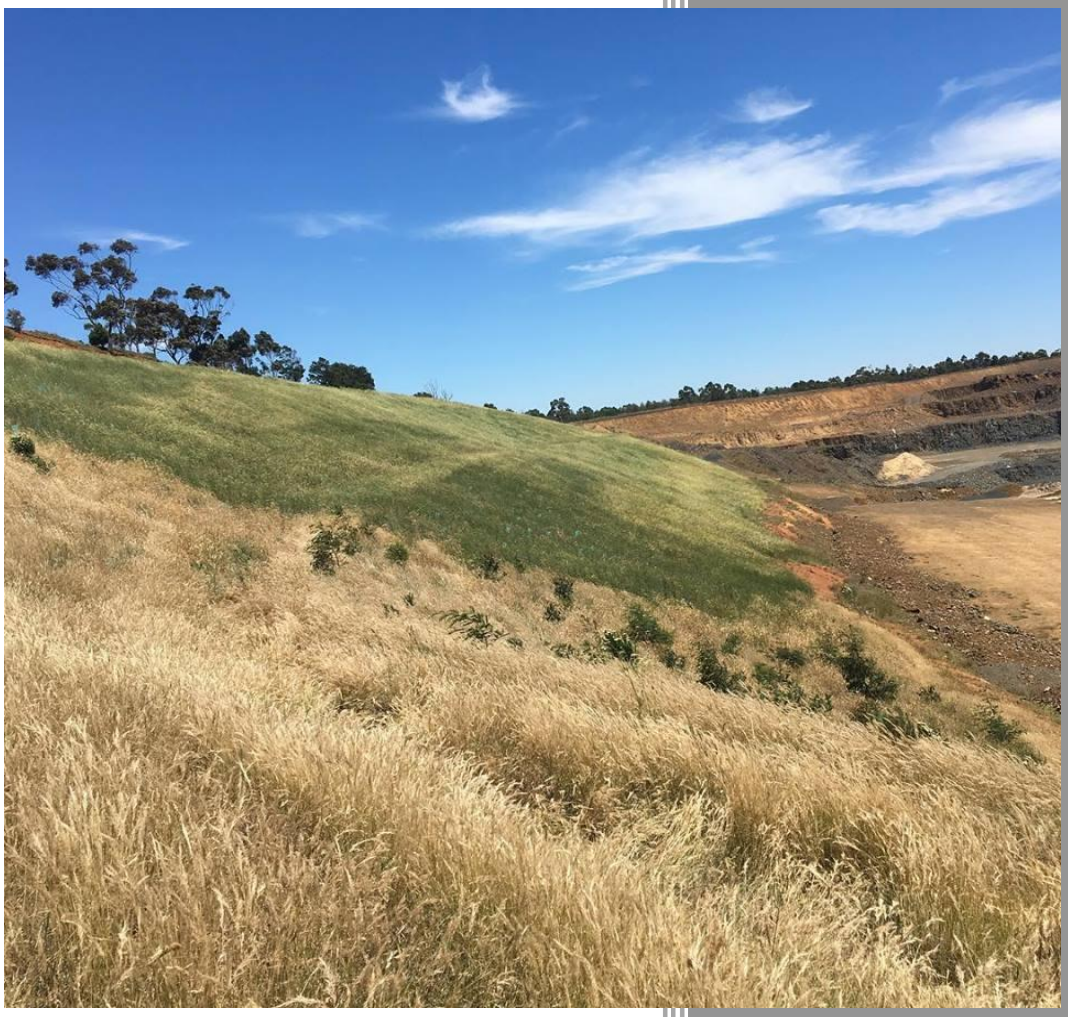
2020

Mt Shamrock Quarry Rehabilitation Report



Thomas Fee

Naturelinks 2020

General Information

Report prepared by Thomas Fee.

Site Location: Holcim Mt Shamrock Quarry Mt Shamrock Rd, Pakenham Upper, Vic,

Client: Matt Dodd – Mine Manager. Mt Shamrock Quarry, Holcim

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Cover photo: 2017 direct seeding are in foreground contrasted by 2018 direct seeding area. Photo taken by Thomas Fee for Naturelinks Landscape Management

Report Scope

This report addresses all revegetation and maintenance works carried out by Naturelinks in the area identified as South-East Extraction over the period of 2017- 2019. As part of the Mt Shamrock revegetation works Naturelinks undertook direct seeding and planting works of approximately 3.9 Ha within the SE Extraction area of the quarry. The area rehabilitated is outlined below along with revegetation and management steps undertaken. As well as detailing restoration works, this report outlines issues encountered and management challenges identified throughout the rehabilitation process. Following this a summary list of proposed future management actions is detailed.

South-east Extraction Area Rehabilitation Works 2017 -2019

The area referred to as SE Extraction re-vegetation refers to all revegetation works undertaken from 2017-2019 located in the South-eastern corner of the operational Quarry area. This area is approximately 3.9 hectares in total and is comprised of three separate Areas (see Figure 1). Areas 1 and 2 [Figure 2 (left)] were revegetated in 2017 and together total approximately 2.7Ha, with the 2018 revegetation area totalling approximately 1.2Ha [Figure 2 (right)]. Restoration works were undertaken in all areas and include direct seeding using a sterile cover crop and native seed mix followed by an initial planting of mid and upper story tube-stock. All species selected appear in the EVC 16 List of species for Lowland Forests located within the Gippsland Plains Bioregion as specified in the Holcim Landscape & Rehabilitation Management Plan, Mt Shamrock Quarry, Pakenham (2014).

Figure 1: 2017/18 Total Mt Shamrock South-east Extraction Re-vegetation area (3.9Ha).

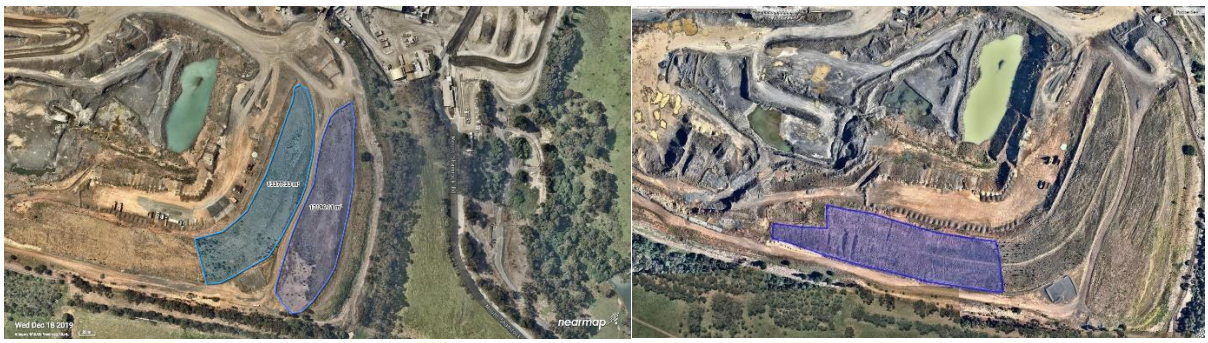

Figure 2: Left – Revegetation Areas 1 & 2 (2017). Right - Revegetation Area 3 (2018).

Site preparation was undertaken by Holcim in the form of spreading stored top-soil across the re-vegetation sites. Naturelinks then undertook weed control works in the form of two non-selective spray runs throughout the site prior to direct seeding. Following these spray works, hydro-seeding was undertaken with 2.7 Ha undertaken in 2017 and 1.2Ha carried out in June 2018. Direct seeding was carried out by Subcontractor Hydrograss Pty. Ltd. using a native and sterile Rye seed mix embedded within liquid paper mulch then applied directly to the bare earth. Table 1 refers to the seed mix and proportions for each species along with sowing rates, all native seed is sown at a total 40kg/Ha in conjunction with the cover crop of Sterile Rye Corn sown at a rate of 100kg/Ha, combined a sowing rate of 140kg/Ha of seed was sown on site. In total 156kg of native seed has been sown over 3.9Ha. Further installation of understory plantings has been carried out at various periods throughout 2017-19.

Table 1: Native seed mix sowing rates and proportions for SE Extraction revegetation area (3.9Ha).

Species	Common Name	Sowing Rate	Percentage of Seed	Total Seed
Themeda triandra	**Kangaroo Grass**	**6kg/Ha**	**15%**	**23.4kg**
Rytidosperma sp. mix	**Wallaby-grass**	**24kg/Ha**	**60%**	**93.6kg**
Microlaena stipoides	**Weeping Grass**	**10kg/Ha**	**25%**	**39kg**

Naturelinks have identified that understorey species planted multiple years from the time of direct seeding and the over story plantings have a higher incidence of survival than those planted the same year as direct seeding. 3100 understorey species were planted through all the revegetation areas over a period of 2 years after direct seeding occurred (Table 2). Site surveys undertaken in late 2019/early 2020 assessed native vs exotic cover for understorey species across all sites. All areas were walked through by two observers and percentage cover of native vs exotic species were given for three sample areas (1-3) per observer. Areas 1 & 2 (refer to Figure 2) showed mixed results spatially across the sites averaging a 70% native vs 30% exotic across the sites. Within these sites some sample areas showed native cover as high as 90/10% native/exotic respectively and as low as 20/80% native/exotic cover in areas where *Phalaris aquatica* has found favourable conditions (discussed below). Area 3 was difficult to assess due to an unexpected 2019 second year of germination of the Rye cover crop providing up to 90% of the understory cover. An estimation of cover for this area is currently 20/80% native/exotic respectively. This may prove problematic in the future if significant Wallaby Grass germination does not occur in 2020.

Table 2: Understorey species planted in 1.2 Ha SE Extraction Re-vegetation area.

Understorey Species	Common Names	Type	Number of Individuals Planted
Dianella revoluta var. revoluta	**Black-anther Flax Lily**	**Tubestock**	**500**
Lomandra longifolia var. longifolia	**Spiny-headed Mat rush**	**hiko**	**1000**
Lomandra longifolia var. longifolia	**Spiny-headed Mat rush**	**cells**	**1500**
Aceana novae-zealandia	**Bidgee Widgee**	**Tubestock**	**100**
Total			**1600**

Table 3 below identifies all species planted throughout the site through years 2017 – 2019, with all 2019 plantings being infill only plantings. A total of 2960 tree and shrub species have been planted overall. Naturelinks undertook field surveys to identify survival rates of planted species. Survival rates were determined using simple counts of surviving individuals across all areas. Individuals were grouped into three broad categories; Acacia, Eucalyptus and Mixed Shrub species. Survival rates of individual species were not determined; however, notes were taken on the performance of individual species whilst counts were undertaken. Table 4 outlines species that exhibited high, low and mixed results for species mortality (mixed results here may refer either to an individual that may be performing well in a particular subset of the site such as in a favourable microclimate area or of a species with patchy survival throughout the site as a whole). Survival rates of the three species categories are shown in Table 5. Total survival of all species is 30% over all plantings in the focus areas. This is significantly reduced from those of earlier plantings in the other Extraction areas. Whilst identifying direct causality of such low survival rates is beyond the scope and capacity of this report, some hypotheses are discussed below.

Table 3: Species list and quantities for upper and mid-strata species planted in all SE Extraction re-vegetation area.

SE Extraction species planted					
Species	**2017**	**2018**	**2019 - Infill**	**Total**	**Proportion (%)**
Eucaylptus viminalis	45	50	200	**295**	10.0
Eucalyptus cypellocarpa	45	25	45	**115**	3.9
Eucalyptus obliqua	45	25	100	**170**	5.7
Eucalyptus radiata	45	25	100	**170**	5.7
Eucalytpus fulgens	25	50	150	**225**	7.6
Acacia melanoxylon	113	45	100	**258**	8.7
Acacia dealbata	102	45	200	**347**	11.7
Acacia myrtifolia	90	45	50	**185**	6.3
Leptospermum lanigerum	330	50	50	**430**	14.5
Epacris impressa	0	70		**70**	2.4
Hakea nodosa	135	40	125	**300**	10.1
Pultenea gunnii	0	50		**50**	1.7
Cassinia aculeata	45	50		**95**	3.2
Acacia verticillata			200	**200**	6.8
Ozothamnus ferrugineus			50	**50**	1.7
Total	**1020**	**570**	**1370**	**2960**	**100**

Table 4: Species performance based on survey notes taken during site counts.

Species	Low Mortality	High Mortality	Mixed Results
Eucaylptus viminalis			*
Eucalyptus cypellocarpa			*
Eucalyptus obliqua	*		
Eucalyptus radiata	*		
Eucalytpus fulgens		*	
Acacia melanoxylon	*		
Acacia dealbata			*
Acacia myrtifolia	*		
Leptospermum lanigerum		*	
Epacris impressa		*	
Hakea nodosa	*		
Pultenea gunnii			*
Cassinia aculeata	*		
Acacia verticillata		*	
Ozothamnus ferrugineus			*

Table 5: Survival rates of planted species

Categories	Planted	Survived	Proportion survived %
Eucalyptus Species	975	310	32
Acacia Species	990	349	35
Mixed Species	995	235	24
Total	**2960**	**894**	**30**

Significant loss of plantings occurred throughout SE Extraction over the 2017/2018, with some sections seeing isolated losses of up to 90% of species planted. It is likely that multiple factors contributed to these losses, including high temperatures low winter and summer rainfall, shallow soil profile, localised soil compaction and steep slopes in some areas all contributing to low levels of a plant available water in the soil profile through poor water infiltration through the soil. Other factor include inappropriate species selection, High winds and aspect and insufficient subsequent water provided to plantings. From these observations it was determined that areas where high tree mortality occurred were also where high percentages of native understory occurred, predominately Wallaby Grass species. On the other hand, a high percentage cover of exotics was also found where high rates of tree survival were evident. Although a definitive reason as to why this occurred cannot be given without further study, it is possible that this is in direct relationship with water availability and water flow through the site. Where high survival rates and good tree health occur, invasive species that usually appear in wet environment such as *Phalaris aquatica* tend to quickly outcompete and dominate the Wallaby Grass understory.

Rehabilitation Maintenance Works

Weed management practices undertaken by Naturelinks predominantly centre on selective and non-selective herbicide application delivered by either high pressure quick spray units or knapsack spray works for more sensitive areas. Selective herbicide runs utilising broadleaf only herbicides is often undertaken as large areas can be sprayed at a time using Quicksprays without damage occurring to the native grass dominated understorey. Using a quickspray unit to control exotic grass species is only appropriate in some areas and is employed at a very low pressure in areas of lower quality. Naturelinks has begun to use these units more frequently in order to manage larger areas over a shorter time period. In areas of high quality or more inaccessible areas, knapsack spray techniques are employed in order to minimise off target damage to any *Rytidosperma species.* Table 6 details the most common weeds found in the SE revegetation area.

Table 6: List of common weed species found on re-vegetation areas.

Common Weeds	Common Name
Arctotheca calendula	Cape Weed
Avena fatua	Wild Oats
Brassica fruticulosa	Twiggy Turnip
Bromus sp	Bromus species
Conyza sp.	Fleabane sp
Cirsium vulgare	Spear Thistle
Cynodon dactylon var. dactylon	Couch
Dittrichia graveolens	Stinkwort
Dactylis glomerata	Cocksfoot
Cortaderia selloana	Pampas Grass
Helminthotheca echioides	Ox-tongue
Holcus lanatus	Yorkshire Fog
Hypochaeris radicata	Cat's Ear
Lysimachia arvensis	Scarlet Pimpernell
Malva nicaeenis	Mallow-of-Nice
Onopordum acanthium ssp. acanthium	Scotch Thistle
Paspalum dilatatum	Paspalum
Phalaris aquatica	Toowoomba Canary-grass
Plantago lanceolata	Ribwort
Polygonum arenastrum	Wireweed
Raphanus raphanistrum	Wild Radish
Solanum nigrum s.l	Black Nightshade
Sonchus asper ssp. asper	Rough Sow-thistle
Sonchus oleraceus	Sow-thistle
Rubus fruticosus spp. agg.	Blackberry
Silybum marianum	Variegated Thistle
Setaria sp.	Pigeon Grass

Supplementary watering has occurred throughout Summer months wherever possible, however the steepness of slopes and access issues have led to watering being unreliable and some areas being unable to be watered. Holcim has also introduced watering using their own watering cart, this has been very effective at providing water to areas along the top access track and can be mobilised quickly and efficiently. Survival rates are particularly high in these areas. Other management activities include tree guard maintenance and brushcutting of Phalaris to stop seed set and prepare for future spray works. This technique ensures minimum off target spray works when undertaking weed control.

Issues and Future Management Recommendations

Numerous issues have been identified during revegetation operations. A brief summary of issues and recommendations is detailed below (Table 7). This covers specific issues surplus to normal seasonal weed control and management activities. To date existing budgets allow us to manage these areas for most high threat weeds only, in this space there have been multiple success stories for weed eradication and most broadleaf weeds are controlled to acceptable levels. However, due to the difficult nature of controlling perennial grasses amongst a grass dominated understory , there is some concern that these grasses (particularly Phalaris and Couch) are outcompeting large areas of Wallaby Grass understory. Large scale and sustained weed control and future planting and/or direct seeding may be required to halt progress of these incursions (shown in figure 3&4). These works would be surplus to already planned and budgeted 2020 works. Table 7 details both issues and proposed solutions to management issues identified which could be implemented for both existing and future revegetation works.

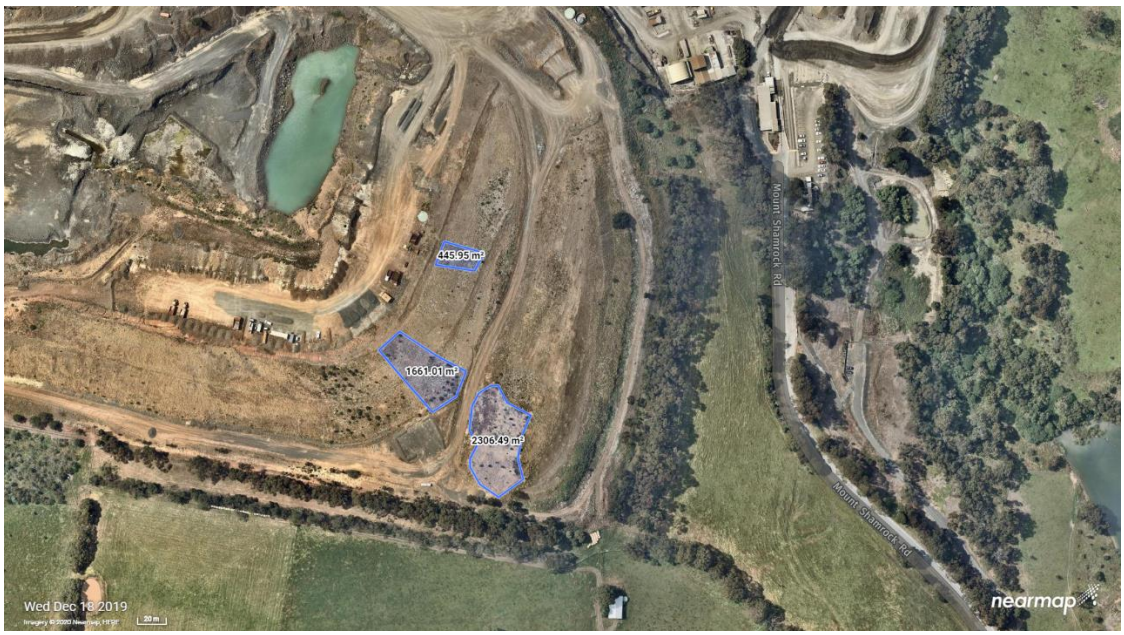

Figure 3: Areas of SE Extraction exhibiting with high cover (>80%) Phalaris.

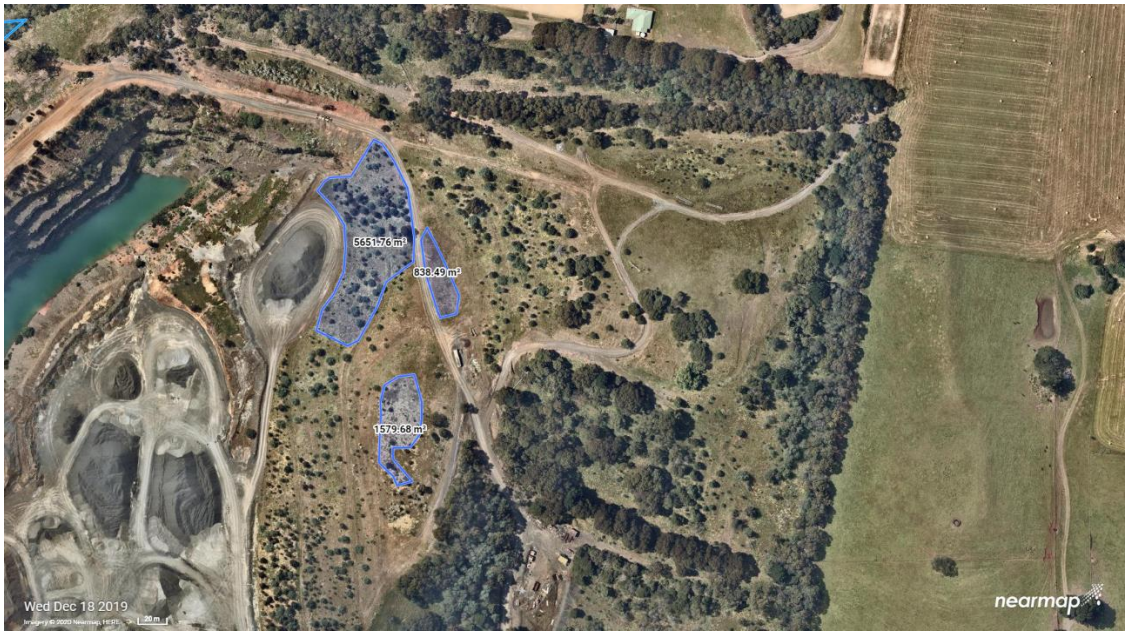

Figure 4: Areas of Extraction exhibiting high (>80%) cover of Perennial grass cover (predominantly Couch and Phalaris)

Table 7. Management issues and recommendations for current and future management areas.

Management Issues	Management Recommendations
Low germination rates of Themeda triandra and Microlaena stipoides in direct seeding mix	1. Diversify seed mix and include Poa species, Austrostipa sp and other appropriate species
Spread and dominance of Phalaris aquatica in specific wetter areas.	1. Brushcut biomass and follow-up spray works - 2x runs per annum. 2. Plant and direct seed with appropriate species following control (see Appendix 2 below). 3. Seasonal Ecological burn of understory followed by intense weed control and localised direct seeding.
Localised infiltration and spread of *Avena sp.*	1. Knapsack spray of germinating Avena - 2 x visits
Watering of Plants – inefficiencies and access	1. Set-up irrigation system and easy access tank for SE Extraction areas. 2. Use watering budget on areas where irrigation unable to service.
High plant mortality	1. Adjust species list to accommodate more dry tolerant species found in the area (see below) 2. Provide mulch circles around all future plantings 3. Increase biodiversity in all strata – includes plantings and seed mix. 4. In-fill plantings to be staged over minimum of 3-5 years after initial planting. This ensures plantings and species lists can be adapted to more suitably reflect differing site conditions observed during management of revegetation.

Soil moisture and plant available water	1. Decrease slope in future revegetation areas, 2. Avoid soil compaction (no vehicles or heavy machinery on revegetation areas after spread of soil) 3. Increase depth of topsoil. 4. Mulch circles around all plantings.
High understory mortality (Lomandras). Poor performance of understory plantings directly after seeding.	1. Plant understorey species a minimum of one year after direct seeding. 2. Staged understory plantings over minimum of 2-5 years after direct seeding. 3. DO NOT plant cells, insufficient root establishment occurs prior to summer. High mortality of cells. 4. Increase diversity – plant more Dianella. Continually enhance species lists (see appendix 1&2).

Contents

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Appendix 1. Dry area tolerant species surveyed in EA Owens Reserve and Chambers Reserve found within 5km of Mount Shamrock Quarry. Species found in Lowland Forest, Dry Forest and Shrubby Foothill Forest EVC's.

Species	Common Name	Notes
Upper Story (canopy)		
Eucalyptus Obliqua	Messmate	Found locally, more tolerant of drier soils
Eucalyptus radiata subsp. radiata	Narrow-leaf Peppermint	Found locally, more tolerant of drier soils
Eucalyptus goniocalyx	Long-leaf Box	Found locally, more tolerant of drier soils
Eucalyptus dives	Broad-leaf Box	Found locally, more tolerant of drier soils
Upper - Mid Story (tall shrubs)		
Ozothamnus ferrugineus	Tree Everlasting	Tolerates dry once established
Cassinia aculeata	Dogwood	Tolerates dry once established
Cassinia longifolia	Long-leaf Cassinia	Found locally, more tolerant of drier soils
Acacia mearnsii	Black Wattle	Found locally, more tolerant of drier soils
Acacia stricta	Hop Wattle	Found locally, tolerates dry once established
Acacia paradoxa	Hedge Wattle	Found locally, more tolerant of drier soils
Hakea decurrens subsp. physocarpa	Bushy Needle wood	Found locally, more tolerant of drier soils
Hakea nodosa	Yellow Hakea	Tolerates dry once established
Hakea ulicina	Furze Hakea	Found locally, tolerates dry once established
Banksia marginata	Silver Banksia, Warrock	Found locally, more tolerant of drier soils
Banksia spinulosa var. cunninghamii	Hairpin Banksia	Found locally, tolerates dry once established
Allocasuarina littoralis	Black Sheoak	Found locally, tolerates dry once established
Acacia verticillata. Ssp. verticillata	Prickly Moses	Found locally, tolerates dry once established
Lower-mid story (small shrubs)		
Pultanea scabra	Rough Bush-pea	Found locally, more tolerant of drier soils
Correa reflexa	Common Correa	Found locally, more tolerant of drier soils
Goodenia ovata	Hop Goodenia	Found locally, tolerates dry once established
Grevillea alpina (Southern Hill form)	Mountain Grevillea	Found locally, tolerates dry once established
Epacris impressa	Common Heath	Found locally, tolerates dry once established
Acacia myrtifolia	Myrtle Wattle	Found locally, tolerates dry once established
Groundcover/Climbers		
Poa sieberiana		Found locally, more tolerant of drier soils
Dianella tasmanica	Tasman Flax-lily	Found locally, tolerates dry once

		established
Dianella admixta var. revoluta		Found locally, more tolerant of drier soils
Dianella amoena		Found locally, tolerates dry once established
Poa rodwayii		Found locally, tolerates dry once established
Platylobium obtusangulum	Common Flat-pea	Found locally, more tolerant of drier soils
Lomatia ilicifolia	Holly Lomatia	Found locally, tolerates dry once established
Veronica pleba		Found locally, tolerates dry once established
Billardieria mutabilis	Common Apple-berry	Found locally, tolerates dry once established
Solongoyne sp.		
Hovea heterophylla	Common Hovea	Found locally, tolerates dry once established
Pimelea humilis	Common Rice-flower	Found locally, tolerates dry once established
Pimelea flava subsp flava	Yellow Rice-flower	
Lomandra longifolia subsp. longifolia	Spiny-headed Mat-rush	Found locally, tolerates dry once established
Lomandra filiformis	Wattle Mat-rush	
Tetrahena juncea	Forest Wire-grass	
Pandorea pandorana	Wonga-vine	

Appendix 2: Species appropriate for seeding/planting in areas currently dominated by Phalaris aquatica following control.

Species	Common Name	Notes
Austrostipa rudis ssp. rudis	Veined Spear-grass	Moist soils – semi shade
Dianella tasmanica	Tasman Flax-lily	Tolerant of seasonally dry and wet soils
Poa enseformis		Moist clay – semi shade
Poa labillardierei var. larbillardierei	Common Tussock-grass	Moist soils – full sun-semi shade
Tetrahena juncea	Forest Wire-grass	Moist soils, tolerates dry once established
Themeda triandra	Kangaroo grass	Adaptable
Juncus amabilis	Hollow Rush	Full sun, tolerates dry conditions and seasonal inundation