Appendix 3.6. Soil and Land Management Advice

Soil and land management findings and advice for proposed recreation camp at 60-70 Bournemouth Street, Bundeena NSW

9th February 2016

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This document and its attachments are copyright of Land and Soil Capability and is only to be used within the context of the purpose of the document. The purpose of the document is to provide professional advice and opinion on the following soil and land management regime matters as requested by the client, Mr Ron van Ardenne:

- Advice on soil stability and recommendations on ground cover management within areas identified as Inner Protection Area (IPA) and Fuel Reduction Area (FRA) to avoid both wind erosion and water erosion.
- Advice and recommendations to avoid rill and gully erosion from concentrated water flows
- Advice and recommendations for wastewater management
- Advice and recommendations to control potential erosion issues associated with tracks and paths within the site

Documents which describe ecological assessment and vegetation management have been provided by Cumberland Ecology (2016) and RVA Australia (2016) are relied on in the preparation of this document. Any errors in these documents may impact on the recommendations provided below.

Methods and soil features:

The site and several adjacent areas were inspected over three hours in the company of the client on the 14th of December 2014. Two soil profiles were examined to approximately 50cm – one just below the site crest near the steepest and most north easterly tent entrance (UTM GDA 329798 6226075) and a second profile approximately in the centre of the Inner Protection Area (UTM GDA 329782 6226030). A third profile was also visually examined but not disturbed at the edge of the adjacent clearing (UTM GDA 329861 6225898) See Figure 1 for soil profile locations.

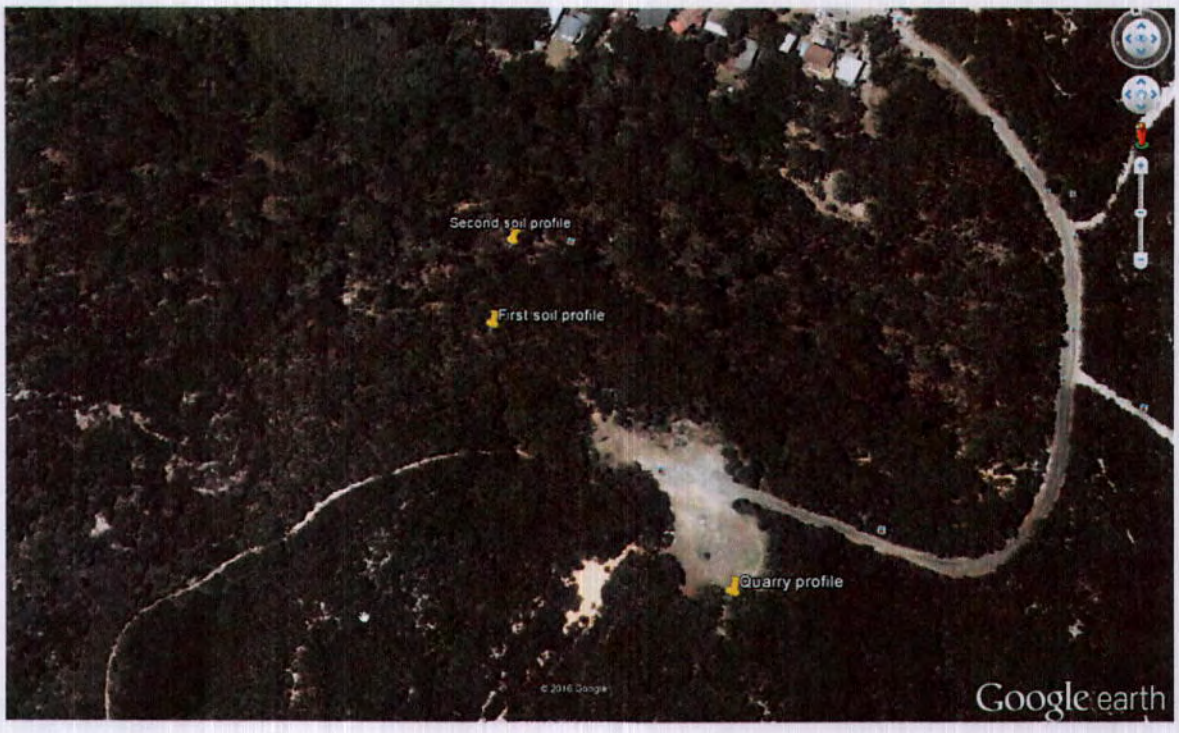

Figure 1: Google earth image of the site and surrounding area showing soil profile locations

Three soil horizons A1, A2 and an incipient Bs pan horizon were separately sampled at the tent site. At the second site the A1 horizon and Bs/B horizon were separately sampled. The third profile near the dune crest, adjacent to the quarry/tip/sandstone storage area was examined but not sampled.
The soil horizons are described as follows:

A1 surface horizon: Loose light grey single grained fine and medium sand grains within a matrix of fine charcoals, humic materials and decomposing organic matter. Roots and root mats are classed as being many to common, and pH is moderately to slightly acid. Most people would recognise this as very sandy topsoil. It is often very water repellent (see figure 2). Thickness appears to vary between 30cm on flatter areas and 10cm on the steeper dune slopes. This material when not disturbed by virtue of roots and organic matter forms a stable cap to protect the highly erodible soil materials below.

Figure 2:Profile near tent site. Single grained sandy A1 horizon above the single grained bleached sandy A2 horizons. Note water drop tracks due to high water repellence.

A2 horizon. Light grey single grained sand. With increasing depth the amount of organic material diminishes leaving pure single grained sand (see figure 2). The A1 and A2 horizon are readily identifiable as soil material Kn1 of the aeolian Kurnell Soil Landscape by Hazelton and Tille (1990). Thickness appears to be mostly 20 cm on crests and becomes thinner and may be sporadic on the steeper slopes. (slope gradients on the dune slopes approach approximately 40 percent or 22 degrees).

Bs/B Horizon. Brighter brownish yellow single grained sand with occasional slightly coherent iron pan material noted (Kn4 and Kn3). Most people would recognise this as being similar to beach sand without shells (see figure 3).

Figure 3: Single grained coloured sandy B horizon

All soil materials sampled were consistent throughout the site and adjacent areas and are consistent with the Kurnell Soil Landscape described in Soil Landscapes of the Wollongong – Port Hacking Sheet map and report (Hazelton, *et al.* 1990 and Hazelton and Tille, 1990).

Salient soil and landscape features

The landscape consists of windblown Quaternary fine and medium grained sands forming dunes which have been stabilised by native forest vegetation. The main soil type on the site is classified using the Australian Soil Classification (Isbell, 2003) as a thin, non-gravelly, sandy, sandy fragic (weakly coherent B horizon) aeric (well drained) sesquic (iron coated and not iron and organic coated B horizon) Podosol which is considered, from site geomorphology, to be probably greater than 5m deep.

Such soils are single grained and loose. Because they are single grained and fine grained they are particularly prone to wind erosion where ground cover has been removed, and especially where fragile binding organic materials and roots in the A1 horizon have been subject to frequent foot or vehicle traffic. The single grained aspect of these soils also renders them subject to extreme erosion where water flows are concentrated into specific areas. However, sheet erosion hazard is usually low as these soils are very well drained and seldom saturate. It is noted that the entire site appears to show some signs of sheet erosion (on upper sides of obstacles such tree trunks as well as debris dams) as and this is attributed to both bioturbation by ants, as well as low ground cover after fire and water repellence associated with fire and native vegetation. Bioturbation, observed across the site, especially by ants, has resulted in A2 horizon material being naturally redeposited on the soil surface. This loose and erosion prone material may be mistaken for accelerated sheet erosion and loss of topsoil fabric. Nutrient status of wind blown coastal podosols, when they are relatively undisturbed, such as with both the current and proposed land uses – where weeds are very uncommon, is very low, as is plant available water holding capacity. The sandy nature of these soils means that the soil water content at permanent wilting point is low. This means that plants are able to respond to small and frequent water applications in comparison with heavier textured soils. Annual rainfall is around 1200mm and relatively evenly distributed throughout the year. Driest months are usually around September and highest erosive rainfall occurs during late summer (especially February).

Fuel reduction management

Inspection of fire management zones on the same Kurnell soil landscape at the edge of suburban Bundeena shows that areas with low traffic and complete soil profiles (with undisturbed A1 horizon), have persistent ground cover of couch and buffalo grasses, as shown in Figure 4.

Figure 4: Mown site on a similar slope to the inner protection area, and same soil type, next to houses at Bundeena, showing generally consistent ground cover of introduced grasses and native plants.

Advice and recommendations for fuel reduction areas.

Current NPWS fuel management practices of periodically burning the land as part of the Spring Gully SFAZ clearly result in poor ground cover. This is visible both on the site and google earth where it can be seen that large patches of A2 horizon material are visible and exposed (see Figure 5).

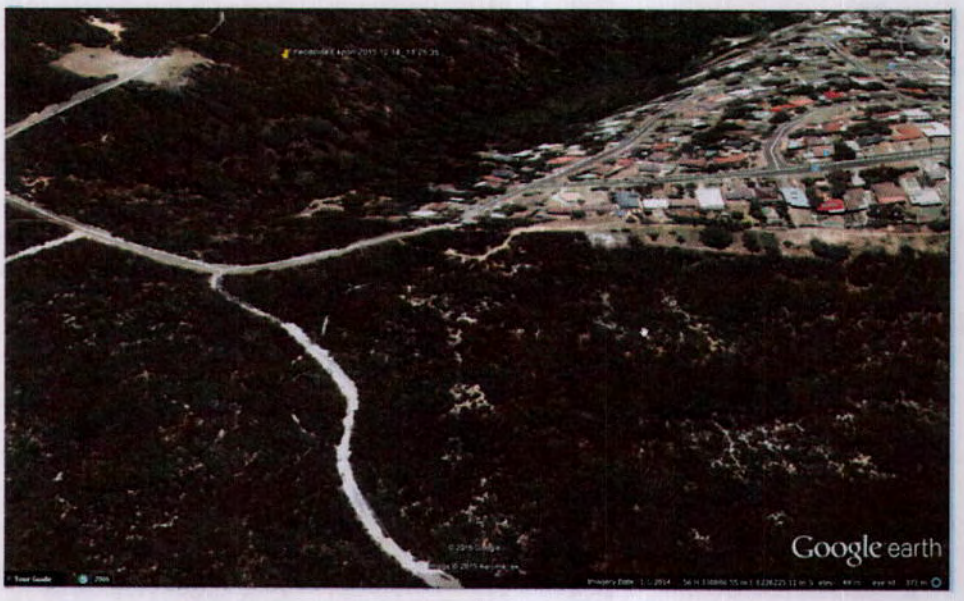

Figure 5: Aerial view of the site & Bundeena & periodically burned National Park. Note numerous patches of bare soil in foreground & dune blowout behind quarry. Figure 4 was taken near the houses on the middle right.

From a water erosion perspective trees do little to stabilise soils. Ground cover, however, is the crucial factor to be managed to mitigate against sheet and wind erosion. Trees do have a role reducing wind velocity and wind erosion. Reduction of wind velocity will be particularly crucial close to the crest on western aspects where there is a long wind fetch. Complete tree clearing is likely to increase wind erosion hazard but the proposed tree thinning in the current proposal is not expected to impact on wind erosion hazard because the IPA would retain enough upright trees, also it is surrounded by present trees to the south, west and east.

Mowing by hand to a plant height of around 15cm is expected to increase ground cover by encouraging plant branching and small plant growth. This will also increase surface roughness and will mitigate proliferation of bracken. Thinning tree cover can also be expected to promote understorey growth due to less expected competition for soil moisture and to a lesser extent better access to light.

Raking to reduce fuel loads can be effective where the maintenance of ground cover is closely supervised and those doing raking can competently recognise an initial target of 90% ground cover – especially from January to mid -March for water erosion and in winter in preparation for times of greatest wind erosion hazard namely August through to November. It is strongly recommended that a regime be established and maintained to monitor and photographically record ground cover at a series of permanent locations. Ground cover levels can drop during dry periods or after disturbance such as fire. At such times mowing without raking is recommended. Flexibility and management attention will be crucial to successful maintenance of ground cover.

Recommended techniques to establish increased ground cover and surface roughness are to initially use brush matting from slashed material to encourage endemic native seedlings. Once seedlings are

established, the brush may be removed to reduce fuel loads or relocated to the next patch. It is recommended to apply this technique in small consecutive batches arranged along the contours in a series of non-overlapping patches.

It is also recommended that any subsequent mowing and/or raking be arranged along the contour in a series of non-overlapping patches.

After fire landscapes are typically damper (due to less transpiration) and so the soil now provides opportunity for seedling growth and survival.

Avoiding rill and gully erosion from concentrated water flows

The loose nature of the soils means that they are vulnerable to concentrated water flows. The proposed designs of driveway and building and tent structures ensure that all incoming water, including stormwater and other runoff, is diverted either into storage tanks or soak away pits to eliminate the high erosion hazard on the site soils from concentrated water flows. All overflows must have broad and level sills.

The optional use of soil wetting agents (surfactants) could be effective in reducing/eliminating soil water repellence and increasing seedling growth as more water would be partitioned into the soil profile. This will also reduce the risk of sheet, rill and gully erosion by reducing the risk of runoff.

It should be noted that the NPWS Royal National Park Fire Management Plan 2009 allows the use of surfactants, for fire fighting, at distances greater 50 m of watercourses and swamps. The proposed IPA is located more than 50 m away from the nearest watercourse. Eco-hydrate, from Organic Crop Protectants, is an example of a suitable biodegradable surfactant for improving soil water infiltration, reducing erosion and encouraging ground cover that could be applied on site.

Use of recycled water onsite

Irrigation through a sprinkler based delivery system of treated greywater is expected to be useful for increasing ground cover by small plants. Small and frequent water applications are recommended during times of water stress, especially after mowing and leaf litter removal. Should excess water be available, the addition of larger applications of extra water are not expected to result in any waterlogging or plant growth issues as the sandy soils are extremely well drained.

Due to the impact of phosphorus on native plants and the impact of phosphorus on long term weed issues, it is highly recommended that all soaps and water additives be as low in phosphorus as possible. Long term application of high SAR (sodium absorption ratio) cleaning products is less critical but should be avoided.

Pump-out or composting toilet systems are preferred, with septic trenches being also suitable for deep sandy soils. Any pump-out or composting systems should be installed on concrete aprons with emergency bunds to contain any spillages.

Erosion control along tracks and paths

Control of foot and vehicle traffic through the use of fences and signs is highly recommended. A series of gravel filled, level 'stepping stone' boxes which are lined with strong permeable geotextile fabric are recommended for slopes of greater than 10 percent gradient and will be essential for slopes which are greater than 25 percent. These boxes will allow water to infiltrate, will contain gravel and will allow ground cover to proliferate next to the boxes. Because the boxes are installed with level rims 'erosion' of gravel will be minimised.

Conclusions

Current NPWS fuel management practices of periodically burning the subject site and surrounding land as part of the Spring Gully SFAZ clearly result in periodically poor ground cover. The proposed tree thinning, soil and vegetation management will result in improved ground cover and reduce current soil erosion risks, especially during months of greatest risk for water and wind erosion events. Operations to thin mulch but maintain groundcover will need careful implementation, close supervision and monitoring. Furthermore, using the highly permeable soil for absorption of appropriately designed stormwater, greywater management, and effluent management systems will provide sustainable solutions for on-site erosion and soil nutrient management.

X

Greg Chapman
Director Land and Soil Capability Consulting

9 February 2016

References

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Hazelton PA and Tille PJ (1990) *Soil Landscapes of the Wollongong-Port Hacking 1:100,000 sheet report.* Soil Conservation Service of NSW. Sydney.

Isbell RF (2003) *The Australian Soil Classification* (revised edition). CSIRO publishing. Collingwood, Victoria.

RVA Australia Pty Ltd (2016) Plan of Management, Bundeena Coast Eco Lodge, RVA Australia Pty Ltd February 2016.

Appendix One

Curriculum Vitae: Greg Chapman

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Career:

July 2013 to present: *Director Land and Soil Capability Consultancy.* Part time soil, land management and ecological consulting, specialising in the provision of spatial ecosystem service and resilience science products to assist regional institutions with geographic prioritisation and strategic planning. Clients include Local Land Services, Natural Resources Commission and Federal Department of Agriculture, Forestry and Fisheries. MCAS-S based products include mapping ecosystem services, mapping temporal distance to resilience tipping points for soil condition by soil type and land use according to sustainability of land management. Also mapping geographic vulnerability to extreme climate events such as intense rain after drought, windstorms and extreme hot and cold. Developed business case and implementation plan for the Australian Soil Assessment Program as part of the Australian Soil Research, Development and Extension Strategy on behalf of the National Committee for Soil and Terrain.

Founding member and the inaugural secretary of the NSW Soils Knowledge Network- small, elite group of retired and semi-retired soil specialists who disseminate soil extension and knowledge to institutions such as Local Land Services.

Honorary Science Fellow for the science division of the NSW Office of Environment and Heritage, providing soils advice and improving Revised Universal Soil Loss equation soil erodibility spatial layers.

Active Soil Science Australia member. Co-organised regional soil science forum for NW NSW.

2006- July 2013: *Theme Leader Soil Condition and Land Management MER.* Responsible for NSW soil condition and land management capability monitoring, evaluation and reporting. Development of methods, standards, encouraging data collection and delivery to inform natural resource management decisions.
Lead multidisciplinary 30 member project team to successfully design and implement $4m soil condition and land management benchmarking program. Some achievements:

- Conceptualised and delivered initial maps of land management within its capability to assist prioritisation of intervention and extension efforts by NSW regional land management authorities
- Acclaimed for leading the development and first deployment of the erosion and flooding Bushfire Area Assessment Team (BAAT). For the Wambelong/Warrumbungles fire and developed rapid response priority mapping methods using MCAS-S.
- Acknowledged by CSIRO as developing the best existing soil monitoring data set and highest utility soil carbon dataset in Australia.
- Recognised by CMA contacts as Soil & Land MER 'extremely useful' for catchment action planning.
- NSW MER methods recommended by CSIRO as the basis for national carbon and pH monitoring and for the national Soil Carbon Research Program.
- Encouraged, collaborated and contributed to advances in sheet erosion modelling to best in the world standards. Developed applications and influenced outputs to be arranged as NSW standards for bushfire management, monitoring and catchment planning.
- Praised by HNCMA, SCA and NSW Office of Water for innovative impact allowing targets setting and setting land based priorities to improve water quality.
- Developed spatial threat analysis system using soil condition and land management within capability to prioritise targets for catchment action planning.
- Praised for taking NRM targeting "to a higher level" by HNCMA for coordinating, developing and delivering soil and land spatial priority products for catchment management authorities using innovative spatial viewer (MCAS-S) technology – including mapping four separate soil ecosystem service values.
- Use of ecosystem service concept linking soil values to people values as a framework for investment
- Designed and instigated the SoilWatch performance monitoring program. Adopted by most CMAs and contributing 250+ additional soil monitoring sites to the 853 sites at low cost.
- Influenced/supported NRC designing NRM targets and positioning soil condition monitoring, soil mapping and land use mapping as high priority activities
- 2010 Soil Science World Congress presentation on Land Management within Capability assessment

Also:

- Represented NSW on National Committee for Soil and Terrain. Used influence to break a delivery deadlock in providing NSW soils information to the Australian Soil Resource Information System. Steering committee member for TERN soils facility which delivered over state of the art digitally modelled soil parameters for multiple control sections. Participated in MCAS-S based priority planning workshops for soil acidity and soil carbon. Instigated and chaired specialist sub-committee for nationalised laboratory test methods and database result storage.
- Provided instrumental technical input to DPI Strategic Regional Land-Use Planning strategy (BSAL).
- Collaboratively arranged establishment of the NSW Soil and Land Network for CMAs and NSW soil agencies to develop standards and undertake "critical mass" soils projects –eg training.

1996-2006 *Manager Soil Information Systems, renamed Manager, Soil Natural Resources Decision Support* Managed Soil Landscape Mapping Program and the NSW Soil and Land Information System. Technical development, soil advice and advocacy, product development, project and program management of the NSW Soil Survey Team, Soil survey laboratory and Soil and Land Information System.

- Nominated for the Premier's Award for development of specific land capability mapping system for orderly planning in coastal NSW.
- Strategic development and management of the NSW Soil Data System and its redevelopment into the NSW Soil and Land Information System including development of SPADE (Soil profile access data engine), spatial linkage to GIS and development of queries to build numerous derivative maps for a wide range of natural resource management applications
- SALIS database increased from 1000 profiles to over 60000 and recognised as the best of its kind in Australia by the Australian Association of Commercial Soil Surveyors.
- $9m external funding obtained to accelerate strategic soil map coverage, develop new soils products and strengthen and populate soil data bases.
- 96% of NSW covered by modern soil mapping under my leadership.

1990 -1996 *State Manager Soil Survey and Soil Survey Coordinator.*
Directed and resourced all aspects of the NSW Soil Landscape mapping program.

- Trained and developed the NSW soil survey team and ran and further developed the NSW Soil Landscape mapping program.
- Three month soil survey in Kuwait followed by three months visiting soil survey institutions in Europe.
- Coastal Acid Sulfate Soil Risk Mapping instigated, designed, lead and successfully completed within "an impossible time frame". Coordinated release of this controversial work, including: 10 regional workshops, front page newspaper; television news and numerous radio interviews.
- Influenced risk map conversion to SEPP maps- preventing environmental damage to numerous coastal water bodies along the entire NSW coast.
- Development of Soil Landscape mapping and derivative products. >44:1 benefit:cost ratio. (ACIL 1996)

1986-1990 *Soil Conservationist – soils specialist.* Laboratory Manager at Scone Research Service Centre.

- Commercial lab establishment & achieving National Testing Authority Registration.
- Expert soil forensics witness.
- Successful completion of numerous soil survey and consulting jobs.
- Senior author of Sydney Soil Landscapes- first 1:100,000 soil landscape map. Published and launched by the Minister to great fanfare.

1986-1984 *Urban Areas Investigations Team Soil Conservationist.* Urban Capability studies and report editing. Soil Landscape mapping in Sydney area.

Education:
BSc Macquarie University. Soils, Ecology and Land Management. 80-83 GPA 3.43. Independent employed mature age student. Science dux Balgowlah Boys High for four years.

Other:
Staff development: Soil survey team developed with exceptional camaraderie, eg via round robin peer field review. Massive development in soil surveyor extension and influencing skills.

>$9m in external funding received and all 30+ projects completed and successfully delivered.

>110 publications, conference presentations and major reports. Focus mostly on soil information application and landscape processes.

President NSW Branch Australian Soil Science Society 2002-2004 and Office bearer 1998-2006

Peer recognition: Stage 3 Certified Practicing Soil Scientist (highest level obtainable).

President Springwood Bushwalking Club (2004-2007 and 2011-2015 plus other committee positions).

Recreation: Travel, Gardening, Bushwalking- especially leading multi-day wilderness navigation walks.