JAMES WARREN & Associates Pty Ltd

ENVIRONMENTAL CONSULTANTS

VEGETATION MANAGEMENT & REHABILITATION PLAN

ALTITUDE 1
TERRANORA, NSW

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A REPORT TO METRICON QLD PTY LTD

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1 INTRODUCTION

1.1 Background

James Warren and Associates (JWA) have been engaged by Metricon QLD Pty Ltd to prepare a Vegetation Management & Rehabilitation Plan (VMRP) for the proposed subdivision of the following land parcels at the southern end of Fraser Drive, Terranora:

- Lot 1 DP 304649;
- Lot 1 DP 175235;
- Lot 1 DP 781687;
- Lot 2 DP 778727;
- Lot 1 DP 781697;
- Lot 1 DP 169490; and
- Lots 40 & 43 DP 254416.

Under section 3A of the *Environmental Planning & Assessment Act 1979* (EPA Act 1979), a major projects application has been lodged with the Department of Planning. Director General's Environmental Assessment Requirements (DGEARs) have been issued dated 23rd November 2009 **(MP 09_0166) (APPENDIX 1).**

This VMRP has been prepared in response to the following DGEARs:

> *2.7 Outline the long-term management and maintenance of any areas of open space or conservation including ownership and control, management and maintenance funding, public access, revegetation and rehabilitation works and bushfire management.*
>
> *13.8 Provide a detailed Vegetation Management Plan (VMP) for the area of the site zoned 7(a) Environmental Protection (Wetlands and Littoral Rainforests) and for future dedication to the Tweed Shire Council. As a minimum the VMP should incorporate scoped and appropriate performance requirements for any habitat/wetland rehabilitation works (e.g. in relation to the diversity and density of plantings, seedling survival and growth rates, cumulative crown coverage, and the abundance and diversity of weed species) referenced to appropriate benchmarks (such as comparable, undisturbed vegetation communities).*

1.2 The Subject site

1.2.1 Site description

The subject site encompasses several land parcels consisting of:

- Lot 1 DP 304649;
- Lot 1 DP 175235;
- Lot 1 DP 781687;
- Lot 2 DP 778727;
- Lot 1 DP 781697;
- Lot 1 DP 169490; and
- Lots 40 & 43 DP 254416.

An aerial photograph of subject site is shown in **FIGURE 1**. The majority of the site has been cleared of native vegetation and is comprised of grazing land and abandoned crops.

SEPP 14 Wetland No. 23 occurs immediately adjacent to the northern boundary of the subject site. This wetland is protected by State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP 14). The location of this SEPP 14 wetland in relation to the subject site is shown in **FIGURE 2**.

1.2.2 Landuse Zones

The predominant zoning over the Subject site is 2(c) Residential (Urban Expansion). The eastern portion of the Subject site occurs adjacent to an area of SEPP 14 Coastal Wetlands and is zoned 7(a) Environmental Protection (**FIGURE 3**).

1.3 Aims & Objectives

The aim of this Vegetation Rehabilitation and Management Plan (VRMP) is to direct the rehabilitation and management of proposed Open Space and Conservation areas.

Areas of the site subject to rehabilitation and management can be separated into four (4) distinct categories **(FIGURE 4):**

1. Active Open Space;
2. Stormwater treatment areas;
3. Passive Open Space; and
4. Conservation Areas.

The specific objectives of this VMRP are to:

- Identify areas of retained vegetation that will be maintained through weed control and general maintenance;
- Identify areas that will be rehabilitated using natural regeneration or revegetation plantings;
- Provide management guidelines for the revegetation, natural regeneration and weed control to be implemented;
- Provide guidelines for the translocation of a *Macadamia tetraphylla* plant;
- Outline a maintenance and monitoring program for the site; and
- Provide management guidelines for the on-going conservation of vegetation on the site.

1.4 Structure of the VMRP

This Vegetation Management Plan has been divided into the following Sections:

2 MANAGEMENT INTENT

2.1 Introduction

This section identifies the management intent for areas of:

1. Sports fields
2. Stormwater treatment areas;
3. Passive Open Space; and
4. Conservation Areas.

2.2 Sports Fields

No rehabilitation will be undertaken in these areas with the exception of revegetation with lawn grasses and maintenance (i.e. mowing) **(FIGURE 4).**

2.3 Stormwater Treatment Areas

A number of Stormwater treatment areas are proposed throughout the subject site (**FIGURE 4).**

The initial concept and design details can be reviewed in the *Conceptual Stormwater Assessment and Management Plan* and the *Stormwater Management Plan* Description (G & S 2010).

The treatment of urban stormwater runoff and the supply of high quality water to the adjacent wetland habitats is the primary focus of these areas. Revegetation works will be completed both within and surrounding the stormwater devises. Aquatic species will be planted within the stormwater treatment areas and wetland trees, shrubs and groundcovers will be planted in the surrounds.

Vehicular access to Stormwater treatment areas will restricted to maintenance vehicles. Access by the public will generally be restricted. Access will be restricted through the use of exclusion fencing and a locked gate will be provided for maintenance vehicles.

2.4 Passive Open Space

Several areas have been identified for Passive Open Space on the subject site and are identified in **FIGURE 4.** These areas provide primarily for activities such as nature walking and other low impact activities. Other activities, such as leashed walking of pets, that do not impinge upon the passive recreation of others or wildlife, may also occur within these areas.

The retention of existing native vegetation, rehabilitation works where necessary, and the provision of low impact recreation facilities such as walking tracks will be the focus of Passive Open Space areas. Passive Open Space areas on the subject site will also form a fauna movement corridor between council owned land to the south of the site and the SEPP 14 Wetland to the north.

Vehicular access to Passive Open Space areas will restricted to maintenance vehicles. Access will be restricted through the use of bollards or similar structures and a locked gate will be provided for maintenance vehicles.

2.5 Conservation Areas

The area of the subject site proposed for conservation purposes is shown in **FIGURE 4.** This area is intended to provide a buffer between the proposed development and the SEPP 14 Wetland which occurs adjacent to the northern site boundary.

No recreation is proposed within the Conservation Area. The primary focus within this area will be the retention and protection of existing native vegetation and the rehabilitation of degraded areas.

Vehicular access to Open Space areas will restricted to maintenance vehicles. Public access to this area will be prohibited. Access will be restricted through the use of bollards or similar fauna-friendly structures and a locked gate will be provided for maintenance vehicles.

3 CONSTRUCTION PHASE MANAGEMENT

3.1 Introduction

In order to protect the ecological values of the site, vegetation management practices will be of the highest importance during the clearing, construction and rehabilitation phases of the development. Native vegetation will be retained, rehabilitated and protected within Conservation areas and Passive Open Space areas. Native vegetation will also be retained where possible within Stormwater treatment areas and Open Space areas however, the focus will be on revegetation works and landscaping works in these areas respectively.

The regeneration and revegetation works proposed within the Conservation area, Passive Open Space areas and Stormwater treatment areas are discussed in detail in Section 6.

The methods proposed to ensure the retention and protection of existing native vegetation where appropriate during the construction phase are discussed below.

3.2 Extent of Vegetation Disturbance

The construction of access roads, services and stormwater treatment devices will require bulk earthwork activities. During this time vegetation disturbance should be minimised to the absolute area necessary, in order to conserve ecological values within the proposed Conservation and Open Space areas.

Existing native vegetation will be retained where possible and weed infestations removed before any supplementary planting is carried out in accordance with the Rehabilitation Strategy (i.e. Section 6). Any vegetation to be retained will be clearly identified and access to these areas will be restricted prior to the commencement of any earthworks.

3.3 Vegetation Protection Measures

Retained vegetation areas should be protected from the following possible on site disturbances:

- Earthworks;
- Construction of pathways;
- Machinery storage;
- Site waste dumping;
- Stockpiling of mulch/chipped material or soil;
- Erosion;
- Unauthorised vegetation removal;
- Herbicide application; and
- Introduction of exotic flora species.

Appropriate vegetation management strategies during the construction phase of the development are outlined below:

- Prior to the commencement of any vegetation clearance, the Contractor shall identify all native vegetation to be retained on construction plans and in the field.

- Protective fencing is to be erected around areas of retained vegetation prior to the commencement of works and shall be maintained during the construction period. The exclusion fencing shall ensure the protection of retained vegetation, understorey and root zone. Within these excluded areas the following activities shall not be permitted:

    - Storage and mixing of materials;
    - Vehicle parking;
    - Liquid disposal;
    - Machinery repairs and/or refuelling;
    - Construction site office or shed;
    - Combustion of any material;
    - Stockpiling of soil, rubble or debris;
    - Any filling or excavation including trench line, topsoil skimming and/or surface excavation, unless otherwise approved by the Project Manager; and
    - Unauthorised pesticide, herbicide or chemical applications.

  Mulch stock piles may be stored within the Open Space areas to be utilised for landscaping purposes.

- All activities in an area adjacent to any protected tree or area shall be carried out in such a manner as to minimise any damage to trees and / or the conserved area.

- When trenching or excavation is to be undertaken within the root zone of any tree, roots will be severed cleanly rather than torn with a backhoe or other excavation equipment. All roots are to be exposed first and then cut cleanly with a sharp saw or loppers. Exposed roots are to be kept moist and covered with hessian for the duration of the exposure. Where roots with a diameter larger than 50 mm are encountered excavation should be undertaken by hand and such roots tunnelled under.

- Trees deemed by an Ecologist to be potentially impacted upon, shall be protected by the application of carpet underlay, 1.8m high palings strapped to the trunk and/or corrugated iron, or some other similar material to encase the trunk of the tree.

- Prior to commencement of Operational Works, the applicant shall tag all trees located within the Open Space areas which are to be retained and shall install all approved protection measures.

- No clearing shall occur outside nominated clearing zones.

- The erosion and sediment control measures shall not be dismantled until areas to be rehabilitated have been covered by mulch to a minimum depth of 150mm.

3.4 Vegetation Removal and Disposal Methods

Any hollow logs or other habitat resources shall be collected and relocated to Passive Open Space and Conservation areas prior to commencement of clearing works.

Clearing shall occur in the sequence of cutting, shearing of felled vegetation and tub grinding. Upon completion, grubbing operations shall ensure the site is left free draining with no ponding of stormwater.

Any cleared native vegetation is to be chipped and utilised as mulch on site. Declared and/or environmental weeds shall be disposed of at an appropriate Council green waste facility.

Any timber that is too large for chipping may be sold for milling. Combustion disposal methods are prohibited on and off the site.

3.5 Erosion & Sediment Control

In order to minimise damage to dedicated Open Space and Conservation areas, erosion and sediment control measures will be employed throughout the development phase. Particular care should be taken around riparian zones and drainage lines. Earthworks that are necessary for the installation of services and natural surface alterations should be minimised and only conducted during dry periods. Design details for erosion and sediment control measures have been discussed in greater detail within the Stormwater Management Plan prepared by Gilbert and Sutherland (2010). This section provides a summary of the erosion and sediment control measures proposed across the site that will mitigate the potential impacts on Open Space and Conservation areas during the construction phase of the development **(FIGURE 5).**

Erosion and sediment control devices (e.g. silt fences and temporary sedimentation ponds) shall be installed prior to the commencement of work in each stage. Sediment and erosion control fences will be installed along all boundaries between Open Space areas and the developable areas. All runoff from disturbed areas shall be collected via surface drains and diverted to a sedimentation pond. Temporary sedimentation ponds may only be removed once the site has been revegetated following the completion of bulk earthworks. Erosion and sedimentation control measures within Open Space areas should be maintained until landscaping has been completed and becomes established.

All erosion and sediment controls will remain installed and maintained by the developer during the entire construction and maintenance phases of development up until handover to Council. Erosion and sediment control measures will require inspection and maintenance throughout the course of construction works, during the maintenance period and following each rainfall event. All temporary and permanent erosion control measures are to be inspected monthly as well as following rainfall events.

4 LANDSCAPE MANAGEMENT

The intention of the proposed development is to select native trees that will:

- Continue the landscape character of existing native vegetation within and surrounding the subject site;
- Be visually appealing to help promote and market the proposed development; and
- Be compatible with the existing sites and proposed development conditions.

All landscaping within the proposed development should utilise locally endemic species of proven local provenance. The preferred locations for street plantings should be as recommended by Anembo Consultants Pty Ltd (2010) (**FIGURE 6**).

5 REHABILITATION STRATEGY

5.1 Introduction

The Rehabilitation Strategy for the subject site proposes a combination of assisted natural regeneration, where appropriate, and revegetation works. Several areas of the subject site have been identified for rehabilitation works, particularly within the proposed Passive Open Space and Conservation Areas. Revegetation works are also proposed where appropriate within Stormwater Treatment Areas and Open Space Areas.

The objectives of the Rehabilitation Strategy are:

- To enhance the vegetation to be conserved;
- To revegetate disturbed areas where appropriate with endemic species,
- To obtain a minimum of 70% native canopy cover within identified regeneration and revegetation areas;
- To reduce detrimental edge effects and other disturbance related impacts on the adjacent SEPP 14 Wetland;
- To improve the value of the subject site as habitat for fauna groups; and
- To manage weeds using plantings of endemic species and best practice control methods to achieve less than 10% exotic weed cover within each stratum.

5.2 Assessment of Restoration Potential

5.2.1 Background

To determine which areas of the site should be the focus of regeneration and revegetation activities, vegetation to be retained was mapped and divided into six (6) management categories based on restoration potential. Classification in this way helps to ensure that regeneration and revegetation resources can be utilised in the most efficient and effective manner.

5.2.2 Management Categories

The six (6) management categories are based on the McDonald (1996) vegetation restoration system[1] and are shown in **TABLE 4.**

TABLE 4
VEGETATION MANAGEMENT CATEGORIES AND ACTIONS

Management Categories (Based on restoration potential)	**Management Actions**
Grade 1 – Very good condition. Structure and composition of vegetation community generally intact. Low evidence of degradation. Likely to recover fully with passive intervention.	Maintenance

[1] Degradation classification system used in McDonald, M. Christine, 1996. Ecosystem resilience and the restoration of damaged plant communities: A discussion focusing on Australian case studies. Ph.D. Dissertation, University of Western Sydney.

Management Categories (Based on restoration potential)	Management Actions
Grade 2 – Good condition. Structure somewhat altered by low level impacts. Likely to recover fully if casual factors and their secondary impacts are removed by active intervention. Likely to degrade further if no remedial action taken.	Natural or assisted regeneration
Grade 3 – Moderate condition. Structure altered by high level impacts. High level visual impacts may be present. Likely to recover fully if casual factors and their secondary impacts removed by active intervention, but will take longer to recover that a site of higher condition.	Assisted regeneration
Grade 4 – Poor condition. Structure and/or composition highly altered. Sufficient biota remains for natural regeneration if casual factors and their secondary impacts are removed and dynamic processes reinstated. Reintroduction of some species (including Threatened species) may be required.	Assisted regeneration/ revegetation
Grade 5 – Very poor condition. Structure and/or composition severely altered. Either insufficient biota remain for natural regeneration (except some ruderal species) or sever weed infestation occurs and is likely to prevent native regeneration.	Assisted regeneration/ revegetation
Grade 6 – Nil native vegetation.	Revegetation

5.2.3 Restoration Potential on the Subject site

During the field study the restoration potential of the site was assessed with regard to the ecosystems ability to naturally regenerate. The restoration potential is based on the condition of the current native vegetation, the level of weed infestation and the amount of work that will be required to return the area to a native vegetation community.

Within the subject site, the restoration potential ranges between Grade 2 (good condition) through to a Grade 5 (very poor condition) (**FIGURE 7**).

The Grade 2 (good condition) areas occur mostly around large mature trees. In these areas, native species diversity is relatively high and the level of weed invasion is low. Areas that are mapped as Grade 2 (good condition) will only require minor regeneration assistance in the form of weed removal and continued monitoring.

The areas mapped as Grade 3 (moderate condition) have a moderate occurrence of exotic weed species with a few native species present. These areas will require assisted regeneration in the form of weed removal and continued maintenance and monitoring. Revegetation may be required in some areas where native species do not occur. The need for revegetation will be assessed two (2) months after the primary weeding has occurred.

The areas mapped as Grade 4-5 (poor to very poor condition) have a high occurrence of exotic weed species, usually nil canopy cover and only small numbers of native species. These areas will require a larger effort in terms of weed removal and continued maintenance. Revegetation will also be required in areas where weed infestations have dominated and native seedling germination is low. The need for revegetation will be assessed two (2) months after the primary weeding has occurred.

5.3 Assisted Natural Regeneration

5.3.1 Background

The majority of vegetation on the subject site has experienced both historical and current anthropogenic alterations, principally due to high levels of clearance, planting of crops and grazing grasses, and cattle grazing. This anthropogenic modification has provided opportunities for weed species to invade the natural vegetation communities. Exotic species have persisted and competed with native species for limited resources (e.g. light, nutrients and water). This acts as a limiting factor for regeneration of native species. Therefore, in order to enhance the natural values of the site, weed control and weed removal techniques are required for all identified vegetation management categories at varying levels.

An overview of the principals underpinning this report is provided in **ANNEXURE 1**.

Assisted regeneration will be encouraged within areas identified in **FIGURE 8**. The objectives of the site regeneration strategy are to:

- Remove weeds utilising “best practice” protocols;
- Improve the current habitat values of the site; and
- Provide a buffer to ecological features from potential impacts of the proposed development.

Natural regeneration will be continually monitored for the life of the program. Where natural recruitment is poor, active revegetation through planting will be completed. If necessary, revegetation methods will follow those outlined below in Section 6.4.

5.3.2 Primary Weeding

Weed eradication will be undertaken within areas identified for assisted regeneration on a progressive basis through localised treatment of grass species via mechanical removal (hoe/rake, hand pulling and/or slashing) or with Roundup Biactive ©. A list of weed species recorded on the subject site is provided in **ANNEXURE 2**. Woody weed species will be hand pulled or controlled using weed control techniques listed within **ANNEXURE 3.**

All chemical users should be experienced and licensed in accordance with the relevant legislation. Utmost care must be taken when utilising chemicals to ensure that no drift occurs outside of the treatment area. Spraying should not occur on windy days or within 24 hours of predicted rainfall.

Primary weeding should commence at the start of the active growing period (approximately November), or on an as needed basis. Preparation before spraying, in the form of manual clearing weeds from around native plants, must be carried out.

Weed material that does not contain any fertile parts will be mulched and spread on the ground and any weeds that may have fertile parts present will be disposed of at an approved waste disposal facility such as Council landfills or transfer stations.

5.3.3 Secondary Weeding

Secondary weeding involves the eradication of weeds that have been overlooked or re-shoot after primary treatment. Secondary weeding will occur 3 to 4 months after primary weeding and no later than 6 months.

5.3.4 Boundary Marking

The boundaries of revegetation and regeneration areas indicated in **FIGURE 7** will be marked with star pickets and tape and will be erected immediately before regeneration work commences.

Signage is to be erected stating: "No Entry – Native Plant Regeneration Area".

All contractors are to be made aware of restrictions applying to the exclusion zones.

5.4 Revegetation

5.4.1 Background

Within disturbed areas, competition between native propagules and exotic weeds often favours exotic pioneering species. In order to enhance the ecological functioning of areas degraded by exotic species, revegetation works will provide a framework by which indigenous species may reclaim lost habitat via the processes of natural recruitment and succession. Therefore, the aim of revegetation works is to restore the historical ecological values of the site through the use of weed removal techniques and the provision of indigenous canopy species. Further discussion on the principles of ecological restoration works is contained in **ANNEXURE 1**.

Revegetation will be required within all areas identified in **FIGURE 7.** Revegetation will commence no later than six (6) months after the primary weeding is completed. At this time, an assessment will be made as to level of natural regeneration present within these areas. Any areas where the native seedling germination is considered to be low will require revegetation.

5.4.2 Revegetation Phases

Site revegetation works will be undertaken where required in six (6) phases. These are:

- **Phase 1**: Site preparation - will commence as soon as possible after disturbance and when the area has been designated as suitable for revegetation.
- **Phase 2**: Initial planting - will commence as soon as the horticulturalist is satisfied that weed species have been successfully controlled.
- **Phase 3**: Growth and maintenance.
- **Phase 4**: Supplementary planting to replace dead seedlings - will commence within two (2) months of the initial planting in each area and replacement of any seedlings that have perished will occur.

- **Phase 5**: Additional plantings - works can commence where advanced canopy growth is evident and the Horticulturist determines that supplementary planting is necessary to satisfy the aims of the site revegetation plan.
- **Phase 6**: Ongoing maintenance - will continue indefinitely on an as needs basis for a period not more than two (2) years from the completion of Phase 1.

5.4.3 Site Preparation (Weed Control)

Site preparation will be as per the Site Regeneration Strategy (Sections 6.3.2 and 6.3.3.).

5.4.4 Propagation

Plants to be used in the revegetation are to be either propagated in a nursery using material (seeds, cuttings, tissues etc.) from species which occur onsite, or obtained from local nursery able to supply stock from local provenance. Where existing nursery stock from local provenance is not available, collection should be carried out as detailed below. The following details will be collected from each source plant:

- Location (GPS position);
- Date of collection;
- Name of collector;
- Soil type;
- Health of plant; and
- Collection method.

Whenever possible, seed will be removed directly from plants by shaking or cutting branches over a tarpaulin. Secateurs will be sterilised between each use. Seed will be placed in small envelopes with the collection details clearly marked. If the seed is extremely small it will be stored in glass or plastic vials to avoid undue loss.

It is expected that during the seed collection program, a site will be visited on several occasions to ensure optimum seed ripeness. The seed collection program will be prepared in consultation with Council and NSW National Parks and Wildlife Service (NSW NPWS) prior to commencement. The program will be prepared by the Nursery/Revegetation team in consultation with the Horticulturist.

The amount of seed collected will not exceed 5% per plant. Seed will not be collected from isolated populations or rare plants.

The seed will be cleaned, its viability checked and prepared for storage. Seed that has lost viability will not be used in the revegetation works due to the dangers of genetic aberration.

If seed collection proves difficult or impossible, other forms of propagation, such as cuttings, may be attempted.

5.4.5 Planting Program

5.4.5.1 Terrestrial revegetation areas

Seedlings will be sufficiently developed so as to have a significant chance of survival. Seedlings will be at least the sixth leaf stage and/or 20 cm in height.

Tube stock seedlings will primarily be used for the plant-out.

Tube stock will be sun hardened (plants should be held in full sunlight and systematically stressed to the point of wilting for at least two months prior to planting).

All exclusionary fencing will be in place before planting occurs.

Planting will occur at the optimum time of the year when there is high soil moisture (between January and May), unless irrigation is available and accessible.

If required, the Horticulturist may make minor alterations to this revegetation strategy depending on the site requirements. The following strategy will be employed:

- Seedling sites will be spot sprayed with Roundup Biactive© one (1) week prior to commencement;
- All seedlings will be soaked in water overnight prior to planting;
- All seedlings will be provided with a wetting agent such as rain-saver[2] crystals;
- Weeds will be controlled, in the short term, through the application of suitable mulch around individual plantings and with spot applications of an appropriate herbicide.
- All seedlings will be protected by a tree guard (commercial tubing or equivalent); and
- Watering will be undertaken after the seedlings have been planted on an 'as needed' basis.

The plants growing medium would be soaked prior to planting and the plant cores should be buried to approx 1-2cm deep.

The seedlings shall be planted on the same day as their transport from the nursery. No seedlings will be left unprotected on the site whilst awaiting planting. Planted seedlings will be marked with a piece of biodegradable tape and staked.

Only nitrogenous fertilisers will be used to avoid the introduction of Phosphorous, Potassium and other micronutrients.

Planting in areas exposed to full sun or westerly sun will be avoided in the peak summer months, where possible.

[2] Rain-saver is a polymer water crystal that has been specifically developed for plants. The polymer absorbs and holds water and nutrients at a specific tension which makes it available to plant roots but does not release to the soil. Rain-saver has proven very successful in more difficult environments (e.g. Roadside plantings on the Pacific Motorway between Brisbane and the Gold Coast and in frontal dunes at Pottsville (R. Keene *pers comm.* 2000).

5.4.5.2 Aquatic revegetation areas

Appropriate aquatic vegetation is already present within the farm dam to be retained and is relatively dense. It is considered the most appropriate rehabilitation treatment for this dam will be regular weed management. This will allow natural recruitment of the appropriate aquatic vegetation to occur. In areas where dense natural recruitment occurs, or where disturbance may occur during construction activities, native aquatic species should be harvested to be planted in aquatic rehabilitation areas.

The constructed wetlands manual recommends planting into damp or dry soil and then to irrigate after planting. Planting into wet mud or shallow free water is also possible (DLWC 1998). The manual provides the following information on planting wetland species:

- Where possible planting is to occur into the available dry substrates, when this is not practical, planting will occur in the shallow water.
- Wetland plants should be planted in the appropriate zones with regard to water depth.
- Plants are to be manually planted to ensure that recommended densities are achieved.
- The manual planting methods to be undertaken involve:
    - Selection of planting area;
    - Selection of species to be planted and appropriate density;
    - Using string line to determine area for each planting zone;
    - Digging small spade holes in the appropriate mean water depth;
    - Place roots zones into small spade holes;
    - Cover and compress the sediment around the roots.
- The planting out of the aquatic species is to be completed by the regeneration team.

5.4.6 Planting density & species selection

5.4.6.1 Terrestrial revegetation areas

Revegetation will occur in both terrestrial and aquatic (i.e. Stormwater treatment areas) situations. Terrestrial revegetation will aim to establish pre-disturbance vegetation communities. A list of species to be used for planting within these revegetation areas is provided in **ANNEXURE 4.**

These revegetation areas will be planted according to the following densities Per 100 m^2:

- 10 large trees;
- 10 small trees;
- 10 shrubs; and
- 25 groundcover plants.

Species diversity will be maintained throughout these Revegetation areas and consist of the following densities (per 100m^2):

- A minimum of three (3) different large tree species;
- A minimum of three (3) different small tree species;

- A minimum of five (5) different shrub species; and
- A minimum of five (5) different groundcover species.

5.4.6.2 Aquatic revegetation areas

A list of species to be used for planting within the Stormwater treatment areas and planting densities is provided in **ANNEXURE 5.**

5.4.7 Fencing

The boundaries of revegetation areas will be marked with star pickets and tape and will be erected immediately before revegetation work commences. Signage is to be erected stating: "No Entry – Native Plant Revegetation Area". All contractors are to be made aware of restrictions applying to the exclusion zones.

5.5 Long term management

The revegetation and regeneration areas will be subject to ongoing monitoring over a two (2) year period. Over that period, the following management strategies will be employed:

- Progressive weed control (as needed), determined during routine monitoring;
- Follow-up watering as required and determined by landscape contractors;
- Installation of erosion and sedimentation control measures prior to any construction activities, weed control or revegetation activities in adjacent areas, where necessary (e.g. if large areas of weeds are to be physically removed);
- Maintenance of existing vegetation except where water sensitive urban design facilities/devices are required. Landscaping of infiltration drains, swales and other stormwater management facilities/devices will also be implemented to facilitate integration of these facilities/devices into the surrounding natural environment.
- Fencing & access

5.6 Tendering of Works

A suitably qualified Bushland Restoration Team will be engaged via a tender process. If necessary an annual tender process for each stage of the revegetation strategy may be undertaken.

The Horticulturist will consult with the appointed Bushland Restoration Team to finalise the list of species to be planted in relevant locations. The final list will depend upon the availability of species at the time required. If the species listed in **APPENDIX 2** are not available, provision will be made to secure and plant these species at a later stage. If certain species contained in this document are not considered suitable then a justification should be recorded by the Horticulturist and lodged with Council.

The Restoration Team will provide the Horticulturist with a revegetation strategy which will include a program for the collection of material (seed and cuttings) to be utilised in vegetative revegetation. The strategy will discuss the following points;

- Collection proposal;

- Species mix and density;
- The source of seeds/cuttings to be utilised;
- Size of the cuttings/seedlings to be utilised;
- Date at which revegetation is to commence; and
- Strategies for early care and monitoring of the revegetation area.

6 TRANSLOCATION OF THE *MACADAMIA TETRAPHYLLA*

6.1 Introduction

Five *M. tetraphylla* plants were recorded on and immediately adjacent to the development site. One of these will require translocation from the proposed development site **(FIGURE 9).**

Translocation may be defined as the deliberate transfer of plants or regenerative plant material (Vallee *et al* 2004). The individual, of *M. tetraphylla,* is located within the site proposed for development and is under immediate threat from vegetation clearance (**FIGURE 3**).

Management of *M. tetraphylla* will involve a combination of translocation actions, consisting of translocating the existing plant combined with the establishment of at least an additional 2-3 (1:1.5) propagated plants (re-stocking) into suitable nearby habitat. Re-stocking refers to an attempt to increase population size or diversity by adding further individuals to an existing population. Upon completion of the translocation project, a total of at least three individuals, will be established in the translocation area.

Although there is no specific literature on the translocation of *M. tetraphylla*, anecdotal evidence suggests that the translocation of this species will be successful. The translocation of reproductively mature *Macadamia integrifolia* (i.e. plantation Macadamias) is almost always successful (K. Wilson pers. com. June 2008). Kim Wilson is currently undertaking the translocation of a number of mature *M. tetraphylla* on a development site in the Ballina area, however, the details of post-translocation success are as yet unavailable.

The guidelines for translocation have been prepared in accordance with the Guidelines for the Translocation of Threatened Plants in Australia (Vallee *et al*. 2004).

6.2 Legislative Context

Macadamia tetraphylla is listed as *Vulnerable* under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (1999) (EPBC) and *Vulnerable* NSW Threatened Species Conservation Act (1995) (TSC).

6.3 *Macadamia tetraphylla* Description

Macadamia tetraphylla is one of 7 endemic *Macadamia* species (9 in the world) in Australia. *Macadamia tetraphylla* is a member of the Proteaceae family. Plants are small to medium-sized trees growing up to 18m. The leaves are 10-25 cm long and narrowly oblong to oblanceolate. Leaves are in whorls of 4 sometimes 5, thick, stiff and hairless. The leaf margins are toothed and prickly. New growth is pinkish-red. The flowers are creamy-pink to purplish and hang in long strings. The fruit is a follicle, globose, 2-3 cm in diameter with 1-2 hard seeds (Harden *et al* 1991).

This species grows in subtropical rainforest from Rous near Lismore to Mt Tamborine and is uncommon in the wild (Williams *et al*. 1984; Floyd 1989).

6.4 Translocation Team

JWA have prepared these guidelines and will coordinate the translocation of the *M. tetraphylla*. Trevor Franklin (Horticulturalist) from Australian Plant Nurseries will be preparing the site, propagating the additional *M. tetraphylla* and conducting the

translocation. The following additional people have been consulted for information prior to and during the formulation of this plan:

- Brett O'Donnovan (Terania Rainforest Nursery);
- Kim Wilson (Gray Plantation);
- Assoc. Prof. Caroline Cross (University of New England);
- Megan Thomas (Queensland Herbarium).
- Dr Phil Pisanu (South Australian Dept. of Environment and Heritage)

6.5 Biological Assessment of Macadamia tetraphylla

6.5.1 Introduction

Little published literature exists on the biology, ecology and distribution of *M. tetraphylla*. The information in the following section is predominantly derived from Australian Herbaria records (AVH 2006) and personal communication with Botanists who are familiar with the species.

6.5.2 Distribution of the Taxon

The majority of records of *M. tetraphylla* are from locations situated in South-east Queensland and Northern NSW. There are 83 records held in Herbaria in NSW, Canberra, Victoria and QLD (AVH 2006). Although, isolated occurrences of this species are recorded in remnant rainforest patches, the viability of these small populations is uncertain as little is known about the breeding system or the population size required to sustain *M. tetraphylla* (C. Gross pers. com. July 2008).

Specific information of *M. tetraphylla* populations is unavailable. However, the broad location and size of populations used in research by Dr Pisanu (2001) is as follows:

- Populations with 10-20 adults plants are located in:
  - Lennox Head State Environmental Planning Policy (SEPP) Wetlands;
  - Mullumbimby Creek;
  - Terranora Lakes.

- Populations with greater than 10 adult plants are located in:
  - Amber Drive Lennox Head;
  - Mooball.

- Populations with less than 10 adults are located in:
  - Minyon Falls (FR);
  - Inner Pocket (NR);
  - Limpinwood (NR).

6.5.3 Taxonomic Assessment

Within Australia there are seven (7) species of Macadamia: *M. tetraphylla; M. integrifolia; M. jansenii; M. whelanii; M. grandis and M. claudiensis*. All of these are endemic in eastern Australia. Outside Australia, one species, *M. hildebrandii* is endemic in Sulawesi, Indonesia (Gross 1996).

6.5.4 Propagation Potential

Plants for use in the Macadamia Nut industry are readily propagated from cuttings suggesting this may be possible with *M. tetraphylla*.

Macadamia tetraphylla is self-compatible but does require an insect pollinator. However, seed set is significantly higher after cross-pollination compared to self-pollination (Pisanu 2001). Seeds of *M. tetraphylla* are easily germinated and grown but there is a higher success rate with seed harvested from larger populations compared to smaller populations. This indicates that small populations of *M. tetraphylla* may be affected by inbreeding depression (Pisanu 2001).

6.5.5 Known Habitat and Co-occurring Flora

Macadamia tetraphylla is primarily found on soils derived from the Tweed volcano and its associated lava flows but is also sometimes found on sedimentary deposits along creek lines and on flood planes (Pisanu 2001).

Macadamia tetraphylla grows in subtropical rainforest. Floyd (1999) divides Subtropical rainforest into Warm-subtropical rainforest, Cool-subtropical rainforest and Littoral rainforest and defines floristic alliances within these categories. *Macadamia tetraphylla* occurs in the *Argyrodendron trifoliolatum* Alliance within Warm-subtropical rainforest and the *Cupaniopsis anacardioides-Acmena* spp. Alliance within Littoral rainforest. Additionally, there is one record for *M. tetraphylla* in Dry rainforest in the *Drypetes australasica-Araucaria* Alliance.

6.5.6 Disease Susceptibility and Threatened Processes

No information exists on the susceptibility of *M. tetraphylla* to any particular diseases. However, possible threatening processes to *M. tetraphylla* populations have been identified by DECC (2005). These include:

- Clearing and fragmentation of habitat for coastal development, agriculture and roadworks;
- Risk of local extinction due to low numbers;
- Grazing and trampling by domestic stock;
- Fire;
- Invasion of habitat by weeds; and
- Loss of local genetic strains through hybridisation with commercial varieties.

6.6 Ecological Assessment of *M. tetraphylla* on the Subject Site

The Subject Site is a highly disturbed block of land that was previously used for cropping and grazing. Five isolated *M. tetraphylla* plants were recorded. These plants occur in degraded regrowth areas of Lowland rainforest regrowth.

6.7 Ecological Assessment of Proposed Translocation Site

The ideal situation for the translocation of this species is within the areas designated for revegetation and as close as possible to the area where the plant was removed **(FIGURE 9).**

6.8 Pre-translocation Assessment

The exact site of translocation will be chosen at the time of rehabilitation works. The translocation area will be marked accurately on a map and *in situ* with survey pegs. This area will also be indicated by restricted entry signage outlining the project.

Exclusion fencing will also surround the translocation and will consist of 1.2m star pickets at 4m intervals with four (4) strands of galvanized fencing wire.

6.8.1 The Translocation Habitat

The translocation area will be subject to revegetation which will include indigenous species typical of a Lowland Rainforest.

6.8.2 Time of Translocation

The translocation will be undertaken during favourable site conditions (i.e. morning and afternoon and not during windy conditions) to ensure transpiration rates are minimal.

If soil moisture levels are too low and the ground is too hard where the plants for translocation are growing, the plant may need to be watered several times 1-2 days prior to the actual translocation to lessen the risk of stress or plant mortality during the process.

6.8.3 Transporting Plants

In general, time in transit will be minimal and the plant will be adequately secured during transit. To minimise transpiration and the root ball drying during transit, the plant will be lightly pruned and wrapped in wet Hessian prior to movement.

6.9 Planting

The translocation hole will be prepared and ready prior to removing the *M. tetraphylla*. The hole will be prepared with water and a small amount of sandy loam to promote root growth following translocation.

Planting will give attention to the following (Vallee *et al*. 2004):

- The spatial arrangement and location of the plantings should reflect the capability of *M. tetraphylla* reaching 18m in height;
- Facilitate cross-pollination via small insects;
- Positioning plants in relation to other vegetation (plants will be planted in close proximity to existing vegetation for shading and protection where possible);
- Positioning plants in relation to other factors (e.g. edge effects) – plants will not planted in close proximity to the community edge, roads or tracks; and
- Backfilling soil around transplant, firming down and leaving slight depression to facilitate watering.

6.9.1 Plant Densities

Little research has been completed on the breeding system or population Biology of *M. tetraphylla* with the exception of Pisanu (2001). Pisanu selected experimental populations of 3 size classes >20, 10-20 and <20 adult plants in areas on >50ha, 10-50ha and <10ha indicating the *M. tetraphylla* is found in varying densities. The translocation area covers an area of approximately 5000m^2 indicating that the area is suitable to accommodate the existing stem of *M. tetraphylla* and an additional 5-6 plants.

6.9.2 Additional Plantings

The additional 5-6 plants will be produced from cuttings and/or seed taken from a population in close proximity to the Subject Site. At least double this amount will be propagated.

The propagation and planting of additional plants is to ensure there is a net increase of the local population. Additionally, there will be replacement plants available in case of mortality.

When the propagated plants are of a suitable age to plant in the translocation area, they will also be planted in accordance with that outlined in Section 7.9.

Propagated plants will also be identified with permanent tags to allow them to be distinguishable from the translocated plant.

6.10 Post Translocation Management and Monitoring

The objective of the management program for *M. tetraphylla* is to ensure the short and long-term persistence of a viable population of the species within the translocation area.

The objectives for the success and management of *M. tetraphylla* at the Subject Site are:

- Successful translocation of the *M. tetraphylla* plant into the translocation area;
- Revegetation of the translocation area with suitable native species;
- Prevent and manage weed invasion within the translocation area; and
- Any necessary appropriate responses to inadequate performance will be implemented immediately to avoid potential long term negative impacts on the species.

6.10.1 Short Term Performance Indicators

Indicators which demonstrate short-term performance of translocated *M. tetraphylla* can be linked to both plant and habitat features as detailed below:

- Plant features:
  - Plants persist within the translocation area and increase in biomass; and
  - Plants are able to produce reproductive structures.

- Habitat features:
  - Suitable conditions for *M. tetraphylla* in the translocation area are maintained (e.g. degrading processes affecting the habitat are minimised, such as run-off, human access, erosion and siltation, changes in microclimate, soil moisture and soil chemistry);
  - No significant increase in the level of weed invasion within the translocation area; and
  - Fire is managed appropriately.

6.10.2 Long-term Performance Indicators

Indicators which demonstrate long-term performance of the translocated *M. tetraphylla* will be linked to both plant and habitat features as detailed below:

Plant features:

- Successful establishment of revegetation area.
- Survival of translocated plants;
- Greater than 70% of the *M. tetraphylla* individuals are surviving; and
- The population is capable of producing flowers and fruit and is likely to survive in the long term (i.e. the flowering of the replanted individuals is consistent with levels of the naturally occurring similar communities in the locality.

Habitat features:

- There is no net increase in weed invasion from a baseline to be determined immediately after the replanting program by the Horticulturalist
- Weed occurrence in the translocation area will be the subject of strict management;
- There is no threat to the translocated population from fire; and
- The translocation area is protected from stormwater, erosion and siltation, changes in microclimate and human access that may negatively affect the success of the translocated population.

7 MONITORING

7.1 Introduction

A well-designed restoration monitoring program will allow project managers to detect results months, years, or decades following implementation of a plan. Monitoring data can be used by project managers to demonstrate the ability of the project to meet stated goals and objectives.

This section outlines the monitoring required for the proposed regeneration and revegetation areas.

7.2 Performance Targets

Average projected foliage cover (PFC) is often used to measure the success of revegetation programs however PFC is considered unsuitable in this context as a parameter for measuring the success of revegetation/regeneration works. This parameter is subject to variables outside the scope of this plan (e.g. climatic variables, unpredictable growth rates) and therefore has limited application in this context. The measurement of average projected foliage cover is essentially a surrogate of plant density. Therefore a suitable performance target would be that 95% of the plant density will be maintained.

With regards to floristic diversity, a suitable performance target would be that 100% of the floristic diversity of the original plant matrix is maintained.

Average canopy height is another measure often used to determine the success of revegetation works. Again it is considered that this parameter is subject to variables outside the scope of this plan. Regardless of the implementation of appropriate maintenance regimes, the applicant has no control over plant growth rates, and can not guarantee that plants will reach an arbitrary minimum height. It is therefore considered that canopy height is not a suitable measurement of the success of the regeneration and revegetation and works.
Finally, with regards to survival rate a suitable performance target would be the survival of 95% of the total number of trees planted.

TABLE 6 summarises the proposed Performance Targets for the Regeneration and Revegetation of the Restoration Area on the subject site.

TABLE 6
PERFORMANCE TARGETS

Performance Indicator	Target	Achieved
Survival and continued growth of seedlings.		
Establishment of a native ground cover.	70% after 2-3 years	
Average native ground cover.	90% after 5th year.	
Establishment of a native canopy cover.	70% after 2-3 years.	
Average percentage of a native canopy cover.	90% after 5th year.	
Height of any planted tree	minimum of 1.5m at year 3; 2.5 m after year 5	

Natural recruitment of native seedlings throughout planting areas.		
Establishment of a healthy SEPP 14 Buffer Zone.	After year 5	
Environmental weeds	<1%	
The successful translocation of the *M. tetraphylla*		
Infrastructure functional and well-maintained in a state suitable for hand over to Tweed Shire Council.		

7.3 Monitoring of Natural Regeneration Areas

The monitoring program will include regular monitoring by a qualified ecologist who is to complete the following:

- **Transects**
  - Five (5) transects are to be placed within natural regeneration areas;
  - Transect locations are to be permanently marked;
  - Transects are to be 25 metres in length;
  - During monitoring visits tape measures are to be placed on the ground and the specific measureable features recorded along the transects.
  - Specific measurable features include:
    - Areas of native vegetation cover;
    - Areas of weed cover;
    - Areas of deceased plants/bare ground/mud;
  - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Quadrats**
  - Three (3) Quadrats ($5m^2$) are to be placed along each of the transects;
  - Quadrats must be placed 5m apart along the length of the transect;
  - Quadrats are to be placed semi randomly within five (5) meters of the transect line;
  - The boundary of the quadrat with respect to the tape measure (e.g. between 5 – 10 metres on tape measure) will be recorded;
  - For each quadrat the following specific measurable features will be recorded:
    - Plant species occurring
    - Percentage cover
    - Height
    - Relative abundance of native species
  - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Fixed Photo points**
  - permanent photo stations are to be located on each transect;
  - Four (4) photos are to be taken from each transect. Photo are to be taken to the north, south, east and west;

- Photos should be labeled with the:
  - Transect code
  - Direction of view
  - The date & time
- Photos must be supplied in the monitoring reports in a form of prints no smaller than 4" x 6" and must be colour.

7.4 Monitoring of Revegetation areas

This monitoring program is to be completed at the same time as the natural regeneration areas. The monitoring is to be completed by a qualified ecologist who is to complete the following:

- **Transects**
  - Five (5) transects are to be placed within revegetation areas;
  - Transect locations are to be permanently marked;
  - Transects are to be 25 metres in length;
  - During monitoring visits the transects are to be walked and specific measurable features recorded along the length of the transect;
  - Specific measurable features include:
    - Areas of vegetation cover (revegetation species);
    - Areas of weed cover;
    - Areas of deceased plants/bare ground/mud;
  - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Quadrats**
  - Three (3) Quadrats ($5m^2$) are to be placed along each of the transects;
  - Quadrats must be placed 5m apart along the length of the transect
  - Quadrats are to be placed semi randomly within five (5) meters of the transect line;
  - For each quadrat the following specific measurable features will be recorded:
    - Plant species occurring
    - Percentage cover
    - Height
    - Relative abundance of native species
  - Results are to be shown in a table which is to be presented in the monitoring reports.

- **Fixed Photo points**
  - permanent photo stations are to be located on each transect;
  - Four (4) photos are to be taken from each transect. Photo are to be taken to the north, south, east and west;
  - Photos should be labeled with the:
    - Transect code,
    - Direction of view
    - The date & time
  - Photos must be supplied in the monitoring reports in a form of prints no smaller than 4" x 6" and must be colour.

7.5 Timing

The monitoring is to be completed by a qualified ecologist. Site visits should occur:

- Six (6) weeks after primary weeding;
- Six (6) weeks after initial plant-out;
- Every three (3) months thereafter until plants are sufficiently established (between two (2) - three (3) years)
- Every six (6) months until project is completed (estimated 5 years).

7.6 Reporting of Monitoring Results

Following each inspection by the qualified ecologist, a report will be prepared that will include tables and photographs from the monitoring visits. The report will discuss the following:

- Works undertaken;
- Progress of regeneration/revegetation areas against performance targets using photos and tables showing the results of the monitoring visits;
- Significant problems encountered (death of seedlings, broken fences, vandalism etc.) and the effect of these on the plantings and aims of the revegetation or regeneration strategy;
- Success or failures of measures implemented to rectify previously identified problems; and
- Measures to be taken to rectify new problems.

8 ADAPTIVE MANAGEMENT

The principles of adaptive management have been incorporated into the administration of restoration projects within a variety of governmental funding authorities and programs (Thom 1997). Comprehensive, long-term monitoring is a component of adaptive management, which relies on the accumulation of evidence (via long-term monitoring) to support a decision that demands action. If established early in the project planning phase and implemented during successive monitoring and management phases, adaptive management can be a powerful method to systematically assess and improve the performance of restored ecosystems (Thom 2000).

Examples of some potential adaptive management actions that may be required in the future include:

- Areas of natural regenerating Saltmarsh might reveal encroachment by Phragmites or other invasive plant species.
- Monitoring of tidal and/or Stormwater devices may reveal deficiencies in the design of a culvert or water control structure, which may result in insufficient drainage.
- Manual harvesting or chemical control may be periodically required to control the spread of invasive plants.
- The specific design features of a culvert or water control structure may require enhancement or modification during successive years to optimize tidal flow patterns

Before the implementation of any Adaptive management strategies a report is to be provided to the Tweed Shire Council detailing the proposed management actions and the predicted outcomes from such management practices.

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ANNEXURE 1 - ECOLOGICAL RESTORATION PRINCIPLES

Ecological restoration aims to restore pre-existing indigenous ecosystems and ecological processes on disturbed sites, maintaining and developing the natural ecosystem to self perpetuate (Perkins 1992). Perkins (1992) put forward a *restoration continuum* spanning from assisted natural regeneration, the least interventionist, to reconstruction (of original communities on cleared sites) and fabrication (of new communities on changed sites). These activities are undertaken in different circumstances in the field, but the boundaries are blurred, allowing practitioners to consider sites on an individual basis, according to the level of disturbance and the restoration potential identified in the site. The aim of ecological restoration is to restore to the highest practicable extent, and to develop a system that is sustainable in the long term.

In disturbed areas that cannot solely rely on natural regeneration potential, revegetation can be undertaken to reconstruct the original forested communities. Cleared sites can be replanted with species grown from seed collected in nearby local native vegetation. The use of seed of local provenance (origin) is a key principle underpinning the integrity of the work, and avoids possible genetic pollution of local woodland when future pollen exchange takes place between remnant and replanted woodland.

Unfortunately the suite of species that is available is often narrow, determined by practicalities of seed collection, the ability to propagate in a nursery and limits on field establishment in the environmental conditions prevailing on cleared land. Conceptually, this is merely establishing a framework into which additional plant and animal diversity can recruit or be reintroduced once the environment is modified (Perkins 1992).

Cleared sites are seldom completely devoid of native species. It is common to observe paddocks supporting threads of the original ground cover vegetation. This is often apparent in paddocks historically sown with exotic grasses to improve pasture. While the introduced grasses are usually dominant, a surprising diversity of native grasses and groundcovers can often persist. They have remained through a history of sustained grazing and are by definition adapted to grazing. The act of excluding livestock or other management activities can threaten native diversity, as biomass from the introduced grasses smothers these plants. Alternative biomass reduction can be achieved with slashing and fire however these have different effects and their own practical limitations.

Total groundcover biomass is reduced under a developing canopy, a phenomenon also evident in re-growing forest communities. The vigour of exotic grasses is greatly diminished and some are unable to grow, leaving room for native plants that are adapted to the woodland ecosystem. Of course some native plants lose vigour in the forest canopy as well. Revegetation is thus forming an important mechanism for grassland manipulation and as a tool for creating a variety of niches in the ground layer. At the same time, revegetation is achieving the obvious objectives of increasing habitat values, restoring normal hydrology and increasing the range of species available to recover in a site after disturbance. Revegetation needs to be used in combination with other techniques, and these processes will need to be studied in detail before they can be conclusively described as positive.

The mechanism of planting is likely to be a most important strategy in revegetation of the site, not as an end in itself, but as an important tool to ameliorate changed sites and release ecosystem resilience. While prolonged monitoring needs to be maintained in revegetation areas, there are indications that environmental conditions within the site will change in interesting ways as revegetation develops.

Reference

Perkins, I. 1992. *Land and Vegetation Management Plan for the Horsley Park Corridor.*

ANNEXURE 2 - WEED SPECIES LIST

Grouping	Family	Botanical Name	Common Name
Dicotyledons	Anacardiaceae	*Mangifera indica*	Mango
Dicotyledons	Araliaceae	*Schefflera actinophylla*	Umbrella tree
Dicotyledons	Asclepiadaceae	*Gomphocarpus physocarpus*	Balloon cotton bush
Dicotyledons	Asteraceae	*Ageratina adenophora*	Crofton weed
Dicotyledons	Asteraceae	*Ageratina riparia*	Mistflower
Dicotyledons	Asteraceae	*Ageratum houstonianum*	Blue billygoat weed
Dicotyledons	Asteraceae	*Baccharis halimifolia*	Groundsel bush
Dicotyledons	Asteraceae	*Bidens pilosa*	Cobblers pegs
Dicotyledons	Asteraceae	*Carduus sp.*	Milk thistle
Dicotyledons	Asteraceae	*Cirsium vulgare*	Black thistle
Dicotyledons	Asteraceae	*Conyza albida*	Fleabane
Dicotyledons	Asteraceae	*Crassocephalum crepidioides*	Thickhead
Dicotyledons	Asteraceae	*Hypochoeris radicata*	Flatweed
Dicotyledons	Asteraceae	*Senecio madagascariensis*	Fireweed
Dicotyledons	Asteraceae	*Soliva pterosperma*	Bindii
Dicotyledons	Asteraceae	*Tagetes minuta*	Stinking roger
Dicotyledons	Asteraceae	*Taraxacum officinale*	Dandelion
Dicotyledons	Asteraceae	*Wedelia trilobata*	Singapore daisy
Dicotyledons	Asteraceae	*Xanthium occidentale*	Noogoora burr
Dicotyledons	Basellaceae	*Anredera cordifolia*	Madeira vine
Dicotyledons	Caesalpiniaceae	*Senna pendula var. glabrata*	Winter senna
Dicotyledons	Convolvulaceae	*Ipomoea cairica*	Coastal morning glory
Dicotyledons	Convolvulaceae	*Ipomoea indica*	Morning glory
Dicotyledons	Fabaceae	*Desmodium uncinatum*	Silver-leaved desmodium
Dicotyledons	Lauraceae	*Cinnamomum camphora*	Camphor laurel
Dicotyledons	Musaceae	*Musa paradisica*	Banana
Dicotyledons	Ochnaceae	*Ochna serrulata*	Mickey mouse plant
Dicotyledons	Oleaceae	*Ligustrum lucidum*	Large-leaved privet
Dicotyledons	Oleaceae	*Ligustrum sinense*	Small-leaved privet
Dicotyledons	Passifloraceae	*Passiflora edulis*	Passionfruit
Dicotyledons	Passifloraceae	*Passiflora suberosa* var. *suberosa*	Corky passionfruit
Dicotyledons	Passifloraceae	*Passiflora subpeltata*	White passionflower
Dicotyledons	Phytolaccaceae	*Rivina humilis*	Coral berry
Dicotyledons	Polygonaceae	*Persicaria strigosa*	Smartweed
Dicotyledons	Solanaceae	*Solanum mauritianum*	Wild tobacco tree
Dicotyledons	Solanaceae	*Solanum nigrum*	Black-berry nightshade
Dicotyledons	Solanaceae	*Solanum seaforthianum*	Brazilian nightshade
Dicotyledons	Verbenaceae	*Lantana camara*	Lantana
Monocotyledons	Asparagaceae	*Asparagus aethiopicus*	Asparagus fern
Monocotyledons	Asparagaceae	*Asparagus plumosus*	Climbing asparagus fern
Monocotyledons	Cyperaceae	*Cyperus eragrostis*	Tussock sedge
Monocotyledons	Poaceae	*Andropogon virginicus*	Whiskey grass
Monocotyledons	Poaceae	*Axonopus fissifolius*	Narrow-leaf carpet grass
Monocotyledons	Poaceae	*Chloris gayana*	Rhodes grass
Monocotyledons	Poaceae	*Cynodon dactylo*	Couch grass

Grouping	Family	Botanical Name	Common Name
Monocotyledons	Poaceae	*Digitaria didactyla*	Queensland blue couch
Monocotyledons	Poaceae	*Eragrostis* sp.	Lovegrass
Monocotyledons	Poaceae	*Melinis minutiflora*	Molasses grass
Monocotyledons	Poaceae	*Melinis repens*	Red natal grass
Monocotyledons	Poaceae	*Paspalum conjugatum*	Sour grass
Monocotyledons	Poaceae	*Paspalum dilatatum*	Paspalum
Monocotyledons	Poaceae	*Paspalum wettsteinii*	Broad-leaved paspalum
Monocotyledons	Poaceae	*Setaria* sp.	Pigeon grass
Monocotyledons	Poaceae	*Urochloa mutica*	Para grass

ANNEXURE 3 - WEED CONTROL METHODS

The following are control techniques that are to be utilised during site regeneration works:

- **Cut Stump Method** - This method involves cutting plant stems as close to ground level as possible and immediately painting the cut stump with herbicide. This treatment can also be applied as a basal bark application to the first 15-20 cm (entire circumference) of an uncut stem if the adult bark has not yet developed. Chemical use with this application is dependant on the proximity of the weed to naturally ponding water or waterways and whether or not the chemical is registered for aquatic use.

- **Stem Injection** - Herbicides may be applied directly to the plant via stem injection. This involves applying a herbicide to the plant directly by drilling a hole into the stem and inserting the chemical. Axe cuts for stem injection can also be used. Cuts can be made at regular intervals around the stem and should leave a "pocket" in to which the chemical must be immediately injected. Axe cuts should penetrate the cambium layer, but not the hardwood.

- **Spray Method** - There are two (2) types of spraying methods that will be employed where appropriate:

    - Selective blanket spraying: The area must initially be checked for the presence of any native species. Any weeds within 2 m of the drip zone of existing native species will be removed by hand. Alternatively, native species will be covered with impermeable material (e.g. a tarpaulin) for protection during spraying;
    - Spot spraying: The spray nozzle will be kept close to ground to avoid any overspray. Individual weeds will be spot-sprayed at the site. This method of spraying will be employed as native species are interspersed throughout the exotic grasses; and
    - Herbicides specific to each target species, where appropriate, will be identified prior to the implementation of any works. Herbicides will be applied in accordance with the manufacturer's specifications and when environmental conditions are most preferred (e.g. wind and rainfall).

- **Cutting and Chipping** - Manual weeding may involve cutting and chipping, pulling, digging or slashing and is preferred, depending on the growth stage and situation as detailed:

    - Where native plants are growing within a weed infestation and the use of selective herbicide is not possible;
    - Where inadequate foliage is present to allow for successful uptake of herbicide e.g. Mile-a-minute runners typically exhibit this trait; and
    - When hand weeding, the stem must be grasped firmly at the base of the plant and pulled. A trowel, mattock or sharp knife may be needed to loosen the soil. Care must be taken not to leave behind stems or other plant pieces that may re-shoot. Hand weeding should

also be undertaken at times when weeds are not seeding to reduce dispersal and spread. Hand pulling is not recommended for some weed species as they readily sucker if their roots are disturbed e.g. *Lantana camara*. This method will be employed when removing exotic grass species within retained vegetation.

- **Ring Barking -** This method involves removing the lower bark from the stem using a sharp implement to expose the phloem and xylem tissue to the outer environment thereby destroying it.

- **Basal Bark Method** - This method involves applying a herbicide to the lower 35-45 cm bark around the entire stem using a hand-pump backpack sprayer fitted with a shut-off at the wand tip and an adjustable cone nozzle or a small, ATV (All Terrain Vehicle)-mounted sprayer with a shut-off at the wand tip and an adjustable cone nozzle.

ANNEXURE 4 – REVEGETATION SPECIES LIST

Grouping	Family	Botanical Name	Common Name
Dicotyledons	Acanthaceae	*Pseuderanthemum variabile*	Pastel flower
Dicotyledons	Amaryllidaceae	*Crinum pedunculatum*	Crinum lily
Dicotyledons	Anacardiaceae	*Euroschinus falcata*	Ribbonwood
Dicotyledons	Apocynaceae	*Alyxia ruscifolia*	Prickly alyxia
Dicotyledons	Apocynaceae	*Carissa ovata*	Currant bush
Dicotyledons	Apocynaceae	*Melodinus australis*	Southern melodinus
Dicotyledons	Apocynaceae	*Parsonsia straminea*	Common silkpod
Dicotyledons	Apocynaceae	*Tabernaemontana pandacaqui*	Banana bush
Dicotyledons	Araliaceae	*Polyscias elegans*	Celerywood
Dicotyledons	Arecaceae	*Archontophoenix cunninghamiana*	Bangalow palm
Dicotyledons	Asclepiadaceae	*Hoya australis*	Native hoya
Dicotyledons	Bignoniaceae	*Pandorea jasminoides*	Bower vine
Dicotyledons	Boraginaceae	*Ehretia acuminata*	Koda
Dicotyledons	Casuarinaceae	*Allocasuarina littoralis*	Black she-oak
Dicotyledons	Casuarinaceae	*Casuarina glauca*	Swamp she-oak
Dicotyledons	Celastraceae	*Denhamia celastroides*	Denhamia
Dicotyledons	Cunoniaceae	*Caldcluvia paniculosa*	Soft corkwood
Dicotyledons	Cunoniaceae	*Pseudoweinmannia lachnocarpa*	Rose Marara
Dicotyledons	Dilleniaceae	*Hibbertia scandens*	Climbing guinea flower
Dicotyledons	Dioscoreaceae	*Dioscorea transversa*	Native yam
Dicotyledons	Ebenaceae	*Diospyros pentamera*	Myrtle ebony
Dicotyledons	Elaeocarpaceae	*Elaeocarpus grandis*	Blue quandong
Dicotyledons	Elaeocarpaceae	*Elaeocarpus obovatus*	Hard quandong
Dicotyledons	Elaeocarpaceae	*Elaeocarpus reticulatus*	Blueberry ash
Dicotyledons	Elaeocarpaceae	*Sloanea woollsii*	Yellow carabeen
Dicotyledons	Euphorbiaceae	*Breynia oblongifolia*	Coffee bush
Dicotyledons	Euphorbiaceae	*Glochidion ferdinandi* var. *ferdinandi*	Cheese tree
Dicotyledons	Euphorbiaceae	*Glochidion sumatranum*	Umbrella cheese tree
Dicotyledons	Euphorbiaceae	*Homalanthus populifolius*	Native bleeding heart
Dicotyledons	Euphorbiaceae	*Macaranga tanarius*	Macaranga
Dicotyledons	Euphorbiaceae	*Mallotus claoxyloides*	Green Kamala
Dicotyledons	Euphorbiaceae	*Mallotus phillippensis*	Red kamala
Dicotyledons	Eupomatiaceae	*Eupomatia laurina*	Bolwarra
Dicotyledons	Fabaceae	*Callerya megasperma*	Native wistaria
Dicotyledons	Faboideae	*Castanospermum australe*	Black bean
Dicotyledons	Faboideae	*Kennedia rubicundra*	Purple running pea
Dicotyledons	Lauraceae	*Cryptocarya laevigata*	Glossy laurel
Dicotyledons	Lauraceae	*Cryptocarya microneura*	Murrogun
Dicotyledons	Lauraceae	*Cryptocarya obovata*	Pepperberry tree
Dicotyledons	Lauraceae	*Cryptocarya triplinervis var pubens*	Three-veined laurel (hairy form)
Dicotyledons	Lauraceae	*Endiandra globosa*	Black walnut
Dicotyledons	Lauraceae	*Endiandra pubens*	Hairy walnut
Dicotyledons	Lauraceae	*Endiandra sieberi*	Hard corkwood
Dicotyledons	Lauraceae	*Neolitsea dealbata*	White bolly gum
Dicotyledons	Lauraceae	*Pratia purpurascens*	White root
Dicotyledons	Melastomataceae	*Melastoma affine*	Native lasiandra
Dicotyledons	Meliaceae	*Dysoxylum fraserianum*	Rosewood

Grouping	Family	Botanical Name	Common Name
Dicotyledons	Meliaceae	*Synoum glandulosum*	Scentless rosewood
Dicotyledons	Menispermaceae	*Stephania japonica*	Snake vine
Dicotyledons	Mimosaceae	*Archidendron muellerianum*	Veiny lace flower
Dicotyledons	Monimiaceae	*Wilkiea austroqueenslandica*	Smooth wilkiea
Dicotyledons	Monimiaceae	*Wilkiea huegeliana*	Veiny wilkiea
Dicotyledons	Moraceae	*Ficus coronata*	Creek sandpaper fig
Dicotyledons	Moraceae	*Ficus macrophylla*	Moreton bay fig
Dicotyledons	Moraceae	*Ficus virens*	White fig
Dicotyledons	Moraceae	*Ficus watkinsiana*	Strangler fig
Dicotyledons	Moraceae	*Streblus brunonianus*	Whalebone tree
Dicotyledons	Moraceae	*Trophis scandens*	Burny vine
Dicotyledons	Myrtaceae	*Acmena hemilampra*	Broad leaved lilly-pilly
Dicotyledons	Myrtaceae	*Acmena smithii*	Common lilly pilly
Dicotyledons	Myrtaceae	*Corymbia intermedia*	Pink bloodwood
Dicotyledons	Myrtaceae	*Lophostemon suaveolens*	Swamp box
Dicotyledons	Myrtaceae	*Lophostemon confertus*	Brushbox
Dicotyledons	Myrtaceae	*Melaleuca quinquenervia*	Broad-leaved paperbark
Dicotyledons	Myrtaceae	*Pilidiostigma glabrum*	Plum myrtle
Dicotyledons	Myrtaceae	*Syzygium oleosum*	Blue lilly pilly
Dicotyledons	Oleaceae	*Notelaea longifolia*	Large mock olive
Dicotyledons	Oleaceae	*Olea paniculata*	Native Olive
Dicotyledons	Pittosporaceae	*Pittosporum multiflorum*	Orange thorn
Dicotyledons	Pittosporaceae	*Pittosporum revolutum*	Hairy pittosporum
Dicotyledons	Pittosporaceae	*Pittosporum undulatum*	Sweet pittosporum
Dicotyledons	Rhamnaceae	*Alphitonia excelsa*	Red ash
Dicotyledons	Rubiaceae	*Atractocarpus benthamiana*	Native gardenia
Dicotyledons	Rubiaceae	*Morinda jasminoides*	Morinda
Dicotyledons	Rubiaceae	*Pomax umbellata*	Pomax
Dicotyledons	Rubiaceae	*Psychotria loniceroides*	Hairy pyschotria
Dicotyledons	Rutaceae	*Melicope elleryana*	Pink-flowered doughwood
Dicotyledons	Rutaceae	*Zieria smithii*	Sandfly ziera
Dicotyledons	Sapindaceae	*Arytera distylis*	Twin-leaved coogera
Dicotyledons	Sapindaceae	*Cupaniopsis newmanii*	Long-leaved tuckeroo
Dicotyledons	Sapindaceae	*Elattostachys nervosa*	Green tamarind
Dicotyledons	Sapindaceae	*Guioa semiglauca*	Guioa
Dicotyledons	Sapindaceae	*Jagera pseudorhus*	Foambark
Dicotyledons	Sapindaceae	*Mischocarpus pyriformis*	Yellow pear fruit
Dicotyledons	Sapotaceae	*Pouteria chartacea*	Thin-leaved condoo
Dicotyledons	Sterculiaceae	*Commersonia bartramia*	Brown kurrajong
Dicotyledons	Thymelaeaceae	*Wikstroemia indica*	Wikstromeia
Dicotyledons	Ulmaceae	*Aphananthe philippinensis*	Rough-leaved elm
Dicotyledons	Vitaceae	*Cissus antarctica*	Water vine
Dicotyledons	Vitaceae	*Cissus hypoglauca*	Five-leaf water vine
Ferns and Fern Allies	Adiantaceae	*Adiantum hispidulum*	Rough maidenhair
Ferns and Fern Allies	Adiantaceae	*Pellaea falcata*	Sickle fern
Ferns and Fern Allies	Aspleniaceae	*Asplenium australasicum*	Bird's nest fern

Grouping	Family	Botanical Name	Common Name
Ferns and Fern Allies	Athyriaceae	*Diplazium dilatatum*	Lady fern
Ferns and Fern Allies	Blechnaceae	*Blechnum cartilagineum*	Gristle fern
Ferns and Fern Allies	Blechnaceae	*Blechnum indicum*	Swamp water fern
Ferns and Fern Allies	Blechnaceae	*Doodia aspera*	Rasp fern
Ferns and Fern Allies	Cyatheaceae	*Cyathea leichhardtiana*	Prickly tree fern
Ferns and Fern Allies	Dennstaedtiaceae	*Pteridium esculentum*	Bracken
Ferns and Fern Allies	Dryopteridaceae	*Lastreopsis munita*	Naked shield fern
Ferns and Fern Allies	Glecheniaceae	*Histiopteris incisa*	Batswing fern
Ferns and Fern Allies	Schizaeaceae	*Lygodium microphyllum*	Climbing snake fern
Monocotyledons	Araceae	*Alocasia brisbanensis*	Cunjevoi
Monocotyledons	Araceae	*Pothos longipes*	Pothos vine
Monocotyledons	Arecaceae	*Calamus muelleri*	Lawyer vine
Monocotyledons	Arecaceae	*Livistona australis*	Cabbage palm
Monocotyledons	Asteliaceae	*Cordyline petiolaris*	Broad-leaved palm lily
Monocotyledons	Asteliaceae	*Cordyline rubra*	Red-fruited palm lily
Monocotyledons	Commelinaceae	*Commelina cyanea*	Native wandering jew
Monocotyledons	Cyperaceae	*Gahnia sieberiana*	Red-fruited saw-sedge
Monocotyledons	Cyperaceae	*Lepidosperma laterale*	Variable sword-sedge
Monocotyledons	Flagellariaceae	*Flagellaria indica*	Whip vine
Monocotyledons	Lomandraceae	*Lomandra longifolia*	Long-leaved matrush
Monocotyledons	Luzuriagaceae	*Eustrephus latifolius*	Wombat berry
Monocotyledons	Luzuriagaceae	*Geitonoplesium cymosum*	Scrambling lily
Monocotyledons	Phormiaceae	*Dianella caerulea*	Blue flax lily
Monocotyledons	Poaceae	*Entolasia stricta*	Wiry panic
Monocotyledons	Poaceae	*Eragrostis* sp.	Lovegrass
Monocotyledons	Poaceae	*Hemarthria uncinata*	Matgrass
Monocotyledons	Poaceae	*Imperata cylindrica*	Blady grass
Monocotyledons	Ripogonaceae	*Ripogonum album*	White supplejack
Monocotyledons	Smilacaceae	*Smilax australis*	Prickly smilax
Monocotyledons	Smilacaceae	*Smilax glyciphylla*	Smooth smilax
Monocotyledons	Zingiberaceae	*Alpinia caerulea*	Native ginger

ANNEXURE 5 – AQUATIC REVEGETATION

A palette of species recommended for planting in the wetland areas of the site has been developed based on the existing local flora assemblages and the recommendations contained in the Constructed Wetlands Manual (DLWC 1998). A comprehensive wetland species list is provided below.

AQUATIC REVEGETATION SPECIES LIST

Planting zone	Common Name	Botanical Name	Plant Density/m^2*
1	Bare twigrush	*Baumea juncea*	2-3
	Long-leaved matrush	*Lomandra longifolia*	
	Water Couch	*Paspalum distichum*	
	Common spike-rush	*Eleocharis acuta*	
2	Twigrush	*Baumea rubiginosa*	3-4
	Giant sedge	*Cyperus exaltatus*	
		Lepironia articulata	
		Lepidosperma longitudinale	
	Marsh Clubrush	*Bolboschoenus fluviatilis*	
	River clubmarsh	*Schoenoplectus validus*	
	Spike rush	*Eleocharis equisetina*	
3	Jointed Twigrush	*Baumea articulata*	3
		Schoenoplectus mucronatus	
4	Tall spikerush	*Eleocharis sphacelata*	3-4
	Giant sedge	*Lepironia articulata*	

* Denotes total plant density within each zone.

Planting zones have been derived from the Constructed Wetlands Manual (DLWC 1998) and are as follows:

1) Mostly dry (75%) – some seasonal water logging
2) Wet (50%)/ Dry (50%)
3) 0.25m – 0.5m deep
4) 0.5m – 2m deep

It should be noted that planting densities shown are the estimated maximum planting density for each planting zone. Natural recruitment of native species in some areas will reduce necessary planting densities.

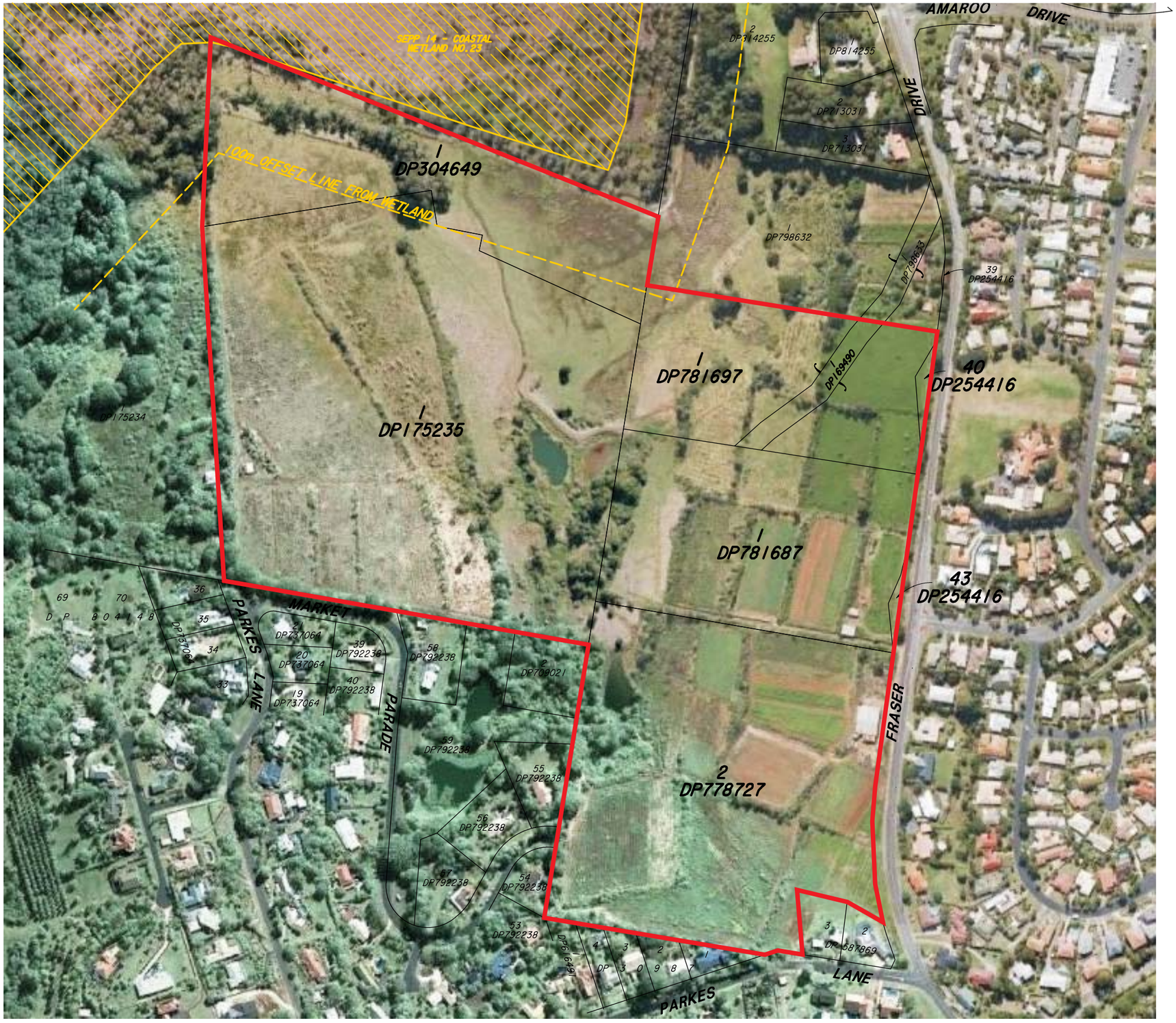
LEGEND

Site Outline

0 50m 100m

1 : 4000

SOURCE: Google Earth 2009 Aerial Photograph SCALE: 1 : 4000 @ A3 JAMES WARREN & ASSOCIATES PTY LIMITED Environmental Consultants	CLIENT Metricon QLD Pty Ltd PROJECT Vegetation Management & Rehabilitation Plan Altitude One Fraser Drive, South Terranora, NSW Shire of Tweed	**FIGURE 1** PREPARED: BW DATE: 06 December 2010 FILE: N09031_VMRP_Aerial.cdr	TITLE **AERIAL PHOTOGRAPHS**



LEGEND

SEPP14 Coastal Wetland
Site Outline

0 50m 100m

1 : 4000

SOURCE: State Env. Planning Policy No. 14; Google Earth 2009 Aerial Photograph

SCALE: 1 : 4000 @ A3

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Altitude One
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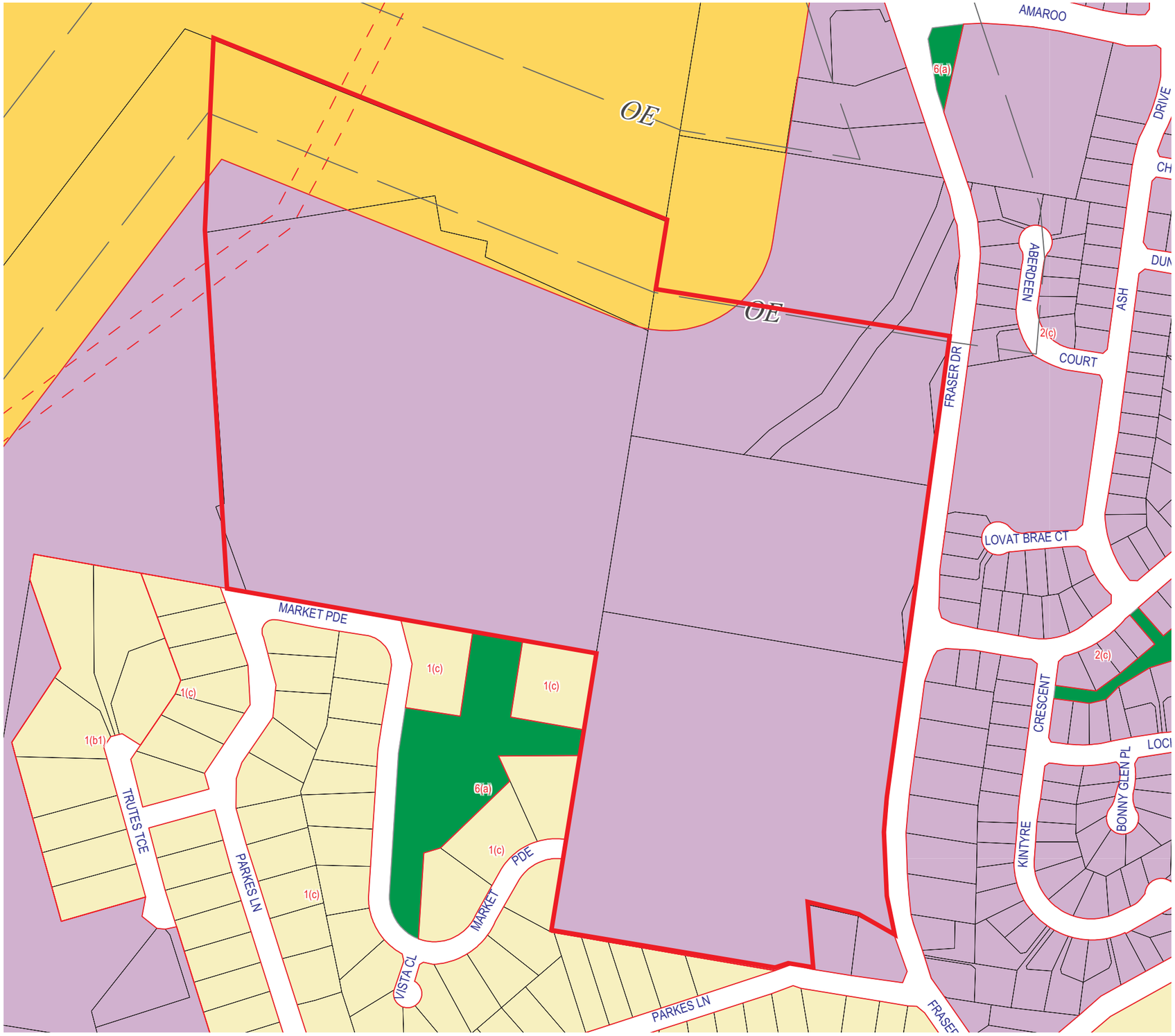
Shire of Tweed

FIGURE 2

PREPARED: BW
DATE: 06 December 2010
FILE: N09031_VMRP_SEPP14.cdr

TITLE

SEPP 14 COASTAL WETLANDS



LEGEND

- 1(b1) Agricultural Protection
- 1(c) Rural Living
- 2(c) Urban Expansion
- 6(a) Open Space
- 7(a) Environmental Protection (Wetlands & Littoral Rainforests)
- Site Outline

0 50m 100m

1 : 4000

SOURCE: Tweed LEP 2000

SCALE: 1 : 4000 @ A3

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Shire of Tweed

FIGURE 3

PREPARED: BW
DATE: 06 December 2010
FILE: N09031_VMRP_LEP.cdr

TITLE

TWEED LOCAL ENVIRONMENT PLAN

AMAROO DRIVE

2 DP 814255

1 DP 814255

227 DP755740

EASEMENT FOR TRANSMISSION LINE 15 WIDE AND VARIABLE WIDTH (DP6422691)

FUTURE

1 DP304649

PARKWAY

BOUNDARY

2 DP713031

3 DP713031

DRIVE

ZONE

BROADWATER

1 DP798632

DP798633

39 DP254416

STAGE 9

STAGE 7

STAGE 10

STAGE 6

STAGE 3

STAGE 2

STAGE 8

STAGE 1

1 DP175234

RIGHT OF WAY (B43665)

69 D P 804148

70

36 DP737064

35 DP737064

34 DP737064

33 DP737064

PARKES LANE

MARKET

21 DP737064

20 DP737064

19 DP737064

39 DP792238

40 DP792238

PARADE

58 DP792238

2 DP709021

59 DP792238

55 DP792238

56 DP792238

57 DP792238

54 DP792238

53 DP792238

STAGE 4

STAGE 5

STAGE 11

FRASER

1 DP616491

4 3 2 1 DP 30987

3 2 DP 587869

PARKES LANE

INITIAL ROAD ACCESS POINT VIA TEMPORARY ROAD (RIGHT OF CARRIAGEWAY) - ROAD TO BE REMOVED AND LOTS CREATED UPON CONSTRUCTION AND CONNECTION OF THE ESTATE TO BROADWATER PARKWAY & BROADWATER PARKWAY TO FRASER DRIVE. (REFER DIAGRAM)

LEGEND

- Sports Fields
- Passive Open Space
- Conservation Area
- Stormwater Treatment Areas
- Site Outline

N

0 50m 100m

1 : 4000

SOURCE: JWA Site Investigations; B&P Surveys (Ref: 18053B-H.pdf); Gilbert & Sutherland (Ref: GJ0901_Base3.pdf)
SCALE: 1 : 4000 @ A3

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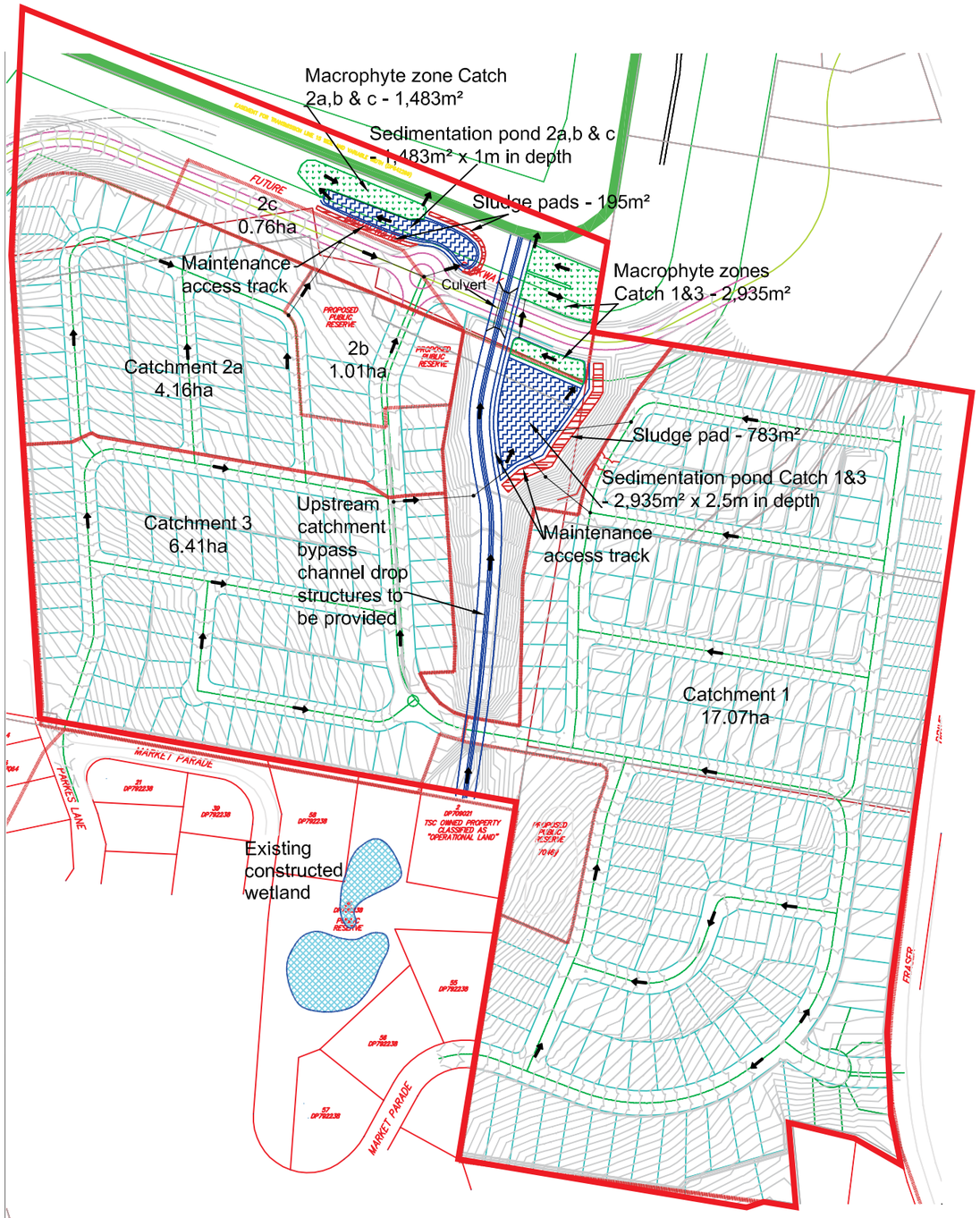
Shire of Tweed

FIGURE 4

PREPARED: BW
DATE: 06 December 2010
FILE:N09031_VMRP_Mgt Intent.cdr

TITLE

MANAGEMENT INTENT



LEGEND

Direction of surface runoff
Site Outline

SOURCE: JWA Site Investigations; Gilbert & Sutherland (Ref: GJ0901_Base3.pdf)

SCALE: 1 : 4000 @ A3

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Shire of Tweed

FIGURE 5

PREPARED: BW
DATE: 06 December 2010
FILE:N09031_VMRP_Stormwater.cdr

TITLE
PROPOSED STORMWATER MANAGEMENT

LEGEND

- Flowering Accent Tree
- Flowering Accent Tree
- Flowering Theme, Street, Batter, Buffering Tree
- Evergreen Main Street, Batter, Buffering Tree
- Evergreen Minor Street, Batter, Buffering Tree
- Turf Areas, Parks and Verges
- Stormwater Treatment Area
- Garden and Batter Vegetation Area
- Existing vegetation to remain and rehabilitated
- Site field stone garden retaining walls

NOTES:
This plan is conceptual, subject to change, and not for construction. Refer to landscape detail plan, elevation, section, and A3 booklet for more information. Also refer to other project consultant data for additional related project information.

N

0 50m 100m

1 : 4000

SOURCE: Anembo (Ref: 100325 CP 3.pdf);

SCALE: 1 : 4000 @ A3

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Shire of Tweed

FIGURE 6

PREPARED: BW
DATE: 06 December 2010
FILE:N09031_VMRP_Landscape.cdr

TITLE

LANDSCAPE CONCEPT PLAN

AMAROO DRIVE

2 DP 814255

1 DP 814255

2 DP713031

3 DP713031

PARKWAY DRIVE

BOUNDARY

227 DP755740

EASEMENT FOR TRANSMISSION LINE (15 WIDE AND VARIABLE WIDTH (DP642269)

FUTURE

1 DP304649

ROADWATER

ZONE

1 DP798632

DP798633

39 DP254416

1 DP175234

STAGE 9

STAGE 7

STAGE 10

STAGE 6

STAGE 3

STAGE 2

STAGE 8

STAGE 1

RIGHT OF WAY (B43665)

69

70

36 DP737064

35 DP737064

34 DP737064

33 DP737064

D P 8 0 4 1 4 8

PARKES LANE

MARKET

21 DP737064

20 DP737064

19 DP737064

39 DP792238

40 DP792238

58 DP792238

PARADE

2 DP709021

59 DP792238

55 DP792238

56 DP792238

57 DP792238

54 DP792238

53 DP792238

STAGE 4

STAGE 5

STAGE 11

FRASER

DP 616491

4 3 2 1 DP 3 0 9 8 7

3 2 DP 587869

PARKES LANE

INITIAL ROAD ACCESS POINT VIA TEMPORARY ROAD (RIGHT OF CARRIAGEWAY) - ROAD TO BE REMOVED AND LOTS CREATED UPON CONSTRUCTION AND CONNECTION OF THE ESTATE TO BROADWATER PARKWAY & BROADWATER PARKWAY TO FRASER DRIVE. (REFER DIAGRAM)

LEGEND

- Grade 1 - Excellent Condition
- Grade 2 - Good Condition
- Grade 3 - Moderate Condition
- Grade 4 - Poor Condition
- Grade 5 - Very Poor Condition
- Site Outline

N

0 50m 100m

1 : 4000

SOURCE: JWA Site Investigations; B&P Surveys (Ref: 18053B-H.pdf); Gilbert & Sutherland (Ref: GJ0901_Base3.pdf)
SCALE: 1 : 4000 @ A3

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Shire of Tweed

FIGURE 7

PREPARED: BW
DATE: 06 December 2010
FILE:N09031_VMRP_Restoration.cdr

TITLE

RESTORATION POTENTIAL

AMAROO DRIVE

2 DP 814255

1 DP 814255

2 DP713031

3 DP713031

PARKWAY DRIVE

BOUNDARY

227 DP755740

EASEMENT FOR TRANSMISSION LINE (5 WIDE AND VARIABLE WIDTH (DP6422691)

FUTURE

1 DP304649

BROADWATER

ZONE

1 DP798632

DP798633

39 DP254416

1 DP175234

STAGE 9

STAGE 7

STAGE 10

STAGE 6

STAGE 3

STAGE 2

STAGE 8

STAGE 1

RIGHT OF WAY (B43665)

69

70

36 DP737064

35 DP737064

34 DP737064

33 DP737064

D P 8 0 4 1 4 8

PARKES LANE

MARKET

21 DP737064

20 DP737064

19 DP737064

39 DP792238

40 DP792238

58 DP792238

PARADE

2 DP709021

59 DP792238

55 DP792238

56 DP792238

57 DP792238

54 DP792238

53 DP792238

STAGE 4

STAGE 5

STAGE 11

FRASER

DP 616491

4 3 2 1 DP 309871

3 2 DP 587869

PARKES LANE

INITIAL ROAD ACCESS POINT VIA TEMPORARY ROAD (RIGHT OF CARRIAGEWAY) - ROAD TO BE REMOVED AND LOTS CREATED UPON CONSTRUCTION AND CONNECTION OF THE ESTATE TO BROADWATER PARKWAY & BROADWATER PARKWAY TO FRASER DRIVE. (REFER DIAGRAM)

LEGEND

- Assisted Natural Regeneration
- Revegetation (Terrestrial Species)
- Revegetation (Aquatic Species)
- Site Outline

N

0 50m 100m

1 : 4000

SOURCE: JWA Site Investigations; B&P Surveys (Ref: 18053B-H.pdf); Gilbert & Sutherland (Ref: GJ0901_Base3.pdf)
SCALE: 1 : 4000 @ A3

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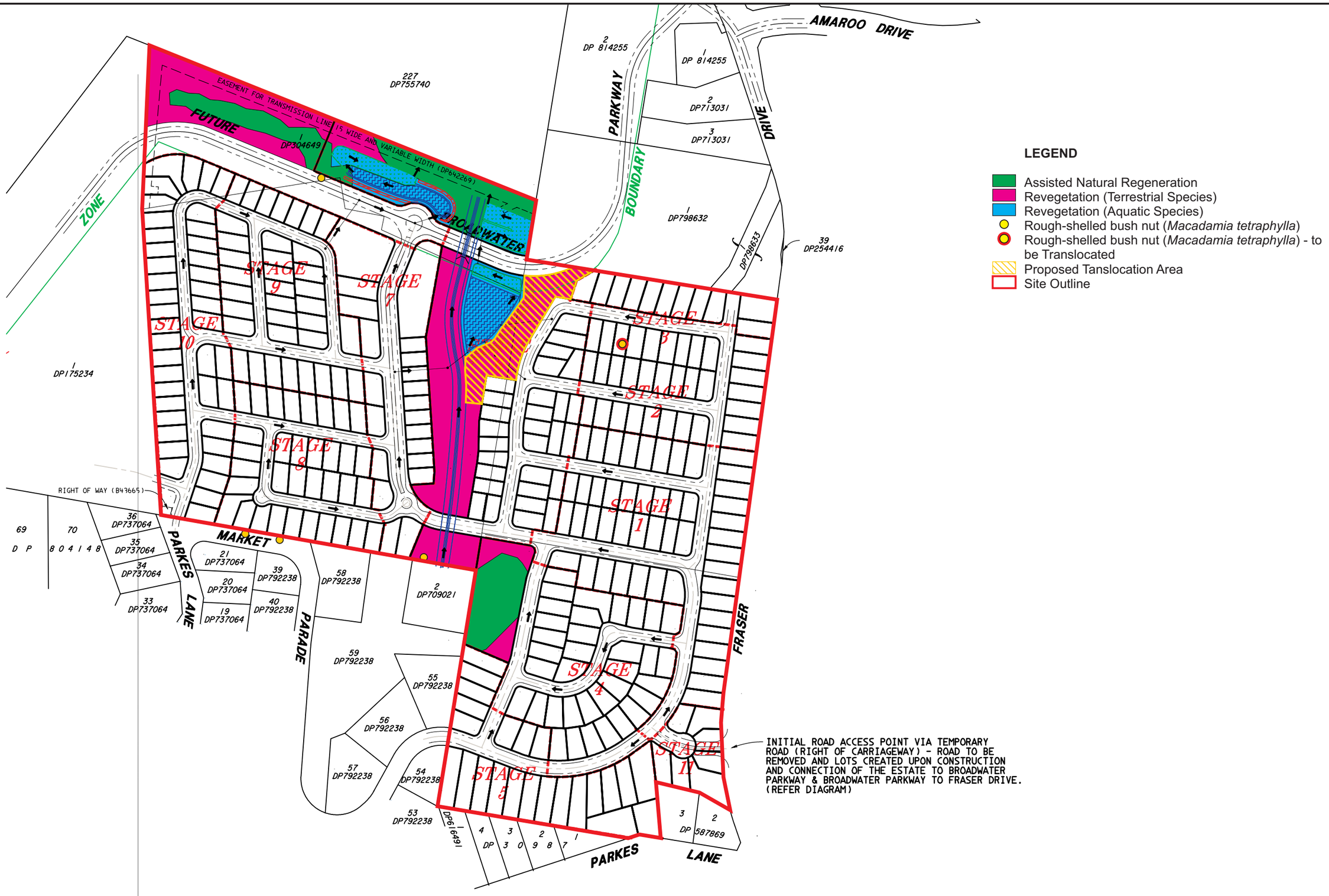
Shire of Tweed

FIGURE 8

PREPARED: BW
DATE: 06 December 2010
FILE: N09031_VMRP_Rehab.cdr

TITLE

REHABILITATION STRATEGY



SOURCE: JWA Site Investigations; B&P Surveys (Ref: 18053B-H.pdf); Gilbert & Sutherland (Ref: GJ0901_Base3.pdf)
SCALE: 1 : 4000 @ A3

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Environmental Consultants

CLIENT
Metricon QLD Pty Ltd

PROJECT
Vegetation Management & Rehabilitation Plan
Altitude One
Fraser Drive, South Terranora, NSW
Shire of Tweed

FIGURE 9

PREPARED: BW
DATE: 06 December 2010
FILE: N09031_VMRP_Maca.cdr

TITLE
TRANSLOCATION OF *MACADAMIA TETRAPHYLLA*