AMENDED IN RED

By: Brandon Bouda

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Queensland Government

deveco PTY LTD

Deveco PTY LTD
PO BOX 288 Ferny Hills Qld 4055
Australia

PLANS AND DOCUMENTS referred to in the PDA DEVELOPMENT APPROVAL

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Queensland Government

BUSHFIRE RISK HAZARD ANALYSIS
Teviot Downs, North of Pub Lane.

Client: **VILLA GREEN Pty Ltd**
C/- Julian Kemp
Principal Planner
RPS

Principal Author: Dr Mark Pillsworth
Director **deveco** Pty Ltd
mpillsworth@westnet.com.au

Specialist Authors referenced : Professor Roderick W Rogers DSc. (UQ Botany)
Owen Foley (Ecological Survey)

7 December 2016

Statement of Limitations

deveco Pty Ltd has conducted the Bushfire Risk Hazard Assessment (BRHA) that is the subject of this report and has prepared this report on the basis of that assessment and interpretation of government guidelines (Qld.) in determining that risk.

The work was conducted, and the report has been prepared, in response to specific instructions from the client through Julian Kemp (Principal Planner RPS) to whom this report is addressed, within the time and budgetary requirements of the client, and in reliance on certain data and information made available to **deveco**. The evaluations, opinions and conclusions presented in this report are based on those instructions, requirements, data or information, and they could change if such instructions etc. are in fact inaccurate or incomplete.

deveco will not update the report and has not taken into account events occurring after the time its assessment was conducted.

This document is only intended as a guiding document in planning for management of bushfire risk and applying guidelines as released by the State (Qld.) to be submitted as a reference document in a future development application. No third party is entitled to rely on this document or the contents of the document. No responsibility is accepted by **deveco** for any conclusions, inferences or determinations that any third party makes as a result of reading this document.

This report is intended for the sole use of the client and only for the purpose for which it was prepared. Any representation contained in the report is made only to the client.

The following table records the issues and revisions of the document. If only a few revisions are made, only the new or revised pages are issued. For convenience, the nature of the revision is briefly noted as well as the page numbers.

Version	Date	Pages / Comments	Origin	Check
LR1.0	14.12.16	Report for distribution to client	MP/OF	MP

Summary of Issues

Bushfire is an essential part of the natural Australian landscape and many plant species rely on fire for germination. Prior to European settlement, the Aborigine purposely used fire to manage their territorial lands, but Europeans fired the landscape to clear vegetation primarily for agricultural pursuits. As the population of Australia has steadily increased, our urban areas and townships increasingly neighbour remnant vegetation and consequently there is an increasing risk to the human population and property.

It is in the peri-urban areas, such as Teviot Downs, that more rigorous and detailed Bushfire Risk Hazard Assessment (BRHA) now needs to be addressed and overriding factors such as climate change need to be considered. Whereas in the past only slope, aspect and broad vegetation type were used to determine such risk i.e. SPP 1/03 *Mitigating the Adverse Impacts of Flood, Bushfire and Landslide.*

CSIRO research scientists (Sustainable Ecosystems – Land and Water) were contracted by State Department of Infrastructure, Local Government & Planning (QLD) to review mapping of Bushfire prone areas and assessment of risk, and a new State Planning Policy (SPP) *Natural Hazards, Risk and Resilience – Technical Manual* (April 2016) has now been released.

Whereas previously across Teviot Downs SPP 1/03 was applied by an expert team which understood the intuitive factors inherent in this guideline, and resulted in competent BRHA performed with scientific determination of site specific factors e.g. site species height in response to edaphic factors, in the new SPP a more detailed consideration of fuel loads determined by vegetation community is included with inclusion of extreme weather weightings.

It is of fundamental importance of applying the new SPP that it is recognised that the combined McArthur (1967) *Fire Behaviour Model* and Bryam's (1959) *Fire Line Intensity Model* that the worst case scenarios are applied. Simply this is because the government agency responsible for mapping Bushfire Prone Areas must be conservative when guiding decisions, which involve human health risk. But the caveat here is that much of the analysis to produce Bushfire Prone mapping at Local Government scale, needs to verify the accuracy of, for example, existing Regional Ecosystem mapping which will be useful in determining fuel loads for a vegetation community. It is essential that the Bushfire Prone areas so mapped are ground truthed and regularly reassessed in regrowth areas. There is then the significance of weed infestation e.g. *Lantana camara,* which modify the physical fuel load characteristics for a site i.e. increasing height and intensity of fire.

With specific reference to the area of Teviot Downs north of Pub Lane (NPL), direct application of the new SPP would be in error as Remnant Vegetation mapping shows that this area is an 'island' with clearing on private properties contiguous almost continuous i.e. fire connectivity across the boundary of the estate is minimal and then limited to the immediate boundary. The mosaic of

narrow corridors of native vegetation in drainage lines both oriented north – south and on the northern boundary are of such a narrow width (north – south <80m; northern boundary <120m) that the CSIRO scientists suggest a mapping procedure of 'Patch and Corridor Filtering' to merge these features with surrounding areas to increase the accuracy of their mapping beyond the 85% estimated at present.

Native vegetation to be retained NPL in the eventual estate configuration is not of a sufficient aerial extent to be assessed for fire risk under the new SPP, and this is a sound outcome and fundamental to determining site based fire management strategies e.g. provision of buffers to allotments.

It is suggested therefore that previous recommendations approved by the ULDA and based on expert scientific observation in the reporting framework of SPP1/03 with regard to buffers to retained vegetation guide the determination of the configuration of allotments within the built environment footprint remain current.

These recommendations, with additional clarifications also added, are:

- *A 33m setback is required between dwellings along the interface of Stages with the Remnant vegetation in the drainage gullies. Selectively retained mature trees within this setback area, including active linear parkland with mown understorey, should represent less than 30% of the natural canopy (FPC) for this site to reduce any fire hazard rating to 0.*

- *Where development interfaces with vegetation in easements on the estate boundary then a bushfire hazard management plan by others e.g. Powerlink and SEQ Water, will need to be verified. These management plans will need to have as their focus a maintenance regime which prevents vegetation growth becoming a fire hazard.*

- *In the NE portion during any staged development without clearing of the development footprint prior to commencement of works, there will need to be a progressive firebreak constructed on the development boundary.*

~~Where the above recommendations are implemented in full, no elevated construction measures under AS3959 are necessary for dwellings established on the residential lots illustrated on the development layout (Refer **Figure 2**).~~
Where the above recommendations are implented in full, no elevated construction measures under AS3959 may be required, however the bushfire risk of a property will need to be confirmed at the building stage to determine the level of construction required to address any potential bushfire impacts.

Background

Site History - Setting

Teviot Downs can be conveniently divided into areas either north or south of Pub Lane.

To the north of Pub Lane, there is an area of land about 700m across in the north-east corner of Teviot Downs Estate which carries woody vegetation (Refer **Figure 1**) associated with a system of gullies. The vegetation on this patch has been thinned in the past, and perhaps cleared almost entirely in more distant times. Prior to become a residential estate in October 1992 with the sale to Kurtz Developments, Associated Forest Products used this area for logging and plantation timbers. Areas not developed in the 1990s then became a favourite place for trail bike riding and horse trails, for example, and bush fire regularly ravaged the landscape.

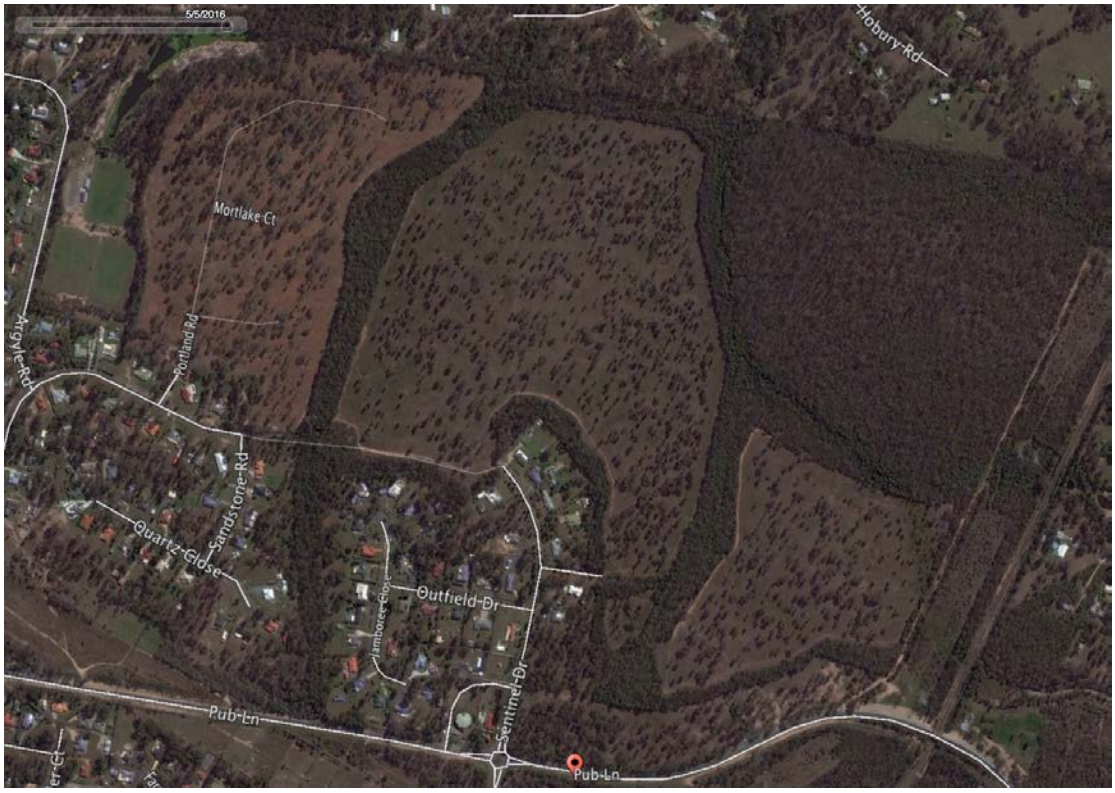

Figure 1: Remote image of existing vegetation in the ULDA approved development area north of Pub Lane. The vegetation is divided into 3 areas of cleared i.e. non remnant vegetation by two drainage lines oriented north - south and another roughly west – east which forms the southern boundary of a mosaic of remnant and regrowth vegetation in the north – east corner of the allotment.

Previously, in the area north of Pub lane (NPL) there were three proposed development nodes comprising 275 allotments over what was planned as Stages 35-38. A Reconfiguring a Lot Development Approval was given on 6 October 2010 (Logan City Development Permit RL/57/2009) with conditions for

ensuring permanent access to adequate water supply for fire fighting, which stated that tank water had to be available on an allotment basis.

These conditions are now redundant with the approved application to the ULDA for a redesigned precinct north of Pub Lane where allotments will be greatly reduced in size and dwellings will have connections to the water supply and sewerage network (Refer **Figure 2**). The bushfire hazard assessment that follows uses the vegetation extent as shown in the proposed amendment to the approved development configuration (Refer **Figure 2**) i.e. maximum width of vegetation in north – east corner <120m, and corridors <80m.

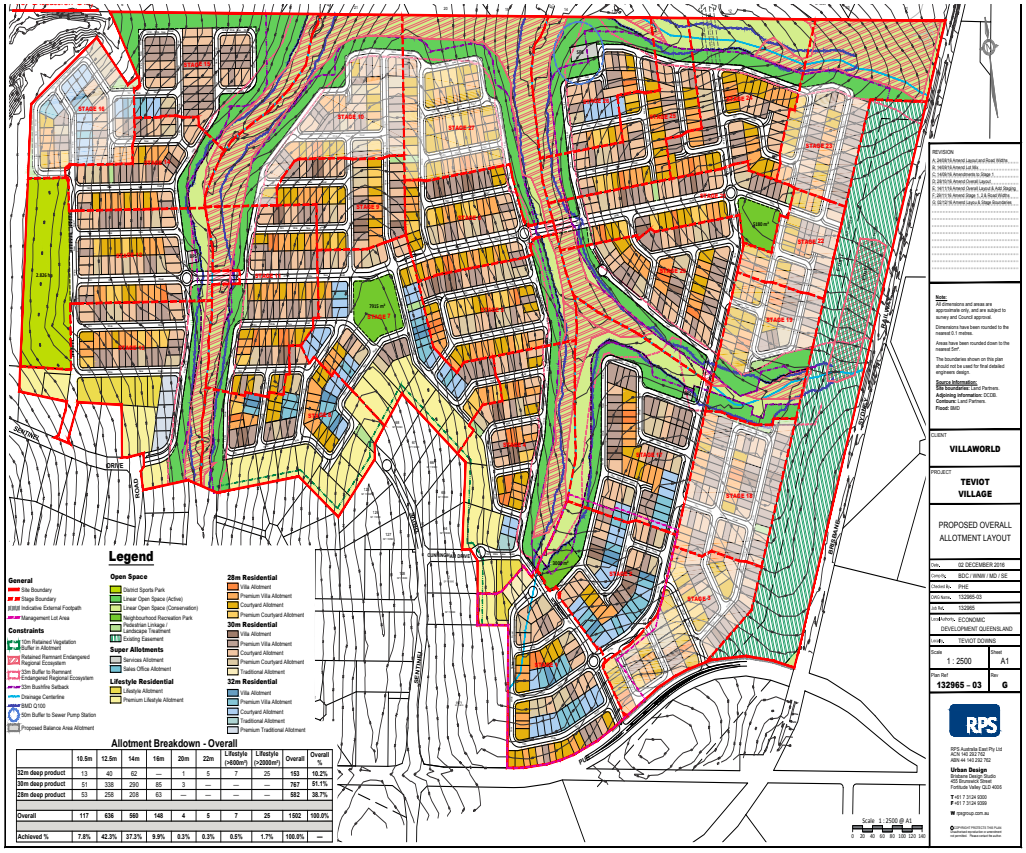

Figure 2 : Proposed amendment to the approved development master plan showing the drainage lines (Green Corridors[1]) being retained as important landscape linear patches of natural vegetation providing visual amenity for the nodes of high density housing proposed. **Note**: approved development clears most vegetation in the north – east corner up to a natural swale that roughly parallels the northern boundary and retains a strip of regrowth & remnant vegetation with a maximum width around 120m.

It is provisional that the vegetation is cleared before building in stages commences and that maintenance of regrowth vegetation is performed i.e. regularly slashed. It noted also that there is 'active' Linear Open Space to each 'Green Corridor' i.e. mowed verges to natural vegetation retained in drainage lines with ~~selected~~ retention of mature trees.

[1] Development Environmental International (2003) *Fauna Movement Plan.*

Fundamental Considerations in Bushfire Risk Hazard Assessment (BRHA)

Built Environment

In past acreage development applications, the master plan NPL has dictated design fundamentals for fire hygiene, and the alignment and density of housing was of secondary consideration to vegetation communities neighbouring and the required setback(s) from such vegetation. As this current development scenario has emerged, the principal factors in assessing bushfire risk changed, and now principal in this are:

(i) The size of allotments which have been progressively reducing (now mainly <<2500m^2), concurrent with an increase in the number of allotments (Plan Ref. 132965-03; 1500 allotments – Refer **Figure 2**);
(ii) Reticulated mains water supply;
(iii) Orientation of smaller allotments with roadways and cleared verges to what are now 'linear parks' with active zones (mown) conserving gully lines of Regionally Endangered Regional Ecosystems;
(iv) Isolation of any vegetation so conserved in gully lines from any significant vegetation in areas offsite.

In previous acreage development scenarios, important influences in bushfire management were the spatial extent of the bush-land interfacing the development NPL e.g. the NE corner, and its offsite links (limited) with other vegetation. In the current proposal, the vegetation contiguous with housing when constructed will be linear and approximately <120m in maximum width in the north – east corner and <80m width in the Green Corridors, this being vegetation in ephemeral watercourse/drainage features, and some with a more permanent 'chain of ponds' (Refer **Figures 3a** & **b** ; Drone Video flight-paths – Refer **Appendix A**) i.e. the vegetation understorey will be usually 'green' (moist) grasses. It follows that the bushfire risk is greatly lessened in the current proposal due to the reduced spatial extent of any vegetation now proposed to be retained, and the observation that any vegetation is not in a corridor linking with significant vegetation offsite (Refer **Figure 1**).

It is also important to note that the slopes NPL are gentle and generally are less than or very close to five percent (Refer **Figures 4a** & **b**), and as stated the vegetated areas around proposed development areas are normally narrow (Refer **Figure 1**). However, if during any staging sequence, some development areas may be contiguous with remnant vegetation[2], then a firebreak of >33m will need to be maintained on the boundary of the advancing development.

[2] Although it is specifically commented above that this is an unacceptable situation and all clearing should be performed before the commencement of building.

Figure 3a: Looking north along retained natural vegetation leading to NE corner.

Figure 3b: 'Chain of ponds' in corridor at location indicated by blue arrow in **Figure 3a.**

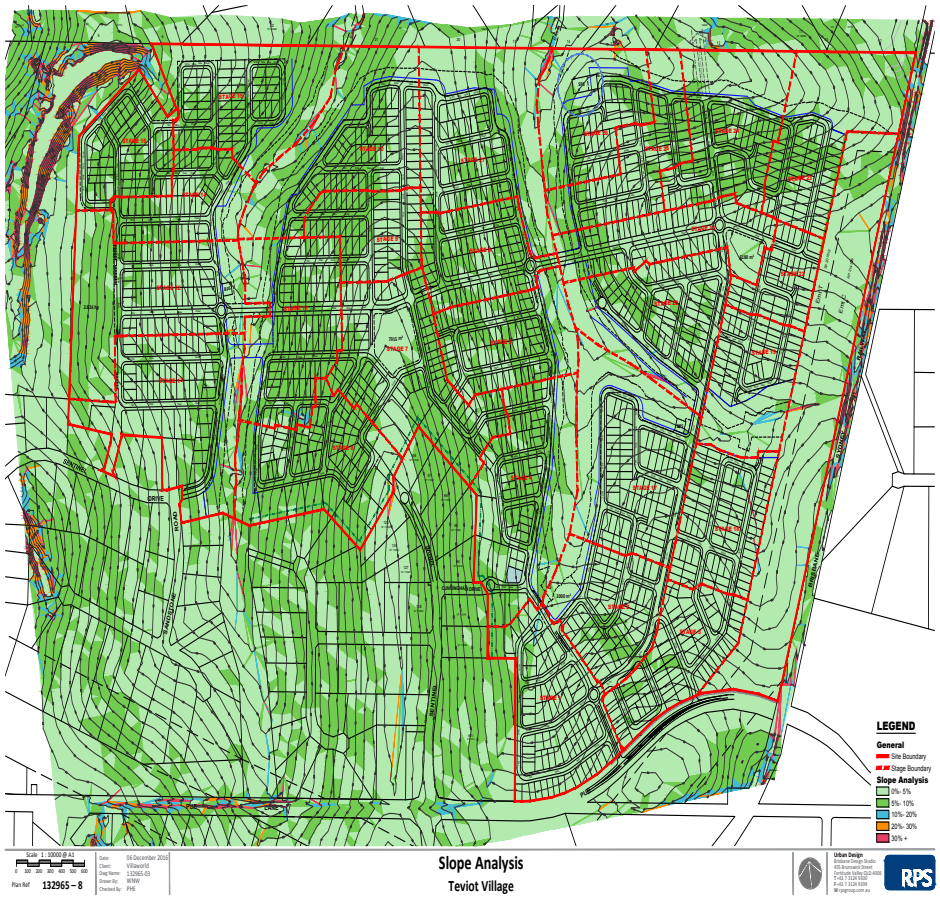

Figure 4a: Slope analysis north of Pub Lane with light and dark green areas representing slopes of 0-5%, and 5-10% respectively. The neighbouring area in the north west with steep slopes is the sparsely vegetated slopes of the lagoon (Refer **Figure 4b**).

Figure 4b: Lagoon on north – west boundary NPL.

A consequence is that there is little opportunity for fire to burn up-slope into any of the planned residential areas, and a 'hot' fire would not eventuate in this narrow, 'green' (moist) linear vegetation landscape. The proposed fire buffers calculated in this report are based on height of mature vegetation on site and these heights are therefore resultant from site edaphic factors.

The vegetated areas conserved NPL are proportionately, when compared with the previous parkland residential lots, not only very small, but are easily accessed by road and will have mains water available for fire fighting. ***The very small lots proposed will not be large enough to carry enough woody vegetation to pose a fire risk in themselves***.

The Bushfire Hazard Overlay mapping by Logan City Council 2015 (replaces the Development Constraints Overlay of Beaudesert Shire Planning Scheme 2007) identifies that much of the site is contained in a "Medium Bushfire Hazard Area", however, this is based on old aerial photography and will not be an accurate assessment of site conditions post development with the small allotments proposed (1500 allotments in the size range 294m^2 – 480m^2) with roadways separating allotments from retained vegetation most of the boundary.

Previous BRHA – SPP1/03

Previous BRHA reporting to SPP1/03 provides a detailed assessment of the bushfire risk affecting the site (Refer **Appendix B**). This report found that the planned estate is largely low-medium fire risk (lowest possible using 'scores' in SPP1/03), and had some areas that must be assessed as of medium risk due to the interface with significant Remnant vegetation i.e. north – east corner (Refer **Figure 1**). Therefore, in an overall hazard condition, analysis of bushfire hazard applying SPP Guideline 1/03 demonstrated that the fringes of the development nodes of NPL of Teviot Downs must be considered as **medium bushfire hazard**[3] areas on this interface (although a low score in this category) i.e. SPP1/03 states that a 50m safety buffer should be allowed where remnant vegetation remains and of sufficient width to pose a bushfire risk, or modified according to local conditions.

The 50m required was modified to suit site conditions however, and as stated in the code requirements set out in Appendix 5 - Table B 1.2(b) of the SPP 1/03 guideline, future dwellings should be separated from conserved "hazardous" vegetation i.e. where there is remnant vegetation with sufficient width and fuel potential, by a setback of 1.5 x site canopy height as determined by site mature trees i.e. **buffer width 1.5 x 22m = 33m**.

This previous assessment to SPP1/03 Guidelines is mentioned here, even though it is now replaced by *State Planning Policy – Special interest technical*

[3] AS3959 calculations for cleared grassland with slope downslope 5-10% (max.) and with 33m buffer to vegetated drainage corridors **BAL 12.5 - LOW** (Source: *Bushfire Prone Planning*). This is conservative as the vegetation in the Green Corridors is supported by a 'chain of ponds' and the available soil moisture greatly reduces any fuel source combustibility.

manual: Natural Hazards, Risk and Resilience; a 'fit for purpose' approach in undertaking natural hazard studies and risk assessments (April 2016), as it demonstrates that historically the planning NPL has been competent, considerate of State Planning Policies, and inclusive of buffers to retained natural vegetation. Fundamentally what has changed now is that there is now less retained natural vegetation across NPL with almost no fire connectivity with woodland/forest on the boundaries, and allotments are much smaller i.e. akin to an island of high density dwellings with maintained buffers on its boundaries (mostly with roadway) and it follows that the current ULDA approved development plan ensures low fire risk.

Approvals – Fire Management Water Supply

The current development plan ensures low fire risk to dwellings (also refer to BRHA following [4]), but nonetheless the capacity to control fire on the boundaries of the proposed development is a necessary issue. As this is a high density housing development, infrastructure design now needs to include water for fire control on the boundaries i.e. engineering of water supply for this purpose.

Approvals have controls for water supply including 'Fire Provision' under *Guidelines for Planning and Design of Urban Water Supply Schemes* (Water Resources, 1989). Now these have been revised by DERM as *Planning Guidelines for Water Supply & Sewerage* (April, 2010; Chapter 6 amended March 2014) and relevant sections to guide design in the new proposal NPL in particular are Chapter 6 *Regulatory requirements, Section 6.5 Fire flow policy.*

In the new guidelines (DERM April, 2010; Chapter 6 amended 2014) it states:

6.1 Overview

Water for fighting fires is a community service provided by water service providers through their water network. Provision of network capacity to fight fires in the community is an important part of the water supply network, however this is no legal requirement for this service to be provided. This section outlines the issues that should be considered by water service providers in relation to providing water for fire fighting.

6.2 Purpose

The purpose of this section is to:

- Summarise any regulatory requirements associated with fire provision and fire safety installations.
- Outline the roles and responsibilities of each party with respect to fire provision and fire safety installations.
- Describe a Fire Flow Policy that could be developed by water service providers.
- Outline minimum fire flow performance that should be provided by the water service provider.
- Provide guidance on the use of recycled water for fire fighting.

[4] *State Planning Policy – Special interest technical manual: Natural Hazards, Risk and Resilience; a 'fit for purpose' approach in undertaking natural hazard studies and risk assessments* (April 2016).

6.3 Regulatory requirements

While there are no legislative requirements for a water service provider in Queensland to provide a water supply for fire fighting purposes, water service providers typically provide fire hydrants in road reserves for this purpose. These fire hydrants are maintained at standards set by the provider.

6.5 Fire flow policy

6.5.1 Overview

A Fire Flow Policy is a commitment to cooperate and communicate with the local fire service to provide an appropriate standard of fire protection to the community.

To comply with this guideline, a water service provider must develop a policy detailing the fire fighting provisions required for water supply reticulation systems in its area. Cooperation with the local fire service is essential for the continuing provision of reliable fire service.

A Fire Flow Policy should include the following:

- Risk Assessment – A plan to identify and address existing and future fire risks (refer to Section 6.5.2)
- Fire Flow Provision Register – Reference to the maintenance of a property register detailing cases where additional fire provision is to be delivered above or beyond the levels specified in this guideline and where street fire hydrants are used in lieu of on-site fire safety installations (refer to Section 6.5.3)

Any design and planning for 'Fire Provision' referencing water required for fire fighting is outside the scope of any considerations in this document. However, the fundamental principles of reducing fire risk through measuring fire hazard, as in the State Planning Policy Guideline (SPP1/03 – *Mitigating the Adverse Impacts of Flood, Bushfire & Landslide (June 2003))* remain as foundations in reducing bushfire hazard by guiding development design principles, as is historically the case for this development.

Buffers

In SPP1/03, and now replaced by State Planning Policy *Natural Hazards, Risk And Resilience* (April 2016), methodologies are prescribed which are adopted/approved by the Queensland Fire and Rescue Service (QFRS). The previous BRHA was carried out in accordance the SPP 1/03 Guideline (Refer **Appendix B**) and determined buffers for site conditions.

Required Bushfire Buffers – SPP 1/03

- *A 33m setback is required between dwellings along the interface of Stages with the Remnant vegetation in the drainage gullies.*

- *Where development interfaces with vegetation in easements on the estate boundary then a bushfire hazard management plan by others will need to be verified.*

- *In the NE portion during any staged development without clearing of the development footprint prior to commencement of works, there will need to be a progressive firebreak constructed on the development boundary.*

Following is a review of BRHA under the current State Planning Policy.

BRHA State Planning Policy – Natural Hazards, Risk and Resilience (April 2016)

The BRHA *Technical Manual* (2016)[5] [6] replaces SPP1/03 , and directly references a comprehensive scientific database on fire behaviour spanning over 3 decades. It comments that SPP1/03 was intuitive, and by that reference is being made to it being necessary to be interpreted accurately by an 'expert' in natural systems management i.e. in particular the interaction of site abiotic influences (slope and aspect) with vegetation communities (fuel loads and physical characteristics of fuel). This is referred to specifically as:

> *The new methodology was developed to overcome limitations in the original SPP1/03 approach with respect to its inherent scientific assumptions, currency, resolution and inadequate consideration of regional differences in fire weather severity.'*

But in support of SPP1/03, when used as a guideline for standardising reporting by an 'expert', it served a useful purpose in defining a framework for bushfire risk hazard reporting.

Nonetheless, the *Technical Manual* (2016) describes a State-wide mapping methodology for bushfire prone areas, and ultimately will be the foundation for Local Governments to produce accurate bushfire risk mapping.

Basically, this science based methodology has as its primary assessment the fire front and what influences the behaviour of fire at that front, including a weighting of Fire Weather Severity for an area taken from climate change modeling (UN IPCC; noting that the accuracy of these models is being constantly updated).

It is a consequence of this categorisation of vegetation (fuel loads and physical characteristics) that strategies for fighting fires from remote locations is possible and can include consideration of population intensities i.e. strategies are dependent on the accuracy of vegetation mapping and site characteristics databases organised into Local Government Areas.

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[5] Above n4.

[6] The *Technical Manual* should be read in conjunction with *CSIRO – a new methodology for State-wide mapping of bushfire prone area sin Queensland* (January 2014).

So combining the fire behaviour model of McArthur (1967) with Byram's (1959) fire line intensity, provides the equation central to assessing fire in natural vegetation:

$$FI = 0.62\ W^2\ FFDI \exp(0.069\ \theta)$$

Where
$FI = 516.7\ W\ R\ \theta$

And
$R\ \theta = R \times \exp(0.069\ \theta)$
$R = 0.0012\ FFDI\ W$

FI	Bryam's Fire-line intensity (kW/m)
H	Net low heat of combustion (kJ/kg)
W	Fuel consumed in the active flame front (kg/m^2)
R	Linear rate of fire spread (km/hr)
Θ	Slope
0.069	Empirical coefficient by McArthur (worst case - fire is moving upslope)
FFDI	Fire Weather Severity (Forest Fire Danger Index)

It is then the grouping of areas so defined in underlying geometries (1km squares to UTM Grid with corresponding 200m diameter 'circular assessment areas') (Refer **Figures 5a** & **b**) with the same FI that develops the large scale bushfire prone maps.

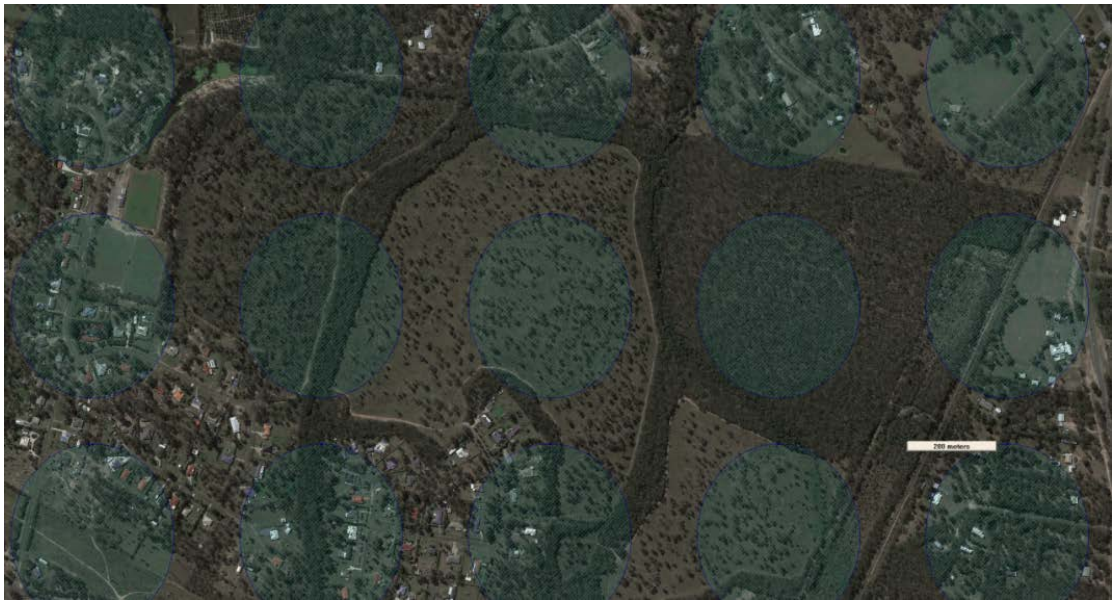

Figure 5a: GIS 200m diameter 'circular assessment areas' linked to 1km squares to UTM Grid as per the CSIRO GIS database.

Figure 5b: Corresponding 1km squares to UTM Grid. Note the underlying geometric constraints and coarseness of the mapping units when dealing with a relatively small landscape unit for the purpose of assessing bushfire hazard in the area so defined as Teviot Downs north of Pub Lane.

Practical Limitations to Application of Methodology

There are two important considerations when a large scale mapping tool as the BRHA[7] is applied, and these are:

(i) Aerial extent of vegetation communities; and
(ii) Need for ground truthing to confirm fuel loads and fuel physical structures over this aerial extent.

But of first consideration is the ability of the GIS 'interrogation' grid to determine the aerial extent of bushfire prone areas. Obviously the vegetation pattern across NPL is not in a natural state and is maintained in an estate development configuration. The current BRHA is clearly not of a scale or has a fine pattern recognition algorithm to determine BRHA conditions on this allotment i.e. NPL.

Then there is the need for vegetation mapping to align the geometry of the current BHRA to determine aerial extent of vegetation communities for the purpose of applying a estimation for fuel loads[8] [9] i.e. Regulated vegetation

[7] Above n4

[8] Above n4: Table 2: Vegetation Hazard Classes and Potential Fuel Loads

mapping under the *Vegetation Management Act* 1999 (State) (Refer **Figures 6a** & **b**). This is a useful example as it will be the most extensive patch of vegetation remaining, mapped as remnant in the north - east corner, after completion of the estate.

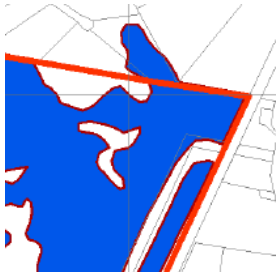

Figure 6a: Remnant vegetation mapping.

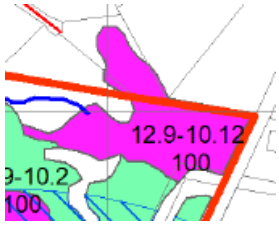

Figure 6b: Vegetation community mapping. Vegetation mapping under the *Vegetation Management Act* 1999 would be interpreted as woodland to open forest and a potential fuel load of 30t/ha.

Ground truthing of this vegetation at this location (Refer **Figure 7**) revealed that the mapping (Refer **Figure 6**) was incorrect and it was in fact a mosaic of remnant vegetation and regrowth (Refer **Appendix C**) and accordingly, the assignment of a potential fuel load of 30t/ha would not be a reflection of existing conditions for the purpose of identifying bushfire prone areas.

Another important feature at this locale is the swale and drainage line fuel accumulation as there are vigorous overland stormwater flows at his site i.e. leaf litter is removed from the forest floor (Refer **Figure 8**). While in areas of whip-stick regrowth with *Alphitonia excelsa* and *Acacia spp.* There is little build up of fuel loads on the forest floor (Refer **Figure 9**).

There is one caveat however and that is concerned with infestation with the pest species *Lantana camara* which can accumulate growth at the base of trees and thus build up vertically and posing a potentially important modification to fire behaviour in a fire front with promotion of hot fire due to the physical characteristics of this fuel (Refer **Figure 10**). There was one other weed which is ubiquitous across this site i.e. Giant Rats Tail *Sporobolis pyramidalis* , but it does not influence fire behaviour (Refer **Figure 11**).

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[9] QFRS Guidance on conducting Reliability Assessment State Bushfire Prone Area Mapping (September 2016) p4 'Refer to recent aerial photography, **other available mapping** and local knowledge when undertaking the assessment'.

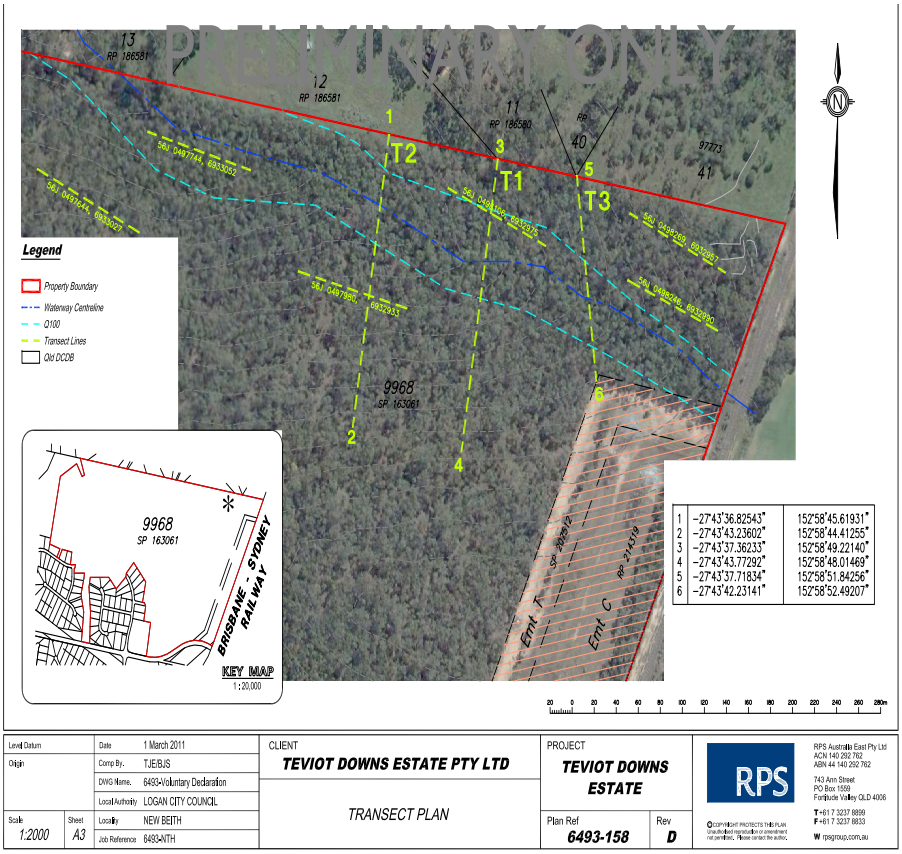


Figure 7: Positions of transects in north – east vegetation to be conserved in approved development plan bu ULDA: Transects 1 & 3 were located from existing boundaries (fence lines of neighbouring properties which intercept the northern boundary of the estate), while T2 start was measured along the fence line 200m. Transects T1 & T3 were measured by 50m tape perpendicular to the northern boundary, while T3 was ended at a locatable point in the electricity corridor (yellow marker for water pipeline). In this fashion, there is no error in the positions from hand held GPS. To complete the transect data sheets, these locations were determined by RPS surveyors (Refer **Appendix C**).

CSIRO fire research scientists realise the difficulties in application of the Fire Intensity (FI) model proposed (refer above) in a mosaic of landscapes with considerable modification since European settlement i.e. where there would not naturally been a vegetation discontinuity, now the built environment is contiguous with remnant patches. With regard to further development like that NPL, the scales discount the usefulness of the application of these models to determine bushfire prone areas and risk.

CSIRO fire research scientists estimate that 85% of mapping of bushfire prone areas is accurate, but then comment on the need for 'Patch and Corridor Filtering'[10]. With the encountering of small patches and narrow corridors, as is the case with the final configuration NPL, they conclude that the aerial extent and behaviour of the fire line will be unlikely to reach the level predicted applying the Bryam's & McArthur models. They then recommend removing narrow corridors <100m through a process of patch erosion and dilation and

[10] Above n6: p5 2.2.1 'Patch and Corridor Filtering'.

Figure 8: Leaf litter transported in overland flows to drainage lines where they are transported offsite down catchment.

Figure 9: Whip stick regrowth in the north - east corner NPL with low fuel loads on the forest floor.

Figure 10: Patches of *Lantana camara* pioneering in the north – east corner. If left unmanaged, this can form thickets many metres high which would modify the fire behaviour in this area, and with vegetation attaining remnant status would promote a fire line with ember attack on a local scale, but very much dependent on prevailing climatic conditions.

Figure 11: Patches of Giant Rats Tail Grass *Sporobolis pyramidalis* in the paddock behind the sales office.

merging with neighbouring vegetation and using the Vegetation Hazard Class of that vegetation. But in this instance, the vegetation in question NPL is not with fire connectivity with other significant remnant woodlands i.e. an island (Refer **Figure 12**), and native vegetation to be retained in the built environment footprint is to be significantly reduced (Refer **Figure 13**).

Conclusions

Application of the new State Planning Policy[11] to perform BRHA has limited usefulness on areas NPL due to the small scale of the fragmented mosaic of remnant and regrowth vegetation to be retained. The new SPP is based on an underlying geometry at a scale which overwhelms the significance of the vegetation extent existing.

Furthermore, it is demonstrated that the Regional Ecosystem mapping NPL is in error and this affects the estimation of any fuel loads existing.

Recommendation

It is sound to revisit the considerable body of scientific knowledge for this site that founded the previous BRHA and reported in the framework of SPP 1/03, and specifically with respect to buffer widths to retained native vegetation.

These buffers are:

- *A 33m setback is required between dwellings along the interface of Stages with the Remnant vegetation in the drainage gullies. Selectively retained mature trees within this setback area, including active linear parkland with mown understorey, should represent less than 30% of the natural canopy (FPC) for this site to reduce any fire hazard rating to 0.*

- *Where development interfaces with vegetation in easements on the estate boundary then a bushfire hazard management plan by others e.g. Powerlink and SEQ Water, will need to be verified. These management plans will need to have as their focus a maintenance regime which prevents vegetation growth becoming a fire hazard.*

- *In the NE portion during any staged development without clearing of the development footprint prior to commencement of works, there will need to be a progressive firebreak constructed on the development boundary.*

~~Where the above recommendations are implemented in full, no elevated construction measures under AS3959[12] are necessary for dwellings established on the residential lots illustrated on the development layout (Refer **Figure 2**).~~

The bushfire risk of a property will need to be confirmed at the building stage to determine the level of construction required to address any potential bushfire impacts.

[11] Above n4.

[12] *Australian Standards* ® SAI Global

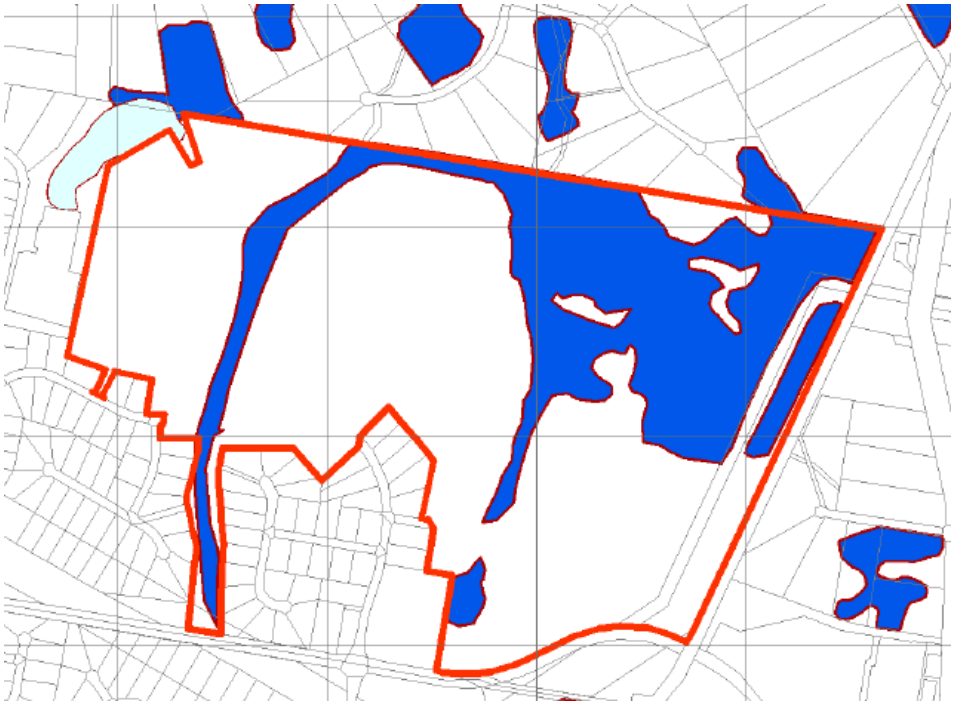


Figure 12: Regional Ecosystem mapping showing Remnant vegetation NPL, although Remnant status is challenged for areas in the NE corner.

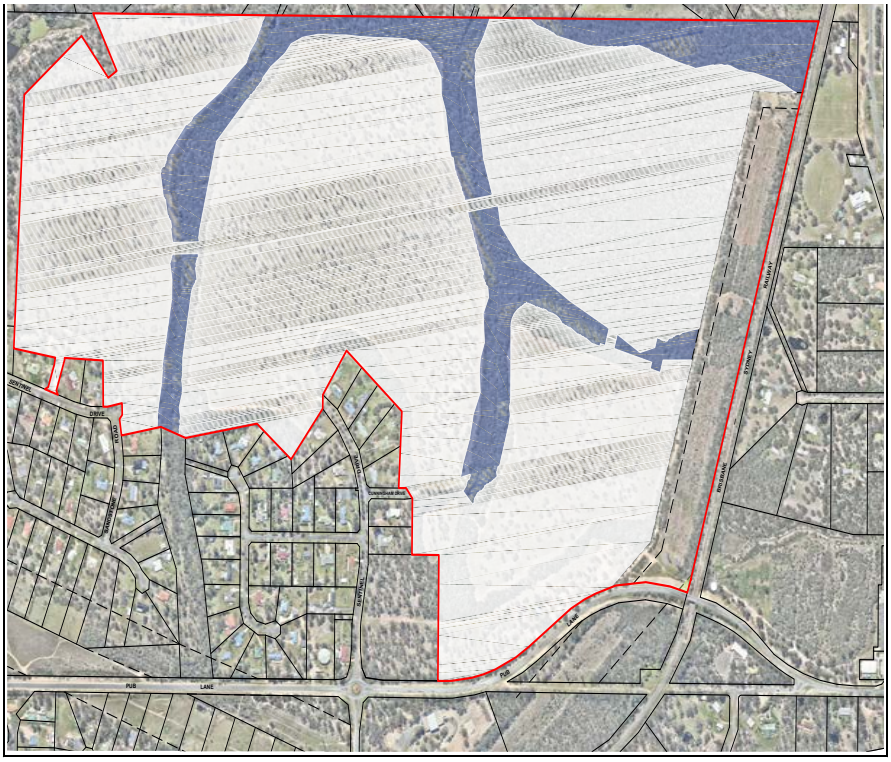
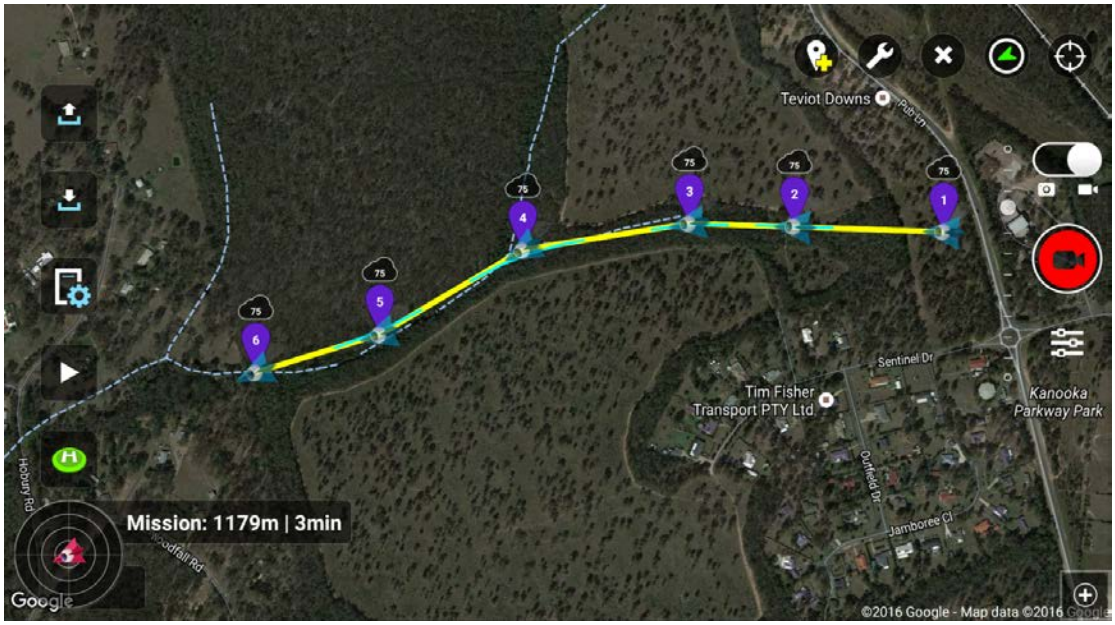
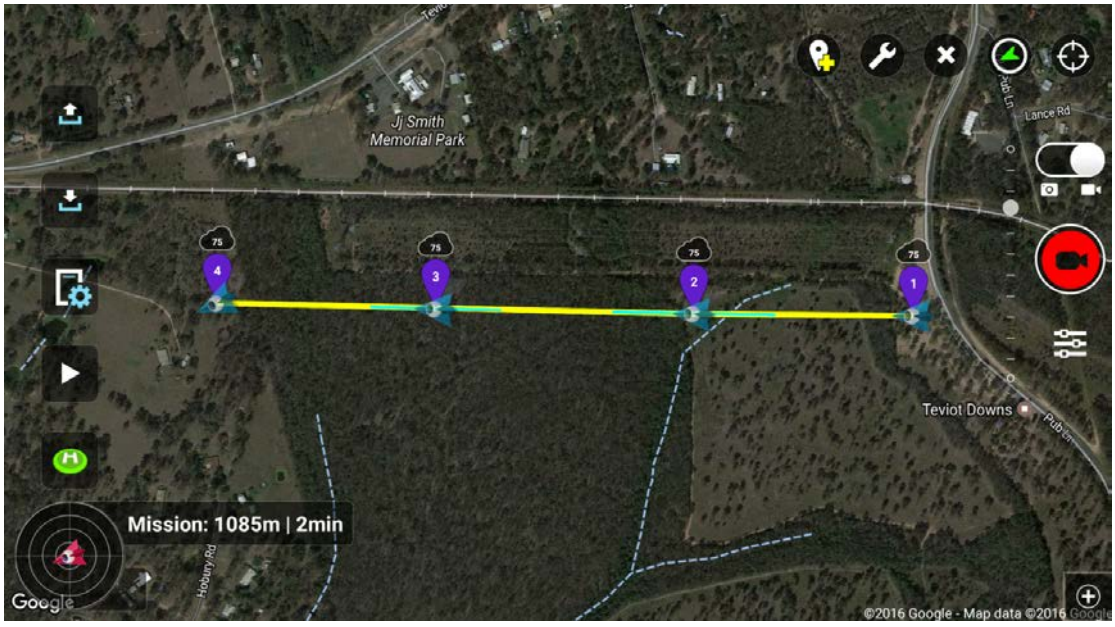


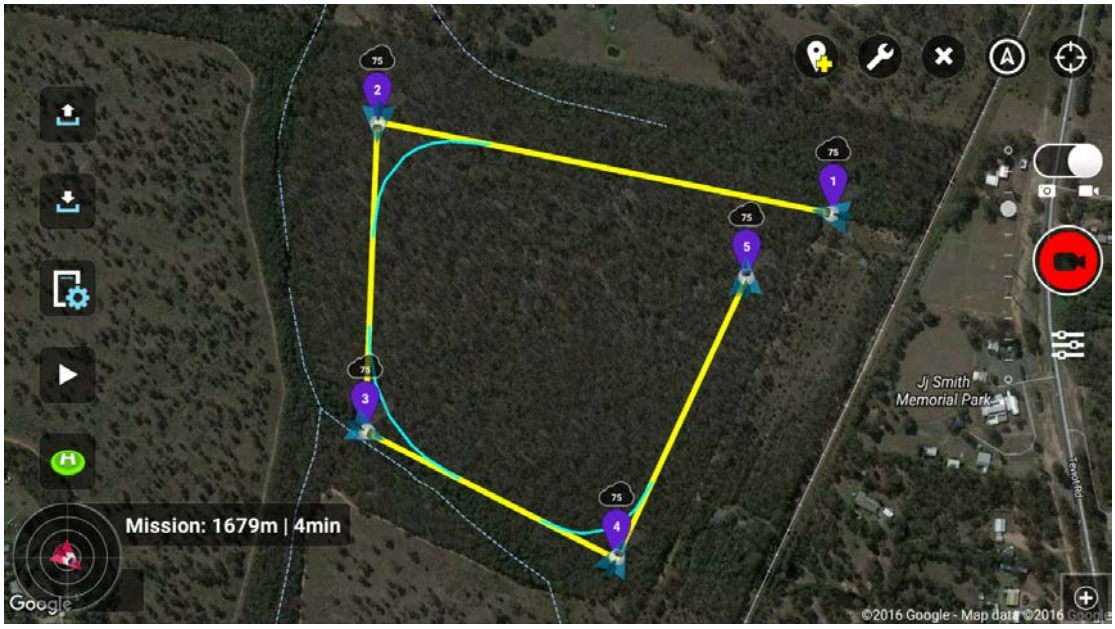
Figure 13: Development area to be cleared of vegetation leaving only narrow corridors across the property north – south and on the northern boundary.

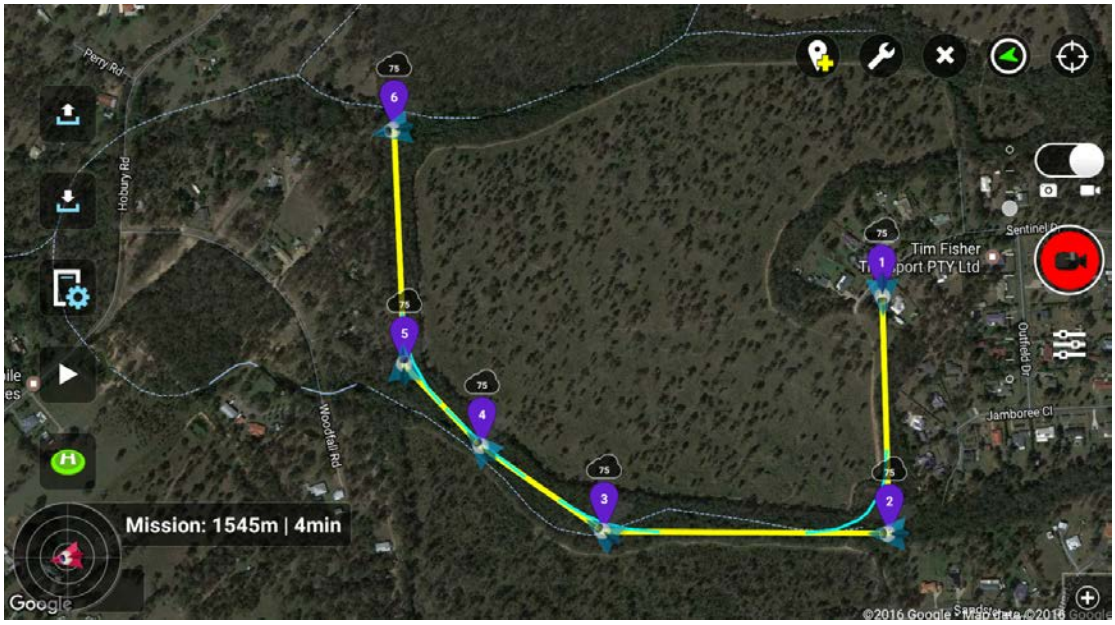
Appendix A

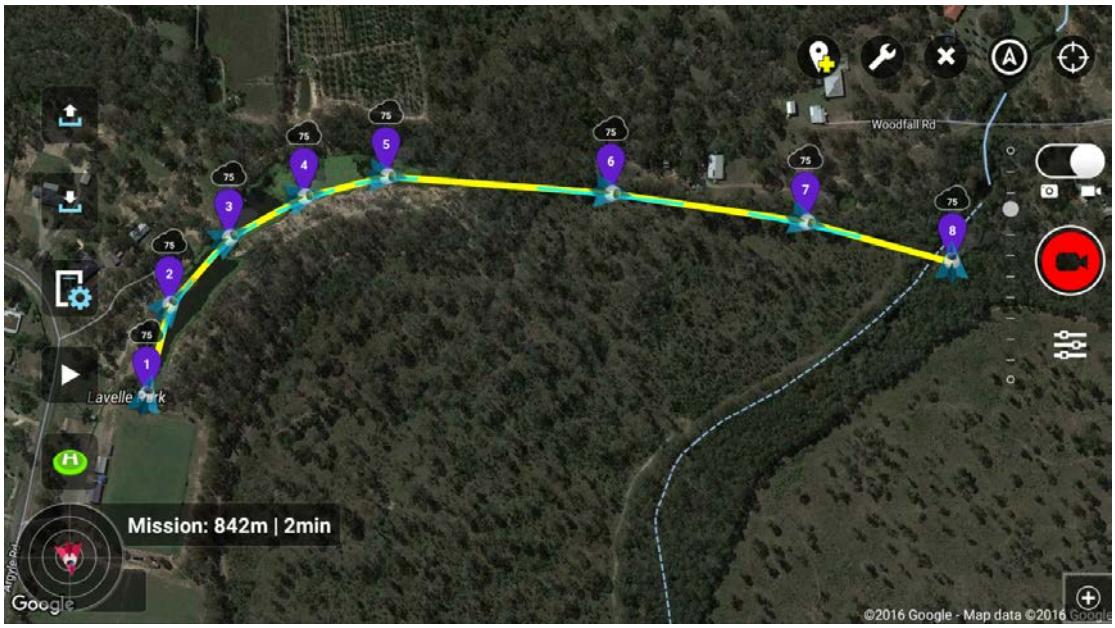
Drone Image Flight-paths


Teviot Downs
Tim Fisher
Transport PTY Ltd
Sentinel Dr
Kanooka
Parkway Park
Mission: 1179m | 3min
©2016 Google - Map data ©2016


Jj Smith
Memorial Park
Lance Rd
Teviot Downs
Mission: 1085m | 2min
©2016 Google - Map data ©2016


Jj Smith
Memorial Park
Mission: 1679m | 4min
Google
©2016 Google - Map data ©2016


Perry Rd
Hobury Rd
Woodhill Rd
Tim Fisher
Outfield Dr
Jamboree Cl
Mission: 1545m | 4min
Google
©2016 Google


Woodfall Rd
Lavelle Park
Mission: 842m | 2min
Google
©2016 Google - Map data ©2016

Appendix B

Bushfire Risk Hazard Analysis

Development Ecology Pty Ltd
11 May 2012

BUSHFIRE RISK HAZARD ANALYSIS
Teviot Downs, North of Pub Lane

Prepared for:

TEVIOT DOWNS ESTATE PTY LTD

11 May 2012

Prepared by:

Development Ecology Pty Ltd
PO Box 288
Ferny Hills QLD 4055

Submitted by:
Dr Mark Pillsworth
Director
Principal Ecologist

Principal Authors
Professor Roderick W Rogers
Principal Botanist
Dr Mark Pillsworth
Principal Ecologist

Summary of Issues

Teviot Downs can be conveniently divided into areas either north or south of Pub Lane. Previously, in the area north of Pub lane (NPL) there were three proposed development nodes comprising 275 allotments over what was planned as Stages 35-38. A Reconfiguring a Lot Development Approval was given on 6 October 2010 (Logan City Development Permit RL/57/2009) with conditions for ensuring permanent access to adequate water supply for fire fighting, which stated:

22 BUSHFIRE HAZARD AREA

22.1 Design and implement the development in accordance with the recommendations of the "bushfire Management Plan", prepared by Development Ecology Pty Ltd dated 1 February 2010.

22.2 Provide for permanent access to an adequate water supply for fire fighting purposes for each Lot. The permanent water supply must be in the form of a 31,500L water tank that:

22.2.1 has a minimum of 5000litres available for fire-fighting purposes at all times;
22.2.2 is provided with adequate vehicle access for a fire-fighting vehicle;
22.2.3 is fitted with water supply outlet pipes of 55mm diameter fitted with a male camlock; and
22.2.4 positions the normal tank outlet to reserve 5,000 litres in the bottom for fire-fighting purposes only; and
22.2.5 is in a place at the time of the completion of the new dwelling.

These conditions are now redundant with the new application to the ULDA for a redesigned precinct north of Pub Lane where allotments will be greatly reduced in size and dwellings will have connections to the water supply and sewerage network. Previous approvals by Beaudesert Shire Council, and now Logan City Council, have controls for water supply including 'Fire Provision' under *Guidelines for Planning and Design of Urban Water Supply Schemes* (Water Resources, 1989). Now these have been revised by DERM as *Planning Guidelines for Water Supply & Sewerage* (April, 2010) and relevant sections to guide design in the new proposal NPL are *Chapter 6 Network Modelling, Section 5.0 Key Elements, Sub-Section 5.7 Fire Provision.*

In the new guidelines (DERM April, 2010) it states:

5.7.1 Intent of Fire Provision

> Provision of network capacity to fight fires in the community is an important part of the water supply network. Most water supply reticulation systems are designed to meet some level of fire protection, however the level provided is variable and depends on the available system capacity.
>
> To comply with this guideline, a service provider must develop a policy detailing the fire fighting provisions required for water supply reticulation systems in its area. Cooperation with the fire authority is essential for the continuing provision of reliable fire service.

It follows that any design and planning for 'Fire Provision' referencing water required for fire fighting is now outside the scope of any considerations in this document, and clearly in the realm of the water authority in concert with the local fire authority. However, the fundamental principles of reducing fire risk through measuring fire hazard, as in the State Planning Policy Guideline (SPP1/03) – *Mitigating the Adverse Impacts of Flood, Bushfire & Landslide (June 2003)* remain as foundations in reducing bushfire hazard by guiding development design principles.

In SPP1/03 methodologies are prescribed, which are approved by the Queensland Fire and Rescue Service (QFRS). This assessment has been carried out in accordance with the SPP 1/03 Guideline

In past development applications, the master plan NPL has dictated design fundamentals for fire hygiene, and the alignment and density of housing was of secondary consideration to vegetation communities neighbouring and the required setback(s) from such vegetation. As this current development scenario has emerged, the principal factors in assessing bushfire risk changed, and now principal in this are:

(v) The size of allotments which have been progressively reducing (now <<2500m^2), concurrent with an increase in the number of allotments;
(vi) Reticulated mains water supply;
(vii) Orientation of smaller allotments with roadways and cleared verges to what are now 'linear parks' conserving gully lines of Regionally Endangered Regional Ecosystems;
(viii) Isolation of any vegetation so conserved in gully lines from any significant vegetation in areas offsite.

This meant that the previous Bushfire Hazard Assessment for parkland residential development (Development Ecology, 24 October 2011) will change where there is an interface with Remnant vegetation as the risk from bushfire is now greatly reduced e.g. in the NE corner, and onsite water reserves for fire

fighting will not be a consideration as in the Development Approval (RL/57/2009) with conditions, this is now a risk element in *Network Modelling* as set out in *Planning Guidelines for Water Supply & Sewerage* (Development Ecology, April 2010) i.e. fire fighting capacity in water mains as designed in engineering, considering local fire authority advice.

In previous development scenarios, important influences in bushfire management were the spatial extent of the bushland interfacing the development NPL e.g. the NE corner, and its offsite links with other vegetation. In the current proposal, the vegetation contiguous with housing when constructed will be linear and < approximately 60m in width, this being vegetation in ephemeral watercourse/drainage features, and some with a more permanent 'chain of ponds' i.e. the vegetation understorey will be usually 'green' grasses. The bushfire risk is greatly lessened in the current proposal due to the reduced spatial extent of any vegetation now proposed to be retained, and the observation that any vegetation is not in a corridor linking with significant vegetation offsite.

The slopes NPL are gentle and generally are less than or very close to five percent, and as stated the vegetated areas around proposed development areas are normally narrow. However during any staging sequence, some development areas may be contiguous with remnant vegetation and a firebreak of 32m will need to be maintained on the boundary of the advancing development. A consequence is that there is little opportunity for fire to burn up-slope into the planned residential areas, and a 'hot' fire would not eventuate in this narrow, 'green' linear vegetation landscape. The proposed fire buffers calculated in this report are based on height of mature vegetation on site and these heights are therefore resultant from site edaphic factors.

The vegetated areas conserved NPL are proportionately, when compared with the previous parkland residential lots, not only very small, but are easily accessed by road and will have mains water available for fire fighting. ***The very small lots proposed will not be large enough to carry enough woody vegetation to pose a fire risk in themselves***.

The Development Constraints Overlay in the Beaudesert Shire Planning Scheme 2007 (which is largely consistent with the Rural Fire Service mapping from 2002) identifies that much of the site is contained in a "Medium Bushfire Hazard Area", however, this is based on old aerial photography and will not be an accurate assessment of site conditions post development with the small allotments proposed (median size category 400 – 600m^2) with roadways separating allotments from retained vegetation.

This report provides a more detailed assessment of the bushfire risk affecting the site. The report has found that the planned estate is largely low-medium fire risk, and no longer has some areas that must be assessed as of medium risk due to the interface with significant Remnant vegetation. Therefore, in an overall hazard condition, analysis of bushfire hazard applying SPP Guideline 1/03 demonstrates that the fringes of the development nodes of NPL (formerly Stages

35-38) of Teviot Downs must be considered as **medium bushfire hazard** areas on this interface (although a low score in this category) i.e. SPP1/03 states that a 50m safety buffer should be allowed where remnant vegetation remains and of sufficient width to pose a bushfire risk, or modified according to local conditions.

However, as stated in the code requirements set out in Appendix 5 - Table B 1.2(b) of the SPP 1/03 guideline, future dwellings should be separated from conserved "hazardous" vegetation i.e. where there is remnant vegetation with sufficient width and fuel potential, by a setback of 1.5 x site canopy height as determined by site mature trees i.e. buffer width 1.5 x 22m = 33m.

Required Bushfire Buffers

- ***A 33m setback is required between dwellings along the interface of Stages with the Remnant vegetation in the drainage gullies.***

- ***Where development interfaces with vegetation in easements on the estate boundary i.e. Stages 21, 23 & 26 and allotments 217 – 227, then a bushfire hazard management plan by others will need to be verified.***

- ***In the NE portion during a staged development without clearing of the development footprint prior to commencement of works, there will need to be a progressive firebreak constructed on the development boundary.***

The Site

The site to be occupied by relatively high-density precincts/Stages north of Pub Lane (NPL), Teviot Downs, consists of generally flat to undulating slopes with shallow drainage features. Some remnant or regrowth vegetation is present along these drainage features and in the northeast portion of the site. As an underlying general fire condition, the high density residential lots proposed are small and will not in themselves be large enough to carry enough woody vegetation to pose a fire risk i.e. the only consideration for Bushfire Hazard Analysis is a setback from conserved vegetation in gully lines ('linear parkland') (vegetation on the western boundary associated with the sports grounds and Lavelle Lagoon is too narrow, and also maintained as linear parkland, to warrant any consideration as a fire risk).

Therefore, NPL the proposed development areas will have an interface with only limited patches of natural vegetation left conserved in what is now termed 'linear parkland', and there is little opportunity for intense fire to build up in these scattered remnants with small fetch. However, the risk that even small fires can cause damage to property and place life at risk remains real.

In Teviot Downs access to the vegetated areas for fire control is good with paved streets planned and mains water close at hand (as determined by application of the DERM *Planning Guidelines for Water Supply & Sewerage* (April, 2010)).

Formal Bushfire Hazard Risk Assessment

Risk factors have been quantified for formal analysis in *Bushfire Hazard Planning in Queensland - June 2003*. This process is applied here.

The development now proposed (Refer **Figure 1**) will have when completed a boundary where there will be an interface with a narrow, linear vegetation landscape along a drainage line i.e. linear parkland conserving RERE in gully lines (Refer **Figures 2a** & **b**).

Fire risk hazard components are calculated for the conserved RERE interface only, as the high density residential lots proposed are small and will not in themselves be large enough to carry enough woody vegetation to pose any bushfire risk, using tables in SPP Guideline 1/03.

Three factors are involved in this calculation: ***vegetation***, ***slope*** and ***aspect***. Comment on site-specific conditions follows, with reference to the interface with the Remnant vegetation.

1. Vegetation

In general, NPL the vegetation of the site comprises two basic assemblages, very lightly wooded grassy areas, which are to be subdivided into medium to high-

density residential building lots, and Remnant or regrowth natural vegetation in drainage features and in the NE corner.

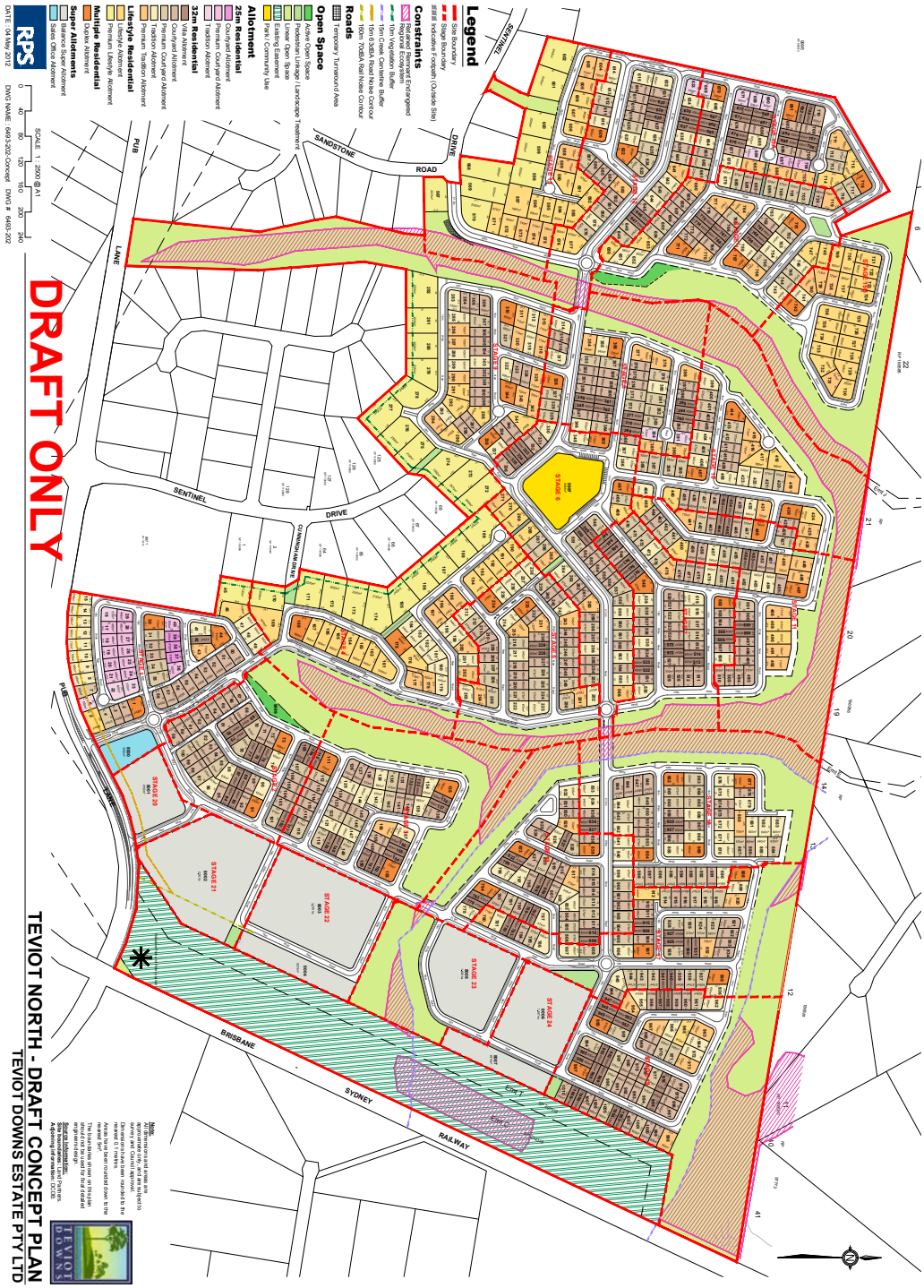


Figure 1: Preliminary layout showing staging of development and its relative position NPL. Note that where a stage does not have a roadway on its boundary after construction (internal stages in NE corner), a 33m wide fire break will need to be cleared between the development and any remnant/regrowth vegetation. This will be be the case in stages 16,17, 18 A + B as these are to be developed in areas which are not under a maintenance regime unlike the areas referred to as Areas A, B & C i.e. there will be areas of remnant/regrowth vegetation contiguous.

Figure 2a: Arrow (blue) showing example of interface on boundary along Stages 2 & 5 with linear parkland vegetation i.e. RERE conservation landscape < approximately 60m width. Arrow (red) shows the larger vegetated area in the NE, which is isolated from offsite vegetation by clearing. If this area is not initially cleared, a 33m fire break will need to be maintained on any advancing development boundary.

Figure 2b: Aerial image showing that the vegetation is isolated from vegetated areas offsite by neighbourhood clearing. Note previous development 'nodes' termed 'A' 'B' & 'C'.

Remnant vegetation conserved in the drainage features i.e. thin linear vegetated corridors.

The natural vegetation is grassy eucalypt forest, usually with an *Acacia leiocalyx* mid-story. The woodland is variable in species composition with *Eucalyptus crebra* and *Corymbia citriodora* dominating on ridges and *Eucalyptus seeana, Eucalyptus tereticornis* and *Corymbia citriodora* in lower lying areas. Most of this has previously been maintenance thinned and does not resemble the original vegetation community. The open areas, previously referred to as Areas A, B & C (Refer **Figure 2b**), have a tree canopy cover of less than 12% with a grassy understorey developing as a result of periodic slashing. This is non Remnant and therefore poses very little bushfire hazard threat on the boundaries of development in these areas and will not be considered further, as periodic maintenance slashing by the developer negates any risk.

Melaleuca quinquenervia is dominant in the drainage feature proper.

The Hazard score associated with the woodlands is 6 (this is very conservative as the canopy cover is < 12%), and of the slashed grass 2 (although this is under the control of the developer and could be reduced to 0), according to table **A3.1** of SPP guideline 1/03.

Estimate of Mature Canopy Height for this Site

The vegetation of the site comprises regrowth following clearing for development some decades ago. Some of the site has now achieved the status of remnant vegetation of least concern. The area is appropriately described as eucalypt woodland with a variable understorey of *Acacia* or low shrubs and grass. Beneath the power lines the vegetation has been reduced to slashed grasses.

Within the vegetation some trees can be found that are remnants of the pre-clearing vegetation. These were apparently left as landscape trees in the proposed estate (area cleared for 4000m^2 allotments in 2002 by Forester Kurtz leaving only the vegetation in the gullies intact). It is likely, therefore, that they were trees of stature at that time, and now, twenty or thirty years later, can be treated as mature trees. Some of the larger trees appear to have died in recent years. The most prominent of these older trees still living were located and both diameter at 1.5m above soil level and height measured. DBH was determined using a tape to measure circumference. Height was measured using a clinometer and a tape.

Trees more than 20m tall are quite uncommon (Refer **Figure 3**: **Appendix 1**)

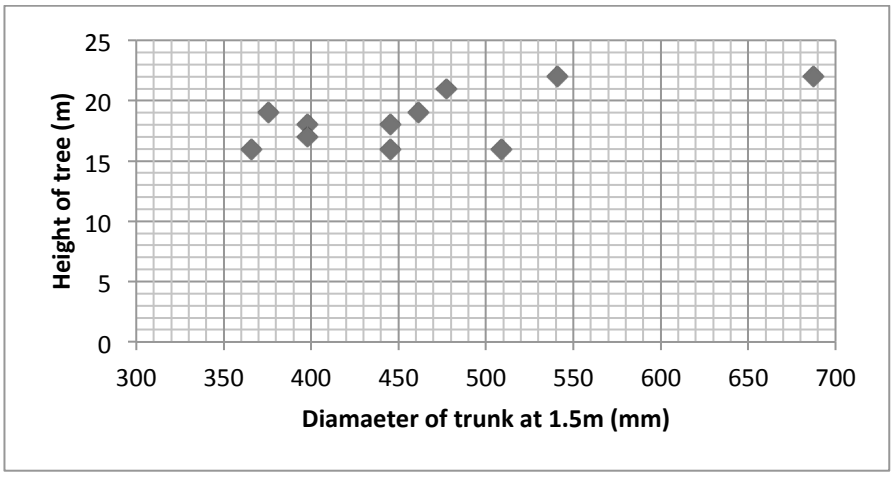


Figure 3: The relationship between trunk diameter at 1.5m (DBH) above soil level and tree height for the eleven tallest trees found in or near Stages16,17, 18A, 18B, 19, 24, 25 & 26 , Teviot Downs.

It seems likely that edaphic (mostly soil fertility) factors limit the height to which trees grow in this area, although it is well established that eucalypts show considerable genetic difference over small distances and it is possible that the trees in this area of low soil fertility are genetically limited in their height.

Nevertheless, it is concluded therefore that, the mature tree canopy in Stages 16, 17, 18A, 18B, 19, 24, 25 & 26 are measured to have a **maximum height of 22m**, not often exceeding 20m. This is considered to be indicative of species across this site as edaphic factors are largely consistent across this site. The DBH indicates that at this height these mature trees display growth relationships consistent with these species, and coupled with the Eucalypts' fire resistant bark, these trees would not readily fall during bushfire on this estate.

Therefore, as stated in the code requirements set out in Appendix 5 - Table B 1.2(b) of the SPP 1/03 June 2003 guideline, future dwellings should be separated from conserved "hazardous" vegetation i.e. remnant vegetation, by a setback of 1.5 x site mature canopy height (22m) of mature species present (33m) i.e. 1.5 x 22m = 33m.

Understorey in/near gullies in NE corner

The environment of stages 16,17, 18A, 18B, 19, 24, 25 & 26 all has a moderate bushfire hazard risk, but mostly at the low end of that hazard risk category.

The vegetation close to the proposed staged development is a small area in total, limiting the potential for a fire to reach a high intensity. That the vegetation is confined to narrow tongues after development further restricts any bushfire hazard.

In these tongues, typical understorey vegetation i.e. potential fuel, is surviving on a nutrient poor soil, which has limited penetration by weeds (Refer **Figure 4**:

Appendix 2) and even those present, have not grown vigorously. *Lanatana camara*, for example is present only as a few small plants. This further reinforces the bushfire hazard assessment that the risk will be low in the moderate classification i.e. a 33m buffer to dwellings will be conservative.

2. Slope

Slope on the interface with the Remnant linear vegetation can be categorised as plain (less than 5%), which has a hazard score of 1, or undulating (5-10%), which has a hazard score of 2 (Refer **Figure 4**).

3. Aspect

Aspect has no significant impact on fire hazard here due to the minimal slope (approximately 5%), width of the linear vegetation < approximately 60m width, and that the proposed development is medium to high density residential lots which are small (median size category 400 – 600m^2) and will not in themselves be large enough to carry enough woody vegetation to pose any fire risk.

Figure 3: Ground layer within the community north of the proposed development showing its open, mostly weed-free nature. Where the over-storey is less dense a grassy layer usually dominated by fine native grasses establishes in dry areas and native sedges or the native grass *Imperator cylindrica* in swales. This constitutes a low risk in the moderate classification of bushfire assessment and supports a bushfire buffer of 33m to dwellings being conservative.

Hazard Score

From the above, a *Hazard Score* can be calculated and this will then trigger the provision for a safety buffer of set width where the score is > 5.5 (Refer **Table 1**).

Table 1: Hazard score ranges to identify the severity of bushfire hazard. (Table A 3.5 from SPP Guideline 1/03)

Total hazard score	Severity of bushfire hazard	Width of safety buffer
13 or greater	High	100 metres
6 to 12.5	Medium	50 metres
1 to 5.5	Low	Not applicable

The assessment that follows links the hazard with the proposed development sequence/stages.

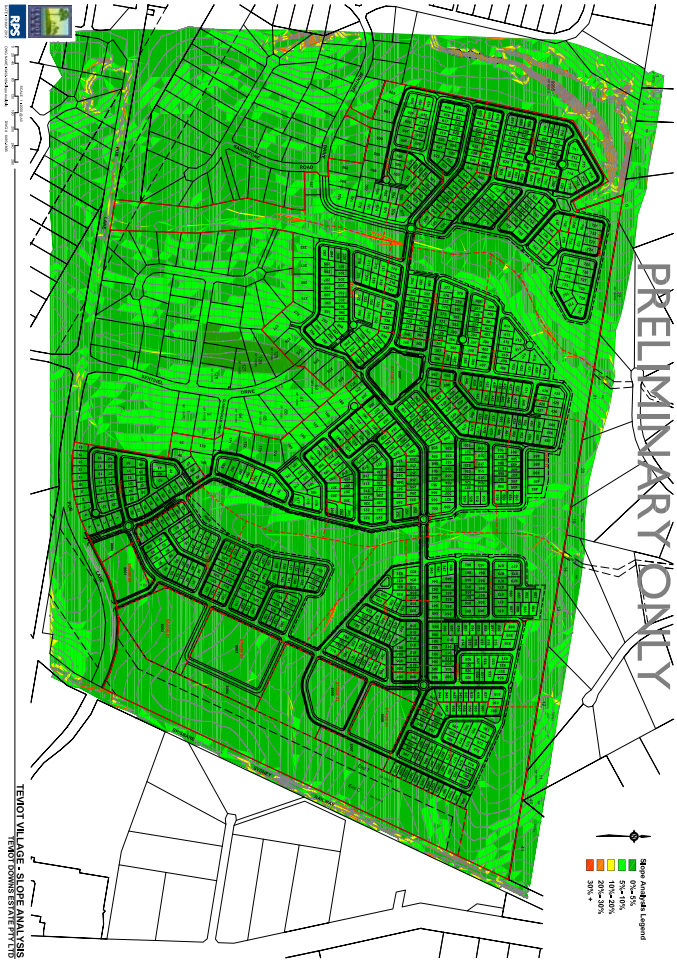


Figure 4: Map showing slope analysis across Precinct 1. Dark green areas are <5% slope, pale green areas 5 – 10% slope, and yellow 10 – 20% slope which is restricted to the railway cutting, creek banks, and a borrow pit contiguous with Lavelle lagoon.

Boundaries of Stages

In the developed configuration, all Stages except 21, 23 & 26, along with allotments 216 – 227, will have only one important area with regard to bushfire hazard risk assessment and that is on the interface with the Remnant linear vegetation in gully lines now retained as linear parks.

In the NE portion during a staged development without clearing of the development footprint prior to commencement of works, there will need to be a progressive firebreak constructed on the development boundary. This firebreak should be maintained at a width of 1.5 x mature height of trees i.e. 1.5 x 22m = 33m.

Across the balance of the proposed development NPL, slopes of any interface with a drainage feature are well below 10% and generally less than 5%. This does not pose a significant bushfire risk with maintenance slashing of the proposed buffers.

Table 2: Fire risk analysis for lots on the interface with Remnant vegetation in the drainage feature and NE portion/corner (from SPP Guideline 1/03).

Element	**Data**	**Hazard Score**
Vegetation	Eucalypt woodland	6
Slope	Less than 10%	2
Aspect	North to East and less than 5%	0 - 1
Total		**8 - 9**

- *This equates to a medium bushfire hazard risk (Refer **Table 1**) and therefore a bushfire hazard buffer of 33m from this vegetation is required along the RERE conservation areas in 'linear parks'.*

Internal development areas

The fundamental feature in this area is that it will be covered by medium to high-density housing and, therefore, the allotments will not in themselves be large enough to carry enough woody vegetation to pose a bushfire risk (Refer **Table 3**).

Table 3: Fire risk analysis for plain lots *Stages 1 – 19 urban sites.*

Element	**Data**	**Hazard Score**
Vegetation	Gardens	0
Slope	Less than 10%	2

Aspect	Not applicable	0
Total		**2**

- *This equates to no bushfire hazard risk (Refer **Table 1**) and requires no buffer(s) or other treatments.*

Stages 21, 23 & 26, along with allotments 216 – 227

These areas on the eastern side of the development NPL do not have a perimeter boundary road and front directly to a pipeline and power easement.

Fire hazard management in these easements is the responsibility of others and review of maintenance slashing/clearing in this area would need to be sourced and provided to owners/body corporates on this development offsite interface so as to ensure vigilance of fire risk and timely management of vegetation regrowth.

Field Verification

The slopes into the drainage gullies with Remnant vegetation are gentle and generally are less than or very close to five percent, and the vegetated areas (RERE) narrow i.e. a linear park ~60m width.. A consequence is that there is little opportunity for fire to burn up-slope into the planned residential areas. The proposed fire buffers can, therefore, be considered conservative i.e. 33m.

The vegetated areas are not only small, but are easily accessed by roads, which function both as a firebreak and have mains water available for fire fighting. The very small lots proposed will not be large enough to carry enough woody vegetation to pose a fire risk in themselves, and the areas for subdivision now carry only very sparse tree cover.

The planned estate is largely low fire risk, but has some areas that must be assessed as of moderate risk.

Fire History

There has not been a fire in the region north of Pub Lane for some years.

Required Bushfire Buffers

Analysis of bushfire hazard scores shows that the margins (i.e. 50m zone) of the interface with natural vegetation are within a medium bushfire hazard area. Accordingly, as stated in the code requirements set out in Appendix 5 - Table B 1.2(b) of the SPP 1/03 June 2003 guideline, future dwellings should be separated from conserved "hazardous" vegetation i.e. remnant vegetation, by a setback of 1.5 x site mature canopy height (22m) of mature species present (33m).

- ***A 33m setback is required between dwellings along the interface of Stages with the Remnant vegetation in the drainage gullies.***

- ***Where development interfaces with vegetation in easements on the estate boundary i.e. Stages 21, 23 & 26 and allotments 217 – 227, then a bushfire hazard management plan by others will need to be verified.***

- ***In the NE portion during a staged development without clearing of the development footprint prior to commencement of works, there will need to be a progressive firebreak constructed on the development boundary.***

APPENDIX 1

Species and their morphometrics
as measured from mature trees on the site NPL
and verified 6 December 2016.

Large trees found in the site.

Species	Location (WGS 84 : UTM – UPS)		circumference (mm)	dbh (mm)	height (m)
Eucalyptus crebra	56J0498015	6932793	1250	398	18
E. crebra	56J0498011	6932748	1600	509	16
E. crebra	56J0497986	6932817	1250	398	17
E. crebra	56J0497911	6932812	1500	477	21
E. crebra	56J0487910	6932813	1400	445	16
E. crebra	56J0497857	6932798	1450	461	19
E. crebra	56J0497836	6932798	1700	541	22
E. crebra	56J0498004	6932671	1180	375	19
E. crebra	56J0498023	6932716	1400	445	18
E. crebra	56J0498025	6932754	1150	366	16
Corymbia intermedia	56J0497815	6932540	2160	687	22
E. tereticornis	56J0497892	6932546	1120	356	15
Lophostemon suaveolens	56J0497968	6932609	1150	366	11

APPENDIX 2

Plants recorded from the regrowth area in the NE corner – predominantly in/near the gullies to be conserved.

This is a list compiled during observations on 16th April 2012 (verified 6 December 2016).

Species

Acacia irrorata
Acacia leiocalyx
Allocasuarina littoralis
Alloteropsis semialata
Alphitonia excelsa
**Bidens pilosa*
Chrysocephalum apiculatum
Commelina diffusa
Corymbia citriodora
Corymbia intermedia
Crassipedium sp.
Dianella caerulea
**Digitaria didactyla*
Eragrostis aff *brownii*
Eucalyptus crebra
Eucalyptus seeana
Eucalyptus tereticornis
Gahnia aspera
Goodenia hederacea
Goodenia rotundifolia
Hybanthus stellarioides
Imperator cylindrica
**Lantana camara*
Lepidosperma laterale
**Lobelia purpuracens*
Lomandra longifolia
Melaleuca bracteata
Murdannia graminea
Paspalidium sp.
**Paspalum dilatatum*
**Paspalum urvillei*
Petalostigma pubescens
Pimelia linifolia
Poranthera sp.
Themeda triandra
Wahlenbergia gracilis

Appendix C

Transects to groundtruth vegetation in north – east corner mapped as remnant vegetation 'Sparse Woodland to Open Forest' with a maximum potential fuel load of 30t/ha; an estimate to be used in a worst case scenario to determine bushfire prone areas.

Transect Records

Canopy Cover on Transect 1

Transect 1 can be interpreted as passing through 4 zones. Total canopy cover represented graphically (Refer **Figures 6(a)** & **(b)**) is taken from transect data (Refer **Table 1)**. Transect data show cover of canopy greater than or equal to 12 m tall – a figure that is 75% of 15m, taken here as a conservative estimate of the height of the mature canopy. Some trees reach or even exceed 20m tall.

The entire area was last cleared/thinned in 1992.

The landscape for ***Transect 1*** appears to fall into four sections:

- 0m - 55m: regrowth vegetation only exceeding 15 m where a tree from the northern neighbouring property leans into the transect i.e. canopy crosses the fence. *This is presently **mapped correctly** as non-remnant vegetation on V6.0 RE mapping.*

- 55m - 110m: swale dominated by *Lophostemon suaveolens* which, although mostly short, should be considered remnant vegetation. *This is presently **mapped correctly** as RE 12.9/10.12 on V6.0 RE mapping.*

- 110m – 170m: gentle slope with low regrowth including large areas of *Acacia leiocalyx*. *This is presently **mapped incorrectly** as RE 12.9/10.12 on V6.0 RE mapping : this area is non-remnant.*

- 170m – 200m : remnant vegetation dominated by *Eucalyptus crebra* and *Corymbia citriodora* on a low ridge. *This is presently **mapped correctly** as RE 12.9/10.2 on V6.0 RE mapping*.

These zones are then represented graphically with colour bars (Refer **Figures 6 (a)** & (**b)**), based on the statistics from Transect recordings (Refer **Table 1**).

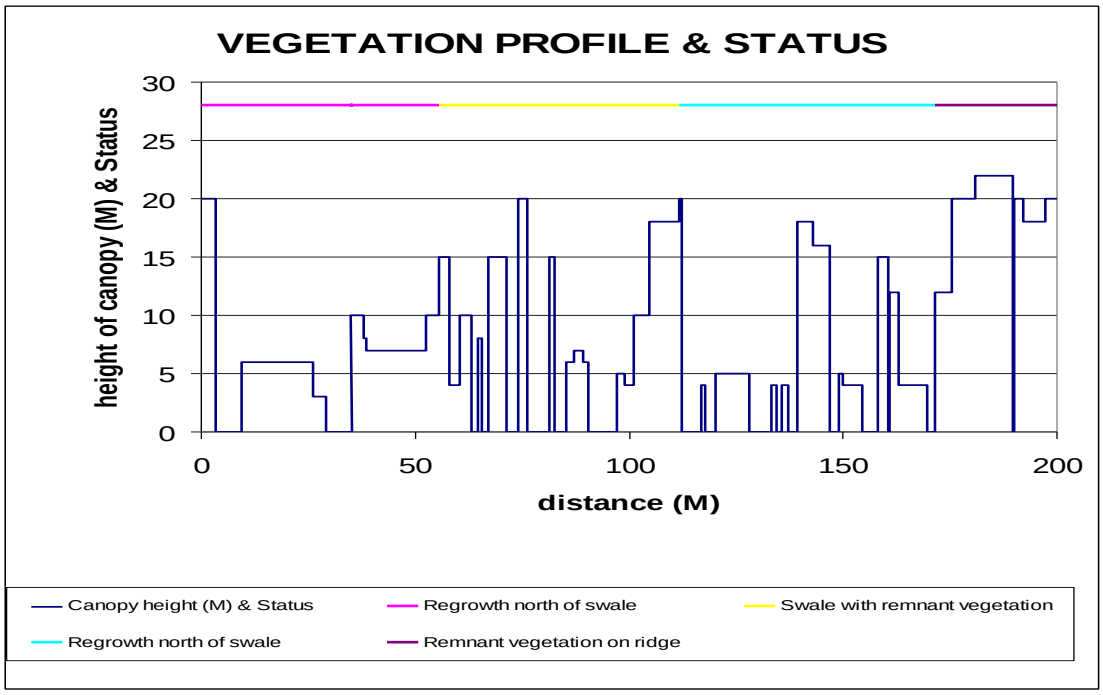


Figure 6(a): Profile of the canopy of trees and taller shrubs along a 200m long transect at Teviot Downs, 4th February 2011 (verified 6 December 2016). Distances measured, heights are estimated.

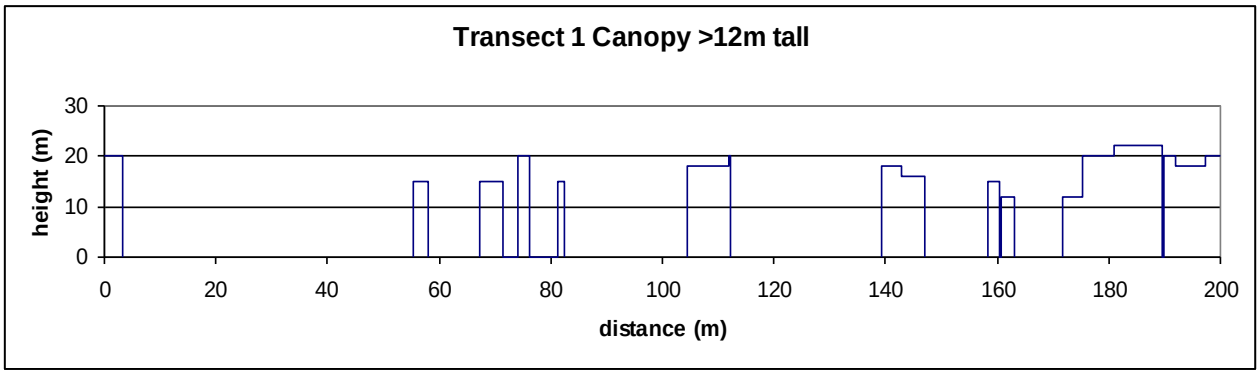


Figure 6(b) Profile of the canopy of trees standing 12m or taller along a 200m long transect at Teviot Downs, 4th February 2011 (verified 6 December 2016). Distances measured, heights are estimated.

Table 1: Details of a 200 m long transect surveyed at Teviot Downs, 4th February 2011 (verified 6 December 2016).

Transect 1	Length …200m	
Start point:	56J / 498058/ 6933027	
End point:	56J/ 498028/ 6932839	
Datum:	GDA94 or WGS84	
Interval (metres)	**Intercept**	**Stratum/height**
0-3.4	3.4	**20**
9.5 – 26.0	15.5	6
26.0 – 29.0	3.0	3.0
35.2 – 37.8	2.8	10

Notes:
only the crown cover of trees over 3 metres tall have been Included in the transect table
▪
Eucalyptus tereticornis
Acacia leiocalyx
Alphitonia excelsa
Lophostemon suaveolens

37.8 – 38.6	0.8	8	*Alphitonia excelsa*
38.6 – 52.5	13.9	7	*Acacia leiocalyx*
52.5 – 55.5	3.0	10	*Corymbia citriodora*
55.5 – 57.9	2.4	15	*Eucalyptus tereticornis*
57.9 – 60.5	2.8	4	*Lophostemon suaveolens*
60.5 – 63.0	2.5	10	*Corymbia citriodora*
64.5 – 65.5	1.0	8	*Lophostemon suaveolens*
67.2 – 71.3	4.1	15	*Lophostemon suaveolens*
74.1 – 76.2	1.6	20	*Lophostemon suaveolens*
81.2 – 82.5	1.3	15	*Lophostemon suaveolens*
85.3 – 87.0	4.7	6	*Acacia leiocalyx*
87.0 – 89.1	2.1	7	*Lophostemon suaveolens*
89.1 – 90.4	1.3	6	*Acacia leiocalyx*
97.0 - 99.0	2	5	*Lophostemon suaveolens*
99.0 – 100	1	4	*Alphitonia excelsa*
100. 0 - 101.0	1	4	*Acacia leiocalyx*
101.0 – 194.6	3.6	10	*Lophostemon suaveolens*
104.6 – 111.8	7.2	18	*Eucalyptus crebra*
111.9 – 112.2	0.3	20	*Eucalyptus crebra*
116.7 – 117.9	2.2	4	*Acacia leiocalyx*
120.3 – 128.0	9.7	5	*Acacia leiocalyx*
133.3 – 134.5	11.2	4	*Acacia leiocalyx*
135.8 – 137.2	1.4	4	*Acacia leiocalyx*
139.4 – 143.0	3.6	18	*Eucalyptus crebra*
143.0 – 147.0	4	16	*Corymbia citriodora*
149.0 – 150.0	5	5	*Allocasuarina littoralis*
150.0 - 154.6	4.6	4	*Acacia leiocalyx*
158.2 – 160.5	2.3	15	*Corymbia citriodora*
160.7 – 163.0	2.3	12	*Corymbia citriodora*
163.0 – 167.7	4.7	4	*Acacia leiocalyx*
169.2 – 169.6	0.4	4	*Acacia leiocalyx*
171.6 -175.4	3.8	12	*Corymbia citriodora*
175.4 – 177.6	1.4	20	*Eucalyptus crebra*
177.6 – 181.0	2.4	20	*Corymbia citriodora*
181.0 – 189.7	8.7	22	*Corymbia citriodora*
190.0 – 192.1	2.1	20	*Corymbia citriodora*
192.1 – 197.4	5.3	18	*Eucalyptus crebra*
197.4– 200.0	2.6	20	*Eucalyptus crebra*

Intercept summary

U: crown cover

M: crown cover = %

Canopy Cover on Transect 2

Transect 2 can be interpreted as passing through 2 zones. Total canopy cover represented graphically (Refer **Figures 7(a)** & **(b)**) is taken from transect data (**Refer Table 2**). These figures show canopy greater than or equal to 12m tall – a figure that is 75% of 15m, taken here as a conservative estimate of the height of the mature canopy. Some remaining trees exceed 20m tall.

The entire area was last cleared/thinned in 1992.

The two landscape sections for ***Transect 2*** are:

- 0-110m: swale dominated by *Lophostemon suaveolens,* which although mostly short compared with nearby natural vegetation, should be considered remnant vegetation. This should be considered a wet phase of RE 12.9 /10.12 as some *Eucalyptus seeana* occurs in the swale. *It is presently* ***mapped incorrectly*** *on V6.0 RE mapping as non-remnant vegetation*.

- 110 – 200m: gentle slope with low regrowth including large areas of *Acacia leiocalyx*. This area cannot be classified as remnant because of the very low cover of trees less than 75% of the height of the mature vegetation. *This is* ***mapped incorrectly*** *as Remnant on the V6.0 RE mapping*.

These zones are then represented graphically with colour bars (Refer **Figures 7 (a)** & (**b)**), based on the statistics from Transect recordings (Refer **Table 2**).

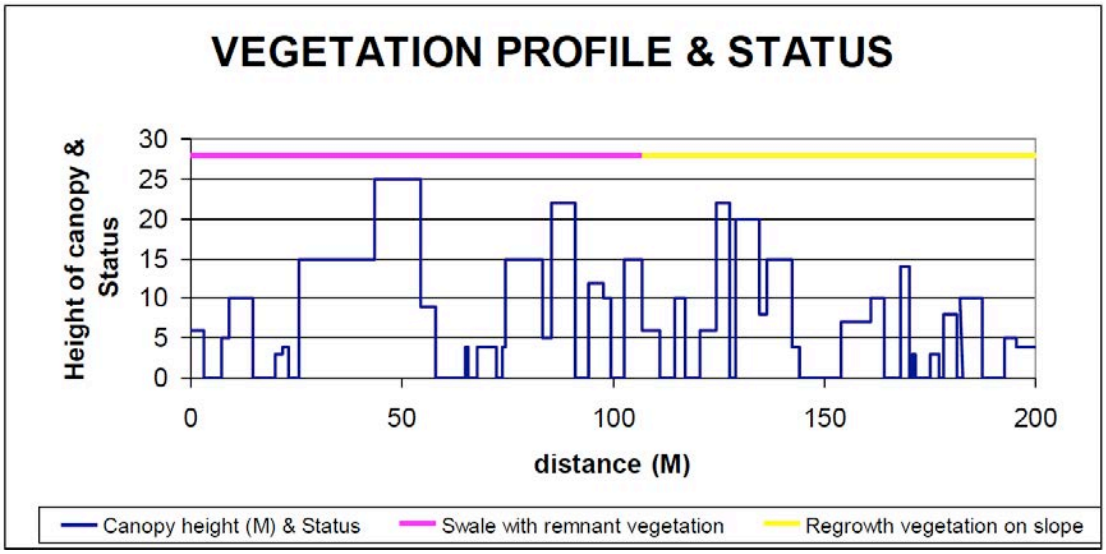


Figure 7(a). Profile of the canopy of trees and taller shrubs along a 200m long transect at Teviot Downs, 4th February 2011 (verified 6 December 2016). Distances are measured, heights estimated.

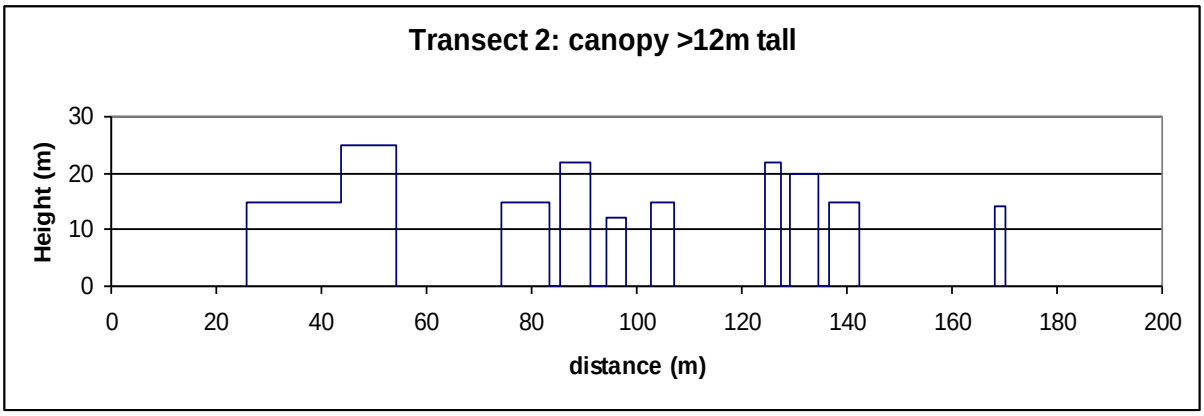


Figure 7(b): Profile of the canopy of trees standing 12m or taller along a 200m long transect at Teviot Downs, 4th February 2011 (verified 6 December 2016). Distances are measures, heights estimated.

Table 2: Details of a 200m long transect surveyed at Teviot Downs, 4th February 2011 (verified 6 December 2016).

Transect 2 Length …200m		
Start point: 56J / 497959 / 6933049		
End point: 56J/ 497920 / 6932850		
Datum: GDA94 or WGS84		
Interval (metres)	**Intercept**	**Stratum/height**
0 – 3.0	3	**6**
7.3 – 9.0	1.7	5
9.0 – 14.9	5.9	10
20.2 – 21.7	1.5	3
21.7 – 23.2	1.5	4
25.8 – 30.3	4.5	15
30.3 – 43,6	13.3	15
43.6 – 54.4	10.8	25
54.4 – 58.0	3.6	9
64.9 – 65.6	0.7	4
67.8 – 72.3	4.5	4
73.8 – 74.4	0.6	4
74.4 – 83.3	8.9	15
83.3 – 85.3	2.0	5
85.3 – 91.2	9.9	22
94.2 – 97.8	3.1	12
97.8 – 99.3	1.5	10
102.7 – 107.0	4.3	15
107.0 – 111.1	4.1	6
114.5 – 117.2	2.7	10
120.5 – 124.4	4.9	6
124.4 – 127.6	3.2	22
129.0 – 134.5	5.5	20

Notes:
only the crown cover of trees over 3 metres tall have been Included in the transect table
▪
Allocasuarina littoralis
Allocasuarina littoralis
Lophostemon suaveolens
Lophostemon suaveolens
Acacia leiocalyx
Corymbia intermedia
Lophostemon suaveolens
Eucalyptus crebra
Lophostemon suaveolens
Lophostemon suaveolens
Corymbia intermedia
Acacia leiocalyx
Lophostemon suaveolens
Acacia leiocalyx
Corymbia intermedia
Lophostemon suaveolens
Corymbia intermedia
Lophostemon suaveolens
Acacia leiocalyx
Corymbia intermedia
Acacia leiocalyx
Eucalyptus crebra
Eucalyptus tereticornis

134.5 – 136.5	2.0	8	Acacia leiocalyx
136.5 – 142.3	5.8	15	Eucalyptus crebra
142.3 – 144.0	2.7	4	Acacia leiocalyx
154.0 – 155.8	1.8	7	Corymbia intermedia
155.8 – 161.0	5.1	7	Acacia leiocalyx
161.0 – 164.3	3.3	10	Corymbia intermedia
168.1 - 170.0	1.9	14	Corymbia citriodora
170.8 – 171.5	0.7	3	Alphitonia excelsa
175.0 – 177.1	2.1	3	Acacia leiocalyx
178.2 – 181.2	3.0	8	Corymbia citriodora
182.7 – 187.2	4.5	10	Corymbia citriodora
192.5 – 195.4	3.9	5	Acacia leiocalyx
195.4 – 200	4.6	4	Alphitonia excelsa

Intercept summary

U: crown cover =

M: crown cover = %

Canopy Cover on Transect 3

Transect 3 can be interpreted as passing through 2 zones. Total canopy cover represented graphically (Refer **Figures 8(a)** & **(b)**) is taken from transect data (Refer **Table 3**). These figures show canopy greater than or equal to 12m tall – a figure that is 75% of 15m, taken here as a conservative estimate of the height of the mature canopy. Some remaining trees exceed 20m tall.

The entire area was last cleared/thinned in 1992.

In ***Transect 3*** the two zones are:

- 0 - 35m: regrowth dominated by *Acacia leiocalyx*. This area is too low and has too little cover to be considered remnant vegetation. *It is presently **mapped incorrectly** as RE 12.9 10.12 on V6.0 RE mapping.*

- 36 – 140m : This area is largely a swale with *Lophostemon suaveolens* and is appropriately considered remnant vegetation 12.9/10.2 as it lies up slope from the locations of *Eucalyptus seeana* which is found in the swale at lower levels. *This is **mapped correctly** as Remnant 12.9/10.2 on V6.0 RE mapping.*

These zones are then represented graphically with colour bars (Refer **Figures 8 (a)** & (**b)**), based on the statistics from Transect recordings (Refer **Table 3**).

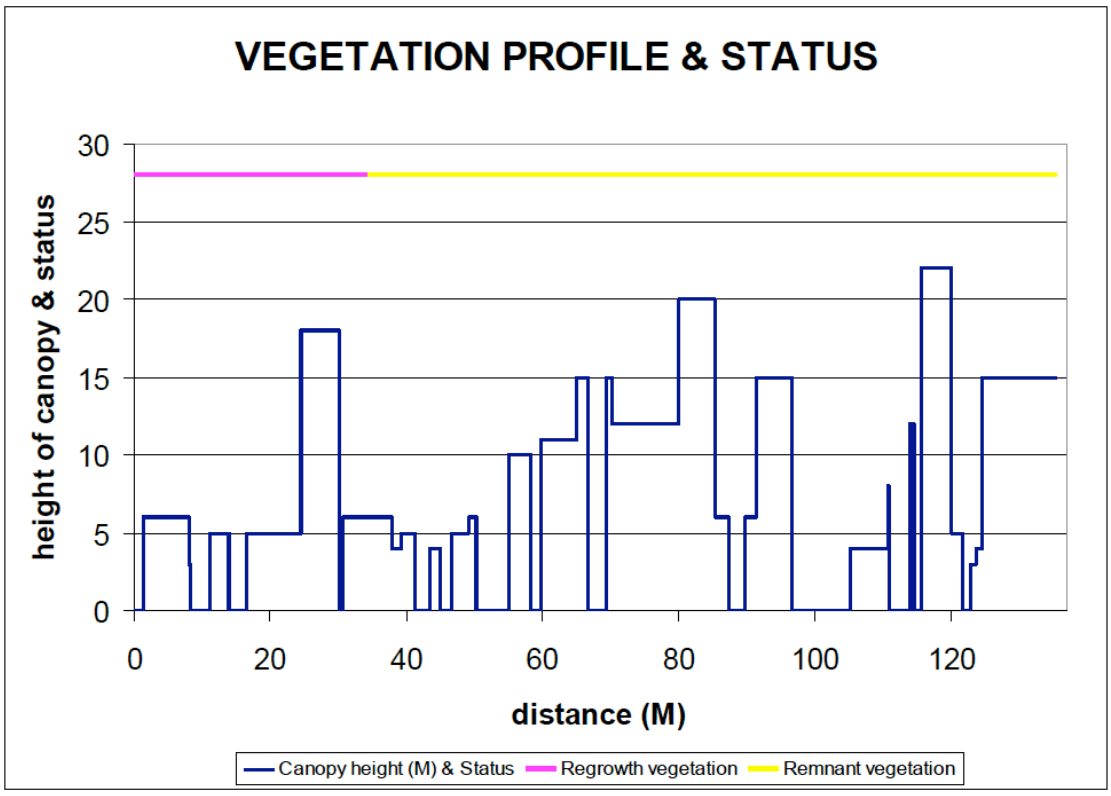


Figure 8(a): Profile of the canopy of trees and taller shrubs along a 140m long transect at Teviot Downs, 4th February 2011 (verified 6 December 2016). Distances are measured, height of trees estimated.

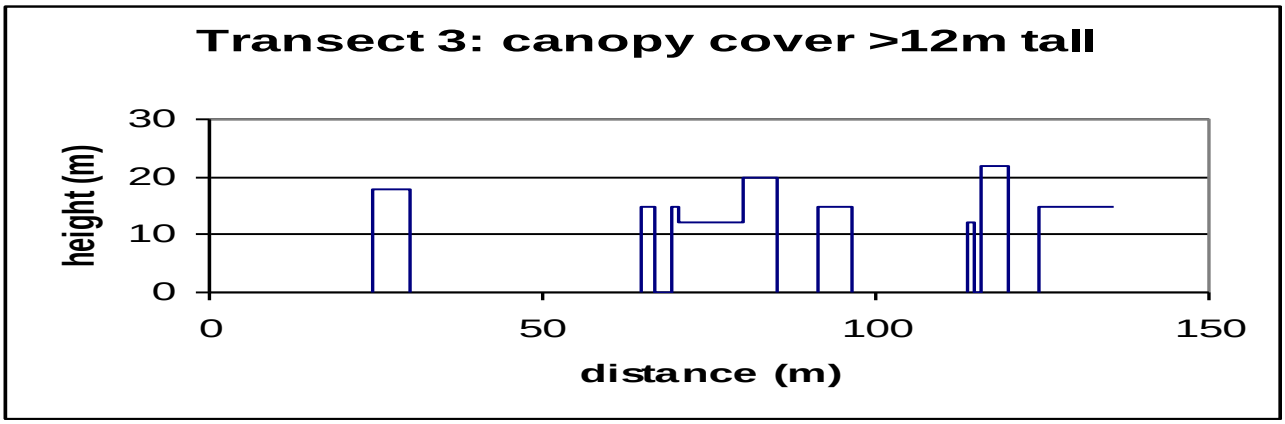


Figure 8(b): Profile of the canopy of trees 12m or more tall along a 140m long transect at Teviot Downs, 4th February 2011 (verified 6 December 2016). Distances are measured, height of trees estimated.

Transect 3	Length …135.5m	
Start point:	… / … / …	
End point:	… / … / …	
Datum:	GDA94 or …	
Interval (metres)	**Intercept**	**Stratum/height**
1.3 – 1.6	0.3	**6**
1.6 – 8.1	6.5	6
8.1 – 8.3	0.2	3

Notes:
only the crown cover of trees over 3 metres tall have been Included in the transect table!
▪
Allocasuarina littoralis
Lophostemon suaveolens
Allocasuarina littoralis

11.2 – 13.8	2.6	5	Allocasuarina littoralis
16.5 – 19.2	2.7	5	Alphitonia excelsa
19.2 – 24.4	5.2	5	Acacia leiocalyx
24.4 – 30.2	5.8	18	Corymbia citriodora
30.6 – 34.4	3.6	6	Acacia leiocalyx
34.2 – 37.8	3.6	6	Lophostemon suaveolens
37.8 – 39.3	1.5	4	Alphitonia excelsa
39.3 – 41.2	0.8	5	Lophostemon suaveolens
43.4 – 45.0	1.6	4	Lophostemon suaveolens
46.5 – 47.6	1.1	5	Alphitonia excelsa
47.6 – 49.2	1.6	5	Allocasuarina littoralis
49.2 – 50.3	1.1	6	Alphitonia excelsa
54.9 – 58.2	3.3	10	Allocasuarina littoralis
59.8 – 65.0	5.2	11	Allocasuarina littoralis
65.0 – 66.7	1.7	15	Lophostemon suaveolens
69.4 – 70.2	0.8	15	Allocasuarina littoralis
70.2 – 80.0	9.8	12	Acacia leiocalyx
80.0 – 85.3	5.3	20	Lophostemon suaveolens
85.3 – 87.3	2.0	6	Alphitonia excelsa
89.3 – 89.6	0.3	6	Allocasuarina littoralis
89.6 – 91.3	1.7	6	Acacia leiocalyx
91.3 – 96.6	5.3	15	Lophostemon suaveolens
105.2 – 106.7	1.5	4	Acacia leiocalyx
109.1 – 110.7	1.6	4	Acacia leiocalyx
110.7 – 110.9	0.2	8	Allocasuarina littoralis
113.9 – 114.6	0.7	12	Lophostemon suaveolens
115.6 – 120.1	4.5	22	Corymbia intermedia
120.1 – 121.6	1.5	5	Allocasuarina littoralis
123.0 – 123.7	0.7	3	Alphitonia excelsa
123.7 – 124.6	0.9	4	Acacia leiocalyx
1244.6 – 135.5	8.9	15	Lophostemon suaveolens

Intercept summary

U: crown cover

M: crown cover = %