SESL AUSTRALIA
Environment & Soil Sciences

# VHR Revegetation Processes & Methodologies

## 553 East Seaham Road

## Seaham NSW 2324

**Prepared for:**

**Valley Hydramulch & Revegetation (VHR)**

**October 2018**

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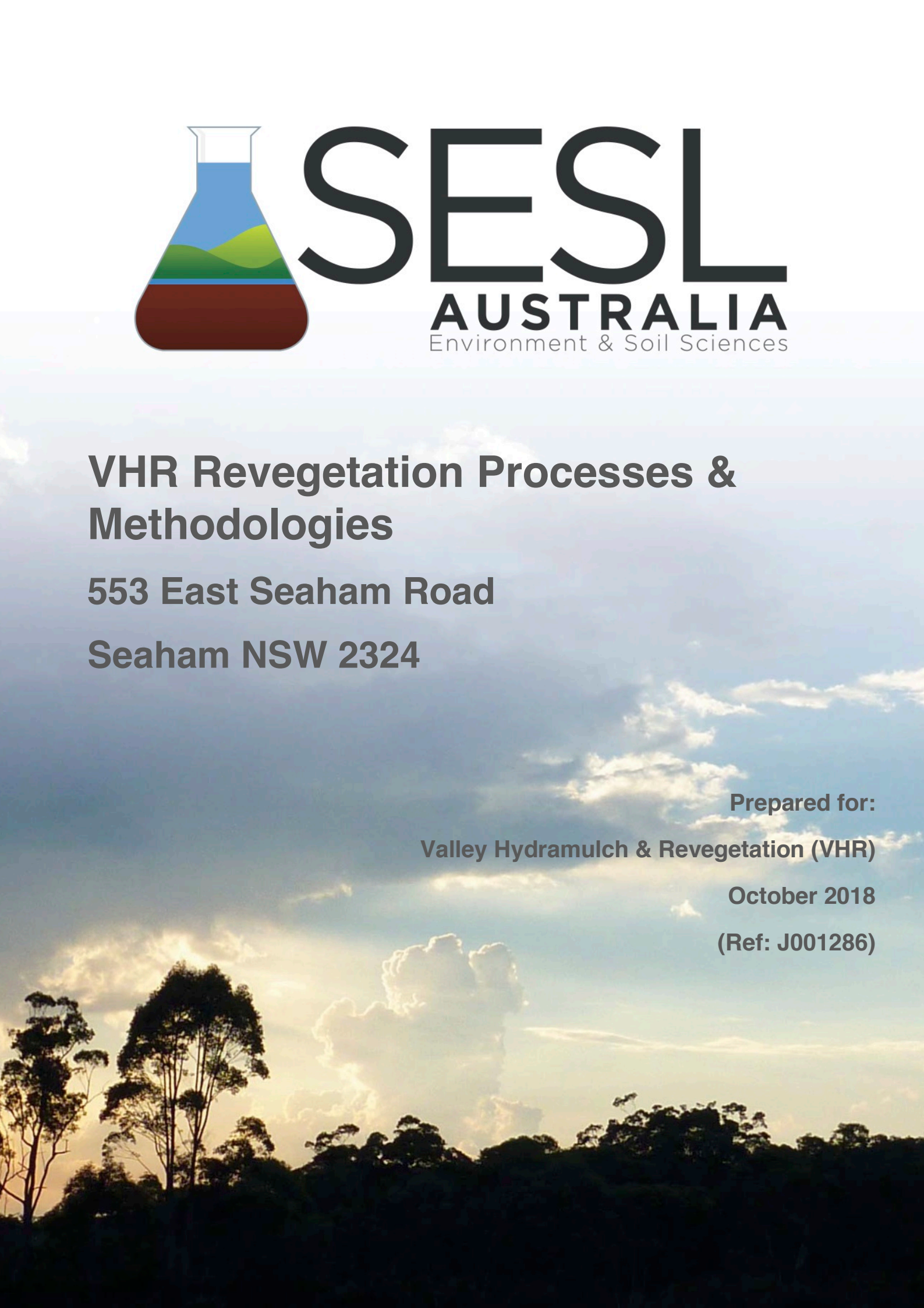

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ABN 70 106 810 708
T 1300 30 40 80
F 1300 64 46 89
E info@sesl.com.au
W sesl.com.au

POST PO Box 357, Pennant Hills NSW 1715
LAB 16 Chilvers Rd, Thornleigh NSW 2120
ACT Level 4, 15 Moore St, Canberra ACT 2601
VIC Level 1, 21 Shields St, Flemington VIC 3031
QLD Level 10, 15 Green Square Cl, Fortitude Valley QLD 4006

# 1 EXECUTIVE SUMMARY

This report details both the Roads and Maritime Services (RMS) and Valley Hydramulch and Revegetation (VHR) management practices which are designed for contractors to revegetate roadside batters as well as implement soil erosion control. The vegetation management practices for RMS and VHR are as follows:

- RMS Specifications G40 recommends clearing, stockpiling, mulching native vegetation and then blending with stripped uncontaminated site soil. Site soil should be tested and ameliorated in accordance with soil scientist professional advice. There is no validation process to ensure ongoing quality control.
- VHR vegetation management strategy is to test and ameliorate topsoil in accordance with soil scientist professional advice and use ANL's Greenlife compost for erosion control and nutritional benefits. VHR monitors the long-term success of the project.

The objective of this report is to demonstrate how VHR approach their project works and exceed the guidelines set out in RMS Specifications R178 and G40. VHR deems that this exceedance is necessary in order to establish germination and long-term growth of site vegetation. VHR demonstrates the reliability of their methodology through provision of examples of project works.

This report discusses the importance of soil testing with a competent agronomic laboratory and following through on the amelioration requirements provided by a qualified soil scientist or professional. Depth of soil, fertiliser amendments and the benefits of using compost over mulch is also covered. The repercussions of not adhering to these prescribed amelioration works is maybe poor germination but also loss of long-term sustainable native vegetation resulting in the invasion of exotic weed species.

The purpose of the revegetation is in preventing soil erosion and improving sediment control but it is also important for aesthetic purposes.

Figure 1. VHR Project Works: Permanent native grass cover after seven months at Hunter 8 Rail Duplication Stage 1.

# 2 INTRODUCTION

SESL Australia Pty Limited (SESL) was engaged by Valley Hydramulch and Revegetation (VHR), to prepare an Endorsement Report outlining VHRs vegetation processes and methodologies and how they are effective in landscape rehabilitation including reducing soil dispersion.

Roadside landscape rehabilitation is governed by Roads and Maritimes Services (RMS) and is outlined in Specifications R178 and G40. The general process outlined in G40 is to recycle the cleared vegetation on site by mulching in stockpiles and reuse with stripped uncontaminated site soil. However, it is not outlined in the RMS specifications that the soil should be ameliorated with at least Monammonium Phosphate (MAP) and lime as this process has proven to be a success with revegetation and soil erosion control.

VHR follows the R178 and G40 guidelines however as part of their methodology they ensure that their topsoil is assessed through an appropriate NATA Accredited Laboratory and the amelioration strategy outlined by a qualified soil scientist is implemented. They ensure that Microfine Lime, Microfine Gypsum and a compost blanket are included as part of their vegetation management and erosion strategy.

This report has been prepared to compare VHR strategies and demonstrate how they exceed the requirements that are set by Roads and Maritime Services (RMS). RMS vegetation management plans are designed to ensure that contractors employ a minimum vegetation strategy that contribute towards vegetation reestablishment and reutilisation of cleared vegetation to reduce soil dispersion.

Both RMS and VHRs management practices are outlined in this report including the following:

- Comparison of RMS Specifications R178 and G40 and VHRs vegetation management strategies;
- The importance of including topsoil with an appropriate depth for the desired vegetation and the repercussions of not doing so;
- The importance of using a suitably composted organics and the repercussions of using a woody highly carboniferous vegetation that has not been properly composted;
- VHR's processes of reducing potential on-site dispersion risk; and
- Examples of VHR rehabilitation successes which includes before and after photography.

## 2.1 BACKGROUND

VHR has expressed concern that revegetation works undertaken solely in accordance with RMS Specification R178 and G40 are not always providing adequate results even when fully been adhered to. VHR has stated





ABN 70 106 810 708
T 1300 30 40 80
F 1300 64 46 89
E info@sesl.com.au
W sesl.com.au

POST PO Box 357, Pennant Hills NSW 1715
LAB 16 Chilvers Rd, Thornleigh NSW 2120
ACT Level 4, 15 Moore St, Canberra ACT 2601
VIC Level 1, 21 Shields St, Flemington VIC 3031
QLD Level 10, 15 Green Square Cl, Fortitude Valley QLD 4006

the following, *"observations of the construction phase of many projects has been that although the intention and the basics are there, the execution has been deficient resulting in unsatisfactory outcomes. Typically cover crop grasses germinate but quickly die back leaving bare and piebald surfaces which then become covered in weeds…. An RTA Study concluded that the addition of compost was beneficial for germination and long-term nutrition and composting of site won mulch was seen as a solution to the problem of disposal of cleared timber".*

VHR has voiced concern that there is limited spacing for mulch stockpiling and composting on freeway sites and as a result the general composting process is not been adhered to. Composting according to NSW EPA Compost Order (2016) means a process of managed biological transformation to achieve pasteurisation and/or a biological stability can be demonstrated. The mulch stockpiled on-site does not undergo this process therefore does not provide the same beneficial properties comparable to a compost. Since the mulch is considered "immature" it presents certain problems during reuse. The site mulch is beneficial for two primary reasons:

1. can be used as a tool for erosion management; and
2. reusing vegetation on-site without needing to remove off site and preparing a Timber Reuse and Disposal Plan.

VHR also states that, "*Ameliorants are either not applied or, are applied in liquid form at too low concentrations to be effective. Inorganic fertilisers are often not applied. Lime and gypsum are applied strictly on consideration of the pH of the soils when they have a wider function in the soil rehabilitation process."*

Although the R178 and G40 documents discuss minimal best practice management strategies for revegetation which focus primarily on erosion prevention, VHR has placed emphasis in their methodology to ensure the soil is chemically balanced, nutritionally adequate and organics are sufficiently composted to achieve successful revegetation that is also a successful strategy for erosion management. Using immature or partly composted organics recycled from site is possible but as VHR point out, and we agree, adequate amounts particularly of lime and nitrogen are needed otherwise plant growth depression is often seen.

# 3 COMPARISON OF RMS SPECIFICATION R178 AND VHR's VEGETATION MANAGEMENT STRATEGIES

RMS QA Specification R178 was developed for use with roadworks and bridgeworks contracts led by RMS or local NSW Councils. The R178 states its primary purpose is to minimise soil erosion however the revegetation is also important for aesthetics. The requirements have been set out for vegetation of cut and fill batters, median areas, open drains.

VHR amelioration and vegetation management strategies ensure a full suite of analysis is undertaken by a NATA accredited laboratory. VHR ensures that the amelioration strategy provided by a qualified Soil Scientist is included in VHRs management strategy. VHR ensures that they use a 6 mm minus Organic Compost AS4454 – 2003 certified in their amelioration plan.

The comparison can be seen in Table 1.

Table 1. Comparison of RMS and VHR amendment strategies and practices.

| | RMS Requirements (R178 and G40) | VHR |
|---|---|---|
| **Hydro-mulching/ Hydroseeding (RMS) Compost Blankets (VHR)** | G40 recommends that native trees removed during clearing and grubbing to be mulched and stockpiled and reused with site topsoil in the revegetation sites. Mulch stockpiles must be monitored and turned to avoid spontaneous combustion.<br>R178 recommends using locally derived straw from cereal crops comprising of wheat, oats or rice however not meadow hay. Alternatively, the use of cellulose fibre mulch derived from sugarcane, shredded recycled paper or wood fibre is accepted. Mulch must be dyed green using a non-toxic biodegradable dye.<br>A slow setting anionic bitumen emulsion (Specification RMS 3254) or a non-toxic biodegradable polymer binder are must be used at an application rate of 60kg/ha.<br>Produce hydromulch/hydroseed slurry mixtures by adding the specified materials into the tank and agitate until a homogenous blend is obtained and hydroseed within 2 days of completion of soil preparation providing weather permits. Apply uniformly at an application rate outlined in Table R178.1. | VHR complies with the RMS 178 requirements and exceeds them with the use of using a fine cellulose fibre compost blanket that is AS4454 certified (*6 mm minus Organic Compost to AS4454 – 2003)* combined with granular ameliorants. VHR use ANL's Greenlife™ Mulch & Compost that comprises of a mixture of Municipal Waste Compost, Fine Wood Fibre. The compost blanket is free of wood chip as VHR from experience has have found that it becomes a maintenance problem on batters with cause for clean-up due to loss from run off in heavy rain.<br>Compost blankets are hydraulically applied using a quick process which can be applied at 200 metres wide and 40 metres vertically from one application unit. Polyacrylamide binder is used a polymer binder<br>Solids content varies from 7000kg/ha for Light Compost Blankets and 33,000kg/ha for Heavy Compost Blankets which is in exceedance of RMS requirements whilst still been relatively thin so as not to slump off batters. |
| **Soil Testing** | Stripped topsoil must be testing using a NATA accredited laboratory. Testing must occur from each location that it is sourced. Testing must include:<br>• Date | VHR addresses each Freeway Site individually by ensuring a full topsoil testing suite is completed which exceeds RMSs basic suite which will capture topsoil variation at each site.<br>VHR soil testing suite assesses for: |

| | | |
|---|---|---|
| | • cation analysis<br>• pH<br>• salt content<br>• particle analysis and<br>• amelioration recommendations.<br>Soil must be screened prior to use and free from stumps, roots, clay lumps or stones >50mm. Soil must be free of weeds and if present must be buried below 500mm of inert fill.<br>If site soil is not suitable for use then imported topsoil is required and must be tested to properties outlined in 2.1.3 of R178. | • date<br>• pH<br>• salt content<br>• cation balance<br>• macro nutrients: nitrate-N (NO3), phosphorus (P), potassium (K), sulphur (S), calcium (Ca), magnesium (Mg)<br>• trace elements: iron (Fe, manganese (Mn), zinc (Zn), copper (Cu), boron (B)<br>• physical properties: texture, structure<br>• organic matter. |
| **Preparation of Surface: Slopes** | RMS 178 advises to tyne slopes with gradients of 5 to 1 or flatter to a depth of 150 mm to produce a loose surface and remove all stones. When the batters are steeper than 5 to 1 by three passes of a steel chain. | VHR complies with R178 for working on slopes and batters. VHR uses a pickle chain to spread the topsoil leaving horizontal furrows without compaction. This process is undertaken to rip the topsoil allowing for a loose seed bed so that rainfall can be absorbed, and seed can set. Careful attention is made to not compact the soil whereby reducing oxygen levels and the absorption of water. |
| **Temporary vegetation** | Vegetate stockpiles, stockpile sites and other areas nominated by the Principal to control erosion and weed invasion with the following cover crop species:<br>(a) Rye Corn (during the months of April to August) at a rate of 35 kg per hectare;<br>(b) Japanese Millet (during the months of September to March) at a rate of 35 kg per hectare. | Use of additional long-term cover crop provides temporary grass cover of fine leaf perennial rye grass and clover to out compete weeds in the time between haying off of the annual cover crop and establishment of the native plants, which can be as long as two years in unfavourable weather conditions. |

# 4 IMPORTANCE OF TOPSOIL TESTING FOR REVEGETATION

The general topsoil properties for achieving optimum plant growth are good permeability, texture, structure (friable or granular), organically enriched with appropriate nutrient reserves and biologically active. A topsoil should function as a nutrient reserve with good root anchorage, good aeration with fast water entry and ideal moisture holding properties.

Undisturbed Australian soils are typically hostile, nutrient deficient and have low fertility and do not meet desired topsoil properties. In order to address these undesirable chemical properties, it is recommended in the R178 to have the soil tested by a NATA accredited laboratory to determine what properties require correcting prior to plant growth. This is especially crucial if nursery grown tube stock are planted as they do not adjust well going from a highly fertile, moist and temperature-controlled environment into a natural Australian soil. Plant loss can occur if amelioration isn't employed.

The reuse of site soils is the recommended option for both environmental and financial reasons rather than the importation of material. To determine the reuse potential of the soil for revegetation test results will need to be interpreted and written up by a soil scientist, agronomist or horticulturalist describing the findings and implication for landscape for rehabilitation.

## 4.1 DATA INTERPRETATION

The interpretation of soil results should focus particularly on identifying the following aspects that occur in Australian soils:

• the correction of unsuitable pH. Most natives prefer a range of pH 6.0 – 7.0 therefore either iron sulphate is used to acidify or lime to neutralise acidity should be incorporated.

• the presence of limiting salinity levels. Salinity should be assessed to determine if levels are undesirable for seeds and seedlings. In the instance that salinity levels are too high and cannot be leached then importation of topsoil maybe required.

• the presence of cation exchange anomalies, such as sodic, calcic, magnesic or aluminium toxic conditions. Anomalies can be brought about through imbalances in cation exchange. Sodic soils can cause dispersion, magnesic topsoils can be hardsetting, high aluminium occur with highly acidic soils, calcic soils are due to the high presence of calcium carbonates. Amelioration is required to ensure the cation exchange is in balance and soil has desirable properties.

• the nutrient status and its suitability for the intended landscape plantings. If the natural soil fertility is insufficient to support the landscape intentions. Sandstone-based soils, for example, will not support most landscape types except indigenous low nutrient woodland and heath. Most plants will starve without fertility enhancement.

• the potential for toxicities due to phosphorus (in P-sensitive plants), manganese, aluminium and zinc in particular. High phosphorus can be toxic to native plants that have evolved to survive in low phosphorus environments.

• physical properties particularly the potential for low permeability, resistance to compaction and potential for waterlogging and degree of stoniness that may affect reuse.

## 4.2 TOPSOIL DEPTH

The required topsoil depth correlates to the species that are been planted, the maintenance they will receive and annual rainfall. Topsoil depth requirements of grasses and shrubs are shallower in comparison to trees which require a deeper profile for structural stability. Trees will grow both horizontal feeder roots and vertical roots for stability. Therefore, a shallow soil profile increases the risk of windthrow during wet weather events as the vertical roots do not have enough rooting depth to stabilise the tree.

A shallow profile will dry out quickly and will also hold less nutrients therefore in a roadside environment where it is assumed there will be no ongoing maintenance a deeper soil profile is preferred. Steeply sloped sites in hot conditions need even greater soil depths in comparison to flatter cooler areas. Table 2 outlines recommended topsoil depths in relation to plant height.

Table 2. Recommended topsoil depths in relation to plant height.

| Plant Type | Minimum Total Soil Depth (mm) | Topsoil Depth (mm) | Minimum Subsoil Depth (mm) |
|---|---|---|---|
| Grasses | 150 | 150 | 0 |
| Mass Planting Shrubs | 400 | 200 | 0 - 200 |
| Mass Planting Trees | 400 | 200 | 200 |

## 4.3 VHR TOPSOIL PREPARATION

VHR has found that the best cost-effective results are obtained when the ameliorants are applied to the surface of the topsoil after spreading on revegetation areas. VHR's experience indicates in conjunction with post application soil testing confirms that when Microfine Lime, Microfine Gypsum and 6 mm minus Organic Compost to AS4454 – 2003 are surface applied in the hydromulch, they are fully absorbed into the surface and penetrate to the subgrade with the plant roots. With the use of a pickle chain to spread the topsoil, leaving horizontal furrows, VHR has found this process to be an excellent technique for erosion control. This methodology also

ensures compaction does not occur. Compaction significantly impacts the germination and growth of tube stock from reduced aeration and pore spaces for water infiltration and root penetration.

The most important amelioration for mulches are lime to neutralise the hardwood acidity and urea to overcome the nitrogen drawdown.

# 5 RAW MULCH AND COMPOST – CHEMICAL PROPERTIES AND EROSION CONTROL MEASURES

This section discusses the benefit and limitations of raw mulch in comparison to appropriately composted vegetation. The G40 Specification recommends that natives (not exotics) removed during clearing grubbing to be reused for soil erosion and sediment control measures. It outlines briefly that the native vegetation is to be stockpiled and turned on occasion to prevent spontaneous combustion. There is no mention of timing and the balance of carbon to nitrogen ratios to develop a compost therefore the end result will generally be a raw mulch in the very early stages of decomposition.

In order for composting to occur, a nitrogen source should be introduced as the woody highly carboniferous vegetation will be slow to compost, the moisture content should be >40% by weight and should be regularly turned over a 6 week period preferably achieving temperatures of 55°C for 3 consecutive days with a minimum of 3 turns (NSW EPA Compost Order 2016).

It is understood that achieving a composted product in a roadside environment is highly challenging therefore the RMS has allowed for raw mulch to be an acceptable product to be used on roadside landscapes as an effective method for erosion control and a strategy for reducing waste to landfill. It is important to note that raw mulch will not provide a nutrient source and is highly likely to cause nitrogen drawdown whereby the microbes in the soil will be competing with the plant stock for the limited nitrogen source. The problem occurs when contractors use an insufficient supply of fertilisers and consequently the plant stock is left starving, quite often not surviving and leaving space for weed invasion. Phosphorus drawdown also occurs as woody matter is very low in phosphorus.

Providing that adequate ameliorants are used with the raw mulch to overcome nutrient deficiency; this strategy is an environmentally sound technique for erosion control. At a minimum SESL recommends that lime is incorporated to help overcome the intense acidity from the hardwood. To overcome N and P drawdown some monoammonium phosphate (MAP) and urea is used to overcome nitrogen and phosphorus drawdown. In work performed by SESL on the Glenugie Bypass south of Grafton, plant growth on a soil/raw mulch mix was very poor until these fertilisers were applied. When establishing native plants only very small amounts of P are needed but in most situations some is needed.

VHR have elected not to use raw mulch but instead a fine cellulose fibre compost blanket that is AS4454 certified (*6 mm minus Organic Compost to AS4454 – 2003)* combined with granular ameliorants. VHR use ANL's Greenlife™ Mulch & Compost that comprises of a mixture of Garden organics Waste Compost, Fine Wood Fibre. The compost blanket is free of wood chip as VHR from experience has have found that it becomes a maintenance problem on batters with cause for clean-up due to loss from run off in heavy rain. The compost blankets are in exceedance of the RMS requirements for quantity of organics to be used however they are still relatively thin so as not to slump off batters. No N drawdown is seen and establishment is rapid.

# 6 VHR PROJECT EXAMPLES

## 6.1 EXAMPLE 1: NORTHERN HUME ALLIANCE – HUME HIGHWAY DUPLICATION AND UPGRADE WAGGA TURNOFF TO HOLBROOK

Conventional road batters and regrade areas require revegetation to comply with the environmental management plan, even while during extended drought conditions. Following site trials of various methods conducted in December 2007 a light compost blanket application was adopted in February 2008. The application rate was approximately 6.5 tonne/ha and to date approximately 3,500,000 sq m of the application has been completed.

VHR's application included cover crop grass, native grass and native tree seed and early stabilisation requirements have been met or exceeded. Despite sparse and inconsistent rainfall all areas have developed a good grass cover and native species are beginning to emerge. The blanket has provided good erosion control until cover crop grasses germinate.

The availability of extensive soil test results enabled design of a site-specific mix. Results reflect the adequacy of soil preparation. Loose surface soils with horizontal furrows produce the best results with little surface rilling and almost total rainfall retention.

Figure 2. Section N3 -Cut 7 Batter after eight weeks.

## 6.2 EXAMPLE 2: BALLINA BYPASS ALLIANCE – PACIFIC HIGHWAY DUPLICATION AND UPGRADE.

Extensive earthworks and regrading to the batch plant site with limited available area resulted in steep (1.5:1) cut and fill batters in compacted clays and sedimentary shales. Topsoil application and retention on batters was not feasible and a compost blanket was applied in late December 2008. The application rate was 10 tonne/ha, the mixture included pasture grass and native grasses with good germination providing soil stabilisation and erosion control. Access difficulties meant that most batters were not chained.

General road batters required special attention considering the erosion potential due to intense rainfall which regularly occurs in the area. A light compost blanket at 7.5 tonne/ha was applied with excellent results and no erosion during intense rainfall.

Figure 3. Hydraulic application of compost blanket clay batters as cut for formation mid-December 2008.

Figure 4. Grass cover after six weeks mid-December 2008 to end January with nil rain until 25th January 2009 (same project as a Figure 5, Ballina Bypass Alliance).

Figure 5. Hydraulically applied compost blankets case studies - Ballina bypass alliance (same dates as Figure 4).


Figure 6. Vegetation at edge of application April 2010

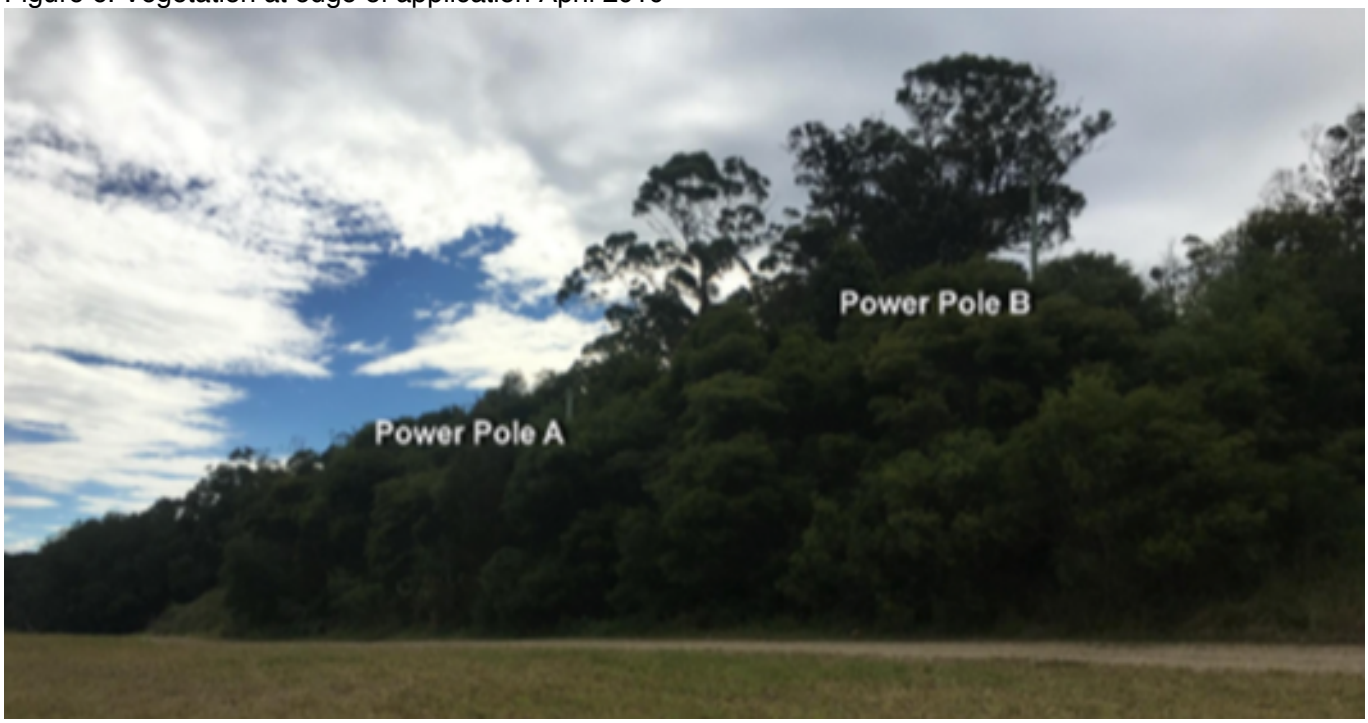


Figure 7. Native vegetation established on batter July 2016.

## 6.3 EXAMPLE 3: BENGELLA MINING COMPANY

Decommissioning of the Stockton Rifle Range required removal of contaminated surface soils and stabilisation of the raw sand surface to prevent wind erosion and establish a vegetative cover.

The sand was raw and fine grained with little nutrition or organic matter.

A light compost Blanket at 7.5 tonne/ha was applied resulting in an immediate crusted surface layer preventing wind erosion. Germination commenced within seven days even without rainfall or mechanical watering.

Figure 8. Treated area seven days after application with 6.6mm over two days.

Figure 9. Surface crust has formed.

## 6.4 EXAMPLE 4: HUNTER 8 DUPLICATION STAGE ONE.

Specification for stabilisation of cut batters in clay and shale stratum nominated installation of cells and filling with topsoil. Site access and time and cost constraints required consideration of alternative methods, topsoil replacement was not an option.

A trial section was prepared in cut 4 with various surface preparations varying from bare cut batters, chained batters and chained batters with a thin topsoil cover. Total trial area was 1,500 sq m.

A compost blanket at 7.5 tonne/ha was applied resulting in an immediate crusted surface layer preventing wind and water erosion. In loose areas the ameliorants penetrated and formed a deeper crust than in cut only batters.

Figure 10. Batter chaining operation – first pass.

Figure 11. Batter after four passes with chain. Weak shales easily scarified.

Figure 12. Finished compost blanket with complete surface cover.





ABN 70 106 810 708
T 1300 30 40 80
F 1300 64 46 89
E info@sesl.com.au
W sesl.com.au

POST PO Box 357, Pennant Hills NSW 1715
LAB 16 Chilvers Rd, Thornleigh NSW 2120
ACT Level 4, 15 Moore St, Canberra ACT 2601
VIC Level 1, 21 Shields St, Flemington VIC 3031
QLD Level 10, 15 Green Square Cl, Fortitude Valley QLD 4006

Figure 13. Grass cover after 10 days on 6th April 2010.

Figure 14 Grass cover after 3 months on 26th June 2010.

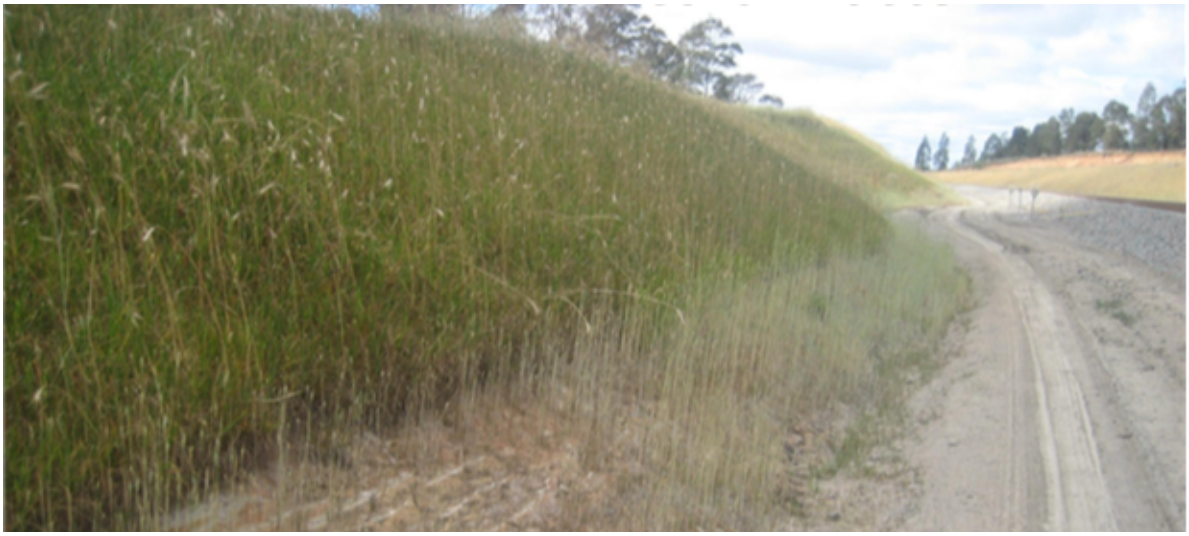

Figure 15. Grass cover after 7 months on 30th October 2010. Permanent grasses on batter.

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# 8 LIMITATIONS

*SESL has performed consulting services for this project as outlined in our discussions and in accordance with current professional and industry standards for environmental site assessment. The findings of this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of this site and do not represent the actual state of the site at all points. Should materials or conditions be encountered other than those which have been described these will require additional assessment.*

*SESL assessment is based on the result of limited site investigation. SESL cannot provide unqualified warranties nor assume any liability for site conditions not observed, accessible during the time of the investigations.*

*Despite all reasonable care and diligence, the ground conditions encountered and the concentrations of contaminants measured may not be representative of conditions between the locations samples and investigated. In addition, site characteristics may change as a result of soil heterogeneity, chemical reactions and other events. These changes may occur subsequent to SESL investigation and assessment.*

*This report and associated documentation and the information herein have been prepared solely for the use of the client and any relevant authority. Any reliance assumed by third parties on this report shall be at such parties own risk. Any ensuring liability resulting from use of the report by third parties cannot be transferred to SESL.*





WATER MINING SPORTS & RECREATION HORTICULTURE & AGRICULTURE ENVIRONMENTAL ENGINEERING & GEOTECH URBAN HORTICULTURE & LANDSCAPING

ABN 70 106 810 708
T 1300 30 40 80
F 1300 64 46 89
E info@sesl.com.au
W sesl.com.au

POST PO Box 357, Pennant Hills NSW 1715
LAB 16 Chilvers Rd, Thornleigh NSW 2120
ACT Level 4, 15 Moore St, Canberra ACT 2601
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