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Gunns Pulp Mill Effluent Pipeline Four Mile Beach Dune Crossing Remediation and Revegetation

Prepared for

Gunns Pty Ltd

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1. Introduction

This report describes remediation and revegetation requirements of the dune area where it is crossed by the proposed Gunns pulp mill effluent pipeline on its route to the ocean outfall off Four Mile Beach in northern Tasmania.

Atteris Pty Ltd has prepared a report on the conceptual engineering design of the ocean outfall and dune crossing[1].

This current report is based on the Atteris conceptual engineering design, and on an inspection of aerial photographs and two site visits, undertaken in August 2005.

2. Site description

2.1 Nearshore

The nearshore zone in the proposed crossing area consists of a highly to extremely weathered basalt platform with a variable sand cover and scattered cobbles of basalt.

2.2 Beach

The beach in the proposed crossing area consists of a relatively thin sand cover over a wave-cut platform of highly to extremely weathered basalt. An accumulation of shingle occurs at the back of the beach along most of the area to the east of the site, with larger accumulations to the west of the site, near the cliffs of Four Mile Bluff. Small pebbles are scattered over the sand surface between low and high tide levels along most of the beach.

2.3 Dunes

The beach is backed by a foredune that is currently being eroded. This foredune is highest on the western end (in the vicinity of the proposed crossing it is 6 – 8 m high) and lowest on the eastern end near Five Mile Bluff (1 – 2 m high). The foredune is backed by a series of older easterly trending dunes.

Wind erosion of the coastal dunes has occurred extensively along the northeast coastline of Tasmania, resulting in the replacement of pre-existing stabilised dunes with transgressive dunes. There is some evidence that the development

[1] Atteris Pty Ltd (December 2005) *Gunns Limited Bell Bay Pulp Mill Project Ocean Outfall Conceptual Engineering Study*. Report prepared for Gunns Limited.

of these transgressive dunes has been a response to burning and stocking of dune country previously stabilised by vegetation (Davies 1965)[2].

2.4 Swales

Swales are long narrow or broad depressions that occur between two linear dunes. They may be shallow or deep and are frequently close to the watertable level. Where they are close to the watertable the swales often have a damp sandy, marshy or peaty floor.

In the wider area they are very long and broad depressions, often with marshy or peaty floors and drainage lines.

2.5 Vegetation cover

The foredunes have been stabilised by marram grass and the hind dunes have been stabilised by a closed scrub of coast wattle, prickly mimosa and marram grass. Many of the older dunes have been sown to improved pasture[3].

Vegetation mapping by GHD[4] has identified the following vegetation communities along the proposed route:

- Coastal scrub (SAC) ~ 23%
- *Melaleuca ericifolia* (NME) ~ 2%
- Marram grassland (FMG) ~ 11%
- Grassland (GSL) ~ 4%
- Bracken fern (FPF) ~ 13%
- Agricultural (FAG) ~ 43%
- *Xanthorrhoea arenaria* & X. *bracteata*, *Acacia ulicifolia* ~ 4%.

2.6 Aboriginal heritage

There are no known Aboriginal sites within the site boundaries[5]. However, if suspected Aboriginal relics are uncovered during the pipeline installation, work in the immediate vicinity will cease and the Aboriginal Heritage Office will be contacted for advice.

[2] Davies, JL ed (1965) *Atlas of Tasmania*. Lands and Surveys Department, Hobart.
[3] Pinkard, GJ (1980) *Land Systems of Tasmania Region 4*, Tasmanian Department of Agriculture.
[4] GHD Plan 3116482 of 23/08/05, and shown in Atteris Pty Ltd (December 2005) *Gunns Limited Bell Bay Pulp Mill Project Ocean Outfall Conceptual Engineering Study*. Report prepared for Gunns Limited.
[5] See Stone, T. and Stanton, S. (December 2005) *An Aboriginal site survey for the proposed Gunns pulpmill, effluent and water supply pipeline routes and temporary accommodation camp near George Town, northern Tasmania.* Report prepared for Gunns Limited.

2.7 Sensitivity to disturbance

Coastal dune sands are sensitive to disturbance. They are particularly prone to wind erosion following the removal of their binding cover, regardless of whether they have a surface cover of marram grass, coastal scrub or sown pastures.

The swale areas may be less sensitive than the dune areas to wind erosion because of their protected nature and the presence of organic matter binding the soil.

3. Dune crossing methodology

The installation of the pipeline will be undertaken by a pipeline contractor under a design and construct contract with Gunns. At this stage, Atteris Pty Ltd has undertaken conceptual planning of the dune crossing for Gunns, provided as a separate report[6]. The Atteris report provides a description of expected construction methodology.

The pipeline will be buried to a minimum depth of 750 mm of cover. The pipe will have an internal diameter of 900 mm and, subject to the external wall thickness, an external diameter of approximately 1.2 m.

The pipeline installation will involve a combination of open trenching and tunnelling.

Horizontal direct drilling (HDD) is an alternative installation method that has previously been used in the nearby area for the Tasmanian Natural Gas Pipeline and Basslink. HDD ostensibly would be less disturbing to the environment than trenching. However, as described in the Atteris report, HDD is not a practical option through the dunes because geological conditions pose an extremely high risk of failure for such a large diameter borehole, and the distance the drive area would need to be located back from the shoreline to avoid the sensitive dune system (approximately 650 m) would be problematic with such a large pipe. The gas pipeline hole diameter was much smaller than is required for the Gunns pipeline, and the Basslink hole even more so. The fact that those projects successfully used HDD has little relevance to the Gunns pipeline. Furthermore, the likelihood and hence environmental impacts of an HDD blowout during construction are considered to be significant because of the high pressures involved and the relatively thin cover of unconsolidated sediments. A blowout would release drilling muds under high pressure, which could spray widely, smothering vegetation and making revegetation and rehabilitation problematic.

A pipeline stringing and launching area will be established on agricultural pasture inland from the dune system. In this area, sections of pipe 200 to

[6] Atteris Pty Ltd (December 2005) *Gunns Limited Bell Bay Pulp Mill Project Ocean Outfall Conceptual Engineering Study*. Report prepared for Gunns Limited.

250 m long will be stored before being sequentially welded together as the pipeline is progressively pulled out to sea.

To facilitate the pull out, high areas on the pipeline alignment will be excavated and low areas will be traversed with temporary tower supports. The stringing excavations will be used as part of the final trench for the pipeline burial, and the tower supports will be removed when the pipeline is lowered into its trench.

The pipeline will approach the stringing and launching area from the mill side in an excavated trench, which will be 2 m wide at its base. The pipeline will leave the stringing and launching area towards the dune system in a similar excavated trench for a short distance prior to entering a 1.5 to 1.8 m diameter bored tunnel underneath the section of the hind dunes that is dominated by *Xanthorrhoea arenaria and X. bracteata*. The depth of this tunnel will need to be sufficient to avoid damage to the deeper root systems of the *Xanthorrhoea arenaria/ bracteata* and alteration to the local drainage patterns. Tunnelling will avoid impact on this sensitive vegetation. The tunnel through this dune will be approximately 50 m long.

Tunnel creation would be by pipe jacking, whereby specially made casing pipes are hydraulically pushed through the sand from one side of the dune to the other. Entry and exit pits would need to be dug at each end. Spoil is removed from the casing pipe, allowing the effluent pipeline to be laid inside it.

On the seaward side of the hind dune, the pipeline will again be laid in an excavated trench that runs through bracken fern, coastal heathland and grassland. There is also a small area of *Melaleuca ericifolia* that will be impacted upon.

The pipeline will need to maintain a relatively constant grade as it passes under the dune system, meaning that it will lie at varying depths below the ground surface depending on the relative height of the dunes. In the Atteris conceptual design, the pipeline depths (depth of base of trench/tunnel) below ground surface vary between 1.9 m and 4.7 m. As described in a separate geomorphological report[7], because of the possibility of coastal retreat due to climate change, we consider that the pipeline will need to be trenched from the back of the beach inland to the 25 m mark with the top of the pipe at least 2 m below the surface horizon of the weathered basalt underlying the sand dunes and then it should be allowed to rise to no closer than 0.5 m below that horizon by the 42 m mark. At the toe of the foredunes, the pipe will therefore have at least 2 m of cover.

Different trenching methods will be used for different trench depths and different situations.

[7] Pitt & Sherry (August 2005) *Geomorphological assessment – effluent pipeline shoreline crossing*. Report prepared for Gunns Limited.

The simplest form of trenching is an open trench with walls laid back on a 1 in 2 batter for 4 m either side of the trench. This form of trenching is only practical for trench depths less than 2 m. The total trench width would be 10 m. The excavator would work along one side of the trench and excavated material would be temporarily stored alongside the trench prior to backfilling. This working and storage area would typically be 7 to 10 m wide. The total width of disturbance would therefore be up to 20 to 25 m wide.

An alternative form of trenching is a trench with vertically shored sides. This form of trenching is suited to deeper trenches (1.0 to 3.5 m deep) in tighter or more sensitive areas. The excavator would work along one side of the trench and store excavated material in stockpiles on the other side. The total width of disturbed area would be up to approximately 15 to 20 m wide.

For trench depths greater than 4 m, a second level of shoring could be used to achieve the extra depth while not increasing the width of the disturbed area. Alternatively, in less sensitive areas, trenching deeper than 4 m could be achieved by the excavator first benching in to 1 m deep with a sloping side trench and then digging a shored trench for the remainder of the depth. The total width of the disturbed area would be approximately 20 to 25 m.

The total area of disturbance for the dune crossing will be determined by a combination of the trenching methodology, the need for temporary stockpiles of excavated material prior to backfilling and the requirements for a pipe stringing and launching area, with amenities and vehicular parking. A site boundary will be delineated to control the maximum extent of disturbance. The conceptual design site boundary is shown in the Atteris report[8].

4. Potential impact of effluent pipeline construction

The impacts of pipeline construction will depend on a number of factors including the route, method of construction, depth to which the pipeline is laid, location of storage and working areas, the time of construction (where in the seasonal cycle) and the length of time that construction takes.

Potentially:

- Any alterations to existing processes operating on the coastline are likely to have some impact in the vicinity of the crossing and, possibly, elsewhere.
- Activities that result in disturbance of unconsolidated or semi-consolidated materials may have localised, as well as more widespread, effects. In particular, removal of vegetation will increase the potential for, and occurrence of, wind erosion on these materials.

[8] Atteris Pty Ltd (December 2005) *Gunns Limited Bell Bay Pulp Mill Project Ocean Outfall Conceptual Engineering Study*. Report prepared for Gunns Limited.

- Activities that change the existing groundwater conditions may result in localised saline groundwater intrusion into the coastal groundwater.
- Activities that disturb the ground, as well as the importation of soil and other materials, may lead to the introduction and subsequent spread of weeds and pathogens such as *Phytophthora cinnamomi*.

4.1 Dunes

There will be a significant short term impact on the dunes, particularly the foredune, within the crossing site's boundaries as a result of construction activities.

Trenching through the dunes will require the removal of vegetation and the disturbance of unconsolidated and semi-consolidated sediments over a width of up to approximately 25 m. Removal of vegetation will increase the potential for wind erosion in the area of the construction activities.

Temporary storage of excavated material prior to backfilling will temporarily smother vegetation until the material is removed for backfilling. Areas of low vegetation, such as marram grass or pasture, will be preferentially used for stockpile locations. Marram grass, in particular, should recover quickly from the smothering and should not be significantly impacted. Pasture is likely to be more impacted by smothering but it should retain its binding properties until and while new shoots push through the residual covering of sand.

Stockpiling of the soil component of excavated materials will also result in alteration to the structure of these skeletal soils, making them more prone to erosion.

Any large cut through the dunes will temporarily change wind flow patterns across the dune surface in the area of the cut and result in the funnelling of wind through the gap produced by the cut. As a result, the sides of any such cut will be exposed to significant wind erosion.

Enhanced wind erosion potential caused by removal of vegetation, excavation of deep cuts across the dunes and the establishment of temporary sand storage piles could result in the development of significant transgressive or blow out dunes. The occurrence of these features, which already exist on a large scale in nearby areas, could potentially be intensified by construction activities in these dune fields.

The extent and significance of these risks will be dependent on the depth to which it is necessary to excavate, the length of time that it is necessary to keep excavations open and the weather conditions prevailing over the construction period.

Wherever possible, the trench opening and backfilling will be progressive so that long sections of trench are not open at any one time. This will minimise and localise risk areas and make precautionary measures more focussed and therefore effective. However, it is recognised that construction methodologies

such as pipe stringing may significantly reduce the possibility of progressive trench opening and backfilling.

The inland movement of disturbed sand as a result of wind action is potentially the most significant environmental problem in the coastal zone associated with the works. Accordingly, all construction activities in this sensitive zone will involve:

- Minimum practicable disturbance of unconsolidated and semi-consolidated sands.
- Undertaking appropriate measures to control the movement of any disturbed materials.
- Stabilisation of areas of disturbed sand as soon as practicable; this will involve temporary stabilisation of such areas pending completion of construction activities and final stabilisation.
- Rehabilitation of disturbed areas as soon as practicable after stabilisation.

In the longer term, there will be similar risks of erosion and blow outs until revegetation has stabilised the dune surface.

4.2 Swales

Construction activities in the swale areas are considered to be of lower risk than in the elevated dune areas as swales are less exposed to the direct effects of prevailing winds. In addition, the presence of organic matter within the sands in these areas makes them less prone to wind erosion.

Trenching in these areas will require dewatering, which will result in a lowering of the water table during construction.

If trench development across the beach and initial foredune area allowed sea water to flow into the swale area behind the foredune, this would in turn allow the intrusion of saline water into, and displacement of, the existing fresh groundwater system in the coastal area. Such an intrusion could have an adverse impact on existing vegetation in the area.

4.3 Agricultural land

Cleared agricultural land behind the dune system will be used for the pipeline stringing and launching area, and for site amenities and parking. These areas will need to be hardstand, using imported gravel. Importing gravel could potentially introduce weeds and/or *Phytophthora cinnamomi*.

Creating the hardstand will temporarily remove pasture grasses from this area.

4.4 Impact mitigation

Potential impacts of pipeline construction will be reduced by:

- Using environmental protection measures, such as wind fences and geotextile ground covers, for all significant areas of disturbance.
- Using appropriate methods such as pipe jacking in particularly sensitive areas of the onshore dune crossing.
- Minimising the size of trench excavations required through the use of shields and shoring.
- Managing groundwater through the use of construction sequencing, water table lowering (eg. groundwater spears) and undertaking construction works in sensitive areas during the summer period when the groundwater level is naturally lower.
- Identifying any areas where lowering of the groundwater table may impact on specific vegetation and identifying appropriate management measures to be undertaken.
- Establishing appropriate management plans to deal with risks, particularly incidents such as hydrocarbon spills, which may compromise the revegetation process.
- Establishing a fire (including wildfire) management plan for the construction area and adjoining areas.
- Preparing a site hygiene plan that will establish protocols in order to minimise the risk of introduction of weeds and *Phytopthora cinnamomi*.
- Obtaining gravel for hardstand areas from a source known to be weed and *Phytopthora cinnamomi* free, and removing and storing topsoil prior to gravel laying, for later rehabilitation reuse.
- Initiating all appropriate rehabilitation measures within the shortest possible time frame.

5. Remediation and revegetation of effluent pipeline route

The installation methods chosen will have a considerable bearing on the remediation and revegetation requirements along this section of the project. Detailed planning of remediation and revegetation will need to be prepared as part of the detailed engineering design. At this conceptual design stage, key principles and requirements can be identified.

The ideal construction time for the pipeline dune crossing will be during late summer or early autumn, when groundwater levels will be lower and winds less intense, although with appropriate protective measures construction at other times of the year would also be possible.

There is no in principle reason why artificial erosion protection measures could not meet or better that provided by the natural vegetation, and if appropriate protective measures are implemented the environmental impacts should not spread beyond the immediate area of disturbance, regardless of the time of year construction occurs.

Gunns will require its construction contractor to demonstrate adequate planning, commitment and preparation to ensure that this outcome is achieved.

Remediation and revegetation will be an ongoing process that will start with detailed planning prior to construction and will continue through the construction and post-construction periods.

The remediation and revegetation measures required to address disturbance associated with the proposed construction activities in this sensitive risk area are likely to be considerable and are also likely to be long term. As a result, they will have a longer term component to allow for both the success of the rehabilitation process to be assessed and also to ensure that any problems that might arise can be addressed on an ongoing basis.

Dune remediation and revegetation will be governed by a Construction Environmental Management Plan (CEMP) that will be prepared by the pipeline contractor in accordance with the principles and requirements described in the current document and in accordance with any conditions that might be imposed through the project approval process. It is anticipated that any such approval conditions would include a requirement that the CEMP be prepared to the satisfaction of relevant authorities, in particular the Department of Primary Industries, Water & Environment.

5.1 Construction Environmental Management Plan

Prior to the commencement of trench construction and pipeline installation Gunns will require its pipeline contractor to develop a CEMP for the dune crossing. This plan will address all environmental management measures to be undertaken prior to construction, during construction and after completion of the work. It will also contain details of how the success of the rehabilitation measures will be assessed and how any post-construction problems that may arise will be addressed.

The CEMP will include subsidiary plans for construction management, remediation and revegetation, and an integrated weed and *Phytophthora cinnamomi* management plan.

5.1.1 Construction management

The CEMP will ensure that construction activities are organised so as to minimise impacts and hence reduce the amount of post-construction remediation that will be necessary. An integral part of this management plan will be the identification of the hygiene controls that will be applied to control the introduction and spread of weeds and *Phytophthora cinnamomi*.

Perimeter firebreaks and traps for water borne and aeolian sediment will be established prior to the commencement of large scale clearance of the vegetation along the pipeline route.

Rehabilitation measures will be commenced during the construction process and will include short term measures to prevent erosion during construction and initial rehabilitation in areas where construction has been completed.

The area cleared for pipeline installation will be kept to the minimum practicable level. The main work site, the stringing and launching area, will be located behind the dunes, on cleared agricultural land. Access to the dune system will be restricted and kept to the minimum necessary.

In order to minimise impacts the clearing of vegetation will be kept to the absolute minimum required to undertake the construction activities and will be staged so that large bare areas are not left exposed for extended periods of time. This will be achieved by only clearing required areas as needed, not clearing the whole site before commencement of construction, and by undertaking progressive rehabilitation of the construction site wherever possible.

All excavations will be appropriately stabilised and any bare areas will be temporarily stabilised with appropriate surface fabrics pending final stabilisation after construction.

Hessian or synthetic mesh type wind fencing will be used to reduce the potential for wind erosion. This fencing will collect any sand that is mobilised and prevent its movement over the wider area.

Excavated material stockpiles will be covered with biodegradable or geosynthetic textiles after excavation and prior to replacement in the excavated trench to ensure that this material does not become subject to wind erosion. The nature and extent of any surface cover required will be dependent on the timing of completion of construction as there may be a time lag between the completion of construction activities and the optimal time for establishment of a grass cover.

All drainage off hardstand areas will be collected and appropriately diverted to prevent any surface erosion. Silt-stop fencing will be used to control any surface runoff from the disturbed areas and to prevent runoff from adjoining areas washing across and eroding out the rehabilitated areas. Installation of silt-stop fencing will be undertaken in accordance with best practice guidelines to minimize any potential for downstream scour.

Fencing to exclude both stock and other browsing animals will be installed along the margins of all disturbed areas to prevent access by these animals until revegetation is complete and mature. The desirability of attempting to exclude burrowing animals in critical areas will be assessed.

Wherever feasible, excavation, pipeline laying and trench refilling will be integrated to minimise the period of time that any particular area is exposed and rehabilitation measures implemented concurrently with the construction process. During the process of trench infill, compaction rates will be carefully controlled to ensure that the properties of the infilled area match those of the surrounding areas as closely as possible.

These measures will ensure that the amount of remediation required on the completion of construction activities is kept to the minimum practicable level and will facilitate the rehabilitation process.

5.1.2 Remediation and revegetation

The aim of the remediation and revegetation plan will be to match the revegetation re-established in disturbed areas to the existing vegetation, whilst recognising the priority need for rapid stabilisation of the site. The plan will take into account variations in local environmental factors, such as variations in soil types and drainage characteristics, as well as variations amongst the different vegetation communities of the area.

The primary aim of rehabilitation in the short term will be to return the disturbed areas to their initial shape, stabilise these areas to prevent erosion and also to prevent invasion of the rehabilitated areas by weeds. Short-term rehabilitation will involve the use of biodegradable fabrics to protect surfaces from wind and water erosion and the rapid establishment of a grass cover over all disturbed areas pending the re-establishment of larger plants and woody vegetation in those areas not currently given over to improved pasture. Only sterile annual grasses will be used to provide a temporary grass cover over these surfaces. Sterile perennial grasses will not be used for this purpose.

The aim of long-term rehabilitation will be to re-establish the pre-existing vegetation cover in the various areas that have been disturbed by pipeline construction activities. The extent of long-term rehabilitation measures required will vary over the site, depending on the type of original vegetation cover and the time required for its re-establishment.

Backfilling of the trenches will to all practical extents reproduce the original sand dune profiles. Exact replication will not be possible but a general replication will be achievable. Particular care will be taken to provide the disturbed areas with a similar aerodynamic profile to the original and to not introduce topographical features that would create localised wind eddies or funnelling, which could trigger blowouts.

Rehabilitation of disturbed areas will be undertaken progressively during the construction phase, wherever practicable. Following completion of pipeline

installation all remaining areas will be rehabilitated. A variety of rehabilitation measures will be adopted to reduce any potential for wind scouring of cleared surfaces before they have become revegetated. These measures will be specific to the individual needs of the different areas and also to the time at which rehabilitation is undertaken.

All cleared areas on the dune system will be planted with sterile annual grasses to achieve a rapid cover. Planting with appropriate native vegetation, including native sandbinding grasses, will follow in all areas to be returned to a native vegetation cover, the grass gradually being replaced by the native species.

Areas that currently have a marram grass cover will be replanted with marram grass. Although marram grass is an introduced species, the planting of which is now being discouraged, marram is nevertheless an integral part of the existing ecosystem at this site and an arbitrary exclusion of marram from the pipeline route rehabilitation would be both inconsistent with the surrounding vegetation community and ineffectual because marram is likely to reinvade the route anyway.

Biodegradable fabrics will be used to temporarily stabilise the bare areas over the period of time that it takes for the sterile annual grasses, marram grass and native sand binding grasses to establish a suitable surface cover.

Sterile annual grass planting will facilitate rapid recolonisation of cleared areas by vegetation. The native species will be progressively planted amongst the grass to initiate a succession of species that will return the disturbed areas to a community form and structure that matches adjoining areas. It is likely that this will take several years.

During this period, the mesh-type fencing, erected during the construction period to reduce the potential for wind scouring, will be maintained on the site. Maintenance of this fencing will assist the establishment of the grass and native vegetation cover by providing localised wind protection.

Gravel will be removed from hardstand areas and replaced with the stockpiled topsoil, which will be resown with a grass mix commensurate with the surrounding pasture.

Site specific remediation measures will be required for all disturbed areas across the dunes and swales, including all pipeline trench excavations and all construction sites. The extent of remediation measures required will vary from locality to locality, depending on the activities undertaken in the particular area.

The order of priorities in the remediation process for the disturbed dune and swale areas will be as follows.

Priority 1: Reshape the contours in the disturbed areas to restore them, as nearly as practicable, to their original shape and stabilise the reshaped areas so that the revegetation process will not be compromised by erosion of the newly established surface.

Priority 2: Establish a grass cover over all disturbed areas; pasture grasses in agricultural areas and pasture grasses and/or sterile annual grasses in other areas.

Priority 3: Establish a cover of native sandbinding grasses and larger plants and woody vegetation in areas that currently have this type of cover and improved pasture in areas that are currently used for grazing.

Priority 4: Assess the long term success of the remediation process and address any areas where remediation has not been as successful as anticipated.

The revegetation measures to be undertaken in the various vegetation zones, together with the long term aims of rehabilitation, are summarised in Table 1 and discussed below.

Vegetation type	Initial rehabilitation measures	Aim of long term rehabilitation
Coastal scrub	Replant with sterile annual grasses; protect areas between plants with a biodegradable fabric	Re-establishment of coastal scrub
Melaleuca ericifolia	Replant with sterile annual grasses; protect areas between plants with a biodegradable fabric	Re-establishment of *Melaleuca ericifolia*
Grassland	Replant with a mixture of sterile annual grasses and native grasses	Re-establishment of the native grassland
Marram grassland	Replant with sterile annual grasses; protect areas between plants with a biodegradable fabric	Re-establishment of a marram grassland cover
Agricultural land and grassland	Seed with an appropriate pasture grass mixture	Re-establishment of an appropriate pasture cover
Bracken fern	Seed with an appropriate pasture grass mixture	Re-establishment of appropriate pasture cover
Xanthorrhoea arenaria/X. bracteata	Area not disturbed; no rehabilitation required	N/A

Table 1: Rehabilitation measures to be undertaken in the various vegetation zones.

Coastal scrub: Areas dominated by coastal scrub will be replanted with sterile annual grasses and native sandbinding grasses. Re-establishment of coastal scrub in these areas will be allowed to occur naturally over time, with no specific measures being undertaken to re-establish the coastal scrub in these areas. Any applications of fertiliser in these areas to be returned to coastal scrub will be strictly in accordance with the approved CEMP.

Areas dominated by Melaleuca ericifolia: Areas dominated by *Melaleuca ericifolia* will be replanted with sterile annual grasses and native sandbinding grasses in the short term. In the longer term, a program of replanting will assist re-establishment of *Melaleuca ericifolia* vegetation in these areas. Any

applications of fertiliser in these areas to be returned to *Melaleuca ericifolia* vegetation will be strictly in accordance with the approved CEMP.

Grassland: Areas dominated by native grassland will be replanted with a mixture of sterile annual grasses and native grasses consistent with the surrounding grassland. Any applications of fertiliser in these areas to be returned to grassland will be strictly in accordance with the approved CEMP.

Marram grassland: Existing marram grassland areas will be replanted with sterile annual grasses and native sandbinding grasses, unless otherwise advised by DPIWE. Any applications of fertiliser in these areas to be returned to marram grass vegetation will be strictly in accordance with the recommendations of the approved CEMP.

Agricultural land and grassland: Areas currently dominated by grassland will be resown with pasture grasses consistent with the adjoining agricultural areas. Fertilisation of the re-established pasture will be consistent with the current farm practices. Care will be taken to ensure that in spreading fertiliser over the re-established pasture it is not spread into adjoining vegetation areas that may have different fertiliser requirements. Pasture consistent with the existing pasture cover will be re-established in all disturbed areas of agricultural land. The aim will be to return these areas back to improved pasture as quickly as possible to minimise any long-term impacts on farming practices.

Areas dominated by bracken fern: Areas currently dominated by bracken fern will be resown with pasture grasses consistent with the adjoining agricultural areas. Fertilisation of the re-established pasture will be consistent with the current farming practices. Care will be taken to ensure that in spreading fertiliser over the re-established pasture it is not spread into adjoining vegetation areas.

Areas dominated by Xanthorrhea arenaria/X. bracteata: These areas will not be affected by effluent pipeline construction as it is proposed to undertake an auger bore beneath the area. Consequently, this area will not require any rehabilitation measures.

5.1.3 Weed and *Phytophthora cinnamomi* management

An integral requirement of both the construction phase and the rehabilitation process will be to ensure that weeds do not invade and take over the newly revegetated areas. In order to achieve this weeds identified in the vegetation assessment of the site will be targeted. Treatment of these weeds will be in accordance with the appropriate Weed Management Plans, developed in accordance with the *Weed Management Act 1999*, and the DPIWE weed Service Sheets.

An additional integral requirement of both phases will be to ensure that *Phytophthora cinnamomi* is not introduced to or spread within the area. In order to achieve this, management procedures will be developed in accordance with the DPIWE Interim *Phytophthora cinnamomi Management Guidelines*.

An integrated weed and *Phytophthora cinnamomi* management plan will be prepared that identifies protocols required during both the construction and rehabilitation phases to ensure that weed species and/or *Phytophthora cinnamomi* are not imported into the site with introduced materials or on construction equipment, particularly tracked machinery.

5.1.4 Rehabilitation Assessment

An integral component of the rehabilitation and revegetation program will be an assessment program. This component will be required to establish:

- The criteria against which the success of rehabilitation can be conveniently measured.
- The measures to be undertaken in the event that initial revegetation efforts are unsuccessful in any particular areas.

This rehabilitation assessment program will ensure the long term success of the remediation and rehabilitation process.