INTERIM RECOVERY PLAN 154

Ferricrete floristic community (Rocky Springs type)

Interim Recovery Plan

2004-2009

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Photograph: Sheila Hamilton-Brown

July 2004

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Government of Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
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FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos. 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

CALM is committed to ensuring that Endangered, and where appropriate and feasible, other threatened ecological communities are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by the Minister.

This Interim Recovery Plan will operate from July 2004 to June 2009 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Endangered, this IRP will be reviewed after five years and the need for a full Recovery Plan assessed.

This IRP was given regional approval on 9 July, 2004 and was approved by the Director of Nature Conservation on 29 September, 2004. The allocation of staff time and provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting CALM, as well as the need to address other priorities.

Information in this IRP was accurate at July 2004.

ACKNOWLEDGMENTS

The following people provided valuable advice and assistance in the preparation of this IRP:

John Blyth	Acting Manager, CALM's WA Threatened Species and Communities Unit (WATSCU)
Rebecca Carter	Nature Conservation Coordinator, CALM's Moora District
Sharon D'Elboux	Former Community Landcare Coordinator, Shire of Three Springs
Val English	Acting Senior Ecologist, WATSCU
Robert Gomer	Volunteer, Perth
Angas Hopkins	Project Leader Biodiversity Conservation Strategy, CALM, Crawley
Greg Keighery	Principal Research Scientist, CALM's Science Division
Lorraine Leuba	Volunteer, Perth
Robyn Luu	Project Officer, WATSCU
Doug Sawkins	Agriculture Western Australia, Narrogin
Noel Schoknecht	Research Scientist, Agriculture Western Australia, South Perth
Peter Spalding	Rehabilitation Adviser, Iluka Resources Ltd., Eneabba
Russel Speed	Senior Hydrogeologist, Agriculture WA, Geraldton
Allan Tinker	Western Flora Caravan Park, Eneabba
Greg Woodman	Principal, Woodman Environmental Consulting Pty. Ltd

SUMMARY

Name: Ferricrete floristic community (Rocky Springs type).

Description: This tall shrubland is located on irregularly inundated red brown sandy loams over ferricrete dominated by *Acacia blakelyi, Allocasuarina campestris, Dryandra stricta* and *Labichea lanceolata* subsp. *lanceolata*. Associated species include *Alyogyne hakeifolia, Borya sphaerocephala, Isotoma hypocrateriformis, Petrophile seminuda, Stylidium dichotomum, Thysanotus patersonii* and *Waitzia paniculata*.

IBRA Bioregion: Geraldton Sandplains

CALM Region/District: Midwest Region/Moora District

Local Government Authorities: Shires of Carnamah and Three Springs

Recovery Team: Moora District Threatened Flora Recovery Team

Current status: This community was assessed by the Western Australia Threatened Ecological Communities Scientific Committee (TECSC) on 18 September 2000 as Vulnerable, and this ranking was endorsed by the Western Australian Minister for the Environment on 6 November 2001. The TECSC reassessed the community as Endangered on 15 February 2002, following further survey that confirmed the absence of the community from other potential habitat.

Habitat requirements: The floral composition of the Ferricrete community is assumed to be a response to soil/substrate types and depths. The community only occurs on infrequently inundated red and brown sandy loams over ferricrete soils, and the ferricrete substrate is extremely restricted in distribution in the Eneabba region. To date only 20 other ferricrete soil-landscape units have been identified within an area of approximately 750,000 ha and the vegetation on a number of these has been completely destroyed. Ferricrete is a mineral formed in the soil profile at the water-table when iron-oxides accumulate and cement together to form a gravely or nodule-rich band. Transport and deposition of iron is controlled by fluctuations of the groundwater level and the community is dependent on the presence of the ferricrete substratum, the aquifer providing the conditions for the formation and maintenance of the ferricrete substratum, and the local catchment for the surface waters that provide the inundation of these communities.

Critical habitat: The area of occupancy of the known occurrences corresponding to the red and brown sandy loams over ferricrete, the aquifer providing the conditions for the formation and maintenance of the ferricrete substratum, and the local catchment for the surface waters that inundate these areas.

Habitat critical to the survival of the community and important occurrences: Given that the Ferricrete floristic community (Rocky Springs type) is listed as Endangered and only two occurrences are known, all known habitat for the community is considered critical habitat and both occurrences are important.

Benefits to other species/ecological communities: There are several Priority species within the Threatened Ecological Community (TEC) including *Verticordia amphigia* and *Dryandra stricta*, (both Priority 3) *Homalocalyx chapmanii* (Priority 1) and *Thryptomene johnsonii* (Priority 2) all of which will benefit from the implementation of recovery actions outlined in this interim recovery plan. Recovery actions specific to occurrence 2 may also have major benefits for two occurrences of the endangered ecological community 'Organic Mound Springs (Three Springs area)' that occur on the same land parcel.

International obligations: This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that convention. The Ferricrete floristic community (Rocky Springs type) is not listed under any specific international treaty, however, and therefore this IRP does not affect Australia's obligations under any other international agreements.

Role and interest of indigenous peoples: There are no known Indigenous communities associated or involved in the management of areas affected by this plan. A search of the Department of Indigenous Affairs Aboriginal Heritage Sites Register indicated that there are no listed Aboriginal Heritage Sites in the area of this ecological community. Input and involvement will be sought from any Indigenous groups that have an active interest in the areas covered by the community, and this is discussed in the recovery actions.

Social and economic impacts: Parties affected by this plan include CALM's Moora District and Midwest Region, Iluka Resources Limited, Shire of Three Springs, and managers of land adjacent to occurrences. There are not likely to be any adverse social or economic impacts to any of these parties as a consequence of the implementation of this plan. The extant occurrences are found in areas designated as 'A' Class Nature Reserves and neither of the occurrences is subject to current mining leases. The Moora District, Midwest Region, Iluka Resources Limited, and the Shire of Three Springs have been informed of the importance of the TEC and their cooperation will be sought to ensure that management activities do not impact the occurrences. Specific involvement of these and any other parties in the implementation of the plan is outlined in the appropriate recovery actions.

Evaluation of the plans performance: CALM, in conjunction with the Recovery Team will evaluate the performance of this IRP. In addition to annual reporting of the Recovery Team, the plan is to be reviewed within five years of its implementation.

Guide for decision-makers: Section 1 provides details of current and possible future threats. Developments in the immediate vicinity of the occurrences require assessment. No developments should be approved unless the proponents can demonstrate that they will have no significant impact on the ecological community or on the groundwater or surface waters that maintain the wetland habitat.

Existing recovery actions: The following recovery actions have been or are currently being implemented;

1. Recovery Team has been established.
2. All known possible occurrences have been surveyed, and no further occurrences were located in surveys undertaken in additional likely habitat.
3. Environmental markers have been erected for occurrence 2.
4. The unvested Shire Camping reserve that contains occurrence 2 has been upgraded to an 'A' Class Nature Reserve.

IRP Objective(s): To maintain, and where possible improve, the overall health and condition of both occurrences of the 'Ferricrete floristic community (Rocky Springs type)' and reduce the level of threat to the community so that it does not move into a higher category of threat during the life of this plan.

Criteria for success:

- Maintenance of the diversity and composition of native species in the community as defined in Appendix 1, taking account of natural change in the community over time.
- Improvement in terms of reduction of threatening processes, including maintenance of hydrology, and minimising impact of road maintenance, fire, disease, weed levels and introduced animals, as defined in this document taking account of natural change in the community over time.

Criterion for failure:

- Significant loss of area or further modification of occurrences of the threatened ecological community as a consequence of threatening processes as listed in this document.

Summary of recovery actions for the Ferricrete floristic community (Rocky Springs type)

Action	Action
1. Coordinate recovery actions	10. Obtain biological and ecological information
2. Map critical habitat	11. Replant and rehabilitate where necessary
3. Monitor the extent and boundaries of the occurrences	12 Control introduced animals
4. Design and implement a flora monitoring program	13. Review the need for a full Recovery Plan
5. Determine the fire ecology of the community	**Recovery actions specific to occurrence1:**
6. Develop and implement a fire management strategy	14. Liaise with Iluka Resources Limited
7. Design and implement weed control strategy	**Recovery actions specific to occurrence 2:**
8. Obtain hydrological information	15. Liaise with the Shire of Three Springs
9. Monitor and manage dieback disease	16. Liaise with surrounding landholders

1. BACKGROUND

1.1. History, defining characteristics of ecological community, and conservation significance

Numerous studies have highlighted the conservation significance of the vegetation in the Mt Lesueur-Eneabba area (for example Burbidge and van Leeuwen 1990). Of the vegetation types in the area, sclerophyllous shrubland or 'kwongan' dominates, is particularly floristically rich, and is 'mainly associated with three soil types: laterite, coastal travertine limestone, and deep, leached siliceous soils' (Griffin *et al*. 1983). Each soil type contains unique kwongan assemblages (Hnatiuk and Hopkins 1981; Hopkins and Hnatiuk 1981).

Griffin *et al*. (1983) surveyed over 500,000 ha of the kwongan vegetation on laterite centred around Eneabba (31 sites). They found that two of these sites in the area known as 'Rocky Springs' were not typical laterite, and were actually ferricrete and were associated with a unique vegetation association. The Rocky Springs sites lie within the 'Rocky Springs complex' which is a combination of exposures of a ferrugineous layer (formed by groundwater enrichment) and Mesozoic sediments with varying amounts of shallow sand and gravel mantle. The vegetation of the Rocky Spring complex includes several woodland (*Eucalyptus accedens, E. wandoo, E. loxophleba, E. todtiana* and *Banksia prionotes*), shrubland (*Allocasuarina campestris, Dryandra stricta, Melaleuca acerosa, Labichea lanceolata* and *M. hamulosa*), and mallee (*Eucalyptus drummondii* and *E. eudesmioides*) communities (Griffin and Hopkins 1985). The vegetation of the Rocky Spring occurrence of the threatened ecological community (TEC), comprises tall shrubland dominated by *Acacia blakelyi, Allocasuarina campestris, Dryandra stricta* and *Labichea lanceolata* subsp. *lanceolata*.

1.2. Distribution

Historical

Ferricrete substrate is extremely restricted in distribution in the Eneabba region. To date, only 20 other ferricrete soil landscape units have been identified within an area of approximately 750,000 ha (N. Schoknecht, personal communication[1]). The vegetation on a number of these has been completely destroyed and the original assemblages that occurred on them are unknown. It is thought, however, that the TEC is naturally restricted to the ferricrete substrate and possibly only a few occurrences ever existed.

Current

There are only two known occurrences of this TEC (Table 1). Occurrence 1, the Rocky Springs site, lies within a Nature Reserve on the Eneabba Plain in the Shire of Carnamah. The occurrence is currently intact but its proximity to an adjacent sand mining operation and agricultural land increases its chances of being damaged or destroyed. The major threatening process is a disruption in the hydrological processes that maintain the occurrence as a consequence of water abstraction from the mining operation. Other threatening processes include inappropriate fire regime, dieback disease caused by the plant pathogens *Phytophthora* spp., damage by introduced animals, and weed invasion.

Occurrence 2 occurs within a reserve (recently upgraded to an 'A' class reserve) immediately adjacent to a saline creek and agricultural land just east of the edge of the Dandaragan Plateau in the Shire of Three Springs. A secondary (i.e. unsealed) gravel road runs through it and separates the occurrences into two sections (2a & 2b). Although the area has been fenced, it is subject to disturbance from road grading activities, and regular fires which may be inappropriate for the long term management of the community. In addition, the creekline is affected by secondary salinisation, and the water table is

[1] Noel Schoknecht – Research Scientist, Agriculture Western Australia, South Perth

believed to be rising in the area (S. D'Elboux, personal communication[2]). Other threatening processes include weed invasion and disease caused by *Phytophthora* spp.

Table 1: Summary of occurrence information for the Ferricrete Floristic Community

Occ.	Land Status	Estimated area (ha)	Condition	Threats
1	'A' Class Nature Reserve (South Eneabba NR 27886)	4	Very Good	Water drawdown and other mining activities, inappropriate fire regime, weed invasion, disease, and damage by introduced animals
2a	'A' Class Nature Reserve, Bunney Rd, Three Springs (reserve 12705)	6	Moderately to highly modified	Inappropriate fire regime, weed invasion, road widening activities, disease, rising water tables and salinity
2b	'A' Class Nature Reserve Bunney Rd, Three Springs (reserve 12705)	2	Slightly modified	As for 2a

1.3. Biological and ecological characteristics

The floristic composition of the ferricrete floristic community is assumed to be a response to the soil/substrate types and depths. Little is known of the biology and ecology of the community and gaining more information about this is a priority in this IRP.

Appendix 1 provides a list of species that have been recorded in occurrences.

1.4. Hydrology/Hydrogeology and Water Quality

Ferricrete is a mineral formed in the soil profile at the water-table when iron-oxides accumulate and cement together to form a gravely or nodule-rich band. Transport and deposition of iron is controlled by fluctuations in the groundwater level. Iron is soluble in, and therefore transported by, reducing acid waters and is precipitated at higher Eh (above 0.4) and/or pH (above 6) (Nielsen 2002). Recent research also indicates that the characteristics of ferricrete are likely to have been influenced by the plant community that historically occurred on these wetlands. Further, certain lateritic soils may have been partly derived from iron-rich complexes generated by roots of proteaceous plants (Pate *et al*. 2001).

Both occurrences of this Ferricrete floristic community occur in the Eneabba area which lies in the Northern Perth Basin. The underground water potential of the Perth Basin has long been recognized and water supply in the Eneabba area depends on groundwater because the surface drainage is ephemeral, flowing only in exceptionally wet periods, and is often brackish or saline (Lowry 1974).

The Yarragadee Formation is the confined aquifer that underlies occurrence 1 and the watertable of the aquifer ranges from 100-150 metres AHD with salinity less that 1000 mg/L. It is also acidic and iron-rich (Mory 1994). Groundwater is used for town water and farm supplies, and an extra 10 x 10^6 cubic metres is also abstracted annually for mineral sands processing (Mory 1994). Groundwater in the thin sandstones of the Cattamarra Coal Measures, which overlay the Yarragadee formation in this area, range from fresh (<1000 mg/L) to saline (up to 4000 mg/L) (Mory 1994). Permeable sandstone beds in the Yarragadee Formation and Cattamarra Coal Measures are lenticular (containing lens shaped soil peds or pores) and bores in these units are drilled until a suitable permeable bed is encountered (Lowry 1974). It is likely that a local superficial aquifer (probably fresh) associated with the sandy terrain around occurrence 1, would have a significant seasonal effect on the vegetation.

[2] Sharon D'Elboux – Ex-Community Landcare Coordinator, Shire of Three Springs

The Parmelia Formation is the unconfined aquifer underlying occurrence 2 with the base of the aquifer, the Otorowiri siltstones, cropping out along the Dandaragan Scarp near occurrence 2. The confined Yarragadee Formation lies below the Otorowiri siltstones in this area (Waters and Rivers Commission (WRC) 2003). The aquifer extends eastwards from here and the Department of Agriculture has identified the area of groundwater recharge as being a number of kilometres to the east of occurrence 2 near the Urella Fault, and have recently erected monitoring bores/piezometers to investigate the recharge (R. Speed, personal communication[3]). The first set of comprehensive data will be available in three years. The water-table is at an elevation of approximately 150-220 metres AHD. Water quality ranges from fresh to brackish, up to about 4000 mg/L (Mory 1994) but is mainly of low salinity (less than 1000 mg/L) with some small areas of higher salinity close to the Urella Fault (WRC 2003).

1.5. Critical Habitat

Critical habitat is habitat identified as being critical to the survival of a listed threatened species or listed threatened ecological community. Habitat is defined as the biophysical medium or media (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced (sections 207A and 528 of Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)).

The critical habitat of the 'Ferricrete floristic community (Rocky Springs type)' comprises the area of occupancy of the known occurrences corresponding to:

- red and brown sandy loam;
- ferricrete substratum;
- the aquifer providing the conditions for the formation and maintenance of the ferricrete substratum and;
- the local catchment for the surface waters that inundate these areas.

1.6. Habitat critical to the survival of the community and important occurrences

Given that the Ferricrete floristic community (Rocky Springs type) is listed as Endangered and only two occurrences are known, all known habitat for the community is considered critical habitat and both occurrences are important.

1.7. Benefits to other species/ecological communities

There are several Priority species within the Ferricrete floristic community including *Verticordia amphigia* (Priority 3), *Dryandra stricta* (Priority 3), *Homalocalyx chapmanii* (Priority 1) and *Thryptomene johnsonii* (Priority 2) all of which will benefit from the implementation of recovery actions outlined in this recovery plan. Recovery actions specific to occurrence 2 may also have major benefits to two occurrences of the endangered ecological community 'Organic Mound Springs (Three Springs area)' which occur on the same land parcel.

1.8. International obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that convention. The Ferricrete floristic community (Rocky Springs type) is not listed under any specific international treaty, however, so this IRP does not affect Australia's obligations under any other international agreements.

1.9. Role and interest of indigenous peoples

[3] Russell Speed - Senior Hydrogeologist, Department of Agriculture, Geraldton

There are no known indigenous communities associated or involved in the management of areas affected by this plan. A search of the Department of Indigenous Affairs Aboriginal Heritage Sites Register indicated that there are no listed Aboriginal Heritage Sites in the area of this ecological community. Input and involvement will be sought from any indigenous groups that have an active interest in the areas of the community, and this is discussed in the recovery actions.

1.10. Social and economic impacts

Parties affected by this plan include CALM's Moora District and Midwest Region, Iluka Resources Limited, Shire of Three Springs, and neighbouring landholders. There are not likely to be any adverse social or economic impacts to any of these parties as a consequence of the implementation of this plan. Both occurrences of the Ferricrete floristic community are found in areas designated as 'A' Class Nature Reserves and neither of the occurrences is subject to current mining leases.

The Moora District, Midwest Region, Iluka Resources Limited, and the Shire of Three Springs have been informed of the importance of the TEC and their cooperation will be sought to ensure that management activities do not impact the occurrences. Specific involvement of these and any other parties in the implementation of the plan is outlined in the recovery actions.

1.11. Evaluation of the plans performance

CALM, in conjunction with the Recovery Team will evaluate the performance of this IRP as part of their annual reporting process. In addition to annual reporting of the Recovery Team, the plan is to be reviewed within five years of its implementation.

1.12. Threatening processes

Mining, hydrological change and salinisation

Mining operations by Iluka Resources Limited near occurrence 1 involve groundwater abstraction/dewatering. Groundwater abstraction has the potential to alter the hydrological head that maintains the groundwater levels beneath the ferricrete substrate. Occurrence 1 lies adjacent to two sand mining operations (the east and west mines) in which a considerable amount of groundwater has already been abstracted. The west mine is being closed and rehabilitated, but may be reopened in the future. The east mine, which is thought to be directly affecting the flow of groundwater responsible for the formation and maintenance of the ferricrete substratum (A. Hopkins, personal communication[4]), will still be operating for a number of years (P. Spalding, personal communication[5]). As part of Iluka Resources Limited commitment to the groundwater abstraction license, a number of vegetation transects, including some in the Nature Reserve, are being monitored (G. Woodman, personal communication[6]). None of these, however, are near the TEC, nor thought to be appropriate to identify potential changes in the TEC.

Occurrence 2 lies adjacent to a saline creek which, on occasion, floods the lower-lying part of the TEC. The component species affected are unlikely to be able to cope with increased saline or water-logged conditions, particularly if flooding events occur more regularly as a result of rising regional water tables due to increased recharge of ground water from cleared farmland to the east of this occurrence.

Climate change

Commander (2000) has found that land use changes overshadow the effects of climate variability on deeper groundwater systems. Therefore altered hydrology due to farming practices in recharge areas are

[4] Angas Hopkins - Project Leader Biodiversity Conservation Strategy, CALM, Crawley
[5] Peter Spalding - Rehabilitation Adviser, Iluka Resources Ltd., Eneabba
[6] Greg Woodman - Principal, Woodman Environmental Consulting Pty. Ltd

likely to have a greater effect on major groundwater aquifers such as the Yarragadee and Parmelia formation than climate change. Rainfall data has only been collected for the Eneabba area since 1965 and therefore it is not possible to predict long term changes in rainfall for this area. However, it is likely that the succession of dry winters experienced in the Midwest region over the last three years would have an effect on superficial groundwater aquifers adjacent to both occurrences. This decline may affect the local water levels that provide the conditions for the formation and maintenance of the ferricrete substratum and provide the groundwater conditions upon which at least some components of the plant assemblage are likely to depend.

Weed invasion

Weeds can have significant impacts on a community through competition with the native species, prevention of regeneration and alteration of fire regimes (Hobbs and Mooney 1993). Disturbances such as fires, nutrient enrichment, grazing, and death of plants from disease can predispose areas to weed invasion if weed propagules are present. At present there is little weed invasion in occurrence 1, but its proximity to a minesite and the major highway increase the risk. Due to its proximity to a gravel road, agricultural land and a saline creek; and the regular occurrence of fires and road grading activities, weeds are reasonably common in occurrence 2.

Altered fire regimes

An increase in the frequency of fire can prevent species from completing growth and reproductive cycles and result in altered community structure or local extinction of species. Occasional fire may, however, be required for regeneration of the community. Fire can also influence species composition by causing increased weed invasion. Too-frequent fires are a major concern for occurrence 2 which is surrounded by freehold agricultural properties and until recently was not managed for conservation.

Road grading activity

The Shire of Three Springs has been regularly grading the road that passes through occurrence 2. In the past, vegetation (including from other areas) has been pushed into the reserve and gravel dumped into the creek. This introduced material may be a source of weeds and disease and the grading of drainage areas could also lead to soil erosion problems in the occurrence.

Disease

Dieback disease caused by the plant pathogens *Phytophthora* spp. is a serious threat as there are high numbers of species likely to be susceptible to the disease in and surrounding the TEC (G. Keighery, personal communication[7]). The *Phytophthora* spp. pathogens, which cause the roots to rot and result in death from drought stress, are commonly introduced and spread in infected soil, mud and gravel.

Introduced animal activity

Rabbits (*Oryctolagus cuniculus*) occur in both occurrences and may have an impact through grazing of components of the community, increased nutrient levels from their droppings and the introduction of weeds.

1.13. Guide for decision-makers

Section 1 provides details of current and possible future threats. Developments in the immediate vicinity of the occurrences require assessment. No developments should be approved unless the proponents can demonstrate that they will have no significant impact on the ecological community, or on the groundwater or surface water that maintain the community.

[7] Greg Keighery -Principal Research Scientist, CALM's Science Division

1.14. Conservation status

The 'Ferricrete floristic community (Rocky Springs type)' community meets the following criterion for Endangered (EN) ecological communities:

B) Current distribution is limited, and:
i) geographic range and/or number of discrete occurrences, and/or area occupied is highly restricted and the community is currently subject to known threatening processes which are likely to result in total destruction throughout its range in the short term future (within approximately 20 years)

1.15. Recovery strategy

To design recovery actions for both occurrences, and identify and influence the management of the catchments, thereby maintaining natural biological and non-biological attributes of the sites and the current area covered by the community.

To conduct appropriate research into the ecology of the community to develop further understanding about the management actions required to maintain or improve its condition.

2. RECOVERY OBJECTIVES AND CRITERIA

IRP Objective(s): To maintain, and where possible improve, the overall health and condition of both occurrences of the 'Ferricrete floristic community (Rocky Springs type)' and reduce the level of threat to the community so that it does not move into a higher category of threat during the life of this plan.

Criteria for success:
- Maintenance of the diversity and composition of native species in the community as defined in Appendix 1, taking account of natural change in the community over time.
- Improvement in terms of reduction of threatening processes, including maintenance of hydrology, and minimising impact of road maintenance, fire, disease, weed levels and introduced animals, as defined in this document.

Criterion for failure:
- Significant loss of area or further modification of occurrences of the threatened ecological community as a consequence of threatening processes as listed in this document.

3. RECOVERY ACTIONS

Existing Recovery Actions

The Moora District Threatened Flora Recovery Team (MDTFRT) is the Recovery Team for this community. The Recovery Team membership includes District Nature Conservation staff, local community members, Shire representatives, property owners, WATSCU staff, Regional Herbarium members and botanists with an interest in threatened flora and communities in the Moora District. The Recovery Team reports annually on progress with recovery work to CALM's Corporate Executive.

All known possible occurrences have been surveyed, and no further occurrences were located in surveys in other likely habitat.

Environmental markers were erected, in consultation with the Shire of Three Springs and the MDTFRT, to advise Shire road maintenance workers of the boundaries of occurrence 2.

Negotiations were undertaken to acquire the unvested Shire camping reserve that contains occurrence 2.

The reserve was declared a Class ‘A’ reserve for the purpose of 'Conservation of Flora and Fauna' and was placed under the care, control and management of the Conservation Commission in November 2002.

Future Recovery Actions

The following recovery actions are roughly in order of descending priority; however this should not constrain addressing any of the priorities if funding is available for ‘lower’ priorities and other opportunities arise.

1. Coordinate recovery actions

The Moora District Threatened Flora Recovery Team (MDTFRT) will continue to coordinate recovery actions for the Ferricrete community and other Declared Rare Flora and communities in their region. They will include information on progress in their annual report to CALM’s Corporate Executive and funding bodies.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated Cost: $2,200 per year (to run team)
Completion date: Ongoing

2. Map critical habitat

It is a requirement of the EPBC Act that spatial data relating to critical habitat be determined. Although critical habitat is described in Section 1, the areas as described have not yet been mapped and that will be done under this action. If any additional occurrences are located, then critical habitat will also be determined and mapped for these locations.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated Cost: $2,000 in first year
Completion date: Year 1

3. Monitor the extent and boundaries of the occurrences

The size of each occurrence will be determined, the extent monitored, and condition determined and compared. The boundary of each occurrence will be monitored regularly and can be determined from current aerial photographs and annual ground-truthing. This information will be added to CALM’s TEC database as recommended in English and Blyth (1999).

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: $2,000 for the initial monitoring ($900 per year for subsequent monitoring)
Completion date: Ongoing

4. Design and implement a flora monitoring program

A monitoring program will be established for occurrences of the Ferricrete community. As Iluka are required to undertake vegetation monitoring as part of their licence condition, they will be encouraged to assist with the monitoring. The line intercept method will be used. This involves installing a transect or a suite of transects, and any permanent plots already in place will also be utilised. Species present at set intervals along the transect will be then recorded.

The occurrences will be monitored every three years, or following a major disturbance event, such as fire, to provide information on condition, and changes, in the community. Data collected will then be entered onto a database and analysed. Results will also be added to the threatened ecological communities database as recommended in English and Blyth (1999). This information is essential for

determining changes in the community over time and the effects of disturbance events (eg too frequent fire).

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: $11,250 in year one and year 4
Completion date: Ongoing

5. Determine the fire ecology of the community

Funds will be sought to research recovery of the community from fire, and to determine the implications of findings for management (for example, collection and storage of seed for future re-introduction in case of fire, and prescriptions for frequency, timing and intensity of prescribed burning). A fire-history map of the occurrences will also be developed and updated regularly.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: WATSCU and Moora District to determine costs
Completion date: Ongoing

6. Develop and implement a fire management plan

A fire management strategy will be developed. This will consider minimising wildfires, the requirements for firebreaks/fire-fighting access tracks, fire management (including the need for and design of prescribed burns), and fire suppression. The strategy will include an annual fire monitoring and reporting schedule.

Responsibility: Moora District through the MDTFRT
Estimated cost: $4,000 per year ($2,000 per occurrence)
Completion date: Ongoing

7. Design and implement weed control strategy

A weed control strategy will be developed that considers the nature of each occurrence and the need for continued maintenance. The weed control program will include:
1. Determining which weeds and native species are present.
2. Selection of the appropriate herbicide and setting priorities for treatment.
3. The control of invasive weeds by hand or spot spraying as soon as the weeds emerge.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: $3,000 per year
Completion date: Ongoing

8. Obtain hydrological information

Existing hydrological data will be sought from Iluka Resources and the Department of Agriculture and evaluated. These data may be suitable for determining the likelihood of changes to the hydrology of both occurrences of the TEC as a consequence of activities in the catchments. If the data are insufficient, additional piezometers/monitoring bores may need to be installed to monitor changes to the groundwater at both occurrences.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: $500 each year to obtain existing information. WATSCU and Moora District to determine cost of additional hydrological investigations if required
Completion date: Ongoing

9. Monitor and manage dieback disease

The presence of dieback disease will be determined through mapping, and collection and testing of suspected soil and plant samples. Priority areas for dieback treatment in the community will be determined using CALM's Dieback Management Guidelines (Department of Conservation and Land Management 1999). Data on dieback presence and impact, and future biodiversity implications, such as the loss or decline of structurally or functionally important taxa, are likely to be important determinants of the priority of treatment for individual occurrences.

Treatments recommended in the current Dieback Management Guidelines (CALM 1999) will be implemented for infected areas, commencing with the highest priority areas. The protocol will incorporate results of monitoring from current and future methods of experimental dieback treatments.

If phosphite spraying is undertaken, the dieback front will be mapped accurately using differential GPS, and a photo monitoring point set up. The dieback front will be monitored at least every two years in summer.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated Cost: $6,200 every two years for monitoring and spraying (if required)
Completion date: Ongoing

10. Obtain biological and ecological information

Research designed to increase understanding of the biology of the significant species in the community will provide a scientific base for management in the wild. Research will include:

1. Study of the soil seed bank dynamics and the role of various factors (disturbance, competition, rainfall and grazing) in recruitment and seedling survival.
2. Seed germination requirements.
3. Impacts of dieback disease.
4. Quantification of level of seed predation or removal of seed.
5. Determination of reproductive strategies, phenology and seasonal growth.
6. Factors determining level of flower and fruit abortion.
7. Effects of weeds on recruitment and establishment.
8. Response of floristic community to changes in salinity, period of inundation and groundwater levels.

Responsibility: WATSCU and Moora District through MDTFRT in liaison with Science Division
Estimated cost: $40,000 in year one; $35,000 per year thereafter
Completion date: Ongoing

11. Replant and rehabilitate where necessary

Degraded areas of the community will be replanted and rehabilitated. Species that are appropriate for use in rehabilitation will be identified from plot data held in Griffin *et al*. (1983) for each occurrence or from flora monitoring (recovery action 4). These species will then be propagated from material collected from surrounding areas to preserve local provenance.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: WATSCU and Moora District to determine costs
Completion date: Ongoing

12. Control introduced animals

Both occurrences are impacted by rabbits. In addition to grazing of the flora, the soil is being disturbed, and this combined with the increased nutrient levels and the presence of weed seed in rabbit droppings

is introducing weeds into the habitat. Baiting or trapping will be undertaken in and around the habitat as required.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated Cost: $3,000 per year
Completion date: Ongoing

13. Review the need for a full Recovery Plan

At the end of the fourth year of its five-year term this Interim Recovery Plan will be reviewed and the need for further recovery actions will be assessed. If the ecological community is still ranked as Endangered at that time a full Recovery Plan may be required.

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: $17,500 in Year 5
Completion date: Fifth year (if required)

RECOVERY ACTIONS SPECIFIC TO OCCURRENCE 1

14. Liaise with Iluka Resources Limited

CALM staff will liaise with Iluka Resources Limited to manage their mining operations in a manner sympathetic to the nature conservation values of the Nature Reserve and TEC. This will include consideration of disease hygiene management to ensure that *Phytophthora* spp. are not spread, appropriate management of fire, and weed control.

Responsibility: CALM's Environmental Protection Branch and Moora District through the MDTFRT
Estimated cost: $750 per year
Completion date: Ongoing

RECOVERY ACTIONS SPECIFIC TO OCCURRENCE 2

15. Liaise with the Shire of Three Springs

CALM staff will liaise with the Shire of Three Springs with regard to management of activities that have the potential to impact the occurrence (road widening, rubbish disposal and drainage activities).

Responsibility: WATSCU and Moora District through the MDTFRT
Estimated cost: $500 per year
Completion date: Ongoing

16. Liaise with surrounding landholders

CALM staff will liaise with the surrounding landholders/managers with regard to managing their properties to ensure that potential impacts on conservation values of the reserve that contains occurrence 2 are minimised. In particularly, drainage, introduced animal control, fire and stock movement will be considered.

Responsibility: WATSCU and Moora District through the MDTFRT
Cost: $500 per year
Completion date: Ongoing

4. TERM OF PLAN

This Interim Recovery Plan will operate from July 2004 to June 2009 but will remain in force until withdrawn or replaced. After five years, the need to review this IRP or to replace it with a full Recovery Plan will be determined.

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Appendix 1. Species located in each occurrence of the Ferricrete floristic community (Rocky Springs type) (Note: list is not complete)

	Occurrence	
Species	**1**	**2**
Acacia blakelyi	√	√
Acacia lasiocarpa	√	
Acacia saligna	√	
Allocasuarina campestris	√	√
Alyogyne hakeifolia	√	√
Amphipogon strictus	√	
**Anagallis arvensis*	√	
Banksia leptophylla var. melletica		√
Brachyscome pusilla	√	
Borya sphaerocephala	√	√
Calandrinia calyptrata	√	
Caladenia longicauda	√	
Calothamnus quadrifidus	√	
Calytrix flavescens	√	
Calytrix gracilis		√
Cassytha pomiformis	√	
**Centaurea melitensis*	√	
Centrolepis drummondii	√	
Chamaescilla corymbosa	√	
Crassula colorata	√	
Crassula peduncularis	√	
Dodonaea pinifolia		√
Drosera erythrorhiza	√	
Drosera glanduligera	√	
Drosera macrantha	√	
Drosera menziesii subsp. menziesii		√
Dryandra stricta (P3)	√	√
**Galium murale*	√	
Glischrocaryon aureum	√	
Gnaphalium sphaericum	√	
Goodenia drummondii subsp. drummondii	√	
Grevillea petrophiloides		√
Grevillea pinaster	√	√
Haemodorum simplex	√	
Hakea scoparia		√
Hibbertia huegelii		√
Homalocalyx chapmanii (P1)		√
Hibbertia rupicola		√
Hydrocotyle diantha	√	
**Hypochaeris glabra*	√	
Isopogon divergens	√	
Isopogon dubius	√	
Isotoma hypocrateriformis	√	√
Jacksonia hakeoides	√	

Jacksonia ulicina	√	
Labichea lanceolata subsp. *lanceolata*	√	√
Lepidosperma tenue	√	
Leptosema aphyllum		√
Levenhookia dubia	√	
Lobelia heterophylla	√	
Lobelia rhombifolia	√	
Lobelia winfridae	√	
Melaleuca conothamnoides		√
Melaleuca uncinata		√
Neurachne alopecuroidea	√	
Opercularia spermacocea	√	
**Pentaschistis airoides*	√	
Petrophile brevifolia	√	
Petrophile seminuda	√	√
Podotheca gnaphalioides	√	
Schoenus nanus	√	
Scholtzia laxiflora		√
Selaginella gracillima	√	
Stylidium dichotomum	√	√
Stylobasium australe	√	
Thelymitra villosa	√	
Thryptomene johnsonii (P2)		√
Thysanotus patersonii	√	√
Trachymene coerulea subsp. leucopetala	√	
Trachymene pilosa	√	
Triglochin centrocarpa	√	
Triglochin nana		√
Verticordia amphigia (P3)	√	
Verticordia densiflora		√
Wahlenbergia gracilenta	√	
Waitzia paniculata	√	√

* introduced species

Appendix 2. Summary of costs for each Recovery Action

	Year				
Recovery action	**1**	**2**	**3**	**4**	**5**
Coordinate recovery actions	$2,200	$2,200	$2,200	$2,200	$2,200
Map critical habitat	$2,000				
Monitor the extent and boundaries of the occurrences	$2,000	$900	$900	$900	$900
Design and implement a flora monitoring program	$11,250			$11,250	
Determine the fire ecology of the community	*	*	*	*	*
Design and implement a fire management strategy	$4,000	$4,000	$4,000	$4,000	$4,000
Design and implement a weed control strategy	$3,000	$3,000	$3,000	$3,000	$3,000
Obtain hydrological information	$500	$500*	$500*	$500*	$500*
Monitor and manage dieback disease	$6,200		$6,200		$6,200
Obtain biological and ecological information	$40,000	$35,000	$35,000	$35,000	$35,000
Replant and rehabilitate where necessary	*	*	*	*	*
Control introduced animals	$3,000	$3,000	$3,000	$3,000	$3,000
Review the need for a full Recovery Plan, and write if required					$17,500
Recovery actions specific to occurrence 1:					
Liaise with Iluka Resources Limited	$750	$750	$750	$750	$750
Recovery actions specific to occurrence 2:					
Liaise with the Shire of Three Springs	$500	$500	$500	$500	$500
Liaise with surrounding landholders	$500	$500	$500	$500	$500

* Moora District Threatened Flora Recovery Team to determine and seek funds

Totals

Year 1	$75,900
Year2	$50,350
Year 3	$56,550
Year 4	$61,600
Year 5	$74,050
OVERALL TOTAL	$318,450