INTERIM RECOVERY PLAN NO. 314

SEDGELANDS IN HOLOCENE DUNE SWALES

INTERIM RECOVERY PLAN 2011-2016

September 2011

Department of Environment and Conservation
Species and Communities Branch
Locked Bag 104, Bentley Delivery Centre, WA, 6983

Department of Environment and Conservation

Australian Government
Department of Sustainability, Environment, Water, Population and Communities

FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Environment and Conservation (DEC) 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.

DEC is committed to ensuring that critically endangered 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 DEC's Director of Nature Conservation.

This Interim Recovery Plan will operate from September 2011 but will remain in force until withdrawn or replaced. It is intended that, if the community is still listed as critically endangered after five years, the need for an updated plan will be evaluated.

The provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting DEC, as well as the need to address other priorities.

Information in this IRP was accurate at September 2011.

This interim recovery plan replaces plan number 110 Sedgelands in Holocene dune swales 2002-2007 by V. English, J. Blyth, N. Gibson, D. Pember, J. Davis, J. Tucker, P. Jennings and B. Walker.

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Cover photograph by Valerie English.

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Anne Harris	Swan Coastal District DEC
Bob Goodale	Community member of recovery plan implementation group
Christine Comer	Naragebup Environment Centre
David Mort	City of Rockingham
Jennifer Feszczak	Geographic Information Services Section DEC
Jill Pryde	Species and Communities Branch DEC
Kate Brown	Urban Nature DEC
Mia Podesta	Species and Communities Branch DEC
Dr Neil Gibson	Science Division DEC
Dr Phillip Jennings	Murdoch University
Robert Campbell	Regional Parks Branch DEC
Ryan Vogwill	Previously Natural Resources Branch DEC
South West Aboriginal Land and Sea Council	
Tiffany Fowler	Wellington District DEC
Tim Fisher	Regional Parks Branch DEC

CITATION

This Interim Recovery Plan should be cited as:

Department of Environment and Conservation (2011). Interim Recovery Plan 2011-2016 for Sedgelands in Holocene dune swales. Interim Recovery Plan No. 314. Department of Environment and Conservation, Perth.

SUMMARY

Name: Sedgelands in Holocene dune swales (generally referred to in this plan as 'the sedgeland community').

Description: The community occurs in linear damplands and occasionally sumplands, between Holocene dunes. Typical and common native species are the shrubs *Acacia rostellifera, Acacia saligna*, *Xanthorrhoea preissii,* the sedges *Baumea juncea, Ficinia nodosa, Lepidosperma gladiatum*, and the grass *Poa porphyroclados*. Several exotic weeds are found in this community but generally at low cover values.

DEC Regions: Swan, South West

DEC Districts: Swan Coastal, Wellington

Shires: City of Rockingham, City of Wanneroo, Shire of Capel

Current status: Community assessed June 1996 as Critically Endangered. Also listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Becher Point wetlands are also nominated as a Wetland of International Importance under the Ramsar Treaty, an important suite of wetlands in 'A Directory of Important Wetlands in Australia', and are on the Register of the National Estate.

Habitat requirements: Water regime is the primary abiotic determinant influencing characteristics of wetland plant communities. Depth, timing and duration of flooding and length of the dry period all affect vegetation composition and distribution (Froend *et al.* 2004). The sedgelands in the damplands and sumplands of the Holocene dune swales have relatively specific water regime requirements to maintain current biology, but are tolerant of seasonal and longer-term variations that reflect natural climatic patterns.

The typical wetland in which this community type occurs is a dampland that becomes water logged in winter, and retains relatively high moisture near the surface of the soil profile in summer. The plant community occasionally occurs in sumplands, which have shallow surface water - generally less than 20cm for up to 2 months of the year.

The soils of these wetlands are sands or sandy-loams with a pH of about 8.0. The soils are more saline close to the coast, and this reflects inputs from salt spray. Nutrient levels are similar to those reported for other Quindalup sands.

Important occurrences: Occurrences that provide for a representative cross section of each geomorphic age sequence of this community and that can be managed for conservation and/or with conservation included in their purpose are considered critical to the survival of this community.

Affected interests: Occurrences of the sedgelands community are located on land managed by DEC, City of Rockingham, WA Beach and Golf Resort Pty Ltd, LandCorp and private land holders. Land owners and managers of all occurrences may be affected by actions in this plan, in particular land not managed by DEC at IP14, Lark Hill, on the western side of Golden Bay, and adjacent to Bakewell Drive in Port Kennedy.

Indigenous interests: The South West Aboriginal Land and Sea Council (SWALSC), an umbrella group, covers the areas considered in this plan. Comment was sought from the Council about any aspects of the plan, but particularly about the proposed on-ground actions. Table 4 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance. No general significance to indigenous people has been identified for the ecological community. Action 2 identifies the intention to continue liaison with relevant groups, including indigenous groups.

Social and economic impacts and benefits: Pedestrian access by means of formal walk trails has potential to allow the aesthetic values of the sedgelands to be appreciated without degrading the community, and this provides a social benefit. Where specific active recreational pursuits such as four wheel driving are prevented through access control, this may be perceived as a social impact, however such access control also helps to prevent the continued degradation of the sedgelands and maintain other social benefits.

Two major areas that contain the community have been subject environmental impact assessment. Other occurrences may be threatened by proposals to clear for housing or from hydrological change following clearing and development of adjacent land. Implementation of actions such as seeking to protect the hydrological processes in the adjacent sedgeland community may result in an impact on development.

Wetlands such as this sedgeland community provide various ecosystem services such as absorption of nutrients and other chemicals from polluted surface and groundwater. These services would have an economic value but are lost when wetlands are cleared and filled.

Related biodiversity impacts and benefits: Recovery actions implemented to improve the quality or security of the community are likely to improve the status of any species within the community. Occurrences at Lake Richmond are in very close proximity to another State and EPBC-listed threatened ecological community; the 'Stromatolite like microbialite community of coastal freshwater lakes (Lake Richmond)'. If actions implemented improve the quality of the Lake Richmond sedgelands occurrences it is likely the microbialite community will benefit - particularly if recreational impacts and fire frequency are decreased and groundwater quality is maintained or improved.

Term of plan:
Western Australia
The plan will operate from 2011 to 2016 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be evaluated by the recovery plan implementation group.

Commonwealth
In accordance with the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) this recovery plan will remain in force until revoked.

The recovery plan must be reviewed at intervals of not longer than 5 years.

IRP objective(s): To maintain or improve the overall condition of the sedgelands in Holocene dune swales community and reduce the level of threat.

Critical habitat: The critical habitat for the sedgelands in Holocene dune swales is the system of dunes and swales in which they occur, the fresh superficial groundwater that provides water to the swale wetlands, and the catchment for this groundwater.

Criteria for success:

- an increase of one or more in the number of occurrences of this community managed for conservation and/or with conservation included in their purpose, and that leads to an increase in the completeness of a geomorphic age sequence,
- representative areas of each geomorphic age sequence maintained in the same or improved condition (Bush Forever 2000 scales), and
- 90% or more of the aerial extent of occurrences maintained at the same condition rank, or improved (Bush Forever 2000 scales)

Criterion for failure:

- Loss of all representatives of a geomorphic age group that contains the sedgelands in Holocene dune swales community or decline in condition of all members of that age group to degraded condition or poorer.

Recovery Actions

Define the community in greater detail	Continue vegetation monitoring program
Continue to liaise with relevant groups to implement this IRP	Continue groundwater monitoring
Identify all occurrences of the community	Establish minimum and maximum threshold water levels, influence land management to maintain hydrology
Continue to minimise recreational disturbance to the community	Monitor the need for rehabilitation in the community
Implement fire management strategy	Implement the planned feral and introduced animal control program
Monitor response to fire	Continue negotiations for appropriate management of other occurrences outside current reserves
Continue to implement weed control strategy	Continue to report on success of recovery plan
Continue to ensure any infrastructure does not impact the community	

1. BACKGROUND

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

The Rockingham-Becher Plain has been formed through the accumulation of Holocene sediments and contains a continuous depositional history from 7000 BP to present (Semeniuk 2007). This affords the plain a high geomorphological significance due to the information it provides about the evolutionary record of sea-level history and climatic changes (Tauss 2002). The best record occurs along a linear transect from Becher Point through to the hinterland, with the record preserved spanning the last 8,000 years of the Holocene Epoch of the Quaternary Period (Semeniuk and Searle 1986).

Wetlands occur within the swales where the watertable is close to or at the ground surface in the wetter months of the year. V & C Semeniuk Research Group (1991) and Hill *et al.* (1996) classified large and small wetlands within the Cooloongup, Becher and Peelhurst suites. The most typical form is that of the Becher Suite, which is made up of over 250 very small to small sumplands and damplands, many of which contain occurrences of this community.

The present known distribution of the sedgelands in Holocene dune swale community as described by Gibson *et al*. (1994) is approximately 193 ha (Table 1) and is almost entirely located within linear wetland depressions (swales) occurring between parallel sand ridges of the Rockingham-Becher Plain. Additional occurrences include a small area at Yanchep and a small area at Dalyellup. Holocene dunes with wetlands around Preston Beach, South of Lancelin and at Cheynes Beach may also contain occurrences of this community.

The actual assemblage of species varies between occurrences of the threatened ecological community. In addition to the presence of the sedgeland community, the conservation values of the wetlands are primarily related to the geomorphic significance of the site and the respective location of the wetlands along the evolutionary time sequence. When conserved as a representative unit, the relative youth of the wetlands, and the range of wetlands of different ages in association with their geomorphic history, provide important opportunities for research on wetland evolution (V & C Semeniuk Research Group 1991). The Rockingham-Becher Plain has been radiocarbon dated (Woods and Searle 1983) and an age sequence of the sedgeland occurrences in this area produced (Table 2). A number of excellent examples of wetlands between a few hundred and 4500 years of age have been reserved or are planned for reservation. Fewer examples from earlier in the time sequence, between 4500 and 7000 years of age are reserved. Wetlands of this age are known to exist at Dalyellup, Lark Hill in Port Kennedy, east of Bakewell Drive in Port Kennedy, near Lakes Cooloongup and Walyungup, and at Yanchep. Generally these older occurrences have a tree overstorey and so the community is subdivided into ‘sedgelands in Holocene dune swales’ (Sub-type 19a) and ‘woodlands over sedgelands in Holocene dune swales’ (Sub-type 19b) based on floristic differences between these groups (Bush Forever 2000), but both sub-community types represent the TEC ‘sedgelands in Holocene dune swales’. For the purpose of this plan they are jointly referred as the ‘sedgelands community’.

The vegetation composition of the wetlands is likely to be related to both age and proximity to the watertable. It is unknown to what extent fire has influenced the present structure or composition of the community. Typical and common native shrub species are summer-scented wattle (*Acacia rostellifera*), orange wattle (*Acacia saligna*) and grass tree (*Xanthorrhoea preissii*). Typical sedges include the bare twigrush (*Baumea juncea*), knotted club rush (*Ficinia nodosa*) and coast sword-sedge (*Lepidosperma gladiatum*). The native grass *Poa porphyroclados* is also common in the community. Some older occurrences have an overstorey characterised by tuart trees (*Eucalyptus gomphocephala*), swamp paperbark (*Melaleuca rhaphiophylla*) and swamp banksia (*Banksia littoralis*). Appendix 1 provides a list of taxa located in the community.

Table 1: Extent and location of occurrences (see also Appendix 2)

Occurrence Number	Location	Estimated Area
XYan10	Yanchep	~ 1ha
IP14-01,02,03,04,05,06,07,08; IP14-09north, 09south,09centre; IP14-plot1,plot2, plot3; IP14-10north,10south; MyIP14-02, 03,04,05,06,07,08,09,10,12,13	Industrial Park 14 (IP 14), Rockingham	~ 60ha
Rich01,02,03,04,05,06,07	Lake Richmond, Rockingham	~ 28ha
Cool14,15,09; MyCool01; Walyungup01,02,03,04,05,06,07,08	Lakes Cooloongup/Walyungup	~ 41ha
PtKennedy16,18,49,50,28,121,120,115,113,104, 124,98,125,95; PtKennedy23; PtKennedy26; Pt Kennedy25,123,122,116,118, 119,96,100,90,94,92,91,97; PtKennedy101,103; Pt Kennedy new01	Port Kennedy (outside Scientific Park)	~ 15ha
PtBecher01north,01south; PB01,06; PointBecher01,02,03,07,32,35; PointBecher Plot1; PtBecher38Sc; MyPoint Becher01,02,03, 04,05,06,07,08,09	Port Kennedy Scientific Park	~ 20ha
Larkhill13,17,18,21,22,23,24,26,27,29,30,150,152,158,160	Lark Hill, Port Kennedy	~ 7ha
SecretHarbour42,46,01,16,54; Secret Harbour 168,169,19,20; Goldenbay Plot 1,2; Goldenbay 01; MyGB01,02,03,04,05, 06,07	Secret Harbour and Golden Bay	~ 19ha
Muddy01,02	Dalyellup	~ 2ha

Table 2: Geomorphic age of sedgeland occurrences on the Rockingham-Becher Plain (data from Woods and Searle 1983)

Location	Age (years)
IP14	5000-6000
Lake Richmond	2000-4000
Lake Cooloongup	>6000
Lake Walyungup	>6000
Port Kennedy (including Scientific Park – Point Becher)	0-5000
Secret Harbour	0-4000
Golden Bay	0-4000

Table 3: Location and management of occurrences

Occurrence number	Location	Land ownership	Management comments	Purpose/ Land Use
Sedgelands in Holocene dune swales occ 1, 2, 48, 49, 50, 52, 59, 66, 78, 80, 81, 82, 83, 84, 86 (PB01, PtBecher01north, PtBecher01south; PB06; PointBecher32; PointBecher01; PointBecher02; MyPoint Becher07, PointBecher35; PointBecher03; PtBecher38Sc; MyPoint Becher01; MyPoint Becher02; MyPoint Becher03; MyPoint Becher04; MyPoint Becher05; MyPoint Becher06; MyPoint Becher08) **Woodlands over sedgelands in Holocene dune swales** occ 24 (PointBecher07, PointBecher Plot01)	Crown reserve 44077 (Lot 138 on plan 219088. Lot 216 on plan 219947) Port Kennedy Scientific Park.	Conservation Commission of WA	Regional Park, Managed by Department of Environment and Conservation (DEC) Regional Parks Branch	Bush Forever site 377
Sedgelands in Holocene dune swales occ 4,5, 94 (Rich01, Rich02, Rich03, Rich04; Rich05; Rich07) **Woodlands over sedgelands in Holocene dune swales** occ 38 (Rich06)	Crown Reserve 9458 (Lot 1596 on plan 218621, Lot 18 on plan 218763). Crown Reserve 47145 (Lot 8001 on plan 25925). Crown Reserve 47553 (Lot 8006 on plan 40534, Lot 4839 on plan 35616). Crown Reserve 48406 (Lot 5070 on plan 40535). Crown Reserve 48310 (Lot 8018 on plan 45031). Crown Reserve 48653 (Lot 8016 on plan 48290). Road Reserve FID 197502. Road Reserve FID 65024.	Department of Regional Development and Lands Unvested Crown land	Regional Park, Managed by the City of Rockingham with input from DEC City of Rockingham	Bush Forever site 358
Sedgelands in Holocene dune swales occ 17 (MyCool01)	Lot 0 on plan 1118.	WA Planning Commission	Regional Park, Managed by DEC's Regional Parks Branch. Freehold	Bush Forever site 356
Sedgelands in Holocene dune swales occ 18, 19, 20, 21, 45, 53, 54, 55, 57, 58, 60, 71, 91, 92, 93 (PtKennedy98; PtKennedy101; PtKennedy103; PtKennedy95; PtKennedy113; Pt Kennedy 94; Pt Kennedy 91; Pt Kennedy 92; Pt Kennedy 90; Pt Kennedy 97; Pt Kennedy 96; Pt Kennedy new 01; Pt Kennedy124; Pt Kennedy115; Pt Kennedy125) **Woodlands over sedgelands in Holocene dune swales** occ 13, 25 (PtKennedy104; Pt Kennedy 100)	Lot 17 on diagram 65566.	Industrial Lands Development Authority	Freehold	
Sedgelands in Holocene dune swales occ 27, 28, 30, 96, 97, 98, 100 (Larkhill22; Larkhill23; Larkhill26; Larkhill158; Larkhill160; Larkhill18; Larkhill21) **Woodlands over sedgelands in Holocene dune swales** occ 18, 19, 20, 41 (Larkhill24; Larkhill27; Larkhill29; Larkhill17)	Lot 9000 on plan 56652.	WA Planning Commission	Freehold	Bush Forever site 356 (excludes LarkHill 24, 26, 27, 29)
Sedgelands in Holocene dune swales occ 33 (SecretHarbour16)	Crown reserve 50308 (Lot 314 on plan 64296 Lot 9045 on plan 64297.	Department of Regional Development and Lands Secret Harbour Pty Ltd	Managed by Department of Regional Development and Lands Freehold	
Sedgelands in Holocene dune swales occ 36 (SecretHarbour42)	Crown reserve 46831 (Lot 1567 on plan 24161).	Department of Regional Development and Lands	Managed by City of Rockingham	
Sedgelands in Holocene dune swales *occ 37 (SecretHarbour54)* *Cleared – historic record only*	*Lot 840 on plan 39557.*	*Private land owner*	*Freehold*	

Sedgelands in Holocene dune swales occ 38 (PtKennedy23)	Crown reserve 48116 (Lot 947 on plan 44073).	Department of Regional Development and Lands	Managed by City of Rockingham	
Sedgelands in Holocene dune swales *occ 39 (PtKennedy26 Cleared – historic record only*	*Road reserve FID 261050.*	*Unvested Crown land*	*Managed by City of Rockingham*	
Sedgelands in Holocene dune swales occ 40 (PtKennedy18)	Crown reserve 47165 (Lot 4870 on plan 35747).	Department of Regional Development and Lands	Managed by City of Rockingham	
Sedgelands in Holocene dune swales occ 41, 43 (PtKennedy50; PtKennedy49)	Lot 14 on plan 58958, Unallocated Crown Land.	Department of Regional Development and Lands	Freehold	
Sedgelands in Holocene dune swales occ 42 (PtKennedy16)	Lot 14 on plan 58958, Unallocated Crown Land. Lot 13 on plan 58958.	Department of Regional Development and Lands Department of Regional Development and Lands	Freehold Freehold. Leased to WA Beach and Golf Resort Pty Ltd	
Sedgelands in Holocene dune swales occ 44 (Walyungup01)	Lot 328 on plan 202704.	WA Planning Commission	Regional Park, Managed by DEC's Regional Parks Branch. Freehold	Bush Forever site 356
Sedgelands in Holocene dune swales occ 47 (PtKennedy120)	Lot 581 on plan 202752. Road reserve FID 361674.	WA Planning Commission Unvested Crown land	Freehold Managed by City of Rockingham	
Sedgelands in Holocene dune swales occ 61 (PtKennedy 116) **Woodlands over sedgelands in Holocene dune swales** occ 29 (Pt Kennedy 118)	Lot 581 on plan 202752.	WA Planning Commission	Regional Park, Managed by DEC's Regional Parks Branch. Freehold	
Sedgelands in Holocene dune swales occ 62, 65 (Pt Kennedy 123; Pt Kennedy 122)	Lot 200 on plan 302704.	Water Corporation	Regional Park, Managed by DEC's Regional Parks Branch. Freehold	Bush Forever site 356
Sedgelands in Holocene dune swales occ 70 (Pt Kennedy 119) **Woodlands over sedgelands in Holocene dune swales** occ 23 (PtKennedy121)	Lot 582 on plan 202752.	WA Planning Commission	Regional Park, Managed by DEC's Regional Parks Branch. Freehold	
Sedgelands in Holocene dune swales occ 87 (MyPoint Becher09)	Lot 502 on plan 58960, Lot 503 on plan 58960, Unallocated Crown Land.	Department of Regional Development and Lands	Freehold	
Sedgelands in Holocene dune swales *occ 88, 90 (Secret Harbour 168 (Cleared – historic record only); Secret Harbour 20 (Cleared – historic record only)* ***Woodlands over sedgelands in Holocene dune swales*** *occ 34, 35 (Secret Harbour 19; Secret Harbour 169)*	*Lot 2152 on plan 45018.*	*Minister for Education*	*Freehold*	
Sedgelands in Holocene dune swales occ 95 (Walyungup06) **Woodlands over sedgelands in Holocene dune swales** occ 1, 30, 31, 39, 40 (Cool09; Walyungup02; Walyungup03; Walyungup07; Walyungup08)	Lot 461 on plan 11301.	WA Planning Commission	Regional Park, Managed by DEC's Regional Parks Branch (excluding Walyungup02). Freehold	Bush Forever site 356
Sedgelands in Holocene dune swales occ 99, 101 (LarkHill152; LarkHill150) **Woodlands over sedgelands in Holocene dune swales** occ 98 (LarkHill13)	Crown Reserve 24059 (Lot 542 on plan 202443). Lot 796 on plan 202443.	Water Corporation WA Planning Commission	Managed by Water Corporation Regional Park, Managed by DEC's Regional Parks Branch. Freehold	Bush Forever site 356
Sedgelands in Holocene dune swales occ 102, 103, 105, 106, 107, 108 (MyGB03; MyGB02; MyGB05; MyGB06; MyGB07; MyGB01)	Lot 2 on plan 53920.	Housing Authority	Freehold	
Sedgelands in Holocene dune swales occ 104 (MyGB04)	Lot 2 on plan 53920. Crown Reserve 34664 (Lot 2486 on diagram 28721).	Department of Housing and Works Department of Regional Development and Lands	Freehold Managed by City of Rockingham	

Woodlands over sedgelands in Holocene dune swales occ 3 (IP14-07, MyIP14-09, MyIP14-10, MyIP14-12, MyIP14-13)	Lot 500 on plan 61891. Lot 427 on plan 245445.	WA Land Authority Industrial Lands Development Authority	Freehold Freehold	
Woodlands over sedgelands in Holocene dune swales occ 6 (IP14 Plot1, IP14-05, IP14-06)	Lot 500 on plan 61891, Lot 11 on plan 23754, Lot 2 on diagram 37651, Lot 92 on plan 226155. Unallocated Crown land FID 51729. Lot 13 on plan 23754. Road reserve FID 51994.	WA Land Authority Department of Regional Development and Lands Jandakot Wool Washing Pty Ltd Unvested Crown land	Freehold LandCorp Freehold Managed by City of Rockingham	
Woodlands over sedgelands in Holocene dune swales *occ 7, 28, 100, 103, 104, 108 (IP14-02; IP14-09Centre, IP14-09North, IP14-09South, IP14-Plot2, IP14-Plot3; MyIP14-02 (NAS); MyIP14-03 (NAS); MyIP14-04 (degraded – historic record only); MyIP14-08 (degraded – historic record only)*	*Lot 500 on plan 61891.*	*WA Land Authority*	*Freehold*	
Woodlands over sedgelands in Holocene dune swales occ 8 (IP14-08)	Lot 500 on plan 61891. Lot 501 on plan 61891, Lot 502 on plan 61891.	WA Land Authority Water Corporation	Freehold Freehold	
Woodlands over sedgelands in Holocene dune swales occ 9, 27, 36 (IP14-03; IP14-10North, IP14-10South; IP14-04)	Lot 500 on plan 61891, Lot 21 on plan 35112.	WA Land Authority	Freehold	
Woodlands over sedgelands in Holocene dune swales occ 10 (XYan10)	Crown reserve 9868 (Lot 11544 on plan 217799).	Conservation Commission	Managed by DEC	Bush Forever site 288
Woodlands over sedgelands in Holocene dune swales occ 11, 12 (Cool14; Cool15)	Crown reserve 18452 (Lot 22 on plan 3893).	Department of Regional Development and Lands	Regional Park, Managed by DEC's Regional Parks Branch. Freehold	Bush Forever site 356
Woodlands over sedgelands in Holocene dune swales occ 14 (PtKennedy28)	Lot 201 on plan 302704. Lot 768 on plan 202443. Road reserve FID 247430.	Water Corporation WA Planning Commission Unvested Crown land	Freehold Freehold Managed by City of Rockingham	Bush Forever site 356
Woodlands over sedgelands in Holocene dune swales occ 15 (LarkHill30)	Lot 884 on plan 202761. Lot 771 on plan 202443. Road reserve FID 266508.	Private land owner WA Planning Commission Unvested Crown land	Freehold Freehold Managed by City of Rockingham	Bush Forever site 356 (northern portion of occ)
Woodlands over sedgelands in Holocene dune swales occ 21 (GoldenBay Plot1, GoldenBay Plot2, GoldenBay01)	Crown reserve 42604 (Lot 4060 on diagram 80616), Crown reserve 42734 (Lot 4061 on diagram 80617). Lot 28 on plan 18327, Lot 26 on plan 18327, Lot 25 on plan 18327. Road reserve FID 197939. Lot 55 on plan 18327.	Department of Regional Development and Lands Private land owner Unvested Crown land Department of Regional Development and Lands	Department of Regional Development and Lands Freehold Managed by City of Rockingham Freehold	

Woodlands over sedgelands in Holocene dune swales occ 22, 37 (SecretHarbour46; SecretHarbour01)	Lot 9045 on plan 64297.	Secret Harbour Pty Ltd	Freehold	
Woodlands over sedgelands in Holocene dune swales occ 26 (Pt Kennedy 25)	Lot 200 on plan 302704, Lot 201 on plan 302704.	Water Corporation	Regional Park, Managed by DEC's Regional Parks Branch. Freehold	Bush Forever site 356
Woodlands over sedgelands in Holocene dune swales occ 32 (Walyungup04, Walyungup05)	Lot 461 on plan 11301, Lot 19 on diagram 87270. Crown reserve 23780.	WA Planning Commission City of Rockingham	Regional Park, Managed by DEC's Regional Parks Branch. Freehold Regional Park, Managed by DEC's Regional Parks Branch	Bush Forever site 356
Woodlands over sedgelands in Holocene dune swales occ 33 (IP14-01)	Lot 1001 on plan 47607.	Western Australian Land Authority	Freehold	
Woodlands over sedgelands in Holocene dune swales occ 99 (Muddy01, Muddy02)	Lot 9084 on plan 66982.	Housing Authority	Freehold	
Woodlands over sedgelands in Holocene dune swales *occ 105, 106, 107 (MyIP14-05 (degraded – historic record only); MyIP14-06 (NAS); MyIP14-07 (degraded – historic record only)*	*Lot 501 on plan 61891.*	*Water Corporation*	*Freehold*	

Italics = cleared – historic record only

Table 4: Threats, landform data, indigenous sites, groundwater levels, condition of occurrences

Sub type	Occ. Number	Threats	Quadrat Analysis	Predominant Landform unit (Churchward and McArthur 1980)	Depth to groundwater(static level - m below ground) from Department of Water Groundwater - Water Information System (WIN)	Aboriginal sites (from GIS layer Aboriginal Sites Register - Department of Indigenous Affairs)	Condition (from on ground survey/GIS layer #Veg Machine veg trend 2000-2009) Fire (GIS layer and TEC database) / Comments
19a	Occurrence 1 (PB01, PtBecher01North, PtBecher01South)	Groundwater decline Over-grazing by native or introduced species Weed invasion Inappropriate fire regime (too frequent) Recreational activities	One quadrat established (PB01), Analysed.	Quindalup complex	No data - bore within Occ, commence 1 May 1998. Site ID 23025819.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Fire fuel age 2 years.
19a	Occurrence 2 (PB06)	Recreational activities Over-grazing by native or introduced species Weed invasion Inappropriate fire regime (too frequent) Groundwater decline	One quadrat established (PB06). Analysed.	Quindalup complex	No data - bore within Occ commence date 1 May 1998 - Site ID 23025816). No data - bore 64m west of Occ – drill date 1 May 1998 (estimate) - commence 1 May 1998 - Site ID 23025807.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age 2 years.
19a	Occurrence 4 (Rich01, Rich02, Rich03, Rich04) * Bore data from 5 instead of 2 taken due to shape of occur	Inappropriate fire regime (too frequent) Weed invasion Recreational activities Hydrological changes - water quality and/ or levels	One quadrat established (Rich01). Analysed.	Quindalup complex	No data - Site ID 20024960. No data - bore within Occ – drill date 30 June 1964 - Site ID 20024985). No data - bore 13m east of Occ – commence date 20 December 1983. Site ID 2972. No data - bore 51m south of Occ – drill date 30 June 1964 - Site ID 20024990. No data - bore 78m west of Occ – drill date 30 June 1964 - Site ID 20025006.	Within Man-Made Structure/ Fish Trap and Ceremonial site	Mainly in excellent condition. Veg Trend indicates mostly no major change on the west side of Occ and a mostly negative change on the east side of Occ. Fire fuel age ≥6 years on northeast edge and 4 years on eastern edge.
19a	Occurrence 5 (Rich05)	Inappropriate fire regime (too frequent) Weed invasion Recreational activities Hydrological changes - water quality and/ or levels	No quadrats established.	Quindalup complex	No data - bore 164m south of Occ – drill date 30 June 1964 - Site ID 20024990. No data - bore 241m east of Occ – drill date 30 June 1964 - Site ID 20024989.	Within Ceremonial site. Boundary of Man-Made Structure/Fish Trap site nearby	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Fire fuel age ≥6 years and 4 years on eastern edge.
19a	Occurrence 17 (MyCool01)	Weed invasion Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No data - bore 148m northwest of the Occ- drill date 30 June 1964 - Site ID 20023922.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly no major change. Fire fuel age 1 year.
19a	Occurrence 18 (PtKennedy98)	Weed invasion Clearing Inappropriate fire regime (too frequent) Hydrological changes - water quality and/ or quantity Rubbish dumping	One quadrat established (PtKennedy98). Analysed.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age ≥6 years.

19a	Occurrence 19 (Ptkennedy101)	Weed invasion Clearing Inappropriate fire regime (too frequent) Hydrological changes - water quality and/ or quantity Rubbish dumping	One quadrat established (PtKennedy101). Analysed.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age ≥6 years.
19a	Occurrence 20 (Ptkennedy103)	Weed invasion Inappropriate fire regime (too frequent) Hydrological changes – water quality and/ or quantity	One quadrat established (PtKennedy103). Analysed.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age ≥6 years.
19a	Occurrence 21 (PtKennedy95)	Clearing- complete vegetation clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Fire fuel age ≥6 years.
19a	Occurrence 27 (LarkHill22)	Clearing- complete vegetation clearing Weed invasion Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 28 (LarkHill23)	Clearing- complete vegetation clearing Weed invasion Grazing by native or introduced species Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. No fire data.
19a	Occurrence 30 (LarkHill26)	Inappropriate fire regime (too frequent) Weed invasion Grazing by native or introduced species	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in good to very good condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age 3 years.
19a	Occurrence 33 (SecretHarbour16)	Hydrological changes- water quality and/or quantity Weed invasion Rubbish dumping Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	**7.70m (from top of casing bore 201m north of Occ on 8 May 2009 - commence date 13 April 1977 - Site ID 2992).** **7.45m (from top of casing bore 202m north of Occ on 8 May 2009 - drill date 1975, - commence date 10 June 1975 - Site ID 2991).**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. Likely long unburnt.
19a	Occurrence 36 (SecretHarbour42)	Weed invasion Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Trampling	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. No fire data.
19a	*Occurrence 37 (SecretHarbour54) Cleared*	*Clearing- complete vegetation clearing (historic threat only)*	*No quadrats established.*	*Quindalup complex*	***0.80m (bore 32m southwest of Occ on 10 April 1985 - drill date 10 April 1985 - Site ID 20025134.***	*No known sites in close proximity*	*Completely degraded - no longer extant (land cleared)*
19a	Occurrence 38 (PtKennedy23)	Weed invasion Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Trampling	No quadrats established.	Quindalup complex	No data - bore 262m northwest of Occ- drill date 1 May 1998 (estimate) -, commence date 1 May 1998 - Site ID 23025781. No data - bore 267m northwest of Occ- commence date 1 May 1998 - Site ID 23025798.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.

19a	*Occurrence 39 (PTKennedy26) Cleared*	*Clearing- historic threat only*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Completely degraded no longer extant (land cleared)*
19a	Occurrence 40 (PtKennedy18)	Weed invasion Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Trampling Rubbish dumping	No quadrats established.	Quindalup complex	**2.45m (bore 218m southeast of Occ on 14 October 1999 - drill date 14 October 1999, commence date 14 October 1999 - Site ID 20083764.** No data - bore 283m west of Occ- drill date1 May 1998 (estimate), commence date 1 May 1998 - Site ID 23025780.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly no major change with some positive and some negative change. No fire data.
19a	Occurrence 41 (PtKennedy50)	Clearing- complete vegetation clearing Weed invasion Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Trampling	No quadrats established.	Quindalup complex	No data - bore 78m southeast of Occ- drill date 1 May 1998, commence date 1 May 1998 (estimate) - Site ID 23025801). No data - bore 78m southeast of Occ- drill date 1 May 1998, commence date 1 May 1998 (estimate) - Site ID 23025802.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly no major change. No fire data.
19a	Occurrence 42 (PtKennedy16)	Clearing- complete vegetation clearing Weed invasion Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Trampling	No quadrats established	Quindalup complex	No data - bore 25m west of Occ - commence date 1 May 1998 - Site ID 23025809). No data - bore 103m east of Occ - commence date 1 May 1998 - Site ID 23025810).	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 43 (PtKennedy49)	Clearing- complete vegetation clearing Weed invasion Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Trampling	No quadrats established.	Quindalup complex	No data - bore 125m south east of Occ - commence date 1 May 1998 -Site ID 23025800). No data - bore 126m southeast of Occ- drill date 1 May 1998, commence date 1 May 1998 (estimate) - Site ID 23025801.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some negative to major negative change. No fire data.
19a	Occurrence 44 (Walyungup01)	Weed invasion Inappropriate fire regime (too frequent) Trampling	No quadrats established.	Quindalup complex	**1.29m - bore 73m north of Occ on 2 July 1975 - drill date 17 May 1975, commence date unknown - Site ID 20023954.** No data - bore 128m north east of Occ- drill date 30 June 1964 - Site ID 20023921).	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. No fire data.
19a	Occurrence 45 (PtKennedy113)	Clearing- complete vegetation clearing Weed invasion Inappropriate fire regime (too frequent) Rubbish dumping	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates a negative to major negative change. No fire data.
19a	Occurrence 47 (PtKennedy120)	Clearing- complete vegetation clearing Weed invasion Inappropriate fire regime (too frequent) Recreational activities Rubbish dumping	No quadrats established.	Quindalup complex	6.66m - from top of casing bore 220m south east of Occ on 18 March 1997- commence date 1 January 1984 - Site ID 3244.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly no major change. No fire data.

19a	Occurrence 48 (PointBecher32)	Hydrologic changes- water quality and/or quantity Weed invasion Recreational activities Rubbish dumping	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Thought to have been washed away with storm surge, but recent survey indicates occurrence still intact
19a	Occurrence 49 (PointBecher01)	Weed invasion Recreational activities Inappropriate fire regime (too frequent) Grazing by native or introduced species Groundwater decline Nutrient enrichment Rubbish dumping	No quadrats established.	Quindalup complex	No data - bore 8m east of Occ - commence date 1 May 1998 - Site ID 23025815. 0.005m from top of casing - bore 123m north of Occ on 18 August 2009 - commence date 28 July 1983 - Site ID 3403.	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age 2 years.
19a	Occurrence 50 (PointBecher02)	Weed invasion Recreational activities Inappropriate fire regime (too frequent) Grazing by native or introduced species Groundwater decline Nutrient enrichment Rubbish dumping	No quadrats established.	Quindalup complex	No data - bore 115m northwest of Occ - commence date 1 May 1998 - Site ID 23025815).	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a major negative change. Fire fuel age 2 years.
19a	Occurrence 52 (MyPoint Becher07, PointBecher35)	Weed invasion Recreational activities Inappropriate fire regime (too frequent) Grazing by native or introduced species Groundwater decline Nutrient enrichment Rubbish dumping	No quadrats established.	Quindalup complex	No data - bore 25m south of Occ - commence date 1 May 1998 - Site ID 23025814. No data - bore 269m south east of Occ - commence date 1 May 1998 - Site ID 23025812.	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates a negative to major negative change. Fire fuel age 2 years.
19a	Occurrence 53 (Pt Kennedy 94)	Clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates some negative and some fluctuating change. No fire data.
19a	Occurrence 54(Pt Kennedy 91)	Clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. No fire data.
19a	Occurrence 55 (Pt Kennedy 92)	Clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates no major change. No fire data.
19a	Occurrence 57 (Pt Kennedy 90)	Clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates some areas of negative to major negative change. No fire data.
19a	Occurrence 58 (Pt Kennedy 97)	Clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. No fire data.

19a	Occurrence 59 (PointBecher03)	Weed invasion Recreational activities Inappropriate fire regime (too frequent) Grazing by native or introduced species Groundwater decline Nutrient enrichment Rubbish dumping	No quadrats established.	Quindalup complex	No data - bore 268m northwest of Occ - commence date 1 May 1998 - Site ID 23025815).	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age 2 years.
19a	Occurrence 60 (Pt Kennedy 96)	Clearing Weed invasion Rubbish dumping Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 61 (Pt Kennedy 116)	Hydrologic changes- water quality and/or quantity Weed invasion Rubbish dumping Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	**6.66m from top of casing bore 117m south of Occ on 18 March 1997 - drill date unknown, commence date 1 January 1984. Site ID 3244.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 62 (Pt Kennedy 123)	Hydrologic changes- water quality and/or quantity Weed invasion Rubbish dumping Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	**6.66m from top of casing bore 64m east of Occ on 18 March 1997 - commence date 1 January 1984 -Site ID 3244).** **2.35m from top of casing bore 198m southeast of Occ on 19 January 1996 - commence date 1 January 1984 - Site ID 3243.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	*Occurrence 65 (Pt Kennedy 122)*	*Hydrological changes- water quality and/or quantity* *Weed invasion* *Inappropriate fire regime (too frequent)* *Fragmentation-edge effect- large edge to area ratio*	*No quadrats established.*	*Quindalup complex*	***3.71m from top of casing bore 258m south of Occ on 18 March 1997 - commence date 1 January 1984 - Site ID 3246.*** ***2.37m from top of casing bore 261m south of Occ on 19 January 1996 - commence date 1 January 1984 - Site ID 3245.***	*No known sites in close proximity*	*Reported to be completely degraded, requires verification. Veg Trend indicates some areas of negative to major negative change. No fire data.*
19a	Occurrence 66 (PtBecher38Sc)	Weed invasion Inappropriate fire regime (too frequent) Grazing by native or introduced species Hydrologic changes – water quality and/or quantity	No quadrats established.	Quindalup complex	No data - bore 48m east of Occ – drill date 1 May 1998 (estimate) -commence 1 May 1998 - Site ID 23025807. No data - bore 78m east of Occ - commence date 1 May 1998 - Site ID 23025816.	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age 2 years.
19a	Occurrence 70 (Pt Kennedy 119)	Hydrologic changes- water quality and/or quantity Weed invasion Inappropriate fire regime (too frequent) Recreational activities Rubbish dumping	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. No fire data.
19a	Occurrence 71 (Pt Kennedy new 01)	Clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change on east side of Occ. No fire data.

19a	*Occurrence 78 (MyPoint Becher01)*	*Weed invasion* *Inappropriate fire regime (too frequent)* *Recreational activities* *Clearing*	*No quadrats established.*	*Quindalup complex*	*No data bore 241m northeast of Occ- drill date1 May 1998 (estimate) - commence date 1 May 1998 - Site ID 23025782).* *No data - bore 243m north east of Occ- commence date 1 May 199 - Site ID 23025799.*	*No known sites in close proximity*	*Reported to be completely degraded, requires verification. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. Fire fuel age 1 year.*
19a	*Occurrence 80 (MyPoint Becher02)*	*Weed invasion* *Inappropriate fire regime (too frequent)* *Recreational activities* *Grazing by native or introduced species*	*No quadrats established.*	*Quindalup complex*	*No data - bore 262m northeast of Occ- drill date1 May 1998 (estimate) - commence date 1 May 1998 - Site ID 23025782).* *No data - bore 267m northeast of Occ - commence date 1 May 1998 - Site ID 23025799).*	*No known sites in close proximity*	*Reported to be completely degraded, requires verification. Veg Trend indicates mostly no major change. Fire fuel age ≥6 years.*
19a	*Occurrence 81 (MyPoint Becher03)*	*Weed invasion* *Inappropriate fire regime (too frequent)* *Recreational activities*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Reported to be completely degraded, requires verification. Veg Trend indicates mostly a negative to major negative change. Fire fuel age ≥6 years.*
19a	Occurrence 82 (MyPoint Becher04)	Weed invasion Inappropriate fire regime (too frequent) Recreational activities Clearing- complete vegetation clearing	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates some negative to major negative change on the east side of Occ. Fire fuel age ≥6 years.
19a	Occurrence 83 (MyPoint Becher05)	Weed invasion Inappropriate fire regime (too frequent) Recreational activities Clearing- complete vegetation clearing	No quadrats established.	Quindalup complex	No data - bore 57m north of Occ- drill date1 May 1998 (estimate) - commence date 1 May 1998 - Site ID 23025782. No data - bore 62m north of Occ- commence date 1 May 1998 - Site ID 2302579).	No known sites in close proximity	Mainly in good condition. No Veg Trend data. Fire fuel age ≥6 years.
19a	Occurrence 84 (MyPoint Becher06)	Weed invasion Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 86 (MyPoint Becher08)	Weed invasion Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	No data - bore 99m east of Occ - commence date unknown - Site ID 20024951. No data - bore 155m southeast of Occ - commence date 1 May 1998 - Site ID 23025820.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. Fire fuel age 2 years.
19a	Occurrence 87 (MyPoint Becher09)	Weed invasion Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	No data - bore 172m northeast of Occ - Site ID 20024954.	No known sites in close proximity	Reported to be completely degraded, needs verification. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	*Occurrence 88 (Secret Harbour 168) Cleared*	*Clearing (historic threat only)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Completely degraded no longer extant (land cleared)*
19a	*Occurrence 90 (Secret Harbour 20) Cleared*	*Clearing (historic threat only)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Completely degraded no longer extant (land cleared)*
19a	Occurrence 91 (PtKennedy124)	Clearing Weed invasion Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates a major negative change. Fire fuel age ≥6 years.

19a	Occurrence 92 (PtKennedy115)	Clearing Weed invasion Rubbish dumping Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 93 (PtKennedy125)	Clearing Weed invasion Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some negative to major negative change on west side of Occ. Fire fuel age ≥6 years.
19a	Occurrence 94 (Rich07)	Inappropriate fire regime (too frequent) Weed invasion Recreational activities Hydrologic changes- water quality and/or quantity	No quadrats established.	Quindalup complex	No data - bore within Occ- drill date 30 June 1964 - Site ID 20024977). No data - bore 12m east of Occ - drill date 30 June 1964 - Site ID 20024989).	Within Ceremonial site. Boundary of Man-Made Structure/Fish Trap site nearby	Mainly in very good condition. Veg Trend indicates some positive change in the middle of occ and some negative change in the north and south ends of occ. Fire fuel age 4 years on eastern edge.
19a	Occurrence 95 (Walyungup06)	Grazing by introduced or native species Hydrologic changes- water quality and/or quantity Weed invasion Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some negative and some major negative change. Fire fuel age 2 years.
19a	Occurrence 96 (LarkHill158)	Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some negative to major negative change. No fire data.
19a	Occurrence 97 (LarkHill160)	Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change along north edge of occ. No fire data.
19a	Occurrence 98 (LarkHill18)	Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion	No quadrats established.	Quindalup complex	**3.31m from top of casing bore 287m northeast of Occ on 18 March 1997- commence date 1 January 1984 - Site ID 3242.**	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 99 (LarkHill152)	Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion Grazing by native or introduced species	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in good condition. Veg Trend indicates no major change on northeast corner of Occ. No fire data.
19a	Occurrence 100 (LarkHill21)	Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.

19a	Occurrence 101 (LarkHill150)	Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion Grazing by native or introduced species	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19a	Occurrence 102 (MyGB03)	Clearing- complete vegetation clearing Rubbish dumping Hydrologic changes- water quality and/or quantity Recreational activities	No quadrats established.	Quindalup complex	**2.00m - bore 226m southwest of Occ on 6 March 1988 - drill date 6 March 1988 - Site ID 20025131**.	Boundary of Camp/Water Source site nearby	Mainly in good condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. Likely long unburnt.
19a	Occurrence 103 (MyGB02)	Hydrologic changes- water quality and/or quantity Inappropriate fire regime (too frequent) Grazing by native or introduced species Weed invasion Recreational activities	No quadrats established.	Quindalup complex	**2.00m - bore 220m southwest of Occ on 6 March 1988 - drill date 6 March 1988 - Site ID 20025131.**	Boundary of Camp/Water Source site nearby	Mainly in excellent condition. Veg Trend indicates no major change. Likely long unburnt.
19a	Occurrence 104 (MyGB04)	Hydrologic changes- water quality and/or quantity Grazing by native or introduced species Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	**2.00m - bore 263m south of Occ on 6 March 1988 - drill date 6 March 1988 - Site ID 20025131.**	Boundary of Camp/Water Source site nearby	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. Likely long unburnt.
19a	Occurrence 105 (MyGB05)	Clearing Inappropriate fire regime (too frequent) Hydrologic changes- water quality and/or quantity Grazing by native or introduced species	No quadrats established.	Quindalup complex	No bore data from close proximity	Boundary of Camp/Water Source site nearby	Mainly in very good condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. Likely long unburnt.
19a	Occurrence 106 (MyGB06)	Clearing Inappropriate fire regime (too frequent) Weed invasion Grazing by native or introduced species Hydrologic changes- water quality and/or quantity	No quadrats established.	Quindalup complex	**0.80m - bore 178m northwest of Occ on 10 April 1985 - drill date 10 April 1985 - Site ID 20025134.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. Likely long unburnt.
19a	Occurrence 107 (MyGB07)	Clearing Inappropriate fire regime (too frequent) Weed invasion Grazing by native or introduced species Hydrologic changes- water quality and/or quantity	No quadrats established.	Quindalup complex	**0.80m - bore 80m northwest of Occ on 10 April 1985 - drill date 10 April 1985 - Site ID 20025134.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Likely long unburnt.
19a	Occurrence 108 (MyGB01)	Clearing Inappropriate fire regime (too frequent) Grazing by native or introduced species Weed invasion Recreational activities	No quadrat established.	Quindalup complex	**2.00m - bore 159m southwest of Occ on 6 March 1988 - drill date 6 March 1988 - Site ID 20025131.**	Boundary of Camp/Water Source site nearby	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Likely long unburnt.

19b	Occurrence 1 (Cool09)	Clearing Recreational activities Over-grazing by native or introduced species Inappropriate fire regime (too frequent)	One quadrat established (Cool09). Analysed.	Quindalup complex	**2.32m - bore 208m north of Occ on 2 July 1975- drill date 17 May 1975 - Site ID 20023960).** **2.29m - bore 209m north of Occ on 2 July 1975 - drill date 17 May 1975 - Site ID 20023961.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age ≥6 years.
19b	Occurrence 3 (IP14-07, MyIP14-09, MyIP14-10, MyIP14-12, MyIP14-13)	Clearing Over-grazing by native or introduced species Inappropriate fire regime (too frequent) Hydrologic changes - water quality and/or quantity Weed invasion	No quadrats established.	Quindalup complex	No data- bore 246m southeast of Occ - Site ID 20023722.	No known sites in close proximity	Mainly in degraded condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 6 (IP14 Plot1, IP14-05, IP14-06)	Weed invasion Inappropriate fire regime (too frequent) Hydrologic changes - water quality and/or quantity Grazing by native or introduced species	Two quadrats established (IP14 Plot1, IP14-05). Not analysed.	Quindalup complex	No data - bore 78m southwest of Occ- drill date 21 January 1989 - Site ID 20024145).	No known sites in close proximity	Mainly in good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 7 (IP14-02)	Weed invasion Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age 4 years.
19b	Occurrence 8 (IP14-08)	Clearing Weed invasion Inappropriate fire regime (too frequent) Hydrologic changes- water quality and/or quantity	No quadrats established.	Quindalup complex	No data - bore 217m west of Occ- drill date 30 June 1983 - Site ID 20024266).	No known sites in close proximity	Mainly in good to very good condition. Veg Trend indicates mostly no major change with some negative change. No fire data.
19b	Occurrence 9 (IP14-03)	Clearing Weed invasion Inappropriate fire regime (too frequent) Hydrologic changes- water quality and/or quantity	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates a negative to major negative change on the north half of Occ. Fire fuel age 4 years on southwestern portion.
19b	Occurrence 10 (XYan10)	Weed invasion Inappropriate fire regime (too frequent)	One quadrat established (XYan10). Analysed.	Cottesloe complex-central and south	No bore data from close proximity	Boundary of Mythological site nearby	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Fire fuel age 5 years.
19b	Occurrence 11 (Cool14)	Recreational activities Weed invasion Inappropriate fire regime (too frequent)	One quadrat established (Cool14). Analysed.	Quindalup complex	No data - bore 95m northeast of Occ - Site ID 20023723. **1.9m - bore 106m northwest of Occ on 1 July 1981 - drill date 1 July 1981 - Site ID 20024084.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. Fire fuel age 1 year.
19b	Occurrence 12 (Cool15)	Recreational activities Weed invasion Inappropriate fire regime (too frequent)	One quadrat established (Cool15). Analysed.	Quindalup complex	No data - bore within Occ - Site ID 20023723. **0.15m - bore within Occ on 2 July 1975 - drill date 18 May 1975 - Site ID 20023947.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Fire fuel age 1 year.

19b	Occurrence 13 (PtKennedy104)	Clearing Weed invasion Rubbish dumping Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Likely long unburnt.
19b	Occurrence 14 (PtKennedy28)	Clearing Weed invasion Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	**3.31m - from top of casing bore 4m east of Occ on 18 March 199, commence date 1 January 1984 - Site ID 3242.** **2.35m - from top of casing bore 94m north of Occ on 19 January 1996 - commence date 1 January 1984 - Site ID 3243.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 15 (LarkHill30)	Clearing Weed invasion Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	**3.66m - bore 194m southeast of Occ on 30 June 1966- drill date 30 June 1966 - Site ID 20024710.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a range of trends from major positive change to major negative change (mostly negative). No fire data.
19b	Occurrence 18 (LarkHill24)	Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Grazing by native or introduced species Weed invasion	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 19 (LarkHill27)	Weed invasion Grazing by native or introduced species Clearing- complete vegetation clearing Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 20 (LarkHill29)	Weed invasion Grazing by native or introduced species Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in good condition. Veg Trend indicates mostly a major negative change. No fire data.
19b	Occurrence 21 (GoldenBay Plot1, GoldenBay Plot2, GoldenBay01)	Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Grazing by native or introduced species Rubbish dumping	Two quadrats established (GoldenBay Plot1, GoldenBay Plot2). Not analysed.	Cottesloe complex- central and south, and Herdsman complex	No data - bore 64m east of Occ - Site ID 20024864. 2.00m - bore 89m southwest of Occ on 15 December 1994 - drill date 15 December 1994 - Site ID 20024894.	Within Ceremonial/ Historical site	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 22 (SecretHarbour46)	Weed invasion Hydrological changes- water quality and/or quantity Clearing Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. No fire data.
19b	Occurrence 23 (PtKennedy121)	Hydrological changes- water quality and/or quantity Weed invasion Inappropriate fire regime (too frequent) Recreational activities Rubbish dumping	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 24 (PointBecher Plot01,PointBecher07)	Weed invasion Grazing by native or introduced species Rubbish dumping Recreational activities	One quadrat established (PointBecher Plot01). Not analysed.	Quindalup complex	No data - bore within Occ- commence date 1 May 1998 - Site ID 23025812. No data - bore 89m south of Occ – drill date 1 May 1998 (estimate), commence 1 May 1998 - Site ID 23025807).	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly a negative to major negative change. Fire fuel age 2 years.

19b	Occurrence 25 (Pt Kennedy 100)	Clearing Weed invasion Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates a negative to major negative change. No fire data.
19b	Occurrence 26 (Pt Kennedy 25)	Hydrological changes- water quality and/or quantity Weed invasion Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	**2.35m - from top of casing bore 12m east of Occ on 19 January 1996 - commence date 1 January 1984 - Site ID 3243.** **6.66m from top of casing bore 128m northeast of Occ on 18 March 1997 - commence date 1 January 1984 - Site ID 3244.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 27 (IP14-10North, IP14-10South)	Clearing Inappropriate fire regime (too frequent) Hydrological changes- water quality and/or quantity Weed invasion	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in degraded condition. Veg Trend indicates a negative change on the south side of Occ. Fire fuel age 3 years for mid-western portion.
19b	Occurrence 28 (IP14-09Centre, IP14-09North, IP14-09South, IP14-Plot2, IP14-Plot3)	Inappropriate fire regime (too frequent) Weed invasion Recreational activities Rubbish dumping Grazing by native or introduced species	Two quadrats established (IP14-Plot2, IP14-Plot3). Not analysed.	Quindalup complex	No data - bore 295m southwest of Occ- drill date 7 November 1994 - Site ID 20024231.	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates a negative to major negative change through middle of Occ. Fire fuel age 4 years.
19b	Occurrence 29 (Pt Kennedy 118)	Hydrological changes- water quality and/or quantity Weed invasion Inappropriate fire regime (too frequent) Recreational activities Rubbish dumping	No quadrats established.	Quindalup complex	**6.66m from top of casing bore 155m south of Occ on 18 March 1997 - commence date 1 January 1984 - Site ID 3244.**	No known sites in close proximity	Mainly in good condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 30 (Walyungup02)	Clearing Rubbish dumping Inappropriate fire regime (too frequent) Weed invasion	No quadrats established.	Quindalup complex	**2.32m - bore 107m north of Occ on 2 July 1975- drill date 17 May 1975 - Site ID 20023960).** **2.29m - bore 108m north of Occ on 2 July 1975- drill date 17 May 1975 - Site ID 20023961.**	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of major negative change and some areas of no major change. Fire fuel age >=6 years.
19b	Occurrence 31 (Walyungup03)	Weed invasion Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. Fire fuel age 2 years.
19b	Occurrence 32 (Walyungup04, Walyungup05)	Weed invasion Inappropriate fire regime (too frequent) Recreational activities	No quadrats established.	Quindalup complex	**3.41m - bore 292m west of Occ on 2 July 1975 - drill date 19 May 1975 - Site ID 20023974.**	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates a range of changes from major positive change to major negative change (mostly negative). Fire fuel age ≥6 years on northwest edge.
19b	Occurrence 33 (IP14-01)	Weed invasion Recreational activities Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly no major change. No fire data.
19b	Occurrence 34 (Secret Harbour 19)	Weed invasion Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Rubbish dumping	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in good to degraded condition. Veg Trend indicates a major negative change. No fire data.

19b	Occurrence 35 (Secret Harbour 169)	Weed invasion Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Rubbish dumping	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in good to very good condition. Veg Trend indicates a major negative change. No fire data.
19b	Occurrence 36 (IP14-04)	Weed invasion Recreational activities Grazing by native or introduced species Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in very good condition. Veg Trend indicates mostly no major change. Fire fuel age 3 years for southwest portion.
19b	Occurrence 37 (SecretHarbour01)	Weed invasion Hydrological changes- water quality and/or quantity Clearing Inappropriate fire regime (too frequent)	No quadrats established.	Quindalup complex	**0.80m - bore 262m south of Occ on 22 April 1985- drill date 22 April 1985 - Site ID 20025133**.	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates a negative to major negative change. No fire data.
19b	Occurrence 38 (Rich06)	Inappropriate fire regime (too frequent) Weed invasion Recreational activities Hydrological changes- water quality and/or quantity Grazing by native or introduced species Clearing	No quadrats established.	Quindalup complex	No data - bore 73m east of Occ – drill date 30 June 1964 - Site ID 20024989. No data - bore 202m west of Occ – drill date 30 June 1964 - Site ID 20024990.	Within Ceremonial site	Mainly in very good condition. Veg trend indicates a negative to major negative change. Fire fuel age 4 years.
19b	Occurrence 39 (Walyungup07)	Inappropriate fire regime (too frequent) Hydrological changes- water quality and/or quantity Grazing by native or introduced species Weed invasion	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg trend mostly indicates a negative to major negative change. Fire fuel age ≥ 6 years.
19b	Occurrence 40 (Walyungup08)	Inappropriate fire regime (too frequent) Hydrological changes- water quality and/or quantity Grazing by native or introduced species Weed invasion	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates some areas of major negative change and some areas of no major change. Fire fuel age ≥ 6 years.
19b	Occurrence 41 (LarkHill17)	Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion Fragmentation-edge effect- large edge to area ratio	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in excellent condition. Veg Trend indicates mostly a negative to major negative change. No fire data.
19b	Occurrence 98 (LarkHill13)	Hydrological changes- water quality and/or quantity Inappropriate fire regime (too frequent) Weed invasion Groundwater decline	No quadrats established.	Quindalup complex	No bore data from close proximity	No known sites in close proximity	Mainly in good condition. Veg Trend indicates some areas of no major change and some areas of negative to major negative change. No fire data.
19b	Occurrence 99 (Muddy01, Muddy02)	Hydrological changes- water quality and/or quantity Weed invasion Grazing by native or introduced species	Two quadrats established (Muddy01, Muddy02). Not analysed.	Quindalup complex	No bore data from close proximity	Boundary of Skeletal Material/ Burial site nearby	Mainly in very good to excellent condition. No Veg Trend data. No fire data.

19b	*Occurrence 100 (MyIP14-02)*		*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Reported as degraded no longer extant, requires verification*
19b	*Occurrence 103 (MyIP14-03)*	*Weed invasion* *Recreational activities* *Inappropriate fire regime (too frequent)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Reported as degraded no longer extant, requires verification*
19b	*Occurrence 104 (MyIP14-04)*	*Weed invasion* *Recreational activities* *Inappropriate fire regime (too frequent)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Reported as degraded no longer extant, requires verification*
19b	*Occurrence 105 (MyIP14-05)*	*Weed invasion* *Recreational activities* *Inappropriate fire regime (too frequent)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Degraded - no longer extant*
19b	*Occurrence 106 (MyIP14-06)*	*Weed invasion* *Recreational activities* *Inappropriate fire regime (too frequent)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Degraded - no longer extant*
19b	*Occurrence 107 (MyIP14-07)*	*Weed invasion* *Recreational activities* *Inappropriate fire regime (too frequent)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Degraded - no longer extant*
19b	*Occurrence 108 (MyIP14-08)*	*Weed invasion* *Recreational activities* *Inappropriate fire regime (too frequent)*	*No quadrats established.*	*Quindalup complex*	*No bore data from close proximity*	*No known sites in close proximity*	*Degraded - no longer extant*

Italics = cleared – historic record only; or reported as degraded - no longer extant
Bold = bore data available for occurrence or nearby
#Veg machine data indicates reflectance of vegetation; eg negative trend indicates decline in vegetation cover that may be associated with fire, clearing, decline of tree or shrub layers etc
Weed invasion is noted as a threat where invasive weeds were recorded in the occurrence.

1.2 Description of occurrences

The total area occupied by the 99 extant occurrences of the sedgelands in Holocene dune swales community as described by Gibson *et al*. (1994) is approximately 193 ha (see Table 1). The majority of occurrences are situated on Quindalup dunes. The sedgelands community that occurs in the other areas has been determined by multi-variate analysis of plot data (Gibson *et al*. 1994; DEP 1996) or through other surveys (Trudgen and Weston 1998; DEC unpublished data).

Two sub-groups of the community have been identified by DEP (1996) and Trudgen and Weston (1998), and were reported in Bush Forever (2000). Community type 19a is termed 'sedgelands in Holocene dune swales' and generally occurs in the younger swales. Community type 19b is termed 'woodlands over sedgelands in Holocene dune swales' and tends to occur in older swales. This subgroup has an overstorey of woodlands including tuart trees (*Eucalyptus gomphocephala*), swamp paperbark (*Melaleuca rhaphiophylla*) and swamp Banksia (*Banksia littoralis*). Essentially, sub-groupings appear to relate to variations in depth to groundwater and in age of the dunes ([1]B. Keighery personal communication). However, these sub-groups are all termed 'sedgelands in Holocene dune swales' and categorised as the threatened ecological community, and are grouped in this plan as the same plant community. Of the 99 occurrences considered to be extant, 61 are considered to be type 19a occurrences, and 38 are 19b.

Other possible areas containing the community may be found at Cheynes Beach, Preston Beach and south of Lancelin. These areas should be investigated to see whether they support occurrences of the sedgelands in Holocene dune swales. The floristic composition of these wetlands need to be surveyed and data analysed.

Sedgelands in Holocene dune swales occurrences 1, 2, 48, 49, 50, 52, 59, 66, 78, 80, 81, 82, 83, 84, 86 (PB01, 06, PtBecher01North, PtBecher01South, PointBecher32, 01, 02, 03, 35 MyPoint Becher01, 02, 03, 04, 05, 06, 07, 08, PtBecher38Sc) and Woodlands over sedgelands in Holocene dune swales occurrence 24 (PointBecher07, PointBecher Plot01) are located within the boundaries of Port Kennedy Scientific Park which is part of Rockingham Lakes Regional Park. These sedgelands occur in Holocene dune swales that are highly valued for their excellent demonstration of a continuous depositional history of sediment dating from 7000 BP to present (Tauss 2002). The wetlands of Point Becher are also on the Ramsar List of Wetlands of International Importance and are all located in Bush Forever Site 377. The main threats to the Point Becher occurrences include recreational activities (mainly unauthorised vehicle access), weed invasion and inappropriate fire regime (too frequent).

The draft Ecological Character Description for the Becher Point Wetlands (V & C Semeniuk Research Group 2009) states the following:

"The Becher Point Wetland site meets the following two Ramsar listing criteria:

Criterion 1
A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

The Becher Point Wetlands are an example of shrub swamps and seasonal marshes that have formed in an extensive sequence of inter-dunal depressions that have arisen from seaward advancement of the coastline over recent millennia. This type of wetland system is rare in South-Western Australia. Examples of this type of geomorphological sequence in equally good condition and within a protected area are rare world-wide (RIS 2003).

Criterion 2
A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

[1] Bronwen Keighery; Office of the Environmental Protection Authority

The Becher Point Wetlands support plant communities typical of seasonal and shallow wetlands, and includes a threatened ecological community listed under the Environment Protection and Biodiversity Conservation Act (1999) recorded as *sedgelands in Holocene dune swales of the southern Swan Coastal Plain.* The sedgelands are also unusual due to their small size and scattered nature."

Sedgelands in Holocene dune swales occurrences 4, 5, 94 (Rich01, 02, 03, 04, 05, 07) and Woodlands over sedgelands in Holocene dune swales occurrence 38 (Rich06) are enclosed by Richmond Ave, Fisher St, Lake St and Safety Bay Rd. These occurrences border Lake Richmond and are in very close proximity to another threatened ecological community identified as the 'Stromatolite like microbialite community of coastal freshwater lakes (Lake Richmond)'. Both of these communities are part of Rockingham Lakes Regional Park and are in Bush Forever Site 358. Major threats to the sedgelands occurrences include inappropriate fire regime (too frequent), weed invasion, recreational activity and hydrological changes- water quality and/or quantity.

Sedgelands in Holocene dune swales occurrences 17, 44, 95 (MyCool01, Walyungup01, 06) and Woodlands over sedgelands in Holocene dune swales occurrences 1, 11, 12, 30, 31, 32, 39, 40 (Cool09, 14, 15, Walyungup02, 03, 04, 05, 07) are situated around the edges of Lake Cooloongup and Lake Walyungup which are both included in Rockingham Lakes Regional Park. All occurrences (with the exception of occurrence 30 (Walyungup02)) are within the park boundary and all occurrences are in Bush Forever Site 356.

Occurrences 11 and 12 (Cool14 and Cool15) are situated at the north-eastern end of Lake Cooloongup adjacent to Mandurah Rd. There is a walk trail located along the edge of these occurrences that increases the risk of recreational impacts. Other major threats include weed invasion and inappropriate fire regime (too frequent).

All other occurrences surround Lake Walyungup which is bordered by Safety Bay Rd, Mandurah Rd and Perth-Bunbury Hwy. Occurrence 17 (MyCool01) is located just north of Safety Bay Rd. Weed invasion, inappropriate fire regime (too frequent), hydrological changes-water quality and/or quantity, and recreational activities are prominent threats in these occurrences.

Woodlands over sedgelands in Holocene dune swales occurrences 3, 6, 7, 8, 9, 27, 28, 33, 36, 100, 103, 104, 105, 106, 107, 108 (MyIP14-02, 03, 04,05,06,07,08,09,10,12,13, IP14-01,02,03,04,05,06,07,08; IP14-Plot1, 2, 3, IP14-09North, 09South,09Centre, IP14-10North,10South) are bordered by Crompton Rd, Day Rd, Mandurah Rd, Office Rd and Perth-Bunbury Hwy in East Rockingham (except occurrence 33 (IP14-01) which is to the west of Perth-Bunbury Hwy). The south-east portion of the area is proposed for conservation and all other areas proposed for clearing. Negotiations are continuing in regards to the reservation/clearing of these occurrences.

Woodlands over sedgelands in Holocene dune swales occurrence 10 (XYan10) is located in Yanchep National Park and is included in Bush Forever Site 288. It occurs on Cottesloe soil complex and the main threats to this occurrence are weed invasion and too frequent fire.

Woodlands over sedgelands in Holocene dune swales occurrence 99 (Muddy01, 02) is located in Dalyellup and is relatively isolated from urban areas although it is likely that in the future the occurrence will be close to development. Hydrological changes-water quality and/or quantity, weed invasion and grazing by native or introduced species are all threats to this occurrence.

Sedgelands in Holocene dune swales occurrences 61, 62, 65, 70, 99, 101 (Pt Kennedy 116, 123, 122, 119, LarkHill152, 150) and Woodlands over sedgelands in Holocene dune swales occurrences 23, 26, 29, 98 (PtKennedy 121, Pt Kennedy 25, 118, LarkHill13) are part of Rockingham Lakes Regional Park and are bordered by Perth-Bunbury Hwy, Port Kennedy Dr and Warnbro Sound Ave in Port Kennedy. These occurrences are located in Bush Forever Site 356. Although this area is fenced, recreational activity, mostly trail bikes, is still an issue. Other threats include hydrological changes-water quality and/or quantity, weed invasion and too frequent fire.

Sedgelands in Holocene dune swales occurrences 108, 103, 102, 104, 105, 106, 107 (MyGB01, MyGB02, MyGB03, MyGB04, MyGB05, MyGB06, MyGB07) are situated in a linear swale, close to the coast between Dampier Drive and Turtles Bend in Golden Bay. Housing developments are encroaching on the area and clearing for development is a significant threat for these occurrences. Too frequent fire and changes to water quality and/or levels are also current threats to these occurrences.

Woodlands over sedgelands in Holocene dune swales occurrence 21 (GoldenBay Plot 1, 2, GoldenBay01) is located adjacent to Perth-Bunbury Hwy in Golden Bay. This occurrence is threatened by changes to water quality and/or levels, too frequent fire and grazing by native or introduced species.

Sedgelands in Holocene dune swales occurrence 33 (SecretHarbour16) and Woodlands over sedgelands in Holocene dune swales occurrences 22, 37 (SecretHarbour46, 01) are part of the native vegetation siding Secret Harbour Golf Course in Secret Harbour. They lack sufficient buffers and are likely to be affected by changes to water quality and/or levels, weed invasion and too frequent fire.

Woodlands over sedgelands in Holocene dune swales occurrences 34, 35 (Secret Harbour 19, 169) are adjacent to a sporting oval, Comet Bay College and the Secret Harbour Golf Course in Secret Harbour. These occurrences are in poor condition and there is no buffer around them. They are subject to threats including weed invasion, changes to water quality and/or levels and too frequent fire.

Sedgelands in Holocene dune swales occurrence 36 (SecretHarbour42) is located adjacent to Secret Harbour Bvd in Secret Harbour. Current threats for this occurrence include weed invasion, changes to water quality and/or levels and too frequent fire.

Sedgelands in Holocene dune swales occurrences 27, 28, 30, 96, 97, 98, 100 (LarkHill22, 23, 26, 158, 160, 18, 21) and Woodlands over sedgelands in Holocene dune swales occurrences 14, 15, 18, 19, 20, 41 (PtKennedy28, LarkHill30, 24, 27, 29, 17) are bordered by Warnbro Sound Ave, Port Kennedy Dr, Forty Rd and Surf Dr in Port Kennedy (with the exception of occurrence 15 (LarkHill30) east of Forty Rd, Port Kennedy). All occurrences are in close proximity to the Lark Hill Thoroughbred Training Complex and are under threat from changes to water quality and/or levels. Other threats include weed invasion, too frequent fire, and grazing by native or introduced species. Sedgelands in Holocene dune swales occurrences 27, 28, 96, 97, 98 and 100 (LarkHill22, 23, 158, 160, 18 and 21) and Woodlands over sedgelands in Holocene dune swales occurrence 41 (LarkHill17), and the northern portion of occurrence 14 (PtKennedy28) are part of Bush Forever Site 356.

Sedgelands in Holocene dune swales occurrences 18, 19, 20, 21, 45, 47, 53, 54, 55, 57, 58, 60, 71, 91, 92, 93 (Pt Kennedy98, 101, 103, 95, 113, 120, 94, 91, 92, 90, 97, 96, Pt Kennedy new01, Pt Kennedy124, 115, 125) and Woodlands over sedgelands in Holocene dune swales occurrences 13, 25 (Pt Kennedy100, 104) are situated east of Bakewell Dr in Port Kennedy. These occurrences are adjacent to light industry and consequently, the main threats include clearing, weed invasion, too frequent fire, and rubbish dumping.

Sedgelands in Holocene dune swales occurrence 87 (MyPoint Becher09) is situated just outside the northern boundary of Port Kennedy Scientific Park. The condition of the occurrence needs to be clarified.

Sedgelands in Holocene dune swales occurrence 37, 38, 40, 41, 42, 43 (Pt Kennedy26, PtKennedy23, Pt Kennedy18, 50, 16, 49) are in close proximity to the Port Kennedy Golf Course and housing developments in Port Kennedy. These occurrences are under threat from clearing, weed invasion and changes to water quality and/or levels.

Sedgelands in Holocene dune swales occurrences 37, 88, 90 (SecretHarbour54, Secret Harbour 168, 20) are no longer extant as they were cleared for urban development.

1.3 Biological and ecological characteristics

Most of the wetlands are damplands; they are waterlogged with high moisture near the surface in summer. Some are sumplands and are seasonal inundated usually for less than 2 months of the year. The sedgeland community also occurs adjacent to the waterbodies of Lakes Walyungup, Cooloongup and Richmond. The community in these situations is typically a dense, species-poor sedgeland dominated by bare twigrush (*Baumea juncea*) and knotted club rush (*Ficinia nodosa*).

Several weed taxa are known to occur in the community and although they generally form only a minor component of the vegetation, some weed species have become a problem in areas where disturbance levels are high. Localised infestations of weeds such as Geraldton carnation weed (*Euphorbia terracina*) pose a large threat to a number of occurrences.

In some of the older swales near Lakes Walyungup and Cooloongup, at Yanchep, and at IP14, an open tree cover has developed over the sedgeland. At Lake Walyungup, swamp banksia (*Banksia littoralis*) forms the canopy while at Yanchep, IP14 and Lake Cooloongup tuart (*Eucalyptus gomphocephala*) dominates the overstorey. Both species are known to tolerate damp conditions.

All occurrences except those on the eastern side of Golden Bay and at Yanchep occur on the Quindalup soils of the Aeolian Deposit group as mapped by Churchward and McArthur. The Quindalup soils are found in dunes and beach ridges which consist of calcareous sands (Churchward and McArthur 1980).

The Yanchep occurrence is located on the Cottesloe soil and landform unit and the occurrence on the eastern side of Golden Bay is situated on both Cottesloe and Herdsman units. The Cottesloe unit is part of the Aeolian Deposit group and is described as a low undulating area with shallow brown sands over limestone, and much exposed limestone. The Herdsman unit is also included in the Aeolian group and mainly consists of peaty swamps (Churchward and McArthur 1980).

1.4 Geology and sedimentology

The Becher cuspate foredune developed in response to a falling sea level during the middle to late Holocene period, forming a sequence of submarine banks and beachridge plains on the inter-ridge depression between the Spearwood Ridge (on the mainland) and the nearshore Garden Island Ridge (V & C Semeniuk Research Group 2009). This is the geomorphic outline for the formation of the Becher Point wetlands.

V & C Semeniuk Research Group noted that the wetlands at Point Becher are located between beachridges 1-3 m high, and 30-60 m apart. Elevation of swales is variable, as are heights of separate basins along a single swale, however, there is a general increase in swale elevation in a southerly direction (V & C Semeniuk Research Group 2009). Occurrences of the sedgelands community on the Rockingham-Becher Plain have been formed within the swales on this prograding coastline (Semeniuk 2007).

Individually the Becher Point wetlands are small, but represent different stages of evolutionary development. The sediment at depth is the Leederville Formation and is overlain by Rockingham Sand, with overlying Australind Formation and Tamala Limestone (Semeniuk 2007). Throughout the wetlands, sedimentary fills vary in thickness from 30 to 120 cm with three distinct sedimentary stratigraphic sequences occurring: muddy sand dominated, carbonate mud dominated, and peat influenced (V & C Semeniuk Research Group 2009).

It is unusual that carbonate mud and peat both occur in these wetlands as peat formation and accumulation requires slightly acidic conditions, and carbonate mud formation requires alkaline conditions. Peat generally forms under relatively wet conditions with frequent inundation, higher plant density, and slower plant decay. Peat dominated sediments are currently accumulating in the wetlands and occur as peat infused carbonate mud less than 10 cm thick (V & C Semeniuk Research Group 2009).

Carbonate mud is formed in fresh water. Algal fragments formed in dry times disintegrate to form carbonate mud (Semeniuk 2007). The carbonate mud in the Becher wetlands is correlated to a very seasonal climate, with features that indicate alternating emergence and water inundation/saturation. Carbonate mud sediment ranges in thickness from 5-30 cm (V & C Semeniuk Research Group 2009).

In the Becher Point Wetlands, the development of carbonate mud is intermittent, but it forms the dominant wetland fill as either pure mud or calcilutaceous muddy sand. The muddy sand is the most common fill in these wetlands and usually varies from 25-60 cm thick (V & C Semeniuk Research Group 2009).

High levels of calcium and magnesium help determine plant communities present. Acidic water from rain aids carbonate dissolution and wetland deepening. 'Topping up' or drawdown of wetlands would destroy the hydrological patterns. This has implications for water use at occurrences such as Lark Hill Thoroughbred Training Complex, which is located outside the Ramsar site, altering downgradient flow and influencing the Ramsar wetlands (Semeniuk 2007).

1.5 Hydrology

The sedgelands in Holocene dune swales is a wetland community with occurrences situated in damplands and sumplands. These wetlands have subtle topographic relief therefore soil moisture, vegetation and habitats could be affected by 'unnatural' watertable alterations. In recent times there has been a trend towards a drying climate on the Swan Coastal Plain. Decreased annual rainfall and hotter temperatures are likely to lead to groundwater decline in wetland communities.

Most of the available hydrological data for the community has been derived from studies of the Becher Suite wetlands (V & C Semeniuk Research Group 2009; Semeniuk 2007) and consultants' reports covering Port Kennedy Scientific Park and the IP14 area (RPS Environment and Planning 2010a; Coffey Environments 2009). Some data have also been obtained from the Department of Water (DoW) Groundwater - Water Information System (WIN).

As the Perth metropolitan area continues to expand, significant urbanisation will take place near most occurrences of the sedgeland community. Water tables are likely to rise in the superficial aquifer as a consequence of further clearing in the catchment. Rising water-tables have the potential to cause longer and deeper wetting of these wetlands and therefore to significantly modify the ecological community. Although this is a possible threat, it is expected that the sedgelands are under greater threat from a decrease in groundwater levels due to the combination of a drying climate, and water extraction for irrigation and industrial purposes.

Some of the wetlands (sumplands) contain very limited areas of surface water during the winter months. The typical wetland within the occurrences around Port Kennedy is a dampland which is waterlogged in winter, and retains relatively high soil moisture at the surface of the soil profile in summer. Although the wetlands are expected to be strongly influenced by their proximity to the watertable, they also rely on direct rainfall.

Although bores are located close to many occurrences of the sedgelands, the nature of this community means that only bores running along the swales containing sedgelands will contain water level data applicable to the sedgeland community. Bores located in adjacent swales may also provide relevant information about water quality.

Several monitoring bores are located very close to, or within occurrences of the sedgeland community. Bore data from Semeniuk (2007) and RPS Environment and Planning (2010a) is current and indicates that occurrences of the sedgelands community in Port Kennedy Scientific Park, Lake Walyungup, adjacent to Forty Rd in Port Kennedy, and east of Bakewell Dr in Port Kennedy are located where groundwater is close to the surface (Appendix 3, Appendix 4). Data from bores indicates that groundwater levels are from 2.44m below the surface to 0.5m above ground level.

In the IP14 area a decline of 0.9m in groundwater levels from 1991 to 2004 (Coffey Environments 2009) has been recorded. This may be due to a number of factors including a drying climate and increased water extraction for surrounding heavy industry.

The noticeable drop of annual groundwater levels by about 0.8m in DoW bores close to sedgelands occurrence 33 (SecretHarbour16) after the start of 1993 could be due to a number of reasons. Urban development on the Rockingham-Becher plain has increased greatly over the last 25 years. It is likely that a drying climate and increased water extraction for irrigation for golf courses and household use has caused the groundwater levels to decrease. Due to the location of these bores, the data collected may not be a good indication of groundwater levels or quality in the adjacent sedgelands however it is likely that the groundwater levels have also dropped in a similar manner in the surrounding area.

DoW bores located near other occurrences of the community have the potential to provide useful hydrologic information (Appendix 5). Bore 3243 is in close proximity to occurrence 26 (Pt Kennedy 25). The most recent water level data for this bore is from 1993 and would no longer be relevant. There is currently no water quality data available from this bore. There is available groundwater level and quality information for bores 3242 and 3244, however, the most current data is from 1997 and 1998 and is therefore unlikely to be relevant. If re-sampled, bores 3242, 3243 and 3244 near sedgelands in Holocene dune swales occurrences 47, 61, 62, 98 (Pt Kennedy 120, 116, 123, LarkHill18) and woodlands over sedgelands in Holocene dune swales occurrences 29, 26, 14 (Pt Kennedy 118, 25, 28) could provide a valuable insight to the hydrology of the occurrences that are in very close proximity to urban development and the effects of being adjacent to a sporting complex with grassed ovals. Data may also highlight differences in hydrological processes between older and younger occurrences of the community.

1.6 Important occurrences

Occurrences that provide for a representative cross section of each geomorphic age sequence of this community and that can be managed for conservation and/or with conservation included in their purpose are considered critical to the survival of this ecological community.

1.7 Affected interests

Occurrences of the sedgelands community are located on land managed by DEC, City of Rockingham, WA Beach and Golf Resort Pty Ltd, LandCorp and private land holders. Land owners and managers of all occurrences may be affected by actions in this plan, in particular land not managed by DEC at IP14, Lark Hill, on the western side of Golden Bay, and adjacent to Bakewell Drive in Port Kennedy.

Indigenous interests:

The South West Aboriginal Land and Sea Council (SWALSC) covers the areas considered in this plan. A staff member from SWALC was consulted with regard to the appropriate method to gain input from the group. Comment was sought from the Council about any aspects of the plan, but particularly about the proposed on-ground actions. Table 4 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance. No general significance to indigenous people has been identified for the ecological community. Action 2 below identifies the intention to continue liaison with relevant groups, including indigenous groups.

1.8 Social and economic impacts and benefits

The coastal nature and aesthetic values associated with the sedgeland community attract a range of people including local residents and tourists. Pedestrian access by means of formal walk trails has potential to allow the aesthetic values of the sedgelands to be appreciated without degrading the community, and this provides a social benefit.

Unauthorised vehicle access and other recreational activities particularly in occurrences at IP14, Port Kennedy Scientific Park and near Bakewell Drive are social activities that are damaging to the community. Where specific active recreational pursuits, such as four wheel driving, are prevented through access control this may be perceived as a social impact by some members of local communities, however such access control also helps to prevent the continued degradation of the sedgelands and hence to maintain other social benefits.

Occurrences near Bakewell Drive are zoned for light industry and some occurrences at IP14 are planned for heavy industry. Both areas are generally planned for further development. The economic value of both areas if developed is high and both suites of occurrences in these areas are potentially threatened by clearing and secondary impacts such as hydrological change. Both the IP14 and Bakewell Drive areas have been subject to environmental impact assessment.

The occurrences on the west side of Golden Bay are situated in a prime location for housing and some may be threatened by proposals to clear or from hydrological change following clearing and development of adjacent land. The proposals to develop part of the site are subject to environmental impact assessment processes. Implementation of actions such as seeking to protect the hydrological processes in the adjacent sedgeland community may result in a perceived impact on the income from residential development however such controls may also help to prevent the degradation of the sedgelands and hence to maintain other social benefits.

Wetlands such as this sedgeland community provide various ecosystem services such as absorption of nutrients and other chemicals from polluted surface and groundwater. These services would have an economic value but are lost when wetlands are cleared and filled.

1.9 Related biodiversity impacts and benefits

Recovery actions implemented to improve the quality or security of the community are likely to improve the status of any species within the community. Occurrences at Lake Richmond are in very close proximity to another EPBC and state-listed threatened ecological community; the 'Stromatolite like microbialite community of coastal freshwater lakes (Lake Richmond)'. If actions implemented improve the quality of the Lake Richmond sedgelands occurrences it is likely the microbialite community will benefit - particularly if recreational impacts and fire frequency are decreased and groundwater quality is maintained or improved.

1.10 Term of plan

Western Australia
The plan will operate from 2011 to 2016 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Critically Endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be assessed by the recovery plan implementation group.

Commonwealth
In accordance with the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) this adopted recovery plan will remain in force until revoked.

The recovery plan must be reviewed at intervals of not longer than 5 years.

2.0 Threatening processes

The remaining occurrences of the sedgelands in Holocene dune swale community have been subject to extensive historical disturbance. Most of these processes are still common to most known occurrences of the community:

- hydrological changes - water quality and/or levels
- clearing
- inappropriate fire regime (too frequent)
- increased weed invasion
- recreational activities
- over-grazing by native or introduced species (as indicated by obvious levels of impacts to edible vegetation by grazers)
- rubbish dumping
- fragmentation, edge effects, large edge to area ratio
- lack of knowledge to guide management

Hydrological changes – water quality and/or levels

A large number of occurrences are located in damplands and sumplands in close proximity to developed lands including roads, industry, housing, golf courses, a horse training facility, a sporting complex and several sporting ovals. As a consequence it is likely that groundwater levels and quality, and hydrological processes in the area have been altered.

Historic and current clearing, particularly on the Rockingham-Becher Plain is expected to have caused a rise in the watertable, however, increased extraction from household and industrial bores as well as extraction for irrigation golf courses, sporting complexes and other sporting ovals is likely to draw down groundwater levels. A general drying trend from the drying climate on the southern Swan Coastal Plain has led to groundwater decline in wetlands containing the sedgelands community at IP14 and in the Port Kennedy area in general (eg Coffey Environments 2009; RPS 2010a), and by inference throughout the whole area of occurrence of the sedgelands in Holocene dune swales community. The net effect of these impacts on the water table is unknown.

Water quality of occurrences on the Rockingham-Becher Plain is also likely to be affected as an increased amount of nutrients enter the wetlands through the use of fertiliser on the large grassed areas. It is unknown if pesticides or other contaminants of the groundwater are present in unacceptable quantities however, use of the wetlands as rubbish disposal sites (for example at IP14 and near Bakewell Drive in Port Kennedy) also has the potential to cause groundwater contamination. Nutrient contamination has been recorded at the community at Lark Hill and Kennedy Bay, when high levels of phosphate were recorded downstream of areas where fertiliser had been applied (Coffey Environments 2009a; RPS 2010a).

Groundwater abstraction for irrigation purposes may allow saltwater intrusion into the shallow aquifer in areas close to the coast, although this has not been recorded in monitoring data available to date (RPS 2010a). Hydraulic gradient at the watertable is very low, therefore movement of any contaminated water from the wetlands would be a slow process.

A major consideration for wetland management is recognition of the importance of groundwater levels upon the ecological function of sumplands and damplands, and hence the viability of the Holocene swale community. Data from RPS Environment and Planning (2010a), Semeniuk (2007) and Coffey Environments (2009) indicate that groundwater levels on the Rockingham-Becher Plain are within 3m from the ground surface where bores are drilled (Appendices 3, 4, 6). These data can provide a rough guide to the dependence of the community on groundwater and the probable susceptibility to change. Froend *et al*. (2004) notes that wetlands in which the groundwater is within 0-3m of natural ground surface, are considered to be highly groundwater dependent therefore highly susceptible to changes in groundwater levels.

Froend *et al*. (2004) also recognised that wetlands for which groundwater is within 0-3m of the surface, a change in groundwater level of <0.25m is regarded as low risk, a change of between 0.25m and 0.5m is moderate risk, and a change of >0.5m results in high risk of impact to the wetlands. In the IP14 area a decline of 0.9m has occurred in annual high groundwater levels from 1991 to 2004 (Coffey Environments 2009). This may be due to a number of factors but is probably mainly as a consequence of the drying climate, and increased water extraction for surrounding heavy industry may also be contributing to declining groundwater levels.

Where urbanisation or other developments occur, careful monitoring associated with a reactive management capacity will be needed to ensure that water extraction does not result in unacceptable drawdown in the summer months. The use of water-sensitive design can be used to reduce irrigation requirements.

Land clearing

Rapid urbanisation and expansion of the Rockingham region has occurred over the past 25 years, with extensive clearing of wetlands. It is likely that less than 20% of the original area of the swale wetlands now remains on the Rockingham-Becher Plain. Although many occurrences of the community are located in reserves, many unreserved occurrences may be planned for developments that involve clearing. Future clearing is likely to be associated with developments for road works,

housing or industry. Areas of prograding shorelines such as Whitfords that may have supported the community have been cleared. The possible occurrence at Preston Beach is located on private land and National Park, and a portion may be planned for developments that involve clearing.

Areas planned for development in the immediate future include occurrences at IP14, Bakewell Drive in Port Kennedy, and on the western side of Golden Bay. Occurrences near Bakewell Drive are adjacent to light industry and occurrences at IP14 are adjacent to heavy industry. The economic value of both areas if developed is high and both suites of occurrences in these areas are potentially threatened by clearing and secondary effects following clearing such as hydrological change. The occurrences on the west side of Golden Bay are situated in a prime location for housing, and some are also threatened by proposals to clear or hydrological change following clearing.

Inappropriate fire regime (too frequent)

Fires are likely to have a significant effect on vegetation composition in Mediterranean ecosystems (Abbott and Burrows 2003). It is likely that the fire frequency in the Holocene dune swale community has increased greatly since European settlement. On the Swan Coastal Plain many ecosystems are fire responsive and may require a particular fire regime to assist regeneration (Abbott and Burrows 2003). If an appropriate fire frequency is exceeded, however, species that are obligate seeders may not have sufficient time to flower and produce seed. If the time between fires is too long, obligate seeders may senesce and be unable to regenerate. Therefore, wildfires or prescribed burns must occur at appropriate intervals, and possibly at the appropriate season and intensity, to sustain the integrity of plant communities.

Too frequent fire can increase the risk of invasive weeds establishing within small remnants of native vegetation (Abbott and Burrows 2003), including occurrences of this community. It is likely that the burn regime in areas that contain the sedgelands has been modified to one of far more frequent fires, especially hot burns, since European settlement. The risk of fire is generally increased by the presence of grassy weeds in the understorey, as they are likely to be more flammable than many of the native species in the herb layer. As a wetland community, frequent fire poses a major threat to the sedgelands. The majority of occurrences have been recently and frequently burnt or show evidence of fire.

Burrows (2008) notes that there is no single optimum fire regime that will meet all management objectives, but that there are fire regimes that can be applied based on available evidence. Burrows recommends fire regimes based on vital attributes, regimes that provide for diversity of frequency, season and intensity, and provide habitat diversity, and a fine-grain mosaic of habitats. Burrows suggests that if these fire regimes are implemented in an adaptive management framework, they provide good quality data and can lead to better fire management.

The juvenile period of many species that occur in the community is listed in Appendix 1. Although the juvenile periods of many taxa is not known, the data included in Appendix 1 can be used as a guide, noting that this species list only includes species recorded in some quadrats. Burrows *et al.* (2008) recommend a minimum period between fires that are lethal to fire-sensitive plants (obligate seeders with long juvenile periods) of at least twice the juvenile period of the slowest maturing species. That is, the juvenile period of plant taxa that are killed by fire and only reproduce from seed can be used as a guide to determine minimum inter-fire intervals. In fire sensitive habitats, this may be increased to 3-4 times the juvenile period for fire sensitive species (Barrett *et al.* 2009). Appendix 1 indicates that panjang (*Acacia lasiocarpa*), summer-scented wattle (*A. rostellifera*), and orange wattle (*A. saligna*) are obligate seeders with the longest juvenile period of 36 months. Tuart (*Eucalyptus gomphocephala*) and flooded gum (*E. rudis*) are not killed by fire but have the longest juvenile period of species on the list which is 48 months. This should also be taken into account when determining inter-fire intervals.

In addition, the drying climate needs to be considered when designing appropriate fire regimes. It is likely that reduced rainfall will cause diminishing growth rates, and plant maturation times will also be prolonged. Longer inter-fire intervals will therefore be desirable in the current drier climatic scenario.

On currently available data, the minimum inter-fire interval should be at least six years, but with additional time to allow for the current dry climate, a more conservative burn regime is required. Given that these wetlands are suffering from increased weed invasion, increased drying and dominance of

non-wetland adapted plants due to the current frequent burns due to arson (V. English personal observation) and increased dryness due to the drying climate, for the life of this plan planned burns should only be instigated in this community for occurrences that are long unburnt.

There are a series of monitoring sites already established in many occurrences including quadrats and transects and many of these are likely to be suitable for adapting for monitoring the effects of fire. A measurable, repeatable, statistically valid monitoring system will need to be designed and implemented to monitor the effects of fire regime on the composition of the community.

Weed invasion

Most occurrences of this community are close to weed sources such as urban developments and weed invasion is most significant in areas where disturbance levels are high. Occurrences subject to frequent fires are more prone to weed invasion as many weeds recorded in the sedgelands come from a fire responsive environment and native species often do not have sufficient time to regenerate or resprout before weed populations establish. Where occurrences are in good condition, it is likely associated with the density of cover of native species, especially sedges. The occurrences with dense sedgelands demonstrate resistance to weed invasion if left undisturbed (V. English personal observation).

The species list at Appendix 1 was prepared with data from seven of the quadrats in the community. Consequently, some of the weed species that currently pose the greatest threat to the sedgelands are not included but are some of the highest priorities for control. These include Geraldton carnation weed (*Euphorbia terracina*), dune onion weed (*Trachyandra divaricata*), bridal creeper (*Asparagus asparagoides*), sharp rush (*Juncus acutus*), rose pelargonium (*Pelargonium capitatum*), cottonbush (*Gomphocarpus fruticosus*) and pampas grass (*Cortaderia selloana*).

Recreational activities

Areas that contain the sedgeland community have historically been used for off-road vehicle and motor bike circuits, by horse riders, for management tracks and firebreaks, as grazing areas for cattle and horses, and as sources of peat.

The majority of occurrences are located in close proximity to urbanisation and recreational activities affect several areas that contain the community. Pedestrian access by means of formal and informal walk trails can have a negative effect on the community as people walk through occurrences and trample vegetation. Unauthorised vehicle access is a major problem in several groups of occurrences in particular Port Kennedy Scientific Park, IP14 and east of Bakewell Drive. Fences bordering these sites are constantly breached enabling four wheel drives and trail bikes to access these areas. As a result issues such as rubbish dumping, increased fire frequency, trampling of vegetation and increased weed spread are noticeable.

Occurrences at Yanchep, Dalyellup and possible occurrences at Preston Beach and south of Lancelin are more remote from urban areas than occurrences on the Rockingham-Becher Plain and are likely to have historically been less impacted by recreational activities. Developments are, however, also encroaching towards these additional areas.

Over-grazing by native or introduced species

Historically, much of the Rockingham-Becher Plain was used as pastoral land and selectively grazed by cattle and horses. It is evident that high numbers of rabbits have invaded several occurrences of the community and in Lark Hill, Golden Bay and Port Kennedy Scientific Park palatable species have been selectively grazed and damage to vegetation has resulted from high densities of warrens.

Some occurrences in the community particularly near Golden Bay and Dalyellup have high kangaroo numbers. Damage to vegetation is evident in their resting areas and along the pathways they create. Although these impacts would be associated with the natural system, damage may have been exacerbated by increased density of animals due to loss of alternative habitat on adjacent lands.

Rubbish dumping

Areas that contain the sedgeland community have historically been used as rubbish disposal sites.

Because occurrences are located in close proximity to urban areas, rubbish dumping takes place as a consequence of recreational activities such as camping, and pedestrian access on formal and informal walk trails. Unauthorised vehicle access allows larger rubbish items including car bodies and furniture to be dumped in areas that contain the community, particularly at IP14 and occurrences east of Bakewell Drive.

Fragmentation

Several occurrences of the sedgelands community occur in areas of remnant vegetation which have a large edge to area ratio. This can cause a range of problems including increased damage from wind and accelerated drying out of the wetlands. Potential flow-on effects from other threats are increased such as weed invasion and opportunity for rubbish dumping. Where native vegetation still occurs adjacent to occurrences, the retention of these areas will be sought to maintain their role as buffers.

Lack of knowledge for management purposes

There is a general lack of knowledge of the sedgeland community. There is limited information available to the general public and many occurrences are not appropriately fenced or do not have signage to ensure people are aware of the values of the threatened ecological community. Lack of knowledge of the sedgeland community has the potential to lead to inappropriate management. Monitoring fire patterns and hydrology, as well as other threats is useful to establish parameters to guide effective management.

1.12 Conservation status

The ecological community was assessed in June 1996 as Critically Endangered in Western Australia. It meets criterion B (iii) as follows, for Critically Endangered:

> *Current distribution is limited and there may be many occurrences but total area is very small and each occurrence is small and/or isolated and extremely vulnerable to known threatening processes*.

The ecological community is listed as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

1.13 Strategy for recovery

To identify, and influence the management of the areas in which the community occurs, so maintaining natural biological and non biological attributes of the sites, in particular occurrences that cover the full geomorphic age sequence.

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

To liaise with land managers and other appropriate stakeholders to implement the plan.

Other plans that influence management of land on which the sedgeland community occurs include the Rockingham Lakes Regional Park Management Plan (DEC 2010). This plan provides an overview to guide management of the natural environment, cultural heritage, recreation and resource use in the Lake Richmond, Port Kennedy Scientific Park, and the Lake Cooloongup and Walyungup parks, that all contain the sedgeland community. RPS Environment and Planning (2010b) provides greater detail about weed control and rehabilitation for the Rockingham Lakes Regional Park. Fire management or response plans have been developed for some occurrences including those in IP14, all regional parks, and Yanchep National Park. A control program for feral and introduced animals has been developed for Port Kennedy Scientific Park and focuses on reducing impacts of feral cats and other introduced pests including rabbits and foxes.

1.14 Guidance for decision makers

Section 1.11 provides details of current and possible future threats. Proposed developments in the region of the sedgeland community require environmental impact assessment. In such an assessment, direct clearing of the community, or developments that lead to significant changes in quality or levels of groundwater would be expected to have a significant impact on the threatened ecological community.

Actions that could result in any of the following may result in a significant impact to the sedgelands in Holocene dune swales community:

- a significant decrease in groundwater levels required for the survival of the community
- a significant increase in fire frequency
- clearing leading to significant increase in further fragmentation of the community
- a significant decline in water quality
- a significant increase in recreational impacts/damage
- a significant increase in opportunity for introduction or increase in density of weeds or introduced /feral animals known to damage the community

2.1 Completed and existing actions

- a recovery plan implementation group has been established.
- likely habitat for the community including Leda, Dunsborough and areas near Lakes Cooloongup and Walyungup have been investigated.
- advice and recommendations have been provided with regard to possible reservation of occurrences at IP14, Lark Hill, Golden Bay, Lot 40 Forty Road, and near Bakewell Drive. Advice and recommendations were also provided with regards to possible development of a road on the edge of Lake Cooloongup and other areas proposed for development.
- a project that involves flora survey of permanently marked transects in coastal areas termed “Surveying WA's Littoral Ecology (SWALE)” was initiated in Port Kennedy Scientific Park (Tauss 2002). The project was funded by Coastwest and managed by DEC, the Regional Herbarium, and the Rockingham Regional Environment Centre. The project involves 20 regional Herbaria. The sites within the park have been located to include the threatened wetlands, beach ridge plain and Becher Point.
- liaison between Swan Coastal District, City of Rockingham and LandCorp resulted in rubbish removed from IP14. Liaison between DEC and LandCorp resulted in agreement that LandCorp would fix fences, replace gates, install new gates and remove rubbish at Bakewell Drive.
- DEC’s Regional Parks Branch worked with the City of Rockingham and Mirvac to manage vehicle access in Port Kennedy Scientific Park including repair of the feral proof fence. Limestone boulders have been interspersed with vegetation in an attempt to help control vehicle access. Heavy duty boom gates have also been installed at management access points into the park. A fence has been installed around two of the younger swales closest to Becher Point to minimise disturbance to these areas.
- advice has been received on buffers required to help maintain the hydrology of the sedgeland community, and this was forwarded to decision making bodies.
- the fires that went through IP14 in 2007 and 2008 were mapped by DEC Swan Coastal District.
- fire response plans have been developed for regional parks that contain the community, for IP14, and for Yanchep National Park. These plans continue to be applied and are updated annually for areas managed by DEC. The plans are circulated to Fire and Emergency Services Authority (FESA), local bush fire brigades and the City of Rockingham by DEC’s Regional Parks Branch.
- weed mapping and weed control plans have been developed for regional parks that contain the community.

- DEC's Regional Parks Branch coordinated mapping of weeds in Port Kennedy Scientific Park and specific weed control was completed using funds from a Wetlands Conservation Grant. Geraldton carnation weed (*Euphorbia terracina*) control was implemented in 2007 - 2010 in two large occurrences in Port Kennedy Scientific Park. This reduced cover of the weed from ~20% to ~0.5% with levels of cover remaining low after fire. Dune onion weed (*Trachyandra divaricata*) control was undertaken in 2008 but many resprouted in 2009.
- sharp rush (*Juncus acutus*) was also mapped and weed control implemented in Lake Cooloongup and Lake Walyungup Regional Parks. Weed control was conducted in 2007 - 2010 in Lakes Cooloongup and Walyungup targeting sharp rush (*J. acutus*), pampas grass (*Cortaderia selloana*) and cottonbush (*Gomphocarpus fruticosus*).
- with funding assistance from the Commonwealth's Natural Heritage Trust, DEC's Swan Coastal District mapped condition, determined priority areas for weed control, and undertook manual control of Geraldton carnation weed (*Euphorbia terracina*) at the Lake Richmond occurrences in 2009.
- an information shelter was erected in 2003 at Port Kennedy Scientific Park. The panels include information about the significance of the dunes, sedgelands and fauna in the park.
- the stage 2 area at Port Kennedy Scientific Park was reserved as an A Class reserve for Conservation of Flora and Fauna under the care, control and management of the Conservation Commission (Ministerial Condition 2).
- a management officer was employed for Port Kennedy Scientific Park.
- location has been agreed, and vermin proof fencing installed, at the Port Kennedy Scientific Park. Maintenance of this fence is ongoing.
- a fire history map has been developed for the Port Kennedy Scientific Park and this data is accurate back to around 2006.
- a strategic firebreak has been installed around the perimeter of Port Kennedy Scientific Park alongside the vermin proof fence.
- advice and recommendations have been provided regarding possible reservation of IP14, Lark Hill, Forty Road, Golden Bay, Port Kennedy Golf Course Stage 2, and the area adjacent to Bakewell Drive. Comments were provided on issues relating to minimising hydrological and other impacts at Port Kennedy Golf Course Stage 2, IP14 and Lark Hill.
- the purpose of Lake Richmond reserve has been amended to reflect its conservation value and is now specified as for 'conservation and recreation'.
- the previously privately owned portion of Lake Richmond has been reserved.
- advice has been provided with regards to buffers and maintaining water levels for wetlands at Lark Hill.
- trials to determine control techniques for Geraldton carnation weed (*Euphorbia terricina*) where it is invading sedgelands in Holocene dune swales in Port Kennedy Scientific Park have been completed by DEC's Swan Region. A control technique that is very effective against this weed and has little impact on native flora has been developed and is being implemented across populations of the weed in Port Kennedy. The results have been presented at a series of conferences and workshops and are currently being prepared for publication.

Actions implemented as part of the previous recovery plan (English *et al*. 2002) that are considered to have been most successful in achieving conservation of the sedgelands community include:

- attaining land tenure that ensures long-term conservation management,
- well planned, consistent and sustained efforts at controlling unauthorised recreational pursuits (especially four wheel drive access), and
- well resourced, consistent and targeted efforts at controlling weeds.

The main ongoing seemingly intractable threat to the community is too frequent fire caused by arsonists. With ongoing development in the general areas occupied by the sedgeland community, hydrological change has emerged as a potentially significant obstacle to capacity to sustain the sedgeland community into the future. Hydrological issues have therefore become a much greater focus for activity in this plan.

3. RECOVERY PROGRAM

3.1 Objective

To maintain or improve the overall condition of this plant community in the known locations and reduce the level of threat.

3.2 Criteria for success

The plan will be deemed a success if, after the 5 year term of the plan there has been:

- an increase of one or more in the number of occurrences of this community managed for conservation and/or with conservation included in their purpose and that leads to an increase in the completeness of a geomorphic age sequence,
- representative areas of each geomorphic age sequence maintained in the same or improved condition (Bush Forever 2000 scales), and
- 90% or more of the aerial extent of occurrences maintained at the same condition rank, or improved (Bush Forever 2000 scales).

3.3 Criterion for failure

The plan will be deemed unsuccessful if, after the 5 year term of the plan there is:

- Loss of all representatives of a geomorphic age group that contains the sedgelands in Holocene dune swales community or decline in condition of all members of that age group to degraded condition or poorer.

RECOVERY ACTIONS

3.4 Recovery actions

1. Define the community in greater detail

Recent quadrat data and habitat information will be used to define the community in greater detail and to provide a more comprehensive species list for the community.

The sedgeland community is currently defined from a species list taken from a limited number of quadrats in occurrences (Gibson *et al.* 1994; Government of Western Australia 2000). Quadrats have since been established in many additional occurrences of the sedgelands and information from these quadrats will be used in provision of a more comprehensive species list for the community.

Habitat information from quadrats will also be used to define the community. The wetlands in which this community type occurs are Holocene dune swales. This is a fundamental characteristic of the community and is important for defining it.

Responsibility: DEC (Species and Communities Branch)
Cost: $30,000
Completion date: Year 3

2. Continue to liaise with relevant groups to implement this plan

The community will be provided information about the threatened ecological community through the following means:

- this plan will be distributed to managers of land on which this community occurs,
- appropriate signage will be increased, and
- media opportunities will be exploited

A number of the occurrences of this community are managed by authorities other than DEC, are unvested, or privately owned. For example the City of Rockingham manages Lake Richmond and Lark Hill occurrences, and LandCorp manages occurrences located at IP14 and near Bakewell Drive. The involvement, wherever possible and practical, of land managers, local community groups and industry in the recovery of the community is therefore essential to the recovery process. Indigenous groups also provide advice about management of various occurrences and will continue to be consulted about actions in this plan.

Other stakeholders should be consulted on management of the community as they are identified.

Responsibility:	DEC (Regional Parks Branch, Species and Communities Branch, Swan and South West Regions).
Cost:	$10,000 pa
Completion Date:	ongoing

3. Identify all occurrences of the community

Areas that contain suitable habitat for the community will be searched and new occurrences recorded on to the DEC corporate TEC database.

Occurrences of the community, particularly those significant in completing a geomorphic age sequence, will be identified.

The number, age and extent of occurrences of the community on the Rockingham-Becher Plain and other likely areas, as listed below will be clarified:

(i) Holocene dunes with wetlands around Preston Beach
(ii) south of Lancelin
(iii) Cheynes Beach

Responsibility:	DEC (Species and Communities Branch, Swan, South Coast and South West Regions)
Cost:	$10,000 pa
Completion Date:	Year 4

4. Continue to minimise recreational disturbance to the community

Recreational disturbance will be controlled through the following means:

- monitoring impacts of recreational activities, and managing to minimise adverse impacts.
- maintaining fences and other barriers to deter illegal access, arson and other activities that can lead to the introduction or spread of weeds,
- removing rubbish,
- increasing signage, and general surveillance, and
- formalise walking trails with small railings, fences or other unintrusive means where occurrences of the community are bordered by informal walk trails

Responsibility:	DEC (Regional Parks Branch, Swan Coastal District, South West Region) and other land managers.
Cost:	$70,000 pa
Completion Date:	ongoing

5. Implement fire management strategy

No planned burns will be applied for the life of this plan for occurrences that have been burnt frequently and recently.

For occurrences that are long unburnt, a minimum inter-fire interval of at least twice the juvenile period of the slowest maturing fire-sensitive species will be applied. Burns will be planned for a variety of seasons and intensities, interspersed with much longer inter-fire intervals. As almost all occurrences

have been burnt recently and very frequently, no planned burns will be required for the life of this plan for most occurrences.

When planned burns are initiated for occurrences that are found to be long unburnt, burn interval should be at least twice the juvenile period of the slowest maturing obligate seeder. Based on available data, panjang (*Acacia lasiocarpa*) summer-scented wattle (*A. rostellifera*) and orange wattle (*A. saligna*) take 36 months to mature so the absolute minimum recommended inter-fire interval would be 6 years. Such burns should be interspersed with much longer inter-fire intervals such as 3-4 times the juvenile period of the slowest maturing species, which on currently available information for taxa in the community would be 12-16 years, in particular where tuart occurs in the community. Especially given that plant maturation and recovery times following fire are likely to be longer due to the current drier climate, where occurrences have been burnt recently and frequently, the minimum burn interval for the immediate future will be designed to be the longer period of 12-16 years.

Application of the fire response plans that specify firebreak locations, gates, and access tracks will be continued. This includes the ongoing maintenance of firebreaks. No new firebreaks will be constructed in intact vegetation in occurrences, however maintenance of existing firebreaks is appropriate where firebreaks are already constructed, unless maintenance is likely to degrade the community. Careful use of herbicides is the preferred method of maintenance of firebreaks to minimise soil movement and introduction of weed seeds. Local DEC staff should be involved in planning fire break construction and maintenance for all occurrences of the community. A local DEC staff member will be present during wildfires and any future controlled burns in areas containing the sedgelands, to advise on protecting the conservation values of the community.

Fire fighting authorities will need to be advised against constructing new tracks during their operations, including during wildfires. The use of heavy machinery to create new fire breaks within the community needs to be avoided. Chemicals that may be toxic to the community should not be used.

Responsibility:	DEC (Swan Coastal District, South West Region, Regional Parks Branch), relevant Local Authorities and other land managers
Cost:	$40,000 pa for firebreak maintenance and fire response plans
Completion Date:	ongoing

6. Monitor response to fire

There is a need for research into recovery of the community from fire, and to determine the implications of findings for management.

Research to examine the effect of fire regimes, and to determine recovery of the community from fire will be designed and applied. Implications of findings of fire research for management will be determined.

There is also a need to determine appropriate management in the case of unplanned wild fire including weed management the winter following summer wild fire.

Responsibility:	DEC (Swan Coastal District, South West Region, Regional Parks Branch).
Cost:	$10,000 pa
Completion Date:	ongoing

7. Continue to implement weed control strategy

A system of monitoring and adaptive management will be developed to maintain and improve habitat by controlling weeds in occurrences of the community.

Weed mapping and weed control plans will be developed for all occurrences of the community for which this has not yet been done. Plans will identify the highest priority weeds that pose the greatest threat to the community including Geraldton carnation weed (*Euphorbia terracina*), dune onion weed (*Trachyandra divaricata*), bridal creeper (*Asparagus asparagoides*), sharp rush (*Juncus acutus*), rose pelargonium (*Pelargonium capitatum*), cottonbush (*Gomphocarpus fruticosus*) and pampas grass (*Cortaderia selloana*). Appropriate methods of weed control are found in Brown and Brooks (2002)

and may include hand weeding or localised application of herbicide. The use of herbicide in wetlands should be carefully controlled to ensure surface and groundwater are not impacted.

For areas within the Rockingham Lakes Regional Park, weed control will be guided by RPS Environment and Planning (2010b).

Ongoing monitoring will determine success of weed control measures. Weed maps will continue to be updated to determine priority areas for weed control. Vegetation condition maps together with weed maps should guide priorities; that is intact areas will be a priority for weed control.

Responsibility: DEC (Swan Coastal District, Regional Parks Branch, Swan Region)
Cost: $50,000 pa
Completion Date: ongoing

8. Continue to ensure any infrastructure does not impact the community

The siting of any infrastructure, such as an interpretive centre or displays, will be designed to minimise impact on the community. Such interpretive material will provide information on the significance of the wetland areas, the need to conserve them, and how this is being done. This will be completed as part of the Rockingham Lakes Regional Park Management Plan where reserves are part of that park.

Walk trails and cycle ways will be designed such that hydrology around wetlands is not altered and such that there is no direct disturbance of the community.

Responsibility: DEC (Regional Parks Branch)
Cost: $2,000 pa
Completion Date: ongoing

9. Continue vegetation monitoring program

Quadrats and transects have been established by DEC for general monitoring of plant species composition, and to monitor weeds and the effects of fire regimes. These will be monitored every five years, and available ground water level monitoring, see below, will be correlated with these data.

Responsibility: DEC (Regional Parks Branch, Swan Region, Species and Communities Branch).
Cost: $50,000 every fifth year
Completion Date: ongoing

10. Continue groundwater monitoring

A system of monitoring and adaptive management to maintain natural hydrological processes and groundwater levels and quality of the community will be further developed and applied.

Department of Water (DoW) and developers have bores in various occurrences. These will continue to be monitored for water levels and quality. Historical and current data will be analysed to determine trends in groundwater levels and quality in the community and this will be correlated with obvious vegetation change. This information will provide a valuable insight to the hydrological parameters that maintain the sedgeland community.

Responsibility: DoW, relevant developers, DEC (Swan and South West Regions, Species and Communities Branch)
Cost: $50,000 pa
Completion Date: ongoing

11. Establish minimum and maximum threshold water levels and quality, seek to influence land management practices to maintain hydrology

A stated description of the normal range and fluctuation in water levels will be developed as a standard by which to measure maintenance of the system.

Actions to ameliorate or reduce human-induced hydrological change will be identified and implemented.

There is a need to determine threshold levels of groundwater in this wetland community. The continued groundwater monitoring (as described in action 10) will allow for the 'natural' range and fluctuation in water levels to be established. This will provide data about minimum and maximum threshold levels of the community. Appendix 6 provides a summary of the currently limited data available for groundwater threshold levels from six bores within the community.

Where threshold groundwater levels or quality are exceeded, DEC will seek to determine causes and liaise with relevant land managers and DoW in seeking to manage these issues. Most occurrences of the sedgeland community are in close proximity to urban development where clearing, increased water extraction, fertiliser use and other activities are likely to impact hydrology of the community. The sedgelands are a wetland community, and current data indicate that occurrences are likely to be highly groundwater dependant (Froend *et al.* 2004). Wherever possible, DEC, DoW and other relevant groups will seek to influence land management practices to maintain hydrology of the community.

Responsibility:	DoW and DEC (Swan and South West Regions, Species and Communities Branch)
Cost:	$50,000 pa
Priority:	urgent
Completion Date:	ongoing, from new data

12. Monitor the need for rehabilitation in the community

Dune blow outs, such as those in the southern end of the Port Kennedy Scientific Park, should be photographically monitored to determine if changes are naturally occurring. Results of weed monitoring should also be used to decide priority rehabilitation areas. Rehabilitation should only occur where dune blowouts occur as a direct consequence of human activity such as unauthorised four wheel drive access, and not as a consequence of natural coastal processes.

Responsibility:	DEC (Regional Parks Branch)
Cost:	$2,000 pa
Completion Date:	ongoing

13. Implement the planned feral and introduced animal control program

A program has been designed to control feral and introduced animals in Port Kennedy Scientific Park. The program will focus on reducing numbers and effects of feral cats and other introduced pests including rabbits and foxes and implementation is expected to begin at the end of 2011.

Responsibility:	DEC (Regional Parks Branch).
Cost:	$10,000 pa for signage and baiting
Completion Date:	ongoing

14. Continue negotiations for appropriate management of other occurrences outside reserves managed for conservation

Negotiations will be continued in seeking to minimise clearing and to conserve the community. This will include negotiations for declaration of areas as conservation reserves as necessary. Areas that may be under threat from development include Golden Bay, IP14, Lark Hill, Port Kennedy Golf Course Stage 2, Secret Harbour and occurrences near Bakewell Drive in Port Kennedy. Where occurrences still have intact vegetation adjacent, DEC will seek to maintain a buffer that is designed to maintain natural hydrologic processes.

Responsibility:	DEC (Species and Communities and Regional Parks Branches, Swan Region)
Cost:	$30,000 pa
Completion Date:	ongoing

15. Continue to report on success of recovery plan

DEC has overall responsibility for seeking resources to implement the plan, and for overseeing plan implementation. The recovery plan implementation group will continue to prepare annual reports about the progress of plan implementation. At the end of the planned life of this plan, the plan will be evaluated to determine the success of implementation, and determine the need for an updated plan.

Responsibility: DEC (Species and Communities Branch), in consultation with the recovery plan implementation group.
Cost: $5,000 pa
Completion Date: ongoing

Table 4: Summary of costs for each recovery action

Action	Year 1	Year 2	Year 3	Year 4	Year 5
Define the community in greater detail			30,000		
Continue to liaise with relevant groups to implement this IRP	10,000	10,000	10,000	10,000	10,000
Identify all occurrences of the community	10,000	10,000	10,000	10,000	10,000
Continue to minimise recreational disturbance to the community	70,000	70,000	70,000	70,000	70,000
Implement fire management strategy	40,000	40,000	40,000	40,000	40,000
Monitor response to fire	10,000	10,000	10,000	10,000	10,000
Continue to implement weed control strategy	50,000	50,000	50,000	50,000	50,000
Continue to ensure infrastructure does not impact the community	2,000	2,000	2,000	2,000	2,000
Continue vegetation monitoring program	50,000				
Continue groundwater monitoring	50,000	50,000	50,000	50,000	50,000
Establish minimum and maximum threshold water levels and quality seek to influence management	50,000	50,000	50,000	50,000	50,000
Monitor the need for rehabilitation	2,000	2,000	2,000	2,000	2,000
Implement feral and introduced animal control program	10,000	10,000	10,000	10,000	10,000
Continue negotiations for appropriate management of other occurrences	30,000	30,000	30,000	30,000	30,000
Continue to report on success of recovery plan	5,000	5,000	5,000	5,000	5,000
TOTAL	**389,000**	**339,000**	**369,000**	**339,000**	**339,000**

Total of known costs over five years: $1,775,000

Glossary

Introduced species - one that is outside its native distributional range, that has arrived there by human activity, either deliberate or accidental
Feral species - one that has escaped from domestication and returned, partly or wholly, to a wild state

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APPENDIX 1

Ecological characteristics of vascular plants recorded from 7 quadrats in occurrences (From Gibson *et al*.1994; Government of Western Australia 2000)

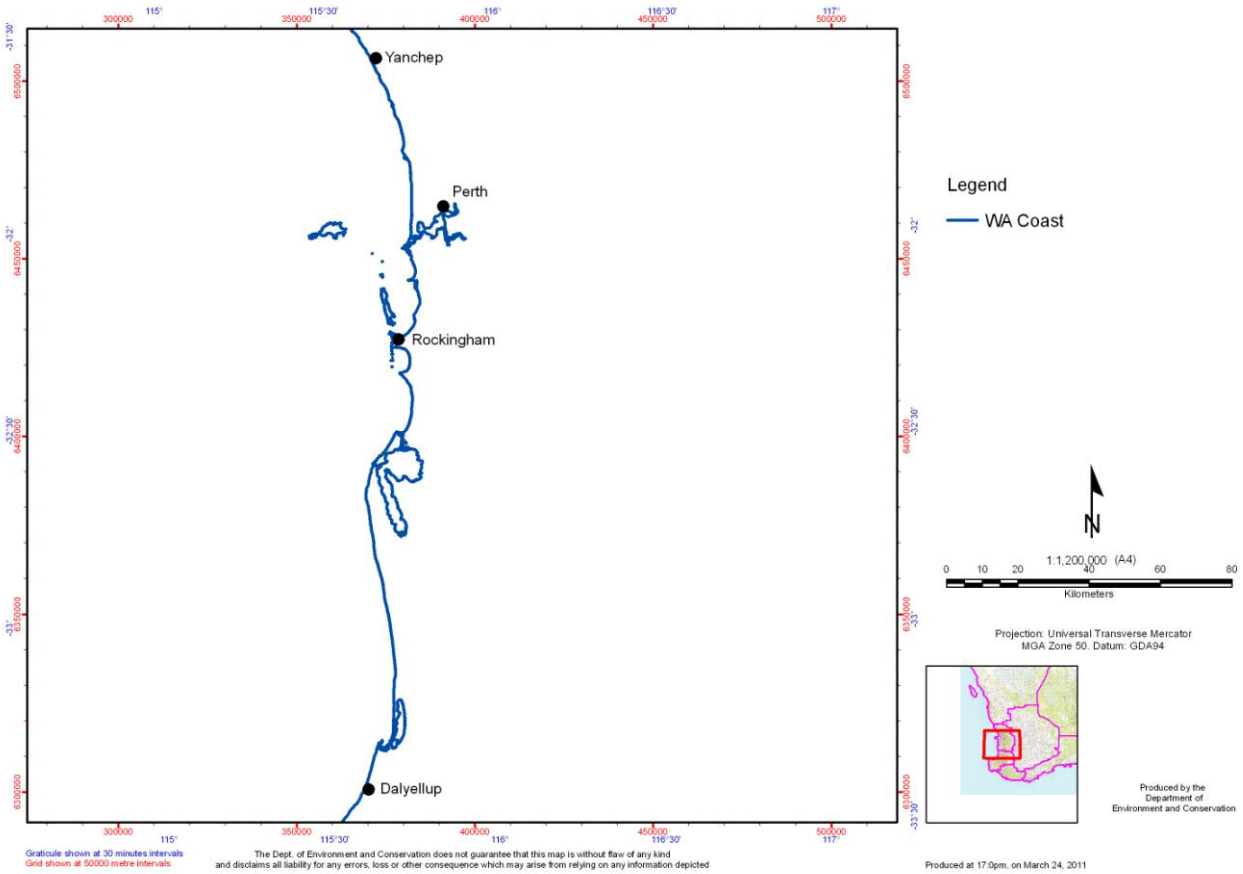
	Taxon	Fire Response (Source-Naturemap)	Months to first flowering (Source-Naturemap)	Longevity (Source-Naturemap)	Dieback response (Source-Naturemap)
	Acacia cochlearis	100% scorch kills, in soil seed storage	24	Perennial	Inferred evidence of resistance
	Acacia lasiocarpa	100% scorch kills, in soil seed storage	36	Perennial	Inferred evidence of resistance
	Acacia pulchella	100% scorch kills, in soil seed storage	24	Perennial	Some evidence of resistance
	Acacia rostellifera	100% scorch kills, in soil seed storage	36	Perennial	Inferred evidence of resistance
	Acacia saligna	100% scorch kills, in soil seed storage	36	Perennial	Inferred evidence of resistance
	Acacia truncata	ND			
	Adriana quadripartita	ND			
	Alyogyne huegelii var. glabrescens	ND			
	Amyema miquelii	ND			
	Anthocercis littorea	Survives 100% scorch, soil suckers	18	Perennial	
	Austrostipa flavescens	100% scorch kills, in soil seed storage	6	Perennial	Inferred variable susceptibility
	Banksia grandis	Survives 100% scorch, epicormics	24	Perennial	Good evidence of high susceptibility
	Banksia littoralis	Survives 100% scorch, epicormics	24	Perennial	Some evidence of high susceptibility
	Baumea juncea	ND			
*	*Briza minor*	Killed by 100% scorch	6	Annual	
*	*Bromus diandrus*	ND			
	Caladenia latifolia	Geophyte (Survives 100% scorch)	12	Perennial	Inferred evidence of resistance
	Carex appressa	ND			
*	*Carpobrotus edulis*	ND			
	Cassytha racemosa	100% scorch kills, in soil seed storage	24	Annual	
	Centella asiatica	Survives 100% scorch, soil suckers		Perennial	
*	*Cerastium glomeratum*	ND			
*	*Cirsium vulgare*	100% scorch kills, no seed storage	12	Perennial	
	Clematis linearifolia	ND			
	Comesperma virgatum	ND			
	Conostylis candicans subsp. Candicans	ND			
*	*Conyza sumatrensis*	ND			
*	*Crassula glomerata*	ND			
*	*Cynodon dactylon*	ND			
*	*Cynosurus echinatus*	ND			
	Daucus glochidiatus	ND			
*	*Dischisma arenarium*	ND			
	Epilobium billardiereanum	ND			
	Epilobium billardiereanum subsp. billardiereanum	ND			
	Epilobium hirtigerum	ND			
	Eucalyptus gomphocephala	Survives 100% scorch, epicormics	48	Perennial	Inferred evidence of resistance

	Eucalyptus rudis subsp. rudis	Survives 100% scorch, epicormics	48	Perennial	Inferred evidence of resistance
*	*Euphorbia peplus*	ND			
	Ficinia nodosa	ND			
	Gahnia trifida	Survives 100% scorch, basal sprouts	24	Perennial	Inferred evidence of resistance
*	*Galium murale*	100% scorch kills, in soil seed storage	12	Annual	
*	*Geranium molle*	ND			
	Geranium retrorsum	ND			
	Hakea prostrata	Survives 100% scorch, basal sprouts	36	Perennial	Inferred variable susceptibility
	Hardenbergia comptoniana	Survives 100% scorch, basal sprouts	30	Perennial	
*	*Holcus sp.*	ND			
	Hydrocotyle diantha	ND			
	Hypolaena pubescens	ND			
	Isolepis cernua	ND			
	Jacksonia furcellata		12	Perennial	
	Juncus kraussii subsp. australiensis	ND			
	Kennedia coccinea	100% scorch kills, in soil seed storage	20	Perennial	Inferred evidence of resistance
	Kennedia prostrata	100% scorch kills, in soil seed storage	18	Perennial	Inferred evidence of resistance
	Lachnagrostis filiformis	ND			
*	*Lagurus ovatus*	ND			
	Lepidosperma gladiatum	Survives 100% scorch, soil suckers	24	Perennial	Inferred evidence of resistance
	Lepidosperma longitudinale	Survives 100% scorch, soil suckers	24	Perennial	
	Lepidosperma squamatum	Survives 100% scorch, soil suckers	22	Perennial	
	Leucopogon interstans	ND			
	Leucopogon parviflorus	Survives 100% scorch, basal sprouts	30	Perennial	
	Lobelia anceps	Killed by 100% scorch	12	Perennial	
	Logania vaginalis	Survives 100% scorch	20	Perennial	
*	*Lolium rigidum*	ND			
	Lomandra maritima	ND			
*	*Lysimachia arvensis*	100% scorch kills, in soil seed storage	10	Annual	
*	*Lysimachia arvensis var. arvensis*	ND			
	Melaleuca rhaphiophylla	Survives 100% scorch, basal sprouts		Perennial	
*	*Melilotus indicus*	ND			
	Microtis media	ND			
	Muehlenbeckia adpressa	100% scorch kills, in soil seed storage	30	Perennial	
	Myoporum caprarioides	ND			
	Opercularia hispidula	Survives 100% scorch, soil suckers	18	Perennial	
	Opercularia vaginata	100% scorch kills, in soil seed storage	24	Perennial	
	Oxalis perennans	ND			
*	*Parentucellia viscosa*	100% scorch kills, in soil seed storage	13	Annual	
	Parietaria debilis	ND			
*	*Paspalum distichum*	ND			
*	*Pelargonium capitatum*	100% scorch kills, no seed storage	12	Perennial	
	Pelargonium littorale subsp. littorale	ND			
	Phyllanthus calycinus	Survives 100% scorch, soil suckers	24	Perennial	
	Pimelea argentea	ND			
	Poa porphyroclados	Killed by 100% scorch	6	Perennial	Inferred evidence of resistance

	Rhagodia baccata subsp. dioica	ND			
*	*Rumex crispus*	ND			
	Samolus repens	100% scorch kills, in soil seed storage	30	Perennial	
	Scaevola crassifolia	100% scorch kills, in soil seed storage	30	Perennial	
	Schoenus trachycarpus	ND			
	Senecio ramosissimus	100% scorch kills, no seed storage	30	Biennial	
*	*Solanum nigrum*	Killed by 100% scorch		Perennial	
*	*Sonchus asper*	100% scorch kills, no seed storage		Biennial	
	Sonchus hydrophilus	ND			
*	*Sonchus oleraceus*	100% scorch kills, no seed storage		Annual	
	Sporobolus virginicus	ND			
	Spyridium globulosum	100% scorch kills, in soil seed storage	6	Perennial	
	Stackhousia monogyna	Killed by 100% scorch	12	Perennial	
	Stypandra glauca	Survives 100% scorch, soil suckers	18	Perennial	
	Templetonia retusa	100% scorch kills, in soil seed storage		Perennial	
	Trachymene coerulea subsp. coerulea	ND			
	Tricoryne elatior	100% scorch kills, in soil seed storage	24	Perennial	
*	*Trifolium campestre var. campestre*	ND			
*	*Trifolium glomeratum*	ND			
	Trymalium ledifolium var. ledifolium	Survives 100% scorch, basal sprouts	22	Perennial	Some evidence of variable susceptibility
	Xanthorrhoea preissii	Survives 100% scorch, large apical bud	9	Perennial	Good evidence of high susceptibility

* = Introduced; ND = no data available in Naturemap

APPENDIX 2: General location map



APPENDIX 3

Data from monitoring bores within occurrences or in close proximity to occurrences of the sedgelands community (Semeniuk 2007)

Bore	Occurrence (within or in close proximity to bore)	Min threshold (metres below ground level) Lowest level (summer)	Max threshold (metres below ground level) Highest level (winter)#
161	Pt Kennedy 98	0.90	-0.50
162	Pt Kennedy 101	1.10	-0.40
163	Pt Kennedy 103	1.30	0.00
WAWA	Pt Kennedy 123, 25	0.90	-0.30
135	LarkHill13	1.04	-0.36
136	LarkHill13	1.40	0.00
45	Pt Kennedy 16	1.27	-0.03
35	PointBecher Plot 1	1.30	-0.10
1N	PointBecher01 North	0 (sea level)	0.49
Cooloongup A	MyCool01	1.50	0.30
swi	PB01	0.89	-0.01
swii	PB01	1.09	0.09
swiii	PB01	0.61	-0.29
9-1,2,3	PtBecher38Sc	1.05	-0.05
9-4,5,6,7	PtBecher38Sc	0.82	-0.28
9-9,10,11,12,14	PtBecher38Sc	0.93	-0.37

#Negative values indicate water levels are above ground

APPENDIX 4

Data from monitoring bores within occurrences or in close proximity to occurrences of the sedgelands community (RPS Environment and Planning 2010a)

Bore	Occurrence (within or in close proximity to bore)	Min threshold (metres below ground level) Lowest levels (summer)	Max threshold (metres below ground level) Highest levels (winter)
MB1	27m west of Pt Kennedy 16	1.19	0.50
MB2	108m east of Pt Kennedy 16, 161m east of Pt Kennedy 49	2.44	1.15
MB4	within PointBecher07	2.29	1.37
MB6	23m east of PointBecher35	1.70	0.80
MB7	on edge of PointBecher01	1.62	0.00

MB8	within PB06	1.92	1.35
MB11	within PB01	1.47	0.79
MB14	9m west of PointBecher07	1.47	0.60

APPENDIX 5

Data from Water Information System (WIN) bores within occurrences or in close proximity to occurrences of the sedgelands community (DoW data)

Bore	Occurrence (within or in close proximity to bore)	Min threshold (metres below ground level)	Max threshold (metres below ground level)	Comments
3242	22m west of Pt Kennedy 28. Data useful for water level and quality.	3.55	1.94	High levels of N solids. Data taken from 1998.
3243	12m east of Pt Kennedy 25. Data useful for water level and quality.	3.16	1.61	Water level data from 1993.
3244	65m east of Pt Kennedy 123. *Data useful for water quality only as too far from occurrence*	6.94	5.48	Water level data from 1997.

APPENDIX 6

Data from monitoring bores within occurrences or in close proximity to occurrences of the sedgelands community (Coffey Environments 2009)

Bore	Occurrence (within or in close proximity to bore)	Min threshold (metres below ground level) lowest levels (summer)	Max threshold (metres below ground level) Highest levels (winter)
ERGM7	IP14 Plot1	1.99	1.11
ERGM9	IP14-08	2.69	1.91
ERGM10	IP14-03	2.48	1.63
ERGM12	IP14-10North	2.30	1.43
ERGM13	IP14-Plot3	2.84	1.81
ERGM15	IP14 Plot1	2.04	1.16