QUEDJINMIA RESERVE

Reserve no. 43008

Environmental Management Plan

Adopted by the City of Busselton

March 2016

City of Busselton

Geographe Bay

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1 Introduction

Reserve 43008 is a 13 ha crown reserve located in Dunsborough WA, within the City of Busselton. The reserve is vested in the City of Busselton for the purpose of "recreation, community centre and drainage". The reserve contains the Naturaliste Community Centre, which incorporates the Dunsborough Library, indoor sports stadium, crèche and other community facilities. It is adjacent to the Dunsborough Playing fields, although this area is outside the reserve boundary.

Most of the reserve has been retained as native remnant vegetation which provide an important habitat for native flora and fauna, which is particularly significant within a growing urban environment.

The reserve also contains a number of significant Aboriginal heritage sites, including camping ground, ceremonial, mythological and burial sites.

To the east of the reserve, urban development has resulted in a number of residential dwellings being constructed within 10 metres of the western edge of the reserve. The potential for bushfire hazards to accumulate close to these dwelling within the reserve is high and the fuel loads of bushfire fuels need to manage to minimise the wildfire risks to these houses.

This Environmental Management Plan incorporates elements of aboriginal heritage, social uses, and native flora and fauna, and bushfire hazards to maintain and enhance these biological and cultural values while minimising the risk from bushfire for adjoining landowners.

2 Purpose and Scope of this Management Plan

The objective of this Environmental Management Plan is to protect and enhance the environmental, social and heritage values of the reserve whilst ensuring the safety of the adjoining landholders.

This plan outlines the values of the Reserve and the threats to those values.

Management strategies are outlined to achieve this, based on the principle that the safety concerns of landowners and users of the reserve are considered without negatively impacting on the conservation values.

Fire management guidance and recommendations are proposed within this plan that follow this principle.

Consultations with the local indigenous community were conducted as part of this management plan's development. This was facilitated by Brad Goode & Associates (Consulting Anthropologists and Archaeologists). The outcomes of these consultations are documented separately (Huxtable, 2015), however where required, this report's outcomes are referenced within this Environmental Management Plan.

3 Legislative and Policy Framework

There are a broad range of legislation, policy, consultations and guidelines that apply to the reserve and the proposed management actions. The following have been considered in the preparation of this plan.

- Aboriginal Heritage Regulations 1974
- Bushfires Act (1954) WA.
- City of Busselton Community Infrastructure Division Technical Standards and Specifications;
- City of Busselton Environment and Heritage Conservation Policy (2010)
- City of Busselton Local Planning Scheme No.21 (2010)
- Environmental Protection and Biodiversity Conservation Act (1990)
- Report of an Aboriginal Heritage Survey of a Fire management plan for reserve 43008 and other projects proposed within the town of Dunsborough, Western Australia (Brad Goode and Associates, 20105),
- State Planning Policy 3.4: Natural Hazards and Disasters;
- Western Australian Aboriginal Heritage Act 1972;
- Wildlife Conservation Act (1950) WA

4 Site Description

Crown Reserve 43008 (Lot 4976 on Plan 19038) is located in Dunsborough and lies between Caves Road, Dunsborough Lakes Drive, the Dunsborough Playing Fields and the Windlemere Estate residential development (Map 1).

It lies at the junction between the Swan Coastal Plan and the Leeuwin Ridge. The Reserve is moderately flat but slopes upwards towards the west rising from 10 m above sea level (Australian Height Datum AHD) to 15m AHD on the eastern boundary which adjoin Windlemere Estate (Map 1). An open drainage system

follows the western boundary of the Reserve, designed to provide drainage for high rainfall events from the urban development to the west.

5 Social Values

5.1 Aboriginal History and Values

The following synopsis was provided by Mr Brad Goode from Brad Goode & Associates.

Reserve 43008 has a rich history of prehistoric and historic Nyungar occupation. Over the last 40 years several archaeologists and anthropologists have conducted heritage surveys on portions of the reserve and have documented the reserves scientific and cultural values that are known to be present.

In 1978 when Caves Road was realigned southwards artefacts were exposed within the road cutting bordering the reserve. Mr Charles Dortch (archaeologist) from the W.A Museum who investigated the matter found artefacts dating beyond 5000 years. According to Mr Dortch this site was clearly much larger, extending some 200m into Reserve 43008 (Dortch, J 1995:1, & Dortch, J; 1998; 4-5).

In 1993 Ms Louise Bavin (archaeologist) was commissioned by the Western Australian Water Authority to conduct a survey for a water pipeline route that truncated Reserve 43008. Artefacts were found upon the surface and within the roads embankment along the south side of Caves Road and where Windlemere Drive borders the reserve to the south. (Bavin: 1993: 16)

In 1994 Mr Joe Dortch was commissioned to conduct a test excavation at the site for the pipeline. Mr Dortch's excavation further dated the age of recovered artefacts to 12000 years and extended the geographical boundaries of the site to include areas adjacent to the site on the north side of Caves Road, a site now occupied by Chicken Treat, and also on the western side of Cape Naturalist Road near the new Dunsborough Police Station (Dortch, J 1995:1-2

In 2002 Mr Wayne Glendenning (archaeologist) was commissioned by the City of Busselton to survey an adjacent area for the Dunsborough playing fields. Glendenning identified an artefact sites on the western shore on the southern end of the existing lake along the eastern margin of Reserve 43008 and also recorded isolated artefacts along a track on the western border with Windlemere Estate (Glendenning 2002: 11, & Goode 2003: 4-5)

In 2009 Mr David Guilfoyle in a survey of the new playing fields for the City of Busselton identified a moderately-dense stone artefact scatter eroding from the sloping embankment of a water storage dam on the south-eastern corner of Reserve 43008. Here Guilfoyle reported that these artefacts represented late stage manufacture and/or tool maintenance site that showed intensive human occupation over a date range consistent with the dates obtained by Dortch near Caves Road (Guilfoyle 2009: 8).F

The history of the reserves cultural values was first noted by settler families and documented by Hardwick in 1996 when conducted an Ethnographic study of the Dunsborough Playing Fields. In his study he identifies that Quedjinup (Dunsborough) was known to be at the "nexus of tracks or runs coming from the east, west and north-west. These tracks were the paths that brought Wardandi family groups from all over their country in the spring of each year when food resources were abundant enough for Aborigines to conduct large ceremonial gatherings". Hardwick stated accounts from decedents of the original farming families such as Seymour and Jennings make references to these events and Nyungars having camps on the sand ridges within Reserve 43008. (Jennings in Hardwick 1996:7)

In terms of contemporary values the Aboriginal community was first consulted about Reserve 43008 in the early 1990's when Mr Charles and Mr Joe Dortch took Mr Wayne Webb to the site for an inspection. Mr Webb informed Mr Dortch of a burial site known to the Elders of the Busselton Aboriginal community as "Koobins Grave". The exact location of this gravesite was unknown at the time of Mr Webb's inspection. However Mr Webb believes that it is within 200m of Caves Road within Reserve 43008.

In 2003 Goode conducted consultations with several Nyungar families at the site upon behalf of Telstra. In this survey the Elders identified that Koopin was a "full blood" tribal Wardandi man that died upon the beach in Dunsborough during the winter, near the turn of the century. They stated that William Fred Seymour, whose family farmed the land adjacent to Reserve 43008 in his awareness of traditional burial practices, took Koopin's body on the back of his dray to the area commonly known as 'Kips calf paddock' where it was left for the Aboriginal people to bury. (Goode 2002: 4-5). Sometime after a local resident (Mr Les Patton) a former adjacent land owner suggested that the grave is west of and adjacent to the

Naturaliste Community Centre, to the south of the original road to Yallingup near the original fence post delineating Kip Seymour's 'calf paddock' near a group of Sheoak trees. The actual grave is yet to be found.

During these consultations the Elders also advised that Reserve 43008 was a historic camp ground occupied by the Lowe and Sambo families through the spring in the 1930s and 1940s. The location of the camps were known to be in bushland approximately 150m south of Caves Road high on a sandy ridge overlooking a wetland (Goode 2003: 15)

In June of 2009 the reserve was used as a reburial site by the local Aboriginal community with the assistance of the Department of Aboriginal Affairs. Skeletal remains that had been formerly housed at the Western Australian Museum were repatriated to the site and reburied in a ceremony that was filmed. The remains reburied were a female previously from the Dunsborough area and a male previously from the Vasse Drain.

Reserve 43008 in its entirety is now considered by the Nyungar community as highly significant Aboriginal cultural heritage site that has a matrix of prehistoric and historic Nyungar cultural values. Management of this area must therefore consider these values in terms of legislative requirements under the AHA but more importantly in maintaining positive and respectful relations with Nyungar community by continuing to involve them in all management decisions made.

There are four Department of Aboriginal Affairs (DAA) Registered Aboriginal sites and three other Aboriginal Heritage places that have DAA extents that overlay Reserve 43008 (Brad Goode & Associates, 2015).

These are listed in Table 1 and shown in Map 2. Full details are available in the report prepared by Brad Goode & Associates (2015) prepared as part of the consultation for this management plan.

Table 1: Summary of Aboriginal heritage sites with DAA extent within Reserve 43008.

Id	Name	Status	Access	Restriction	Site Type
Registered Aboriginal Sites					
1061	Dunsborough 2: Caves Rd	Registered	Open	No	Artefacts/ Scatter
20004	Dunsborough Playing Fields	Registered	Open	No	Artefacts/ Scatter
20764	Caves Rd Campsite	Registered	Closed	Restricted	Re-burials, Camps
27231	Dunsborough New Playing Fields	Registered	Open	No	Artefacts/ Scatter
Other Heritage Places					
1008	Dunsborough: Windlemere Dr	Awaiting Assessment	Open	No	Artefacts/ Scatter
18902	NCCRF Isolated Artefact	Awaiting Assessment	Open	No	Artefacts/ Scatter
20763	Koopins Grave	Awaiting Assessment	Open	No	Skeletal Material/ Burial

Source: Brad Goode & Associates, 2015.

As part of this Environmental Management Plan, an ethnographic Aboriginal Heritage consultation process was facilitated by Brad Goode and Associates. On the 5th May 2015 a meeting was conducted on the site with the South West Boojarah and the Harris family representatives to go through the elements of this plan and seek their endorsement for the proposed management options. The results of this consultation are compiled in a report prepared by Brad Goode and Associates (2015). Note that during this consultation, a tree was identified by the Nyungar representatives as a "Scar Tree" of Aboriginal origin. This is shown in Map 2 and in Map 9 (as the elders requested a 5 m burning buffer around this tree and the burial sites).

In summary, the Nyungar representatives advised that proposed works in the reserve would not require Section 18 approval under the Aboriginal Heritage Act and that a Regulation 10 permit, under the Aboriginal Heritage Regulations, would be sufficient due to the nature of the works proposed. This was recommended as the Nyungar representatives did not feel that the proposed works would adversely affect the cultural values of Registered Aboriginal sites or other heritage places. They also

advised that the proposed Environmental Management Plan, including the fire management provisions, takes into account the Aboriginal cultural values of the area and proposes to enhance their preservation, as well as implementing culturally appropriate risk management strategies.

The key element that the Nyungar representatives advised was to ensure no soil disturbance occurred during any of the management actions. This concern was due the potential to disturb cultural and heritage artefacts and values. This consideration is incorporated into all of the management actions outlined in Section 8. Management Action F4 involved setting posts to support boom gates. The Nyungar traditional owners advised that it would be recommended to conduct monitoring when undertaking this ground disturbance works and if archaeological material be discovered, that an archaeologist be engaged to record the material and seek advice regarding any approvals that may be required under the Aboriginal Heritage Act. Full details of the outcomes of the consolation are presented in Brad Goode & Associates report.

5.2 Recreation

While the Dunsborough Playing Fields are not within the reserve boundary considered for this management plan, the area and its surrounds are a popular site, valued and used by the community. The Naturalise Community Centre is the main structural element within the reserve. The City of Busselton operates and maintains the centre as a multi-purpose facility for the community. The facility contains a library, indoor spoors court, function rooms, meeting rooms, and a playground and child health clinic. Access to the centre is via a bitumised access road and parking (Map 1).

A network of paths exist within the bushland areas of the reserve. These are extensively used as trails for walking, jogging, cycling, walking dogs on a lead as well as enjoying the amenity of the bushland.

The Centre is also a designated emergency evacuation centre for the Dunsborough town site.

6 Biological Environment

6.1 Soil Landscapes

Soil-Landscape systems are areas with recurring patterns of landforms, soils and vegetation and are used by the Department of Agriculture to maintain a consistent approach to land resource surveys.

The Study Area is underlain by the Leeuwin Complex of granites and gneiss. (Tille and Lantzke, 1990). There are three individual soil-landscape types within the Study Area, falling within two of the broader landscape systems defined by Tille and Lantzke (1990): The Abba System and the Spearwood System (Map 3). These are described as:

- Abba Soil Landscape System (213 Ab): Poorly drained flats on the southern Swan Coastal Plain. Main soils are grey, deep sandy duplex and wet soil. The principal vegetation type is Jarrah-Marri- Paperbark Woodland.
- Spearwood Soil Landscape System (211Sp): Sand dunes and plains on aeolian sand and limestone over sedimentary rocks in the Western Swan Coastal Plain from Dunsborough to Jurien. Yellow deep sands and yellow brown shallow sands. The dominant vegetation is Tuart – Marri Forest and Woodland in the south and heath and open woodland in the north.

The 3 Soil Landscape Units found within the Reserve are:

- 211SpLD1: Ludlow Flats – Sandplain and very low dunes on coastal limestone in the Swan Coastal Plain. Yellow and brown deep sands. Dominant vegetation is Tuart-Peppermint Forest and Woodlands.
- 213AbCKw: Cokelup Wet Clayey Flats – Low lying flats and depressions on alluvium overlying coastal limestones in the southern Swan Coastal Plain between the Capel River and Dunsborough. Wet and Semi wet soils of alkaline grey shallow sandy and loamy duplexes and hard cracking clays. Predominant vegetation is Paperbark-Flooded Gum Woodlands.
- 213AbABw: Abba Wet Flats – Poorly drained flats and depressions on Quaternary alluvium in the southern Swan Coastal Plain between the Capel River and Dunsborough. Wet and Semi-wet soils with pale deep sands supporting Paperbark and Marri forests and woodlands.

6.2 Flora

A systematic flora survey of the reserve was not conducted as part of this management plan. An analysis of the data held on the Departments of Parks and Wildlife's (DPaW's) reveal that 56 monocot species, 104 dicotyledon species and 2 fern species have been documented within a 2 km radius from the centre of the Reserve.

A formal spring threatened flora survey has not been conducted over the reserve in the past, so the actual presence of rare or endangered flora is uncertain, however of the database analysis, the following rare or endangered species are within 5km of the reserve:

- *Caladenia busselliana* (Bussell's Spider Orchid);
- *Caladenia caesarea* subsp *maritima* (Cape Spider Orchid);
- *Caladenia excelsa* (Giant Spider Orchid);
- *Caladenia viridescens* (Dunsborough Spider Orchid);
- *Drakea micrantha* (Dwarf Hammer Orchid);
- *Gastrolobium argyrotrichum*;
- *Hemigenia rigida*;
- *Acacia lateriticola* (glabrous variant);
- *Johnsonia inconspicua*;
- *Acacia semitrullata*;
- *Boronia tenuis*;
- *Calothamnus graniticus* subsp. *graniticus*;
- *Eucalyptus virginea*; and
- *Verticordia lehmannii*.

6.3 Vegetation

The mapping of Heddle et al (1980) categorises two vegetation complexes within the Study Area, (Map 4):

- Abba Complex Vegetation Systems: A mixture of open forest of *Corymbia calophylla – Eucalyptus marginata – Banksia* spp and woodlands of *C. calophylla*. Woodlands of *E. rudis – Melaleuca* spp along creeks and floodplains.
- Ludlow Complex Vegetation Systems: Open woodlands of paperbark (*Melaleuca rhaphiophylla*) and sedgelands of Cyperaceae and Restionaceae specie on broad depressions.

Comparing the current extent to the pre-European extent of each of these complexes, the following percentages remain (WALGA, 2007):

- Abba Complex – 6% remaining; and
- Ludlow Complex – 25% remaining.

As part of this management plan, a survey of the vegetation types within the reserve was conducted. The vegetation was assessed using the releve method whereby the following information was collected at unmarked survey sites;

- GPS coordinates,
- Dominant or important plant species and the differing strata layers, within approximately 10 m radius of the observer,
- Notes on vegetation structure using the method of Muir (1977),
- Vegetation condition score (Keighery, 1994),
- Surface soil texture and colour.

A standardised field data sheet was used to collect field data (Appendix A). A releve point was taken where the native vegetation composition or structure changed and used as the basis to delineate finer scale vegetation types within the reserve. A systemised and structured flora survey was not conducted as part of this management plan.

Most of the reserve could be broadly defined as Marri/Peppermint/Banksia woodland with some areas of Sheoak and Melaleuca. There was considerable variation in the mid and understory areas of the reserve, however without mapping to a micro level, five generalised vegetation types were identified (note that areas

of introduced annual grasslands were not identified as a separate vegetation type as it is addressed in the Section 7.2 Weeds and is reflected in the vegetation condition ranking discussed below).

Using the approach described by Keighery (1994: adapted from Muir, 1977 and Aplin, 1979), the vegetation types are described floristically and structurally as (Map 5):

- Type 1 - Peppermint Banksia & Marri Woodland: Low Open Forest of *Corymbia calophylla, Agonis flexuosa, Banksia attenuata* with scattered *Allocasuarina fraseriana,* over Tall Shrubland of *A. flexuosa*, over Open Shrubland of *A. flexuosa* and *Xanthorrhoea preissii*, over Low Open shrubland of *Acacia pulchella* and *Hibbertia cuneiformis*, with Very Open Sedgeland of *Lepidosperma* and very open creepers of *Hardenbergia comptoniana*. Other species observed include L*epidosperma squamatum, Burchardia congesta, Lomandra* spp, *Xylomelum occidentale, Macrozamia riedlei, Pimelea spp, Conostylis aculeata* and the weeds **Zantedeschia aethiopica* (Arum Lily), **A. longifolia* (Sydney Golden Wattle) and **A. iteaphylla* (Flinders Range Wattle). This comprises 64% of the native vegetation areas of the reserve.
- Type 2 – Peppermint/Banksia/Sheoak Woodland: *Agonis flexuosa, Banksia attenuata, Allocasuarina fraseriana* low open forest over *Agonis flexuosa, Xylomelum occidentale* tall open shrubland over *Agonis flexuosa, Corymbia calophylla* open shrubland over *Acacia pulchella, Allocasuarina fraseriana* low open shrubland over *Lepidosperma squamatum* open sedgeland over *Hardenbergia comptoniana* very open creeper *over Burchardia congesta* very open herbland. Other species found include *Dichopogon capillipes, X. preissii, Jacksonia furcellata, Adenanthos meisneri, Lepidosperma effusum, Spyridium globulosum* and *Gastrolobium praemorsum*. This comprises 15% of the native vegetation areas of the reserve.
- Type 3 – Agonis Woodland: *Agonis flexuosa* low open forest over *Agonis flexuosa* tall shrubland over *Hibbertia cuneiformis* open shrubland over *Hibbertia cuneiformis* low open shrubland over *Hardenbergia comptoniana* scattered creeper over mixed annual grassland. Other major species include *Banksia attenuata, Corymbia calophylla* and **Zantedeschia aethiopica* (Arum Lily). This comprises 14% of the native vegetation areas of the reserve.

- Type 4 – *Melaleuca* Woodland: Low Closed Forest of *Melaleuca rhaphiophylla* and *Agonis flexuosa*, over Open Low Heath of **Zantedeschia aethiopica* (Arum Lily), over Closed Grassland of **Pennisetum clandestinum* (Kikuyu) and assorted annual and perennial grass weeds. This comprises 7% of the native vegetation areas of the reserve.

Vegetation condition was assessed using the scale developed by Keighery (1994) which is the standard for the region (Appendix B). These are shown in Map 6 and are tabulated in Table 2.

Table 2: Vegetation Condition within Reserve 43008.

Condition	Area (m2)	Percentage
Very Good	42,752	60%
Good	7,671	10%
Degraded	16,202	23%
Completely Degraded	4,929	7%

Overall, approximately 70% of the reserve is in Good or better condition, with only 7% being considered to be Completely Degraded.

6.4 Fauna

A search of the Department of Parks and Wildlife's NatureMaps database reveals that 279 animal species have been formally recorded within a 5 km radius of the Reserve: 8 amphibians, 142 birds, 69 fish species, 28 mammal species and 23 reptile species. Of these, 13 are of conservation significance i.e. classified as threatened, priority or as migratory species or similar (note that marine or marine dependant species have not been included in this analysis). Table 3 lists these species and their conservation status.

Table 3: Fauna species of conservation significance found within 5 km radius of Reserve (source NatureMap Database DPaW 2015)

Species	Common Name	Conservation Status
Calyptorhynchus baudinii	Baudin's Black Cockatoo	Vulnerable
Calyptorhynchus latirostris	Carnaby's Black Cockatoo	Endangered
Engaewa reducta	Dunsborough Burrowing Crayfish	Critically Endangered
Phascogale tapoatafa subsp. *tapoatafa*	(Southern) Brush tailed Phascogale	Vulnerable
Pseudocheirus occidentalis	Western Ringtail Possum	Endangered
Falco peregrinus	Peregrine Falcon	Specially Protected
Ctenotus ora	Coastal Plains Skink	Priority 3
Macropus irma	Western Brush Wallaby	Priority 4
Isoodon obesulus subsp fusciventer	Southern Brown Bandicoot	Priority 5
Ardea ibis	Cattle Egret	Protected by international agreement
Ardea modesta	Eastern Great Egret	Protected by international agreement
Haliaeetus leucogaster	White Bellied Sea Eagle	Protected by international agreement
Merops ornatus	Rainbow Bee-Eater	Protected by international agreement

Note that a fauna survey was not conducted as part of this management plan, however, the Reserve is supporting Western Ringtail Possum, Quenda and providing habitat values for black cockatoo species.

The reserve is considered to be significant habitat for Western Ringtail Possums. A survey of the reserve in 2012 found 55 and 59 WRPs respectively, during two night surveys. This is a density of over 6 WRP/hectare. (Harewood pers. comm).

6.5 Summary

Overall, the reserve is a large bushland remnant within a growing urban environment. It provides habitat for a number of rare and endangered fauna species and potentially contains populations of rare or endangered flora species. The vegetation communities within the reserve are under reserved and highly cleared from their pre European extent. The biodiversity values of the reserve are significant and ongoing management will be required to maintain and enhance those ecological values into the future.

7 Threats

7.1 Wildfire

Fire influences the majority of Australian terrestrial ecosystems and many endemic Australian species are threatened by inappropriate fire regimes (State of the Environment Report, 2001). Fire is a natural environmental factor which can decrease, maintain or enhance the native vegetation, depending on the nature of the fire regime and the ecosystem properties. Fires burn differently in different vegetation types, even when they have the same fuel load and are adjacent to one another; similar fires can have very different effects (Whelan, 1995).

Problems can occur, however, where fuel build up has the potential to impact on the values in and nearby an area as a result of wildfires/bushfires. These values can include the ecological/biological elements as well as the human assets such as homes, community centres and other amenities that can be destroyed by a large, out of control wildfire.

A fire regime is the sequence of fires typical of a given area (Lindenmayer and Burgman, 2005) and has four key components (Gill, 1975):

- fire intensity;

- fire type (e.g. crown or ground fire);
- between fire interval (or frequency); and
- season.

Each one of these components has an impact on the vegetation. The ideal would be to replicate the fire regime that existed in the past. However, with the changing land uses and fragmentation of bushland area, natural fire regimes have significantly changed in most areas. With fragmentation come increased disturbance from surrounding areas and increased weed invasion. The invasion of small bush areas by weeds, especially herbs and grasses, has led to dramatic changes in the types of fuels available for fires. Grasses that dry off in summer provide a greater quantity of fine fuels which will easily carry a fire. After burning, these grasses return in greater abundance, thus making the fire problem worse. It is usually difficult to determine what the original fire regime might have been for a particular vegetation type and although much of Australia's vegetation is adapted to cope with fire, it has not necessarily evolved with the current fire regimes.

There are two ways in which plants respond to fire:

- The whole plant is killed and a new generation grows from the seeds (these are called Reseeders);
- Only parts of the plant are killed and new growth arises from stems or rootstocks under the ground (called Resprouters) (Hussey and Baxter, 2006).

The biology of the plants is only one aspect, fire effects are also dependent upon the:

- Fire frequency;
- Fire intensity;
- The time of year.

Fire Frequency

For Reseeders to persist after a fire, they must have been able to reach maturity and set seed before they are burnt again. Since plants vary in the length of time they take to achieve this, the frequency of fires will have a distinct effect on the composition of the plant communities. To preserve the conservation values of the reserve, it is important that fires do not occur more frequently than the time needed for all the plants to reach maturity and set seed. As a general rule of thumb, the

interval between fires should be at least twice as long as it takes the slowest maturing plant to flower and produce seed and before the older plants are no longer able to reproduce.

Fire Intensity

The intensity at which a fire burns depends upon many factors including, the time of year, air temperature and humidity, the amount and moisture of the fuel and the soil and wind strength (Hussey and Wallace, 1993). Note that a dense layer of grasses greatly increases the fire intensity at ground level, regardless of the season. Fires of different intensity favour the regeneration of different plants, and low intensity fires tend to be patchy, leaving areas of vegetation unburnt.

Fire Season

There are three possible fire seasons, each having considerable differences in their impact (Hussey and Wallace, 1993).

Midsummer/autumn

- Fire is usually hot and intense, the fire front is tall and fast-moving;
- It consumes most above ground material;
- It is very likely to burn down mature trees;
- It is likely to cause high mortality to native fauna;
- Will break the dormancy of some buried seeds, e.g. Wattles.

Winter

- It has a low intensity, the fire front is low and slow moving, may go out at night;
- Is patchy, with areas left unburnt;
- It disrupts flowering and seed set for some plants;
- In does not crack dormancy of buried seeds;
- It encourages growth of grass weeds;
- It disrupts the breeding cycle of some fauna;
- Is survived by most adult fauna.

Spring/Early Summer

- Is of low/moderate intensity, some, but not all, tree crowns will be scorched;

- It does not consume all ground organic material, some patches will be left unburnt;
- It will destroy that year's seed crop for many plants;
- In stimulates surface seed germination;
- It does not crack dormancy of buried seed;
- It may kill many young animal, though adults may escape and there will be colonisation of burnt areas from unburnt areas;
- It will encourage the growth of already established perennial grass weeds;
- It helps resprouting plants grow well over summer and out competes seeders;
- It may weaken seedlings so they do not survive the autumn break of the season.

Disturbance is a key factor in opening up the bush to change, and fire is a major disturbance. Small and isolated remnants, such as the reserve, are subject to more disturbing factors placing them under greater stress making them less resilient to changes.

One of the major threats that occur after fire is weed invasion. Having opened up the bushland by reducing canopy and/or shrubs, it is very easy for weed invasion to occur from the edges. With an area like the reserve, surrounded by gardens and grassland areas, it would not take long for weeds from the edge to invade the whole width of the vegetation. This would lead to a change in the community structure, which will provide changes in resources for fauna.

The reserve is classified as an extreme bushfire risk, given the amount of vegetation with the reserve and the proximity to adjoining residential property and the Naturalise Community Centre.

As part of this Environmental Management Plan, an assessment of the amount of fuel within the reserve was conducted. Knowledge of the type, arrangement and quantity of fuel available to support a fire event allows the potential bushfire risks to be assessed and quantified. It also allows for planning to reduce these fuel load and hence reduce the potential risk to the plants and animals in the reserve as well as the houses in the adjoining development.

This assessment focused on the fine fuels that burn readily in a bushfire. Fine fuels are those that readily burn in the continuous flaming zone at a fire's edge. They contribute the most to the fire's rate of spread and flame height. Typically, they are

dead plant material, such as leaves, grass, bark and twigs thinner than 6 mm thick and live plant material thinner than 3 mm thick. Once ignited, these fine fuels generally burn out within two minutes (Hines, *et al*, 2010).

Fuels in bushland can be divided into four layers, each based on its position in the vegetation profile moving from the ground upwards; Surface Fuels, Near surface Fuels, Elevated Fuels (including Bark Fuels) and Canopy Fuels.

Fuel assessments were conducted within the reserve making a visual assessment of each of these four structural layers based on the guidelines produced by Hines, *et al*, (2010). A copy of the template used is included in Appendix C. The four structural assessments were then totalled to provide a total fire fuel load for each of the sites.

Twenty five sites were assessed in the reserve and fire fuel loads were determined at each location.

Fire fuel loads were found to be very high, confirming the extreme fire risk to the reserve and the neighbouring houses.

Fire fuel loads varied between 10 to 30 + tonnes per hectare. The mean fuel levels of the sites are shown in Map 7. The areas along the western boundary that adjoin the residential area are among the highest in the reserve. Ideally, the Department of Fire and Emergency Services and the Department of Parks and Wildlife recommend fuel loads of around 8 tonnes per hectare as being an appropriate target for bushland areas. At this fuel level, fire intensity is reduced to a point where suppression effort is possible and likely to succeed in all but the worst of bushfire danger days. Note that is the fine fuels that provide the bulk of the fire height and rate of spread, however there are numerous logs and thicker branches, particularly in this western section, that can increase intensity and burning time. Ideally this coarse fuel should be removed prior to any fuel reduction burns, or if this cannot occur, they should be constantly monitored during any fire to try to prevent ignition.

Biological diversity benefits from bushland areas having a diversity of habitat areas, which can be obtained by introducing planned fuel reduction burns, in small, manageable areas over a suitable length of time to allow plants to mature and set seeds before the next round of prescribed burns.

A full botanic survey of the reserve has not been conducted and as such a comprehensive list of species within the reserve does not exist. Ideally, the frequency

of a prescribed burn should be determined by knowing the life cycle of the most fire sensitive species within the area, and then planning at least two or more life cycles of that species between burns. This ensures continuity of that species as it has time to germinate, grow to maturity and then set seed, and another generation cycle before any fire impact. For example, one fire sensitive species, Banksia *attenuata* takes approximately 4 years before a seed will grow and reach a stage where it will flower and set seed (Burrows, *et al*, 2008). Therefore a frequency of no less than 8 years will ensure the species continues to exist in the reserve.

Fuel accumulation rates (the amount of fire fuels that naturally accumulate from leaves, branches etc.) for eucalyptus forest/woodland in the south west of Western Australia has been calculated at approximately 0.75-1.0 tonnes per hectare. Therefore a 10 year cycle between burning events, will result in a fuel load of 7-10 tonnes per hectare accumulating. This also accommodates the requirements of *Banksia attenuata*.

For this management plan, burning zones have been determined by breaking up the area into 12 cells based on the existing track network and/or the vegetation of the area (Map 8). By utilising a progressive prescription of fuel reduction burns at 10 yearly intervals, within each cell, the floristic values of the reserve should not change and the bushfire hazard for the neighbouring residents should not exceed 8 tonnes per hectare. This is the assumption used in determining the appropriate fuel reduction burning cycle in Section 8 Management Actions.

Care is needed in Fire Cell 11 as it is located over areas of Peat Soils, which have the capacity to burn underground and maintain fire for considerable time. Burning in this Cell should be conducted prudently and at a time when the underlying soil is wet. Liaison and discussion on the timing of any burning in this cell will be required between the City of Busselton and the local Fire Services, after details site investigations.

Access for bushfire suppression is available using some of the existing tracks, however this should be formalised to enable all weather access. This can be conducted without soil disturbance and hence meet the requirements of the aboriginal community.

It would be recommended that the track on the western section be surfaced with limestone to allow for a rapid attack with a Light Tanker Fire Appliance. Limestone will also minimise the risk of the spread of dieback with the reserve.

This will require the existing track to be maintained to a width of at least 3m and a height of at least 3m. This can be carried out with only minor pruning of the existing vegetation and will not require any removal of any of the native species present.

Full details of the fire services available for the reserve, i.e., water standpipes, hydrant booster, access tracks and gates are shown in Map 9.

The traditional Nyungar representatives have requested that during any burning events, that the burial sites and the scar tree site be buffered from fire for 5 m from their location. This is shown in Map 2 and Map 9 for fire service information.

7.2 Introduced Plants

The natural process of plant dispersal is usually slow and selective. Human induced plant dispersal can occur as rapidly as human transport systems operate. There are about 10,000 named species of flowering plants described in Western Australia and 90% of them are natives. The other 10% (~1,000) have been introduced to the State (Hussey, *et al*, 1997).

Some high priority weeds that are, or may become, a problem to agriculture or the environment can be formally "declared" under the *Agriculture and Related Resources Protection Act 1996*. When it is declared, a plant is placed in one or more categories according to the control strategies considered appropriate. Landowners with declared plants on their property are obliged to control then at their own expense.

Environmental weeds are plants that establish themselves in natural ecosystems and proceed to modify natural process, usually adversely, resulting in the decline of the communities they invade. They usually have no legal standing.

Impacts of environmental weeds on ecosystem function include:

- Resource competition;
- Prevention of seedling recruitment;
- Alterations to geomorphological processes;
- Alterations to the hydrological cycle;
- Changes to the soil nutrient status;
- Alterations to fire regimes;
- Changes to the abundance of indigenous fauna; and
- Genetic changes.

(CALM, 1999).

The impacts weeds have can vary between weed species. The Environmental Weed Strategy for Western Australia (CALM, 1999) ranks the potential effects of weed species based on three criteria:

- Invasiveness: the ability of the species to invade bushland in good or excellent condition;
- Distribution: the current or potential distribution of the species including consideration of known history of spread distribution elsewhere in the world; and
- Environmental impacts: the ability of the species to change the structure, composition and function of ecosystems.

This results in each Environmental Weed species have a rating of High, Moderate, Mild or Low. This management plan uses this approach to rank and prioritise weeds for control.

Environmental weeds require management to ensure the long term survival of the natural ecosystem. The management and control of environmental weeds should be seen in the context of the restoration of the environments they invade (CALM, 1999).

Environments undergoing disturbances often provide opportunities for weed species to establish and grow. Most weeds are spread by human activities, although a few invade by themselves through the dispersal of seed by wind. The main sources include the dumping of garden refuse, via machinery (car tyres, graders, tractors) or through human movement through tracks etc.

The principle mechanisms for weeds establishing in an area include:

- Elevated nutrient levels (either run-off or fertiliser drift);
- Physical disturbances to the soil;
- Increased soil moisture from shading or reduced water infiltration; and
- Increased light at the margins of vegetation.

Underlying Weed Control Principles

The major goals of controlling weeds within bushland areas are to allow the bush to regenerate and maintain and enhance its conservation values. The Bradley method of bush regeneration is one method that suits many situations as it does not involve replanting and allows native plants to re-establish themselves (Bradley 1971, Bradley, 1988, Buchanan, 1989). This approach involves the systematic removal of weeds to allow native plants to re-establish. While the approaches used in this strategy are based upon the Bradley method, we also utilise the appropriate and prudent use of herbicides to control weeds in certain circumstances (e.g. when the density of weeds is too high, or the physical removal is likely to enhance spread), which is not one of the original tenants of the approach. That being said, the underlying principles of the Bradley method are still advocated in our approach. These are listed below.

- *Always work from areas of native plants in good condition, and then move outwards towards more weed infested areas.*

Starting in areas of good condition provides an opportunity for these areas to remain in good condition and because the density of weeds is less, the feasibility of removing weeds from these areas and restoring ecological functions to the patch is higher. Starting by removing weeds scattered though otherwise weed-free bush prevents the deterioration of these areas.

- *Make minimal disturbance.*

Most weeds need disturbance and sunlight for successful regeneration. By minimising the disturbance to the site, the chances of another suite of weed species replacing the one removed is reduced. Any soil that is disturbed should be returned in its original layers to ensure that any native seed stored in the soil will be able to germinate. This also applies to the natural mulch layers in a work area. After weeding, it is recommended that mulch from the surrounding area be added to any gaps that result, to minimise weed regeneration and enhance natural regeneration.

- *Let native plant regeneration dictate the rate of weed removal.*

Weeds need to be removed at a rate that allows for natural regeneration to occur; this is especially the case in areas where revegetation is not occurring. If a large area of weeds is removed at one time, the likelihood of another type of weed replacing the one removed is increased. If a small area is weeded at a time, native regeneration can occur at its own rate.

Weed Survey

The Site was traversed by foot in January and February 2015, and weeds were identified and mapped.

Weeds identified during the process were recorded using Trimble Juno T41 Handheld Computer and ArcPad 8.1 ®.

Introduced Acacia species were dominant in the western section of the reserve and grass weeds were the dominant introduced species in the northern and eastern section of the reserve. Note that at this time of late summer, bulbous weeds such as Arum Lilies were not easily observable. Subsequent visits to the reserve during May 2015 reveal a much higher population/occurrence of Arum Lilies than found in the formal survey.

The major weeds found are listed in Table 4. The property ranking within this table is based on the ranking of the draft WA Environmental Weed Strategy.

Table 4: Weeds from the survey and their priority.

Common Name	Species Name	Priority Ranking
Acacia spp	*Various Garden escapees*	Low - Moderate
Annual Grasses (mostly Kikuyu)	*Mixed species*	Moderate
Arum Lily	*Zantedeschia aethiopica*	High
Bridal Creeper	*Asparagus asparagoides*	High
Flinders Range Wattle	*Acacia Iteaphylla*	Moderate
Nightshade	*Solanum spp.*	Moderate
Sydney Wattle	*Acacia longifolia*	Moderate

Table 5 provides estimates of the abundance of the weeds found. The locations are shown in Map 10. Where clumps of the same species were located and individual plants could not be determined, the area of the clump was recorded.

Species	Number/Area	Notes
Acacia spp		Undeterminable garden escapees
Annual Grasses		
Main Area	15,411 m2	Main area of uncontrolled grasses (Map 10)
	4,671m2	Semi controlled area in the North west section – possible revegetation site.
	3,872m2	Controlled (mown) area used for recreation in north east section.
Arum Lily	11	Will be much higher with late winter survey
Bridal Creeper	12	
Flinders Range Wattle	89 Plants & 373 m2 of clumped plants	
Nightshade	2	
Sydney Wattle	83 plants & 840 m2 of clumped plants	

The drainage area on the western boundary is also dominated by weed species. Appendix D outlines a summary of weed control techniques based on recommendations by the Australian Association of Bush Regenerators.

Acacia is a fire responder species and these mature plants will need to be removed prior to any fuel reduction burning activities. Post burning treatment will also need to occur to reduce their reoccurrence as the density of these species will have produced an extensive seed store which will be retained on the ground and will germinate after any fire. More information is included in Section 8 Management Actions.

7.3 Feral & Pest Animals

Non-native animals such as rabbits, foxes and feral cats, become pests in bushland areas and have a detrimental effect on the local fauna and flora. They prey on

native animals, compete for food and shelter and cause damage to native plants by grazing, trampling and digging. Control methods for feral animals include shooting, poisoning and exclusion fencing. There are numerous regulations covering the use of firearms and the use of poisons is controlled under the Health Act and the Agriculture and Related Resources Protection Act. The main feral and pest animals within the reserve are rabbits, foxes and cats (both feral and uncontrolled domestic cats), though some feral bee hives were observed. These are shown in Map 10.

7.4 Dieback Disease

Dieback is a plant disease caused by an introduced, soil borne water mould of the genus, Phytophthora. There are a number of different species present in the south west, however the most common and destructive is Phytophthora cinnamomi (Department of Conservation and Land Management, 2004). This organism lives in soil and plant roots and is spread by water or the movement of infected soil and roots. This commonly occurs by human activities such as road making, extracting soil or gravel, vehicles or boots carrying infected soil or planting infected seedlings. It can also be transmitted by direct water flow and by animals moving infected soil or roots (Bailey, 1995; Smith, 2003; Department of Conservation and Land Management, 2004). The pathogen may spread slowly (about 1-2 m/year) by moving within and between plant roots, more rapidly by dispersal of its spores through sub-surface or over surface water flow or most quickly of all though the agency of animals or humans (Hill et al., 1994). Spore production reaches a maximum in spring in moist soils and if these soils are transported on feet, vehicles or machinery conditions favour the development of new centres of infection (Shearer and Tippett, 1989).

A review of current methods of managing the problems caused by P. cinnamomi, concluded that eradication of the pathogen was not feasible at either local or regional scale (Podger, 1999). Therefore, management is the only viable strategy.

Two key management strategies are presently recommended; constraining the spread of the pathogen; and reducing its impact were it is present (Environment Australia, 2001).

To constrain the spread, it is first vital to know the areas of infection and the areas clear of infection. Secondly, strategies are needed to keep the pathogen from the uninfected areas. These can include quarantine (this is not likely to be effective or

acceptable for the reserve) and hygiene (including clean down areas, signage, track and firebreak programmes and fire response strategies (access, water sources, etc.). This will have considerable difficulties considering the open access of the reserve for activities such as walking etc.

One effective treatment has been found for controlling the pathogen in infected areas which involves the use of the chemical, phosphite. The chemical has been shown to be effective in inducing resistance when sprayed or injected at low dosages, appears to have a low toxicity for mammals, breaks down rapidly in soil and can be applied as a low-volume aerosol by hand or low flying aircraft (Environment Australia, 2001). It is however, expensive, labour intensive, requires skilled operators and can produce toxic effects if used at levels above the tolerances of plant species (Environment Australia, 2001).

No dieback surveys were conducted during the development of this management plan. There are numerous healthy areas of Banksia species, which would indicate that some areas of the Reserve are not impacted by phytophthora as yet. However, future management should consider that the reserve does have dieback within it and care is needed, particularly in wet conditions, to minimise movement of machinery through the reserve.

8 Management Actions

8.1 Introduction

The following management actions have been developed based on the results of the field investigation, consultations, literature reviews and the overall purpose and objectives for the reserve as mentioned in Section 2 above.

8.2 Guiding Principles

A number of principles are used to guide the management actions that follow.

1. That any soil disturbance is minimised to reduce any impact on the aboriginal heritage and cultural values of the reserve. Should any action require a small level of soil disturbance, monitoring by a representative of the Nyungar traditional owners will be recommended.

2. The values of the biological and ecological assets in the reserve are to be retained and enhanced by the actions of the plan.
3. The bushfire fuel reduction measures prescribed, are to be conducted in acknowledgement of principles 1 and 2 above.

8.3 Management Actions

The following management actions are designed to address the issues and threats to the natural, social and cultural values of the reserve.

Drainage Management		**Priority**
D1	Remove the vegetation from the existing drainage system minimising soil disturbance by: • Cut existing vegetation as close as possible to ground level with secateurs or chain saw, as appropriate; • Apply appropriate herbicide to kill plant, using bioactive formulas of herbicides where possible. • Monitor bi annually and treat any regrowth as required.	High
Weed Management		
W1	Remove Acacia weed species: • Chain saw plants at ground level • Paint cut stump immediately after cutting with Triclopyr 240 g/L/Picloram 120g/L herbicide at the approved off label rate. • Remove woody material from the site to reduce fire fuel loads and potential seed loads. • After any fuel reduction burn as outlined below in Management Action F2, monitoring and removal of any new germinants will need to occur for at least 3 years after any fuel reduction or wild fire.	High
W2	Establish barrier between main Grass weed area in the north (Map 10) and the bushland areas to reduce weed invasion into the bushland. • A slashed area is to be established to keep a manageable area within the kikuyu/mixed grassland area to minimise grass spread into bushland areas.	Medium

	• If resources become available, this barrier area could be overlaid with limestone to formalise the boundary and facilitate additional walk/recreation trails.	
W3	Maintain the grassland area in the north west section as a mown area for recreation activities.	Low
W4	Establish the northern semi controlled area as a site for revegetation activities. • In stages and as resources become available, utilise this section as a revegetation site to restore the ecological and natural values of the section (this was agreed to by the Nyungar traditional owners as part of the consultation process.	Medium
W5	Treat the Arum lilies and other weeds utilise the most recent recommended treatment methods prescribed by the Department of Agriculture.	High
Fire Management		
F1	Remove the solid or heavy fuels (e.g. logs) by excavator or physical removal. • Emphasis should be given to those areas on the western edge (Fire Cell 1 through to Fire Cell 5)	High
F2	Implement a fuel reduction burn programme for the reserve based on 8-10 year burning cycles. • Cells 1-5 being implemented in the winter/spring of 2015 to reduce the fire risk to the adjoining urban areas for the summer of 2015/2016. The cells have been designed to be small due to the high fuel levels within them. The boundaries of most are delineated by the existing tracks, with the exception of Cells 3 and 4, which can be separated by the use of a fire retardant foam fire break, if required. The number of cells treated in any one burn event will be dependent upon brigade resources and weather and will require liaison and negotiation between the City of Busselton and the Dunsborough Brigades. • Note care is needed for any burning in Fire Cell 11 due to the peaty nature of the soil. Any burning must be conducted in winter when the soils are wet and only after site investigations and discussions between the City of Busselton and the Dunsborough Fire Services. • Traditional owners have requested that any burning activity does not impact on the two burial sites in Fire Cell 11 and the Scar Tree in Fire Cell 5. Prior to any fuel reduction burn in these cells, physical removal of fine fuels and grass layers should be	High Medium High

	conducted around the burial sites and scar tree and fire excluded from a 5 m buffer around the actual sites themselves. The use of foams can be used, however physical slashing of the fine fuels should be sufficient to prevent the site from impact. • Other cells to be targeted with a rotational basis over the 2016-2018 autumn/winter/spring depending upon resources. • Records of burning practices (time, season, resources used and results) should be maintained by the City of Busselton and used to determine and amend future burning activities based on a minimum of 8 years between burns to minimise risk to flora.	Medium Medium
F3	Formalise two main access tracks for fire suppression activities. • Establish a limestone 3 metre wide track along the current western walk trail (Shown as Track 1 on Map 9). There should be a vertical clearance of 4 m above the track. The track should be located to minimise the removal of any native species, apart from selective pruning to all ow vertical clearance. • Establish a 5 metre wide limestone track along the current central track (Shown as Track 2 on Map 9). There should be a vertical clearance of 5 m above the track. The track should be located to minimise the removal of any native species, apart from selective pruning to all ow vertical clearance.	High
F4	Four Barrier gates need to be installed to restrict public vehicle access to the newly installed tracks. These need to be a minimum of 3.6m wide and installed on steel bollards. These are shown as Gates A, B, C and D on Map 9. The location is designed to minimise visual impact on the reserve and outside known cultural sites but restrict general vehicle access. The Dunsborough Volunteer Fire and Rescue and Bushfire Brigades will require copies of any keys used to lock these gates. Note a current gate existing on the southern boundary (shown as Gate E on Map 9).	Medium
F5	A 20 m defendable space, clear of overhanging vegetation needs to establish around the Community Centre. This will reduce the fire risk to the centre and allow fire suppression activities to defend the centre during a bushfire event.	Medium
F6	Map 9, which shows the access points, water points, hydrant booster and tracks, should be provided to the Dunsborough Bushfire Brigade and the Dunsborough Volunteer Fire and Rescue Brigade for their reference.	Medium
Revegetation		
R1	The area of semi managed grassland in the north of the reserve	Medium

	(shown as Reveg Area on Map 9) should be used and managed as a site for revegetation activities. This revegetation should occur as funding opportunities arise and utilise local native species, with the goal of restoring the natural vegetation and ecological function of the area over time, as resources become available.	
R2	The areas where the woody acacia weeds are removed should be revegetated with local native species as soon as possible after the weed removal. This will inhibit the regrowth of the acacias and assist with the restoration of the native values of the site.	Medium
Signage and Interpretation		
S1	Appropriate interpretive signage of the flora and fauna values of the reserve should be developed and installed, as resources become available. They should be designed to educate local community users of the site on the plants and animals and their relative biodiversity values of the site. Note that the local Nyungar traditional owners do not wish to have signage of the indigenous cultural values of the site within the reserve.	Low
Ground Disturbance		
G1	Approval, with conditions, has been given under Section 18 of the Aboriginal Heritage Act 1972 for works contained within this plan that involve ground disturbance. Any persons undertaking ground disturbing works must comply with the conditions contained in the approval letter from the Minister for Aboriginal Affairs (Appendix E).	
Monitoring & Review		
M1	A register of management actions for the reserve should be developed and maintained to enable a throughout review of the activities conducted. Details of the specific action, the responsible person/group, the results and an analysis of those results should be conducted at a regular intervals. This will enable further refinement on the management actions with respect to specific treatments and/or timings of these actions.	Medium

9 Maps

Map 1	Site Location
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

- Reserve Boundary
- Contours (m AHD)
- Drain
- Tracks

0 35 70 140 210

Metres

Prepared by Gary McMahon
Ecosystem Solutions
July 2015
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

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Map 2	Aboriginal Heritage
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

Reserve Boundary

DIA Sites

Burial Sites

Scar Tree

0 25 50 100 150

Metres

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July 2015
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Datum - GDA94
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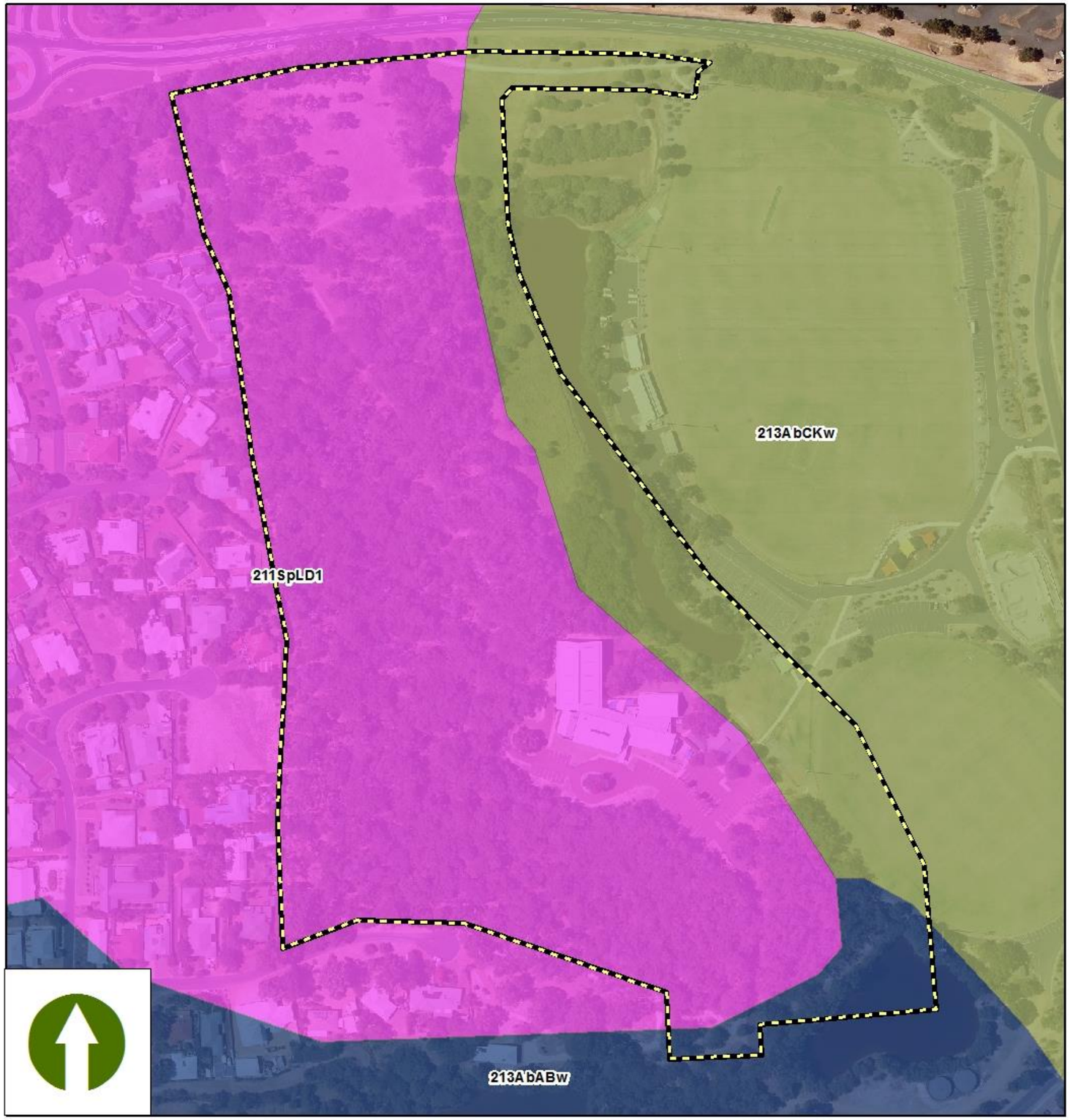

Map 3	Soil Landscapes
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

Reserve Boundary

Soil Landscape Units

211SpLD1 *Ludlow Flats*

213AbABw *Abba Wet Flats*

213AbCKw *Cokelup Wet Clay Flats*

0 25 50 100 150

Metres

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Map 4	Vegetation Types
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

Reserve Boundary

Vegetation Type

Ludlow

0 25 50 100 150

Metres

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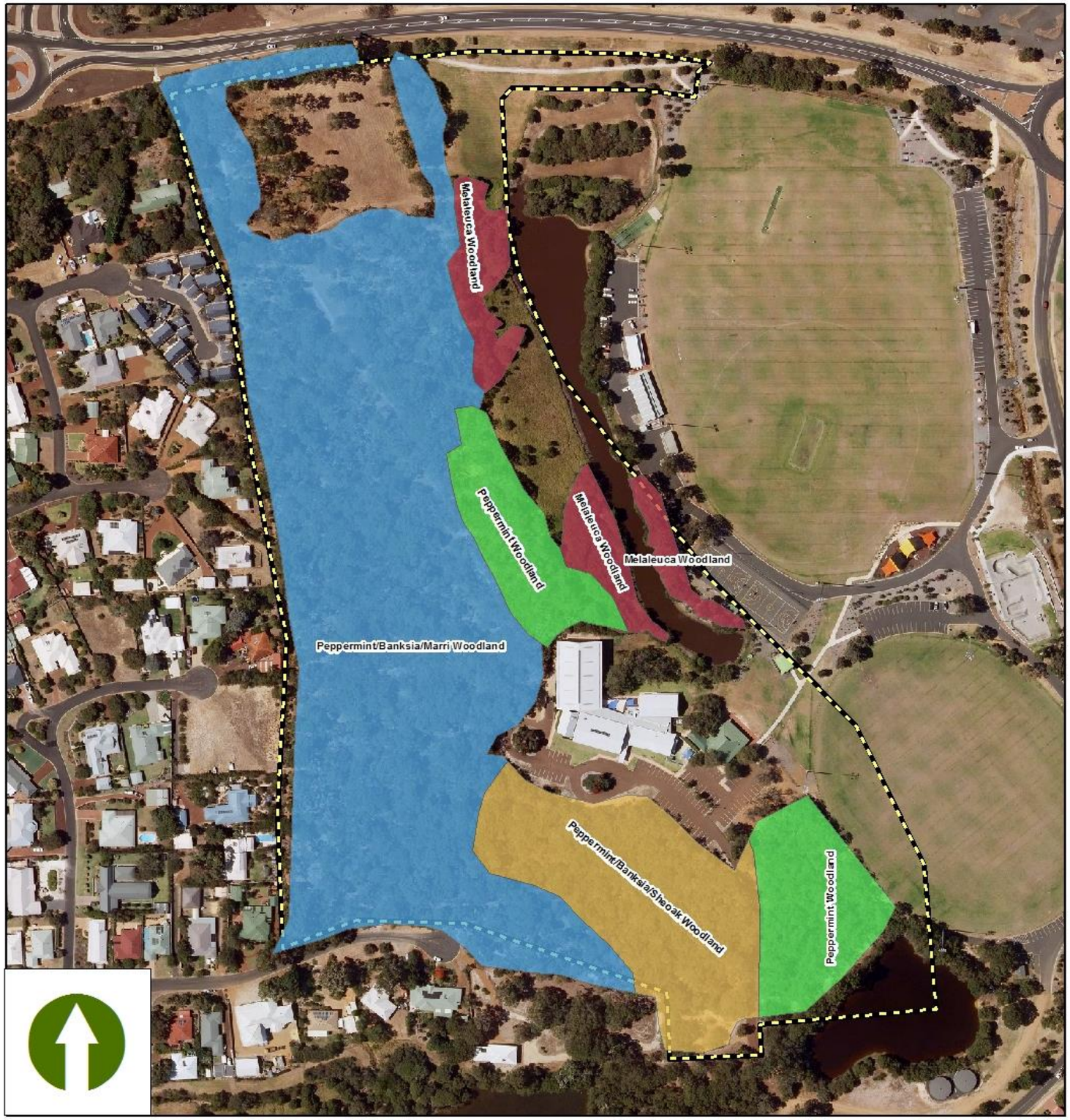

Map 5	Mapped Vegetation
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

Reserve Boundary

Mapped Vegetation

- Melaleuca Woodland
- Peppermint Woodland
- Peppermint/Banksia/Marri Woodland
- Peppermint/Banksia/Sheoak Woodland

0 25 50 100 150

Metres

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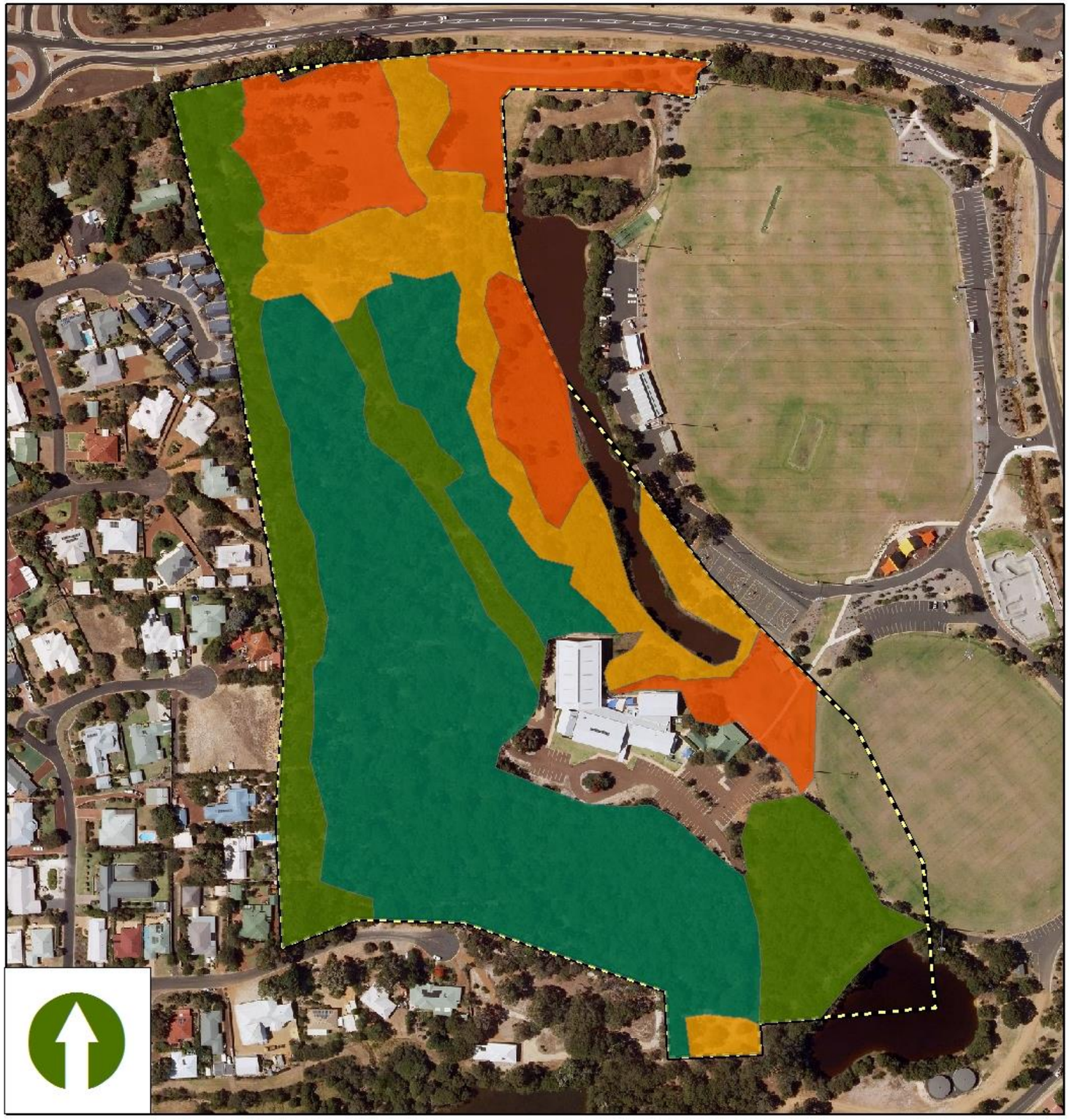

Map 6	Vegetation Condition
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

Reserve Boundary

Condition

- Very Good
- Good
- Degraded
- Completely Degraded

0 25 50 100 150

Metres

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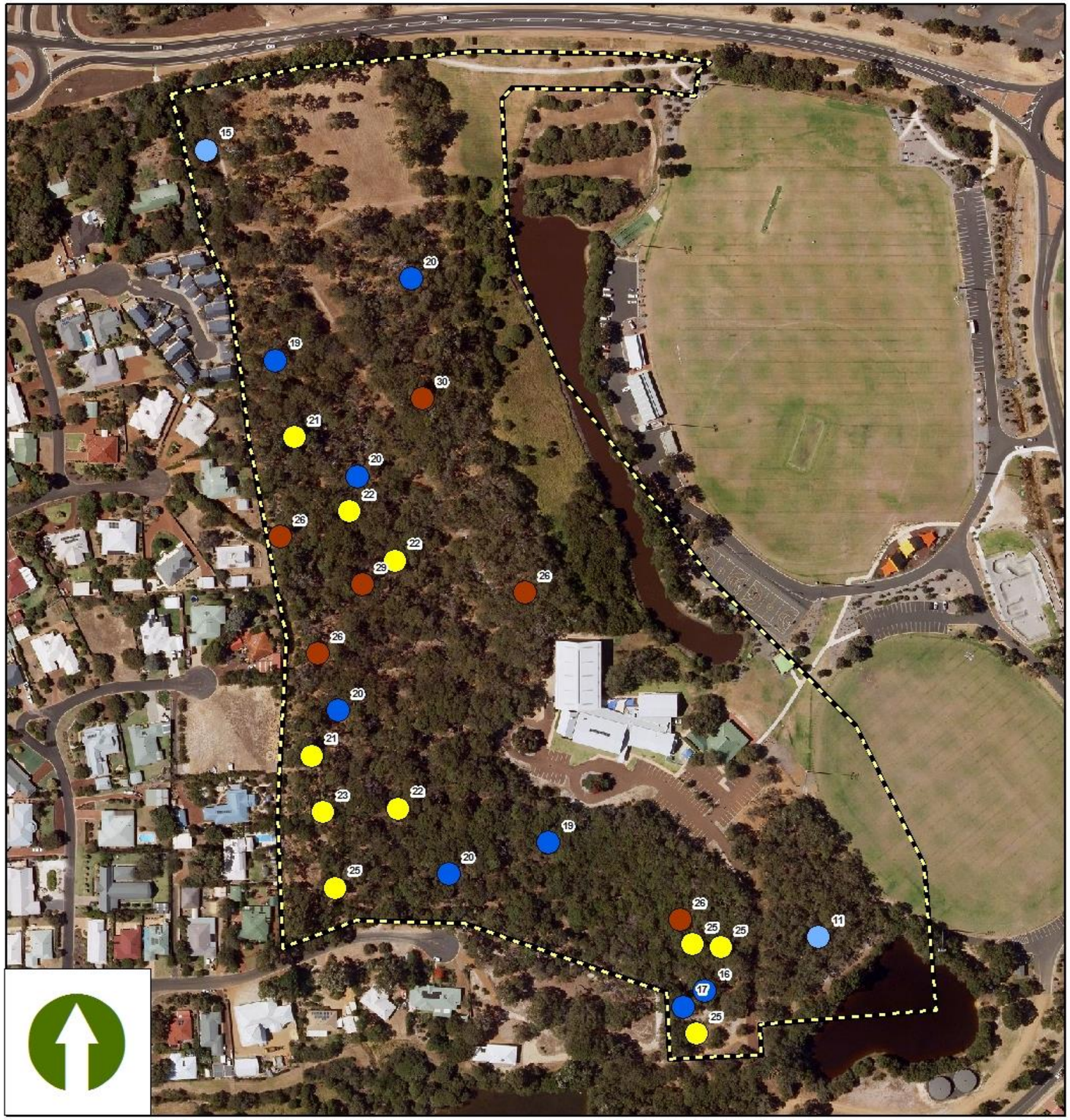

Map 7	Fire Fuel Loads
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

Reserve Boundary

Fuel Loads Tonne/Ha

- 26 - 30
- 22 - 25
- 17 - 21
- 11 - 16

0 25 50 100 150

Metres

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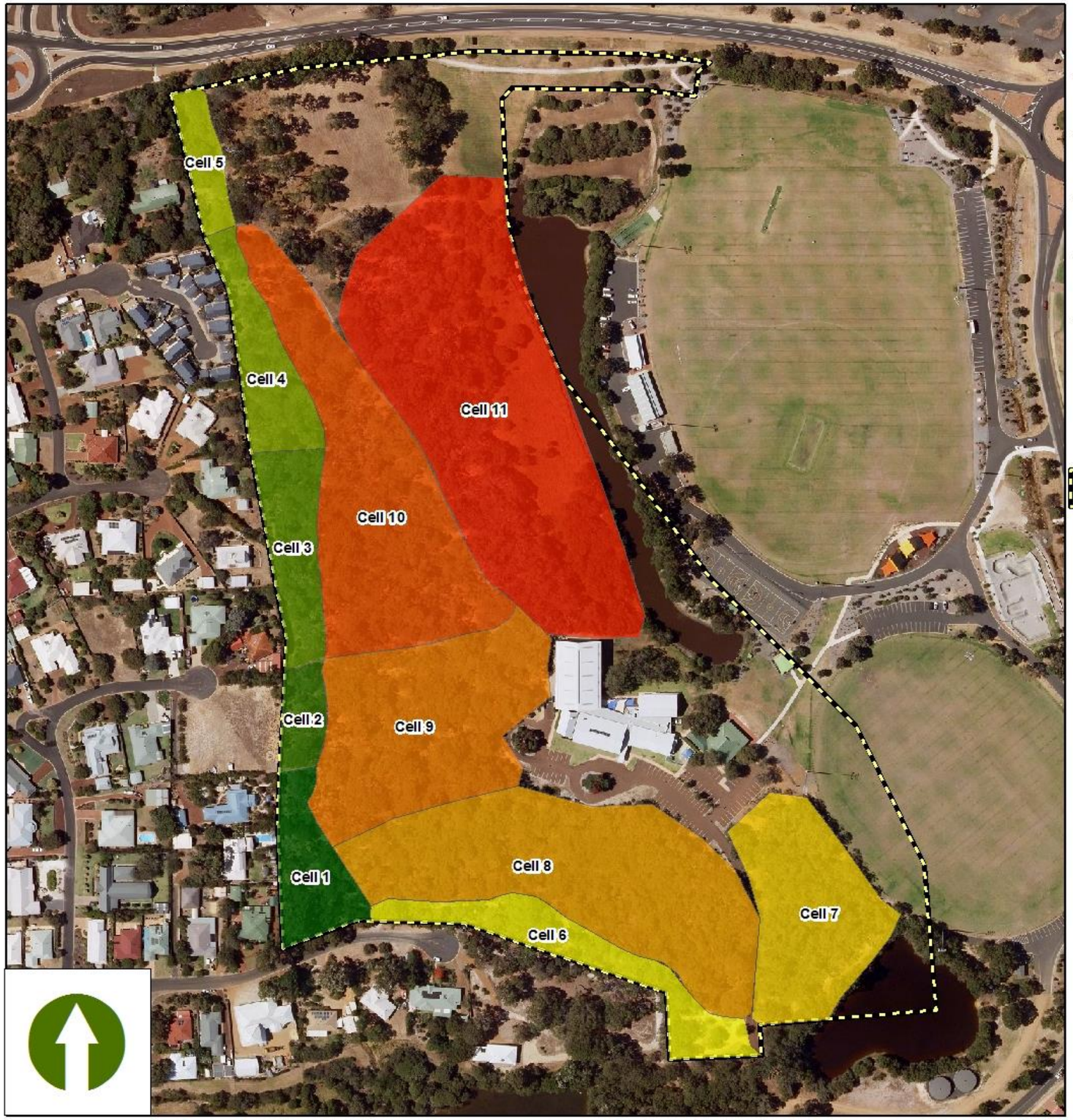

Map 8	Fire Cells
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Fire Cells

Reserve Boundary

- Cell 1
- Cell 2
- Cell 3
- Cell 4
- Cell 5
- Cell 6
- Cell 7
- Cell 8
- Cell 9
- Cell 10
- Cell 11

0 25 50 100 150

Metres

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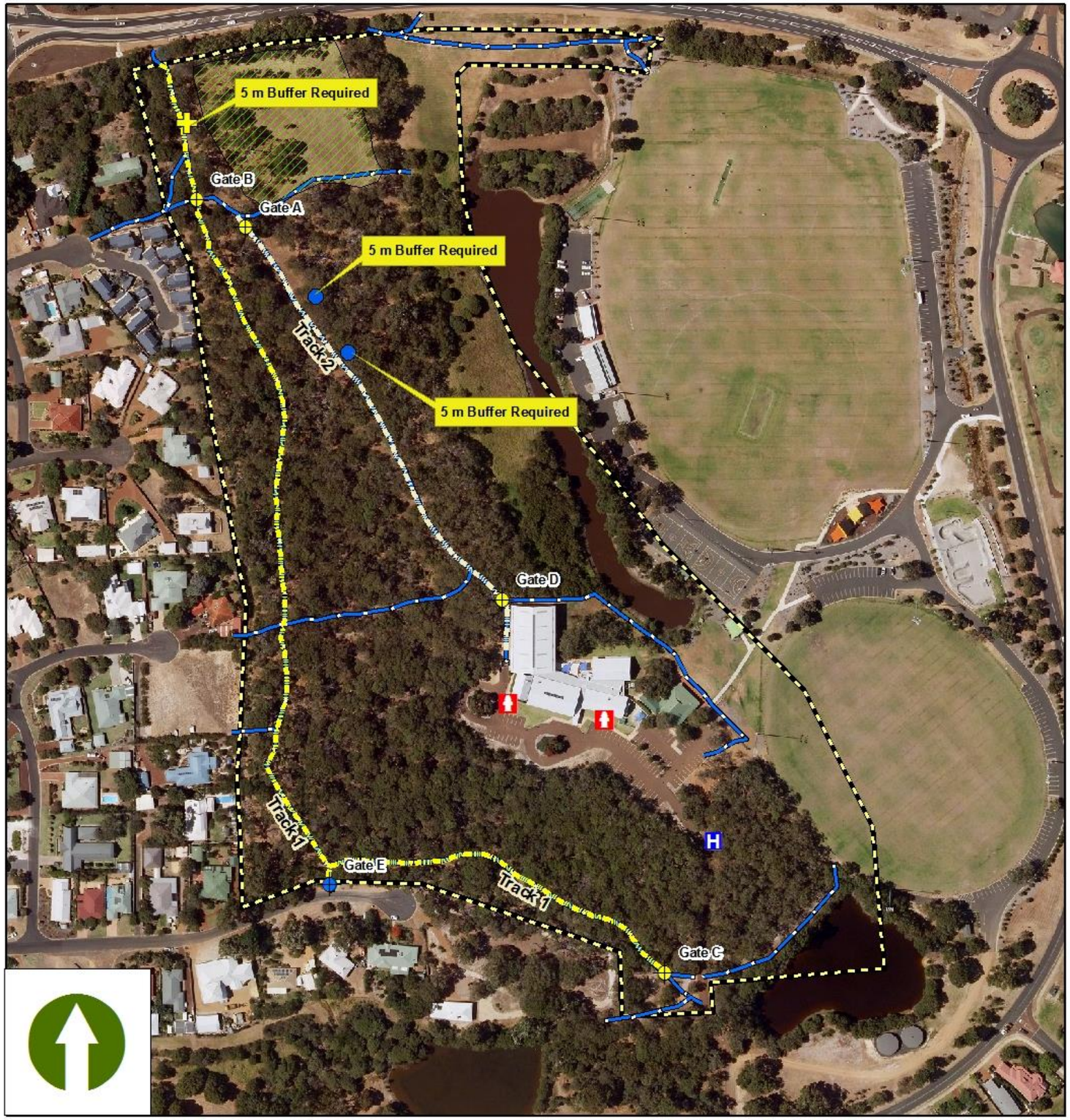

Map 9	Fire Services/Access
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

Gates

- New
- Existing

Water Assets

- Hydrant Booster
- Standpipe - Twin

Upgraded Tracks

- Track 1
- Track 2
- Revegetation Area
- Tracks
- Reserve Boundary

- Scar Tree*
- Burial Sites*

** 5 metre Buffer required for any burning (refer to text for details)*

0 25 50 100 150

Metres

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July 2015
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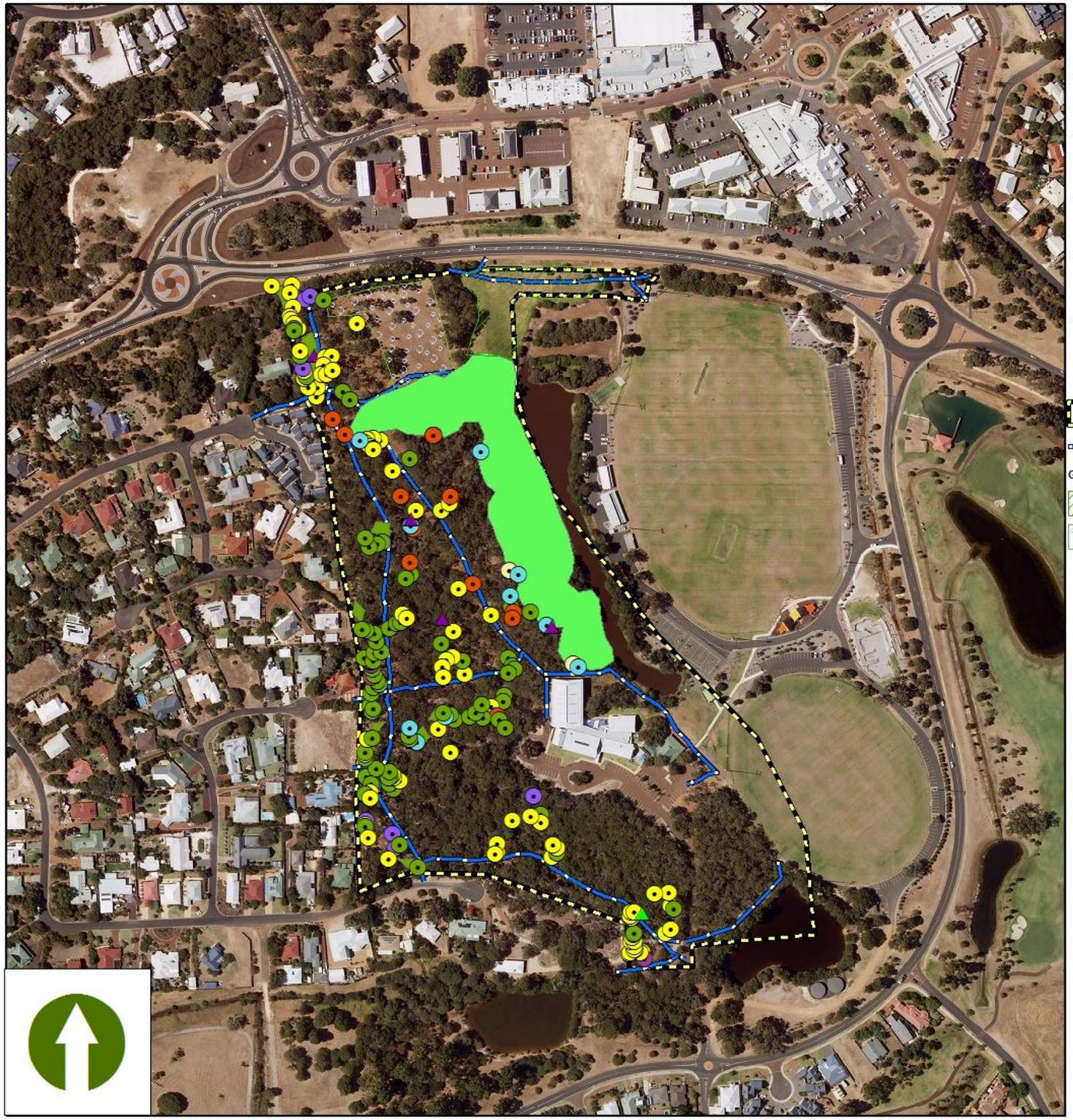

Map 10	Weeds & Pests
Site	Reserve 43008
Project	Environmental Management Plan
Client	City of Busselton
Scale	1: 2,500

Legend

- Reserve Boundary
- Tracks

Grassed Areas

- Mown Area
- Reveg Area

Species

- A. iteaphylla
- A. longifolia
- Acacia spp
- Arum Lillies
- Bridal Creeper
- Garden spp
- Nightshade
- Beehive
- Chairs/ Firepit
- Rabbits
- A. iteaphylla
- A. longifolia
- Uncontroled grasses

0 40 80 160 240

Metres

Prepared by Gary McMahon
Ecosystem Solutions
July 2015
Projection - MGA50
Datum - GDA94
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This map is for planning/discussion purposes only.

ecosystem solutions

10 References

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11 Appendices

APPENDIX A: Revele Data sheet example.

STRUCTURAL VEGETATION, FLORA – Relevé		SITE_ID:
Date:	GPS:	Structural comm. type
Recorder:	Photo no. + direction:	
Location:		

Condition: Pristine Excellent Very Good Good Degraded	
Aspect: N NE E SE S SW W NW	**Slope:** Flat Gentle Mod Steep
Geology: Gran Lat Lime Other	**Rock:** 0 <2 2-10 10-20 20-50 >50
Soil Colour: Grey Dark Brown Light Brown Orange/Brown Red/Brown White Yellow	**Soil Type:** C CL CLS CS L LS S SCL SL SP ZCL ZL ZS
Litter (% cover & depth):	**Bare Ground (% cover):**
Hydrology: Good drain Poor drain Wet all year Seas wet winter/spring	**Topographic position:** Upland Wetland Rock Outcrop Drainage Depression Creekline Riparian Bank Gully Plain Slope Lower Slope Middle Slope Upper Valley Flat

Layer	Height (m)	Cover	Plant Species (Dominant 3 first)
Tree (T2)	10-30		
Tree (T3)	< 10		
Mallee (M1)	> 8		
Mallee (M2)	< 8		
Shrub (S1)	> 2		
Shrub (S2)	1-2		
Shrub (S3)	0-1		
Sedge/Rush (VR)			
Herb (H)			
.Grass (G)			
Other (climbers) (C)			

Cover Codes: D >70% M 30-70% S 10-30% V 2-10% VV <2% E <5% Emergent * = Introduced

Surrounding plants:

Appendix B: Keighery Vegetation Condition Scale. (after Keighery 1994)

Category	Description
Pristine	Pristine or nearly so, no obvious signs of destruction.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. For example damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle track.
Very Good	Vegetation structure altered, No obvious signs of disturbance. For example disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate to it. For example disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration, but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation in no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora composing weed or crop species with isolated native trees or shrubs.

Appendix C: Fire Fuel Data Collection Sheet (from Hines et al, 2010).

Fuel Hazard Assessment Data Sheet

Date:	Collector:	Reserve Name:

Site Information	Site no. 1	Site no. 2	Site no. 3
Location Description:			
Road/ Track Name:			
Year of last known fire			
Slope °			
Aspect			
ID No.			
Vegetation Association (dominant overstorey species)			
Vegetation Association (dominant understorey species)			
Photo reference			
Zone			
Easting (GDA94 MGA UTM)			
Northing (GDA94 MGA UTM)			

Surface fuel layer (Assess over a 10m radius)															
Litter bed depth measurements (mm)															
Average Litter Depth (mm)	mm					mm					mm				
Surface Litter % Cover	%					%					%				
Surface Fuel Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Near-surface fuel layer (Assess over a 10m radius)															
Near-surface % Cover	%					%					%				
Near-surface % Dead	%					%					%				
NS Average Height(cm)	cm					cm					cm				
Near-Surface Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Adjusted Surface and Near-surface Fuel Hazard (Refer to table in the Overall Fuel Hazard Guide)															
Adjusted Surface Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Elevated fuel layer (Assess over a 10m radius)															
Elevated % Cover	%					%					%				
Elevated % Dead	%					%					%				
Elevated Fuel Ave Height (m)	m					m					m				
Elevated Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Bark fuel (Assess over a 10m radius)															
Stringybark Fuel Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E
Gum Bark Fuel Hazard	L	M	H	VH		L	M	H	VH		L	M	H	VH	
Platy/ Subfibrous Bark Fuel Hazard	L	M	H	VH		L	M	H	VH		L	M	H	VH	
Bark Fuel Hazard:	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

(Only use the Stringybark hazard rating if more than 10% of the trees are Stringybark AND it has the highest rating. Otherwise use the bark with next highest rating.)

Overall Fuel Hazard calculation (Refer to table in the Overall Fuel Hazard Guide)															
Overall Fuel Hazard	L	M	H	VH	E	L	M	H	VH	E	L	M	H	VH	E

Comments? Are the plots representative of the average fuels across the sampling location?	Yes	No

Appendix D: Weed Control Approaches.

1- Weeds with Underground Reproductive Structures Removal Techniques:

Hand Removal of Plants with a Taproot

- Remove and bag seeds or fruits;
- Push a narrow trowel or knife into the ground beside the tap root, carefully loosen the soil and repeat this step around the taproot;
- Grasp the stem at ground level, rock plant backwards and forwards and gently pull removing the plant; and
- Tap the roots to dislodge soil, replace disturbed soil and pat down.

Crowning

- Remove and bag stems with seed or fruit;
- Grasp the leaves or stems together so the base of the plant is visible;
- Insert the knife or lever at an angle close to the crown;
- Cut through all the roots around the crown; and
- Remove and bag the crown.

Herbicide Treatment – Stem Swiping

- Remove any seed or fruit and bag; and
- Using an herbicide applicator, swipe the stems/leaves.

Considerations:

- Further digging may be required for plants with more than one tuber;
- Some bulbs may have small bulbils attached or present in the soil around them which need to be removed;
- It may be quicker and more effective to dig out the weed;
- Protect native plants and seedlings; and
- For bulb and corm species the most effective time to apply herbicide is after flowering and before fruit is set.

Exotic vegetation should be removed and stockpiled in a clear area away from adjoining bushland. This stockpile should be removed from the site at a convenient time. As part of the regular maintenance of the restored area any re-growth of the exotic plant species should be removed and disposed of appropriately.

2- Small Hand-Pullable Plants Removal Techniques:

Hand Removal

- Remove any seeds or fruits and carefully place into a bag;
- Grasp stem at ground level, rock plant backwards and forwards to loosen roots and pull out; and
- Tap the roots to dislodge any soil, replace disturbed soil and pat down.

Considerations:

- Leave weeds so roots are not in contact with the soil, e.g. hang in a tree, remove from site or leave on a rock.

3- Woody Weeds Removal Techniques:

Cut and Paint (Woody weeds to 10 cm basal diameter)

- Make a horizontal cut close to the ground using secateurs, loppers or a bush saw; and
- Immediately apply herbicide to the exposed flat stump surface.

Considerations:

- Cuts should be horizontal to prevent herbicide from running off the stump, sharp angle cuts are hazardous;
- Herbicide must be applied immediately before the plant cells close (within 30 seconds) and translocation of herbicide ceases;
- If plants resprout cut and paint the shoots after sufficient re-growth has occurred; and
- Stem scraping can be more effective on some woody weeds.

Stem Injection

- At the base of the tree drill holes at a 45 degree angle into the sapwood;
- Fill each hole with herbicide immediately; and
- Repeat the process at 5 cm intervals around the tree.

Frilling or Chipping

- At the base of the tree make a cut into the sapwood with a chisel or axe;
- Fill each cut with herbicide immediately; and
- Repeat the process at 5 cm intervals around the tree.

Considerations:

- Plants should be actively growing and in good health;
- Deciduous plants should be treated in spring and autumn when leaves are fully formed;
- For multi-stemmed plants, inject or chip below the lowest branch or treat each stem individually; and
- Herbicides must be injected immediately before plant cells close (within 30 seconds) and translocation of herbicide ceases.

4- Vines and Scramblers Removal Techniques:

Hand Removal

- Take hold of one runner and pull towards yourself;
- Check points of resistance where fibrous roots grow from the nodes;
- Cut roots with a knife or dig out with a trowel and continue to follow the runner;
- The major root systems need to be removed manually or scrape/cut and painted with herbicide; and
- Any reproductive parts need to be bagged.

Stem Scraping

- Scrape 15 to 30 cm of the stem with a knife to reach the layer below the bark/outer layer; and
- Immediately apply herbicide along the length of the scrape.

Considerations:

- A maximum of half the stem diameter should be scraped. Do not ringbark;
- Larger stems should have two scrapes opposite each other; and
- Vines can be left hanging in trees after treatment.

5-Grass Weed Removal Techniques

Hand Removal

- Remove any seeds or fruits and carefully place into a bag;
- Grasp stem at ground level, rock plant backwards and forwards to loosen roots and pull out; and
- Tap the roots to dislodge any soil, replace disturbed soil and pat down.

Considerations:

- Remove weeds from location to prevent re-infestation

Spot Spraying.

- Use a small hand sprayer or backpack
- Adjust the nozzle to a single stream spray
- Spray appropriate herbicide onto the target plant.

Considerations

- Avoid spraying non-target species
- Shield neighbouring non-target species with a bucket or other protection.
- Special shields can be used to protect non-target species and to ensure that stream of herbicide from sprayer does not drift onto non-target species.

Blanket Spraying

- Use backpack sprayer or machinery based equipment
- Used in areas of dense weeds with no native vegetation or when using a selective herbicide (e.g. Fusilade ®)

Considerations

- If any native species present, make sure they are not affected by the selective herbicide.

Suggested Weed Control Methods

Species	Priority	Control Methods	Timing	Control Notes*
Annual Pasture Grasses	Moderate	Hand weeding, Herbicide wiping, Spot spraying, Blanket spraying	Aug-Oct	Spray at 3-5 leaf stage with Fusillade 10 ml/10L (500ml/ha) + wetting agent; repeat over following 2 years.
Arum Lily (*Zantedeschia aethiopica*)	High	Hand weeding, Herbicide wiping, Spot spraying	April-Nov	Difficult to dig out in most sites. Spot spray metsulfuron methyl or chlorosulfuron 0.4g/15L + wetting agent (Pulse). Higher concentrations in one litre hand held sprayer applying a single squirt to leaves avoids off target damage. Best results when plants are 8-12cm high. Respray 2 months later to get missed growth. Glyphosate 1:100 in June to Oct – Several applications may be needed. Use bioactive glyphosate in wet areas to avoid animal impacts. Try to spray before flowering to stop seed set.
Bridal Creeper (*Asparagus asparagoides*)	High	Herbicide wiping, spot spraying, release of fungus is a possibility.	Aug - Sept	Spray glyphosate 1% with wetting agent OR metsulfuron methyl 0.04g/10L + wetting agent. Best results occur with treatment during flowering. A rust fungus (Puccinia spp) can infest the plant, this can be transferred between plant by moving affected leaved (they had a yellow spot on them) or from insects (leaf hopper (Zygina sp). The spreading of the rust form infected plants can be an effective and cheap way of controlling the plant.
Woody Acacias	Moderate	Hand pull small plants, Herbicide	Anytime, but ideally autumn for chemical control	Basal Bark treatment with a picloram/triclopyr mix in autumn, can also try an injection with a 50% glyphosate mix or cut and paint with herbicide Cut and paint with "Vigilant" gel, a picloram/aminopyralid product (comes with an applicator)
Nightshade (*Solanum spp.*)	Moderate	Hand Weed	Before seed production	Hand weed small infestations. Shade reduces seed production so revegetation or promote regeneration of site is recommended.

APPENDIX E – Approval letter from the Minister for Aboriginal Affairs

Hon Peter Collier MLC
Minister for Education; Aboriginal Affairs; Electoral Affairs
Leader of the Government in the Legislative Council

Our Ref: 34-64519

Mr Will Oldfield
Senior Environment Officer
City of Busselton
Locked Bag 1
BUSSELTON WA 6280

Dear Mr Oldfield

I refer to your Notice (the Notice) pursuant to the *Aboriginal Heritage Act 1972* (AHA), section 18(2), dated 7 October 2015, submitted by the City of Busselton (the Applicant) on behalf of the State of Western Australia (the Landowner).

I am informed that your intended use of the land the subject of the Notice will impact upon two Aboriginal sites within the meaning of section 5 of the AHA. These sites are DAA 20763 (Koopins Grave) and DAA 20764 (Caves Road Campsite).

I am pleased to inform you that, pursuant to section 18(3) of the AHA, I have granted consent subject to conditions. The form of consent is enclosed.

I take this opportunity to acknowledge and support agreements reached with those consulted as specified in the Notice.

I also draw your attention to the additional information attached, which is provided for your assistance.

If you have any queries in relation to this matter, please contact Mr Matthew Franklin, Site Assessment Officer, Department of Aboriginal Affairs, on (08) 6551 8000.

Kind regards

Hon Peter Collier MLC
MINISTER FOR ABORIGINAL AFFAIRS
02 FEB 2016
Enc.

Level 10, Dumas House, 2 Havelock Street, West Perth Western Australia 6005
Telephone: +61 8 6552 6300 Facsimile: +61 8 6552 6301 Email: Minister.Collier@dpc.wa.gov.au

ABORIGINAL HERITAGE ACT 1972

CONSENT PURSUANT TO SECTION 18(3)

CONSENT GRANTED TO:	City of Busselton
IN RESPECT OF:	Lot 4979 on Deposited Plan P19038 (Reserve 43008), Certificate of Title Volume LR3103, Folio 341 (21 Dunsborough Lakes Drive, Dunsborough) - Reserve 43008 Fire and Environmental Management Plan
REFERENCE:	34-64519
ABORIGINAL SITES TO BE IMPACTED	DAA 20763 (Koopins Grave) and DAA 20764 (Caves Road Campsite)

CONDITIONS OF CONSENT

That the consent holder:

1. Provides a written report to the Registrar of Aboriginal Sites within 60 days of the completion of the Purpose, advising whether and to what extent the Purpose has impacted on all or any Sites located on the Land. The final report should include a detailed description of:
   a. what extent the Purpose has impacted any Aboriginal Site on the Land;
   b. where any Aboriginal Site has been impacted, whether such Site has been partially or wholly impacted by the Purpose, and the level, effect and type of any such impact – preferably by the provision of photographs taken before and after the impact;
   c. where any Aboriginal Site has been subject to archaeological or cultural salvage, when and how such salvage took place, who was present at the salvage and where the material was re-located, the results of the salvage and any subsequent analysis conducted; and
   d. the results and findings of any monitoring of ground disturbing works associated with the Purpose.
2. In accordance with section 15 of the *Aboriginal Heritage Act 1972*, upon discovery of skeletal remains suspected to be of Aboriginal origin, or any material suspected to be skeletal remains of Aboriginal origin (Remains), the Landowner must:
   a. ensure that the remains stay in situ undisturbed, and take all the necessary and reasonable proactive steps to protect the Remains;
   b. report the discovery to the Western Australia Police and the Registrar of Aboriginal Sites (the Registrar); and
   c. comply with directions from the Registrar regarding the removal (if required) and/or management of the Remains, and report to the Registrar the whereabouts of the Remains, including compliance with the Registrar's directions.

SECTION 18 CONSENTS

ADDITIONAL INFORMATION

The following information is provided for the guidance of the consent holder and does not constitute conditions of consent.

1. Right of Review of Decision

Where a consent holder is aggrieved by a decision of the Minister made under section 18(3) of the *Aboriginal Heritage Act 1972* (AHA), including the conditions to which the consent is subject, application may be made to the State Administrative Tribunal for a review. The Tribunal's website is www.sat.justice.wa.gov.au.

2. Consent is Non-Transferable

Consent may be relied upon only by the named consent holder in respect of the named land. Any successor in title must give its own notice under the AHA.

3. Traditional Knowledge Holder

Agreements reached with Traditional Owners and knowledge holders entered into on behalf of the consent holders are acknowledged and supported.

4. Conditions of Consent

- The Department of Aboriginal Affairs carries out routine audits on compliance with the conditions of consent.
- Failure to comply with the conditions of consent may constitute an offence under section 55 of the AHA.
- It is recommended that the consent holder informs all employees and others engaged in the development of their obligations under the AHA, especially with regard to skeletal material.
- Reports to the Registrar of Aboriginal Sites (the Registrar) should use the Section 18 Report Back template which can be downloaded from the Department of Aboriginal Affairs' website at http://www.daa.wa.gov.au/heritage/land-use/section-18/.
- The Registrar welcomes any additional information about Aboriginal sites within the meaning of section 5 of the AHA, or objects within the meaning of section 6 of the AHA.

5. Legislation

The AHA, the *Aboriginal Heritage Regulations 1974* and the *State Administrative Tribunal Act 2004* may be viewed and downloaded from the State Law Publisher website at www.slp.wa.gov.au.