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TABLE OF CONTENTS

1 SCOPE

This Monitoring Program (MP) describes the environmental monitoring activities that are undertaken by BHP Billiton Olympic Dam Corporation Pty Ltd (ODC) in relation to flora at Olympic Dam and the surrounding areas that may be impacted by current mining and processing activities. The purpose of this MP is to set out the measures ODC uses to quantify any change in the extent or significance of impacts of its activities on flora, to assess the performance of the control measures employed to limit these impacts, and to meet relevant legal and other requirements (State 17a).

This MP addresses a number of distinct elements of flora monitoring. For each element, the MP sets out some background information, the purpose of the monitoring and the deliverables which are produced as a result of the monitoring The MP also includes a description of the methods for measuring achievement of **compliance criteria** and the movement of trends towards **leading indicators** (where applicable).

This MP relates to flora that is normally associated with open rangeland country in central Australia and the Great Artesian Basin (GAB) springs in the wellfield areas. It has been updated to include the potential area required for any future expansion, including the **expanded Special Mining Lease** (SML), Roxby Downs Municipality, and the future saline water wellfield, accommodation village, infrastructure corridors and airport sites (Aus 5a; State 17a).

Flora monitoring within the above-defined area is principally designed to determine the nature, extent and degree of any operational impacts, either positive or negative, on indicator species or functional groups. The causal agents of these impacts, generically known as ‘aspects’ include gaseous, aerosol and dust emissions, liquid waste streams, physical ground disturbance and alteration of groundwater levels. At-risk flora species and weed species are also monitored.

1.1 Responsible ODC personnel

The Olympic Dam Asset President is responsible for ensuring that all legal and other requirements described in this MP are met.

ODC employs an environmental scientist and sufficient other staff with experience and qualifications to fulfil the requirements of this MP.

1.2 Review and modification

This MP is reviewed annually. Major changes or amendments following the review are documented in Appendix F (see section 10) to this MP.

2 DETAILED PROCEDURE

2.1 Emission impacts to vegetation

2.1.1 Background

Atmospheric emissions from the Olympic Dam mining and processing operations, and the construction activities associated with the Olympic Dam expansion, include:

- dust from quarrying, mining and milling operations;
- dust from the Open Pit and associated activities;
- dust arising from the use of vehicles and heavy machinery on unsealed roads;
- saline aerosols from the existing raise bore ventilation shaft exhausts, and mist containing solvents from the tailings storage facilities and evaporation ponds;
- gaseous and acidic emissions, primarily sulphur dioxide (SO_2), other sulphur oxide gases, sulphuric acid, hydrogen fluoride, and heavy metal compounds from the smelter.

Fugitive dust is emitted by activities within the SML and surrounding areas where land disturbance activities occur. Land disturbance activities also take place at Roxby Downs Village and Olympic Dam Airport due to facility upgrades. Dust is also generated from the Backfill Quarry north-west of the mine operation and from vehicles conveying quarried material to and from the backfill plant and stockpiles.

Fugitive dust is readily dispersed by the wind, and while dust suppression measures are to be adopted, the potential remains for these emissions to impact local flora.

The mine ventilation shafts (raise bores), used for circulating fresh air underground, intercept two saline aquifers. The water from these aquifers flows into the shafts and a portion is carried to the surface by the upcast ventilation (upcast raise bores) in the form of a saline aerosol. The aerosol is released into the environment, where it accumulates on vegetation and in the soil.

Parts of the copper smelting process (Flash Furnace and Anode Furnaces) result in the generation of SO_2 and other compounds, including copper compounds. The emission of SO_2 from the Smelter is controlled through the collection of SO_2-rich off-gases for conversion to sulphuric acid at the Acid Plant. During normal operation, residual emissions are vented to the atmosphere via the Acid Plant Tail Gas Stack. Fugitive emissions captured by the hygiene ventilation system are vented via the Main Smelter Stack. These low-level emissions are continuous. High-concentration SO_2 emissions can occur as a result of plant upsets. The management of SO_2 is regulated according to **EPA Licence 1301**.

These emissions have the potential to damage vegetation in the areas surrounding the operation. However, many control measures have been employed to reduce emissions and hence the impact of the operations on surrounding flora. These strategies include improved environmental engineering and process control.

Research to date (Griffin and Dunlop, 2007 and 2007a) and the Draft EIS (DEIS) suggests that *Acacia ligulata* and *Dodonaea viscosa* are sensitive to atmospheric emissions and can be used as indicator species. The symptoms displayed by these species provide an indication of the impact of ODC's activities. The symptoms may reflect a number of cumulative impacts from aerosols and gases, from solutes in the soils or systemically in the plants. Sampling has demonstrated a correlation between the number of symptoms present on both species at a site and the levels of copper (Cu) and sodium (Na) in the foliage of these plants. These two contaminants reflect different sources of emissions (the Main Smelter Stack for Cu, and raise bores for Na) and their different spatial distributions. The two plant species, *A. ligulata* and *D. viscosa*, each respond differently to the contaminant levels. The combined symptom count provides a simple and robust measure that is demonstrably linked to emissions levels (State 17kv).

2.1.2 Purpose

- To define the impact footprint of ODC's activities on vegetation by monitoring the indicator species Acacia ligulata and Dodonaea viscosa.

2.1.3 Deliverable(s)

- A map of the impact footprint of ODC's Olympic Dam activities for the Environmental Management and Monitoring Report (EMMR). (Aus 5g; State 17ki)

2.1.4 Method

Monitoring the symptoms of atmospheric emissions on flora occurs within and around the SML on an annual basis (Aus 5i, State 17kiv). Monitoring is centred on the main sources of emissions: the Main Smelter Stack (as the source of Cu and SO_2) the raise bores (as the source of saline aerosols) and the Backfill Quarry and open pit (as the principal sources of dust for the existing operation and the Olympic Dam Project respectively). The radial extent of the existing monitoring sites was extended in FY09 to account for the expansion activities (see Appendix A) (Aus 5h; State 17kii).

Sampling is undertaken in two stages:

- sample sites are located on a predominantly radial grid pattern, with the distance between sample points increasing exponentially out from the centre of the grid (the centre being near the Main Smelter Stack) to a maximum distance of 25 kilometres (km) to locate the approximate extent (front) of each of the emission impacts;
- sampling on a dense though irregular pattern in and around the 'fronts' (detected during the radial sampling) for each of the symptoms to be modelled.

At each location on the radial grid and the 'front' sampling, five individuals of each of the two indicator species, *A. ligulata* and *D. viscosa*, are selected to identify the presence or absence of each of the following 13 symptoms listed below:

- necrotic spots, leaf tip necrosis, apical chlorosis, marginal chlorosis, dorsiventral colour contrasts, deformations, stagging, dead twigs retaining leaves, excessive leaf abscission, leaf dulling, major new growth, salt crystals and death to foliage and/or the plant.

A symptom is recorded as present if evident to any extent and the symptom count is derived from the percentage of foliage affected. The five individuals are those nearest the sampling point and within a radius of 50 metres (m) of the point. If one or both species are not present within 50 m of the point, no sample is recorded for the absent species.

2.2 Long-term changes to perennial vegetation

2.2.1 Background

Changes in the composition and structure of vegetation surrounding the Olympic Dam operation have occurred as a result of emission impacts (Fatchen Environmental 2005). Fatchen reported that in areas that continue to be affected by emissions, recovery, either from regrowth of damaged individuals or recruitment of new plants, may be depressed or even inhibited.

This section aims to determine the longer-term effects of these emissions, if any, on the surrounding perennial plant communities. Perennial species are persistent and are an ideal indicator group as they are not likely to change in abundance in response to season or to most short mesic or xeric periods. Recruitment is likely to be aperiodic and in response to unusually high rainfall periods (Griffin and Dunlop 2006).

By collecting annual data at different proximities to the emission sources and using simple assessment methods, changes in perennial plant communities as a result of emissions can be monitored (Aus 5j; State 17kv).

2.2.2 Purpose

- To determine what impact ODC's operations, including Olympic Dam Project activities, have on perennial plant communities surrounding the operations.

2.2.3 Deliverables

- A report on the annual changes in perennial communities within and surrounding the expanded SML.
- Provide a comparative assessment on perennial species existing at different distances from the Main Smelter Stack.

(Aus 5g; State 17ki)

2.2.4 Method

A total of 70 long-term vegetation monitoring sites are located in a predominantly radial grid (centred on the Main Smelter Stack) surrounding the Olympic Dam operation. Sites are located up to 25 km from

the centre (see Appendix A for flora monitoring site locations (Aus 5h; State 17kii)). Note: EV939, EV929, EV925, EV911, EV910 and EV940 as labelled in Appendix A are not sampled to determine long-term changes to perennial vegetation as they do not fit the criteria required for this sampling.

At each of the sites on the radial grid, a sample quadrat 100 m by 25 m is assessed for perennial vegetation species. Within the quadrat the frequency of occurrence is recorded for all perennials. Annual monitoring of these sites and vegetation composition are undertaken to detect if emission impacts continue and, if so, their effects on perennial plant communities (Aus 5i; State 17kiv).

2.3 Land disturbance

2.3.1 Background

All native vegetation in South Australia is protected under the provision of the *Native Vegetation Act 1991* and clearance of vegetation is prohibited unless it is approved by the Native Vegetation Council. Application for clearance approvals are to be accompanied by a management plan that describes a significant environmental benefit (SEB). BHP Billiton has proposed an SEB offset through land that can be protected and managed as a set-aside area.

In 2010 the Gosse Springs Native Vegetation Management Plan was approved to establish a Significant Environmental Benefit (SEB) offset area of 10,963 hectares (ha) (see Appendix B for Gosse Springs SEB area, detailing vegetation communities). In the event of the progression of the Olympic Dam Project additional SEB areas will be established in the Arid Lands, Northern and Yorke and the Eyre Peninsula NRM regions to achieve a total SEB offset of 139,781 ha for the Olympic Dam Project (see Appendix C for proposed SEB offset areas in the Arid Lands NRM Region) (this is not anticipated to occur within the timeframe of this EPMP). Ongoing management of these areas and records of disturbance in relation to SEB offset areas and vegetation communities are required as a condition of approval and are detailed further in section 2.8 (Aus 82, 82a).

The various mine, process and infrastructure development activities involve the clearance of vegetation and ground surface for access roads, laydown areas, new facilities and infrastructure, surface soil stockpiles, general excavation and waste management areas. The results of all development activities include:

- clearance of topsoil and vegetation (for the construction of newly proposed infrastructure and access tracks, extraction of sand from dunes and rock quarrying, etc.);
- the alteration of surface soils and surface water flows.

All activities that result in land clearance are subject to ODC's internal Application for an Environmental / Indigenous Heritage Clearance Permit (EIHCP) (Document No. 56830). In addition, management plans direct the handling of vegetation, topsoil and erosion and sediment control measures.

The extent of land disturbance and the impact of drilling activity are controlled through site procedures developed with earthworks contractors.

Waste management and infrastructure expansion is subject to the approval of the appropriate authorities and is regulated through discussions with planning personnel and site procedures developed with earthworks contractors.

2.3.2 Purpose

- Define the direct disturbance impact footprint of infrastructure, development, resource drilling and associated waste management activities.
- Ensure that all disturbance activities have been undertaken in compliance with the EIHCP and SEB processes.
- Ensure that the total area of vegetation cleared does not exceed the total area indicated in the **EIS** (17,269 ha) (State 4) and that the area of SEB is sufficient.

2.3.3 Deliverable(s)

- A map of the direct disturbance impact footprint of ODC's Olympic Dam activities.
- A statement of comparison between the impact footprint of ODC's Olympic Dam activities (i.e. within and outside the SML) and the offset areas under SEB processes, to track progress towards a life of mine ratio of 8ha set aside for each hectare disturbed.

  (Aus 5g; State 17ki)

2.3.4 Method

The extent of physical land disturbance is measured annually using GIS technology and remotely sensed imagery (Aus 5i, State 17kiv). Geo-referenced imagery of the SML and Roxby Downs Municipality (Aus 5h; State 17kii) are analysed for physical disturbance during the period prior to image capture. Evidence of disturbance is cross-referenced against the EIHCP system records for the same period. For land disturbance occurring following image capture until the end of the reporting period, the area is calculated from the EIHCP database. These figures are adjusted appropriately in the following reporting period to reflect actual disturbance.

As part of the EIHCP process, each applicable land disturbance is allocated an appropriate SEB offset ratio. Total offset areas are then subtracted from the total SEB offset areas that have been approved by the Native Vegetation Council, and a remaining SEB offset area is reported.

2.4 Pest plants

2.4.1 Background

Weeds within the Olympic Dam region are managed through the Weed Management Strategy – Roxby Downs and Andamooka Region (BHP Billiton 2010), a collaborative effort driven by ODC, in conjunction with **Arid Recovery**, the Roxby Council and the Andamooka Progress and Opal Miners Association. The Weed Management Strategy takes significant direction from overarching National and Regional Pest Strategies, especially the South Australian Arid Lands (SAAL) Natural Resource Management (NRM) Pest Management Strategy (Pitt et al. 2006).

The Weed Management Strategy includes a risk assessment of weed species that are currently found within the Olympic Dam region or which may become a problem in future. In the strategy, a weed's risk is assessed according to its habitat type (developed or rangeland), invasiveness potential and feasibility to control. All infestations of species declared under the NRM Act 2004 must be controlled in accordance with the Act. Species declared under the Act (as of November 2011) that are known to be present within the Olympic Dam region are: Prickly Pear, Innocent Weed (*Cenchrus incertus*), Bathurst Burr (*Xanthium spinosum*), Caltrop (*Tribulus terrestris*), Salvation Jane (*Echium plantagineum*), Onion Weed (*Nothoscordum inodorum*), Athel Pine (*Tamarix aphylla*), Noogoora Burr (*Xanthium pungens*) and Three-corner Jack (*Emex australis*). African Boxthorn (*Lycium ferocissimum*) and Horehound (*Marrubium vulgare*) are also found within ODC's high-voltage power line corridor from Port Augusta to Olympic Dam. If any declared species are found on ODC managed land, control and any government notification requirements are to be initiated in accordance with the relevant provisions under the Act.

Targeted weed management strategies may also occur through a coordinated approach between ODC, responsible landowners, **Arid Recovery**, Andamooka Progress and Opal Miners Association and Roxby Council, aimed at identifying and controlling priority species.

Ground disturbance, including the movement of vehicles and the transfer of soils, can potentially increase the abundance of pest plants. ID 1.2 of the EMP, "Spread of Pest Plants and Animals", provides controls to mitigate the spread of weeds, controlling the spread of soil in known weed infestation areas and ensuring the diligent cleaning of plant, equipment and vehicles before construction work commences and before leaving areas infested by declared weeds.

2.4.2 Purpose

- Determine the extent of weed infestations of extreme and high risk weed species within the Olympic Dam region and SML.
- Monitor and control declared weeds and plant pathogens within the SML and surrounding areas (Aus 29b, State 9).

2.4.3 Deliverable(s)

- Define and map the current distribution of extreme and high risk weed species within the Olympic Dam region, Roxby Downs Municipality, the SML and Gosse Springs and Olympic Dam Project SEB areas. (Aus 5g; State 17ki, 17kii)
- Identification of whether measures are required to control declared weeds and plant pathogens in the operations area. (Aus 5g, 29b; State 17ki)

2.4.4 Method

The current distribution of extreme and high risk weed species is determined during scheduled weed monitoring. Comprehensive monitoring is conducted every 18 months, thereby alternating between summer and winter survey periods. Construction sites are surveyed prior to construction activities and 12 months after works are completed and/or after significant rains (Aus 5i; State 17kiv). Routine and opportunistic monitoring is also conducted in high-risk habitats and previous control locations. Areas surveyed include the SML, the Roxby Downs Municipality, pastoral leases and **Arid Recovery** (Aus 5h, State 17kii). Monitoring results are used to determine whether control measures are required when an increase in the abundance or area of extreme and high risk weed species is identified attributable to the operations.

2.5 Great Artesian Basin (GAB) springs vegetated wetland area

2.5.1 Background

The area of vegetated wetland is directly correlated to the rate of artesian flow from a GAB spring and can be used as a proxy for the assessment of GAB spring flow (Williams and Holmes 1978). Changes in the area of vegetated wetland may influence populations of threatened flora and endemic invertebrates. Changes in wetland areas may be used to assess the extent of aquifer drawdown resulting from water extraction. Research has demonstrated that GIS techniques can be used to estimate the size of vegetated wetland (Niejalke and Lamb 2002). This method involves less field time and is deemed more accurate than field assessments.

2.5.2 Purpose

- Quantify the changes in GAB springs vegetated wetland areas that may be attributed to water extraction from the wellfields.
- Provide data to support the **leading indicator** for GAB impacts and alert management when levels approach the **leading indicator** value.

2.5.3 Deliverables

- An evaluation of the area of vegetated wetlands within the GAB springs, and comparison with previously recorded measurements.
- A comparison of spring flow rates and aquifer pressure against predictions made in the Olympic Dam EIS of 1982 and 1997.

(Aus 5g; State 17ki)

2.5.4 Method

The area of GAB spring wetlands is calculated triennially using geo-referenced imagery (Niejalke and Lamb 2002) (Aus 5h, 5i; State 17kii, 17kiv). Imagery is captured in the first year of the **Environmental Management Manual** (EMM) triennium, with areas reported in the second year of the triennium. Additional monitoring which is currently undertaken on the springs, including spring flow rate (biannually) and aquifer pressure (quarterly), will be used to identify any gross changes and may trigger a field assessment between imagery capture (Aus 5i).

Remotely sensed imagery of the vegetated wetlands of GAB springs is classified using spatial analysis software. This technique is not appropriate for some springs due to their small size, or for the small number of wetlands that do not support wetland vegetation. Therefore, these springs are assessed using field techniques. To simplify analysis, spring groups are allocated to predicted impact zones that reflect the anticipated level of hydrological influence caused by water extraction from the wellfields (see Figure 8.3, Great Artesian Basin Monitoring Program – Document No. 2789). These impact zones are used in analysis to determine the impact of water extraction from the wellfields. Wetlands may also be grouped into categories depending on their biological complexity and the elevation of the spring vent.

GAB spring groups to be analysed using the GIS technique include those listed in Appendix E of the Great Artesian Basin Monitoring Program (Document No. 2789). Wetland size is compared with the previous reported measurement to determine the impact, if any, of drawdown (Aus 5j; State 17kv). Springs that show a significant difference in measurement are visited to investigate possible causes. The next round of imagery capture is scheduled for the first half of 2014 (FY14).

2.6 'At-risk' species – Category 1a

A number of at-risk flora species have been recorded within the project area. At-risk species are those where isolated populations or the species population as a whole have the potential to be adversely impacted by the operations. Species include those formally listed under state or national conservation listings and other significant species defined by ODC. At-risk species have been classified by ODC into three main categories: Category 1a, Category 1b and Category 2.

Category 1a includes those at-risk species whose population distribution as a whole is largely restricted to the impact area and which are therefore at a higher risk of being impacted by the operations. This includes flora species restricted to the GAB springs of the Lake Eyre South region in the vicinity of the wellfields.

The degree of at-risk species monitoring undertaken depends largely on the category under which they fall. Monitoring of Category 1a species is intensive in comparison to Category 1b and Category 2 species (see section 2.7), which reflects the species' reliance on the potential impact area. A list of all at-risk flora occurring in the impact zone is included in Appendix D (see section 8). Appendix E (see Section 9) contains a flow chart detailing how at-risk species are identified.

2.6.1 Background

Only one species of Category 1a flora species (Salt Pipewort *Eriocaulon carsonii*) has been recorded on the SML and surrounding potential impact areas including Roxby Downs Municipality, Pastoral Leases, the transmission line corridor and the Wellfields area.

A diverse and rare group of flora is found within the mound springs of the Great Artesian Basin in South Australia and Queensland. These landforms occupy an extremely small percentage of semi-arid Australia. *Eriocaulon carsonii* is a distinctive plant restricted to the active mound springs of the GAB, where it relies on a constant supply of flowing water. The largest single population exists at the Hermit Hill spring complex near Wellfield A. *E. carsonii* is listed as endangered under state and national legislation. Extraction of water from the GAB has the potential to alter the flow of mound spring water within the GAB, which may have an adverse effect on *E. carsonii* populations.

2.6.2 Purpose

- Determine if the distribution and abundance of *E. carsonii* is affected by water extraction from the GAB wellfields. (Aus 29a; State 6)

2.6.3 Deliverables

- A comparison of the abundance and distribution of *E. carsonii,* per impact zone, with previously reported values, to determine any impacts within the GAB wellfields. (Aus 5g; State 17ki)

2.6.4 Method

The relative abundance of *E. carsonii* is estimated annually (State 17kiv) using the Domin cover-abundance scale (Kershaw and Looney 1985). Changes in the cover abundance and the proportion of GAB springs supporting *E. carsonii* are used to assess the dynamics of the population. To simplify analysis, spring groups are allocated to predicted impact zones that reflect the anticipated level of hydrological influence caused by water extraction from the wellfields (see Figure 8.3, Great Artesian Basin Monitoring Program (Document No. 2789)) (Aus 5h, 5i; State 17kii).

2.7 'At-risk' species – Categories 1b and 2

Category 1b includes at-risk species that have an **important population** (where there are few other populations within the region or interstate) that may be critically reliant on the area of impact and the population has the potential to be impacted. Currently there are no at-risk flora species that fall into the category.

Category 2 includes all other species known to occur in the region that are listed under state, national and/or international conservation listings, but can include other regionally or locally significant species that may be adversely impacted by operations (i.e. includes some resident unlisted species) (see Appendix D). Populations of Category 2 at-risk species are not critically reliant on the potential area of operations impact (i.e. only individuals of the species are likely to be impacted). This includes species that have a wider distribution within the state, interstate or overseas and are not considered to be dependent on existing populations within the potential impact area.

2.7.1 Background

There have been 36 at-risk flora species recorded within the SML, surrounding infrastructure areas, Roxby Downs Municipality, pastoral leases, the transmission line and the wellfields area. Species location data is derived from government and ODC databases, the Australian Virtual Herbarium website and the field studies conducted as part of the DEIS. All species were found to be non-dependent on the populations that exist within the impact area and have been classified as Category 2. This includes species that are not listed as threatened, but are considered to be regionally / locally significant.

No specific monitoring programs apply to individual Category 2 species, however all at-risk species are protected where possible under the EIHCP procedure. This procedure includes the requirement to seek alternative locations for disturbance in an attempt to avoid individuals of **listed species**, or to justify the decision that a relocation of the infrastructure is not possible. Where disturbance is unavoidable, at-risk species are relocated.

2.7.2 Purpose

- Determine if there is a requirement to implement any management activity for the protection of Category 1b and/or 2 species in the vicinity of the operations.
- Identify species and areas of habitat that should be avoided where possible during land disturbance activities.

2.7.3 Deliverable(s)

- A map of the known locations of Category 1b and 2 species within the impact area of the Olympic Dam operation.
- A statement of impacts to, and measures undertaken to avoid, Category 1b at-risk species.

(Aus 5g, 29a; State 17ki)

2.7.4 Method

Locations will be investigated opportunistically (Aus 5h, State 17kii) for annual and / or ephemeral at-risk species after periods of substantial rain (Aus 5i, State 17kiv) and added to the EIHCP spatial database for future reference. Locations of these species and perennial at-risk species will be retained in the spatial database and considered when applications for EIHCPs are lodged.

A flora assessment is undertaken in areas known or likely to support at-risk species prior to any significant land disturbance activities as part of the activities for the Olympic Dam Project. Where threatened flora or habitats considered important to threatened species (Category 1b or 2) are found, the EIHCP conditions flag ‘no go’ areas for the project, seek justification for disturbance in these areas, and in certain circumstances require relocation of affected species where disturbance is unavoidable (Aus 29a; State 6, 38).

2.8 Delivery of environmental offsets

2.8.1 Background

As discussed in section 2.3, an SEB offset is being implemented to compensate for vegetation clearance and other **environmental impacts** associated with the Olympic Dam Project. An existing SEB (Gosse Springs) has been approved by the South Australian Government. Additional proposed areas in the Arid Lands NRM region include Emerald Springs and One Box to the west of Lake Eyre National Park and two further adjoining properties; Black Swan and Bedourie. In conjunction with existing national parks and reserves, the proposed offsets will aid in the formation of a contiguous conservation area of 15,650 km^2 (Aus 82b, 82c). Appendix C provides a map of the potential future SEB areas.

The objective of the SEB set-aside area is to not only compensate for **environmental impacts** associated with the expansion, but to also achieve a net gain in biodiversity and conservation value for the region. To achieve this outcome management actions and strategies will be progressively implemented, within each SEB area, that focus on weed and feral animal control, rehabilitation of disturbed areas and other strategies that ensure the protection and recovery of native flora and fauna (Aus 82j).

A native vegetation management plan has been developed for Gosse Springs, detailing the actions that will be conducted to achieve a net benefit. This document also details the contributions the SEB areas will give to the biodiversity conservation priorities of the Australian and South Australian Governments.

The development of each SEB area is undertaken in stages, commencing with Emerald Springs, and in correlation with offset requirements arising from vegetation clearances associated with the expansion.

To ensure the successful and timely delivery of the actions, monitoring of these plans is conducted as part of this MP and reported in the EMMR each year.

2.8.2 Purpose

- To monitor the delivery of strategies and management actions required for the SEB offset areas to ensure a net benefit is achieved (Aus 5g; State 17ki).

2.8.3 Deliverable(s)

- A summary of actions achieved from the SEB implementation plans within the fiscal year through the EMMR (Aus 82k)..
- An annual report to the government on SEB management outcomes through the EMMR (Aus 82k).
- Shapefiles of the SEB areas for inclusion in relevant departmental databases (Aus 82l).

2.8.4 Method

The implementation plans for the Emerald Springs, Bedourie, One Box and Black Swan SEB areas, which form part of the Native Vegetation Management Plan for each offset area, will be routinely reviewed to ensure management actions are being addressed in a timely manner and to make modifications to proposed actions if required.

Details of actions achieved from these plans, within the fiscal year, are reported through the EMMR.

(Aus 5h, 5i)

3 COMMITMENTS

3.1 Reporting

The results and a discussion of the results will be presented in the EMMR, as outlined in the EMM.

3.2 Summary of commitments

Table 3.1: Summary of commitments

Action	Parameter	Frequency
Monitor	The indirect impact of ODC's Olympic Dam activities' footprint on vegetation indicator species (*Acacia ligulata* and *Dodonaea viscosa*)	Annually
Monitor	The total area of direct impact on vegetation	Annually
Monitor	Changes in perennial vegetation in response to emissions from the Olympic Dam Operation	Annually
Monitor	The current status of key pest plant species within the Olympic Dam region	Ongoing
Monitor	Relative abundance of Category 1a species within the wellfields	Annually
Monitor	Presence of Category 1b and 2 species within the expanded SML, region and wellfields	Opportunistically
Assess	Changes in GAB spring vegetated wetland area	Triennially
Assess	Changes in population status of **listed species**	Annually
Assess	Actions achieved from implementation plans for SEB areas	Annually
Rehabilitate	Cleared areas and take measures to avoid disturbance to at-risk species in accordance with the methods prescribed in the EIHCP procedure	As prescribed
Report	Annual land disturbance for the SML and Municipal Leases defined as either being credited to an SEB or not	Annually
Report	Monitoring results in the EMMR to the Indenture Minister	Annually
Review	The Flora MP and modify as appropriate	Annually

4 DEFINITIONS AND REFERENCES

4.1 Definitions

Throughout the EPMP some terms are taken to have specific meaning. These are indicated in bold text in the documentation and are defined in the glossary in section 5 of the EMM. Defined terms have the same meaning wherever they appear in bold text. Some other terms and acronyms are also defined in the glossary, but do not appear in bold text.

4.2 References

BHP Billiton 2009, 'Olympic Dam Expansion – Draft Environmental Impact Statement 2009', BHP Billiton, Adelaide.

BHP Billiton 2010, 'Weed Management Strategy – Roxby Downs and Andamooka Region', unpublished report for BHP Billiton, Olympic Dam.

Griffin, GF & Dunlop, SR 2006, 'Long term changes in the composition of perennial vegetation in response to emission from the Olympic Dam Operations', unpublished report for BHP Billiton Olympic Dam.

Griffin, GF & Dunlop, SR 2007, 'Emissions dispersal patterns and impacts on soils and vegetation in the Olympic Dam operation area', unpublished report to BHP Billiton, Pillar Valley, NSW.

Griffin, GF & Dunlop, SR 2007a, 'Impact of Emissions from the Olympic Dam Mine Operation on the Flora and Soil of the Special Mining Lease', unpublished report to BHP Billiton, Pillar Valley, NSW: Datasticians.

ICRP 2008, Environmental Protection: the Concept and Use of Reference Animals and Plants, ICRP Publication 108, Annals of the ICRP 38 (4–6).

Kershaw, KA & Looney, JHH 1985, 'Quantitative And Dynamic Plant Ecology' (3rd Ed), Edward Arnold, London.

Niejalke, DP & Lamb, KJ 2002, 'Can remote sensing monitor GAB spring impacts? A progress update'. Conference paper presented to the Mound Spring Researchers Forum, Toowoomba, March 2002.

Pitt, J, Greenfield, B & Feuerherdt, L 2006, 'South Australian Arid Lands Pest Management Strategy, 2005–2010', South Australian Arid Lands Natural Resource Management Board, Adelaide.

Williams, AF & Holmes, JW 1978, 'A novel method of estimating the discharge of water from mound springs of the Great Artesian Basin, Australia', *Journal of Hydrology* 38, pp. 263–272.

4.3 Bibliography

Badman, FJ 1995, 'Changes in the incidence of alien plant species at Olympic Dam between 1986 and 1994', Qualifying masters thesis, University of Adelaide.

Bailey, PT, Martin, JH, Noyes, JS & Austin, AD 2001, 'Taxonomy and biology of a new species of *Zaphanera* (Hemiptera: Aleyrodidae) and its association with the widespread death of Western Myall trees, *Acacia papyrocarpa*, near Roxby Downs, South Australia', *Transactions of the Royal Society of South Australia* 125 (2), pp. 83–96.

Fatchen, TJ & Fatchen, DH 1993, 'Mound spring vegetation in the Hermit Hill region: Dynamics, responses to borefield operation and management implications', TJ Fatchen and Associates, Adelaide.

Fatchen Environmental. 2005. An assessment of WMC (Olympic Dam Corporation) emissions impact on the flora of the special mining lease and surrounds [2004]. Report for WMC (Olympic Dam Corporation) Pty Ltd. Mt Barker, SA: Fatchen Environmental Pty Ltd.

Habermehl, MA 1982, 'Springs in the Great Artesian Basin, Australia – Their origin and nature', Australian Government Printing Service.

Harris, CR 1992, 'Mound springs: South Australian conservation initiatives', *Rangeland Journal* 14 (2), pp. 157–173.

Read, JL 1995, 'Recruitment characteristics of the white cypress pine (*Callitris glaucophylla*) in arid South Australia', *Rangeland Journal* 17, pp. 228–240.

Read, JL 2004, ‘Catastrophic drought-induced die-off of perennial chenopod shrubs in arid Australia following intensive cattle browsing’, *Journal of Arid Environments* 58, pp. 535–544.

Read, JL, Kovac, K & Fatchen, TJ 2005, ‘Biohyets: a method for displaying the extent and severity of environmental impacts’, *Journal of Environmental Management*, 77, pp. 157–164.

5 APPENDIX A: FLORA MONITORING SITE LOCATIONS

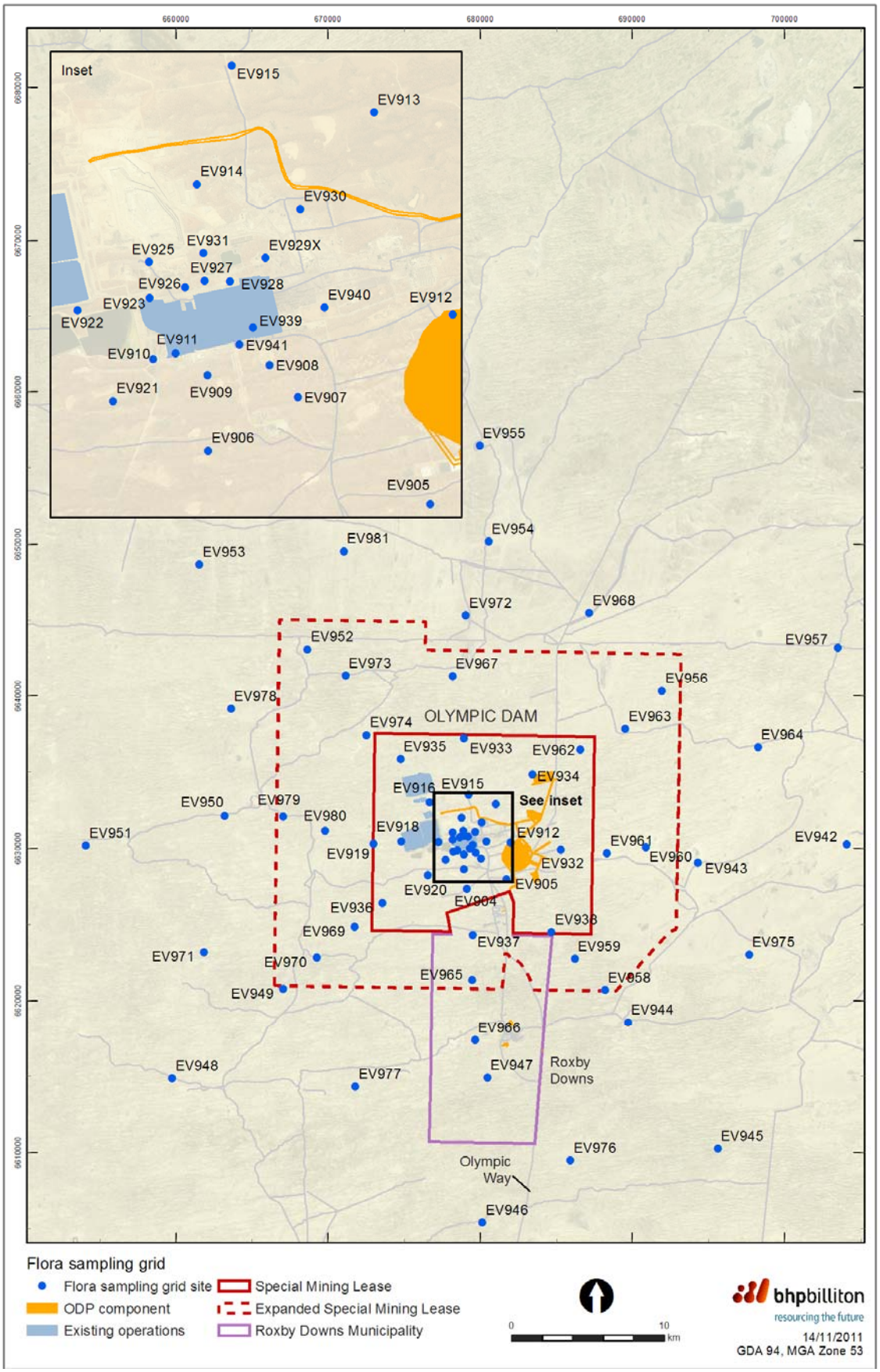


Figure 5.1: Sampling grid for OD flora emissions monitoring and long term vegetation monitoring

6 APPENDIX B: VEGETATION COMMUNITIES WITHIN THE GOSSE SPRINGS AND EMERALD SPRINGS SEB AREAS

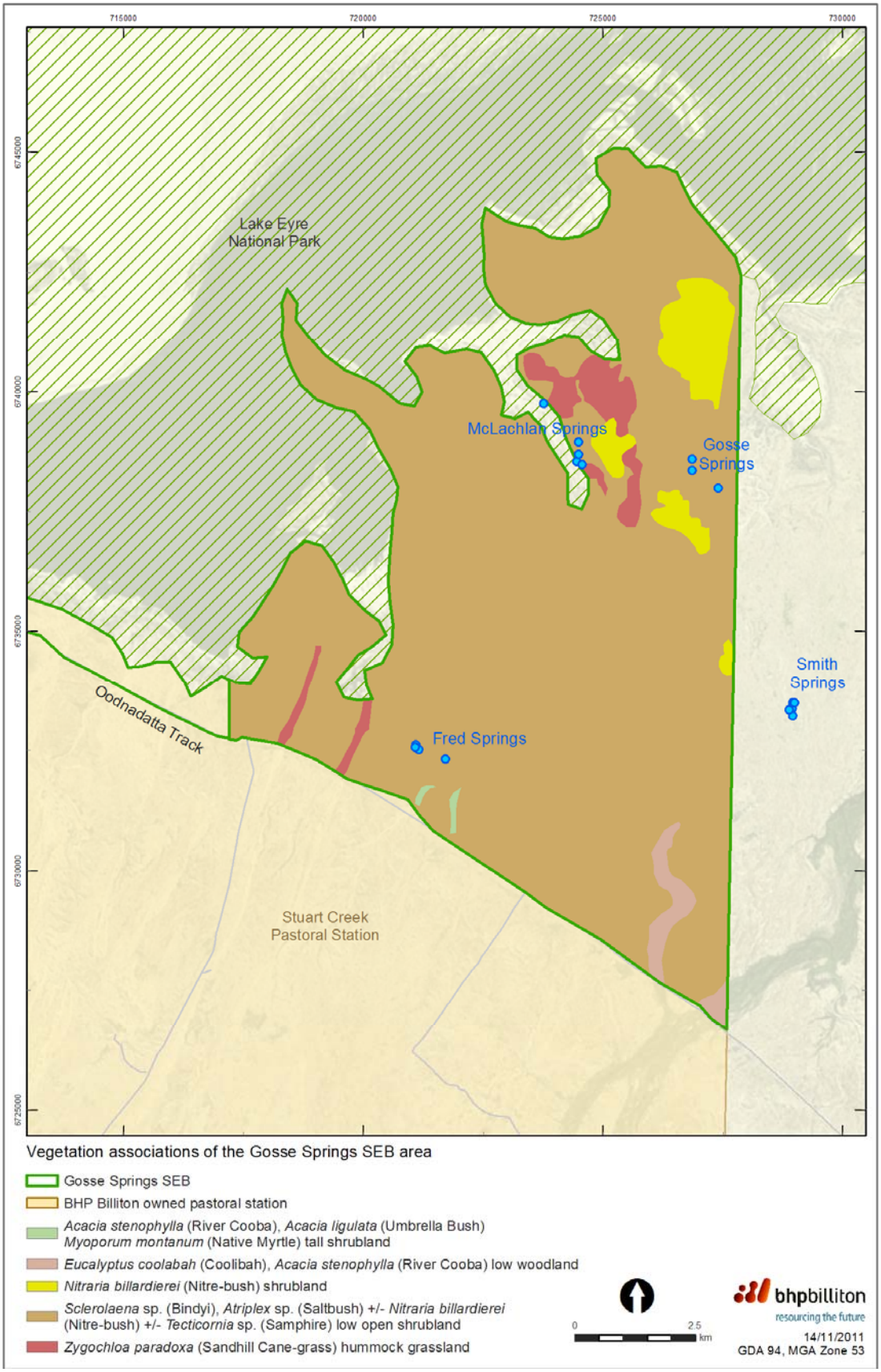


Figure 6.1: Gosse Springs SEB area vegetation associations

7 APPENDIX C: PROPOSED SEB AREAS

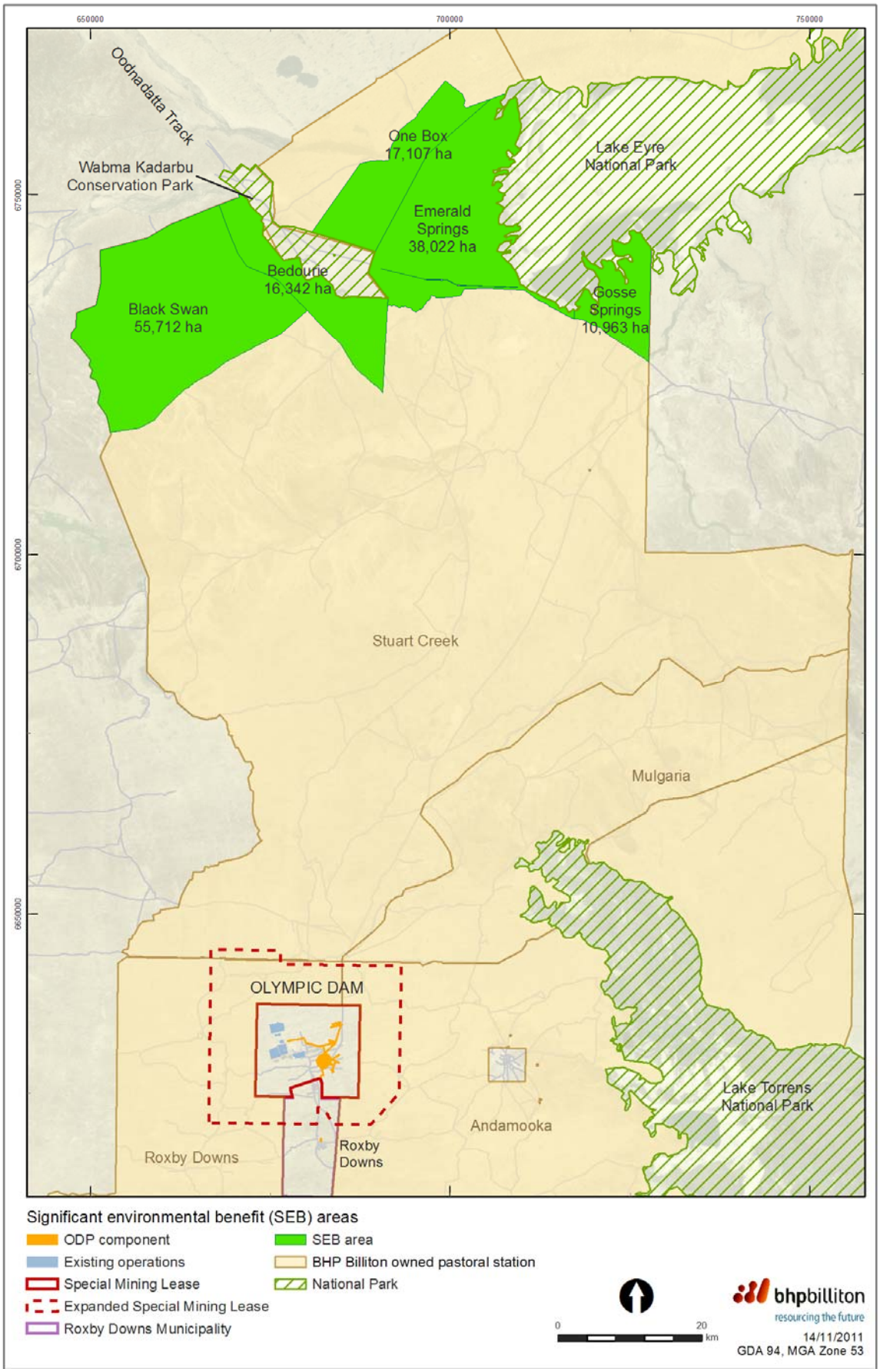


Figure 7.1: SEB offset areas

8 APPENDIX D: AT-RISK FLORA SPECIES LIST

Table 8.1: At-risk flora species list

Common name	Scientific name	Well-fields	OD leases	OD region	Trans-mission line *	EPBC	IUCN	NPW (SA)	Species category	Comments
FLORA										
Mulga	*Acacia aneura*	✓	✓	✓	✓	-	-	.	2	Regionally significant. Six variants.
Western Myall	*Acacia papyrocarpa*		✓	✓	✓	-	-	-	2	Regionally significant. Are long lived and very slow growing – can take 75 years to mature.
Sweet Wattle	*Acacia suavelolens*			✓	✓ ?			V	2	DEH record from Purple Downs Station within 5km of transmission line.
Bullock Bush	*Alectryon oleifolius ssp canescens*	✓	✓	✓	✓	-	-	-	2	Regionally significant – can regenerate from root suckers. Life span of approximately 600 years.
Eichler's Saltbush	*Atriplex eichleri*			✓		-	-	R	2	Specimen from New Years Gift Bore (Stuart Creek Station). Gibber habitat. Possibly on SML.
Koch's Saltbush	*Atriplex kochiana*		✓	✓		-	-	V	2	Many locations from OD region including Andamooka, **Arid Recovery**. Possibly on SML also.
	Brachyscome eriogona			✓			-	R	2	Records from Andamooka Opal Fields/Township.
Red-leg Grass	*Bothriochloa macra*			✓				R	2	DENR records from Andamooka Station. Numerous specimens found interstate.
	Bulbostylis turbinate				✓	-	-	-	2	Condition 144, SA Govt. Gazette, vegetation types that are likely to support threatened species.

Common name	Scientific name	Well-fields	OD leases	OD region	Trans-mission line *	EPBC	IUCN	NPW (SA)	Species category	Comments
Bead Purslane	*Calandrinia sphaerophylla*				✓	-	-	-	2	Condition 144, SA Govt. Gazette vegetation types that are likely to support threatened species.
Matted Water Starwort	*Callitriche sonderi*			✓		-	-	R	2	Specimen from old homestead ruins (Stuart Creek Station). Creek bed habitat – unlikely to be on SML or ML.
Northern Cypress Pine	*Callitris glaucophylla*		✓	✓	✓	-	-	-	2	Regionally significant. Long-lived, with extremely infrequent regeneration. Significant stabilisers of dune systems.
Desert Lime	*Citrus glauca*			✓	✓	-	-	V	2	Isolated occurrences recorded within transmission line corridor (BHP Billiton, 2009) and south-east of Olympic Dam. Found interstate at numerous locations.
Sieber Crassula	*Crassula sieberiana*		✓	✓		-	-	E	2	Specimens recorded on ML and Stuart Creek Station. Open woodland habitat – likely to also exist on the SML. Numerous specimens found interstate.
Downs Flat-sedge	*Cyperuss bifax*	✓				-	-	R	2	DENR records from Stuart Creek Station. Numerous populations interstate.
Zig-zag Bitter-pea	*Davesia pectinata*				✓	-	-	R	2	Recorded within transmission line corridor (BHP Billiton, 2009). Found at multiple locations interstate.
Showy Speedwell	*Derwentia decorosa*			✓				R	2	DENR record from Andamooka Station. Numerous records from other areas within SA. Not directly impacted by operations.
Water Wort	*Elatine gratioloides*			✓		-	-	R	2	Specimen recorded at Wimbrinna Dam (Stuart Creek Station). Also found interstate and overseas.

Common name	Scientific name	Well-fields	OD leases	OD region	Trans-mission line *	EPBC	IUCN	NPW (SA)	Species category	Comments
Flat Spike-rush	*Eleocharis plana*				✓	-	-	-	2	Condition 144, SA Govt. Gazette, vegetation types that are likely to support threatened species.
Salt Pipewort	*Eriocaulon carsonii*	✓				E	-	E	1a	Extremely limited distribution. Largest single population at Hermit Hill Spring complex within the Wellfield region.
Sea-heath	*Frankenia cupularis*	✓		✓		-	-	R	2	Specimen from Blower Waterhole (Stuart Creek Station) and Coward Springs reserve. Found interstate.
	Frankenia plicata			✓		E		V	2	Several DENR locations in eastern area of Andamooka Station. Not directly impacted by operations.
Western Tarvine	*Gilesia biniflora*			✓		-	-	R	2	Specimen from Red Lake (Stuart Creek Station). Found in other regional areas in SA.
	Gratwickia monochaeta				✓	-	-	R	2	Recorded within transmission line corridor (BHP Billiton, 2009). Specimens elsewhere in SA region.
Hairy Bluebush	*Maireana pentagona*		✓	✓		-	-	R	2	Recorded in a canegrass swamp near Borefield Road and at Stuart Creek Station. Commonly found in *Atriplex vesicaria* communities and open woodland.
Slender Soft-horns	*Malacocera gracilis*			✓	✓	-	-	V	2	Recorded within transmission line corridor (BHP Billiton, 2009). Recorded on Andamooka Station.
Large Adder's-tongue	*Ophioglossum polyphyllum*				✓	-	-	R	2	Recorded within transmission line corridor (BHP Billiton, 2009).
Australian Broomrape	*Orobanche cernua var australiana*	✓				-	-	R	2	Found in other SA regions, interstate and overseas. Specimen from near Marree.

Common name	Scientific name	Well-fields	OD leases	OD region	Trans-mission line *	EPBC	IUCN	NPW (SA)	Species category	Comments
Spreading Cress	*Phlegmatospermum eremaeum*			✓	✓			R	2	Spread widely throughout state. Recorded in locations north of Olympic Dam to Moomba.
Quandong	*Santalum acuminatum*		✓	✓	✓	-	-	-	2	Regionally significant – locally uncommon species with cultural significance.
Sandalwood	*Santalum spicatum*		✓	✓	✓	-	-	V	2	Recorded within transmission line corridor (BHP Billiton, 2009) and north of Olympic Dam. Specimens on pastoral leases.
Black's Bindyi	*Sclerolaena blackiana*			✓			-	R	2	Recorded at Coward Cliffs, Stuart Creek Station.
Wild Violet	*Swainsona microcalyx*			✓	✓	-	-	R	2	Recorded within transmission line corridor (BHP Billiton, 2009). Populations also found interstate.
Small-Flower Swainson-pea	*Swainsona minutiflora*	✓		✓		-	-	V	2	Specimen from Priscilla Springs (Stuart Creek Station).
	Swainsona oligophylla			✓		-	-	R	2	Specimen from horse springs (Stuart Creek Station). Also found in other SA regions and interstate.
Small Fruit Twinleaf	*Zygophyllum humillimum*	✓		✓		-	-	R	2	Specimen from Stuart Creek Station. Also found in other SA regions and interstate.
ECOLOGICAL COMMUNITIES										
	The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	✓				E (TEC)			1a	Includes a number of species of endemic aquatic invertebrates.
Mulga Woodlands	*Acacia aneura*		✓	✓	✓			V	2	Relatively common throughout northern South Australia.

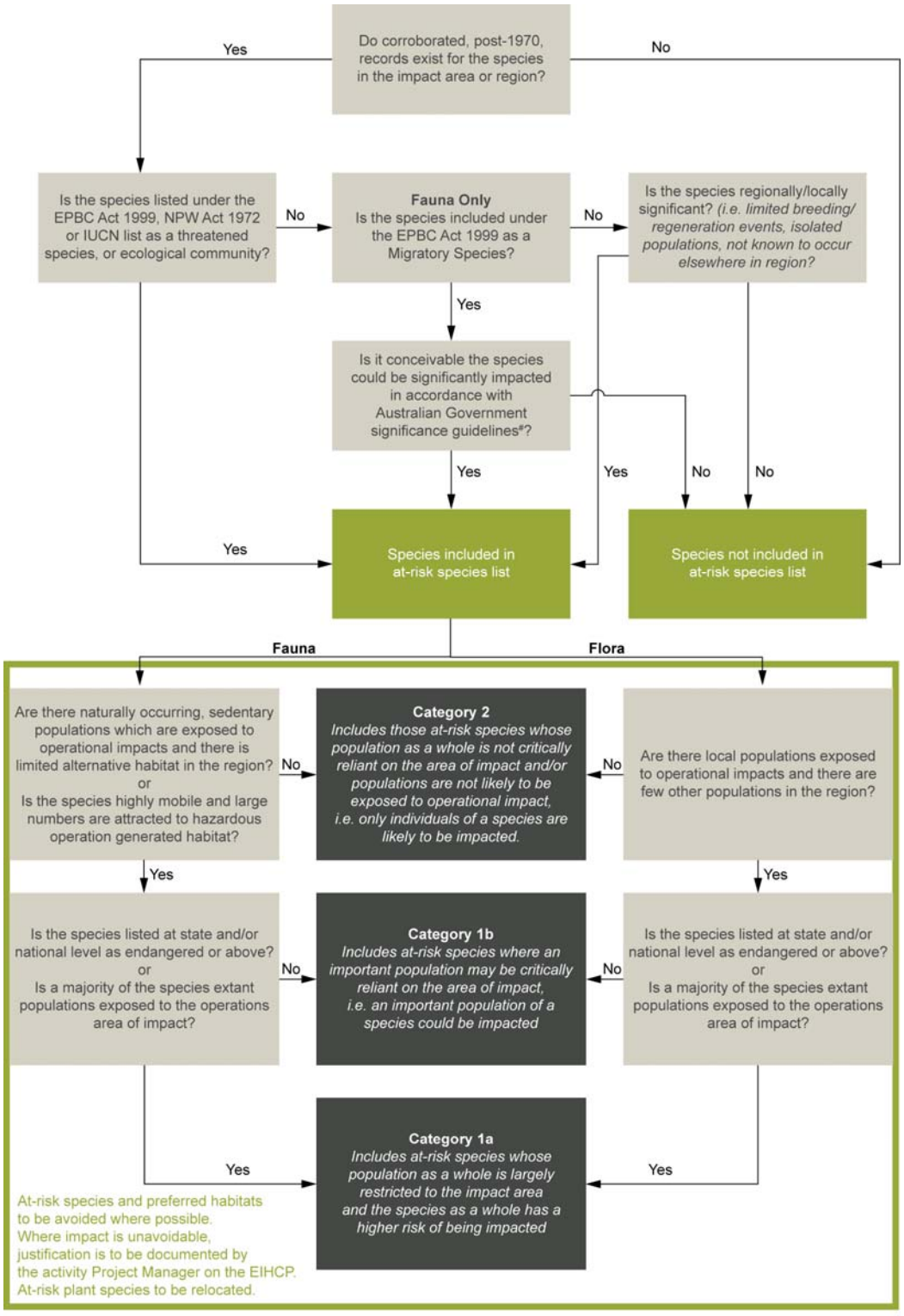
✓= Species recorded within Olympic Dam, Wellfields region or transmission line corridor.

Letters under column EPBC and NPW (SA) represent the category of threat listed in the Environment Protection and Biodiversity Conservation Act 1999 and the National Parks and Wildlife Act 1972 (species listed as at 25/11/2011).

E = Endangered V = Vulnerable R = Rare TEC = Threatened ecological community

* Records of species located within the transmission corridor between the Roxby Downs Municipality and the Davenport Substation at Port Augusta have been sourced from internal databases and BHP Billiton (2009). Species include those recorded within 5 km of the transmission line (DEIS)

9 APPENDIX E: CLASSIFICATION OF AT-RISK FLORA SPECIES



Definitions
Impact area: area which the operations can potentially impact, including the Olympic Dam region and the wellfields and power line
NPW 1972: National Parks and Wildlife Act, 1972 (SA)
EIHCP: Environmental/Indigenous Heritage Clearance Permit
EPBC Act 1999: Environment Protection and Biodiversity Conservation Act, 1999
IUCN: IUCN Red List of Threatened Species, http://www.iucnredlist.org
http://www.environment.gov.au/epbc/publications/nes-guidelines.html

Figure 9.1: Classification of at-risk flora species

10 APPENDIX F: AMENDMENTS TO MONITORING PROGRAM – FLORA FY13

Where applicable a summary of major changes to this MP is provided. Individual changes have not been itemised.