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GEOTECHNICAL STUDY

Proposed Rezoning of Land

at

1 Abbotsford Road, PICTON

Prepared for:

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Executive Summary

INTRODUCTION

A geotechnical study was conducted over land located at 1 Abbotsford Road Picton (the "Property"). The study was prepared in support of a rezoning application which will enable the Property to be subdivided under part R5 Large Lot Residential, part E3 Environmental Management and part RE1 Public Recreation as defined in Wollondilly Shire Councils' Local Environmental Plan 2011.

This Study is one of many specialist studies being carried out over the Property and its contents and preparation are based on guidelines issued by Wollondilly Shire Council (2012).

The Study included site inspections as well the excavation of a number of observation trenches and bores. As a result of this Study, a number of areas were delineated as being suitable for normal residential construction.

As part of the Study, issues related to wastewater development were also assessed, the findings of which were considered in the determination of areas suitable for development.

Based on the findings of this assessment a number of recommendations regarding construction issues have been outlined.

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1. INTRODUCTION

A geotechnical study was conducted during late 2012 and early 2013 over land located at 1 Abbotsford Road Picton (the "Property"). The study was prepared in support of a rezoning application which will enable the Property to be subdivided under part R5 Large Lot Residential, part E3 Environmental Management and part RE1 Public Recreation as defined in Wollondilly Shire Councils' Local Environmental Plan 2011.

This Study is one of many specialist studies being carried out over the Property and its contents and preparation are based on guidelines issued by Wollondilly Shire Council (2012). These guidelines are outlined as follows:

Output

- A geotechnical study which enables a more refined analysis of the land and determines its suitability for residential development and potential on-site management of wastewater.
- Assessment of the development site's geotechnical constraints which provides an accurate description of these constraints, their nature and potential methods of mitigation.
- An evaluation of the Instability Risk of the development site.
- A Guideline for appropriate and suitable development for the site in relation to Geotechnical constraints.

Objectives

- Identify the land within the subject area that has geotechnical constraints that make it unsuitable for residential development.
- Delineate the extent of the residential zoning and the siting of future buildings if geotechnical constraints exist.
- Determine a minimum allotment size based on geotechnical constraints.
- Identify suitable building envelopes on residential lots and the residue lot with regard to slope stability and on-site disposal of wastewater.
- Provide detail on other elements related to geotechnical constraints such as drainage, water storage and soil and water management devices.
- Formulate guidelines regarding suitable development practice on land with geotechnical constraints.

Tasks/Methodology

- 'Desk top' review of available information including soil profile mapping.
- Examine and mapping of the geotechnical attributes and constraints of the site in terms of slope and slip features.

- Assess the Instability Risk of the development site and provide a classification of the potential instability on the site, the reasons for this instability, and the implication posed for development.
- Recommend maximum slopes for dwellings and residential infrastructure.
- Provide a lot layout with building envelopes on land which is not environmentally constrained.
- Include environmentally constrained land in larger residential lots.
- Determine a suitable road layout which ensures safe access to dwellings for future residents.
- Assess information gathered and undertake further analysis of soils and land capability.
- Select appropriate management and evaluation techniques to suit future building and wastewater irrigation onto the future development.
- This task should be carried out having regard to the Onsite Wastewater Feasibility addressed below.

The following sections provide detail to the guidelines outlined above.

2. SITE DETAILS

2.1. Property details

The Property subject to this geotechnical study is identified as 1 Abbotsford Road, Picton (part Lot 1 DP 1086066).

2.2. Location and General Description

The Property is comprised of one portion of land located approximately 5 kilometres north-west of Picton. The Property is split by Fairleys Road and Abbotsford Road on its eastern extremity, with the bulk of the Property lying to the west and south of Abbotsford Road as depicted on Figure 1.

The property is currently used for beef cattle and sheep grazing. Previously, its main use was for dairying purposes and was supported by significant dairy industry infrastructure. The remnants of an old homestead ("Abbotsford") remain, but the Property is otherwise unoccupied.

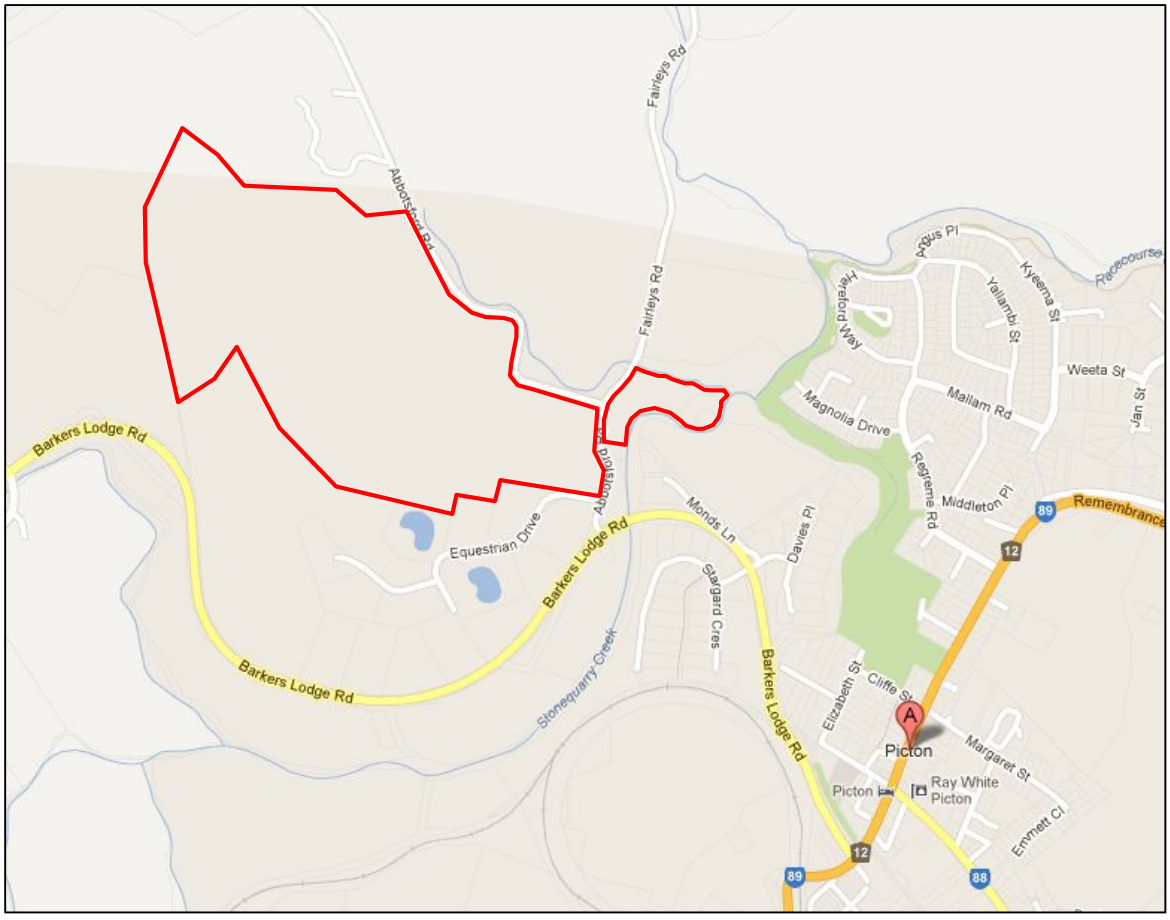

Figure 2. Location of Abbotsford property (red boundary). Source: Google Maps, 2012.

2.3. Local government area

Wollondilly Shire Council.

2.4. Catchment area

The subject land is not located within a scheduled catchment area administered under the Drinking Water Catchments Regional Environmental Plan (REP) No. 1.

3. SITE ASSESSMENT

3.1. Geology

Based on the 1:100,000 Wollongong to Port Hacking geological map sheet (Sherwin and Holmes 1982) the Property is underlain by Bringelly Shale which in turn is underlain by Ashfield Shale. The ridgetops within the Property are generally dominated by Bringelly Shales which are composed of shales, carbonaceous claystone, lithjc sandstones and laminates. A thin layer of sandstone (Minchenbury Sandstone) often separates the Bringelly Shales from the Ashfield Shales. Quaternary sediments occupy the low lying drainage areas. The geology of the property and its immediate surrounds is illustrated in Figure 2.

The property is located close to but not within the Picton and Wilton Mine Subsidence Districts.

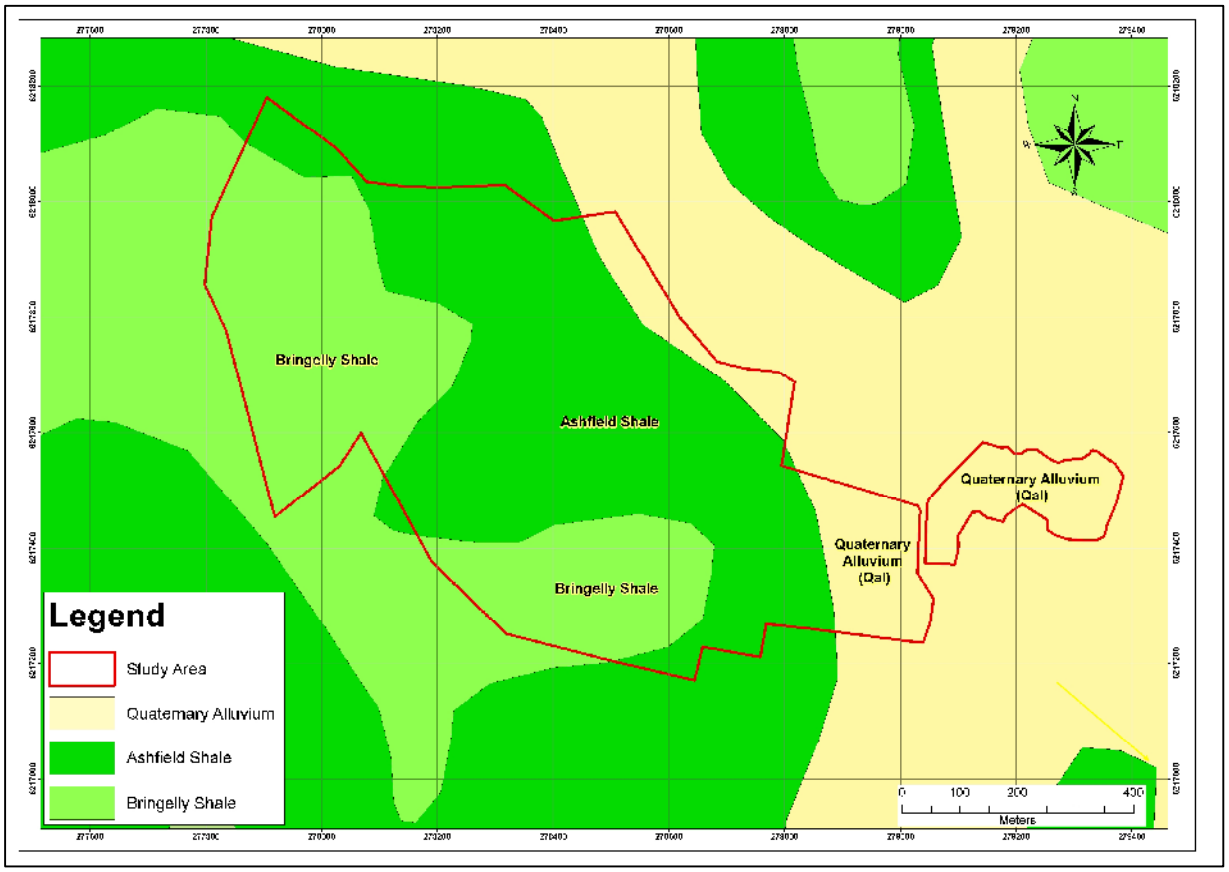

Figure 2: Regional Geology in and around the "Abbotsford" Property

3.2. Soil Landscape Groups

Based on the 1:100,000 Soil Landscapes of Wollongong to Port Hacking map sheet (Hazelton and Tille, 1990), soils on this Property are comprised of the Picton and Monkey Creek Soil Landscape Groups respectively. The distribution of these soil landscape groups are illustrated in Figure 3.

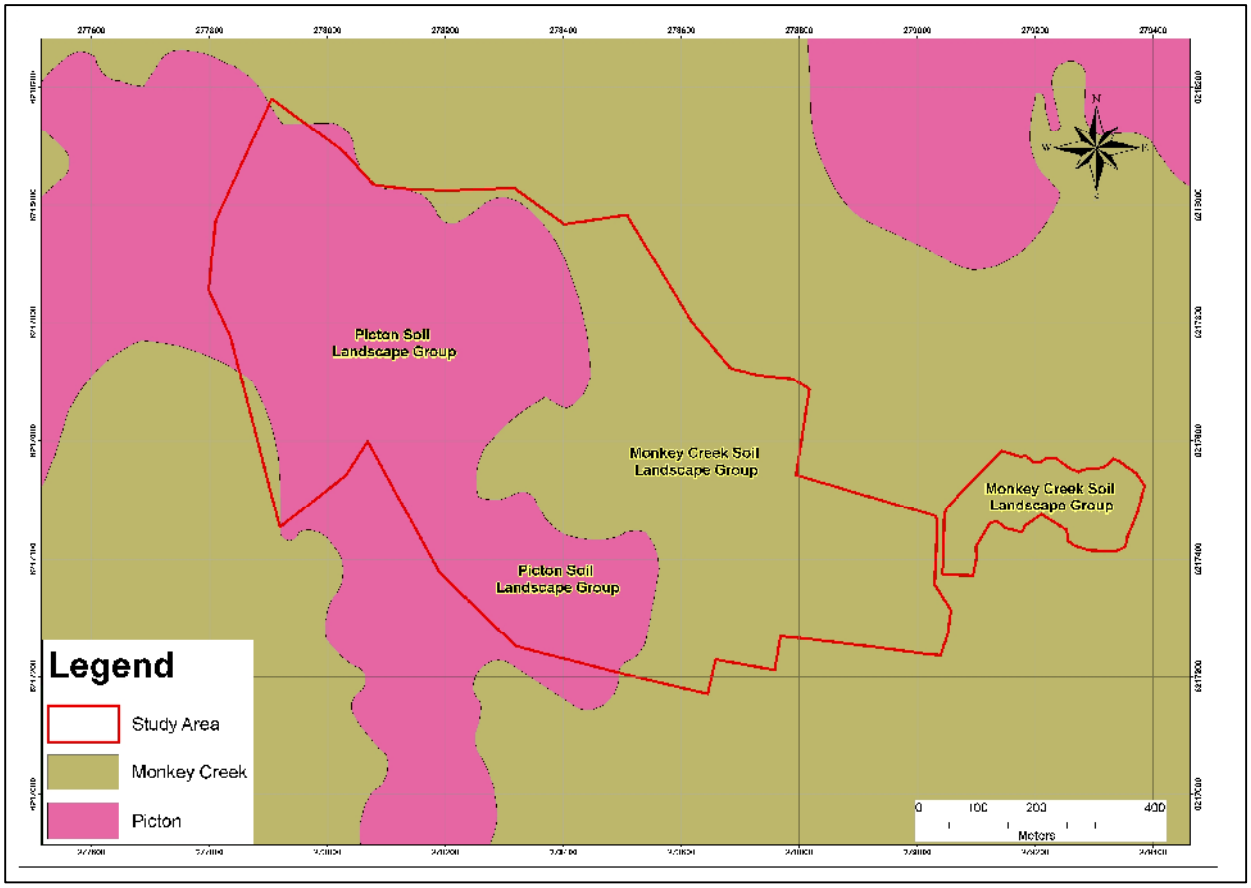

Figure 3: Soil Landscape Groups located in and around the "Abbotsford" property

Characteristics of each landscape group are outlined as follows:

The Picton Soil Landscape Group has the following characteristics:

- Fertility
  Soils of the Picton Soil Landscape Group are considered to have a moderate to low fertility. Top soil is moderately fertile. Subsoils are not fertile and have a low nutrient content. Soils can be deep but with poor soil structure which inhibits root penetration.

- Erodibility
  Varies from moderately erodible to highly erodible, particularly the sub-soil. Slope failure due to throughflow and development of percolines is common.

- Erosion Hazard
  For non-concentrated flows, the erosion hazard is considered to be extreme. Calculated soil loss for the first 12 months of urban development ranges from 300 tonnes /ha for topsoil on steeper slopes to 170 tonnes/ha for exposed sub-soil. Steep slopes are subject to mass movement when saturated. Soil erosion for concentrated flows is high to very high.

- Surface Movement Potential
  Considered to be high. Special foundation designs may be required.

- Landscape Limitations
  Include steep slopes, mass movement hazard, seasonal waterlogging, water erosion, surface movement and rock fall.

- Urban Capability
  Not recommended for urban development. Has limited rural capability unless strict management practices are adhered.

The Monkey Creek Soil Landscape Group has the following characteristics:

- Fertility
  Soils of the Monkey Creek Soil Landscape Group are considered to have a moderate to low fertility. Soils are sodic (locally) and are not suitable for penetration by dee roots, but have good moisture storage.

- Erodibility
  The soils are considered to highly erodible. Soil materials have a high percentage of fine sand and subsoils are low in organic matter.

- Erosion Hazard
  For non-concentrated flows, the erosion hazard is considered to be very high. Calculated soil loss for the first 12 months of urban development ranges up to 55 tonnes /ha for topsoil and 70 tonnes/ha for exposed sub-soil. Soil erosion for concentrated flows is very high.

- Surface Movement Potential
  Considered to be moderately to slightly reactive. Soils are deep and have high clay content.

- Landscape Limitations
  Include flood hazard, permanently high watertables and seasonal waterlogging.

- Urban Capability
  Not recommended for urban development due to flood hazard.

It should be noted that development on the above soil landscape group should be based on the individual merits of the site.

3.3. Slope and topography

The slope and topography of the Property is dominated by a northwest-southeast trending ridge line with a centrally located and northerly trending sub-ridge line. The maximum vertical relief across the property is approximately 60 metres.

Slopes range from 0-5% around the lower lying (drainage) areas to between 15 and 40% for the side slopes. The ridge tops are characterized by narrow (generally less than 15-20 metre) flat areas breaking quickly into very steep slopes. These features are illustrated in Figure 4.

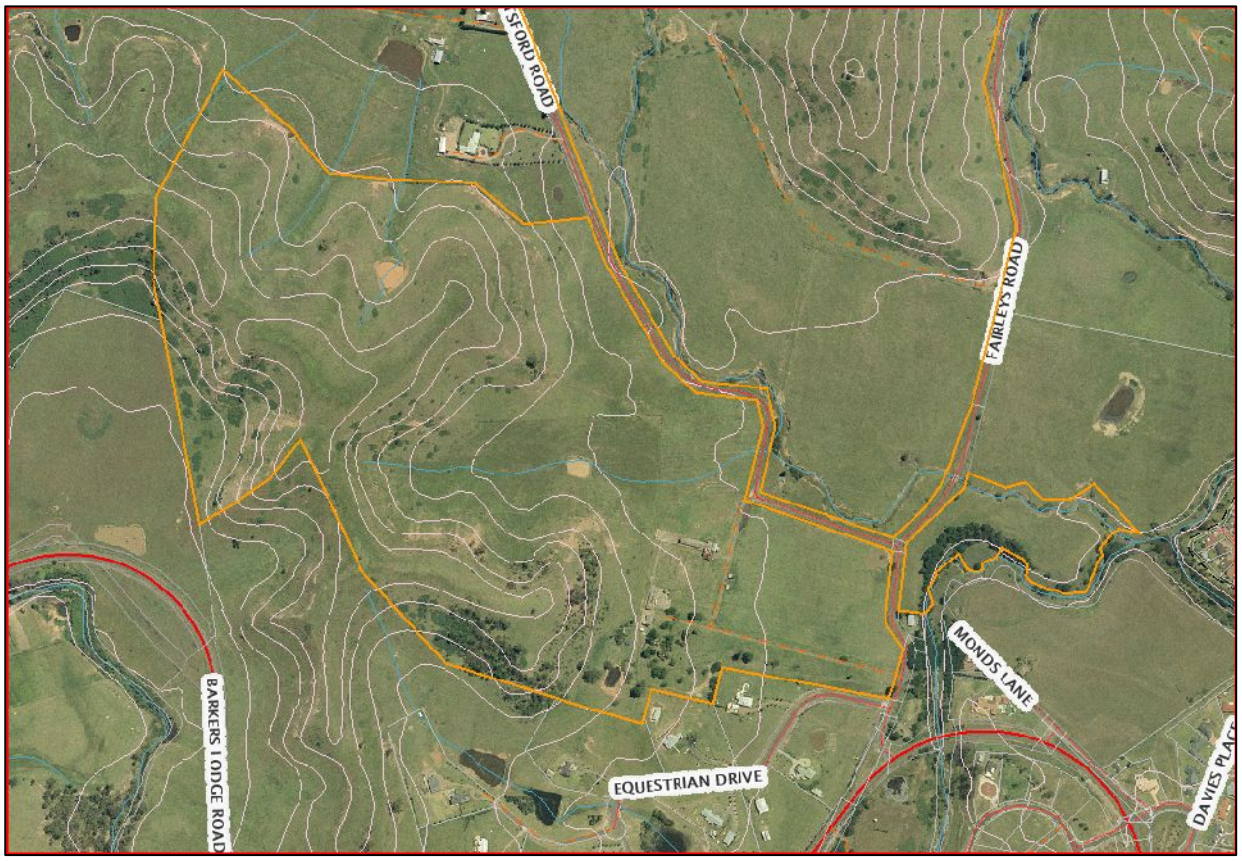

Figure 4: Topographic, vegetation and drainage features in and around the Abbotsford property

3.4. Vegetation

Save for some limited clumps of native bush on the southern side of the Property, the banks of Stonequarry Creek and introduced timbers in around the old homestead, virtually the entire property has been denuded of all native vegetation. Much of the Property is subject to established pasture grasses suitable for the grazing of cattle and/or sheep.

3.5. Buildings

The property is host to the ruins of the "Abbotsford" homestead as well as a number of structures related to past dairying and cattle grazing operations. These include a number of sheds, a silo and numerous yards. The Property is currently unoccupied.

3.6. Drainage lines and dams

The property is host to three small dams and minor intermittent drainage lines, all of which are tributaries to Matthews Creek which is located at the eastern extremity of the Property.

4. GEOTECHNICAL INSTABILITY ASSESSMENT

4.1. Overview

Detailed geotechnical aspects were investigated to ascertain the geotechnical instability of the Property and hence its suitability to host residential development. These investigations included the following:

- Review of existing geological and soils data;
- Assessment of historic aerial photography;
- Site walkover and geotechnical observations;
- Assessment of soil and bedrock profiles by mechanical trenching; and
- Review of appropriate standards of instability risk and risk classification.

The results of this work are outlined in the following sections.

4.2. Review of existing geological and soils data

Available data on applicable geological and soil conditions has been reviewed under Section 3,1 and 3.2 above. No other site specific data has been sighted or is known. However, this regional overview provides an adequate basis on which to assess data gathered in the field and garnered from other sources during the course of this Study.

4.3. Assessment of historic aerial data

A review of historical aerial photography provided by the NSW Department of Land and Property Information was made as part of this geotechnical study. The aerial photography indicates the presence of a number of slumps or land slips dating back to 1955 (the earliest photography available) and most of these features are still observable. Save for a period up to 1970, these slope failures appear not to have moved to any great degree since.

4.4. Site walkover and geotechnical observations

Several site inspections were carried out over the entire property as part of the geotechnical assessment process. These inspections confirmed the presence of many of the slope failures outlined by historic aerial photography as well as the regional observations noted in Section 3.2. In addition, observation of the steeper slopes indicated significant mass erosion taking place, creating the potential for further mass soil slumping and/or failure in the future unless remediation action is taken to stabilise the affected areas.

The main geotechnical features are illustrated in Appendix 1.

4.5. Assessment of soil and rock profiles

To confirm surface visual observations and provide subsurface soil data, a number of observation trenches were excavated on the Property (see Figure 5 for location). Each trench was logged and photographed and samples taken for analysis where appropriate. A total of 12 observation trenches were excavated and their logs are attached as Appendix 2. Observations from the trenches are summarized in Table 1 as follows:

Table 1: Summary of soil profiles

Trench Number	Total Depth (m)	Moisture	Comment
201368-01	3.8	Moist at base	Potential slip zone indicated
201368-02	2.7	Moist at base	Typical undisturbed profile on Ashfield Shale
201368-03	1.7	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-04	4.0	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-05	1.9	Little moisture	Potential slip zone indicated – mid profile
201368-06	2.9	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-07	4.0	Moist at base	Typical undisturbed profile on Ashfield Shale
201368-08	1.2	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-09	4.2	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-010	1.2	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-011	1.7	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-012	3.2	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-013	4.3	Little moisture	Typical undisturbed profile on Ashfield Shale
201368-014	2.9	Little moisture	Typical undisturbed profile on Ashfield Shale

4.6. Review of instability and risk criteria

Development on the Property was assessed against the above criteria as well as an Instability Classification system (Appendix 2). This system is based on two publications:

- Australian Geomechanics Society 1985. Geotechnical Risks Associated with Hillside Development- News, Number 10
- Australian Geomechanics Society, 2002. Landslide Risk Management Concepts and Guidelines Volume 37, No2.

Guidelines from these publications, together with site geotechnical observations provides the basis for enabling a risk classification to be carried out.

Details of the risk category are outlined in Table 2, which has been reproduced from the publication “Geotechnical Risks Associated with Hillside Development” - Australian Geomechanics News, Number 10, 1985.

Table 2: Instability Classification

Risk of Instability	Risk Zone	Explanation	Implication for Development
Very High	1	Evidence of active or past landslips or rockface failure; extensive instability may occur	Unsuitable for development unless major geotechnical work can satisfactorily improve the instability. Risk after development may be higher than usually accepted.
High	2	Evidence of active soil creep or minor slips or rockface instability – may occur during and after extreme climatic conditions.	Development restrictions and/or geotechnical works required. Geotechnical investigation necessary. Risk after development may be higher than usually accepted.
Medium	3	Evidence of possible soil creep or a steep soil covered slope; significant instability can be expected if the development does not have due regard to the site conditions.	Development restrictions may be required. Engineering practices suitable to hillside construction necessary. Geotechnical investigation may be needed. Risk after development generally no higher than usually accepted.
Low	4	No evidence of instability observed. Instability not expected unless major site changes occur.	Good engineering practices suitable for hillside construction required. Risk after development normally accepted
Very Low	5	Typically shallow soil cover with flat to gently sloping topography.	Good engineering practices should be followed.

Refer to Appendix 3 for guidelines regarding residential development in these risk zones. The location and position of these Risk Zones are illustrated in Figure 5. A number of observations regarding the above zoning distribution are detailed as follows:

- Several specific areas have been identified as Areas of Disturbance (AD). A brief description of each (as depicted on Figure 5) is given:
    - AD_A: Predominantly a slump on a steep slope;
    - AD_B: Predominantly a slump on a moderate slope, but seemingly influenced by high moisture levels from upslope;
    - AD_C: Predominantly a slump on a steep slope;
    - AD_D: Predominantly a slump on a steep slope;
    - AD_E: Extensive erosion and slumping on a steep slope;
    - AD_H: Predominantly a slump on a steep slope;
- Slopes greater that 20% all fall within the Risk Zone 1;
- Ridge tops generally all fall within Risk Zone 3, but most tend to be very narrow, falling away rapidly into higher Risk Zones. Because of their narrowness the ridge tops are generally only capable of supporting access roads.

4.7 Wastewater Disposal

Development of the Property will require on site wastewater disposal. The application of wastewater onto any land can potentially affect its long term stability (amongst other things), and as a result, needs to be assessed against all technical and statutory constraints.

In order to satisfy Wollondilly Shire Council wastewater requirements, all household wastewater flows ("black" and "grey" water) are to be treated by an Aerated Wastewater Treatment System (AWTS) complying with the specifications outlined in Appendices 4 and 5.

Although no specific residential lot layout has yet been proposed for the Property, data is presented which has been used to determine the suitability of the land within the Property to host on-site waste water treatment. For the benefit of this report, wastewater requirements for a typical 4-bedroom residence have been used together with soil characteristics as determined by laboratory analysis. The estimated daily wastewater flow-rate (L/residence/day) for a typical 4-bedroom residence is summarized in Table 3.

Table 3. Summary of estimated daily wastewater flow rates from the proposed 4-bedroom residence.

Number of bedrooms in proposed residence	Intended water supply	Estimated potential occupancy[1]	Estimated daily wastewater flow rate (L/person/day)	Estimated daily wastewater flow rate (L /residence /day)
4	Tank water	8	115	920[2]

[1] Based on Wollondilly Shire Council's requirement that 'maximum potential occupancy = number of bedrooms x 2

[2] The daily wastewater flow rate was estimated by multiplying the maximum potential occupancy by 115 L/day as estimated in the industry standard[2] (Table 4.2D) for households without reticulated water supplies with water reduction features (i.e. as required for Basix certification).

Based on Wollondilly Shire Council requirements, nutrient loading and water balance calculations based on the Environment & Health Protection Guidelines (Dept. of Local Government 1998) applicable to the property have been used to estimate the minimum area required for onsite effluent disposal from a typical 4-bedroom residence. These calculations are based on soil characteristics, vegetation, wastewater treatment quality and climatic features. Based on this methodology the minimum EIA requirement's for a 4-bedroom residence ranges from 736m^2 to 900m^2 for subsurface irrigation. For surface spray irrigation, the minimum area requirements are 1500 m^2 – see Table 4 below.

Table 4. Minimum EIA requirements for a typical 4-bedroom residence.

Assessment method	Estimated EIA (m^2)	Comment
Nitrogen loadings	736 - 900	
Phosphorus loadings	87	
Water balance	431	
Minimum EIA required for sub-surface effluent irrigation	736[1]	Maximum value of all methods
Minimum EIA required for surface-spray effluent irrigation	1500[2]	Wollondilly Shire Council's Local Approvals Policy for New Installations of On-site Management Systems for Residential Dwellings

Notes:
1. For sub-surface effluent irrigation, the minimum required EIA to dispose of the estimated wastewater loads from the proposed residence is the greater value determined by the above methods; and
2. For surface methods of effluent irrigation, Wollondilly Shire Council's Local Approvals Policy for New Installations of On-site Management Systems for Residential Dwellings requires a minimum EIA of 1500m^2.

On the basis that the minimum lot size for this property will be 4000 m^2, surface spray irrigation systems utilising an area no less than 1500 m^2 for all proposed future lots will be acceptable. However, in some circumstances, effluent disposal systems utilising subsurface irrigation of between 736-900 will also be acceptable. It is considered that selection of the appropriate system is best done once the subdivision layout is better known.

5. RECOMMENDATIONS

5.1. Building and construction aspects

Based on the criteria outlined in Section 5, a number of building envelopes have been outlined within the Property. These building envelopes are illustrated in Figure 6. The assessment of these building envelopes takes into consideration the stability of the site as well as a number of other physical constraints. It should be noted that construction of residential and associated improvements is considered possible anywhere within the building envelopes subject to the acceptance of some geotechnical risk. Construction within these building envelopes should therefore reflect the degree of risk.

The following overarching guidelines should be applied to all building envelopes to mitigate the geotechnical risks:

- No construction within Risk Zone 1 (see Table 2);
- No construction on slopes greater than 20%;
- Construction within Zone 2 should be subject to extensive geotechnical and engineering investigations, including drilling, trenching and sample analysis;
- Drainage in and around the proposed developments is to be designed prior to construction and is to be strictly controlled to ensure that no instability arises;
- The classification of the site proposed for residential construction according to AS 2870 (as amended) is to be determined once a building site has been selected and submitted as part of the Construction Certificate (Standards Association of Australia, 2011);
- The location and construction of any residential buildings is to be subject to engineering approval prior to any construction taking place and prior to the issue of a Construction Certificate. All construction should be carried out in a manner to ensure the future stability of the site;
- Residential construction should be restricted to slopes no greater than 20%;
- Vegetation (such as weed species) on slopes below or above any developments should not be removed without first establishing alternative vegetation. Alternative vegetation must be established to the same if not greater degree that already exists. The clearing of significant trees and stands of trees should be avoided where possible. Where removal is required, it should have due consideration for the geotechnical stability of the site;
- Soil and water management plans should be prepared for any building site as part of the necessary requirements for the development of each building and construction site; and
- This report is not intended to be used in lieu of the design or investigation of footings, retaining walls or associated structures appropriate for the site by a practicing geotechnical or civil engineer.

5.2 Excavation and Filling

Cut and fill without detailed geotechnical investigation should be restricted to 0.5 metres for all residential and road construction. Beyond this height (depth) works should be subject to further detailed engineering/geotechnical design which will ensure the future stability of the site.

5.3 Residential and other construction

Residential construction within the designated building envelopes as well as access road construction should be subject to the following considerations:

- Where extensive cut and fill is required, excavations should be to solid sandstone or shale. The founding layer should be of the same material;

- Retaining structures to be appropriate to site and design of improvements;
- All foundations should be supported by piering and all pier sockets should be bored to machine refusal into hard rock;
- Drainage design will need to be adequately designed to ensure future stability. The use of cut-off drains for both the sub-surface and surface may need to be considered, both above and below the proposed building envelope;
- The removal of trees and other vegetation should be carefully considered in all cases and wherever possible should be retained;
- Roof water should be conveyed to storage tanks and their overflow piped to dams or natural watercourses well away from the residential development;
- All residential construction should be encouraged to adopt articulated structural panelling and light-weight construction materials wherever possible; and
- It should be noted that cracking in masonry walls and structural movement is almost inevitable in buildings constructed on shales and/or their clay soil derivatives. The building design should take this into account.

Refer to Appendix 6 for guidelines regarding footing maintenance.

5.4 Drainage

All construction activities, whether related to dwellings or roads will require appropriate geotechnical drainage design to ensure that surface and sub-surface water is conveyed away in the most efficient and effective manner.

5.5 Water storage

Should there be a need for individual water storage, all storage is to be contained in tanks suitable for such purpose. Tanks may be located either above ground level and placed on concrete slabs, or they may be placed within an excavated site. In the latter case, the tanks should be located down-slope of any improvements in case of leaks. Tanks should not be located on fill.

5.6 Soil and water management

To effectively reduce soil losses, it is recommended that a number of procedures be implemented. These include:

- Installation of a sediment detention pond to capture soils from the construction site;
- Installation of barrier fencing around the construction site to ensure that work vehicles do not stray into grassed areas;
- Maintenance of grassy vegetation strips wherever possible to act as sediment filters;
- Installation of sediment fencing downslope from construction areas, soil and waste stockpiles and roadways; and
- Installation of bunding to isolate the construction site from run-on as well as run-off.

5.7 Wastewater Management

The following management criteria are recommended:

AWTS Tanks

Any proposed AWTS tank must:

- have a current NSW Health certificate of accreditation;
- be installed at least 1.5 metres from the proposed residence;

- be installed with all vents, electrical components and openings above the 1 in 100 flood contour; and
- be operated and serviced in accordance with the manufacturer's operators manual and recommendations.

Effluent Irrigation Area(EIA)

Any proposed EIA to be installed must:

- Unless otherwise designed by a qualified wastewater consultant, have a minimum area as outlined in Table 3 of this report;
- be located within the available EIA delineated in this report;
- be installed above the 1 in 100 flood contour level;
- comply with the buffer distance requirements outlined in Appendix 8 of this report;
- the irrigation system is to include:
- a flush valve at the lowest point of the EIA;
- a vacuum breaker at the highest point of the EIA;
- root guard on irrigation lines; and
- an appropriate filter on the effluent supply line.
- be grassed with minimal large trees and/or landscaping; and
- be regularly mown and where practical, grass clippings removed.
- include a minimum of 2 warning signs installed along the boundary of the EIA (as per the AS/NZ 1547:2000). The signs should comprise of 20mm high capital lettering in black or white on a green background and contain the following phrase:

"RECLAIMED EFFLUENT
NOT FOR DRINKING
AVOID CONTACT"

- Stock and vehicles (with the exception of a lawn mover) are to be excluded from the approved EIA. To that extent, the paddock located at the southern end of the property is not be used for irrigation as it is used for farm animals.

Plumbing.

All plumbing works must:

- Be undertaken in accordance with the NSW Code of Practice for Plumbing and Drainage 3rd Edition 2006;
- Have an identification tape for all below-ground level pipes, marked in accordance with the AS/NZ 3500.1 Clause 9.5.4.1 and installed on top of the pipeline, running longitudinally, and fastened to the pipe at not more than 3m intervals; and
- Have identification tapes on all pipes or pipe sleeves and must be coloured purple as per AS 2700 and marked with the following in accordance with the AS 1345 'WARNING RECYCLED/RECLAIMED WATER - DO NOT DRINK" at intervals not exceeding 0.5m.

General

For further information regarding onsite wastewater management systems and the land application area, refer to the Environment & Health Protection Guidelines which are available online at: http://www.dlg.nsw.gov.au/dlg/dlghome/documents/information/onsite.pdf and supplements information available in Appendix 5.

5.8 Further assessment

Once a lot layout has been determined, further site-specific geotechnical assessments may delineate additional areas on each allotment that are suitable for residential development that were not identified in this assessment.

6. SATISFACTION OF SPECIALIST STUDY GUIDELINES

Table 5 provides a summary of the Study and identifies how each of the guidelines have been met.

Table 5A: Satisfaction of Guidelines - Output

Output	How and where Guideline addressed
A geotechnical study which enables a more refined analysis of the land and determines its suitability for residential development and potential on-site management of wastewater.	This report has detailed those areas broadly suitable for residential development and associated improvements. Matters relating to wastewater management have been accommodated in the Study.
Assessment of the development site's geotechnical constraints which provides an accurate description of these constraints, their nature and potential methods of mitigation.	Section 3 is a review of all of the relevant constraints that can have an impact upon future development. Potential methods of mitigation are described in Section 5.
An evaluation of the Instability Risk of the development site.	Section 4 summarises all technical observations (field and otherwise) and is the basis for Figures 4 and 5 which illustrates the location of Instability Risk Zones and potential building envelopes.
A Guideline for appropriate and suitable development for the site in relation to Geotechnical constraints.	Guidelines for residential development encompassing geotechnical and wastewater disposal constraints are detailed in Section 5.

Table 5B: Satisfaction of Guidelines - Objectives

Objectives	How and where Guideline addressed
Identify the land within the subject area that has geotechnical constraints that make it unsuitable for residential development.	Figure 5 identifies the geotechnical constraints apparent on the Property. Figure 6 indicates the proposed location of a number of building envlopes and by exclusion indicates that land which is not suitable for residential development.
Delineate the extent of the residential zoning and the siting of future buildings if geotechnical constraints exist. Needs clarification.	For the benefit of this Study, residential zoning is taken to be the area where residential development can occur, subject to the geotechnical and other constraints outlined in the body of the report. These areas has been designated as Building Envelopes and will be able to accommodate residential buildings and associated improvements.
Determine a minimum allotment size based on geotechnical constraints.	Geotechnical and other constraints (in particular, wastewater disposal) would limit the size of residential lots to 1000m^2 in some areas defined as Medium to Low Risk (Section 4). However, the proposed rezoning requires a minimum lot size of 4000m^2.
Identify suitable building envelopes on residential lots and the residue lot with regard to slope stability and on-site disposal of wastewater.	Building envelopes have been defined in Figure 6. No residential lots have yet been defined on the Property as such definition will require input from other specialist studies.
Provide detail on other elements related to geotechnical constraints such as drainage, water storage and soil and water management devices.	These constraints are outlined in Sections 4 and 6.
Formulate guidelines regarding suitable development practice on land with geotechnical constraints.	Guidelines are outlined in Section 5 and cover geotechnical as well as wastewater aspects.

Table 5C: Satisfaction of Guidelines – Tasks/Methodology

Tasks/Methodology	How and where Guideline addressed
'Desk top' review of available information including soil profile mapping.	Review undertaken and covered in Section 3. Soil profiles included as Appendix 2.
Examine and mapping of the geotechnical attributes and constraints of the site in terms of slope and slip features.	Observations summarised as Figure 5.
Assess the Instability Risk of the development site and provide a classification of the potential instability on the site, the reasons for this instability, and the implication posed for development.	As above. See also Table 1.
Recommend maximum slopes for dwellings and residential infrastructure.	Sections 4 and 5.
Provide a lot layout with building envelopes on land which is not environmentally constrained.	This task is to be delegated to a more appropriate specialist such as the Project Co-ordinator once all constraints (not just geotechnical or wastewater) have been considered. Once a lot layout has been finalised, additional geotechnical input can be provided as needed.
Include environmentally constrained land in larger residential lots.	This task would be undertaken once a lot layout is determined.
Determine a suitable road layout which ensures safe access to dwellings for future residents.	This task is to be delegated to a more appropriate specialist such as the Project Co-ordinator once all constraints (not just geotechnical or wastewater) have been considered. Once a lot layout has been finalised, additional geotechnical input can be provided as needed.
Assess information gathered and undertake further analysis of soils and land capability. Requires Clarification.	All relevant information has been gathered and assessed for the benefit of this Study.
Select appropriate management and evaluation techniques to suit future building and wastewater irrigation onto the future development. Requires Clarification.	Generic recommendations for building and wastewater issues are covered in Section 5. Recommendations for each proposed lot will require a case-by-case assessment as each lot is developed.
This task should be carried out having regard to the Onsite Wastewater Feasibility addressed below.	See above.

7. CONCLUSIONS

Based on that assessment and with regard to geotechnical constraints it was concluded that:

- The Property has a number of areas that are suitable for normal residential development (with up to two storey's) and other associated improvements;
- The instability risk rating for the nominated building envelopes depicted on Figure 5 varies from Medium to Very High:
- A number of building envelopes, as depicted on Figure 6, can be used to assist in the definition of future residential development; and
- A further geotechnical assessment will be required on each proposed future lot as part of any residential development to confirm the findings of this Study.

8. LIMITATIONS OF THIS REPORT

This report has been prepared subject to a number of limitations. These include:

- The application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In particular, the occurrence of earthquakes of any magnitude, extreme rainfall events or the effects of climate change have not been considered but should they occur, may have a significant impact on the site. The client agrees that such events are possible but nevertheless accepts the risk that they pose;
- The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site/sites at all points;
- In preparing this report, Harvest Scientific Services Pty Ltd has relied upon certain verbal information and documentation provided by the client and/or third parties. Harvest Scientific Services Pty Ltd did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Harvest Scientific Services Pty Ltd assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Harvest Scientific Services Pty Ltd; and
- This report is not to be relied upon for any purpose other than that defined in this report.

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9. REFERENCES

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Disclaimer

This report was prepared in accordance with the scope of services set out in the contract between Harvest Scientific Services and the client, or where no contract has been finalised, the proposal agreed to by the client. To the best of our knowledge the report presented herein accurately reflects the clients intentions when it was printed. However, the application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document.

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Appendix 1

Geotechnical Pictorial

Appendix 2

Soil Profile Logs

Appendix 3

Guidelines for Hillside Construction

Appendix 4

AWTS General Specifications

The onsite sewage management system to be installed must have been accredited by the NSW Department of Health as a Sewage Management Facility under the provisions of Clause 41 [1] Local Government (General) Regulation 2005 subject to the conditions of accreditation specified in the relevant Schedule/s.

Effluent quality from the proposed treatment system must be of an appropriate standard, as defined in Advisory Note 4 – from NSW Health (2006)[1]. These criteria are outlined below:

- Biological Oxygen Demand (BOD5) < 20 milligrams per litre
- Suspended Solids (SS) < 30 milligrams per litre
- Thermotolerant Coliforms (T. coli) < 30 milligrams per litre

Further, the AWTS to be installed must demonstrate test average total nitrogen and phosphorus values equal to or less than those values outlined in Table 1 below.

Table 1: Required effluent phosphorus and total nitrogen levels in treated effluent prior to effluent irrigation. These nitrogen and phosphorus values were used for design sizing purposes i.e. nutrient loading calculations:

Effluent Quality Parameter	Concentration	Failure Indicator
Total N (Nitrogen)	<20.0 mg/L	>20
Total P (Phosphorous)	<12 mg/L	>12.0

Notes:
1) Total N = TKN (Total Kjeldahl Nitrogen) + TON (Total Oxidised Nitrogen).
2) Total N and Total P represent mean concentration values
3) Total N values are based on current assessment criteria for SCA areas.

The AWTS must have a capacity to treat as a minimum the Estimated Daily Wastewater flow as indicated in the main body of this report, meet the relevant performance criteria outlined in Section 2.4 of the AS/NZ 1547:2000[2] and have capacity deal with peak loads.

[1]NSW Department of Health (2006) Advisory note 4 – Sewage management facility accreditation criteria based on the final application of treated effluent and risk of disease transmission.NSW Department of Health, Sydney, Australia. Available online at: http://www.health.nsw.gov.au/public-health/ehb/general/wastewater/adnote4.pdf;[2] Standards Australia/Standards NZ (2000) AS/NZS 1547:2000 Australian/New Zealand Standard – On-Site domestic wastewater management. Standards Australia and Standards New Zealand, Sydney, Australia.

Appendix 5

Effluent Disposal Area Buffer Distance Requirements

Unless otherwise approved by the consent authority, positioning of all effluent disposal areas must comply with the following buffer distance requirements.

System	Buffer Distance
All land application systems	• 100 metres to permanent surface waters (e.g. river, streams, lakes etc) • 250 metres to domestic groundwater well • 40 metres to other waters (e.g. farm dams, intermittent waterways and drainage channels, etc)
Surface spray irrigation	• 6 metres if area up-gradient and 3 metres if area down-gradient of driveways and property boundaries • 15 metres to dwellings • 3 metres to paths and walkways • 6 metres to swimming pools
Surface drip and trickle irrigation	• 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, property boundaries, driveways and buildings
Subsurface irrigation	• 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, property boundaries, driveways and buildings
Absorption Systems	• 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, driveways and buildings • 12 metres if area up-gradient and 6 metres if area down-gradient of property boundaries • 1m between absorption beds

Appendix 6

Guide to Home Owners on Foundation Maintenance and Footing Performance