding land in relation to four landslide hazard maps issued by Mineral Resources Tasmania[4]. A portion of each map covering Eastmans Green, and part of the Key to the map, are shown.

The maps are:

Map 1: Landslide Inventory and Geomorphology
Map 3: Potential Debris Flow Hazard
Map 4: Potential Rockfall Hazard
Map 5: Potential Deep Seated Landslide Hazard

Map 2 is the geological map of the area, part of which is reproduced in Attachment 1.

The following extract from the explanatory notes to Map 5 explains the purpose and limitations of the landslide hazard maps.

Landslide Inventory

Background, Aim and Purpose

Large tracts of land throughout Tasmania are subject to slope instability and about 60 houses have been destroyed by landslides since the 1950s. Fortunately only minimal loss of life has occurred in this time but such events are highly traumatic to those directly affected and the financial cost to individuals, organisations and the State runs into many millions of dollars. Recent disasters such as the Thredbo Landslide in New South Wales, serve to remind society of the potential for loss of life even from relatively small landslides Fortunately, landslide damage can be avoided when ground conditions are properly understood before construction proceeds and, in already developed areas, this understanding can be used to mitigate the hazard through various measures.

Regional landslide hazard maps provide an insight into the natural hazards that may potentially affect the area concerned. Mineral Resources Tasmania, in partnership with the Launceston City and West Tamar Councils, has produced a new landslide hazard map of the urban Launceston area and surrounds. The information provided is in the public domain and anyone is free to use it provided they read and understand the caveats for use.

Hazard and Risk

According to the joint Australian/New Zealand Standard (AS/NZS 4360:1999) risk is defined as the chance of something happening that will impact upon objectives. It is measured in terms of consequences and likelihood.

The definition of risk is often expressed by the following equation:

RISK = Hazard x Vulnerability x Elements at Risk

A hazard is defined as a source of potential harm or a situation with a potential to cause loss. A hazard, such as a landslide can be measured in terms of location, volume (or area), type, velocity and likelihood with time. Vulnerability refers to the susceptibility and resilience of structures, community and the environment to the hazard. The 'elements at risk' refers to the number of those structures, people, etc exposed to the hazard.

A hazard map attempts to portray the processes operating in an area, conveying all or some of the hazard parameters, generally in a qualitative to semi-quantitative manner. Because of the uncertainties involved, the translation of regional hazard maps into risk maps is challenging and seldom precise. An indication of the likely risk level is provided for each hazard at a regional scale but this will vary in detail. However, provided the limitations of the maps are understood, hazard maps can be used for many purposes in order to achieve the overall goal of safe and resilient communities.

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[4] To view or download each map, go to
http://www.mrt.tas.gov.au/portal/page?_pageid=35,840229&_dad=portal&_schema=PORTAL

Caveats for Use

The following caveats shall apply to the maps.

- The hazards identified are based on imperfect knowledge of ground conditions and models to represent our current understanding of the landslide process. As this knowledge improves our perception of the hazard and the depiction of the zones on the map may also change.
- These maps can be used as a guide (or flag) to the need for specific assessment in potential hazard areas.
- Planning decisions should not be made solely on the basis of the hazard zones delineated on the map.
- The scale limitations of the data should be considered at all times as exceeding this limit could lead to inaccurate decisions about the hazard.
- Specific assessment of landslide hazard and risk should be undertaken by suitably qualified and experienced practitioners in the fields of engineering geology and geotechnical engineering.
- Practitioners undertaking specific assessments should read the text and appendices attached to the maps and obtain a thorough understanding of the methodology and limitations of the maps.
- Areas where no hazard is shown can still have issues with slope instability.
- Anthropogenic influence on slopes cannot be predicted and the occurrence of slope instability resulting from the influence of human actions is specifically excluded from these maps.
- The identification and performance of cut and filled slopes have not been specifically considered in map production and their scale is such that they often cannot be resolved on the maps. The presence of such slopes should always be considered in specific assessments.

Method

A methodology has been specially developed for these maps and will be used for other urban areas of Tasmania. It can be downloaded from the MRT website.

The methodology used is based on:

- Recording observations of land instability in- and surrounding the- study area (the landslide inventory).
- Analysis of the processes that control each landslide type.
- Computer assisted modelling that simulates each of the landslide processes to predict areas that could be affected by future landslides.

Landslide Database

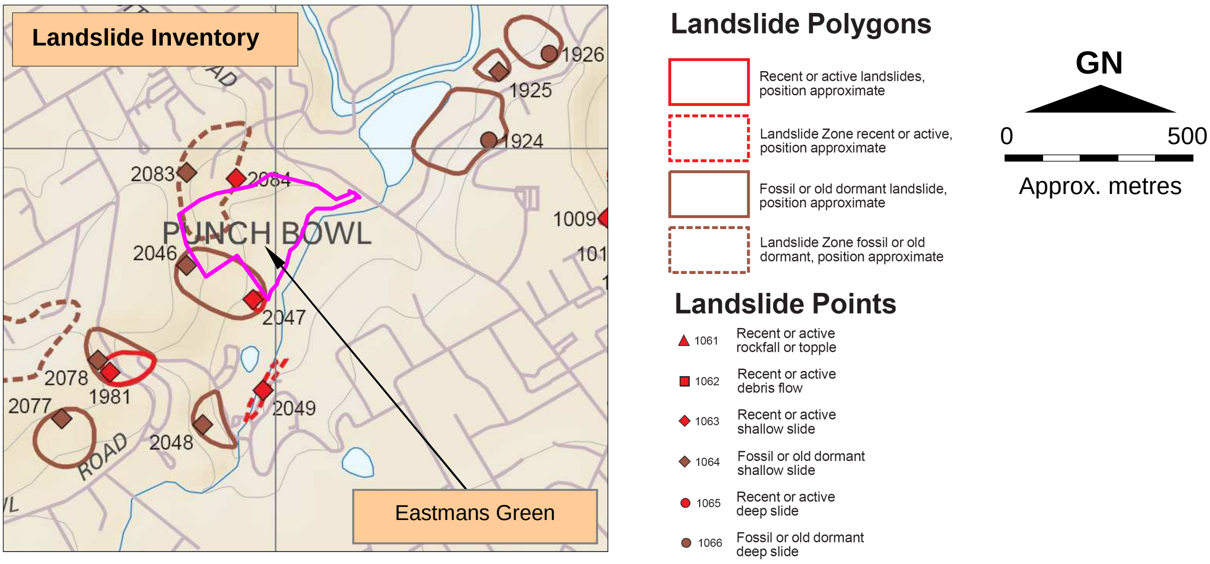
Landslide data shown on this and associated maps is sourced from a landslide database created by Mineral Resources Tasmania (MRT) for the storage of landslide related information in the State. Officially known as the 'Geohazards Module' and part of MRT's TIGER information system, the database has been built to comply with Australian and international standards for the description of landslide information. The Geohazards Module is a public database which is being developed with the view of making it available on the MRT internet site in the near future. GIS layers developed by MRT and shown on the map are supplied to each council in the area and available to the public, once the maps are completed.

Data stored within the module is sourced from both MRT records and external sources. Launceston City and West Tamar Councils provided a number of geotechnical reports to contribute to the knowledge base. However, MRT cannot guarantee that all historic information on landslides held by other parties is in its possession. Further, it is likely that there are a number of unrecognised or subsequently modified landslides in the landscape that may be revealed after these maps are published.

Map 1. Landslide Inventory

Latinovic, N. and Latinovic, M (2005). Map 1, Launceston – Landslide Inventory. Tasmanian Landslide Hazard Series. Mineral Resources Tasmania

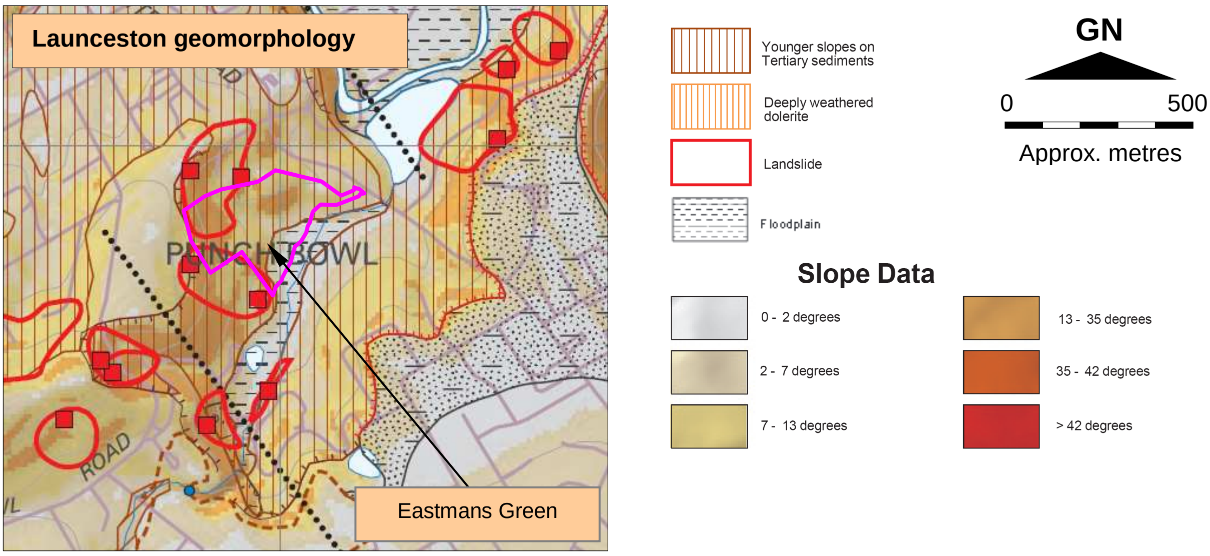
The southwestern corner of Eastmans Green overlaps part of a "fossil or old dormant" landslide, within which are two landslide points: point 2046 (regarded as a fossil old or dormant shallow landslide), and point 2047, shown as a recent or active shallow landslide. The northwestern part of Eastmans Green is included in a fossil old or dormant Landslide Zone (the position of which is approximate) with fossil (2083) and recent (2084) shallow landslides. In the general neighbourhood are several other fossil old or dormant landslides and old or dormant, and active, shallow landslides. For a more detailed discussion of slope stability issues, see Attachment 4.



Map 2. Launceston geomorphology

Selkirk-Bell, J.M. and Mazengarb, C. (2005). Map 2, Launceston – Geomorphology. Tasmanian Landslide Hazard Series. Mineral Resources Tasmania

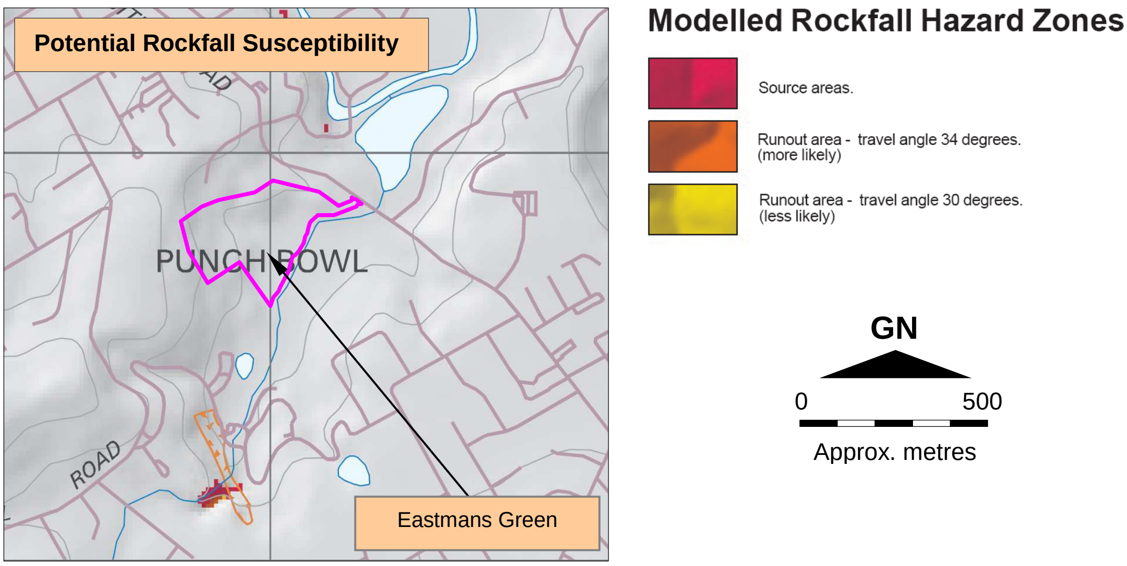
Most of Eastmans Green is mapped as "Younger slopes on Tertiary sediments", with slope angles mainly in the range 7 – 13^0, and smaller slope segments (particularly in the west) in the 13 – 35^0 range. The floor of Kings Meadows Rivulet is mapped as a flood plain.



Map 4. Potential Rockfall Hazard

Mazengarb, C. (2004). Launceston map 5 – Potential Rockfall Hazard. Tasmanian Landslide Hazard Series. Mineral Resources Tasmania

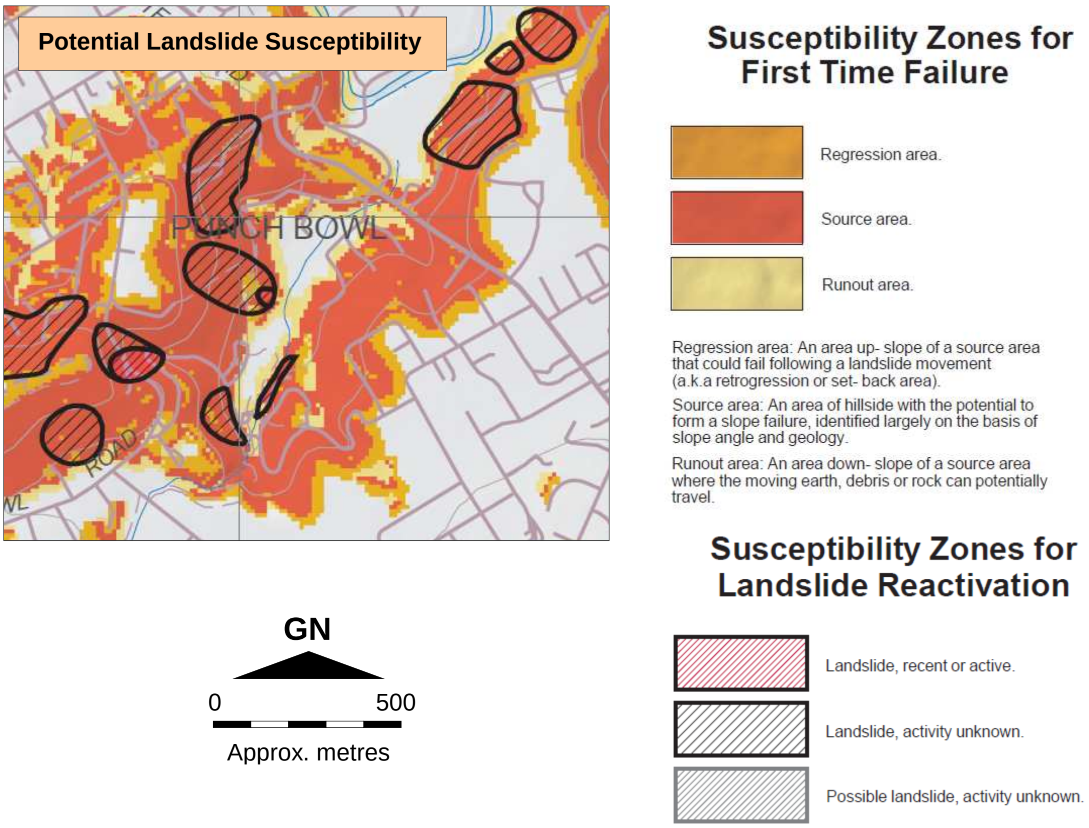
Eastmans Green is not mapped as being susceptible to rock falls.



Map 5. Potential Landslide Susceptibility

Mazengarb, C. (2013). Launceston, map 5 – Slide Susceptibility. Tasmanian Landslide Map Series. Mineral Resources Tasmania

That part of Eastmans Green mapped as "Younger slopes on Tertiary sediments" in Map 2 is regarded as susceptible to landslides (source areas) or landslide runout. The potential for landsliding increases as the slope angle increases, so the parts of Eastmans Green shown as most susceptible are along the western and northern sides.



Attachment 3
(9 pages)
Technical Notes

3.1 Geology

3.1.1 Regional setting[5]

Most of Launceston including the Eastmans Green subdivision lies within the Tamar Graben, an elongate NNW – SSE trending trough underlain by Jurassic dolerite and Lower Parmeener Supergroup rocks and infilled with Tertiary and Quaternary sediments (Figure 3.1).

The Tertiary sediments (referred to as the "Launceston Beds") are a sequence of non-marine materials comprising mainly sand, weakly cemented sandstone, clay, claystone, and mudstone, but also variously including conglomerate, laterite, carbonaceous beds and granule beds. Some horizons are fossiliferous. In the deeper parts of the graben, they may be several hundred metres thick, but locally thin rapidly near basin margins.

The regional dip of the Launceston Beds is southwest, but locally all dip directions can be expected.

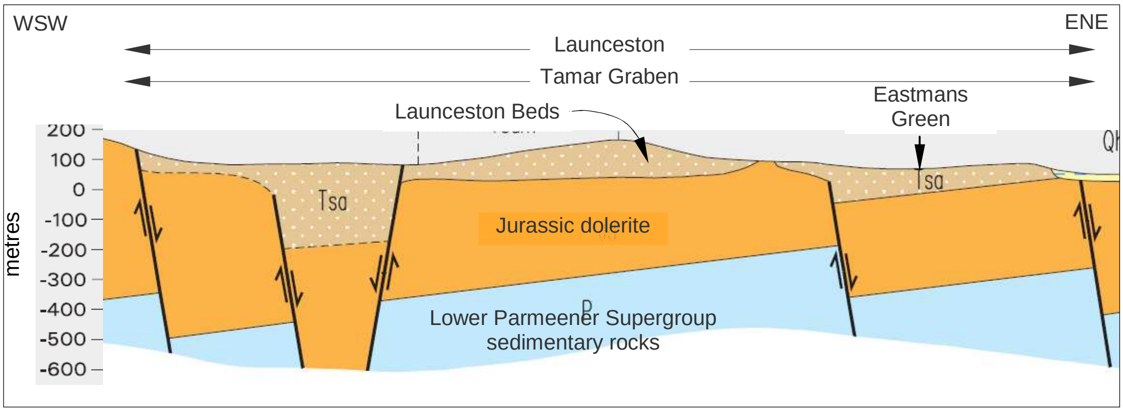


Figure 3.1 Geological cross section through Launceston near Eastmans Green, showing west-dipping Launceston Beds sediments overlying Jurassic dolerite and older sedimentary rocks. Adapted from Calver et al (2005) cited below.

3.1.2 Geology of the Eastmans Green subdivision

Geotechnical site investigations in 2009 and 2011[6], and the current test pitting for AS2870 classifications (the PART 1 reports for individual lots), support the published geology and are in accordance with the regional model.

Two main Tertiary rock types are recognised on the subdivision: a weakly cemented light coloured lithic sandstone, interbedded with a dark coloured fissured claystone[7]. Minor rock types recognised in some test pits include granule conglomerate and laterite. Also present along and near the course of Kings Meadows Rivulet are Quaternary alluvial sediments.

There is at least two, and probably more, sandstone beds beneath the subdivision. Similarly, it is likely, but not established, that two or more claystone beds are also present and interbedded with sandstone.

Dips range from 5^0 to 17^0, and dip directions range from 120^0M to 260^0M (ie southeasterly to westerly).

[5] Calver, C. R. and Forsyth, S. M. F. (compilers) 2005. Map 3, Launceston – Geology. Tasmanian Landslide Hazard Series. Mineral Resources Tasmania.

[6] Cited on page 3 of this report

[7] Both types are easily recognisable in hand specimen or in excavations by untrained observers.

Lithic sandstone

The sandstone is weakly cemented but of a strength adequate enough to support steep excavations in it. Excavation produces an irregular blocky fracture in test pits and hand specimen which is not evident in surface exposure. The material is sometimes thinly bedded, is usually friable and crumbles in the hand, and is Very Dense[8]. Plant fossils are locally present.

Fissured claystone

The claystone is black, grey blue, dark olive grey, or sometimes brown or olive brown. Generally, it is strongly fissured, with an irregular blocky fracture producing roughly equidimensional and sometimes platy joint blocks up to about 50 - 75mm in diameter, and occasionally polished defect surfaces. It is dry or slightly moist, and of a Hard consistency.

Locally the claystone is interbedded with thin siltstone or sandstone horizons.

3.2 Soils

Duplex soils on Tertiary sediments

Undisturbed, natural soils over most of the subdivision are predominantly duplex (two-layered), comprising a topsoil of light coloured, non-plastic sandy silt (SP) or low plasticity clayey silt (CL) averaging about 0.5m thick, over a subsoil of darker, fissured, high plasticity, reactive clay (CH), sandy clay (CL) or silty clay (CH). The subsoil averages about one metre thick.

It is inferred that the soils are at least partly colluvial in origin.

Organic alluvial soils

Dark grey to black organic clay, silty clay and clayey silt soils have formed on alluvial clays in the flood plain of Kings Meadows Rivulet, but have been covered by substantial amounts of uncontrolled fill. Some of these soils are low strength.

Bearing capacities of on-site materials

Undrained shear strength has been measured at most test pits by shear vane and dynamic cone penetrometer. Results are presented in the test pit logs in the PART 1 reports, and collectively here in Figure 3.1. Safe bearing capacity was estimated from the strength testing using a Factor of Safety of 2.5 (the table in Figure 3.1) and is presented for shallow footings in the test pit logs.

Reactivity of clayey soils

The shrink swell index (I_{ss}) is a measure of reactivity. Undisturbed 50mm diameter drive tube samples were collected from most test pits and tested[9] to determine their Shrink-Swell Indices (I_{ss}) to estimate reactivity and to assist in generalised AS2870 classification. Estimated ground surface movement (between extremes of soil drying and wetting) is derived from I_{ss}, and the AS2870 site Class follows[10].

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[8] In 2008 the 20t excavator with a 1.3m general purpose bucket (6 teeth) often found it slow digging in the sandstone.

[9] Although William C. Cromer Pty. Ltd. is not NATA registered, testing was performed essentially in accordance with AS1289.7.1.1-1998. Methods of testing soils for engineering purposes. Method 7.1.1. Soil reactivity tests – Determination of the shrinkage index of a soil – Shrink-swell index. *Standards Australia*. From the Shrink-Swell index, the maximum ground surface movement can be estimated, and hence the site classification.

[10]

1. Regional suction base depth = 2m
2. Change in suction at surface = 1.5pF
3. Assumes layer will be completely dry and completely wet at surface during a 50 year period
4. AS2870 classifications

Class	Ground surface movement
A	0 – 10mm
S	10 – 20mm
M	20 – 40mm
H1	40 – 60mm
H2	60 – 75mm
E	>75mm

Results compiled so far are summarised in Table 3.1.

Soil dispersion
Soils from undisturbed samples from most test pits have been tested for dispersion using a modification of the Emerson Aggregate Test. The technique is outlined in AS/NZS1547:2012 *On-site domestic-wastewater management*, Section E7.

Results compiled so far are summarised in Figure 3.2.

3.3 Cut and fill

General comments
The land surface of the property has been considerably altered by cut and fill over decades – originally for the Eastmans Green oval and access road, and later for the current subdivision.

In the individual AS2870 ("soil test") reports for each lot, an indication of the depth of fill can be obtained from the test pit logs, and by comparing the 1m contour map generated from 2008 1m LiDAR with detailed surveys of the current land surface. Fill depth may be extremely variable across a lot, and across a single house footprint. The distribution of fill may be different from that indicated in test pit logs, or on site plans in individual reports.

Potential for settlement of fill
Fill up to at least 4m thick is present in places. From test pitting done for the PART 1 AS2870 reports for individual lots, the fill is of variable texture and consistency, and appears to have been placed in an uncontrolled manner. Some of it is of low strength (see Figure 3.1) and will probably be undergoing settlement for some time.

Cut and fill batters
Table 3.2 provides guidance on batter angles for development in the subdivision.

3.4 Australian Geomechanics Society Geoguides

Most of the Eastmans Green subdivision is on sloping land. Building on sloping land can involve cuts, fill and retaining structures. Slopes, cut and fill and retaining structures can be geotechnical hazards.

The Australian Geomechanics Society (AGS) is a highly-regarded organisation concerned with geotechnical issues and development. For public education it has produced a series of plain-language information sheets called *Geoguides*, available at

http://lrm.australiangeomechanics.org/other-resources/guidelines/geoguides/.

Interested parties including engineers, designers, architects, builders, building inspectors, owners and occupiers are strongly advised to refer to these AGS Geoguides, and in particular:

- Geoguide LR8 which contains examples of good and bad hillside construction methods, and
- Geoguide LR11 which highlights the importance of keeping detailed building and home maintenance records as owner/occupier.

Geoguide LR8, with additional diagrams about building on hillsides in Launceston, and on fill, is included as Attachment 5 in this report and all the PART 1 reports. Geoguide LR11 is included as Attachment 6 in this report.

Lot	Test pit	Sampled interval (m)		In-situ moisture content (%)	In situ density (t/m3)	Shrink swell index (%)	Sample description	Sample type
14	14A	0.3	0.5	22	1.89	0.7	Sandy gravelly CLAY (CL): coarsely mottled dark grey and orange; low to moderate plasticity	Fill
14	14A	0.8	1.1	24	1.87	0.7	Pebbly gravelly CLAY (CL): orange brown; low plasticity	Fill
15	15B	0.9	1.2	29	1.80	0.6	Gravelly CLAY (CL, CH): mottled grey and orange; varialbe plasticity	Fill
17	17D	0.6	0.9	12	1.82	1.8	Clayey GRAVEL (GC): patchy orange brown and light grey; variable plasticity	Fill
18	18A	0.9	1.2	26	1.87	1.8	Gravelly CLAY: red and grey; variable plasticity	Nat ground
18	18B	0.6	0.9	25	1.85	2.1	Gravelly CLAY GC, CH): orange and brown; moderate plasticity	Fill
19	19A	0.7	1	15	1.84	3.6	CLAY (CH) and sandy gravelly CLAY (CH): mottled red and grey; variable plasticity	Fill
19	19B	0.6	0.9	30	1.86	1.6	Gravelly CLAY (GC, CH): brown; moderate to high plasticity	Fill
20	20B	0.5	0.8	32	1.83	3.5	CLAY (CH): mottled orange and grey; high plasticity	Fill
21	21A	0.7	1	21	1.89	1.6	CLAY (CH): mottled orange and grey; high plasticity	Fill
21	21B	0.4	0.7	39	1.77	3.1	Gravelly CLAY (GC, CH): orange; high plasticity	Fill
21	21B	1	1.3	28	1.84	2.1	Gravelly CLAY (CH): orange; some sandstone and claystone patches; moderate plasticity	Fill
22	22A	0.8	1.1	30	1.77	3.7	CLAY (CH): mottled orange and olive grey; high plasticity	Fill
22	22B	0.5	0.8	27	1.76	3.1	Gravelly CLAY (CH): orange and brown; moderate plasticity	Fill
24	24A	0.5	0.75	30	1.86	2.4	Gravelly CLAY (GC, CH): orange and light grey; some sandstone/claystone fragments	Fill
24	24B	0.8	1.1	23	1.91	1.8	Gravelly CLAY (GC) dark brown and orange; high to moderate plasticity; some spongy dark grey clayey silt patches	Fill
25	25B	0.2	0.4	31	1.82	3.2	CLAY (CH): orange; high plasticity; occasional pebbles	Fill
26	26A	0.4	0.7	33	1.77	3.9	CLAY (CH): dark pinkish orange; some gravel and sandstone patches	Nat ground
41	41A	0.6	0.9	33	1.99	1.7	CLAY (CH): coarsely mottled orange and light yellowish grey; trace silt and sand	Nat ground
41	41C	0.8	1.1	25	1.88	2.4	CLAY (CH): coarsely mottled orange and grey; trace silt and sand	Nat ground
43	43A	0.6	0.9	31	1.84	3.7	CLAY (CH): orange; high plasticity	Nat ground
44	44A	0.5	0.8	27	1.90	4.2	CLAY (CH): orange; high plasticity; trace gravel	Nat ground
44	44A	1.2	1.5	20	2.06	2.4	CLAY (CH): orange; high plasticity	Nat ground
44	44B	0.5	0.8	30	1.82	3.3	No description	Nat ground
45	45A	0.7	1	20	1.92	2.8	CLAY (CH): orange; high plasticity; trace gravel	Nat ground
46	46A	1.5	1.8	23	2.06	0.6	CLAY (CH): mottled orange and grey; high plasticity; trace gravel	Nat ground
47	47A	0.5	0.8	29	1.73	4.1	CLAY (CH): orange grey; high plasticity	Fill
75	75B	0.7	1	31	1.85	2.8	CLAY (CH): bright orange; trace silt and sand; high plasticity	Nat ground
				Mimimum	**1.73**	**0.6**		
				Maximum	**2.06**	**4.2**		
				Average	**1.86**	**2.5**		

Table 3.2 Summary of shrink swell results for samples tested as at June 2014

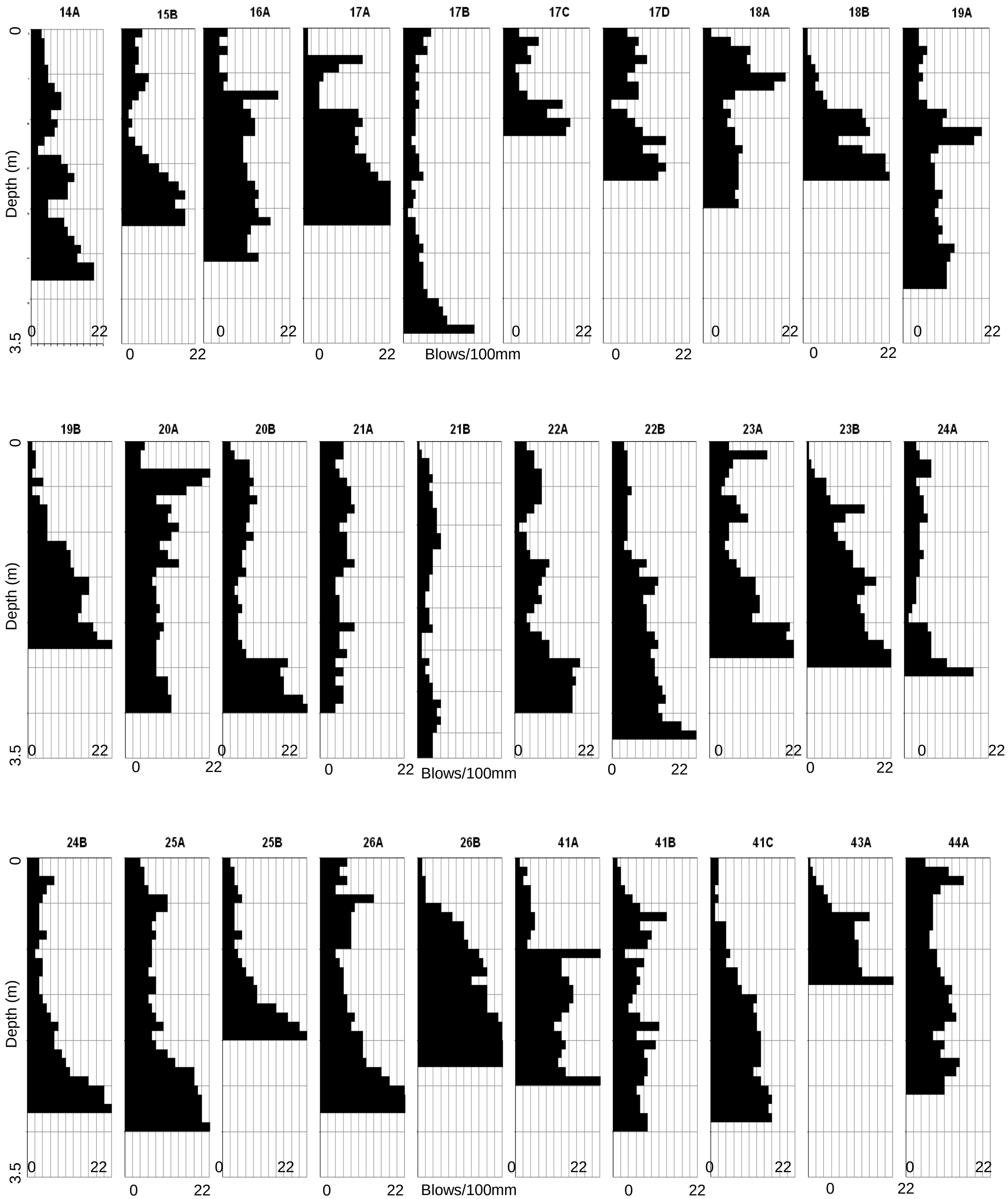


Figure 3.1 **Dynamic cone penetrometer profiles as at June 2014 for 66 test pits on 33 lots at Eastmans Green**

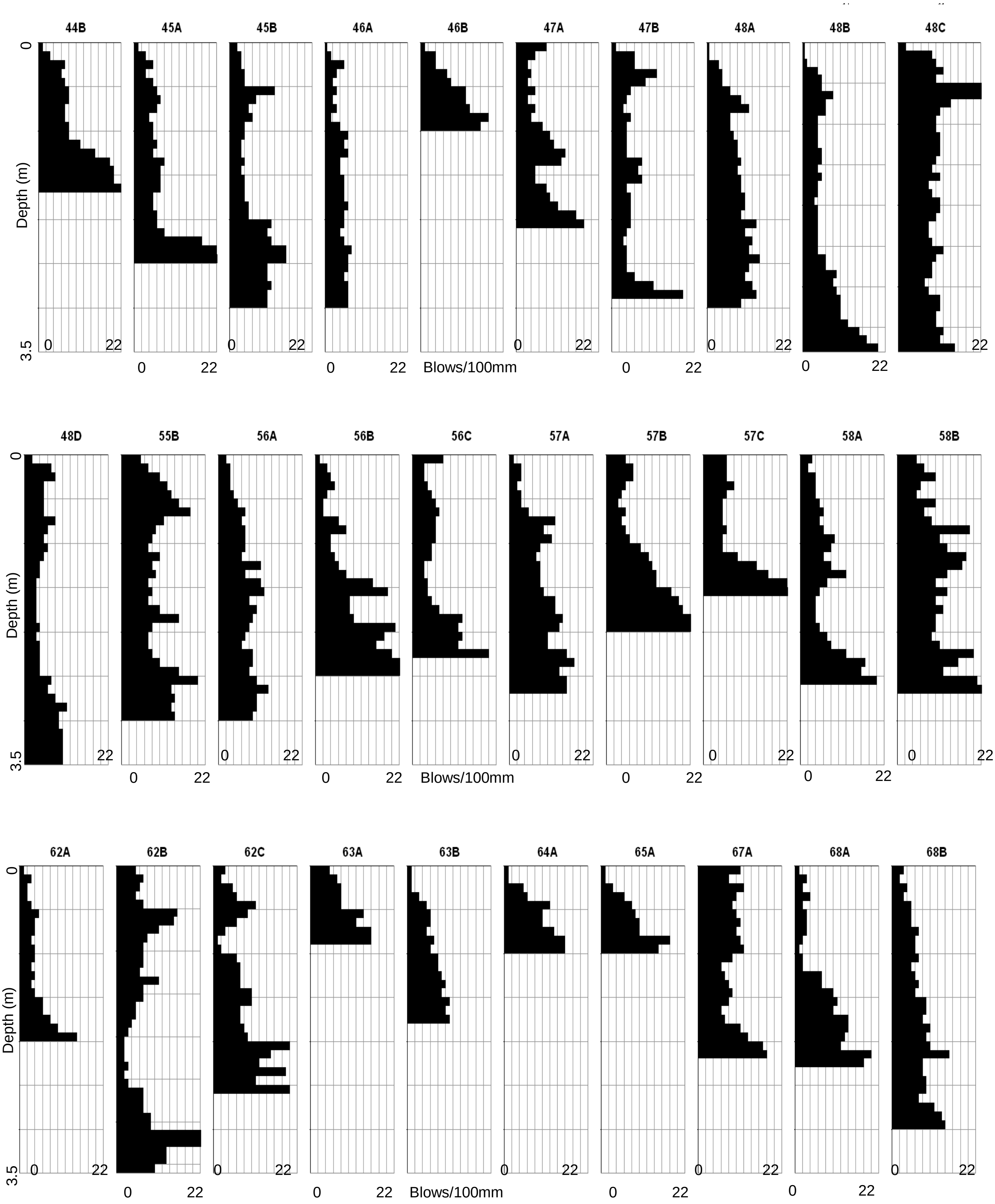
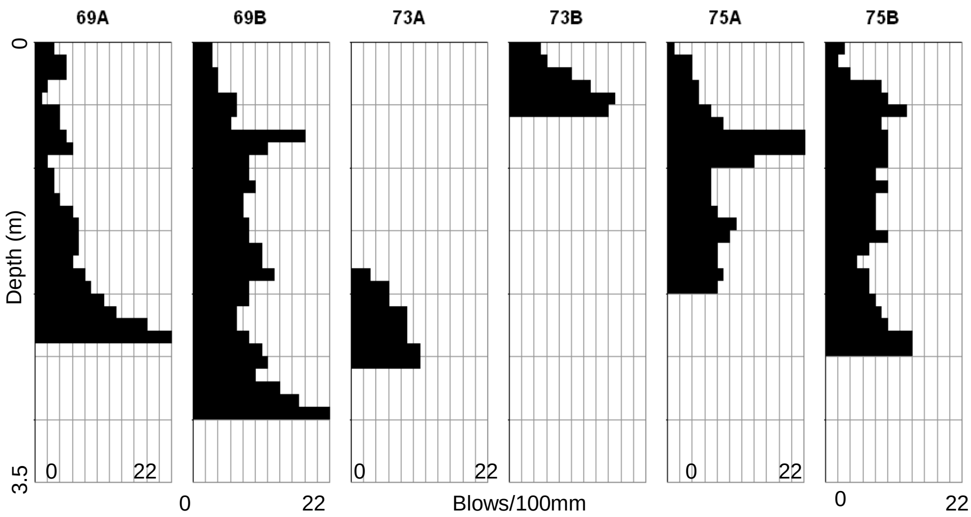
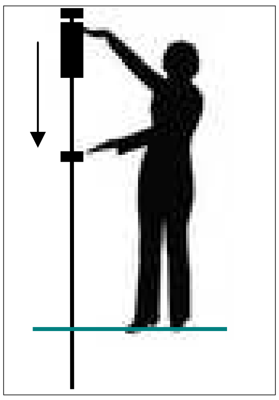


Figure 3.1 (cont'd) **Dynamic cone penetrometer profiles as at June 2014 for 66 test pits on 33 lots at Eastmans Green**



Consistency	Field Test	Undrained Shear Strength c_u Torvane (kPa)	Unconfined Compressive Strength q_u Pocket Penetrometer (kPa) **	Dynamic Cone Penetrometer blows/100 mm *	CPT Resistance MPa	Estimated safe bearing capacity (kPa) (Factor of Safety = 2.5)
Very soft	Easily penetrated >40 mm by thumb. Exudes between thumb and fingers when squeezed in hand.	<12	<25	<1	<0.2	<25
Soft	Easily penetrated 10 mm by thumb. Moulded by light finger pressure	12 - 25	25 - 50	1	0.2 - 0.4	25 – 50
Firm	Impression by thumb with moderate effort. Moulded by strong finger pressure	25 - 50	50 - 100	1-2	0.4 - 0.8	50 – 100
Stiff	Slight impression by thumb cannot be moulded with finger.	50 - 100	100 - 200	2 -4	0.8 - 1.5	100 – 200
Very Stiff	Very tough. Readily indented by thumbnail.	100 - 200	200 - 400	4 - 8	1.5 - 3.0	200 – 400
Hard	Brittle. Indented with difficulty by thumbnail.	>200	>400	>8	>3.0	>400

The Dynamic Cone Penetrometer (DCP) Test is a standard method of assessing the strengths of subsurface materials. A steel hammer weighing 9kg falls 510mm down a steel rod onto a stop, driving the rod (with a 20mm diameter steel cone tip) into the ground. The number of hammer blows to penetrate each 100mm of depth is recorded. The method is described in Australian Standard AS 1289.6.3.2 – 1997 Method 6.3.2: *Soil strength and consolidation tests – Determination of the penetration resistance of a soil – 9 kg dynamic cone penetrometer test.*

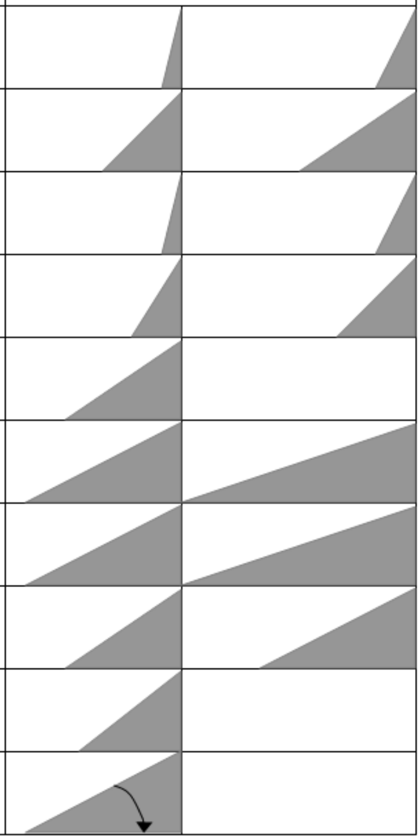


The profiles in this Figure were conducted near test pits on various lots at Eastmans Green. Each show how material strength (from 0 to 22 blows/100mm) varies with depth up to 3.5m. To use the profiles, select a lot and test pit profile. Read off the blows per 100mm at any depth directly from the graph. Using the red-highlighted columns in the table above, read from left to right to convert the number of blows to an estimated safe bearing capacity (kPa) for the soil at that depth. A residential dwelling requires footings to be supported on material with at least 50 – 100kPa of safe bearing capacity depending on footing type (AS2870 Clause 2.4.5). This range corresponds to a DCP reading at least 1 – 2 blows/100mm).

Figure 3.1 (cont'd) **Dynamic cone penetrometer profiles as at June 2014 for 66 test pits on 33 lots at Eastmans Green**

Table 3.2 Suggestions for batter angles on unsupported cut and fill.

	Slope ratio (Hor:Vert)	**Slope angle (degrees)**	**Profiles**
Most rock	1/4:1 to 1/2:1	76 to 63	
Very fractured rock	1:1 to 1.5:1	45 to 34	
Soils (very well cemented)	1/4:1 to 1/2:1	76 to 63	
Most in-place soils	3/4:1 to 1:1	53 to 45	
Loose coarse granular soils	1.5:1	34	
Heavy clay soils	2:1 to 3:1	26 to 18	
Soft clay-rich zones or wet seepage areas	2:1 to 3:1	26 to 18	
Fills of most soils	1.5:1 to 2:1	34 to 26	
Fills of hard angular rock	1.3:1	37	
Low cuts and fills (<2-3m high)	2:1 or flatter	26 or less	



Source: Slope Stabilization and Stability of Cuts and Fills
http://www.blm.gov/bmp/low%20volume%20engineering/M_Ch11_Slope_Stabilization.pdf

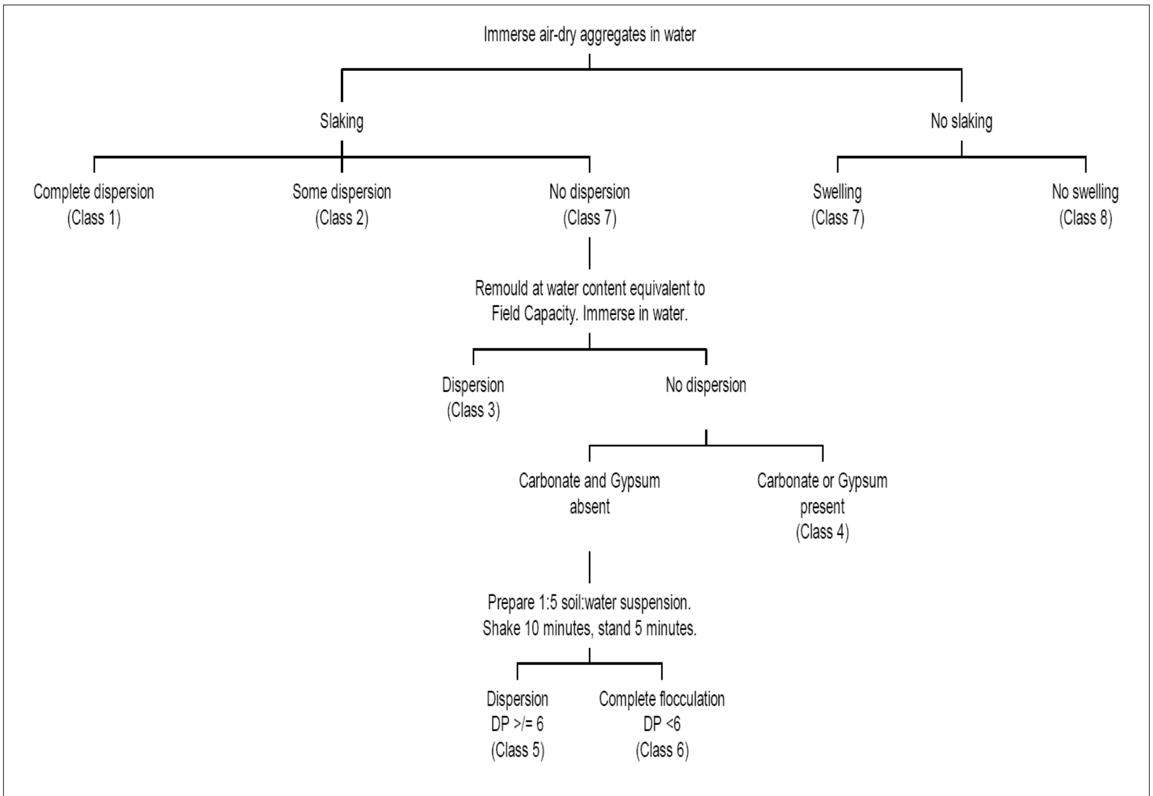


Figure 3.2 **Interpretation of dispersion testing of soil samples from the subdivision**
The number (2, 3, "5 or 6") below the sample identification is the Emerson Dispersion Class for the sample, based on the photo and compared to the explanatory diagram above. About half the samples are dispersive to varying degrees (Class 1, 2 or 3). The test to distinguish these two classes was not done.

Attachment 4

(6 pages)

Landslide Risk Management (LRM)

This Attachment addresses slope stability (landslide) issues for the Eastmans Green subdivision in accordance with the Australian Geomechanics Society (AGS) *Landslide Risk Management* (2007)[11]. The process is depicted in Figure 4.1. The main types of landslides recognised by geotechnical practitioners are depicted in Table 4.1 and Figure 4.2.

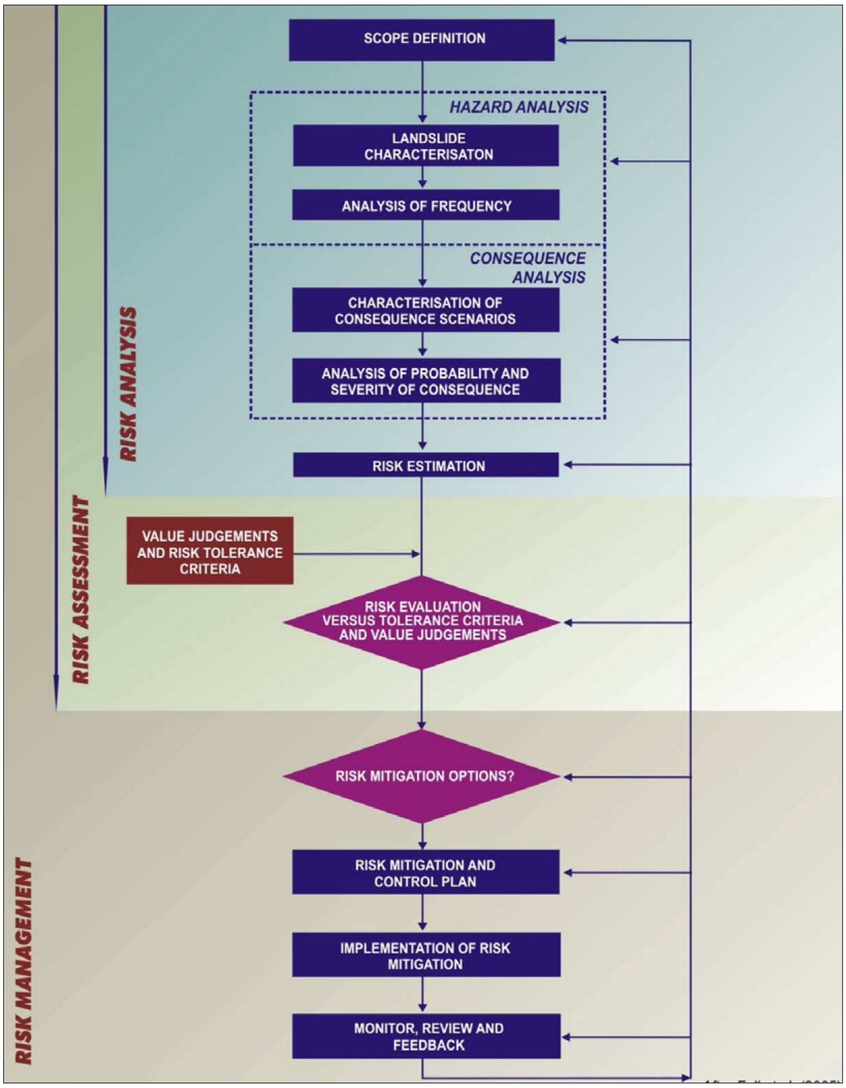


Figure 4.1 **Framework for Landslide Risk Management**
Source: Reproduced without amendment from AGS (2007a). Guideline for Landslide Susceptibility, Hazard and Risk Zoning. Australian Geomechanics, Vol 42 No 1 March 2007

[11] The five AGS documents are:
AGS (2007a). Guideline for Landslide Susceptibility, Hazard and Risk Zoning. Australian Geomechanics, Vol 42 No 1 March 2007
AGS (2007b). Commentary on Guideline for Landslide Susceptibility, Hazard and Risk Zoning. Australian Geomechanics, Vol 42 No 1 March 2007
AGS (2007c). Practice Notes Guidelines for Landslide Risk Management. Australian Geomechanics Vol 42 No 1 March 2007
AGS (2007d). Commentary on Practice Notes Guidelines for Landslide Risk Management. Australian Geomechanics Vol 42 No 1 March 2007
AGS (2007e). The Australian Geoguides for Slope Management and Maintenance. Australian Geomechanics Vol 42 No 1 March 2007

4.1 Preliminary

Published evidence of slope instability
See Attachments (this report)

Field evidence including site investigations and site plan
Refer to:

- Cromer, W. C. (2009). *Geotechnical assessment, 76 – lot subdivision, Penquite Road, Newstead.* (Unpublished report for ECoast Homes Pty Ltd by William C. Cromer Pty. Ltd., 7 April 2009; 137 pages), and

- Cromer, W. C. (2011). *Geotechnical Assessment Addendum Report, Eastman's Green subdivision, Penquite Road, Newstead.* (Unpublished report for ECoast Homes Pty Ltd by William C. Cromer Pty. Ltd., 22 May 2011; 33 pages)

Both are available at http://eastmansgreen.com.au/ and http://www.williamccromer.com/

Conceptual hydrogeological site model
See Figure 4.3, and Cromer (2011) cited above.

4.2 Hazard Analysis

4.2.1 Landslide characterisation

The bedrock at Eastmans Green comprises Tertiary-age weakly cemented sandstone, and fissured claystone. Accordingly, forms of potential slope instability involving (hard) bedrock shown in Table 4.1 do not credibly apply to the subdivision.

Lower slope angles lessen the potential for slope instability source areas to develop, but may instead be at risk of landslide runout if downslope from steep ground. Also at relatively low risk are lots 60 – 67 where topsoil has been removed and weakly cemented sandstone bedrock exposed.

The natural-scale cross section in Figure 4.3 schematically shows six types of potential slope instability on the subdivision under current and post development conditions. The scenarios mainly apply to lots west of Emerald Drive. A seventh type (differential settlement of uncontrolled fill) is strictly not a landslide and is not included here.

4.2.2 Frequency analysis

Table 4.2 (this Attachment) lists the potential occurrence and subjective likelihood of the six scenarios for Eastmans Green under current and post development conditions.

Table 4.1 Main types of landslide movement. Those bordered in red are judged credible on the Eastmans Green Subdivision
Source: From Appendix B of AGS (2007c). Practice Notes Guidelines for Landslide Risk

TYPE OF MOVEMENT		TYPE OF MATERIAL		
		BEDROCK	ENGINEERING SOILS	
			Predominantly Coarse	Predominantly Fine
FALLS		Rock fall	Debris fall	Earth fall
TOPPLES		Rock topple	Debris topple	Earth topple
SLIDES	ROTATIONAL	Rock slide	Debris slide	Earth slide
	TRANSLATIONAL			
LATERAL SPREADS		Rock spread	Debris spread	Earth spread
FLOWS		Rock flow (Deep creep)	Debris flow	Earth flow
			(Soil creep)	
COMPLEX		Combination of two or more principle types of movement		

4.3 Consequence analysis and qualitative risk to property estimation – current situation

Table 4.2 (this Attachment) is a consequence analysis and risk to property assessment for the six scenarios shown in Figure 4.3.

After treatment, consequences for the scenarios range from Insignificant to Major, and the attendant risks are in the Very low to Moderate range.

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

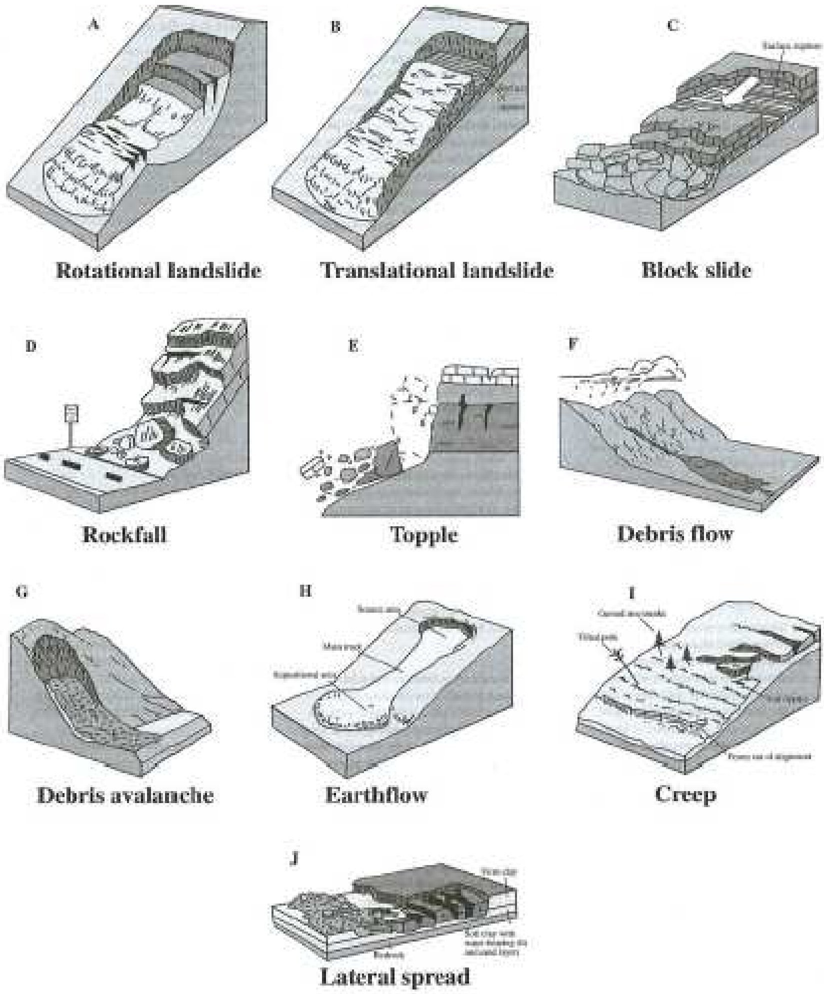


Figure B1: These schematics illustrate the major types of landslide movement.
(From US Geological Survey Fact Sheet 2004-3072, July 2004, with kind permission for reproduction.)

The nomenclature of a landslide can become more elaborate as more information about the movement becomes available. To build up the complete identification of the movement, descriptors are added in front of the two-term classification using a preferred sequence of terms. The suggested sequence provides a progressive narrowing of the focus of the descriptors, first by time and then by spatial location, beginning with a view of the whole landslide, continuing with parts of the movement and finally defining the materials involved. The recommended sequence, as shown in Table B2, describes activity (including state, distribution and style) followed by descriptions of all movements (including rate, water content, material and type). Definitions of the terms in Table B2 are given in Cruden & Varnes (1996).

Description	Typical velocity (mm/sec)	Typical velocity
Extremely rapid		
	5×10^{3}	5m/sec
Very rapid		
	5×10^{1}	3m/min
Rapid		
	5×10^{-1}	1.8m/hour
Moderate		
	5×10^{-3}	13m/month
Slow		
	5 x 10-5	1.6m/year
Very slow		
	5×10^{-7}	15mm/year
Extremely slow		

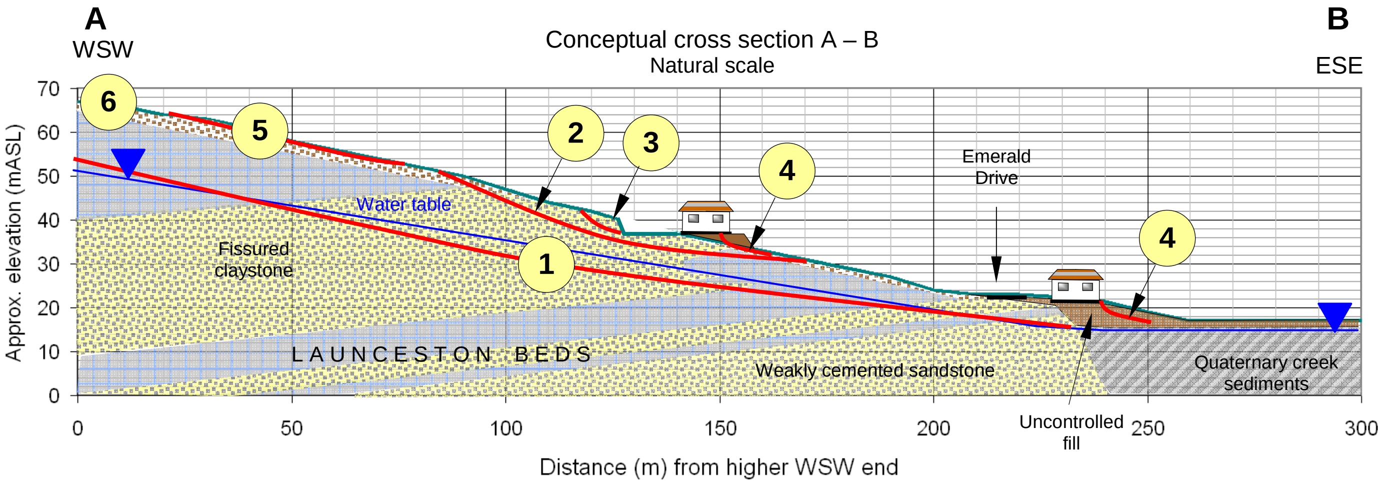
From Figure B3 of AGS (2007c)

Description	Size (m^2)
	0.01
Very small	
	10
Small	
	1,000
Medium	
	100,000
Large	
	1,000,000
Very large	

Size is areal extent of failure zone
After: van Schalkwyk, A and Thomas, M.A. (1991). Slope failures associated with the floods of September 1987 and February 1988 in Natal and Kwa-Zulu, Republic of South Africa. Geotechnics in the African Environment, Blight et al. (Eds), pp. 57-63

Rock: is "a hard or firm mass that was intact and in its natural place before the initiation of movement."
Soil: is "an aggregate of solid particles, generally of minerals and rocks, that either was transported or was formed by the weathering of rock in place. Gases or liquids filling the pores of the soil form part of the soil."
Earth: "describes material in which 80% or more of the particles are smaller than 2 mm, the upper limit of sand sized particles."
Debris: "contains a significant proportion of coarse material; 20% to 80% of the particles are larger than 2 mm and the remainder are less than 2 mm."
The terms used should describe the displaced material in the landslide before it was displaced.
Source: From Appendix B of AGS (2007c). Practice Notes Guidelines for Landslide Risk Management. Australian Geomechanics Vol 42 No 1 March 2007

Figure 4.2 Main types of landslide movement
Source: From Appendix B of AGS (2007c). Practice Notes Guidelines for Landslide Risk Management. Australian Geomechanics Vol 42 No 1 March 2007



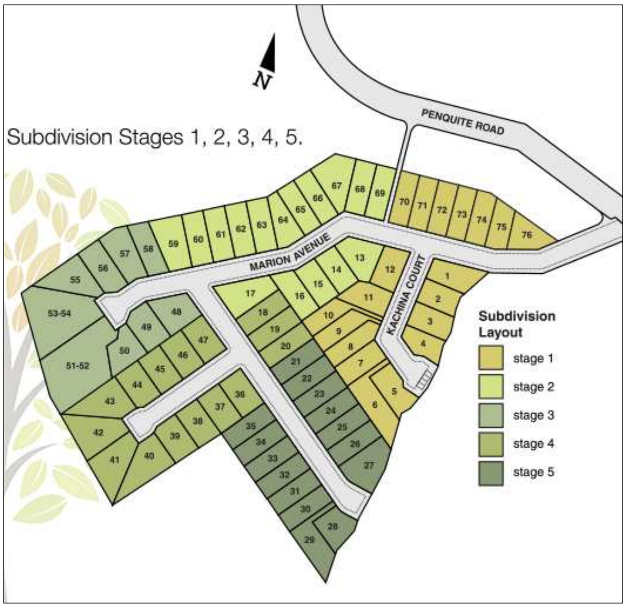


Figure 4.3 Conceptual hydrogeological model through the Eastmans Green subdivision, showing credible potential landslide hazards after residential development. The scenarios mainly apply to lots west of Emerald Drive.

Potential landslide scenarios

1 Scenario 1: Rotational or translational earth or debris slide
Deep-seated, in Launceston Beds; failure surface deeper than 5m; med-large scale; very slow-mod velocity; potentially affecting whole hillside

2 Scenario 2: Rotational or translational earth or debris slide
Shallow, in Launceston Beds; failure surface shallower than 5m; small-medium scale; slow-mod velocity; potentially affecting perhaps up to 25 % of slope, including run-out.

3 Scenario 3: Translational earth or debris slide, fall or topple
Very small scale; on steep, unsupported excavations; rapid – very rapid velocity;

4 Scenario 4: Rotational or translational earth or debris slide
Very small to small scale; shallow, in uncontrolled or unsupported fill (eg beneath or next to houses; on the outside of access drives); failure surface less than 2m deep; slow to very rapid velocity.

5 Scenario 6: Earth or debris flow
Very small to small scale; rapid to extremely rapid velocity; less than about 0.3m deep, in uncontrolled fill on steeper slopes

6 Scenario 7: Soil creep (on steeper slopes only)
Small-medium scale; very slow to extremely slow

4.4 Consequence analysis and qualitative risk to property estimation – after development

Table 4.2 (this Attachment) lists the potential consequences and risks to property for six scenarios for Eastmans Green under current and post development conditions.

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4.5 Qualitative risk to life estimation– current situation

It is subjectively estimated that current slope instability scenarios present acceptable risks to life. No quantitative risk to life has been attempted.

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4.6 Suggested landslide risk mitigation plan

Risk mitigation for the six scenarios is summarised in Table 4.2 (this Attachment), and in the Information Sheet and Attachment 1 in the PART 1 report for individual lots.

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4.7 Certificate of currency for Professional Indemnity Insurance

A copy of the certificate of currency for PI insurance for William C Cromer Pty Ltd is included here as Figure 4.4.

Table 4.2 Likelihood, consequences and risks for landslide scenarios 1 – 6 in Figure 4.3, after development and with or without treatment.

Scenario in Figure 4.3	Description	After development, without treatment: Likelihood	After development, without treatment: Consequences to property	After development, without treatment: Risk to property	Treatment	After development, with treatment: Likelihood	After development, with treatment: Consequences to property	After development, with treatment: Risk to property
1	**Rotational or translational earth or debris slide**: Deep-seated, in Launceston Beds; failure surface deeper than 5m; med-large scale; very slow-mod velocity; potentially affecting whole hillside	Rare	Minor to Major	Very Low to Low	Minimise upslope, off-site stormwater discharge onto higher western side of subdivision.	Rare	Minor to Major	Very Low to Low
2	**Rotational or translational earth or debris slide**: In Launceston Beds; failure surface shallower than 5m; small-medium scale; slow-moderate velocity; potentially affecting perhaps up to 25 % of slope, including run-out.	Possible (likelihood increases with slope angle)	Minor to Major	Moderate (risk increases with slope angle) to High	Minimise upslope, off-site stormwater discharge onto higher western side of subdivision. Incorporate good hillside construction practices for all development. Avoid or minimise excavations. Support excavations on hillsides with engineered, drained retaining walls designed to resist lateral movement. See Attachment 5.	Unlikely (Possible on steeper slopes)	Medium	Low (Moderate on steeper slopes)
3	**Translational earth or debris slide, fall or topple**: Very small scale; on steep, unsupported (artificial) excavations; slow-very rapid velocity;	Likely to Almost Certain	Minor	Moderate to High	Avoid or minimise excavations. Construct engineered, drained retaining walls designed to resist lateral movement for excavations more than 0.8m high	Possible	Insignificant to Minor	Very Low to Moderate
4	**Rotational or translational earth or debris slide**: Very small to small scale; shallow, in fill (eg beneath or next to houses; on the outside of access drives); failure surface less than 2m deep; slow to very rapid velocity.	Possible to Likely	Medium	Moderate to High	Avoid weight bearing fill, or place fill in a controlled manner, with underlying soil first removed, and outer face either supported by engineered, drained retaining walls, or battered in accordance with Table 3.2. Use a deep foundation system to transfer structural loads to adequate strength material beneath fill.	Unlikely to Possible	Insignificant to Minor	Very Low to Moderate
5	**Earth or debris flow:** Very small to small scale; rapid to extremely rapid velocity; less than about 0.3m deep, in soil and/or uncontrolled fill on steeper western slopes	Almost certain for some lots	Minor	High	Minimise upslope, off-site stormwater discharge onto higher western side of subdivision. Use a deep foundation system to transfer structural loads to adequate strength material beneath fill.	Unlikely	Minor	Low
6	**Soil creep** (on steeper slopes only): Small-medium scale; very slow to extremely slow	Almost certain for some lots	Minor	High	Minimise stormwater discharge from higher ground onto western side of subdivision. Use a deep foundation system to transfer structural loads to adequate strength material beneath fill.	Almost certain for some lots	Insignificant	Low

Notes

See Figure 4.2 for explanations of terms relating to landslide type, size and velocity of movement.

Visit the link below to download AGS (2007c) *Practice Note Guidelines for Landsldie Risk Management* for more detailed information.

http://australiangeomechanics.org/admin/wp-content/uploads/2010/11/LRM2007-c.pdf

Tasib

Tasmanian Insurance Brokers

ABN: 88 154 231 802 AFSL: 415160

193 Murray Street
Hobart TAS 7000
T: 03 6234 5884
M: 0429 345 884
E: greg.lewer@tasib.com.au
W: www.tasib.com.au

Confirmation of Insurance

Bill Cromer

5 September, 2014
Ref: 13080195

Re: William C Cromer Pty Ltd

We act as insurance brokers for the above client and at their request confirm the existence and currency of the following insurance:

Class	:	Professional Indemnity
Policy No.	:	TBA
Period	:	31/08/14 to 31/08/15
Insurer	:	As Per Schedule
Sum Insured	:	$1,000,000
Situation	:	As Per Policy Limitations

Covering:

Professional Indemnity

Note: This confirmation is issued as a matter of information only and does not confer any rights upon the confirmation holder. The confirmation does not amend, extend or alter the coverage afforded by the policy/policies detailed herein.

Yours faithfully,

Henry Swieconek
for the Company.

Figure 4.4 Certificate of currency for PI insurance for William C Cromer Pty Ltd

Attachment 5

(4 pages)

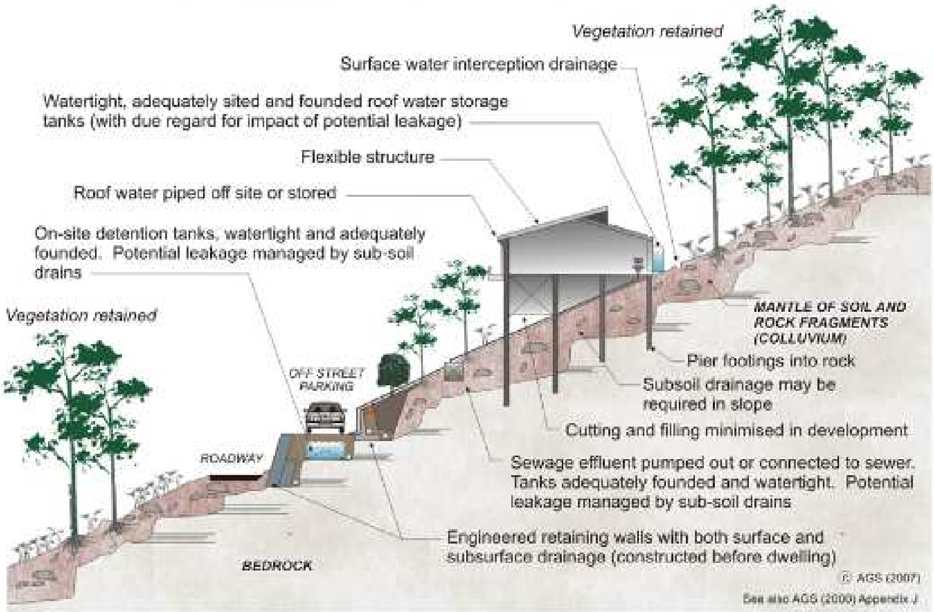
Good and poor hillside construction practices

AGS Geoguide LR8 (Construction Practice)

HILLSIDE CONSTRUCTION PRACTICE

Sensible development practices are required when building on hillsides, particularly if the hillside has more than a low risk of instability (GeoGuide LR7). Only building techniques intended to maintain, or reduce, the overall level of landslide risk should be considered. Examples of good hillside construction practice are illustrated below.

EXAMPLES OF GOOD HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES GOOD?

Roadways and parking areas - are paved and incorporate kerbs which prevent water discharging straight into the hillside (GeoGuide LR5).

Cuttings - are supported by retaining walls (GeoGuide LR6).

Retaining walls - are engineer designed to withstand the lateral earth pressures and surcharges expected, and include drains to prevent water pressures developing in the backfill. Where the ground slopes steeply down towards the high side of a retaining wall, the disturbing force (see GeoGuide LR6) can be two or more times that in level ground. Retaining walls must be designed taking these forces into account.

Sewage - whether treated or not is either taken away in pipes or contained in properly founded tanks so it cannot soak into the ground.

Surface water - from roofs and other hard surfaces is piped away to a suitable discharge point rather than being allowed to infiltrate into the ground. Preferably, the discharge point will be in a natural creek where ground water exits, rather than enters, the ground. Shallow, lined, drains on the surface can fulfil the same purpose (GeoGuide LR5).

Surface loads - are minimised. No fill embankments have been built. The house is a light weight structure. Foundation loads have been taken down below the level at which a landslide is likely to occur and, preferably, to rock. This sort of construction is probably not applicable to soil slopes (GeoGuide LR3). If you are uncertain whether your site has rock near the surface, or is essentially a soil slope, you should engage a geotechnical practitioner to find out.

Flexible structures - have been used because they can tolerate a certain amount of movement with minimal signs of distress and maintain their functionality.

Vegetation clearance - on soil slopes has been kept to a reasonable minimum. Trees, and to a lesser extent smaller vegetation, take large quantities of water out of the ground every day. This lowers the ground water table, which in turn helps to maintain the stability of the slope. Large scale clearing can result in a rise in water table with a consequent increase in the likelihood of a landslide (GeoGuide LR5). An exception may have to be made to this rule on steep rock slopes where trees have little effect on the water table, but their roots pose a landslide hazard by dislodging boulders.

Possible effects of ignoring good construction practices are illustrated on page 2. Unfortunately, these poor construction practices are not as unusual as you might think and are often chosen because, on the face of it, they will save the developer, or owner, money. You should not lose sight of the fact that the cost and anguish associated with any one of the disasters illustrated, is likely to more than wipe out any apparent savings at the outset.

ADOPT GOOD PRACTICE ON HILLSIDE SITES

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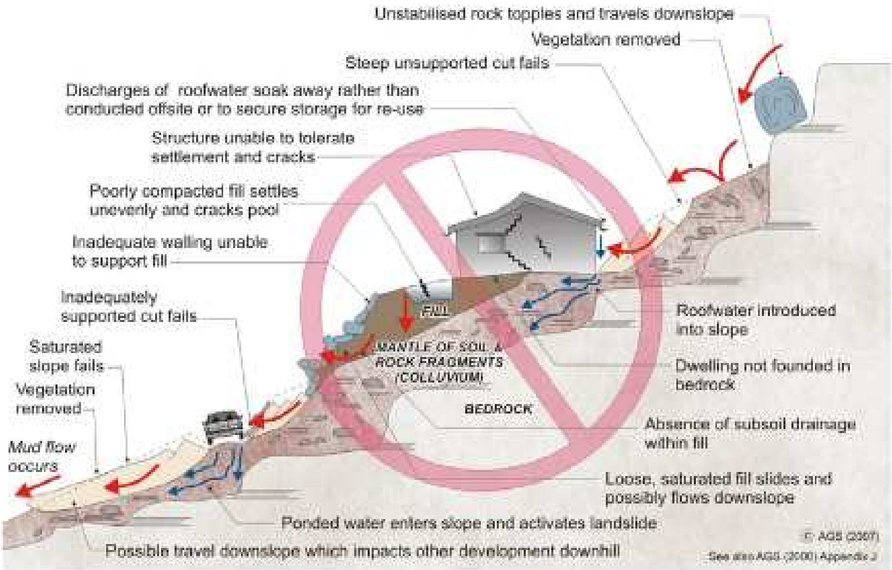
AUSTRALIAN GEOGUIDE LR8 (CONSTRUCTION PRACTICE)

EXAMPLES OF POOR HILLSIDE CONSTRUCTION PRACTICE



WHY ARE THESE PRACTICES POOR?

Roadways and parking areas - are unsurfaced and lack proper table drains (gutters) causing surface water to pond and soak into the ground.

Cut and fill - has been used to balance earthworks quantities and level the site leaving unstable cut faces and added large surface loads to the ground. Failure to compact the fill properly has led to settlement, which will probably continue for several years after completion. The house and pool have been built on the fill and have settled with it and cracked. Leakage from the cracked pool and the applied surface loads from the fill have combined to cause landslides.

Retaining walls - have been avoided, to minimise cost, and hand placed rock walls used instead. Without applying engineering design principles, the walls have failed to provide the required support to the ground and have failed, creating a very dangerous situation.

A heavy, rigid, house - has been built on shallow, conventional, footings. Not only has the brickwork cracked because of the resulting ground movements, but it has also become involved in a man-made landslide.

Soak-away drainage - has been used for sewage and surface water run-off from roofs and pavements. This water soaks into the ground and raises the water table (GeoGuide LR5). Subsoil drains that run along the contours should be avoided for the same reason. If felt necessary, subsoil drains should run steeply downhill in a chevron, or herring bone, pattern. This may conflict with the requirements for effluent and surface water disposal (GeoGuide LR9) and if so, you will need to seek professional advice.

Rock debris - from landslides higher up on the slope seems likely to pass through the site. Such locations are often referred to by geotechnical practitioners as "debris flowpaths". Rock is normally even denser than ordinary fill, so even quite modest boulders are likely to weigh many tonnes and do a lot of damage once they start to roll. Boulders have been known to travel hundreds of metres downhill leaving behind a trail of destruction.

Vegetation - has been completely cleared, leading to a possible rise in the water table and increased landslide risk (GeoGuide LR5).

DON'T CUT CORNERS ON HILLSIDE SITES - OBTAIN ADVICE FROM A GEOTECHNICAL PRACTITIONER

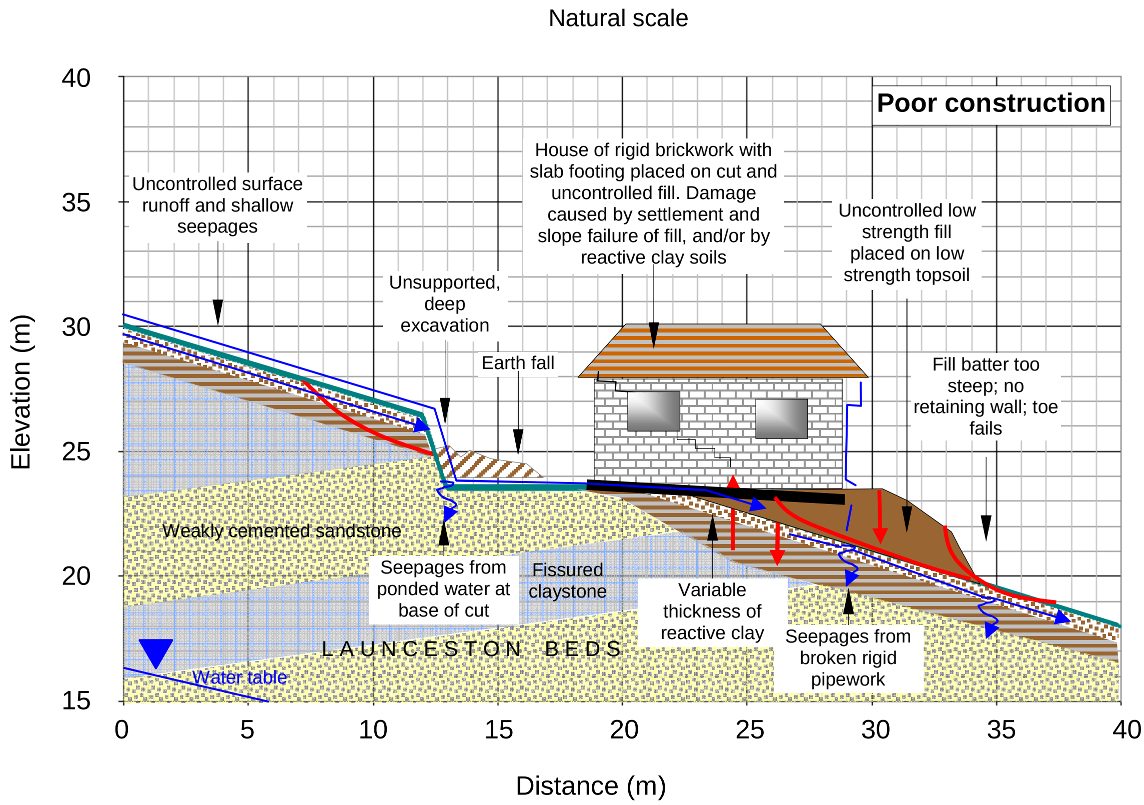
More information relevant to your particular situation may be found in other Australian GeoGuides:

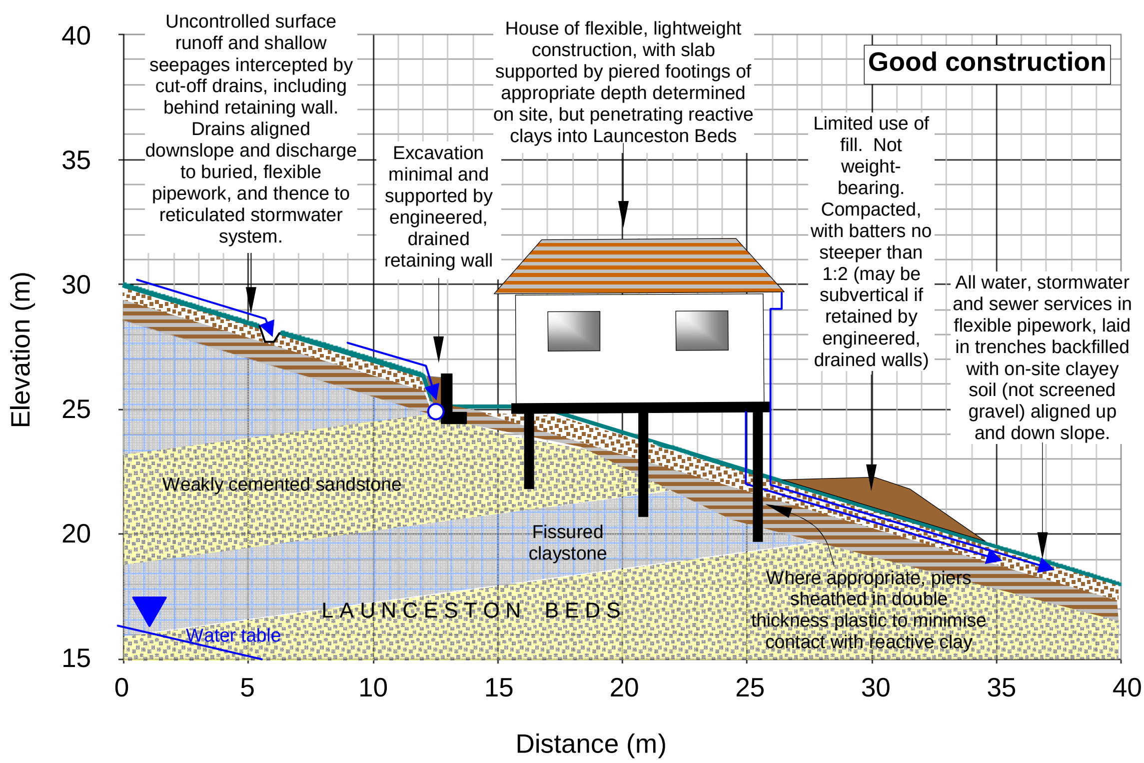
- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides
- GeoGuide LR11 - Record Keeping

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

Generalised good and poor construction practices for hillsides in Launceston

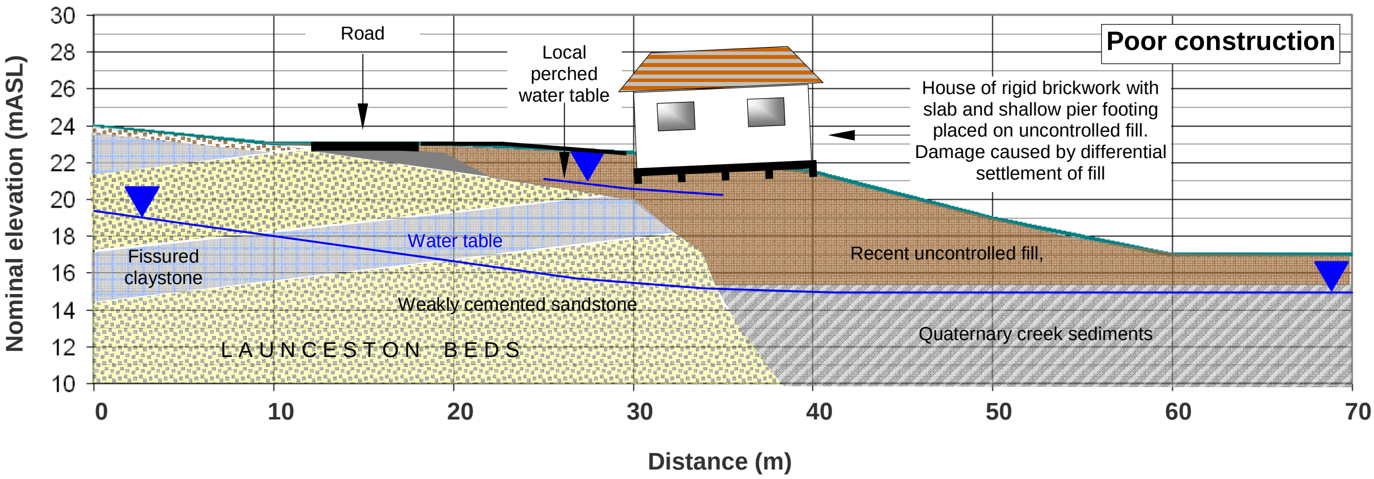
These schematic cross sections apply to houses on hillsides on geologic materials called the Launceston Beds. See Attachment 3 of Part 2 of this report.

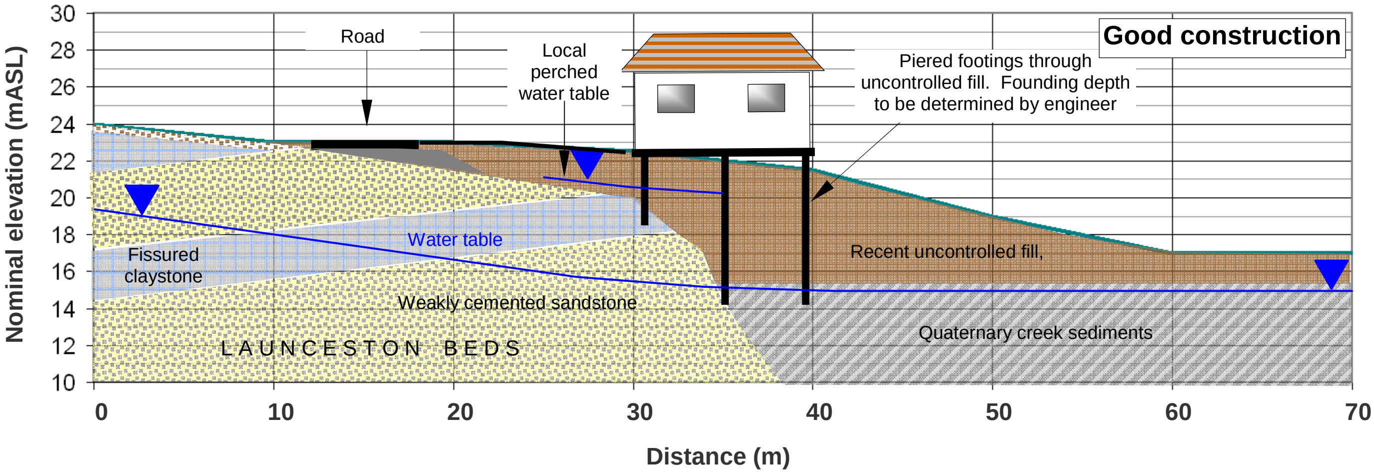




Generalised good and poor hillside construction practices on fill

Natural scale





Attachment 6

(2 pages)

AGS Geoguide LR11 (Record Keeping)

RECORD KEEPING

It is strongly recommended that records be kept of all construction, inspection and maintenance activities in relation to developments on sloping blocks. In some local authority jurisdictions, maintenance requirements form part of the building consent conditions, in which case they are mandatory.

CONSTRUCTION RECORDS

If at all possible, you should keep copies of drawings, specifications and construction (i.e. "as built") records, particularly if these differ from the design drawings. The importance of these documents cannot be over-emphasised. If a geotechnical practitioner comes to a site to carry out a landslide risk assessment and is only able to see the face of a retaining wall, the heads of some ground anchors, or the outlets of a number of sub-soil drains, it may be necessary to determine how these have been built and how they are meant to work before completing the assessment. This could involve drilling through the wall to determine how thick it is, or probing the length of the drains, or even ignoring the anchors altogether, because it is uncertain how long they are. Such "investigation" of something that may only have been built a few years before is, at best, a waste of time and money and, at worst, capable of coming up with a misleading answer which could affect the outcome of the assessment. Documentary information of this sort often proves to be invaluable later on, so treat it with as much importance as the title deeds to your property.

INSPECTION AND MAINTENANCE RECORDS

If you follow the recommendations of the Australian GeoGuides it is likely that you will either carry out periodic inspections yourself, or you will engage a geotechnical practitioner to do them for you. The collected records of these inspections will provide a detailed history of changes that might be occurring and will indicate, better than your own memory, whether things are deteriorating and, if so, at what rate. Unfortunately, without some form of written record, all information is usually lost each time a property is sold. It is recommended that a prospective purchaser should have a pre-purchase landslide risk assessment carried out on a hillside site, in much the same way that they would commission a structural assessment, or a pest inspection, of the building. If the vendor has kept good records, then the assessment is likely to be quicker and cheaper, and the outcome more reliable, than if none are available. Each site is different, but noting the following would normally constitute a reasonable record of an inspection/maintenance undertaken:

- date of inspection/maintenance and the name and professional status of the person carrying it out
- description of the specific feature (eg. cliff face, temporary rock bolt, cast *in situ* retaining wall, shallow leach drain system)
- sketch plans, sketches and photographs to indicate location and condition
- activity undertaken (eg. visual inspection; cleared vegetation from drain; removed fallen rock about 500 mm diameter)
- condition of the feature and any matters of concern (e.g. weep holes damp and flowing freely; rust on anchor heads getting worse; shotcrete uncracked and no sign of rust stains; ground saturated around leach field)
- specific outcomes (eg. no action necessary; geotechnical practitioner called in to advise on the state of the anchors; cliff face to be trimmed following the most recent rock fall; leach field to be rebuilt at new location)

A proforma record is provided overleaf for convenience. Photographs and sketches of specific observations can prove to be very useful and should be included whenever possible. Geotechnical practitioners may devise their own site specific inspection/maintenance records.

More information relevant to your particular situation may be found in other Australian GeoGuides:

- GeoGuide LR1 - Introduction
- GeoGuide LR2 - Landslides
- GeoGuide LR3 - Landslides in Soil
- GeoGuide LR4 - Landslides in Rock
- GeoGuide LR5 - Water & Drainage
- GeoGuide LR6 - Retaining Walls
- GeoGuide LR7 - Landslide Risk
- GeoGuide LR8 - Hillside Construction
- GeoGuide LR9 - Effluent & Surface Water Disposal
- GeoGuide LR10 - Coastal Landslides

The Australian GeoGuides (LR series) are a set of publications intended for property owners; local councils; planning authorities; developers; insurers; lawyers and, in fact, anyone who lives with, or has an interest in, a natural or engineered slope, a cutting, or an excavation. They are intended to help you understand why slopes and retaining structures can be a hazard and what can be done with appropriate professional advice and local council approval (if required) to remove, reduce, or minimise the risk they represent. The GeoGuides have been prepared by the Australian Geomechanics Society, a specialist technical society within Engineers Australia, the national peak body for all engineering disciplines in Australia, whose members are professional geotechnical engineers and engineering geologists with a particular interest in ground engineering. The GeoGuides have been funded under the Australian governments' National Disaster Mitigation Program.

AUSTRALIAN GEOGUIDE LR11 (RECORD KEEPING)

INSPECTION/MAINTENANCE RECORD

(Tick boxes as appropriate and add information as required) Date……………………………………

Site location (street address / lot & DP numbers / map reference / latitude and longitude)

………

FEATURE			Inspected	Maintained	Tested	By Owner	By Professional
Slopes & surface protection:							
☐ Natural slope/cliff	☐ Cut/fill slope		☐	☐	☐	☐	☐
☐ Surface water drains			☐	☐	☐	☐	☐
☐ Shotcrete	☐ Stone pitching	☐ Other	☐	☐	☐	☐	☐
Retaining walls:							
☐ Cast in situ concrete	☐ Concrete block		☐	☐	☐	☐	☐
☐ Masonry (natural stone)	☐ Masonry (brick, block)		☐	☐	☐	☐	☐
☐ Cribwall (concrete)	☐ Cribwall (timber)		☐	☐	☐	☐	☐
☐ Anchored wall	☐ Reinforced soil wall		☐	☐	☐	☐	☐
☐ Sub-soil drains	☐ Weep holes		☐	☐	☐	☐	☐
Ground improvement:							
☐ Rock bolts			☐	☐	☐	☐	☐
☐ Ground anchors	☐ Soil nails		☐	☐	☐	☐	☐
☐ Deep subsoil drains			☐	☐	☐	☐	☐
Effluent and storm water disposal systems:							
☐ Effluent treatment system			☐	☐	☐	☐	☐
☐ Effluent disposal field			☐	☐	☐	☐	☐
☐ Storm water disposal field			☐	☐	☐	☐	☐
Other:							
☐ Netting	☐ Catch fence	☐ Catch pit	☐	☐	☐	☐	☐
☐			☐	☐	☐	☐	☐
☐ …………………………			☐	☐	☐	☐	☐
☐ …………………………			☐	☐	☐	☐	☐

Observations/Notes (Add pages/details as appropriate)

………

………

………

Attachments: ☐ Sketch(es) ☐ Photograph(s) ☐ Other (eg measurements, test results)

Record prepared by …………………………………………… (name): ………………………………(signature)

Contact details: Phone:………………………………… E-mail:……………………………………………………

Professional Status (in relation to landslide risk assessment):……………………………………………

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