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APPLICATION OF VEGETATION DIRECT TRANSFER IN REHABILITATION AT ARROWSMITH

Introduction

VRX Silica are proposing to mine silica sands (the Proposal) at Arrowsmith, Western Australia. This memo relates to the application of Vegetation Direct Transfer (VDT) to the rehabilitation practices at Arrowsmith.

Challenges of the Proposal

The rehabilitation of the Arrowsmith Silica Sands Proposal presents challenges relating to two key areas:

- The vegetation of the project area is identified as Kwongan Heath, which represents a high botanical diversity;
- The Kwongan heath is comprised of many recalcitrant species, especially in the familiesRestionaceae, Cyperaceae, Dilleniaceae and Ericaceae. Many of these species rely on regrowth from underground organs rather than seed and are difficult to propagate.

Background to VDT

The rehabilitation technique of VDT, or community translocation, is the practice of salvaging and replacing intact sods of vegetation with the underlying soil intact (Ross *et al.*, 2000). The dimensions of the sods are determined by economics, practicality and the morphology of the target rehabilitation species but should include soil to maximum depth of 400mm. For the Arrowsmith project, it is proposed that VDT will be carried out to a depth of 400mm to maintain the root structure of key recalcitrant species.

The VDT rehabilitation method has been successfully implemented by Iluka Resources Pty Ltd (Iluka) on 2.5 ha of Palusplain vegetation at the Tutunup South Mineral Sands Project in the South West region of Western Australia in 2010. More recently, Iluka has successfully established 1.6 ha of Kwongan heath at the Eneabba Mineral Sands Project in the Mid West Region of Western Australia in 2012.

The use of this technique by Iluka in the former Jennings mining area aims to improve the establishment of largely recalcitrant sedge and rush species, which tend to be less well represented in rehabilitation via other techniques, due to their low or complete lack of seed production (Norman and Koch 2007), but which often dominate local heath communities. The use of deep profile direct return of the topsoil and overburden in one pass may provide a large scale method of translocating rhizomatous and tuberous species in rehabilitated areas (Norman and Koch 2007).

Key Findings from VDT trials at Eneabba

The following key findings were observed on the VDT trials:

- A total of 130 vascular plant taxa which are representative of 66 plant genera and 28 plant families were recorded within the 16 trial Vegetation Direct Transfer transects in 2019. Of the 130 taxa recorded, five were introduced species.

- Note - Many of the species would overlap with the North Arrowsmith and Central Arrowsmith areas as proposed by VRX Silica.

- The mean alive native foliage cover has markedly increased within all four treatments, with all of the treatments seeing an increase of over double the mean alive native foliage cover recorded during the 2019 monitoring.
    - Note – this outcome is to be expected with the growth of plants over time.

- Total species richness excluding introduced species decreased within all four treatments since the 2015 monitoring. This is most likely due to a reduction in annual species seen in 2019 compared to 2015. A reduction in annual species in this year's survey can be attributed to reduced rainfall and increased temperatures in the three months preceding the survey. Total species richness including introduced species also decreased within all four treatments for the same reasons.
    - Note – this outcome reflects seasonal conditions, rather than a longer term trend.

- The proportion of alive plants by growth form has varied throughout the survey years. In the 2019 monitoring the proportion of perennial herbs and shrubs had increased compared to previous years, while annual grasses and annual herbs have decreased in the current survey compared to previous years. This difference is largely due to the decrease in density of annual herbs such as *Gnephosis tenuissima* and *Levenhookia* spp. These species were recorded last year in wetter areas between the translocated sods of vegetation, where micro-habitats had been created due to the excessive water content within the soil.
    - Note – this outcome reflects seasonal conditions, rather than a longer term trend. It also reflects the drainage and soil return planning used for the VDT trial which differs from the current best practice methods.

- Between 2012 and 2014 within all four treatments there was a noticeable increase in the proportions of alive seeder species and a reduction in the proportions of alive resprouter species. However, the 2015 and 2019 surveys have seen an increasing trend within all four treatments, in the proportions of alive resprouter species, with a concurrent reduction in the proportions of alive seeder species. This is encouraging given that recalcitrant (cannot be propagated easily from seed or vegetatively) resprouter species from the families *Cyperaceae* and *Restionaceae* have often been absent in past rehabilitated areas using standard rehabilitation techniques to the Vegetation Direct Transfer trial.
    - Note – this outcome is encouraging for the Arrowsmith projects.

- A few notable anecdotal observations were recorded during monitoring in 2019. There were generally high numbers of resprouting plants and additional regeneration across the majority of the Vegetation Direct Transfer trial area. There was an overall increase in foliage cover, shrubs were observed to be resprouting, and in particular, *Adenanthos cygnorum* was noticeably larger than previous monitoring years. The continual presence of the tuberous species such as *Haemodorum* and *Thysanotus* was also observed. Furthermore, an increase in shrub growth and soil-binding sedges and rushes has resulted in an increase in soil stabilisation, and a reduction in water and wind driven soil erosion which was observed in previous monitoring years. It appears from quantitative results and anecdotal observations that there is a good level of regeneration of rush and sedge species, in addition to the large increase in foliage cover for shrub species.
    - Note – this outcome is encouraging for the Arrowsmith projects.

Advantages and Disadvantages of VDT

There are a number of advantages and disadvantages of applying the VDT rehabilitation method.

Advantages of VDT

- Rootstock mostly preserved allowing re-sprouting species survival (many recalcitrant)
- Seed bank preserved
- Soil microbiology preserved
- Soil compaction absent

- Soil structure preserved
- Surface stability achieved
- A large number of plant species, particularly recalcitrant species of the Kwongan heath, have roots in the upper soil layer (0 to 30cm).

Disadvantages of VDT

- Preservation of dominant deep rooted or large rooted species i.e. *Banksia, Xylomelum, Eucalyptus* and *Macrozamia* has not been demonstrated as part of the Iluka VDT trials as the Eneabba VDT material was taken from 1980's stockpiled material, translocation of these species is not physically practical or economically viable;
- Rehabilitation using VDT has not been proven for sites greater than 2.5 ha in Western Australia; and
- The VDT process will be restricted in some areas as the larger rooted plants may impede machinery scrapping the soil surface and as such will either have to be avoided during the stripping process or other considerations will need to be made for these species.

The application of the findings from the VDT trials highlight the constraints of applying this methodology to wider scale applications. Whilst the range of larger root system species are less at Arrowsmith North than Arrowsmith Central, these species present a potential physical barrier to the application of VDT, however it is not anticipated to be significant.

To overcome some of the issues it may be necessary to supplement proposed rehabilitation techniques with the following:

- Direct Stripping and spreading of topsoil and overburden from areas where VDT is not possible to supplement rehabilitation and encourage regrowth of native species.
- Avoid stockpiling topsoil and overburden wherever possible to avoid loss of plants through burying of seed and propagules below soil surface and upper surface.
- Collecting seed of native species prior to mining, mulching and ground disturbance activities wherever possible.
- Supplementary infill planting of native species using seed and tube stock.
- Patch planting of selected species that are difficult to establish from seed or the VDT approach, e.g. *Banksia, Xylomelum, Eucalyptus* and *Macrozamia* species.

Mattiske Consulting Pty Ltd
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