

Annexure "J" Vegetation Management Plan



Vegetation Management Plan

Currans Hill, 187, 195 and 203 Turner Road

Prepared for
Turner Road Developments and Ken Broome
September 2017



DOCUMENT TRACKING

Item	Detail
Project Name	Vegetation Management Plan – 187, 195 and 203 Turner Road Currans Hill
Project Number	N: 15COR-1879 and 2099
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Status	Final
Version Number	2
Last saved on	1 September 2017
Cover photo	Photo by Steven House

This report should be cited as 'Eco Logical Australia 2017. *Vegetation Management Plan – Currans Hill, Turner Rd.* Prepared for Turner Road Developments and Ken Broome'.

ACKNOWLEDGEMENTS

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Abbreviations

Abbreviation	Description
EEC	Endangered Ecological Community
ELA	Eco Logical Australia Pty Ltd
GIS	Geographic Information Systems

GPS	Global Positioning System
LGA	Local Government Area
LPI	Land and Property Information
NSW	New South Wales
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i>
VMP	Vegetation Management Plan
VRZ	Vegetated Riparian Zone

Executive summary

This Vegetation Management Plan (VMP) has been prepared by Eco Logical Australia Pty Ltd (ELA) on behalf of Turner Road Development for 187, 195 and 203 Turner Road, Currans Hill within the Camden Local Government Area (LGA). The Turner Rd, Currans Hill subdivision will comprise approximately 95 lots.

This VMP is related to the main drainage line within the site, which runs north-south. Up and downstream of the site has been highly modified by development, i.e. creeks were removed for road drainage and bio-retention, or replaced by grassed swales. The drainage line is approximately 570 m in length and comprises the following channel types from north to south: overland flow (no defined channel for 249 m); defined channel with riparian vegetation (137 m); modified channel (mechanically dug for 98 m) and two farm dams (86 m). The creek is in very poor condition with limited aquatic value only associated with the farm dams.

The threatened community Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW) occurs within the subject site, in the form of approximately 25 scattered paddock trees surrounded by approximately 10.5 hectares (ha) of exotic pasture grasses. This community is a critically endangered ecological community (CEEC) under the NSW *Threatened Species Conservation Act 1995* (TSC Act). Although CPW is also listed as critically endangered under the EPBC Act, the scattered trees present on the subject site do not meet the criteria to be considered part of the community under this Act. A small remnant (0.2 ha) of River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (RFEF) occurs along the existing drainage line on the subject site. This community is an endangered ecological community (EEC) under the TSC Act.

The proposed development seeks to realign and rehabilitate the north-south creek. Three management zones have been identified for the site: a low flow area; detention basin batters and a revegetation zone covering remaining areas within the 30 m vegetated riparian zone (VRZ). The proposed vegetation management works are outlined for each zone, including pre-construction, construction and post-construction phases. Three years of maintenance weeding are included in this VMP.

The monitoring and reporting requirements set out in this VMP include the establishment of photo monitoring points for observing vegetation changes over time; preparation of an annual report summarising the works undertaken to date and any issues encountered and reviewing site progress and compliance with the VMP, including whether the performance criteria indicated in this report have been met. The total cost of implementing the VMP has been estimated at **\$457,246**.

1 Introduction

This Vegetation Management Plan (VMP) has been prepared by Eco Logical Australia Pty Ltd (ELA) on behalf of Turner Road Development for Turner Road, Currans Hill within the Camden Local Government Area (LGA). This VMP relates to the proposed subdivision of the area of land known as 187, 195 and 203 Turner Road, Currans Hill (**Figure 1**). The site is located just north of Narellan, approximately 50 km south west of Sydney.

The proposed works include subdivision of the land and realignment of the north-south drainage line as per the drainage plans in **Appendix A**.

1.1 Objectives of the VMP

The objectives of this VMP are to provide a guide to bush regeneration contractors to:

- Restore and stabilise the area of creek affected by the works
- Slow the water speed in the creek line and stabilise the bed and banks of the creek line
- Revegetate the riparian corridor through removal of weeds
- Revegetate an area of exotic pasture within the riparian corridor with species native to the Cumberland Plain Woodland (CPW) community
- Control noxious and environmental weeds on the site
- Protect flora and fauna habitat
- Provide for a stable bed and bank
- Implement erosion and sediment control to reduce impacts to the creek.

The overall objective of the VMP is to emulate the native vegetation of the area and ensure a naturalised stable creek is functioning.



Figure 1: Location of site

2 Description of the environment

2.1 Existing drainage

The 1:25,000 topographical map shows two second order streams and one first order stream within the site, as shown in **Figure 2**. Due to broad scale mapping, these drainage lines are not representative of the actual drainage lines within the site.

In 2014, ELA mapped the location of the two second order streams within the site, as shown in **Figure 2**. These were located running north-south through the site and also in the south-east corner. The first order stream entering the site from the east was not present and has previously been approved for removal as part of residential development to the east.

The second order stream in the south-east of the site is not the subject of this VMP. Its realignment has been approved and constructed to allow residential development to the east. A new culvert was constructed under Turner Road between January and May 2015.

2.1.1 North-south drainage line

The north-south drainage line is approximately 570 m in length and comprises the following channel types from north to south:

- Overland flow (no defined channel) = 249 m
- Defined channel with riparian vegetation = 137 m
- Modified channel (mechanically dug) = 98 m
- Farm dams = 86 m

The creek is in very poor condition with limited aquatic value only associated with farm dams. Small patches of established trees occur in two locations. These are the only areas that would hold water in a channel (0.5 – 2.5 m wide) with small incised banks (mostly <0.3 m, but up to 1 m in parts). These sections have a clay base with no aquatic or semi-aquatic flora.

This second order stream is considered to be waterfront land under the *Water Management Act 2000* (WM Act). The highly degraded drainage line has been subject to modification up and downstream and on site, and given its condition is considered suitable for treatment as a first order stream, as provided by DPI Water in **Appendix B**.



Figure 2: Existing drainage

2.3 Existing vegetation

2.3.1 Vegetation communities

The threatened community Cumberland Plain Woodland in the Sydney Basin Bioregion (CPW) occurs within the site, in the form of approximately 25 scattered paddock trees surrounded by approximately 10.5 hectares (ha) of exotic pasture. This community is a critically endangered ecological community (CEEC) under the TSC Act. Although CPW is also listed as critically endangered under the EPBC Act, the scattered trees present on the site do not meet the criteria to be considered part of the Commonwealth community under this Act. The area of CPW is small, isolated and of low quality having low native diversity and cover.

A small remnant (0.2 ha) of River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (RFEF) occurs along the main drainage line on the site. This community is an endangered ecological community (EEC) under the TSC Act. The remnant patch has low structural diversity and is isolated from other patches of native vegetation.

2.3.2 Weed species

Two species of category four, declared noxious weeds under the NSW *Noxious Weeds Act 1992* (NW Act) have been observed on the site: *Lycium ferocissimum* (African Boxthorn) and *Olea europaea ssp. cuspidata* (African Olive). Noxious weed categories are explained in **Appendix C**.

3 Management works

Several treatments are proposed to achieve the objectives identified in **Section 1.1** of this VMP:

- Preliminary works
- Vegetation Works.

3.1 Preliminary works

3.1.1 Fencing

Following the completion of stormwater construction works for the creek realignment, the vegetated riparian zone (VRZ) will be fenced to prevent construction machinery from entering the area, unless under supervision from a suitably qualified bush regenerator. Informational signage will be installed around the VRZ fencing to communicate the exclusion zone to contractors. Signage and fencing will remain in place until all civil construction works associated with the development are completed.

3.1.2 Soil preparation

Soil studies in Western Sydney have identified considerable chemical change in soils between the A and B horizons. The B horizons in particular are highly sodic and are prone to deflocculation, erosion and water logging. B horizon soils also significantly reduce the success of revegetation works.

Hence, areas where excavation works will be undertaken to a level at or below the B horizon, including rip-rap, battering and diverted creek lines, they will be required to be treated in the following way:

- Stockpile top soil and A horizon
- Excavate to a level 300 mm below finished surface level
- Place stockpiled A horizon and topsoil on top of B horizon soils, to a minimum depth of 200 mm

In addition, in these areas and in any areas of construction impact or broad scale revegetation (e.g. mulching / jute matting), the following works will be undertaken:

- Allow weed seed to germinate and spray with herbicide
- Place a minimum of 100 mm of topsoil (from stockpile or imported) on top of A horizon
- Improve as required to achieve a locally appropriate soil (e.g. gypsum, trace minerals, etc.)
- Rip and cultivate to ensure a soft, friable soil
- Jute matting or mulching as required.

Soil preparation other than installation of jute matting / mulch is to be undertaken by the civil contractor in consultation with a suitably qualified bush regenerator. The installation of jute matting / mulch will be carried out during vegetation works by the bush regeneration contractor as specified in **Table 4**.

3.1.3 Seed collection and species substitution

Where planting is required, seed must be collected from local provenance species. Specifications for local provenance are given in **Appendix D** and target species are given in **Appendix E**.

3.1.4 Weed control treatments

All bush regeneration, revegetation and maintenance work will be undertaken by a suitably qualified and experienced bush regeneration contractor. Bush regeneration and maintenance work will control pasture grasses, herbaceous species and woody weeds (see **Appendix D**). This weeding will include hand

weeding, slashing, spot spraying, cut and paint or drill and fill. Where herbicide use is required, a non-selective herbicide and other additives identified for use near water will be used (i.e. RoundUp® Bioactive™) when works are being undertaken in or adjacent to the creekline or near standing water. Maintenance will occur on a weekly basis during warmer periods and monthly during cooler periods.

3.1.5 Aboriginal Heritage

An archaeologically sensitive area was identified in the north east of the site, including the patch of RFEF within known Aboriginal Heritage Information Management System (AHIMS) site number 52-2-2122. A salvage excavation is required via application for an Aboriginal Heritage Impact Permit (AHIP) to the NSW Office of Environment and Heritage (OEH).

This AHIP would need to be approved and all salvage works completed prior to commencement of any civil works for the creek realignment (and any subsequent vegetation management works).

If during the implementation of the VMP, suspected Aboriginal artefacts are uncovered, then works should cease and the OEH should be contacted immediately to assist in determining appropriate management.

3.1.6 Adaptive management

As this is a long term project that will be implemented over a number of years, an adaptive management approach will be implemented that enables the successful contractor to learn from and respond to successful and unsuccessful techniques used on the site. In its simplest form this may include the substitution of species identified in the planting table for advanced direct seeding techniques in place of manual planting techniques.

The success of the works will be determined by meeting the performance criteria identified in later sections of this document. Contractors have the flexibility to implement different techniques to those specified here providing that performance criteria are met. Any major departures from the VMP or change to performance criteria must be approved in writing by Camden Council.

3.2 Vegetative works

These works have been identified for the following individual treatment areas as shown in **Figure 3:**

- Zone 1: Low flow areas
- Zone 2: Detention basin batters
- Zone 3: Revegetation.

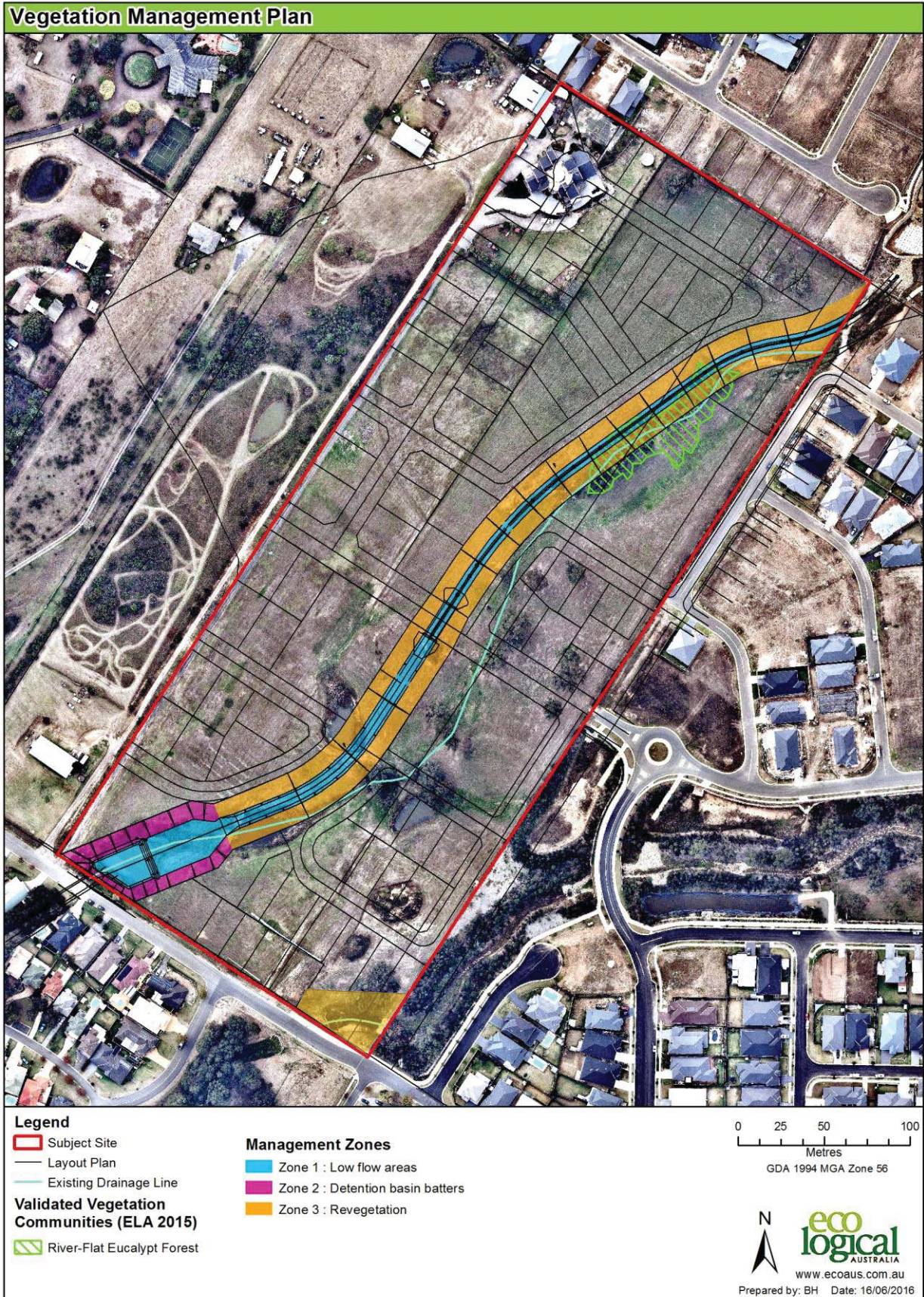


Figure 3: Vegetation management zones

3.2.1 Management Zone 1: Low flow areas

Zone 1, an area of 0.51 ha, encompasses the new creek channel, the raingarden and the rock rip rap areas, which will be re-shaped during construction works. This zone will be covered in heavy weight jute matt (>850g / m²) and revegetated using tubestock. Jute matt is to have a minimum 150 mm overlap with overlaps facing downstream.

Revegetation will be undertaken using a variety of sedge and rush species as identified in **Appendix E** at the densities specified in **Table 1**. The species selected will be a mix of groundcovers.

3.2.2 Management Zone 2: Detention basin batters

Zone 2, an area of 0.16 ha, encompasses the batters of the existing southernmost farm dam. The bank of the dam will be revegetated following construction of the gabion wall, access path, inlet and outlet structures. Intense weed control will be required to prevent new weed establishment in these areas. Sediment fences will be installed and maintained at all inlets to the farm dam until native vegetation is established. This zone will be covered in heavy weight jute matt (>850g / m²) and revegetated using tubestock. Jute matt is to have a minimum 150 mm overlap with overlaps facing downslope into the dam.

Revegetation will be undertaken focusing on hardy sedge and grass species as identified in **Appendix E** to achieve the densities specified in **Table 1**. However, trees and shrubs from the CPW community will also be used.

3.2.3 Management Zone 3: Revegetation

Zone 3, an area of 0.96 ha, encompasses an area dominated by exotic pasture grasses and weeds. It will also cover an area of cleared RFEF. Intense weed control will be required to prevent new weed establishment in these areas. This zone will be covered in heavy weight jute matt (>850g / m²) and revegetated using tubestock. Jute matt is to have a minimum 150 mm overlap with overlaps facing downslope into the channel.

Weed removal shall involve a primary control program using cut and paint woody weeds such as African Boxthorn and African Olive. A secondary / maintenance program will involve using spot spraying, hand-weeding and cut and paint techniques. Further detail on bush regeneration techniques is provided in **Appendix D**.

Revegetation will be undertaken using predominately CPW species as identified in **Appendix E** at the densities specified in **Table 1**.

Table 1: Management actions

Zone	Description	Area (m2)	Revegetation densities (m ²)*				Totals
			Tree	Shrub	Herbs / Scramblers	Sedge / Grass	
Zone 1	Low-flow areas	5,140				6.00	30,838
Zone 2	Detention basin batter	1,627	0.005	0.02		6.00	9,800
Zone 3	Revegetation	10,561	0.01	0.04	1.00	3.00	42,723
Totals	-	16,328	-	-	-	-	83,361

*Includes equivalent amount of direct seeding

4 Maintenance

The entire site will require ongoing maintenance to control weed regrowth from the soil seed bank for many of the weed species. Maintenance work is to be undertaken by a qualified bush regeneration contractor(s) to meet the performance criteria in **Table 2**.

Maintenance will be undertaken on a regular basis of at least weekly in the peak growing seasons (spring and summer) and monthly in cooler periods (autumn and winter). Maintenance will be undertaken for five years after practical completion of establishment works. Practical completion refers to the completion of all civil works, soil preparation, initial weed control and planting.

Completion of the maintenance period is dependent on achieving the required objectives for the VMP area. If the objectives identified in **Section 1.1** or the performance criteria outlined in **Table 2** are not met, the maintenance period will be extended until they have been. Alternately, if the performance objectives are met earlier than expected, Council may agree to an earlier handover. Therefore, maintenance must continue until Camden Council agrees that the objectives and performance criteria have been met and the maintenance period has concluded.

5 Monitoring and reporting

5.1 Monitoring

The bush regeneration contractor will be engaged by the land owner to monitor the vegetation for changes over time. Monitoring will be required on a six monthly basis for the first two years and then annually until handover to Council, estimated to be five years from practical completion.

Short term (follow up) monitoring, is to be undertaken after the initial weed control works. This will determine if the initial treatment has been effective in controlling the target species or if follow up treatments are required and for how long. Follow up monitoring will prevent controlled areas from being reinfested. This monitoring is essential to inform the maintenance works and to get maximum value for money from the initial weed control works.

Long term (annual) weed monitoring will be used for initial work schedule planning, where and when to target weed control works in the coming year and appropriate works to be implemented noting that varying climatic conditions throughout the year may mean that the initial schedules need to be altered.

5.1.1 Photo monitoring points

A number of photo monitoring points will be established across the site to provide a visual reference of changes in the vegetation and performance of the stream works. This will be undertaken prior to the commencement of works and at the beginning of each summer season. The lead supervisor will set up 8 photo points across the site with the following distribution:

- Zone 1: Low flow areas – 3 photo points
- Zone 2: Detention basin batters – 2 photo points
- Zone 3: Revegetation – 3 photo points.

The following method will be used to establish and monitor the photo points:

- Mark the photo point with a six foot star picket and map the location of each photo point
- Take a digital photo of each photo point with the whole length of the star picket visible in the photo to act as a reference point
- Organise the digital photos logically with each image labelled with a unique reference number indicating the location of the photo point, the direction of the photo and the date the photo is taken.

5.1.2 Quadrats

Quadrats (1 m x 1 m) should be undertaken adjacent the photo points located in each zone during each monitoring period. Data collected will include:

- A species list of native species and their percentage cover
- A species list of exotic species and their percentage cover
- Survival rate of all planted vegetation per strata level: i.e. tree, shrub and groundcover
- Vegetation condition.

5.2 Reporting

The bush regeneration contractor will be engaged by the land owner to report on progress of the vegetation for changes over time. Reporting will be required on a six monthly basis for the first two years and then annually until handover to Council, estimated to be five years from practical completion.

Each report will include:

- Works carried out, including a measure of effort (e.g. number of hours, change in weed densities, etc.) and other relevant information (e.g. weed species targeted, areas worked, dominant techniques used, etc.)
- Photos from monitoring points
- Quadrant information
- Any observations, such as the occurrence of new weed species
- A description of any problems or issues encountered (e.g. threatened species, rates of regeneration, etc) and how they were overcome
- A summary of how the site-specific objectives and performance criteria have been met (or not). If these have not been met, further explanation and a proposed response may be necessary
- Relevant maps.

This annual report will highlight the effectiveness of the program and identify any changes needed to improve (i.e. changes to weed control techniques, types of herbicides used or weed priority).

5.3 Performance criteria

The progress and compliance with the VMP will be monitored and reviewed every reporting period (i.e. six monthly for the first two years then annually afterwards). This process will involve the contractor(s), the land owner and the lead supervisor. Annual reports will be submitted to Camden Council. If required, reporting will be followed by a site visit to discuss.

The performance criteria are shown in **Table 2**. Where non-performance occurs and is not immediately rectified a 'stop the clock' notice on the maintenance period may be issued by Camden Council until the non-performance is rectified. In the case of performance criteria not being met due to extreme acts of nature (e.g. fire, flooding) or vandalism, discussions may be held with Camden Council to consider alternative performance criteria.

Table 2: Performance criteria

Zone	Year 1	Year 2	Year 3	Year 4	Year 5
	<p>Commencement of all tasks outlined in the VMP or evidence of planning for their implementation.</p> <p>An increase in native cover and diversity and a decrease in exotic cover and diversity by the end of the maintenance period</p> <p>At the end of each year, a minimum of 85% survival rate of all vegetation strata planted in each zone (e.g. tree, shrub and groundcover)</p> <p>Any localised plant failure within planting areas are addressed with no area larger than 2 m x 2 m without surviving plants at the end of each year;</p> <p>Maintenance replanting is to replace plants by the same species, or where that species is not available, with the same growth form (i.e. tree for tree etc.) and must not decrease species diversity. Any new species to be planted must be from the community being emulated and of local provenance;</p> <p>Monitoring and reporting undertaken in accordance with Section 5</p>				
All zones	All adult seeding noxious weed individuals to be controlled and no establishment of new noxious species	No noxious plants allowed to set seed and no establishment of new noxious species	No noxious plants allowed to set seed and no establishment of new noxious species	No noxious plants allowed to set seed and no establishment of new noxious species	Complete eradication of noxious weeds from the site and no establishment of new noxious species
	Native groundcover vegetation no less than 30% of zone.	Native groundcover vegetation no less than 40% of zone.	Native groundcover vegetation no less than 50% of zone	Native groundcover vegetation no less than 60% of zone.	Native groundcover vegetation no less than 80% of zone
	Exotic groundcover vegetation no more than 40% of zone.	Exotic groundcover vegetation no more than 30% of zone.	Exotic groundcover vegetation no more than 20% of zone.	Exotic groundcover vegetation no more than 15% of zone.	Exotic groundcover vegetation no more than 10% of zone

6 Implementation schedule and cost

The total indicative cost to implement this VMP is estimated at **\$457,246** until the end of the five year maintenance period exclusive of GST (**Table 4** Error! Reference source not found.). Costs may vary significantly over consecutive years of management according to the response to the management actions.

Rates and costs are based on ELA's commercial rates. As such, ELA requests that these figures not be provided to a third party, e.g. tenderers, without the knowledge or approval of ELA estimates of current standard commercial rates and there is potential for variation across the sector along with changes due to inflation. Other assumptions that have been made in regards to estimating costs have been outlined below.

6.1 Fencing

Costs for any fencing works required will be incurred by the client or contractors and have not been included in this budget.

6.2 Site preparation

The expense of machinery and staff time for the implementation of the site preparation works will be incurred by the client.

6.3 Seed collection

Budget for the collection of seed has been included as a separate task. If further seed collection works are required this may be an additional cost. The costs for propagation of these seeds are included as part of revegetation treatments in **Table 4** below.

6.4 Weed control treatments

Bush regeneration contractors will implement the weed control treatments identified in this VMP. These works have been estimated to cost \$2,200 for a team of four bush regenerators, including a supervisor, per day. The cost of bush regeneration works includes the costs of herbicide, vehicles and equipment which are required to implement the VMP.

6.5 Soil and water management plan

A Soil and Water Management Plan for the site will be prepared and implemented prior to construction activities beginning. A copy of the Soil and Water Management Plan will be provided to the bush regeneration contractor by the site engineer. The bush regeneration contractor is not responsible for the installation or maintenance of any erosion or sediment controls required by the civil works.

6.6 Vegetation treatments

Bush regeneration contractors will implement the revegetation treatments identified in this VMP. The majority of the site will be revegetated via tubestock. A total of approximately 13,575 tubestock, or equivalent, will be required with a 10% replacement rate assumed. These replacement plantings would most likely be needed six months to one year after the initial tubestock were installed, and have been included within the costing.

6.7 Monitoring and reporting

Bush regeneration contractors will undertake the monitoring and reporting identified within this VMP. This includes:

- Initial setup of the photo points and quadrats and conducting the baseline surveys
- Undertaking a report every six months for two year and annual for up to five years 12 months including photo points and quadrats
- Preparation of the 'Certificate of Practical Completion' annually

All monitoring, mapping and reporting works have been calculated using the rate for a qualified and trained Restoration Ecologist at \$150 / hour (ex GST).

6.8 Implementation schedule

An implementation schedule for these works is provided in **Table 3**. Any natural regeneration should be assessed and taken into account before revegetation works begin.

Table 3: Implementation schedule

Establishment	Year 1	Years 2-5
Majority of seed collection undertaken	Remaining seed collection completed	-
Site preparation of revegetation areas, including jute matting and mulching	Replacement planting	Replacement planting, if required
Revegetation in all zones		
Primary and secondary control of all weeds	Secondary and Maintenance weed control	Maintenance weed control.
Monitoring and reporting	Monitoring and reporting	Monitoring and reporting

Table 4: Indicative implementation costs

Treatment	Unit Costs for Treatment Zones			Total
	Zone 1	Zone 2	Zone 3	
Total Area (sqm)	5,140	1,627	10,561	17,328
Revegetation				
Seed collection, cleaning, storage	\$3,084	\$980	\$4,277	\$8,341
Site Preparation	\$2,570	\$813	\$5,281	\$8,664
Jute Matting / Mulch	\$0	\$11,793	\$76,571	\$88,364
Tubestock, supply and install	\$69,386	\$22,101	\$96,903	\$188,390
Replacement tubestock, supply and install	\$6,939	\$2,210	\$9,691	\$18,840
Irrigation	\$3,855	\$1,220	\$7,921	\$12,996
Weed control				
Establishment	\$5,140	\$1,627	\$10,561	\$17,328
Maintenance	\$30,838	\$9,760	\$63,369	\$103,967
Associated costs				
Monitoring & Reporting	\$3,855	\$1,220	\$5,281	\$10,356
Totals	\$125,667	\$51,724	\$279,855	\$457,246

References

Brodie L (1999). *The National Trust Bush Regenerators Handbook*. National Trust of Australia (NSW).

Buchanan, R.A. 2000. *Bush regeneration: recovering Australian landscapes*. 2nd edition. TAFE NSW, Sydney.

DPI 2012. *Guidelines for riparian corridors on waterfront land*. Department of Primary Industries Office of Water NSW. Available at: http://www.water.nsw.gov.au/__data/assets/pdf_file/0004/547222/licensing_approvals_controlled_activities_riparian_corridors.pdf

Mortlock, W. 2000. *Florabank Guideline 10: Seed collection ranges for revegetation*. Florabank and the Hawkesbury-Nepean Catchment Management Trust. Available at: <http://www.florabank.org.au/files/documents/Guideline%20No.%2010%20-%20Seed%20collection%20ranges%20for%20revegetation.pdf>

Muyt, A. 2001. *Bush Invaders of South-East Australia*. R.G. & F.J. Richardson. Meredith, Victoria.

Appendix A : Proposed drainage plans

Appendix B : NoW correspondence:

From: Jeremy Morice <Jeremy.Morice@water.nsw.gov.au>

Date: 7 August 2014 2:00:26 PM AEST

To: Ian Dixon <lanD@ecoaus.com.au>

Subject: Re: FW: Merit based assessment - 195-203 Turner Road, Currans Hill (Manooka Valley West)

Hi Ian,

I have reviewed your riparian report prepared for the subject site. Based on the information provided the following NSW Office of Water comments apply to any future development of the site:

- The eastern mapped watercourse as referred to in your riparian report below can be removed.
"To the east of the Driver Property, a residential development has removed a 1st order creek that once flowed into the Driver Property (water in that catchment will flow through road drainage to the larger creek further south). I am advised that this creek has been approved for removal within the Driver Property."
- The second order mapped watercourse from reaches A-I as specified in the report provided is considered to be waterfront land as defined by the *Water Management Act 2000*. It is acknowledged that this watercourse is highly degraded with some reaches of disconnected channel within the site. It is also modified or removed within adjacent properties.

The following requirements for this watercourse apply:

- Given the condition of this watercourse it is considered suitable for treatment as a 1st order stream as specified by the Guidelines for riparian corridors on waterfront land
- The online wet detention basins as proposed in the concept plan are allowable subject to the assessment of detailed design by the NSW Office of Water. Basins require riparian planting including some trees and shrubs along the fringes of the basins. Designs will also require Council approval in regard to water quality and drainage requirements.
- The second order stream located in the south eastern corner of the site requires the establishment of a riparian corridor consistent with its treatment within the adjoining Manooka Valley development to the east of the site.

Any revisions to the current concept subdivision plan for the site should be provided to the NSW Office of Water for further comment prior to submission of a Development Application for the site.

Please give me a call if you wish to discuss any of the above.

Regards,

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Appendix C : Noxious Weed Categories

Control class	Weed type	Example control requirements
Class 1	Plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.	<p>The plant must be eradicated from the land and the land must be kept free of the plant.</p> <p>The weeds are also "notifiable" and a range of restrictions on their sale and movement exist.</p>
Class 2	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.	<p>The plant must be eradicated from the land and the land must be kept free of the plant.</p> <p>The weeds are also "notifiable" and a range of restrictions on their sale and movement exist.</p>
Class 3	Plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.	The plant must be fully and continuously suppressed and destroyed.*
Class 4	Plants that pose a potentially serious threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.*
Class 5	Plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State.	<p>There are no requirements to control existing plants of Class 5 weeds.</p> <p>However, the weeds are "notifiable" and a range of restrictions on their sale and movement exists.</p>

Appendix D : Techniques and specifications

Weed control

Weed control involves a combination of mechanical, physical and chemical techniques to remove the weeds and prevent regrowth. Weed control will be undertaken in all management zones. A selection of the best suited weed control method within the site depends on a number of factors including:

- The species or combination of weeds being targeted
- The density of the weeds
- Resources available (time, labour, equipment and finances)
- Weather conditions of the day

Weed control techniques

Detail of specific weed control techniques to be used such as cut and paint, scrape and paint, herbicide spraying and hand weeding are given in Brodie (1999). The principles of bush regeneration and techniques to trigger natural regeneration are to be in accordance with the Bradley Method and other techniques described in Buchanan (2000). Management techniques for different types of weeds are provided below.

Annual grasses

Annual grasses, such as *Bromus catharticus* (Prairie Grass), should be hand removed or spot sprayed where isolated or in low concentrations. Larger patches of annual grasses may be slashed/brush cut in late spring to early summer, after flowering, but prior to seed set. For most species, slashing/brush cutting prior to late spring through to early summer will promote vigorous growth and should not occur. However, some annual grasses can grow and produce seed at any time of the year dependent on climatic conditions such as high rainfall and warm temperatures. Monitoring of annual species should be undertaken and if new growth occurs, the same treatment will be applied to the new growth to prevent seed production. Individual plants should be hand removed, bagged and disposed of appropriately offsite.

Perennial grasses

Perennial grasses, such as *Paspalum dilatatum* (Paspalum) and *Pennisetum clandestinum* (Kikuyu Grass), will be hand removed where isolated or in low concentrations. Larger patches may be slashed prior to seed production in spring or summer (depending on the growth cycle of the species) and the regrowth spot-sprayed 2-3 weeks later when it is actively growing and approximately 10 cm in length. Monitoring of these species will occur and if new seed production occurs, the same treatment will be applied again as required. However, slashing will not reduce the presence of exotic grasses on its own and must always be combined with targeted removal to reduce densities and allow for native regeneration. Individual plants should be hand removed, bagged and disposed of appropriately offsite.

Woody weeds

If woody weeds invade the site, including species that were present before earthworks such as African Boxthorn and African Olive will be controlled by the cut and paint or drill and fill method using a non-selective herbicide. The most appropriate method to be used depends on the size of the individual to be removed and will be determined by the bush regeneration contractor. Primary weed control should use

techniques that will not encourage flushes of secondary weed growth. All seedlings of woody weeds will be hand pulled or spot-sprayed with a non-selective herbicide.

Creepers and climbers

The control of creepers, including *Asparagus asparagoides* (Bridal Creeper), *Anredera cordifolia* (Madeira Vine), *Rubus fruticosus* sp. agg. (Blackberry) and *Lonicera japonica* (Japanese Honeysuckle), varies depending on the species. For the most part, seedlings will be hand pulled, while mature plants can be controlled by the stem-scrape method or spot spraying using a non-selective herbicide. The precise method to be used will be determined by the bush regeneration contractor depending on the species, size and reproductive status of the individual. All vegetative material removed should be bagged, removed from site and disposed of appropriately.

Herbaceous weeds

Where individual plants of other herbaceous weeds, including *Conyza bonariensis* (Flax-leaf Fleabane) and *Verbena bonariensis* (Purpletop), are found, they will be hand pulled prior to flowering. Where large swaths of these species occur they will be sprayed using a non-selective herbicide. If high densities of mature stands occur, weeds may be slashed first using a brush cutter and any subsequent regrowth sprayed. Regular monitoring of these species will be required to prevent seed production. *Cirsium vulgare* (Spear Thistle) will not be hand-pulled due to its thorns and instead will be spot sprayed using a non-selective herbicide. All vegetative material that is pulled out and has the potential to regrow if deposited on ground will be bagged and removed from site.

Management of weed waste

All exotic vegetation material should be removed from site and composted at a registered green waste disposal facility. Fruiting parts and tubers should be bagged before being removed from site.

Herbicide use

The use of herbicide to control weeds should be carefully considered. Herbicide use should assess potential long-term impacts of the technique including whether the proposed works actually address the source of the weed infestation. However, herbicide application forms an important and useful component of an integrated weed management approach and can be the most appropriate method to control some weed species.

Herbicide use should occur during the active growing season for plants to encourage the chemical uptake into the plant. The selection of herbicides should also consider the type of weed and the location. Where non-selective herbicides are required for use, glyphosate is the most suitable. If herbicides are required to be used near waterways, a glyphosate-based herbicide formulated for use near waterways will be used (e.g. RoundUp© Biactive™).

Broad-leaf selective herbicide may be used as per the Noxious and environmental weed control handbook (DPI 2010). However, this type of herbicide is extremely toxic to aquatic life and must not be used in, or adjacent to, waterways. Registration and records must be kept in accordance with the NSW Pesticide Regulation 2009.

Revegetation works

Revegetation has the twin aims of both re-establishing the original native vegetation community at the site and reducing erosion along the length of the riparian corridor, which will carry greatly increased peak

flows due the increased run-off from the hard surfaces created by the associated residential development. The revegetation must be undertaken in accordance with the Standards for APZ (NSW Rural Fire Service, 2005). Any plantings should consist of local provenance stock. A summary of the revegetation densities is shown in **Table 1**.

Planting of Hiko for trees and shrub species and Hiko or Viro cells for grasses and other groundcover species is the preferred method. Planting should be done via a low impact method such as hand digging or hand auger. The holes dug for each plant should be at least 1.5x the width and 2x the depth of the rootball. Fertiliser should be added to each hole dug as per the label specifications. Water crystals or wetting agents should be added to each plant hole. This will increase the water holding capacity of the soil and reduce watering schedules. Initial irrigation of the plantings is essential to ensure that the soil forms around the rootball and no air pockets are left. This will be required unless sufficient rainfall (approx 10mm) occurs on the day of planting.

Tree guards will need to be installed on each tree or shrub to protect seedlings from extreme weather (frosts and heat), herbivorous grazing and herbicide drift during maintenance. Bio-degradable tree guards are recommended to protect the seedlings. Following the revegetation works, irrigation needs to be undertaken for at least 8 weeks following planting to ensure the establishment of the plants. The level of irrigation will be determined by rainfall and temperature experienced at the planting site.

Mulch should be used where identified. The use of mulch is very important because it provides organic matter to the top soil, improves soil structure and aeration, water infiltration, nutrient availability, and is also useful in the suppression of weed growth (Buchanan 2009). Mulch should be sourced from within the local area. Mulch must be free of weed propagules and invasive woody species such as Coral Tree (*Erythrina x sykesii*). Mulching should not be undertaken within areas of high potential erosion. It is recommended jute matting is used in these areas prior to revegetation.

A temporary irrigation system should be installed to assist in the establishment of vegetation. Timing of the planting of these areas will need to take into consideration surrounding civil works and erosion/sediment control requirements, these areas will not be planted until earthworks have been completed. A maximum rate of attrition of 10% is to be tolerated, with any plant loss above this rate to be replaced at the contractor's expense

Seed collection

For the growth of the plants used in the revegetation works, seed must be collected from local provenance species. Groundcovers, shrubs and trees should be collected in as close proximity (i.e. <20km) as possible to the site, however soil type, climate and aspect of the collections site should also be considered. Native grasses typically have much larger dispersal mechanisms and are to be collected from within the Cumberland Plain of Sydney. Wetland species are to be collected from within the Cumberland Plain component of the Hawkesbury Nepean Catchment.

Where species identified in this VMP cannot be sourced, they may be substituted for other Cumberland Plains Woodland / River-Flat Eucalypt Forest species as identified by Tozer (2003). Species must be substituted with species of a similar form, e.g. trees for tree, grasses for grasses, etc. Only wild native species are to be used. Plants are not to be substituted with horticultural varieties under any circumstances.

Record keeping of seed collection and planting locations are to follow the Florabank guidelines (Mortlock, 2000). A Section 132C licence under the NSW *National Parks and Wildlife Act 1974* will be required to

undertake seed collection works. The bush regeneration contractor is responsible for recording this information and providing it to Camden Council.

Bush regeneration contractors

All vegetation management works in the establishment phase will be undertaken by suitably qualified and experienced bush regeneration contractors who are members of the Australian Association of Bush Regenerators or fulfil the membership criteria. In addition to this, team leaders should have, as a minimum, a Certificate III in Conservation & Land Management or equivalent. The contractor will need to carry out best practice bush regeneration techniques as described by Buchanan (2009). A flexible approach to this site is recommended since techniques may need to be changed or modified to suit site conditions. This approach is consistent with adaptive management and allows the contractor to develop and build on site knowledge whilst implementing this VMP. Monitoring will assist in the development of the VMP actions in subsequent years.

Works in the maintenance phase will be undertaken by the land manager in consultation with Camden Council.

Appendix E : Species list

Type	Scientific name	Common name	Management zones		
			Zone 1	Zone 2	Zone 3
			FW	RFEF/FW	CPW
Tree Canopy Species (>6m)	<i>Angophora floribunda</i>	Rough-barked Apple			X
	<i>Angophora subvelutina</i>	Broad-leaved Apple			X
	<i>Casuarina cunninghamiana</i> subsp. <i>Cunninghamiana</i>	River Oak		X	
	<i>Casuarina glauca</i>	Swamp Oak		X	
	<i>Eucalyptus amplifolia</i>	Cabbage Gum		X	X
	<i>Eucalyptus moluccana</i>	Grey Box			X
	<i>Eucalyptus tereticornis</i>	Forest Red Gum			X
Small Trees / Shrub Species (1.5-6m)	<i>Acacia implexa</i>	Hickory Wattle			X
	<i>Acmena smithii</i>	Lilly Pilly		X	
	<i>Backhousia myrtifolia</i>	Grey Myrtle		X	
	<i>Bursaria spinosa</i>	Blackthorn			X
	<i>Dillwynia sieberi</i>	-			X
	<i>Dodonaea viscosa</i> subsp. <i>cuneata</i>	Wedge-leaf Hop-bush			X
	<i>Indigofera australis</i>	Australian Indigo			X
	<i>Melaleuca decora</i>	-		X	
	<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree		X	
	<i>Tristaniopsis laurina</i>	Water gum		X	
Sedges, Rushes, Reeds & Grasses	<i>Aristida ramosa</i>	Purple Wiregrass			X
	<i>Aristida vagans</i>	Threeawn Speargrass			X
	<i>Baumea articulata</i>	Jointed Twig-rush	X		
	<i>Baumea rubiginosa</i>	Twig-rush	X		
	<i>Bolboschoenus caldwellii</i>	Salt Club-rush	X		

Type	Scientific name	Common name	Management zones		
			Zone 1	Zone 2	Zone 3
			FW	RFEF/FW	CPW
	<i>Bolboschoenus fluviatilis</i>	Marsh Club-rush	X		
	<i>Bothriochloa macra</i>	Red Grass			X
	<i>Carex appressa</i>	Tall Sedge	X	X	
	<i>Chloris truncata</i>	Windmill Grass			X
	<i>Cymbopogon refractus</i>	Barb-wire Grass		X	X
	<i>Cyperus gracilis</i>	Slender Flat-sedge			X
	<i>Dianella longifolia</i>	Blueberry Lily		X	X
	<i>Dichelachne micrantha</i>	Shorthair Plumegrass			X
	<i>Papalum distichum</i>	Water couch	X		
	<i>Einadia hastata</i>	Berry Saltbush		X	X
	<i>Eleocharis sphacelata</i>	Tall Spike Sedge	X		
	<i>Gahnia clarkei</i>		X		
	<i>Imperata cylindrica</i> var. <i>major</i>	Blady Grass		X	
	<i>Isolepis inundata</i>	Swamp Club-sedge	X		
	<i>Juncus kraussii</i> subsp. <i>australiensis</i>	Sea Rush	X		
	<i>Juncus usitatus</i>	Common Rush	X	X	X
	<i>Lomandra longifolia</i>	Spiny-head Mat-rush		X	
	<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Meadow Grass			X
	<i>Persicaria decipiens</i>	Slender knotweed	X		
	<i>Poa labillardieri</i> var. <i>labillardieri</i>	Tussock Grass		X	X
	<i>Rytidosperma caespitosum</i>	Whitetop		X	X
	<i>Rytidosperma racemosa</i> var. <i>racemosum</i>	Wallaby Grass		X	X
	<i>Rytidosperma tenuior</i>	-		X	X
	<i>Schoenoplectus mucronatus</i>	A Club Sedge	X		
	<i>Schoenoplectus validus</i>	River Club-sedge	X		

Type	Scientific name	Common name	Management zones		
			Zone 1	Zone 2	Zone 3
			FW	RFEF/FW	CPW
	<i>Themeda australis</i>	Kangaroo Grass		X	X
Groundcover Species & Vines/Scramblers	<i>Brunoniella australis</i>	Blue Trumpet			X
	<i>Centella asiatica</i>	Indian Pennywort			X
	<i>Clematis glycinoides</i>	Old Man's Beard			X
	<i>Commelina cyanea</i>	Creeping Christian			X
	<i>Desmodium varians</i>	Slender Tick-trefoil			X
	<i>Dichondra repens</i>	Kidney Weed			X
	<i>Geranium solanderi</i>	Native Geranium			X
	<i>Glycine clandestina</i>	Twining Glycine			X
	<i>Hardenbergia violacea</i>	Purple Coral Pea			X



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