coffey environments
SPECIALISTS IN LIVING AND WORKING PLACES

SHOALHAVEN STARCHES ETHANOL PLANT
LANDSCAPE AND VEGETATION MANAGEMENT PLAN

Prepared for:

Manildra Group
Shoalhaven, NSW

Report Date: 26 May 2009
Project Ref: ENVIWOLL00187AC

Written/Submitted by:

Jennifer Parnell

Mathew Misdale

Reviewed/Approved by:

Dr Paul Van De Moezel

coffey environments
SPECIALISTS IN LIVING AND WORKING PLACES

1 July 2009

Manildra Group
Shoalhaven, NSW

Attention: Greg Murphy

Dear Greg

RE: Landscape and Vegetation Management Plan

Coffey Environments is pleased to present Manildra with the Landscape Vegetation Management Plan, to meet condition 43 of the Environmental Assessment Report for the planned expansion of the Shoalhaven Starches Factory.

Please refer to the attached sheets titled "Important Information about your Coffey Environments Report". These sheets should be read in conjunction with this report.

Thank you for your commission for this work and we look forward to the opportunity of being of assistance in the future. Should you have any questions in relation to the report, please do not hesitate to contact the undersigned.

For and on behalf of Coffey Environments Pty Ltd

_____

Jennifer Parnell
Environmental Management Consultant

cc Steven Richardson
Cowman Stoddart

RECORD OF DISTRIBUTION

No. of copies	Report File Name	Report Status	Date	Distribution	Initials
1	ENVIWOLL00187AC_v1.doc	Draft	1 May 2009	Manildra Group	JP
1	ENVIWOLL00187AC_v1.doc	Draft	1 May 2009	Cowman & Stoddart	JP
1	ENVIWOLL00187AC_v2.doc	Final	1 July 2009	Manildra Group	JP
1	ENVIWOLL00187AC_v2.doc	Final	14 September	Manildra Group	JP

CONTENTS

CONTENTS

Tables

Figures

Maps

Plates

LIST OF ATTACHMENTS

Attachments

Volume 2: Library

ABBREVIATIONS

DA	Development Application
DECC	Department of Environment and Climate Change NSW
DNR	Department of Natural Resources (now DWE)
DoP	Department of Planning NSW
DPI	Department of Primary Industries NSW
DWE	Department of Water and Energy NSW
EA	Environmental Assessment
EAR	Environmental Assessment Report
EP&A	*Environmental Planning and Assessment Act 1979*
LVMP	Landscape and Vegetation Management Plan
NWA	*Noxious Weeds Act 1993*
RCMS	Riparian Corridor Management Study

1 INTRODUCTION

1.1 Background

The Manildra Group has successfully applied to increase its ethanol production capacity from 126 million litres per year to 300 million litres a year, at the Shoalhaven Starches factory located on Bolong Road, Bomaderry NSW. To accomplish this increase, plant infrastructure will be constructed and/or upgraded and raw material inputs will increase.

A Part 3A Environmental Assessment (EA) was prepared by Cowman Stoddart (2008) on behalf of Manildra Group to accompany the Development Application. The EA detailed a series of commitments relating to landscaping and enhancing riparian zones onsite, drawing on the information and recommendations provided in Coffey Environments (2008) *Riparian Assessment*.

The Development Application was conditionally approved in January 2009. Condition 43 of the Notice of Approval (DoP, 2009) requires the preparation of a Landscape and Vegetation Management Plan, to be submitted for approval to the Director General (Department of Planning) within six months of the issue of the Notice of Approval.

Shoalhaven Starches factory site is located between the Shoalhaven River and Bolong Road. The western border is adjacent to the mouth of Bomaderry Creek as it flows into Shoalhaven River. Abernethy's Creek transects the factory site and also flows into Shoalhaven River. The wastewater treatment plan and irrigation farm is located approximately 1-2km north-east of the factory. Broughton Creek forms the boundary of the farm for approximately 3.6km. **Figure 1** shows the factory and farm in relation to the four watercourses.

coffey environments SPECIALISTS IN LIVING AND WORKING PLACES	Drawn	AM	**LVMP SHOALHAVEN STARCHES** **Site Locality in Relation to 4 Watercourses**	Original Size: A4
	Approved			Project no: ENVIIWOLL00187AC
	Date	29/04/09		Figure: 1
	Scale	NTS		

1.2 Objectives and tasks

This Landscape and Vegetation Management Plan (LVMP) has been prepared, in consultation with Department of Water and Energy (DWE), to satisfy the requirements of Condition 43 Schedule 3 of the Notice of Approval. Specifically, the objectives are to:

- Prepare a Landscape Plan for the project which identifies screen plantings to minimise visual impacts
- Prepare detailed plans and procedures to:
  - Restore and maintain the waterways and riparian zones of Shoalhaven River, Bomaderry Creek, Abernethy's Creek and Broughton Creek on the site
  - Manage weeds in the vicinity of the riparian zones
  - Integrate works into the proposed landscaping for the rest of the site
  - Manage impacts on fauna
  - Monitor the performance of the proposed restoration works

In preparing the LVMP, Coffey Environments has undertaken the following tasks:

- Review previous reports and relevant guidelines and consult with DWE
- Conduct a site walkover
- Identify screening areas and outline planting procedures and scheduling, preferred species and maintenance requirements
- Prioritise riparian areas requiring plantings, enhancement measures and restoration works and spatially define these areas in a series of diagrams/maps
- Develop an action plan and planting schedule outlining methods and procedures for plantings, enhancement and rehabilitation of riparian zones, including:
- Measures to manage fauna impacts
- Measures to control access
- Maintenance requirements for new plantings
- Develop a weed management plan outlining methods and procedures for the control and eradication of high priority weed species in riparian zones
- Develop an ongoing monitoring plan to assess the success of plantings, enhancement measures and restoration works onsite
- Provide a list of local suppliers

1.3 Guidelines

The LVMP has been developed in consultation with the Department of Environment and Water (DWE) and draws on following guidelines:

- DWE (2008a) Guidelines for Controlled Activities: Riparian Corridors
- DWE (2008b) Guidelines for Controlled Activities: Vegetation Management Plans

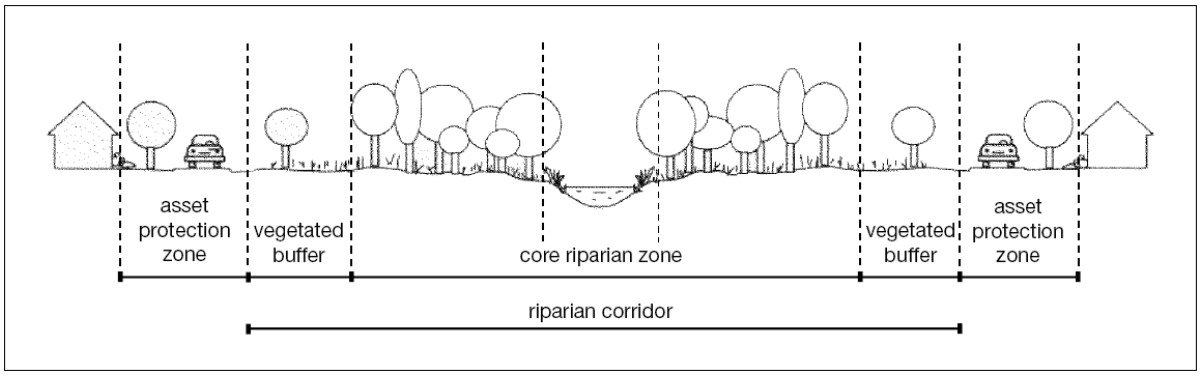
These guidelines are provided in the library for reference.

Guidelines for Controlled Activities: Riparian Corridors

These guidelines outline the recommended corridor riparian zone widths to be considered in the design of controlled activities, with emphasis on ensuring the protection or restoration of riparian areas to improve geomorphic form and ecological functions of the watercourse.

The expansion of the factory site was considered a controlled activity due to the close proximity of the site to Shoalhaven River, Bomaderry Creek and Abernethy's Creek. It was therefore a requirement for DWE to assess the impact of the controlled activity to ensure minimal harm is done to any waterfront land.

Riparian corridor zones



*1. A **Core Riparian Zone (CRZ)** is the land contained within and adjacent to the channel. The Department will seek to ensure that the CRZ remains, or becomes vegetated, with fully structured native vegetation (including groundcovers, shrubs and trees). The width of the CRZ from the banks of the stream is determined by assessing the importance and riparian functionality of the watercourse (Table 1), merits of the site and long-term use of the land. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the CRZ.*

*2. A **Vegetated Buffer (VB)** protects the environmental integrity of the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the VB. The recommended width of the VB is 10 metres but this depends on merit issues.*

*3. An **Asset Protection Zone (APZ)** is a requirement of the NSW Rural Fire Service and is designed to protect assets (houses, buildings, etc.) from potential bushfire damage. The APZ is measured from the asset to the outer edge of the vegetated buffer (VB). The APZ should*

contain cleared land which means that it can not be part of the CRZ or VB. The APZ must not result in clearing of the CRZ or VB. Infrastructure such as roads, drainage, stormwater structures, services, etc. can be located within APZs.

Recommended riparian corridor and buffer zone widths specific to the four watercourses onsite were identified by DWE and are shown in **Table 1**. The recommendations were based on the stream classification system developed through the RCMS process (DNR, 2004).

Table 1: Watercourse classification and recommended buffer zones

WATERCOURSE	CATEGORY	RECOMMENDED CRZ	RECOMMENDED VB
Shoalhaven River	Cat 1	40m	10m
Bomaderry Creek	Cat 1	40m	10m
Broughton Creek	Cat 1	40m	10m
Abernethy's Creek	Cat 2	20m	10m

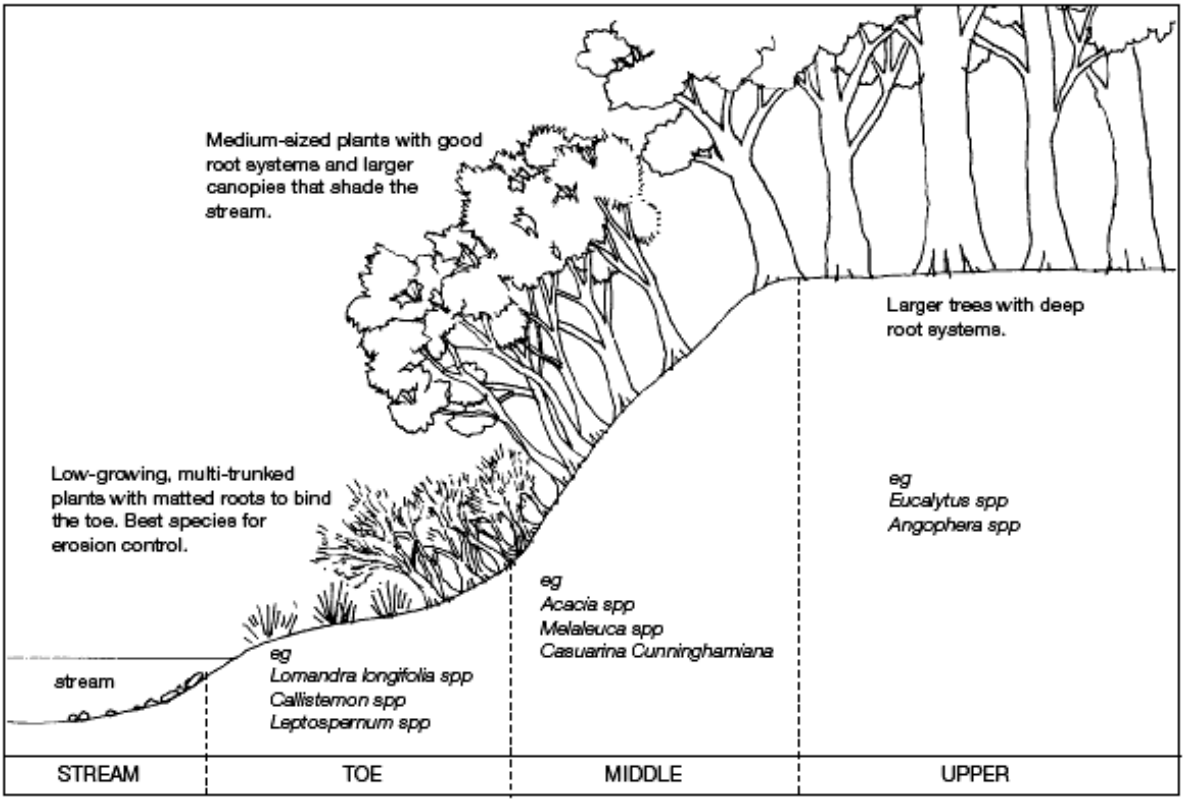
With the exception of the confluence of Shoalhaven River and Bomaderry Creek and Abernethy's Creek north of Bolong Road, the existing infrastructure and buildings at the factory limit the available space necessary to meet the above recommended buffer zones. In addition, some foreshore areas along Broughton Creek are utilised as part of the farm for stock refuge and road access to the pivots, which also limit the space necessary to meet the recommended buffer zones. Due to these restrictions, this plan focuses on improving bank stability and riparian diversity and health within the foreshore areas available. Where it is feasible to do so, the long term objective is to extend riparian zones to meet the recommendations of DWE.

Guidelines for Controlled Activities: Vegetation Management Plans

These guidelines outline the criteria which need to be addressed in a Vegetation Management Plan (VMP) for controlled activities near riparian corridors. The objective of a VMP is to provide for a stable watercourse and riparian corridor which emulates the native vegetation communities in the area. The diagram below illustrates a typical riparian corridor cross section.

To achieve this, VMPs need to address both bank stability and ecology, and provide detailed actions and procedures to complete revegetation and enhancement works including ongoing maintenance and a process for monitoring and review.

Typical riparian corridor cross section



Adapted from Raine, A. & Gardiner, J (1995) Rivercare Guidelines for Ecological Sustainable Management of Rivers and Riparian Vegetation, cited in DWE, 2008a.

1.4 Management zones

Management zones have been developed to allow the prioritisation of actions in the riparian corridors of the four watercourses. The management zones only apply to riparian areas, the landscaping component of this plan is dealt with separately. The following provides a summary of the management zones:

Zone A management areas - address priority bank stability issues and recommended actions aimed at a) improving bank stability, and b) creating and/or enhancing native vegetation communities through new plantings and weed eradication

Zone B management areas - address riparian vegetation health and recommended actions aimed at enhancing native vegetation through restoration works (fill-in planting, thinning etc) and weed eradication and/or control

Zone C management areas - address riparian vegetation health and recommended actions aimed at controlling weeds and assisting native regeneration

The management zones are indicative of the requirement of action only. Currently there are several areas along Broughton Creek that are excellent examples of structurally and floristically diverse riparian vegetation on the Shoalhaven Floodplain and farm management has been protecting them since 1997. It is imperative that these areas continue to be protected and maintained. However, as they do not require major works, they have been designated as Zone C.

The following table provides greater detail on what actions each management zone would entail.

It is anticipated that Zone A areas would transition to Zone B areas, and Zone B areas would transition to Zone C areas and so on, within 2-3 years of the commencement of restoration works.

1.5 Current works

Several programs aimed at habitat restoration/bank stability and enhancing riparian vegetation are currently underway or have been recently been completed. The following information has been provided by Manildra:

- The SEPP Wetland No 369 was permanently fenced off in 1997
- This official wetland was then linked into the next phase of the fencing program in 2003, resulting in almost the entire Broughton Creek frontage being protected from stock
- Planting of Mangrove species along suitable parts of the waterline of Broughton Creek was done in 2005 and 2006. These plantings have had some success with several individuals (up to 2 metre high) appearing to be partially established. Realignment of the fence in one section protects a mature stand of Melalueca stypheliodes, with potential for younger individuals to establish. The habitat restoration work was funded by the Environmental Services Scheme, a NSW state Government initiative
- Recent funding from Southern Rivers Catchment Management Authority (SRCMA) has been obtained to protect a high bank frontage of Broughton Creek which is used as a flood refuge for stock. The area will be assessed for potential bank stability work. Revegetation will commence only after any engineering has been completed. Adjustments to the fence-line, where possible, will enlarge terraces to allow a wider area to plant mid to high canopy plantings adjacent to already protected salt marsh habitat
- Approximately 700 metres of screen planting at the Farm along Bolong Road was established in 2007 as part of the Water Recovery Plant
- Weed suppression is part of the routine electric fence-line maintenance undertaken by the Farm workers along the Broughton Creek frontage
- Contractors are engaged to maintain the other Bomaderry, Shoalhaven and Abernathy's riparian areas
- Existing landscape plantings screen the BOC plant. These will have to be modified so to complete the approved upgrade to the Emergency Fire System
- Some trees need to be removed for vehicular access, maintenance and utility protection i.e. wastewater, optic fibre, power and gas. Additional planting will have to rescreen the new Fire Tanks and BOC facility. Riparian planting at the BOC should not be affected by the Fire System Upgrade

- Previous planting of canopy trees at the rear of the bank along the Shoalhaven River have established well. These are almost high enough to provide additional screening to the Evaporators
- The new planting to screen the new Cooling towers along Bolong Road is complete. Additional individuals to provide additional height will be added or if replacement is required

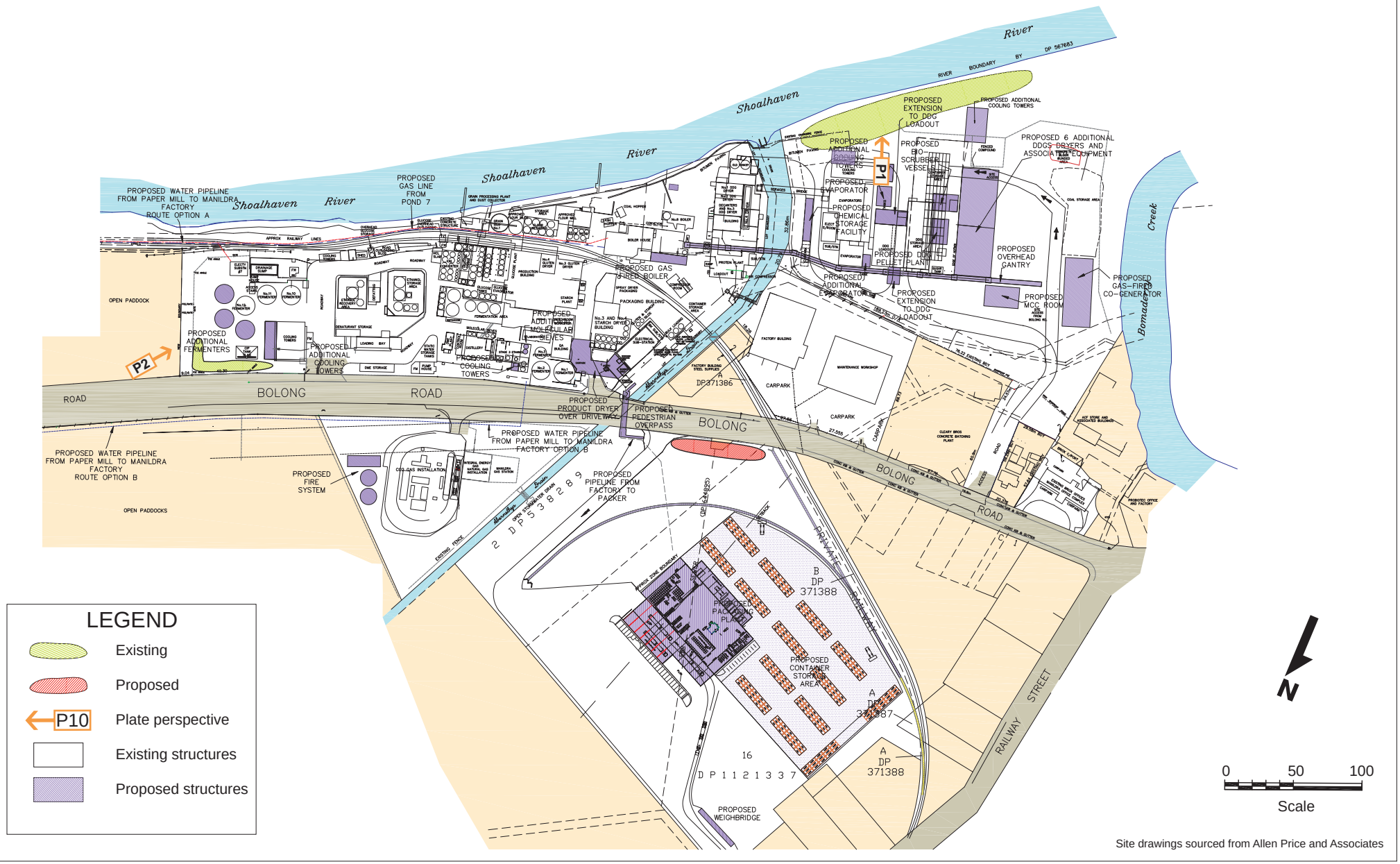
1.6 Consultation activities

In accordance with Condition 43 of the Notice of Approval, DWE has been consulted directly regarding the scope and content of the LVMP. Several informal discussions with DWE representative from the Nowra Office took place, in which advice was sought regarding the content and layout of the LVMP, and significant issues to be addressed.

As part of the review process, this document will be reviewed by DWE and Shoalhaven City Council prior to submission to the Department of Planning.

Screen Plantings

Screen Plantings



Site drawings sourced from Allen Price and Associates

2.1 Landscaping

The Environmental Assessment (Cowman & Stoddart, 2008) for the proposed expansion outlines three areas that require landscaping to screen new buildings and equipment:

- The embankment between Shoalhaven River and the proposed evaporator columns
- The north-eastern and eastern boundaries of the proposed fermenters
- Between Bolong Road and the southern boundary of the proposed packing plant

In addition to this, Manildra have indicated they will modify the existing screen planting at the BOC as part of the Emergency Fire System upgrade to ensure adequate screening of the facility is in place.

Evaporator columns

This area has a semi mature tree-line of *Casuarinas* and some *Eucalyptus* and *Melaleuca* species (7-10m) with growth potential to extend this height. This vegetation is currently of sufficient height to provide adequate screening of the new evaporation columns from Shoalhaven River (**Plate 1**). The recommendations outlined in the EA for screen plantings in this area are not considered necessary. However, some maintenance of the area such as weed control and enhancement plantings will contribute to the future resilience of the riparian vegetation of Shoalhaven foreshore.

Fermenters

This area has been mounded to facilitate drainage and some plantings have recently been undertaken by Manildra personnel (**Plate 2**) between the fermenters and Bolong Road. These plantings include many small to medium height shrubs (2-5m maximum height). Further expansions between the proposed fermenters and adjacent property are anticipated and it is likely that further plantings would need to be removed. Therefore it is recommended that additional *Casuarina glauca's* are planted in the existing planting to add height and screen the fermenters from Bolong Road.

Packing plant

This area is currently an open paddock of Kikuyu grass and some Lantana and Blackberry along the fence line. A mixed species screen of *Melaleuca*, *Eucalyptus* and *Casuarina* species should be planted between the south-eastern corner and the proposed Bolong pedestrian overpass, with a 5m setback from the fence line. It is recommended that the Blackberry and Lantana be removed in preparation for planting.

This planting is based on the packing plant layout of August 2008 and may need to be modified if the layout changes.

Note: Manildra have indicated that additional voluntary screen plantings will be completed on the eastern side of the proposed fire system, north of Bolong Road.

BOC plant

A vegetative screen for the BOC plant was installed on completion of construction works; however Manildra have indicated that this screen planting will need to be modified as part of the upgrade to the Emergency Fire System. The upgrade will involve the removal of several trees for vehicular access, maintenance and utility protection (i.e. wastewater, optic fibre, power and gas). On completion of the upgrade, a trees and shrubs will be planted to screen the new Fire Tanks and the existing BOC Plant.

These works will not interfere in any way with riparian enhancement works recommended for Abernethy's Creek.

2.2 Planting and maintenance

Planting and maintenance requirements for screen plantings are outlined in the following table. **Section 7 Procedures** provides greater detail.

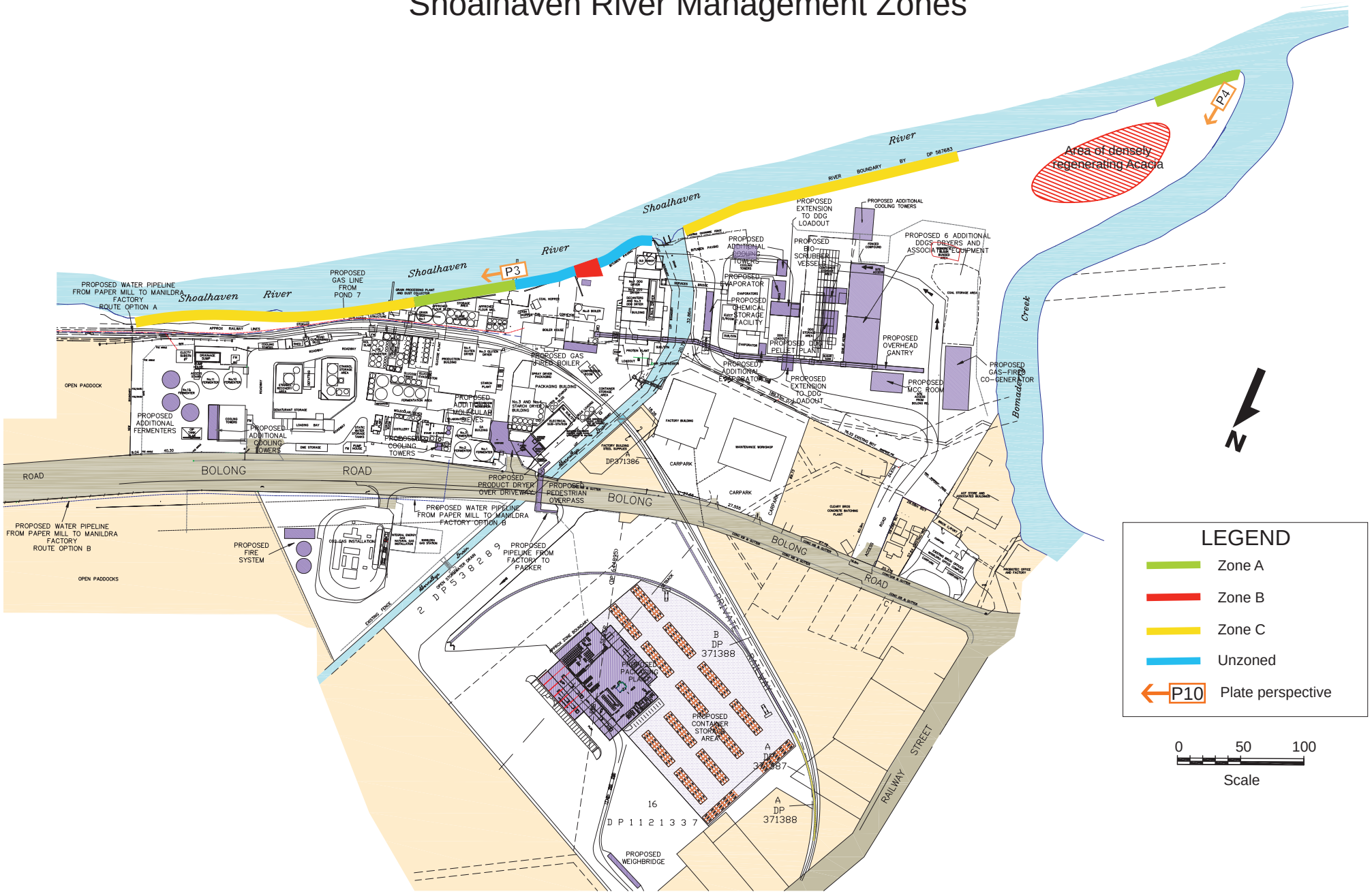
Table 2: Planting and maintenance requirements for screen plantings

	EVAPORATOR COLUMNS	FERMENTERS	PACKING PLANT
SPECIES	-	*Casuarina glauca*	*Refer to Attachment A (screening species list)*
DENSITY	-	Trees & large shrubs @ 1.5m Fill in with ground layer species	Trees & large shrubs @ 2m Fill in with ground layer species
MULCH	-	Leaf mould or bark chips @ 10cm	Leaf mould or bark chips @ 10cm
WATERING	-	Min fortnightly for 6 weeks *	Min fortnightly for 6 weeks *
WEED CONTROL	Spot spray scattered Lantana with herbicide (e.g. glyphosate) monthly for 3 months	Spot spray with broad spectrum herbicide (e.g. glyphosate) monthly for 3 months	Remove Blackberry and Lantana prior to planting
MONITORING	Refer Section 7.3	Refer Section 7.3	Refer Section 7.3

* Watering regime is dependent on weather conditions

Shoalhaven River

Shoalhaven River Management Zones



Site drawings sourced from Allen Price and Associates

Shoalhaven River is characterised by small narrow terraces with a relief of approximately 2-5m. The river flow is steady with minimal surface roughness. The factory is located on the foreshore, with some areas with less than 20m from the hardened area to the waterline.

Naturally occurring deposition on the western end of Pig Island has channelled water along the edge of Shoalhaven River where the factory is located, encouraging scouring of the river bank.

The riparian vegetation fronting Shoalhaven River has been highly modified. The vegetation west of Abernethy's drain consists of a number of mature remnant trees such as *Eucalyptus botryoides* and *Casuarina glauca*. Further downstream, east of the drain, the bank and upper bank is dominated by opportunistic colonisers, primarily Coral trees (*Erythrina x sykesii*) that have established over the past 20-50 years. Coral trees spread by coppicing. They have very weak wood so they fall over easily and spread further. Coral trees are known to undermine bank stability.

3.1 Zone A

Two areas along the foreshore of Shoalhaven River have been designated as 'Zone A' for management purposes:

1. The emergency revetment and the area behind it, up to the boundary of the new flour mill processing plant
2. The area at the confluence of Shoalhaven River and Bomaderry Creek zoned *f(3) Foreshores Protection*

Emergency revetment

The emergency revetment was installed in early 2008 to remediate slumping of the vertical bank. New plantings of native species were completed on, and directly to the rear of, the revetment. However, a visual inspection of the area reveals many of these seedlings have died or been inadvertently sprayed during the maintenance weed spray program.

Currently, the vegetation directly adjacent to the revetment is dominated by Coral trees and perennial grasses (including Kikuyu grass). Young Coral trees where also observed within the revetment (**Plate 3**) and will need to be removed as soon as possible.

Establishing riparian vegetation and improving long term bank stability will need to be undertaken in a staged manner and will take several years to complete. Measures should include:

- Removing immature Coral trees from within the rocks of the revetment
- Frilling of stumps (manual treatment with herbicide as opposed to broad scale spraying) and removing new growth regularly during spring and summer
- Planting fast growing native species, such as Casuarina glauca, in the exposed area behind the revetment and where sucker growth has been contained
- Planting a mixture of Eucalyptus and Melaleuca Spp. to provide a diverse canopy of tree species with deep binding root systems and a screen for the new flour mill
- Planting *Lomandra longifolia* and other tufting / dense growing groundcover between the proposed flour mill and the riparian area to reduce sediment discharges into the river

A full list of species is provided in **Attachment A**, under 'rear of bank'.

The area behind the revetment was affected by construction activities at the time of the site visit and therefore replanting measures will not be possible until the flour mill is completed.

Notwithstanding, remediation measures will be undertaken on the revetment wall as soon as possible, in particular the removal of young Coral trees. Recommendations for revetment planting were made previously in a letter report by Allison Hunt & Associates (2008) when the revetment was first installed and these recommendations should be implemented again. The letter report is provided in **Attachment B** for reference.

Confluence Shoalhaven River and Bomaderry Creek

The vegetation in this area is mostly open and dominated by Kikuyu grass with some Lantana along the water's edge at the mouth of Bomaderry Creek (**Plate 4**). On the western side of the mouth at the water's edge there is a pavement, which may have been an old boat ramp. There is a low old barbed wire fence approximately 10-20m back from the bank.

The confluence is a designated waterway and any obstruction at the toe of the bank and in stream may be considered a navigational hazard.

To improve bank stability, and enhance riparian vegetation and landscape connectivity, restoration works should be completed from the lower bank to the barbed wire fence, an area approximately 10-20m wide and 100m in length. It is recommended that restoration works be completed in two sequential stages with Stage 1 works commencing within 12 months of the finalisation of this plan:

- Stage 1 – enhancement planting and weed control from the lower bank to 10m behind the bank
- Stage 2 – within 12-18 months of successful completion of Stage 1, enhancement planting a further 10m behind Stage 1

Proposed works for Stage 1 will involve:

- Slashing Kikuyu grass with follow-up broad scale spray with Glyphosate or similar herbicide
- Eradicating African Boxthorn (refer to the Library for noxious weed eradication methods)
- Removing of Lantana through cut and paint techniques using either neat Glyphosate or recommended herbicide (Library)
- Planting a fast growing species at the top of the bank such as *Myoporum* and *Casuarina glauca*
- Planting canopy species at the rear of the bank such as *Casuarina glauca* and *Eucalyptus botryoides*
- Planting a variety of groundcover species selected from the list provided in **Attachment A**
- Implementing maintenance and monitoring measures as described in Section 7 of this report.

Proposed works for Stage 2 should be undertaken once Stage 1 plantings have successfully established (approximately 12-18 months) and will involve:

- Slashing Kikuyu grass with follow-up broad scale spray with Glyphosate or similar herbicide
- Removing of Lantana through cut and paint techniques using either neat Glyphosate or recommended herbicide (Library)
- Eradicating other weeds species from the area (e.g. Blackberry, African Boxthorn, Lantana, Privet)

- Planting out canopy, midstorey and groundcover species (**Attachment A** rear of bank)

3.2 Zone B

Two areas along the Shoalhaven River foreshore have been identified as Zone B management areas:

1. Large area of densely regenerated *Acacia mearnsii*, starting approximately 150m east of Bomaderry Creek and continuing eastwards for approximately 175m
2. Small grassy area directly behind the crib shed

Acacia mearnsii

The area of *Acacia mearnsii* is characterised by a dense canopy which is limiting further regeneration of other native species which are growing nearby along the river bank. There is also a dense understorey of Paddys Lucerne *Sida rhombifolia* around the outer edges of the copse restricting seedling regeneration.

The *Acacia mearnsii* has been estimated at around mid-life cycle and will die out leaving an area full of dead wood. Thinning and replanting with other canopy species such as *Casuarina glauca* and *Eucalyptus botryoides* will facilitate a transition to a more resilient and longer lived canopy. This would involve:

- Clearing 10m x 10m plots of acacias and replanting with other canopy species at a density of 2m
- Removing of acacia seedlings to ensure other canopy species become established
- Implementing maintenance and monitoring measures as described in Section 7 of this report

In the long term, a maximum of 1 or 2 individuals of Acacias per 50m^2 is recommended, however, it will take some time to achieve this.

Crib shed

The small area behind the crib shed is dominated by long Kikuyu grass with some Lantana on the eastern edge. It is approximately 5m wide and slopes down towards the shed and the water. Some spraying is conducted along the fence line.

It is recommended that this area be planted out with a mixture of species identified as suitable for top of bank. This would involve:

- Spraying Kikuyu grass to within 2m of the water's edge
- Spot spraying Kikuyu grass (50cm diameter circles) along the water's edge
- Planting out the toe with waterline species
- Planting the area behind it with top of bank species
- Once the canopy species have developed and shaded out the Kikuyu grass, planting native groundcovers

3.3 Zone C

Two areas have been identified as Zone C management areas:

1. Between the eastern boundary of the site and the revetment, approximately 200m
2. From Abernethy's Creek floodgate 200m along the foreshore to the west

Eastern boundary

The vegetation in this area is currently dominated by scattered mature *Eucalyptus maculata* and *Casuarina cunninghamiana*. Lantana was observed in the understorey. Management measures for the area should include:

- Spraying Lantana with broad spectrum herbicide as manufacturer's recommended dosage
- Planting *Lomandra longifolia* in between the trees

Abernethy's Creek Floodgate heading west

The area from Abernethy's Creek floodgate heading west is further divided into two sections: the eastern section and western section.

The eastern section is characterised by mature *Casuarina glauca* and *Eucalyptus botryoides* with a dense to moderately dense understorey of Lantana. Management measures for this area should include:

- Removing Lantana using mosaic technique (where Lantana is sprayed in a chequered pattern and removed in stages so some plants remain to provide soil cover and fauna habitat – refer to the Library)
- In areas that are regenerating poorly, new plantings of midstorey and groundcover species should be considered
- Suppressing African Boxthorn and Blackberry

The western section displays a moderately diverse canopy where present, with relatively poor midstorey and groundcover diversity. Lantana is also present, although not as densely as in the eastern section. Management measures for this area should include:

- Spraying and removing Lantana
- Suppressing African Boxthorn and Blackberry

Reducing potential seed sources of Lantana will contribute towards the future resilience of riparian vegetation and reduce the requirement for future maintenance.

3.4 Unzoned

One area along the Shoalhaven River foreshore has not been classified with a management zone due to its problematic nature. This area is located between the crib shed and the emergency revetment.

The embankment is very steep and the vegetation consists almost entirely of Coral trees with a lower storey of Lantana (**Plate 5**). With the dominance of Coral trees, the likelihood of further slumping in the

area is high as fluvial scouring along this section of bank is also occurring. Nonetheless, as there is no other species present with a deep binding root structure, the removal of the Coral trees will result in a net loss of binding roots and further undermine bank stability in the short term.

A staged approach to removing Coral trees and planting out with native species is recommended. However, prior to any works being undertaken, a geotechnical assessment will be necessary to identify and manage areas prone to bank instability. Further revetments may need to be considered.

Bomaderry Creek

Bomaderry Creek Management Zones

Bomaderry Creek flows through the township of Bomaderry and Nowra North before converging with Shoalhaven River. The top of the bank ranged between 1-3m from the surface.

The majority of the upper bank of Bomaderry Creek is dominated by dense thickets of impenetrable Lantana. A number of mature casuarinas and acacias are present on the bank down to the water's edge. The understorey and ground layer, where present, are dominated by weed species including Lantana and African Boxthorn.

Further downstream near the convergence with Shoalhaven River, the riparian zone becomes more open. Near the mouth of the Creek, Kikuyu Grass dominates and there is little overstorey along the rear of the bank.

4.1 Zone A

The area immediately behind the bank, from the confluence with Shoalhaven River to 250m upstream, has been identified as a Zone A management area. The embankment is very steep and the vegetation is dense in areas. Vegetation on the upper bank is dominated by Kikuyu grass, which is currently slashed regularly.

The foreshore has experienced some recession. The following measures are recommended to improve riparian vegetation and bank stability:

- Spraying Kikuyu grass with Glyphosate at manufacturer's recommended dosage to reduce competition
- Planting the top of the bank with canopy species with deep root systems such as *Eucalyptus*, *Casuarina* and *Ficus rubiginosa* and midstorey species such as *Melaleuca styphelioides* and *Myoporum acuminatum*
- Planting groundcover such as *Lomandra longifolia* and *Dianella spp*. to improve resilience against further weed invasion and allow the canopy and midstorey species to develop

No weed species of concern were identified in the Zone A management area.

Refer to **Section 7** for planting, maintenance and monitoring procedures.

4.2 Zone B

Two areas have been identified along the Bomaderry Creek foreshore as Zone B management areas:

- The upstream embankment from the diary cooperative boundary approximately 100m to the south western bend of Bomaderry Creek
- The downstream embankment from the bend to the confluence with Shoalhaven River

Upstream embankment

This area consists of a moderately diverse canopy of Melaleuca, Casuarina and Eucalyptus species, and White Cedar (*Melia azederach)*. The midstorey is dominated by dense Large Leaf Privet in shaded areas and Lantana in the more open light areas. A number of environmental and noxious weeds were observed and are noted in **Table 3**. It is recommended that weed eradication in this area target Class 3 and 4 noxious weeds, in particular Giant Parramatta Grass, Blackberry and African Boxthorn.

Table 3: Noxious and environmental weeds along Bomaderry Creek

NOXIOUS WEEDS	ENVIRONMENTAL WEEDS
Giant Parramatta Grass *Sporobolus africanus (Class 3)*	Moth vine A*raujia sericifera*
African Boxthorn *Lycium ferocissium (Class 4)*	Paddys lucerne *Sida rhombifolia*
Crofton Weed *Ageratina adenophora (Class 4)*	*Vernena spp*
Blackberry *Rubus fruticosus (Class 4)*	Turkey rhubarb *Acetosa sagittata*
Bridal Creeper *Asparagus asparagoides (Class 5)*	Fleabane *Conzya bonariensis*
Lantana *Lantana camara (Class 5)*	Farmers friend *Bidens pilosa*
	Panic veldt grass *Ehrharta erecta*
	Trad *Tradescantia alba*
	Camphor laurel *Cinnamomum camphori*
	Small Leaf Privet *Ligustrum sinense*
	Large Leaf Privet *Ligustrum lucidum*

The dense understorey of weeds is inhibiting natural recruitment of canopy species with the exception of *Casuarina glauca*, of which several individual seedlings were observed on the lower embankment. The Lantana provides avifauna habitat and several nesting sites were observed. It is not advisable to remove the Lantana all at once, rather a staged mosaic approach is recommended.

Privet species is not classified as a noxious weed along the embankment. It should be frilled and left in place, with follow-up spraying and removal of seedlings is necessary. Frilled Privet is known to germinate as densely as 600 seedlings per square meter (Buchanan, 1996).

If regeneration in areas where weeds have been removed is poor, supplementary plantings will be required. Species will be selected from the list provided in **Attachment A**.

Downstream embankment

The downstream section is characterised by a thin strip of vegetation along the embankment. On the bend itself, the vegetation has been invaded by Large Leaf Privet, Camphor laurel (*Cinnamomum camphori)* and Lantana. The rest of the embankment is dominated by *Casuarina glauca* with varying degrees of Lantana and Privet invasion.

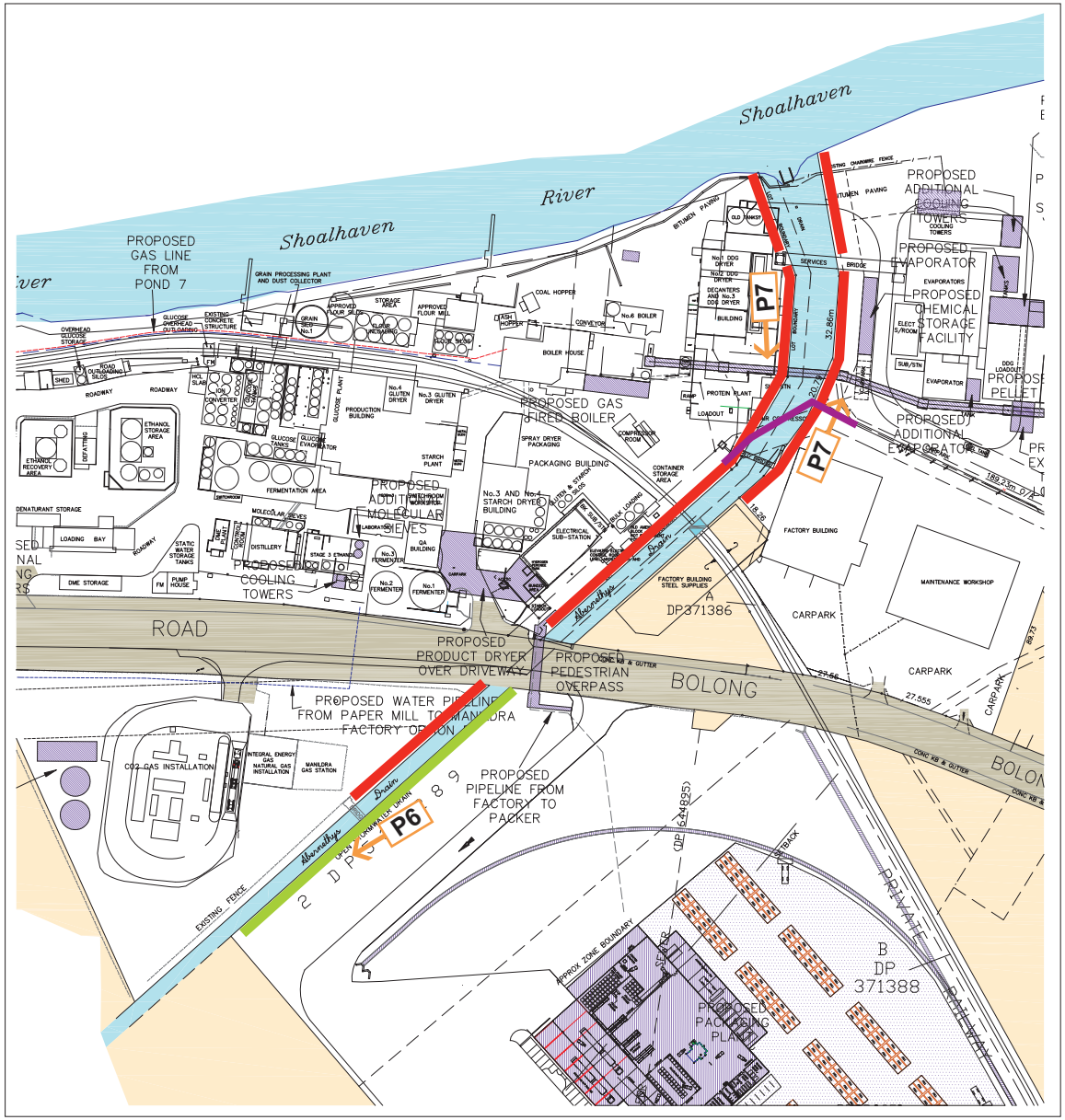
It is recommended that the Privet and Lantana be removed using the same methods as described above. Continuous suppression of noxious weeds in this area will be required so spread is contained.

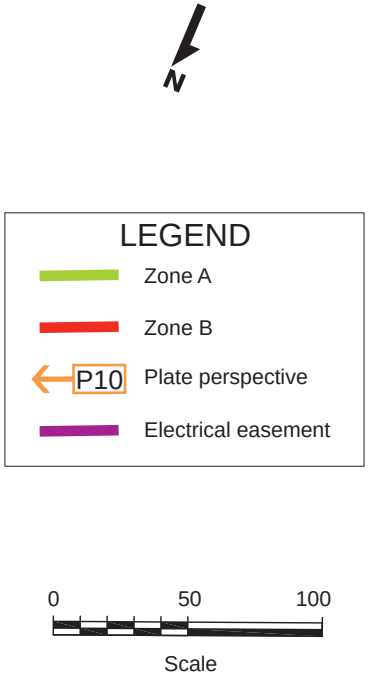
4.3 Zone C

No Zone C management areas have been identified for Bomaderry Creek.

Abernethy’s Creek

Abernethy's Creek Management Zones





Site drawings sourced from Allen Price and Associates

Abernethy's Creek passes through the factory site before it converges with Shoalhaven River. It has been previously dredged and channelled and now resembles an open drain, with hardened sections within the factory site. Bank heights range between 1-3m.

Abernethy's Creek has been significantly modified in the past as a flood mitigation measure and in more recent years to increase the angle and promote rapid stream flow from Shoalhaven Council's waste treatment plant to Shoalhaven River. Shoalhaven City Council recently authorised the removal of a section of riparian vegetation, North of Bolong Road, to access the creek and carry out drain cleaning operations. Consequently, the bank has been undercut along the water surface due to the lack of a binding root structure.

5.1 Zone A

The riparian zone along the western side of Abernethy's Creek immediately north of Bolong Road has been identified as a Zone A management area. The western bank was cleared by Shoalhaven City Council approximately 18 months ago (**Plate 6**). Currently the vegetation is dominated by Kikuyu grass and other introduced pasture grasses, and regenerating *Acacia mearnsii* along the embankment. The management objective is to revegetate the bank and assist with the restoration of a structural and floristically diverse riparian zone. The following management measures are recommended:

- Slashing and spraying Kikuyu grass at the rear of the bank to reduce competition
- Plant out the rear of the bank using the full list of species provided in **Attachment A** – the majority of the planting should be Eucalyptus, Casuarinas and *Ficus rubiginosa* as these species have deep roots

Note: it is recommended that new plantings be completed in 'clumps' spaced 5-10m apart, as this will allow Shoalhaven City Council access to the creek for any future de-snagging or drain cleaning

- Spot spray Kikuyu grass (50cm diameter) from the top of the bank to the water's edge
- Plant the top of the bank *Melaleuca ericifolia* and other listed species
- Plant groundcover species such as *Lomandra longifolia* and *Dianella spp.* to reduce weed invasion and soil erosion

5.2 Zone B

Three areas have been identified as Zone B management areas:

- The eastern bank on the northern side of Bolong Road extending up to the footbridge (approximately 70m)
- The embankment south of Bolong Road extending to the overhead electrical easement
- The embankment from the electrical easement extending south to the floodgate opening at Shoalhaven River

North of Bolong Road to footbridge

Vegetation along the embankment is dominated by Lantana and Large leaf Privet. These weed species will be removed and suppressed to allow regeneration of more resilient riparian vegetation.

The foreshore of Abernethy's Creek is considered to be in an 'urban zone' and therefore Privet species are a class 4 noxious weed (**Plate 7**). Consequently greater effort to control and eradicate Privet from Abernethy's Creek is required.

Lantana is to be removed using a staged mosaic approach. Large Leaf Privet will be frilled and left in place, with follow-up spraying and removal of frilled Privet as required. If regeneration is poor, supplementary plantings will be required. Species to be planted should be the same as the recommendations provided for the western embankment in the previous section (Section 5.1 Zone A).

South of Bolong Road to electrical easement

The vegetation in this area is characterised by mature Brush box (*Lophostemon confertus)* with a scattered understorey of Lantana and other weeds. Management measures for this area should involve:

- Spraying weeds on the embankment
- Planting dense growing or tufted perennials such has *Lomandra longifolia*, *Dianella spp*. or *Poa labillardieri*
- Planting a dense line of *Lomandra longifolia* along the top of the bank to reduce sediment transportation

Electrical easement to floodgate

The vegetation in this area is of moderate diversity along its western bank, but poor diversity and no canopy on the eastern bank.

Madeira vine (*Anredra cordifolia*) has infested the southern corner of the east bank and most of the western bank (**Plate 7**). This weed is difficult to control as it twines into the canopy and readily develop s vegetative tubers which drop into the soil. These tubers can be dug up manually or sprayed with Glyphosate in spring and autumn when the plant is actively growing.

The following management measures for this area are recommended:

- Weed suppression for targeted environmental weeds along both banks, in particular infestations of Large and Small leaf Privet
- Planting the eastern side with *Melaleuca ericifolia* and a selection of understorey species down to the water's edge
- Planting the western bank with *Melaleuca ericifolia* and a selection of understorey species once weed suppression have reduced to minor routine maintenance

5.3 Zone C

No Zone C management areas have been identified for Abernethy's Creek.

Broughton Creek

Broughton Creek Management Zones

Broughton Creek forms the eastern boundary of the Farm over a distance of ~3.6km. Broughton Creek has the typical characteristics of an active meandering stream in alluvial floodplain, with evidence of deposits and scouring within the stream network. Bank heights range between 0-3m.

Riparian vegetation varies greatly along the foreshore. Several areas contain excellent examples of structural and floristically diverse floodplain forest vegetation and have been protected since 1997. Notwithstanding, large areas did not have a functional canopy or midstorey and would therefore be susceptible to bank failure.

6.1 Zone A

The majority of the foreshore of Broughton Creek is open grassland with moderate to steep embankments up to 2m in height. Fluvial scour on the long bends, where overstorey and midstorey vegetation is sparse, is evidenced by bank slumping and undercutting. Several areas require revegetation to improve soil cohesion and bank stability and have therefore been identified as Zone A management areas (refer to the map provided at the start of this section), including:

- Stock refuge at the western end of the farm
- Mangrove plantings along the waterline

Permanent fences are in place along most of the foreshore, with the exception of the stock refuge area at the most western extent of the farm boundary. The distance of the fence from the waterline varies from between 10m to over 40m.

Stock flood refuge

The stock refuge area at the western end of the farm foreshore is unfenced and slightly elevated. It is the only area available for stock during flood events. Vegetation is dominated by Kikuyu grass with a few plantings of native trees (0-5 years) along the top of the bank. Bank slumping was observed in this area in 2008 (**Plate 8**).

Given there are no other areas on the farm available as flood refuges, it is recommended that a strip of approximately 3m from the top of the bank be revegetated to improve bank stability. This would involve:

- Slashing Kikuyu grass and spraying with Glyphosate or similar to within 2m of the water's edge
- Spot spraying Kikuyu grass (0.5m diameter) within 2m of the water's edge
- Planting suitable canopy and midstorey species at the rear of the bank (no less than 2m from the water's edge)
- Scattered planting of *Casuarina glauca* and *Myoporum acuminatum* on the bank (but not the water's edge)

As the plants develop, Kikuyu grass will be shaded out and at this time (approximately 2-3 years) and planting out the rest of the bank and along the waterline with suitable species is recommended.

During flood events, a temporary fence line (electric wire) should be erected to protect the seedlings for being trampled or eaten.

Mangrove plantings

Two areas have been identified as suitable for planting mangroves along the waterline. These areas have sandy depositions suitable for planting mangroves. Previous attempts to establish mangroves and have been undertaken along the bank. **Plate 9** shows several individuals that have successfully established.

Prior to any planting, it is recommended that canopy and midstorey species be planted to establish a healthy riparian zone. Once vegetation on the bank and at the rear of the bank has successfully developed and is shading out Kikuyu grass and providing adequate soil cohesion, Grey Mangroves (*Avicennia marina)*, should be planted along the water's edge.

6.2 Zone B

Several areas require revegetation to improve riparian health and bank stability and have therefore been identified as Zone B management areas. These areas include:

- Embankments denuded of a functional canopy and/or midstorey
- Areas where Kikuyu grass quickly transition to floodplain forests

Embankments denuded of a functional canopy and/or midstorey

Several areas along the embankment do not have a functional canopy and/or midstorey capable of providing bank cohesion and stability. These areas are prone to slumping and undercutting. To improve bank stability it is recommended that these areas be planted out with native species from 1m inside the permanent fence to 2m bank from the water's edge.

Plantings will be carried out in stages over several growing seasons to a) increase the likelihood of successful establishment (particularly along the water edge where previous plantings have failed) and b) to spread the costs associated with planting out larger tracts of land. The first stage will involve:

- Slashing Kikuyu grass and spraying with Glyphosate or similar to within 2m of the water's edge
- Spot spraying Kikuyu grass (0.5m diameter) within 2m of the water's edge
- Planting suitable canopy and midstorey species at the rear of the bank (no less than 2m from the water's edge)
- Scattered planting of *Casuarina glauca* and *Myoporum acuminatum* on the bank (but not the water's edge)

Once the new plants from the Stage 1 have successfully established and shaded out Kikuyu grass on the bank and the waterline (approximately 2-3 years), the second stage of plantings is to be carried out:

- Spot spraying any remaining Kikuyu grass on the bank
- Planting suitable midstorey species on the bank to fill out the Stage 1 planting
- Planting suitable species along the water's edge if there is sufficient sandy deposition for the plants to establish

Transition areas

Areas where Kikuyu grass quickly transition to floodplain forests (**Plate 8**) have been identified as Zone B management areas. These areas would benefit from the removal of Kikuyu grass and other introduced pasture weeds at the transition zone, and planting out with suitable rear of the bank species.

Being able to complete this work will be dependent on the width of the bank available from the transition zone to the fence-line. The fence was installed by farm management under a productivity grant to restrict stock grazing in riparian areas. At this stage, further extension is not a priority.

6.3 Zone C

Several areas have been identified as Zone C management areas. The vegetation in these areas exhibit moderate to good structural and floristic diversity, including floodplain forests with mature *Melaleuca styphelioides*. Weed infestations are low and the canopy is intact. These areas have been protected since 1997.

To ensure these areas remain healthy and resilient, visual inspections at the transition between Kikuyu grass and floodplain forests for potential weed infestations on a quaterly basis should be carried out as part of routine farm maintenance. The next section outlines procedures visual inspections of weed infestations.

7 PROCEDURES

7.1 Planting

Season

Unlike other parts of NSW, rainfall in the Shoalhaven Floodplain consistently exceeds evaporation leading to regular inundation and soil saturation. As such no recommendations as to the season for new plantings have been made in this report. Manildra personnel and their contracts should check the weather forecast regularly to identify the best time for planting. It is advisable that plantings are avoided during peak flood periods.

Plants

Forestry tubestock or potted seedlings is recommended (150mm high by 50mm square pot), particularly for screen plantings and along riparian areas where Kikuyu grass is present. The small but semi-advanced plants require minimal preparation before planting and will have a greater success rate where Kikuyu grass is competing for space (e.g. embankment of Broughton Creek). Potted seedlings are an adequate alternative, however may be more expensive.

Ground preparation

Where possible tyne ripping to 0.5m, or digging, will break up sub-soils and improve the establishment time for deep root systems. This will be particularly useful for plantings at the rear of the bank along parts of Shoalhaven River, Bomaderry Creek and Broughton Creek, where the machine has access.

Prior to plantings in areas where long Kikuyu grass is present, grass should be slashed or whipper-snipped and spot sprayed with glyphosate to clear space for the planting.

Density

Recommended densities for new plantings are provided in **Table 4,** unless specifically referred to in the text of this document. It should be noted that as individual plants complete for nutrients, space and light, plant mortality will occur until planted areas develop and the stratum begins to emulate vegetation native to the area. A greater density in the early stages of development is required to shade out introduced grasses and other weed species and allow natural succession to take place.

Table 4: Planting densities

STRATUM	DENSITY & SPACING
Canopy	2 plants per $10m^2$ plot
Midstorey shrubs (1-5m)	3 plants per $10m^2$ plot
Midstorey shrubs (<1m)	3 plants per $10m^2$ plot
Ground layer (grasses & forbs)	Fill in gaps, where appropriate

7.2 Maintenance

Watering

Given the high rainfall experienced in the Shoalhaven area, the requirement for a watering regime is not likely to be necessary. However, during the first six weeks of planting, new seedlings will require watering on a fortnightly basis as a minimum. If the forecast rainfall is not sufficient to meet this, it is recommended that manual watering be implemented. During hot dry and windy periods, failure to water new plantings may result in high plant mortality and the need to replant with new tubestock / seedlings.

Mulch

A minimum of 10cm of mulch such as leaf mould or bark chips (whichever is available) should be spread around newly planted areas. Mulch helps retain soil moisture in the soil and reduces the re-establishment of weed species and perennial grasses, and can therefore reduce the amount time and costs associated with post planting maintenance.

Weed control

Weed control in newly planted areas will largely target a range of noxious and environmental weeds and perennial grasses. Spot spraying is recommended at monthly intervals for the first three months so new plants can successfully become established. A broad spectrum herbicide will be adequate to undertake the task so long as it is used at the manufacturer's recommended dosages for target weeds.

After three months, a visual inspection of weed control measures is to be undertaken to determine when, or if, the next round of weed control is required (weed monitoring procedures are provided in the following section). If the plants have established sufficiently that they are no longer at threat from weeds or perennial grasses, weed control measures can be reduced to a quarterly basis. After one year, further review will be required to determine the effectiveness of weed control measures.

A weed map has been provided at the start of Section 8 Weed Management. This map is also provided in electronic format so Manildra personnel can add information regarding the spread and intensity of weed infestations onsite on a continual basis.

Fauna Impacts

Kevin Mills Associates (2008) conducted a flora and fauna survey of the factory and farm and found the factory has limited habitat opportunities for native fauna. The riparian zone along Broughton Creek on the farm does provide habitat and landscape connectivity for fauna, in particular bird species, with structurally diverse vegetation in some areas and several mature hollow bearing trees.

During the site visit, it was found that some of the larges infestations of Lantana along the Shoalhaven and Bomaderry Creek foreshore provide nesting opportunities for birds. As such it is recommended these infestations be removed using the mosaic technique as this will progressively remove the plant and allow birds species to relocate more readily as habitat is reduced.

On the farm, diverse vegetation will continue to be protected and managed, with a view to extend vegetation in transition areas. As habitat becomes available and diversifies, it is anticipated that native fauna will progressively move into these areas.

Non-native species such as rats and hares were observed at the farm and currently Manildra operate a regular baiting program. Impacts on new plantings are not anticipated, however, if there is evidence of fauna impacts, tree guards should be employed for the first six months after planting.

Stock management on the farm is discussed in the following section.

Access

Access should be restricted in areas where new plantings have been completed until the plants are sufficiently established.

On the farm, the majority of the foreshore has been fenced, with only one section remaining unfenced and utilised as a flood refuge for stock. The stock refuge has been identified as an area at risk of bank failure and will require remediation plantings to improve bank stability. After planting, it is recommended that temporary fencing be installed 3m behind the bank to protect the plants from being eaten or trampled when in use. The remainder of the rear of the bank will continue to be used as a flood refuge.

On the factory site, new screen plantings and riparian enhancement plantings close to vehicle and/or foot traffic should be clearly marked out with temporary barriers or hazard tape where appropriate and security of the plants in assured. Plantings carried out behind any existing fence (e.g. between the Shoalhaven foreshore and the chain link fence) will not need to be marked out unless personnel or visitors frequent the area.

7.3 Monitoring

This section outlines procedures for the visual inspection of newly planted areas and weed infestations. Visual inspections will be carried out to ensure the success of new plantings, and to assess the extent of weeds infestations and the success of weed suppression measures. The frequency of monitoring will depend on the 'Zone' of the area.

To monitor the success of new plantings, the visual inspection will focus on indicators of plant health and mortality. The following table outlines some the typical management measures to overcome adverse health issues.

Table 5: Typical vegetation health management measures

HEALTH INDICATOR	CAUSE	MEASURES
Discolouration e.g. chlorosis, necrosis, reddening	▪ Nutrient deficiency ▪ Water stress ▪ Acidic soils	▪ Application of fertilisers ▪ Regular watering during dry periods ▪ Application of lime
Browsing damage	▪ Native browsers ▪ Introduced mammals ▪ Insects	▪ Guards on young plants to prevent mammal browsing ▪ Pesticides to reduce insect browsing
Infection e.g. spotting, mould	Folia & stem attack Poor genetic stock	▪ Pesticides to reduce pathogen infections

To monitor the success of eradication measures, the visual inspection will focus on whether the weeds remain absent from the site or are re-emergent. Where weeds have been contained, a photo is to be taken at each monitoring event and compared with the previous year's photo to determine whether the weed remains contained or new growth has occurred.

After each monitoring event, areas where further weed suppression is needed will be identified. Priority should be given to managing target weeds (noxious weeds, or weeds that threaten the ecological viability of healthy vegetation communities' onsite) in the first instance, and be in accordance with the management objectives of the *Noxious Weeds Act 1993* (refer to **Section 8.1**)

Visual assessment procedures are provided in **Tables 6-7** on the following page.

Table 6: Visual inspection of new plantings

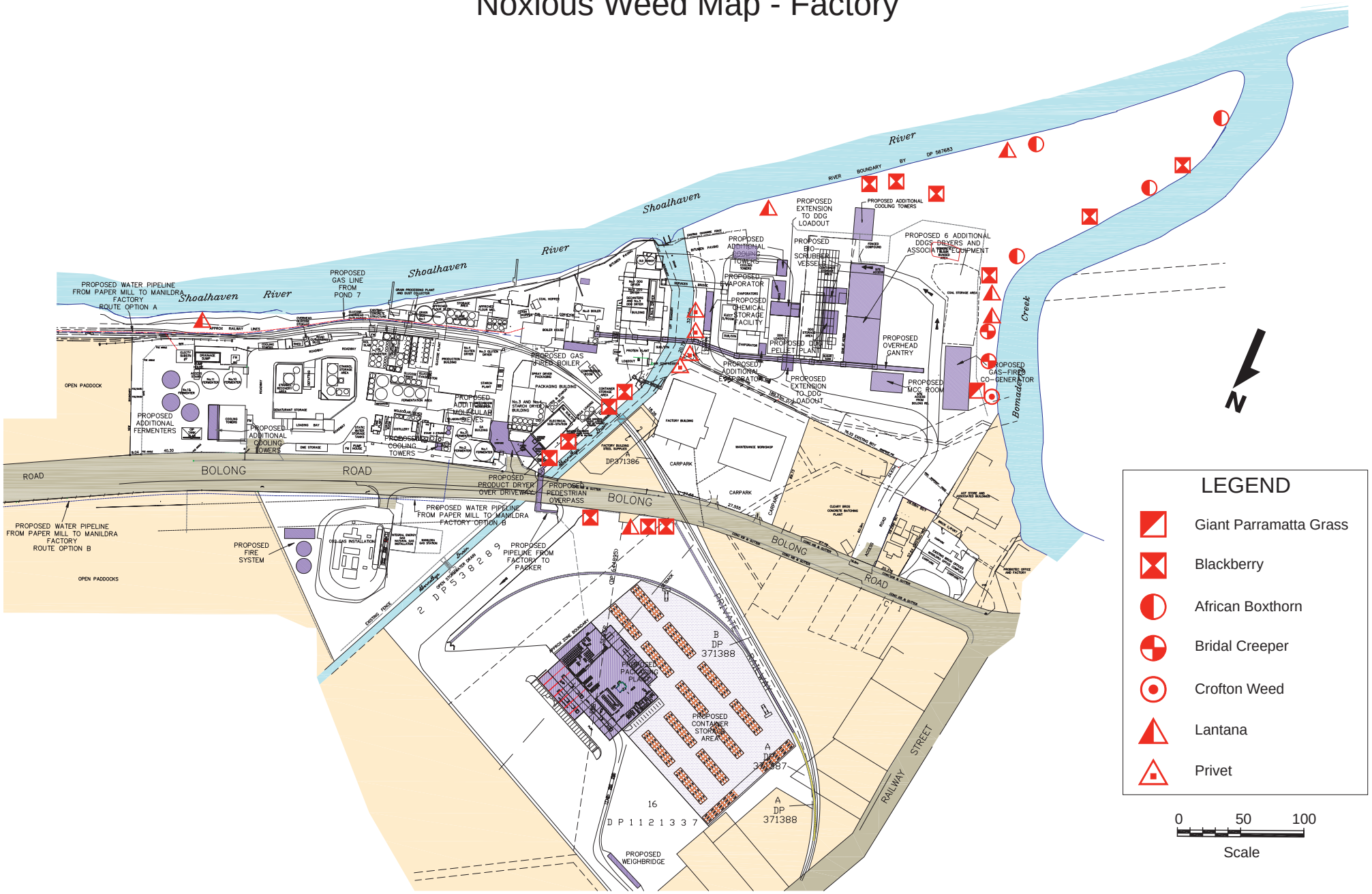
FREQUENCY		SEASON	PROCEDURES
Quarterly	Year 1	Early summer, autumn, winter & spring	1. Visually assess new plantings for indications of: ▪ Discoloration ▪ Plants with browsing damage (mammal and insect) ▪ Infection ▪ Presence of new / flush growth 2. Note any additional information peculiar or unique to the plants 3. Identify appropriate management strategies to ensure ongoing success
Annually	Year 2-5	Early winter	

Table 7: Visual inspection of weeds suppression / re-emergence

ZONE	FREQUENCY		SEASON	PROCEDURES
A	6 & 12 Months	Year 1-2	Early summer & winter	1. Where weeds have been eradicated, visually assess if weeds are 're-emergent' or 'remain absent' 2. Mark re-emergent weeds on the weed map 3. Where weeds are contained, take photos and compare with previous years to determine spread / contraction 4. Note any additional information peculiar or unique to weed area 5. Identify appropriate weed management strategies
	Annually	Onwards	Early winter	
B	6 & 12 months	Year 1	Early summer & winter	
	Annually	Onwards	Early winter	
C	Annually	Onwards	Early winter	

Weeds

Noxious Weed Map - Factory



Site drawings sourced from Allen Price and Associates

8.1 Target weeds

A variety of weed species have been identified in riparian zones of the four watercourses. Weed suppression measures are to target weed species listed under Class 3, 4, and 5 of the *Noxious Weeds Act (NWA) 1993* that apply to a) Shoalhaven City Council area, and b) the whole of NSW.

Class 3 – Regionally Controlled Weeds

Reduce the area and the impact of those plants in parts of NSW

Class 4 – Locally Controlled Weeds

Minimise the negative impact of those plants on the economy, community or environment of NSW

Class 5 – Restricted Plants

Prevent the introduction of those plants into NSW, the spread of those plants within NSW or from NSW to another jurisdiction

Table 8 outlines the weed species to be targeted as part of this plan, and the classification status of those species.

Table 8: LVMP target weed species

SPECIES	CLASS	NWA 1993 MANAGEMENT OBJECTIVES
Giant Parramatta Grass *Sporobolus africanus*	3	*The plant must be fully and continuously suppressed and destroyed*
African Boxthorn *Lycium ferocissimum*	4	*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*
Crofton Weed *Ageratina adenophora*	4	
Lantana *Lantana camara*	4*	
Large Leaf Privet *Ligustrum lucidum*	4^	*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 and the plant may not be sold, propagated or knowingly distributed*
Small Leaf Privet *Ligustrum sinense*	4^	
Blackberry *Rubus fruticosus*	4	
Lantana *Lantana camara*	5	*The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with*
Bridal Creeper *Asparagus asparagoides*	5	

Source: Shoalhaven City Council Weed Control Class 4 Management Plans

** Lantana is only classified as Class 4 when a group of landholders join together to target the species for eradication, otherwise it is classified as Class 5.*

^ Privet species are classified as Class 4 in urban areas only otherwise it is classified as Class 5. Privet observed along Abernethy's Creek is the only place onsite that the species is considered Class 4

8.2 Suppression methods

The resources listed in this section outline detailed best practice guidelines for the eradication and control of noxious and environmental weeds found onsite. These resources are provided in the library for easy reference.

- The Noxious and Environmental Weed Handbook: a guide to weed control in non-crop, aquatic and bushland situations (DPI, 2007), hard copies available from Department of Primary Industries or PDF online at:

  http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0017/123317/noxious-and-environmental-weed-control-handbook-3rd-edn.pdf
- Weed management in riparian areas: south-eastern Australia (CRC Weed Management, 2008)
- Best Practice Management Guide: General guidelines (CRC Weed Management, 2002)
- Manual weed suppression techniques
- Weed Management Guide: African Boxthorn (*Lycium ferocissimum*) (CRC Weed Management, 2007)
- Weed Management Guide: Bridal Creeper (*Asparagus asparagoides*) (NHT, 2003)
- Weed Management Guide: Blackberry (*Rubus fruticosus*) (CRC Weed Management, 2003)
- Agnote: Control of Giant Parramatta Grass (NSW Agriculture, 2001)
- Weed Management Guide: Lantana (*Lantana camara*) (CRC Weed Management, 2000)

The Noxious and Environmental Weed Handbook includes an alphabetised list of weed species and their eradication and control measures from page 30 onwards.

Relevant personnel (i.e. Shoalhaven Starches Management and contractors) are to reference these resources to ensure best practice measures are implemented onsite.

Weed eradication and/or control measures are not to commence until adequate funding for the program from commencement to completion is secured or guaranteed. A strategic approach would take into consideration works completed by other local organisations, particularly near boundary areas, and the availability of local, State and Federal funding grants.

9 SUPPLIERS

Table 9 outlines the some of the suppliers in the area for the provision of materials, and bush revegetation and landscaping expertise. This list is not exhaustive of the resources available in the area.

Table 9: Preferred suppliers list

SERVICES	NAME	ADDRESS	CONTACT DETAILS
Seedlings, landscape plantings, bush regeneration	Jamberoo Native Nursery	127 Curramore Rd, Jamberoo NSW	Ph: 02 4236 0445 Fax: 02 4236 0621 sales@jamberoonatives.com.au
Weed suppression, landscape plantings, bush regeneration	Enviroquest Landscape Management	Po Box 599, Nowra 2541	Ph: 1300 852 393 info@enviroquest.com.au
Bush regeneration & ecological restoration	Proust Bushland Services	PO Box 1077, Tomerong NSW	Ph: 02 4443 6537 pbs@shoalhaven.net.au
Bush regeneration	Conservation Volunteers	Cnr Cliff Rd & Harbour St, Wollongong NSW	Ph: 02 4228 9246
Mulch, soil, compost, spreading services	Soilco	Wogamia Rd, West Nowra NSW	Ph: 02 4422 9944
Mulch, fertilisers, herbicides, tree guards, stakes & edging	All Stake Supply	60 Prices St, Riverstone NSW	Ph: 1300 130 123 info@allstakesupply.com.au
Mulch & tree/stump removal	A&D Tree Services	L33, 1 Central Avenue, South Nowra NSW	Ph: 02 4423 6555 M: 0418 428 824
Mulch & tree/stump removal	Caldman Pty Ltd Tree Services	PO Box 88, Nowra NSW	Ph: 02 4421 4626 M: 0418 447907
Mulch	Shoalhaven Recycling	10 Victa Way, Bomaderry NSW	Ph: 02 4421 4597

1 SUMMARY OF ACTIONS

Table 11 has been developed as a quick reference for the priorities and actions outlined in this plan. The implementation of the plan will be undertaken over two phases. It is anticipated that each phase will take approximately 1-3 years to complete from the commencement of works. Monitoring and maintenance measures are detailed in **Section 7** (**Tables 7-9**) and have not been included in this summary table.

Table 11: Summary of actions, including a schedule of implementation

ASPECT / FORESHORE	MANAGEMENT ZONE	AREA	ACTIONS	IMPLEMENTATION SCHEDULE	REFERENCE
Phase 1					
Landscaping	-	Fermenters	▪ Plant *Casuarina Glauca* at 1.5m spacing to screen fermenters	On completion of construction works	Section 2
		Packaging plant	▪ Remove weeds and plant Melaleuca, Eucalyptus and Casuarina species between packaging plant and Bolong Rd	On completion of construction works	Section 2
Shoalhaven River	Zone A	Emergency revetment	▪ Removal immature coral trees from revetment and adjacent area ▪ Complete revegetation of revetment IAW landscaping plan (**Appendix B**)	Commence immediately	Section 3.1
			▪ Plant fast growing *Casuarina glauca* at rear of revetment ▪ Plant Eucalyptus and Melaleuca canopy species, and Lomandra as a groundcover at rear of revetment	On completion of construction works at flour mill	Section 3.1
		Confluence Shoalhaven River and Bomaderry Creek to 10m behind the bank	▪ Slash and spray Kikuyu grass ▪ Eradicate African Boxthorn and remove Lantana ▪ Plant out waterline with Grey Mangroves and Juncas Krausii ▪ Plant fast growing native species at the top of the bank and canopy species at the rear of the bank, and fill in with groundcovers	Commence within 6 months of plan approval	Section 3.1
Bomaderry Creek	Zone A	Confluence with Shoalhaven River to 250m upstream	▪ Slash and spray Kikuyu grass ▪ Plant top of bank with canopy species and midstorey species ▪ Fill in with groundcovers	Commence within 6 months of plan approval	Section 4.1
Abernethy's Creek	Zone A	Western bank, north of Bolong Rd	▪ Slash and spray Kikuyu grass ▪ Plant full list of riparian species at rear of bank ▪ Plant top of bank with *Melaleuca erificifolia* and other listed species ▪ Fill in the Lomandra and *Dianella spp.*	Commence within 6 months of plan approval	Section 5.1

Broughton Creek	Zone A	Stock flood refuge area to 10m behind bank	▪ Slash and spray Kikuyu grass ▪ Plant canopy and midstorey species at rear of bank ▪ Plant scattered *Casuarina glauca* and *Myoporum acuminatum* on bank (but not the waterline) ▪ Erect temporary barriers when area is used as flood refuge	Commence within 6 months of plan approval	Section 6.1
		Embankments with no canopy or midstorey	▪ Slash and spray Kikuyu grass ▪ Plant canopy and midstorey species at rear of bank ▪ Plant scattered *Casuarina glauca* and *Myoporum acuminatum* on bank (but not the waterline)	Commence within 6 months of plan approval	Section 6.1

Phase 2

Shoalhaven River	Zone B	Dense area of Acacia mearnsii	▪ Clear 10m x 10m plots and replant with other canopy species at 2m spacing ▪ Remove acacia seedlings and monitor success of plantings	Commence within 3 years of plan approval	Section 3.2
		Grassy area behind crib shed	▪ Whipper-snip and spray Kikuyu grass ▪ Plant toe with water line species ▪ Plant canopy and midstorey species at top of bank ▪ Fill in with groundcovers	Commence within 3 years of plan approval	Section 3.2
	Zone C	Eastern boundary to revetment	▪ Spray lantana ▪ Plant out with groundcover species (Lomandra)	Commence within 3 years of plan approval	Section 3.3
		West of Abernethy's outflow	▪ Remove lantana using mosaic approach ▪ Suppress African Boxthorn and Blackberry	Commence within 3 years of plan approval	Section 3.3
	Unzoned	Between crib shed and revetment	▪ Geotechnical assessment of bank stability to assess potential of removing Coral trees from bank	Within 5 years of plan approval	Section 3.4
Bomaderry Creek	Zone B	Upstream and downstream embankment	▪ Remove Lantana using mosaic approach ▪ Eradicate African boxthorn and Blackberry ▪ Frill privet	Commence within 3 years of plan approval	Section 4.2
Abernethy's Creek	Zone B	Eastern bank, north of Bolong Rd	▪ Remove Lantana using mosaic approach ▪ Assist natural regeneration, or supplementary plantings	Commence within 3 years of plan approval	Section 4.2
		Both banks, south of Bolong Rd to electrical easement	▪ Spray weeds on embankments ▪ Dense plantings of groundcover species	Commence within 3 years of plan approval	Section 4.2
		Both banks, south of electrical easement to outflow	▪ Suppress Privet and spray other weeds ▪ Plant eastern bank with selection of midstorey species	Commence within 3 years of plan approval	Section 4.2

Broughton Creek	Zone A	Stock flood refuge area to 10m behind bank	▪ Plant out waterline with suitable mangrove species	On successful completion of Phase 1 works	Section 6.1
		Embankments with no canopy or midstorey	▪ Plant out waterline with suitable mangrove species	On successful completion of Phase 1 works	Section 6.1
	Zone B	Transition areas	▪ Slash and spray and Kikuyu grass ▪ Plant suitable upper bank canopy and midstorey species	Commence within 5 years of plan approval	Section 6.2

REFERENCES

Buchanan (1996). *Bush Regeneration: Recovering Australian landscapes*. McPhersons Printing Group: Strathfield.

Coffey Environments (2008). *Riparian Assessment, Shoalhaven Starches Ethanol Expansion Project.* Prepared for Manildra Group, Bomaderry, NSW.

Cowman & Stoddart (2008). *Environmental Assessment Report for the proposed ethanol production upgrade Shoalhaven Starches* (Manildra Group), Bolong Road, Bomaderry, NSW.

DNR (2004). *Riparian Corridor Management Study Guidelines*. Former Dept. of Natural Resource (currently DWE), NSW.

DoP (2009). *Shoalhaven Starches Expansion Project 06_0228 Notice of Approval*. Department of Planning, Sydney, NSW.

DPI (2005). *Noxious weed declarations for Shoalhaven City Council*. Department of Primary Industries, NSW. http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed, accessed 17 April 2009.

DSE (2006). *Native Vegetation Revegetation Planting Standards – Guidelines for establishing native vegetation for net gain accounting*. Department of Sustainability and Environment, Victoria.

DWE (2008a). *Guidelines for controlled activities: vegetation management plans*. Department of Water and Energy.

DWE (2008b). *Guidelines for controlled activities: riparian corridors*. Department of Water and Energy.

Keith, D. (2004). *Ocean shores to desert dunes: the native vegetation of NSW and the ACT*. Department of Environment and Climate Change, NSW.

Kevin Mills & Associates (2008). *Flora and fauna assessment, proposed upgrade of ethanol plant Shoalhaven Starches Factory Bomaderry, City of Shoalhaven*. Prepared for Cowmen Stoddart ,Nowra, NSW.

Robinson, L. (1991). *Field guide to the native plants of Sydney*. Kangaroo Press: Roseville.

Rutherfurd, I., Jerie, K. & Marsh, N. (2001). *A Rehabilitation Manual for Australian Streams*. Land and Water Resources Research and Development Corporation and CRC for Catchment Hydrology: Victoria.

Stone, C., Matsuki, M. & Carnegie, A. (2003). *Pest and disease assessment in young eucalypt plantations: field manual for using the Crown Damage Index*. National Forest Inventory, Bureau of Rural Sciences, Canberra.

Plates

Plate 1: Existing screen planting between proposed evaporation columns and Shoalhaven River (container height 2m)

Plate 2: Area proposed for landscape planting to screen new fermenters

Plate 3: Coral trees on revetment and adjacent embankment

Plate 4: Vegetation at confluence of Shoalhaven River and Bomaderry Creek

Plate 5: Shoalhaven River embankment and Crib Room

Plate 6: Embankment of Abernethy's Creek, north of Bolong Rd

Plate 7: Madeira vine and Large leaf privet on the embankment of Abernethy's Creek, South of Bolong Road

Plate 8: Stock flood refuge area at western end of Broughton Creek

Slumping observed
site visit April 2008

Plate 9: Advancing mangroves and phragmites along Broughton Creek (Zone A)

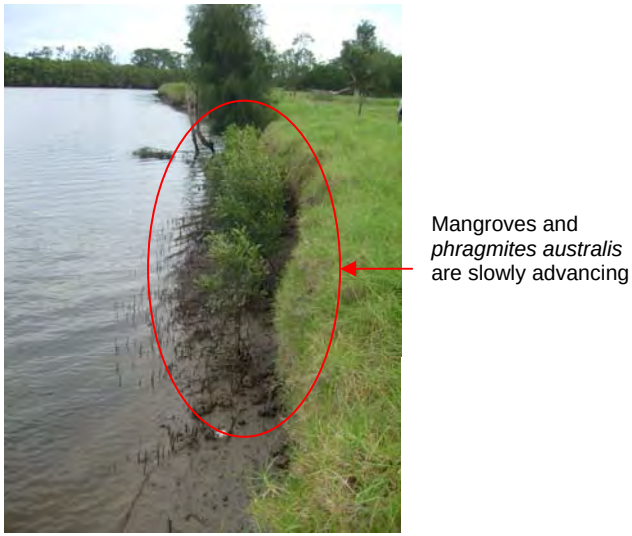


Plate 10: Healthy and representative floodplain forest on Broughton Creek (Zone C)

Attachment A

Species list for riparian enhancement plantings

Attachment A: Species list for riparian enhancement plantings

BANK POSITION	VEGETATION LAYER	SPECIES
Rear of bank	Canopy	Eucalyptus robusta, Eucalyptus botryioides, Eucalyptus saligna x botryioides, Eucalyptus tereticornis, Casuarina glauca, Angophora floribunda, Callistemon viminalis, Melaleuca styphelioides, Melaleuca linariifolia, Alphitonia excelsa, Ficus rubiginosa, Ficus macrophylla, Livistona australis
	Midstorey	Melaleuca ericifolia, Myoporum acuminatum, Rapanea variablis, Glochidion ferdinandi, Omalanthus populifolius, Scalopia braunii, Synoum glandulosum, Acmena smithii, Pittosporum undulatum, Indigofera australis
	Ground layer	Lomandra longifolia, Carex appressa, Dichondra repens, Centella asiatica, Tetragonia tetragonioides, Microlaena stipoides, Einadia hastata, Commelina cyanea, Juncus usitatis, Poa labillardieri
Top of bank	Canopy	Casuarina glauca, Callistemon viminalis, Melaleuca styphelioides, Melaleuca linariifolia, Banksia integrifolia
	Midstorey	Melaleuca ericifolia, Myoporum acuminatum, Pittosporum undulatum, Indigofera australis
	Ground layer	Lomandra longifolia, Carex appressa, Gahnia clarkei, Dichondra repens, Centella asiatica, Tetragonia tetragonioides, Microlaena stipoides, Einadia hastata, Rhagodia candolleana, Commelina cyanea, Juncus kraussii (saltwater), Juncus usitatus (freshwater), Ficinia nodosus, Hibbertia scandens, Poa labillardieri
Water line (if possible)	Canopy	Avicennia marina (High water mark), Aegiceras corniculatum (spring high water mark), Melaleuca ericifolia (freshwater areas), Melaleuca styphelioides, Casuarina glauca
	Midstorey	Melaleuca ericifolia (freshwater areas), Myoporum acuminatum
	Ground layer	Tetragonia tetragonioides, Rhagodia candolleana, Juncus krausii (saltwater), Juncus usitatus (freshwater), Apium prostratum, Triglochin striata, Baumea juncea, Lomandra longifolia, Phragmites australis, Crinum pend-undulatum (Broughton Creek), Bulboschoenus caldwellii (Abernethys), Poa labillardieri

Attachment B

Allison Hunt & Associates (2008) Shoalhaven Starches: landscaping of revetment wall

ALISON HUNT & ASSOCIATES PTY LTD

ABN 76 233 543 751

8 Duncan Street, Arncliffe NSW 2205
Office (02) 9599 0402 Mob. 0408 769 315
alison@ahecology.com

19 June 2008

Mr B Edwards
Beca
PO Box 7079
St Kilda Road VIC 8004

Dear Brendan

Shoalhaven Starches
Landscaping of Revetment Wall

Alison Hunt & Associates Pty Ltd was requested to specify vegetation to be planted in holes in the rock wall and provide a guide to planting. After consultation with a number of sources it is suggested that Swamp Oak be planted mid-height and a number of shrub and herb species included below the mid-height section of the wall. All of these species are extremely hardy, excellent colonisers and will tolerate a range of conditions. A plant schedule is provided in Table 1.

Yours faithfully
Alison Hunt & Associates Pty Ltd

A. Hunt

Dr Alison Hunt
Director

Table 1 Plant Schedule for Vegetation of the Revetment Wall

Species	Description	Position	Planting Guide
New Zealand Spinach (*Tetragonia tetragonioides*)	Prostrate spreading annual or short-lived perennial. Hardy coastal species.	Scattered plantings below mid-height of the revetment wall.	Tubestock should be planted on top of the geotextile fabric between the boulders in good quality soil placed between the boulders. The root zone should be watered well and mulched if possible. Follow up watering should be undertaken until establishment especially if planting is undertaken during a dry spell. Dead plants should be replaced.
Spiny-headed Mat-rush (*Lomandra longifolia*)	A large tufted herb with strap-like leaves up to 1m long. Very hardy.	Scattered plantings below mid-height of the revetment wall.	Tubestock should be planted on top of the geotextile fabric between the boulders in good quality soil placed between the boulders. The root zone should be watered well and mulched if possible. Follow up watering should be undertaken until establishment especially if planting is undertaken during a dry spell. Dead plants should be replaced.
Climbing Guinea Flower (*Hibbertia scandens*)	Salt resistant scrambler with large golden yellow flowers. Often planted near the sea.	Scattered plantings below mid-height of the revetment wall.	Tubestock should be planted on top of the geotextile fabric between the boulders in good quality soil placed between the boulders. The root zone should be watered well and mulched if possible. Follow up watering should be undertaken until establishment especially if planting is undertaken during a dry spell. Dead plants should be replaced.
Pigface (*Carpobrotus glaucescens*).	Prostrate perennial with stems to 2 m long, on coastal sand dunes, usually very close to the sea.	Scattered plantings below mid-height of the revetment wall.	Tubestock should be planted on top of the geotextile fabric between the boulders in good sandy soil placed between the boulders. The root zone should be watered well and mulched if possible. Follow up watering should be undertaken until establishment especially if planting is undertaken during a dry spell. Dead plants should be replaced.
Swamp Oak (*Casuarina glauca*)	Tree 8 – 20 m high, frequently producing root suckers; branchlets drooping. Occurs in brackish situations along coastal streams, somewhat farther inland along major river valleys. Often forming pure stands.	Planted at the mid-height section of the wall.	Obtain seedlings of 5 litre pot size. These should be planted at 10 m centres. A hole in the geotextile fabric should be made and a hole for planting should be dug at least 100% more by volume than the pot size. Plants should be staked if necessary. The root zone should be watered well and mulched if possible. Follow up watering should be undertaken until establishment especially if planting is undertaken during a dry spell. Dead plants should be replaced.