



Shire of
Serpentine
Jarrahdale

Serpentine Sports Reserve Management Plan

Version 2 - March 2020



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1. Executive Summary

1.1. Introduction

The Serpentine Sports Reserve covers a total area of 68 hectares. It is located about 60 km south of Perth on the eastern edge of the Swan Coastal Plain, near the Serpentine River, the Perth to Bunbury rail line and the townsite of Serpentine. The reserve includes recreational facilities, consisting of a golf club, pony club and polocrosse club, and regionally significant areas of remnant vegetation.

The Serpentine Sports Reserve (SSR) consists of two land parcels, one on each side of Karnup Road. Unless otherwise specified, the terms *Serpentine Sports Reserve*, *SSR* or *reserve* refer to the combined areas of both the northern and southern land parcels.

1.2. Objectives

The objectives of this management plan are to:

- Provide the necessary background information and site descriptions for informed management of the reserve;
- Define specific management objectives for maintaining and improving the conservation values of the reserve:
 1. Define areas that may require different management methods (e.g. conservation versus active recreation);
 2. Assess the vegetation quality and potential for rehabilitation;
 3. Assess the major problems affecting safety, aesthetics and public enjoyment, such as fire management and weed control;
 4. Assess the types and degree of environmental degradation and possible ways to address these issues; and
 5. Provide a plan for the user groups to follow when managing and regenerating the area;
- Document the actions required to successfully manage the reserve;
- Identify any management constraints and possible ways to overcome them;
- Ensure consistent management into the future, so that the goal or focus is clearly defined and easy to follow despite change of position holders; and
- Provide the community with the opportunity to become involved in the decision-making process for management of the reserve.

1.3. Location and Description

The Serpentine Sports Reserve consists of two land parcels, one on each side of Karnup Road. On the southern side, Lot 778 Karnup Road is over 46 hectares and was given to the Shire as a “Crown Grant in Trust” in 1925. While this transferred ownership of the land to the Shire, it is still considered part of the Crown Reserves System administered by the State Government. It contains club houses for the golf club and equestrian sports clubs, the first nine holes of a golf course, the David Butfield Equestrian Park, the John Lyster Polocrosse Ground and a small area leased for a communications tower. It also includes regionally significant areas of remnant vegetation in the Paul Robinson Reserve and nearby banksia woodland.

Lot 870 covers 21 hectares and lies to the north of Karnup Road. It is Crown Land and was vested in the Shire in 1965 for the purpose of Recreation and Showgrounds. This reserve (R27453) contains holes 10 to 18 of the golf course.

Figure 1 shows the location of Serpentine Sports Reserve, and Figure 2 shows the land uses current on the two land parcels.

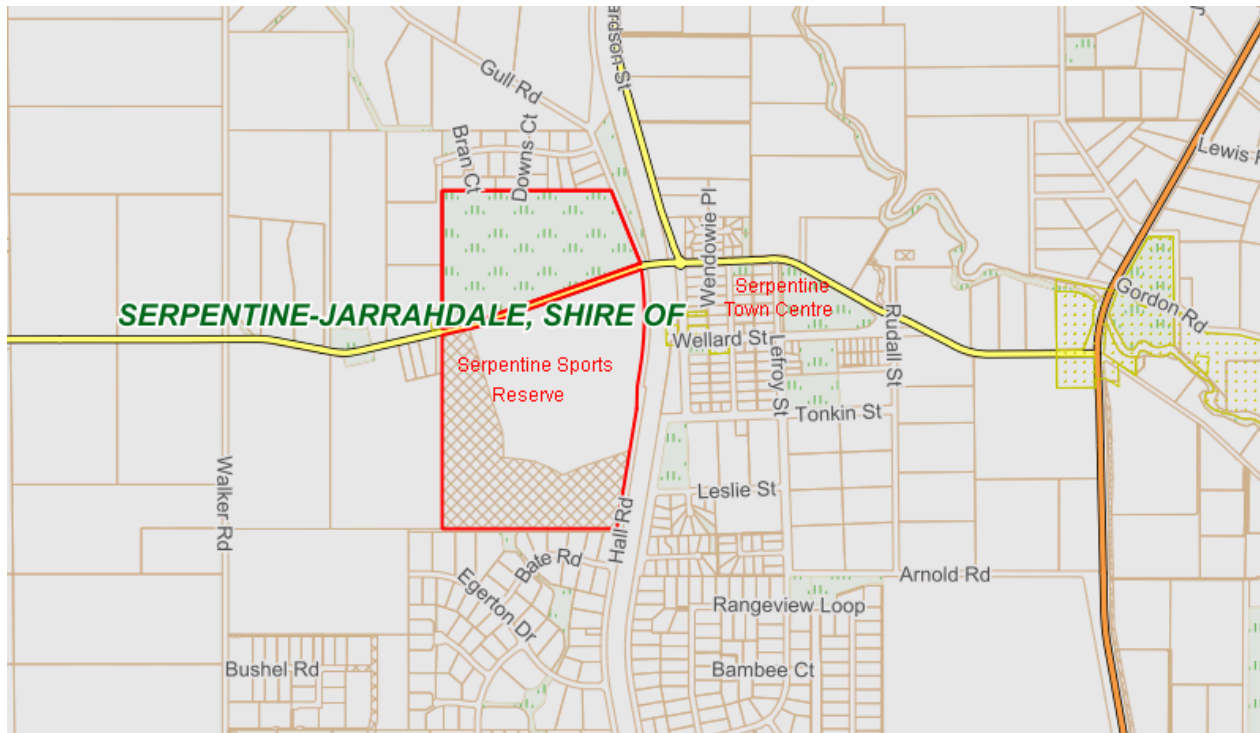


Figure 1 – Site Location of Serpentine Sports Reserve

Prior to European settlement, woodlands and swamps provided resources for Aboriginal people. In the early 1920s, land was made available for settlers, leading to clearing of bush and draining of swamps. The reserve provides important examples of the vegetation complexes which once covered much of the eastern side of the Swan Coastal Plain.

The settlement of Serpentine was originally located one kilometre to the east but moved to its current location when the railway line was built in 1893. The town serviced the rural community and a timber mill operated on the southern portion of the reserve. Recreation began on the reserve at this time.

Serpentine now has an increasing number of residents who commute to Perth. Many of the broad-acre farms have been subdivided, and the land to the north, south and west of the reserve is small-holdings, hobby farms and lifestyle blocks, many of which keep horses.

As more people move into the area, the conservation and recreation values of the reserve are coming under increasing pressure. This plan seeks to sustainably manage the increasing pressures in view of the environmental, social and economic values of the reserve.

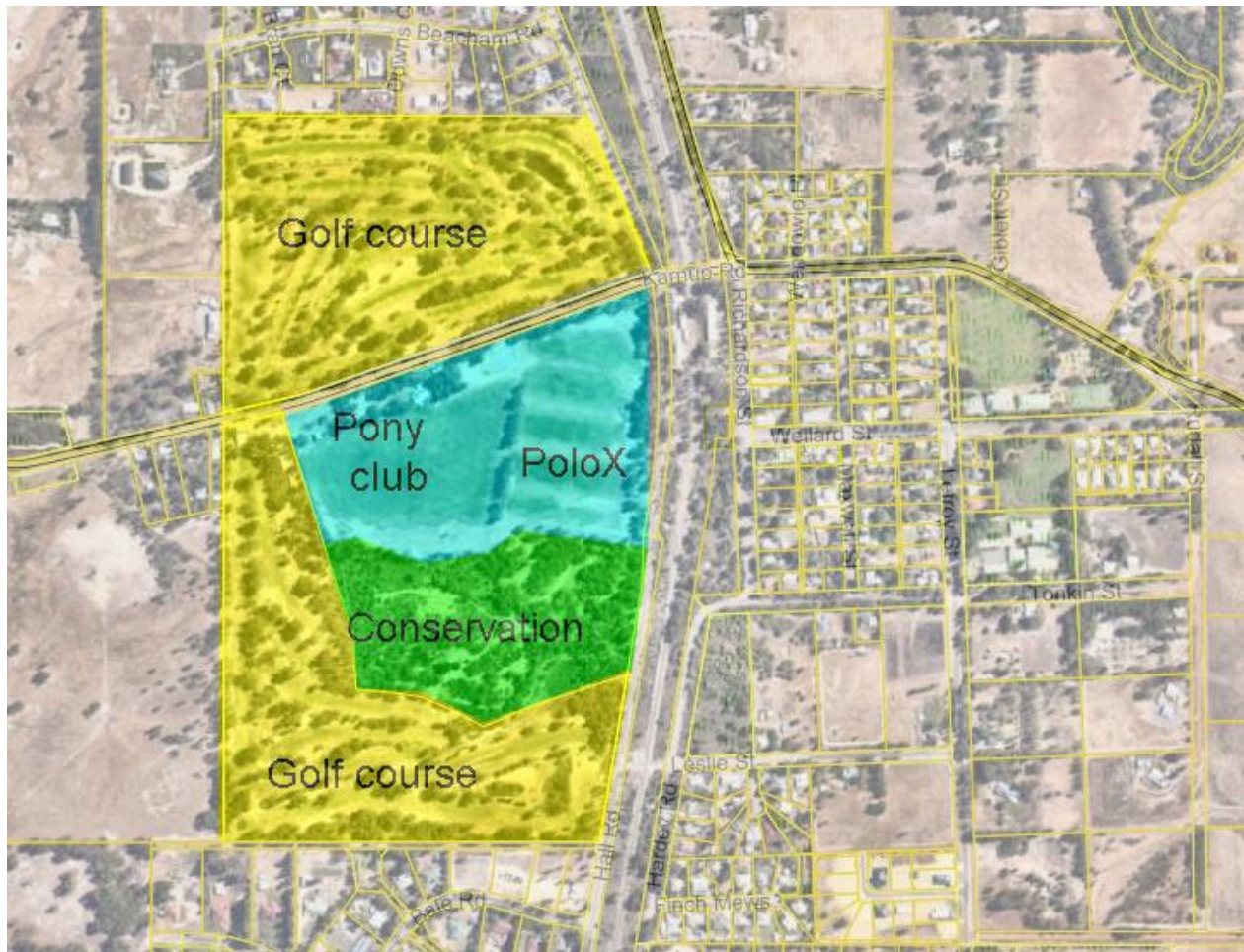


Figure 2 – Land Uses of Serpentine Sports Reserve

1.4. Report Structure

This management plan is structured into the following sections:

- Governance:
 - *Identifies the existing legislation and policies that apply and therefore have management implications for the reserve. The management plan has been prepared within this framework.*
- Environmental characteristics:
 - *Analyses landform, land, water and biodiversity features on the reserve. Threats to these features have also been considered.*
- Social and economic characteristics:
 - *Identifies the main human uses of the reserve, with consideration given to issues such as tenure, access, recreation and heritage.*
- Implementation:

- Provides guidance to Council and the community on implementation mechanisms for each management recommendation. Priorities, responsibilities and potential costs and partners are identified.

1.5. Key Priority Actions

Table 1 – Key Actions for the Management of Serpentine Sports Reserve (Long Term actions and Business as Usual)

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
1	An appropriate application is to be submitted and assessed prior to improvement, development or requests for works.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time
3	Periodically monitor and review leases and licence use of the reserve.	Key Business as Usual	Ongoing	Infrastructure Services	Staff time
6	Audit water use, prepare a water conservation and reuse plan, and apply best management practices for water use on turf surfaces.	Key Long Term	Implemented in Part	Environmental Services, Parks and Gardens	Staff time
7	Design and implement a water quality monitoring program, including nutrient export targets, and develop and monitor nutrient stripping features.	Key Long Term	Implemented in Part	Natural Reserves Coordinator, User Groups	Staff time Funding for monitoring and nutrient stripping
12	Map and treat dieback every three years, according to best management practice.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for dieback mapping and treatment
15	Map and monitor weed distribution, and prepare and implement a weed control program.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for weed mapping and control
22	Identify and protect threatened and priority flora and vegetation communities.	Key Business as Usual	Ongoing	Environmental Services	Staff time Funding for signage
30	An appropriate application is to be submitted and assessed prior to any event camping.	Key Business as Usual	Ongoing	Environmental Health, Development Services	Staff time
31	Maintain the turf areas at an acceptable standard.	Key Business as Usual	Ongoing	Parks and Gardens	Staff time Funding for turf maintenance

1.6. Short Term Actions

Table 2 – Short Term Actions for the Management of Serpentine Sports Reserve

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
2	Change vesting purpose to recognise “conservation” as a purpose for the southern section of the reserve.	Medium Short Term	Not Yet Implemented	Environmental Services	Staff time
9	Liaise with Emergency Services to prepare/update and implement a Fire Management Plan that prioritises conservation alongside people and property.	High Short Term	Not Yet Implemented	Emergency Services, Environmental Services	Staff time Funding for fire management plan preparation
10	Carry out mosaic burns if any control burning is required, allowing habitat restoration before burning the next area.	Medium Short Term	Not Yet Implemented	Emergency Services, Environmental Services	Staff time
13	Adopt and implement dieback hygiene procedures for all users.	High Short Term	Not Yet Implemented	Natural Reserves Coordinator, User Groups	Staff time Funding for hygiene procedures
20	Monitor track width within bushland and adjust access through demarcation and barrier installation as appropriate.	High Short Term	Ongoing	Natural Reserves Coordinator User Groups	Staff time Funding for barriers
34	Consider and document access issues, and develop and implement an access policy.	High Short Term	Implemented in Part	Natural Reserves Coordinator	Staff time Funding for signage

2. Governance

2.1. Vesting and Land Tenure

The SSR consists of two land parcels which are zoned for Parks and Recreation in both the *Metropolitan Regional Scheme* and the *Serpentine Jarrahdale Town Planning Scheme No. 2*. The northern parcel (Lot 870) is crown land vested in the Shire of Serpentine Jarrahdale in 1965 for the purpose of Recreation and Showground. The southern parcel (Lot 778) was given to the Shire as a “Crown Grant in Trust” in 1925. While this transferred ownership of the land to the Shire, it is still considered part of the Crown Reserves System administered by the State Government and use must comply with conditions placed on the grant. Table 3 shows the locations and uses of the land parcels.

Table 3 – Serpentine Sports Reserve Locations and Uses

Location Number	Reserve Number	Area (ha)	Land transfer date	Purpose	Current Use
Cockburn Sound 870	27453	21.8	19/03/1965	Recreation and Showground	Golf course
Cockburn Sound 778	19134	46.4	04/12/1925	Recreation, Racecourse and Showground	Golf course, pony club, polocrosse club and conservation

Under both forms of tenure the Shire is able to lease the land or licence its use, provided the use is consistent with the reserve purpose. The Shire has responsibility for management of the equestrian ovals and the bushland on the southern section of the reserve, while the remainder of the southern and all of the northern sections are leased to the Serpentine and Districts Golf Club (SDGC), which manages the land.

The Shire has overall responsibility for management, use and protection of the lands. This includes ensuring that the management and use of the land complies with relevant State and Commonwealth legislation, regulations and policies, as well as local government legislation and policy frameworks.

The SSR lies within the catchment of the Peel Harvey Estuary. The Water Corporation is responsible for two rural drains through the Serpentine Sports Reserve, within which any works require prior approval.

Many of the works on Shire reserves are undertaken by community members, and must comply with legislation, Shire policies and approved plans, and be coordinated by the Natural Reserves Coordinator.

The reserve has been divided into three different management zones: Conservation, Vegetation Management and Recreation. Figure 3 shows the location and extent of each of the management zones. Each zone has a range of activities that can or cannot occur there.

Conservation Zone: Areas of remnant vegetation of high biodiversity and scientific reference value which are Threatened Ecological Communities and include both dieback free and dieback infected areas. This zone includes dieback treatment, weed control and revegetation where required. Access within this area must utilise dieback hygiene procedures such as clean-down and take extreme care to prevent spread of dieback from infected to uninfected areas.

Vegetation Management Zone: Areas of remnant vegetation of biodiversity and scientific reference value which are not dieback free, and may be disturbed by recreation or weed infested. This is a buffer zone and includes dieback treatment, weed control and revegetation where required

Serpentine Sports Reserve Recreation Zone (remaining uncoloured): Areas with little remnant vegetation which are largely used for active and passive recreational activities, where management relates to reticulation, horse grounds, golf course or other active recreational pursuits.

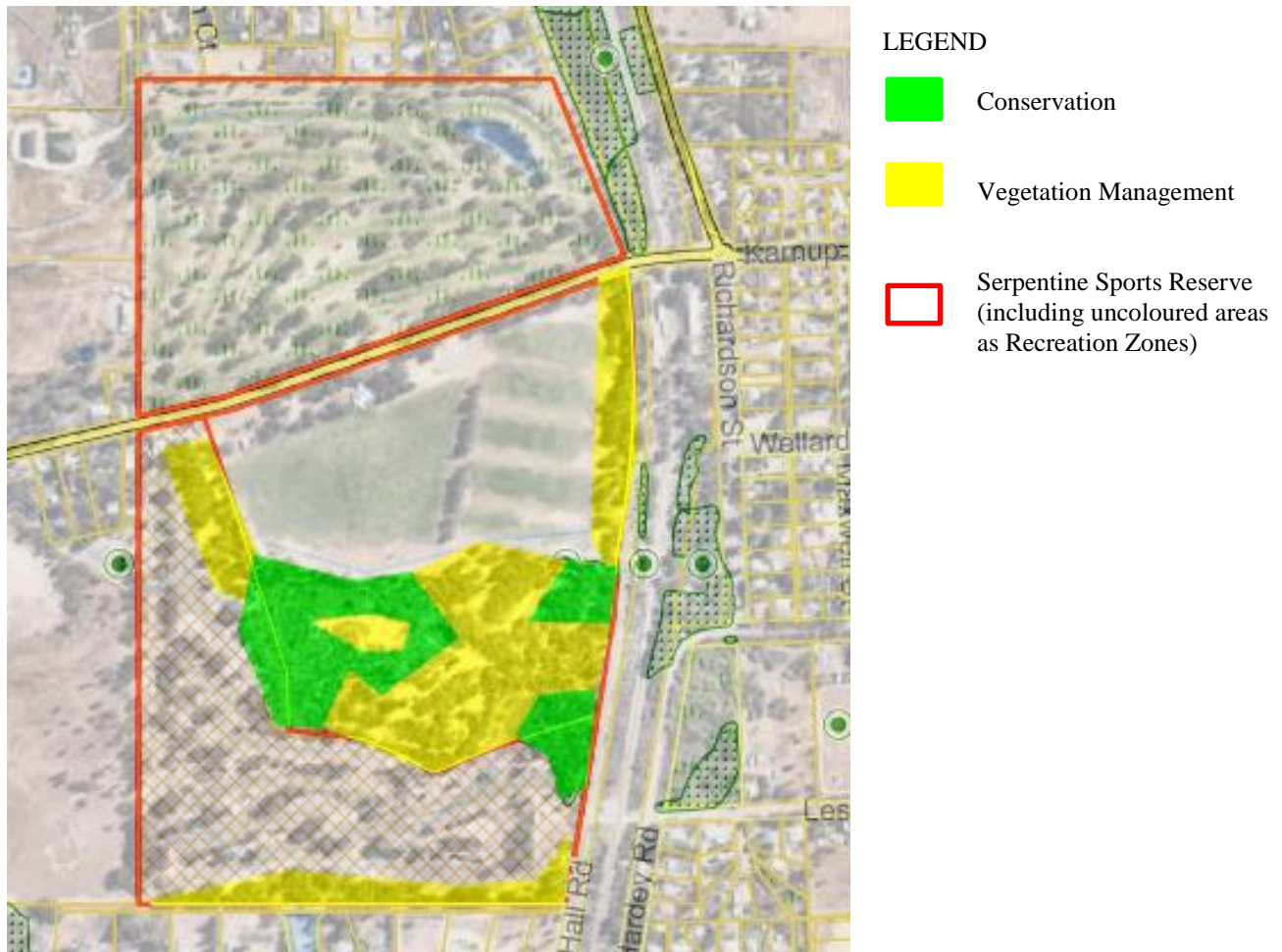


Figure 3 – Management Zones of Serpentine Sports Reserve

2.2. Community Consultation and Participation

Community input is essential for the protection of the high conservation or recreation values of the SSR. The main community forum is the Reserves Advisory Group (RAG) and four main stakeholder groups.

The Reserves Advisory Group (RAG) consists of up to eight community members, Shire staff, and Landcare SJ representatives. Members have a high level of relevant knowledge, expertise or experience and are expected to participate in a non-representative manner.

The roles of the RAG are to:

- Provide advice to Council on reserve values, threats, management targets and strategies to protect ecological and social values and take account of community aspirations;
- Provide advice to Council about on-ground management programs and issues; and
- Undertake audits of reserve management plans and report the results to Council.

The four stakeholder groups involved in the use and management of the SSR are the Serpentine Horse and Pony Club, the Serpentine/Foothills Polocrosse Club, the Serpentine Enviro Group (previously Serpentine Bushland Group) and the Serpentine and Districts Golf Club. Each is an incorporated body affiliated with a State body. All of the community groups that operate on the SSR are entirely voluntary.

2.3. Governance: Actions

Table 4 – Governance Actions for Management of Serpentine Sports Reserve (Short Term actions and Business as Usual)

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
Governance					
1	An appropriate application is to be submitted and assessed prior to improvement, development or requests for works.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time
2	Change vesting purpose to recognise “conservation” as a purpose for the southern section of the reserve.	Medium Short Term	Not Yet Implemented	Environmental Services	Staff time
3	Periodically monitor and review leases and licence use of the reserve.	Key Business as Usual	Ongoing	Infrastructure Services	Staff time

3. Environmental Characteristics

3.1. Land Resources

3.1.1. Description

The exceptional biodiversity in the SSR is due to long-term geological activity, resulting in variations in soil types within relatively short distances. Today, the SSR is situated on the eastern side of the Swan Coastal Plain, where the surface soils originate from two sources.

Firstly, erosion of the Darling Range formed the Pinjarra Plain soil complex, characterised by grey sandy duplex soils, clays, loams and gravels. Secondly, sea level fluctuations formed a series of sand dunes on top of the plain, the oldest of which lies to the east. Soils from this dune system belong to the Bassendean complex, characterised by deep, pale siliceous sands. Agriculture WA soil maps indicate that there are two soil types from the Pinjarra and two from the Bassendean complex within the SSR (Table 5).

Table 5 – Landform and Soil Classifications

Soil type	Location	Description	Land Quality Considerations
Pinjarra 8 phase	Pony club and polocrosse fields, northern and eastern parts of golf course	Moderately deep to deep sands over mottled clays; acidic or less commonly alkaline grey and yellow duplex soils to uniform bleached or pale brown sands over clay.	Wind erosion, waterlogging in low-lying areas
Pinjarra 1b phase	South-west corner of golf course	Deep acidic mottled yellow duplex soils. Moderately deep pale sand to sandy loam over clay.	Moderately susceptible to salinity, soil water storage
Bassendean 1 phase	Remnant vegetation; central and south-west portion of northern sector of reserve	Deep bleached grey sands, sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than two meters.	Wind erosion
Bassendean 3 phase	Golf course in south-east corner of reserve	Moderately deep, poorly to very poorly drained bleached sands with an iron-organic pan, or clay subsoil; surfaces are dark grey sand or sandy loam.	Waterlogging, phosphorus export, acidity

The SSR has a low relief landscape, with the Bassendean soils forming shallow sandy rises and the Pinjarra soils low-lying and poorly drained flats. The natural contours have been altered by excavation in some areas and the addition of soils to others. Soil from several locations within the northern and southern sections was used during the 1970s to elevate fairways, with the excavations helping drainage.

Details of the Bassendean soil profiles can be seen in the sand pit within the bushland, which shows deep, uniformly-grained yellow sand with a shallow grey surface layer enriched by organic matter. Erosion has undermined adjacent bushland. Further north, near the pony club grounds, the sands have clay subsoil.

Bassendean sand from the bushland was used to level, elevate and drain the polocrosse grounds, the sand layer being spread thicker in the south than the north. Major works to the pony club grounds in 1999 levelled the area and replaced the top 200 mm of soil with 300 mm of imported sand.

The pony club uses a cross-country track which passes through the bushland. About 300 m of this was covered with bluemetal fines to help prevent erosion, compaction, formation of ruts and the spread of dieback. The rest of the cross-country trail has a natural surface of Bassendean soil.

Little is known about the current condition of SSR soils. Surface salinity is evident in some areas in the northern section, and there is potential for nutrient build-up and acidification.

3.1.2. Threats and Pressures

Waterlogging is characteristic of the soils over much of the SSR.

Wind erosion occurs when vegetation cover is removed, and has been the primary cause of continued erosion following the extraction of soil from the sand pit. The native vegetation is slowly recovering.

Phosphorus export occurs from the addition of fertilisers to soils that export nutrients, which is likely to result in surface- and ground-water pollution. Excess fertilisers and manure threaten the soil's chemical balance and microbial communities.

Surface salinity can be caused by either the evaporation of shallow pools which concentrates salts, or by rising saline groundwater. Surface salinity can be managed by drainage, while rising groundwater can be controlled through the planting of deep-rooted perennial plants. Increased salinity causes changes to the chemical composition of soils, but is most evident in ground- and surface-water resources.

Soil compaction refers to the crushing of soils to a point where the physical structure is altered, creating layers that are almost impenetrable, affecting fertility and the soil microbial community. The protection of fragile soils by a surface material that holds its structure helps to minimise compaction and erosion.

Acid sulphate soils contain chemicals that, when exposed to oxygen, form sulphuric acid. The chemicals form in swamps, where constant inundation prevents acid formation. If these soils are exposed to air, or the water table lowered, sulphuric acid forms. This alters the chemical nature of the soil and can cause severe pollution of ground and surface water. The acid sulphate soil risk within the SSR is moderate to high, occurring more than three meters from the soil surface. Acidification can be prevented by ensuring that there is no soil disturbance or dewatering below three meters from the surface.

3.2. Water Resources

3.2.1. Description

Water resources of the SSR consist of drains, natural and artificial wetlands, and superficial and artesian groundwater. The area has a Mediterranean climate with hot, dry summers and cool, wet winters. About 70% of annual rain falls from May to August; these winter rains recharge the ground and surface water.

Surface Water

Much of the reserve is low-lying and originally formed part of a dampland (a winter-waterlogged, basin-shaped wetland) with no natural drainage off-site. From the 1920s, a network of drains was constructed to reduce inundation and enable agriculture. The drains flow west to the Serpentine River and the Peel Inlet.

The Peel Harvey Estuary is of regional, national and international significance, and is protected by Commonwealth legislation. The estuary has been severely degraded by nutrients from the catchment which cause algal blooms. The Dawesville Channel increased estuarine flushing, and water quality was also improved through better land management to reduce nutrient inputs.

Catchment land use is subject to policies that set nutrient export targets. These include a maximum phosphorus load from the Serpentine River, water management plans for recreation facilities, and maximum nutrient application rates of 150 kg of nitrogen and 15 kg of phosphorus per hectare per year.

A dampland of 1.8 hectares, south-east of Paul Robinson Reserve, is a Conservation Category wetland. The primary management objective is to preserve wetland attributes and functions, and State policies require land uses to be compatible. The remaining low-lying areas are Resource Enhancement wetlands.

Runoff from the SSR empties into three Water Corporation drains, which also carry runoff from upstream (see Appendix 2 for a drainage map). The first drain runs along the southern and western boundaries of the south sector and carries runoff from south of the townsite and reserve. The second drain bisects the south sector, carrying water from the townsite and most of the reserve, and flows through an artificial nutrient stripping wetland before crossing two fairways to the western boundary, where the two drains join and flow towards the Serpentine River. Runoff from the north sector discharges into a third drain running along its northern boundary, which later joins this combined drain.

In 1999 the pony club arena's drainage was improved, and nutrient export reduced. The drain carrying runoff from the townsite was diverted through an artificial nutrient stripping wetland. The arena surface was reshaped and covered with a deep layer of sand, draining half of the runoff towards a central channel and half into a subsurface channel to the north, which both discharge into the artificial wetland. During peak flow, water backs up from the wetland, water levels approach the surface and local flooding occurs.

The polocrosse field has been raised slightly. The soils have low infiltration rates, and the northern section is often waterlogged throughout winter. The grounds drain towards channels in the north and east and the southern drain. Polocrosse carnivals are held in autumn and spring when drainage is not an issue.

A dam constructed by the golf club provides irrigation water. It is filled from a bore, and receives runoff from the equine areas and fairways. It is next to the artificial wetland, but connectivity is uncertain. During winter the dam overflows.

The fairways are mounded to drain sideways. In both sections, water collects between the fairways. In the south section, the water discharges by a drain through the natural wetland and bushland to join the central Water Corporation drain. Drainage is slow, with localised flooding, particularly south of the club house where the central drain crosses the first fairway. Over time this drain gradually filled, so after heavy rain, water flooded back across the fairway, lasting for several days and raising water levels in the artificial wetland, which backed up and flooded the equine arenas. More recently work has been carried out to mitigate flooding and improve outflows from the reserve.

Information on surface water quality is limited. Along the Serpentine River, total phosphorus levels increase moving downstream, but no difference has been detected between the sampling sites up- and down-stream of the main Water Corporation drain from the SSR and surrounding areas.

Salt-affected land occurs in the north section of the reserve and on the northern edge of the polocrosse field. The largest area is near the western boundary of the north section, where deep-rooted perennial vegetation appears to have reduced the severity. On the polocrosse field it is not clear whether salt or waterlogging is the problem, but salt- and water-tolerant couch grass has replaced the other turf species.

Groundwater

The SSR is in the Serpentine Groundwater Area. Extensive supplies are contained in superficial aquifers. In general, Bassendean sands store more water than Pinjarra soils. The reserve lies on the boundary between these two sediment types, so supplies from the superficial aquifer are likely to be erratic.

The older underlying sediments contain substantial quantities of groundwater (the Leederville Aquifer) in confined (artesian) aquifers. Water leaks down and up between the two aquifers. Groundwater movement is generally from east to west, but flows close to the Serpentine River are more complex. The superficial aquifer discharges to the river (and the artificial surface drains), and water leaks upward to recharge it.

Groundwater extraction is controlled and licensed by the Department of Water and Environmental Regulation. The Shire holds a license to extract water from the Leederville Aquifer, as does the golf club. The Leederville Aquifer in this subregion is more than 50% allocated. Sustainable levels of extraction, and water allocations, are limited as it is a discharge zone where the aquifer is not being replenished.

The SSR is within a proposed *Public Drinking Water Source Area (PDWSA) Priority Level 3*, extending from the Serpentine River south to the Dandalup-Murray System. The purpose of the PDWSA is to protect the quality of water in the superficial aquifer from overuse and pollution. In Priority 3 areas, land use and recreation are permitted provided that threats to water quality can be adequately managed.

Water Use and Management

Regulation of surface water flow and extraction of groundwater have impacts on the environment. People expect access to water, but resources are limited and costs high. Where the needs of community and environment conflict, a balance must be reached or alternatives sought. The State and many local governments are increasing water use efficiency.

Over three quarters of the reserve is turfed and irrigated from the Leederville Aquifer. Shire staff irrigate the pony club and polocrosse fields, with generally less water applied than is best practice.

The golf course fairways are irrigated via a pump on the dam, which is filled from a bore and receives runoff from the horse grounds. The system is owned and managed by the club. Irrigation levels are in line with recommended best practice, but only the centres of the fairways are irrigated.

3.2.2. Threats and Pressures

Water Quality

The most critical water quality issue is nutrient management, which on the SSR is well within the recommended maximum rates of 150 kg/ha/year nitrogen (N) and 15 kg/ha/year phosphorus (P).

The polocrosse field receives total inputs of 46.7 kg/ha/year N and 0.6 kg/ha/year P (40 kg/ha N once a year from fertiliser, plus about 6.7 kg/ha/year N and 0.6 kg/ha/year P from animal waste). The animal waste is not evenly distributed and there may be significant export from high concentration points.

The pony club arena receives total inputs of 108.3 kg/ha/year N and 1 kg/ha/year P (fertilised twice a year at 46 kg/ha and 51 kg/ha N, plus animal waste inputs of about 1 kg/ha/year P and 11.3 kg/ha/year N). The

nutrient loads are not even and may be exported from high use hot spots. Runoff drains into the artificial wetland where nutrients and sediments can be removed.

Nutrient input on the golf fairways is about 25 kg/ha/year N. This is much lower than professional advice (100 kg/ha/year N) for semi-active turf. Fairway shaping and tree planting in channels creates the basis for a “treatment train”. Water travels slowly along shallow channels and collects in artificial sumps, allowing in-stream processes to occur, removing nutrients and sediment.

Water is also used to operate toilets and catering facilities. The toilets at the Eric Senior Pavilion use a Biomax system, while the golf club has a septic system on deep sand with high infiltration. The estimated household equivalents are 1.6 for the Pavilion and 0.3 for the golf club.

Climate Change

Local impacts of global climate change include significant changes to rainfall patterns. Recent dry conditions are predicted to continue, becoming more distinct and associated with warming and more frequent extreme events. Less rainfall provides fewer water resources and increased pressure for conservation and reuse. Pressure is growing to reduce energy use and greenhouse gas emissions. Initiatives at a public facility provide the additional benefit of community education.

Water Pollution

Nutrient export is a significant threat to water flowing into, through and from the reserve. The main sources are fertilisers and animal wastes, but water from upstream may already be poor quality. Fertiliser use is well within recommended rates, but small amounts can cause pollution if large proportions are exported. Effective application relies on nutrient penetration to root depth at a rate plants can assimilate. Best management practices to minimise nutrient export from turfed surfaces include repeated application of small amounts of fertiliser and water, use of soil conditioners and wetting agents, avoidance of fertilisation before very heavy rain or just prior to inundation, and maintenance of healthy vegetation.

Horse manure and urine require careful management. Total inputs are well within allowable limits, but only assuming that it is spread evenly. In practice, the horses spend far more time in some parts of the grounds, particularly the horse pens, than in others. Most of these nutrients are exported. Removal of manure from horse pens could reduce levels at these “hot spots”, but large proportions of nutrients are in urine. Sand or other absorptive material would absorb some of the urine, and subsequent removal reduce the likelihood of export. Covered pens with sealed floors would guarantee the confinement of nutrients.

Best management practice prevents export of nutrients from the source, but nutrients in water can be removed if passed slowly through areas where plant roots can absorb the nutrients. Effective nutrient stripping requires vegetation with roots at appropriate depths and the slowing down of nutrient-rich water. The artificial nutrient-stripping wetland improved nutrient management, but was only designed to process runoff from the pony club grounds. The much larger flows from the townsite put the system under pressure, and residence times may be inadequate.

Chemicals such as pesticides, herbicides, cleaning agents and petrochemicals can also pollute water. A precautionary approach should be taken when transporting, storing and using chemicals, and manufacturers’ instructions must be adhered to at all times.

Water Quality in the Conservation Category Wetland

Inflows to the wetland could disrupt its ecological balance. The golf course drain may import nutrients, weeds and disease, and affect water levels. Ideally, there should be no hydraulic connection between a dampland and surrounding land uses. Flooding of the adjacent fairways has been mitigated by digging drainage reservoirs and raising the fairways. Water quality deterioration could be minimised by redirecting and reusing water from the golf course, or by installing a nutrient stripping wetland. The wetland is an expression of the water table, and any activities that affect the water table impact on it, including alteration of water levels and leaching of nutrients and other pollutants into the groundwater.

Unsustainable Use of Water Resources

Groundwater is a limited resource under increasing demand. Knowledge of aquifers is incomplete, but license allocation helps to keep usage within sustainable limits. There is significant pressure to increase water use efficiency and maintain natural flow regimes. Originally, very little water would have left the SSR. Water sensitive design aims to keep most if not all of the water on site and maximise infiltration. A wide range of best management practices can be adopted to minimise demand, collect, store and reuse water, reduce evaporation, slow the passage of water, and increase transpiration.

Salinity

Salinity alters soil structure and limits plant growth. Secondary impacts include bare sealed surfaces with low infiltration and increased runoff, erosion, and nutrient and sediment transport. Saline waters affect the health of freshwater ecosystems. On the Swan Coastal Plain the primary cause is secondary salinity where salt accumulates from evaporation of standing water, which differs from the salinity caused by rising groundwater. Management includes reducing flood time through drainage, increasing surface water use on site and upstream, and reducing evaporation by shading.

Acid Sulphate Soils

Acid sulphate soils occur in the region, and when exposed to oxygen release sulphuric acid that directly impacts ecosystems and has serious indirect impacts by liberating heavy metals and acid compounds. Systems for detaining and treating storm water must identify and avoid creating an acid sulphate problem.

3.3. Biodiversity

3.3.1. Description

The SSR has about nine hectares of remnant vegetation of three community types, generally in good condition, not well represented elsewhere, and well connected with each other and with remnants on adjacent rail and nature reserves. Small, isolated plants and revegetation contribute to biodiversity.

State legislation protects plants and animals that are listed as Threatened. Priority species have uncertain status and need further research, and depend on active strategies for long-term survival. There are four Threatened flora species in the SSR and seven priority species. State legislation also protects threatened ecological communities, and some are protected by Commonwealth legislation.

Bush Forever is the State's strategic plan to conserve bushland on the Swan Coastal Plain. It identifies areas of regionally significant bushland and strategies for their protection. The SSR bushland is mapped as *Bush Forever Site 375*, grouped with two other sites to form a corridor to other significant areas.

3.3.2. Flora

The SSR lies in the Swan Coastal Plain IBRA region, within which a variety of plant communities occur. The Hedde vegetation classification is based on soil types and landforms with some survey data. A vegetation complex contains plant communities that are associated with a single soil landscape system. The SSR is on the boundary between the Pinjarra Plain and Bassendean Dunes. Hedde lists the vegetation as Guildford Complex, associated with Pinjarra soils. The bushland in the centre of the reserve is more typical of the Southern River Complex which is transitional between Pinjarra and Bassendean.

The Gibson analysis of communities on the Swan Coastal Plain used the presence or absence of particular species in standard sample areas to define floristic groupings. The Gibson study also investigated the total area of each community and defined some as Vulnerable, Endangered or Critically Endangered. Three Gibson floristic communities are represented in the remnant vegetation in SSR. They are Banksia Woodland (community 20b), Marri Woodland (community 3b) and Wetland Heath (community 8).

Banksia Woodland (community type 20b)

“*Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain” covers an area of about 4.5 hectares. The community is listed as *Endangered* under both State and Commonwealth legislation.

This is the most western community, occurring on a low dune of grey Bassendean sand. The central section was excavated more than 50 years ago, leaving a pit scar. West and south is about two hectares of woodland dominated by firewood banksia (*Banksia menziesii*) and candlestick banksia (*B. attenuata*) with scattered jarrah (*Eucalyptus marginata*) and bull banksia (*B. grandis*). The understorey is diverse.

About half of the woodland is in very good condition with little structural alteration. A cross-country horse track bisects the woodland, about 1.5 m wide and surfaced with bluemetal fines. It enters from the north-west corner and travels south and east to the sand pit. Most is dieback free, but the track also traverses dieback-infected bushland.

The banksia-jarrah woodland south of the sand pit and towards the southwest corner is more disturbed, with evidence of historical clearing and weeds which require regular treatment. The condition varies, with healthy diverse understorey mixed with areas where the understorey is highly disturbed.

The dune sands north of the pit and along the northeast boundary have a structurally distinct community. The lower slopes are open woodland of firewood banksia (*Banksia menziesii*) and swamp banksia (*B. littoralis*) with scattered jarrah (*Eucalyptus marginata*) and Christmas trees (*Nuytsia floribunda*). Further upslope the community grades into dense low shrubs with *B. menziesii* and *E. marginata* emergents. It may be a distinct community, or the result of past disturbance or the ongoing disruption of dieback. This community is very diverse and resembles a sandplain heath, with few weeds and healthy vegetation. Dieback is evident, particularly upslope north of the pit. A small area in the open woodland is free of dieback. The horse track continues through this community from the eastern edge of the pit.

Marri Woodland (community type 3b)

“*Corymbia calophylla* - *Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain” is recorded on the east and north-east section of the bushland. The community is listed as *Vulnerable* under State legislation, but is not listed by the Commonwealth.

The marri (*Corymbia calophylla*) woodland has an understorey of sedges and balga (*Xanthorrhoea preissii*). It occurs on the lower slopes, covering about 2 hectares in the north-east and a little less than one hectare in the southeast near Hall Road. There are other small patches of marri on the western edge of the bushland near the golf club dam. All is infected with dieback.

The northeast section is in good condition despite significant disturbance, localised weeds and tracks, but retains much of the original structure and the potential to regenerate. Cleared areas for old horse pens have infestations of lovegrass (*Eragrostis curvula*) and require frequent treatment. The track from the pens to the polocrosse field has some localised lovegrass. A healthy, if fragmented, understorey on the eastern side has weeds confined to the tracks and clearings. A severe infestation of watsonia (*Watsonia* sp.) lies in and next to the road reserve. The western part, including the horse pens, is completely degraded in places, but retains patches with fairly healthy understorey. There are many tracks, including two horse tracks passing through the cleared western edge and the woodland on the eastern side.

The smaller marri woodland to the south is in very good to good condition, linked by revegetation in the Paul Robinson Reserve. An area within and near the Paul Robinson Reserve is degraded, with weed infestations and few native plants in the understorey. Immediately south is an area of woodland in very good condition with diverse, healthy understorey, lying on each side of the fence and extending west towards the wetland. The woodland remnant narrows along Hall Road towards the golf course. There are patches of watsonia along the tracks and the fairway edges.

Wetland Heath (community type 08)

“Herb rich shrublands in clay pans” occurs in the southeast of the reserve, originating in depressions intersecting the water table within the Bassendean Dune system. The wetland covers just over one hectare and supports a low closed heath dominated by swamp teatree, *Pericalymma ellipticum*, and *Melaleuca viminea*. The community is listed as *Vulnerable* under State legislation and as *Critically Endangered* by the Commonwealth. It is a Conservation Category wetland, which has implications for management.

The condition of the wetland vegetation is very good to excellent. There is some weed invasion along the western boundary and the artificial drain. This is a low nutrient environment and any increase affects the vigour of the native plants and delivers a competitive advantage to introduced plants.

Other Vegetation

Outside the remnant bushland the natural vegetation is limited to a linear area along the southern boundary plus scattered trees and clumps elsewhere in the southern section. The bushland along the southern boundary is marri woodland on duplex soils, covering about 1.4 hectares. Condition is good, altered by weeds and partial clearing but retaining its basic structure, and could be regenerated.

Small clumps or narrow lines of native vegetation have been retained between the southern fairways, mostly overstorey species with some understorey. This includes some very large trees with significant aesthetic and habitat values. In the basins, native sedges and other wetland plants have regenerated. Some trees have been planted. A small area of sedges occurs between the polocrosse field and Hall Road.

Some local vegetation fringes the equestrian fields and club houses, and there are stands of marri and flooded gums on the eastern edge of the polocrosse field, including some large flooded gums with significant aesthetic and habitat value. At the corner of Hall and Karnup Roads the remnant marris have a scattered understorey. Small groups of marri occur around the equestrian and the golf club rooms.

The northern section was almost completely cleared when the golf course was established and revegetated with mostly non-local trees.

Revegetation has occurred at two sites within and near the remnant bushland, the Paul Robinson Reserve and the decommissioned go-kart track, using a range of mostly non-local species. A high level of weed infestation occurs in both revegetation areas, requiring regular and intensive management. Before local provenance plants (grown from local seed) were available, non-local species were planted to avoid polluting the gene pool. More recent revegetation has used local species. Ongoing fauna studies provide evidence of the value of this revegetation as habitat that links and expands the natural bushland.

A line of swamp mahogany (*Eucalyptus robusta*) separates the equestrian grounds and continues along the southern boundary of the polocrosse field. Trees have been planted along the eastern boundary, including *E. maculata* and *E. robusta*, and some local trees retained. Along the northern edge a line of trees was planted on either side of the cross-country track, river red gums (*E. camaldulensis*), which are now considered an environmental weed. The trees are well established and have significant amenity value. Many saplings occur along the fenceline and the road reserve. There are weedy Victorian teatree (*Leptospermum laevigatum*) plants near horse jumps that can spread into new areas if not controlled.

A range of non-local trees were planted by the golf club between the fairways in the northern section of the reserve, including *Eucalyptus grandis*, *E. robusta*, *E. camaldulensis* and *Pinus radiata*. The local species *Casuarina obesa* was used in the original plantings and more recent revegetation along the northern edge of the course. All of the trees are now very large and well established. Where shallow drains were created between the fairways, some rushes and sedges have become established.

Conservation Listed Flora

The diverse flora within the remnant bushland encompasses three community types and a range of habitats. Four plant species are listed under State legislation as Threatened Flora and are also protected by Commonwealth legislation. The disturbance of Threatened flora requires the permission of the Minister. Seven species on the reserve are listed as priority species by the State. The conservation listed plant species are shown in Table 6.

Table 6 – Conservation Listed Plant Species of Serpentine Sports Reserve

Conservation Category	Species Name
Threatened Flora	<i>Synaphea stenoloba</i> <i>Tetraria australiensis</i> <i>Verticordia plumosa</i> ssp. <i>pleiobotrya</i> <i>Verticordia plumosa</i> ssp. <i>ananeotes</i>
Priority 1	<i>Synaphea odocoileops</i>
Priority 2	<i>Johnsonia pubescens</i> ssp. <i>cygnorum</i>
Priority 3	<i>Acacia oncinophylla</i> ssp. <i>oncinophylla</i> <i>Isopogon drummondii</i> <i>Lambertia multiflora</i> ssp. <i>australiensis</i>
Priority 4	<i>Anthotium junciforme</i> <i>Drosera occidentalis</i> ssp. <i>occidentalis</i>

3.3.3. Fauna

Fauna were surveyed by the Serpentine Bushland Group and Birds Australia. The Serpentine Bushland group conducted fauna surveys in the Paul Robinson Reserve (Table 7). Surveys throughout the remnant bushland in the more intact ecosystems would likely have expanded the fauna list.

Table 7 – Amphibian, Reptile and Mammal Species Recorded in Paul Robinson Reserve (May 2001 – May 2004)

Fauna Group	Common Name	Species Name
Frogs	<i>Crinia glauerti</i>	Glauerts Froglet
	<i>Crinia insignifera</i>	Sandplain Froglet
	<i>Heleioporus eyrei</i>	Moaning Frog
	<i>Lymnodynastes dorsalis</i>	Pobblebonk
Reptiles	<i>Tiliqua rugosa</i>	Bobtail
	<i>Bassiana trilineata</i>	SW Cool Skink
	<i>Hemiergis quadrilineata</i>	Two Toed Earless Skink
	<i>Menetia greyii</i>	Common Dwarf Skink
	<i>Notechis scutatus</i>	Tiger Snake
	<i>Lialis burtonis</i>	Burton's Legless Lizard
	<i>Varanis gouldii</i>	Goanna
	<i>Cryptoblepharus plageocephalus</i>	Fence Skink
Mammals	<i>Ramphotyphlops australis</i>	Southern Blind Snake
	<i>Isodon obesulus</i>	Southern Bandicoot
	<i>Mus musculus</i> *	House Mouse*
	<i>Rattus sp.</i> *	Rat*

*Introduced species

In 1998, a bird survey conducted by Ninox Wildlife Services recorded 18 species of birds within the remnant bushland (Table 8). Three are listed as significant under the *Bush Forever* classification system.

Table 8 – Bird Species Recorded at the Serpentine Sports Reserve (December 1998)

Species	Category of Significance
Common Bronzewing	3
Galah	
Red-capped Parrot	
Port Lincoln Ringneck	
Laughing Kookaburra	
Rainbow Bee-eater	
Shining Bronze-Cuckoo	
Grey Fantail	
Rufous Whistler	
Black-faced Cuckoo-shrike	
Western Gerygone	
Yellow-rumped Thornbill	3
Splendid Fairy Wren	3
Silvereye	
Brown Honeyeater	
Singing Honeyeater	
Australian Magpie	
Australian Raven	

All native animal species are protected throughout the State. However, some species are listed as rare or likely to become extinct, including the Baudin's, Carnaby's and Forest Red-Tailed Black Cockatoos which occur in SSR. These birds are protected under Commonwealth as well as State legislation. The disturbance, or taking, of these scheduled species attracts higher penalties.

The Southern Bandicoot is listed as a Priority 4 species, meaning that it is in need of monitoring. Until 2004, fauna surveys in the SSR regularly trapped bandicoots, including young animals, suggesting a viable population, but the 2004 data indicated a population crash. The reason is unclear, although a harsh summer may have contributed. The surveys indicate that the area is rich in reptile species.

Black Cockatoos have been recorded in the Serpentine area and are known to feed on local species such as marri and banksia. Cockatoo breeding has been recorded on the Swan Coastal Plain. Breeding of black cockatoo species has not been recorded on SSR, but cannot be discounted.

Rabbits are a major problem and need periodical control. Feral cats and foxes have also been observed.

3.3.4. Threats and Pressures

Dieback (*Phytophthora cinnamomi*)

The spread of dieback is a critical threat to much of Western Australia's bushland. Dieback is a disease caused by the water mould *Phytophthora cinnamomi* that affects the roots of many species, usually leading to their death. Susceptible plants include jarrah (*Eucalyptus marginata*), the banksia family (Proteaceae), heath family (Epacridaceae), pea family (Fabaceae), hibbertia family (Dilleniaceae), balga (*Xanthorrhoea* spp.) and zamia (*Macrozamia* spp.). Marri (*Corymbia calophylla*), kangaroo paws (*Anigozanthos* spp.), sedges (Cyperaceae) and rushes (Juncaceae and Restionaceae) are not affected.

The water mould is spread by the movement of water or soil from infected sites, or directly between plant roots. The most common means for transport to new areas is human activities, particularly on vehicles, tyres, shoes and horse hooves (which can pick up divots of soil).

There is no known way to eliminate dieback once it has been introduced. Dieback control therefore involves minimising its spread by controlling the movement of vehicles, people and stock from affected areas into dieback free areas. It is standard management practice to route pathways to avoid crossing boundaries, provide wash-down or other hygiene facilities for vehicles and pedestrians, provide education, and avoid transporting soil and plant material into dieback free areas.:

Phosphite (phosphoric acid), sprayed on vegetation and injected into trees, mitigates the intensity of disease and can delay onset. The SSR bushland is mapped and treated at three year intervals.

Weeds

Introduced weeds pose a significant threat to native plants through competition for limited resources. Weeds flourish in disturbed sites and often out-compete the native understorey. Displacement of native plant species leads to loss of habitat for fauna, but in some cases fauna still use weeds for habitat.

The primary means of controlling weeds in remnant vegetation is to avoid disturbance. The second strategy is to reduce the carriers of weed seed, including horse manure and other introduced materials, and exclude vectors such as storm-water runoff that can introduce nutrients and other pollutants.

Techniques to control the spread of seed and weed plants range from selective seed head removal to physical or chemical plant removal. Large-scale weed control must be integrated with revegetation, otherwise the bare areas will be recolonised by weeds. The control of weeds that provide significant habitat values also needs to be carefully planned and integrated with revegetation.

Fragmentation

Fragmentation is the process of creating smaller disconnected populations of plants and/or animals. Smaller, more disconnected and poorer condition habitats will contain smaller populations with less genetic diversity and less ability to adapt to change. Fragmentation also creates more edges, which are more vulnerable to disturbances. Overall it decreases resilience and sustainability, reducing the chance of long term survival. Management to minimise fragmentation requires the maintenance and/or establishment of buffers and corridors around and among remnant patches of vegetation.

Loss of Rare and Threatened Species

SSR is significant in preserving several species of threatened flora. The locations and health of individual plants need to be regularly monitored, but the State requires that locations not be common knowledge. Any plans for activities that impact on the bushland should be referred to the relevant State agencies for assessment and/or advice. In particular, tracks should be located away from threatened plants, and maintenance of the cross-country track must avoid disturbance to the threatened plants on its edge.

Trampling

Foot, stock and vehicle movement on plant communities causes breakage, root damage and habitat disruption, and if prolonged, frequent and/or intense causes degradation. Management of trampling involves keeping walkers, stock and vehicles on designated tracks, and not creating new tracks.

Erosion

Wind erosion and movement of soil on the walls and floor of the sand pit could erode the surrounding communities and prevent or suffocate natural regeneration. Mulch or brush cover would reduce erosion and provide better conditions for regeneration or revegetation.

Acid Sulphate Soils

The exposure of acid sulphate soils by excavation or lowering the water table results in plumes of sulphuric acid moving through the groundwater, affecting vegetation, particularly wetlands and aquatic communities. The acid reacts with clay to release heavy metals that impact on surrounding ecosystems and can be transported through ground and surface waters. Management of potential acid sulphate soils focuses on avoiding their exposure to air.

Drainage and Drawdown

Lowering the water table affects all plant communities, particularly the wetland community. Groundwater extraction and water course modification requires State Government assessment and approval.

Feral Animals

Feral animals are an ongoing threat to bushland remnants. Rabbits disturb vegetation, limit regeneration, and compete with local fauna. Foxes and cats predate small birds and mammals. Feral rodents such as the house mouse thrive in adjacent properties. Feral honey bees compete with native bees, and take over nesting hollows. Feral animal control relies on a variety of techniques, including trapping and poisoning. Current reserve usage and proximity to populated areas limits management options.

Appreciation, Awareness and Understanding

A lack of appreciation of the importance of protecting biodiversity, and a lack of understanding of threatening processes, undermines good management. Education programs for all users of the reserve could use techniques such as interpretive signage.

Climate Change

To cope with the stresses of climate change, vegetation must remain healthy and support a large and diverse population. This requires careful management of threatening processes, and positive action to increase ecosystem resilience. Climate change is likely to cause a general southerly shift in species distribution. Ecological linkages are essential to enable this movement of species.

Fire Management

Fire is important for stimulating regrowth and regeneration in native ecosystems, but if uncontrolled can damage property and vegetation and cause high fauna mortality. Small remnants are vulnerable to local extinctions from single catastrophic fires which burn the whole area. Reducing the risk of catastrophic wildfire involves maintaining fire breaks and/or controlled burning to reduce fuel loads. Direction on time of year and intensity of burns for vegetation management will be guided by best practice fire ecology.

Fire is important in conjunction with herbicide usage to control weeds. Controlled burns, if necessary at all, should be planned to affect small areas at a time in a mosaic pattern. Specific biodiversity values must be taken into consideration. The Shire's Emergency Services is responsible for coordinating controlled burns in conjunction with Environmental Services in significant local natural areas.

Fire intervals will be determined by fuel load and interval between burns. Only small areas will be burned at any one time, and seasonality of burning will be determined, within safe limits, by best practice fire ecology. Factors such as weather conditions, wind and soil moisture availability will ultimately determine the timing of prescribed burns. A Fire Management Plan for the reserve is presented in Appendix 3.

3.4. Environmental Characteristics: Actions

Table 9 – Environmental Actions for Management of Serpentine Sports Reserve (Short Term actions, Long Term actions, and Business as Usual)

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
Land Resources					
4	Monitor the profile of the sand pit wall, determine whether soil erosion remediation is required, and take action if required.	Medium Long Term	Implemented in Part	Environmental Services	Staff time Funding for erosion action
5	Monitor turf cover, and manage adaptively to meet appropriate targets.	Medium Business as Usual	Ongoing	Parks and Gardens	Staff time

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
Water Resources					
6	Audit water use, prepare a water conservation and reuse plan, and apply best management practices for water use on turf surfaces.	Key Long Term	Implemented in Part	Environmental Services, Parks and Gardens	Staff time
7	Design and implement a water quality monitoring program, including nutrient export targets, and develop and monitor nutrient stripping features.	Key Long Term	Implemented in Part	Natural Reserves Coordinator, User Groups	Staff time Funding for monitoring and nutrient stripping
8	Monitor water quality entering the conservation category wetland, and filter or redirect golf course runoff if water quality exceeds target levels.	High Long Term	Implemented in Part	Environmental Services	Staff time Funding for monitoring and runoff diversion
Fire					
9	Liaise with Emergency Services to prepare/update and implement a Fire Management Plan that prioritises conservation alongside people and property.	High Short Term	Not Yet Implemented	Emergency Services, Environmental Services	Staff time Funding for fire management plan preparation
10	Carry out mosaic burns if any control burning is required, allowing habitat restoration before burning the next area.	Medium Short Term	Not Yet Implemented	Emergency Services, Environmental Services	Staff time
11	Follow up any burning with weed control measures.	High Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for weed control
Dieback					
12	Map and treat dieback every three years, according to best management practice.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for dieback mapping and treatment
13	Adopt and implement dieback hygiene procedures for all users.	High Short Term	Not Yet Implemented	Natural Reserves Coordinator, User Groups	Staff time Funding for hygiene procedures
14	Surface tracks with appropriate materials, as required.	Medium Long Term	Implemented in Part	Natural Reserves Coordinator, User Groups	Staff time Funding for track materials
Weeds					
15	Map and monitor weed distribution, and prepare and implement a weed control program.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for weed mapping and control
16	Minimise disturbance and weed introduction through maintaining the number and width of tracks.	High Business as Usual	Ongoing	Natural Reserves Coordinator, User Groups	Staff time
17	Pick up all traces of manure, bedding and stock feed from all parts of the reserve within 12 hours.	High Business as Usual	Ongoing	User Groups	Staff time Funding for signage
Revegetation					

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
18	Prepare and implement a bushland rehabilitation and revegetation plan.	High Long Term	Implemented in Part	Natural Reserves Coordinator Landcare SJ Inc User Groups	Staff time Funding for revegetation
19	Continue to prohibit use of marri woodland for stock yards, camping and parking, and establish alternative overflow facilities for polocrosse club.	High Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time
Biodiversity					
20	Monitor track width within bushland and adjust access through demarcation and barrier installation as appropriate.	High Short Term	Ongoing	Natural Reserves Coordinator User Groups	Staff time Funding for barriers
21	Review all fencing and replace if necessary with a design that will not form a barrier to wildlife.	Medium Long Term	Ongoing	Natural Reserves Coordinator	Staff time Funding for fencing
22	Identify and protect threatened and priority flora and vegetation communities.	Key Business as Usual	Ongoing	Environmental Services	Staff time Funding for signage
Fauna					
23	Review fauna surveys, gather additional information, and monitor Black Cockatoos' usage of the reserve.	Medium Long Term	Implemented in Part	Environmental Services	Staff time
24	Monitor feral animals and undertake control programs as required, while complying with all safety and accreditation procedures.	High Business as Usual	Ongoing	Natural Reserves Coordinator Landcare SJ Inc	Staff time Funding for feral animal control

4. Social and Economic Characteristics

4.1. Aboriginal Heritage

Local Aboriginal people are part of the Noongar community, whose territory covers the area southwest of a line from Geraldton to Esperance. Prior to European settlement, family groups in the Serpentine region were part of the Whadjug tribe. During the post-European settlement period, forced migration to Aboriginal settlement camps or into areas where labour was required resulted in a shift of tribal groups.

Noongar family groups did not have permanent places of habitation and generally moved along major river systems, such as the Serpentine and Murray, or chains of freshwater bodies. The family groups would camp for short periods of time at favoured points where food and water were reliable.

The water systems are spiritual places for Aboriginal people. Local tradition records that Waugal, the dreaming ancestor, created the Murray and Serpentine river systems. The Waugal is a spiritual force with a physical serpentine manifestation that is widespread throughout the southwest region. Most of the major rivers that drain the Darling Range, and many creeks, springs, pools, swamps and lakes within the Swan Coastal Plain, are associated with the Waugal belief.

The SSR lies on a level to undulating plain, much of which was inundated swamp land during winter. The wetland areas in the reserve would have been a source of food and may have held spiritual meaning for the local Aboriginal people.

The Swan Coastal Plain has a high density of Aboriginal archaeological sites, associated with the richness of food resources. The State government currently has 23 heritage sites registered in the Shire, and an additional 63 sites are not (or not yet) registered. All places and objects of Aboriginal importance are protected by State legislation.

The Serpentine River is listed on the register of mythological and ceremonial sites, and includes a wide buffer to cover all the Aboriginal values in the vicinity. The SSR is within the buffer and therefore formally listed as a Heritage site.

A Native Title Claim currently exists over land including the Shire of Serpentine Jarrahdale, which enables local Aboriginal people to have their rights and interests recognised under Australian law. Administration of the Gnaala Karla Booja Land Claim is being co-ordinated by the South West Aboriginal Land and Sea Council.

To date no formal consultation has occurred with either the South West Aboriginal Land and Sea Council or local Noongar people regarding management of the SSR. A lack of effective consultation with Noongar people and their representatives could lead to poor management decisions, conflict of use on the reserve and the degradation of Aboriginal values.

4.2. European Heritage

In March 1827, Captain James Stirling arrived in the Swan River, and the Swan River Settlement was founded in June 1829. In 1830, Mandurah was established and settlers moved up the Murray River in search of agricultural land. Remnant bushland provides a glimpse of what the settlers encountered.

Explorers also ventured up the Serpentine River, but navigational difficulties delayed settlement. The area was part of a massive 250,000 acre land grant to Thomas Peel, stretching from Wungong to Pinjarra and out to the coast. However, the nature of the land and vegetation, and the availability of good agricultural land elsewhere, ensured that much of the Peel Estate remained in its natural state for many years.

Some small farms, the largest only a few hundred hectares, were established along the Serpentine River below the scarp in 1865. The Serpentine settlement was at the foot of the scarp, about 1 km east of its present location, but in 1893, with the railway almost complete, the present townsite was gazetted.

Major agricultural development occurred with the group settlement scheme in the early 1920s. Land from the Peel Estate was bought by the Government for settlers from England. The sandy soil and persistent winter inundation made the transition to farmland particularly difficult.

A program to drain the group settlement areas began in 1922. Large drains were cut with the aid of horse-drawn carts and finished by hand. By 1925, 540 km of drains had been completed. The drainage network was later expanded, and the administration and management of most of the drains was taken over during the 1950s by the Public Works Department, later to become the Water Corporation.

During the early 1920s, horse racing was held for three or four years on the south section of the reserve, extending over the John Lyster Polocrosse Ground and part of the David Buttfeld Equestrian Park.

In 1925, Lot 778 Karnup Road (the south section) was vested as a reserve for the purposes of Recreation, Racecourse and Showgrounds (R19134). In 1925 R19134 was transferred to the Serpentine Jarrahdale Road Board by the State, and is still owned by Council. The northern section was vested in the Shire as a reserve for the purposes of Recreation and Showground in 1965.

In 1934 the Serpentine Agricultural Show began. The show was originally split between the SSR and the RSL club house, but all show activities were located on the SSR from 1950 and continued until 1960 when the Serpentine Agricultural Society disbanded and the Show was replaced by a rodeo until 1969.

There was a scout and guide camp site at the western end of the bushland near the dam. Some years ago, leaders were asked to move to a more degraded section further south, but the area has not since been used.

The Whittaker's Brothers Timber Company built a steam-driven mill in the southern section of the reserve, where the remains of the go-cart track are located, opening in 1944. Logs were delivered to the mill by trucks from timber leases in the jarrah forest. After milling, the timber was transported to Subiaco and Midland by rail. The railway spur line entered the reserve where the Hall Road entrance is today.

The mill was a major part of the post-war rejuvenation of Serpentine and a major employer, providing jobs for 40 local men. However, in 1964 sawmill technology changed dramatically. Whittaker's Bros. built a new mill in Kewdale in 1964/5, employing only six local men, and the local mill was closed and dismantled. Whittaker's Bros. had built 10 houses and the State Housing Commission 8 duplexes along Lefroy Street for mill employees. Many of these houses are still lived in today.

The SSR was managed by the Greater Sports Ground Committee from 1949. In 1953 the committee became the Serpentine Sportsman's Council, organising events at the reserve and coordinating the development of football, cricket and the equestrian clubs until its lease expired in 1976.

Organised sport began at the reserve in 1947 when the Serpentine Football Club cleared an area for a football field, covering parts of the John Lyster Polocrosse Grounds and David Buttfeld Equestrian Park.

The football club continued to use the grounds until the mid-1980s. In 1963 the local cricket club constructed a pitch on the reserve, which was used until the mid-1980s.

Both polo and polocrosse were played on the SSR, but polo found another site several decades ago. Polocrosse has been played in the district since the late 1930s, introduced by local farmers Jim Henderson and Ivan Elliott and initially played on suitable paddocks, but moving to the SSR in the 1970s. In the 1980s the club became the Serpentine/Foothills Polocrosse Club, using the Ivan Elliott Pavilion and John Lyster Ground, named for longstanding and active members.

The Serpentine Horse and Pony Club was initiated and affiliated with the Western Australian Pony Club Association in 1964 and requested to use the reserve for events and training. They held their first event in 1967 and remain at the reserve today. In 2003 the grounds were named the David Buttfeld Equestrian Park in memory of a Councillor who supported the club and the upgrading of their facilities.

In 1955, the Serpentine and Districts Golf Club (SDGC) was formed with the aim of developing an 18-hole golf course, disbanded in 1958, and reformed in 1967. The first nine holes were constructed by members and competition started in 1972. At this stage, the course was not irrigated. In 1976 holes 10 to 18 were developed on the northern section of the reserve with the assistance of Alcoa.

During 1971 the Serpentine Go-Kart Club developed a high-quality bitumen track on the old mill site, which was used regularly for practice and competition. However, in 1986 the track closed after numerous requests by residents and a public meeting about noise and relocating the facility.

In 1971, the Netball Association began holding competitions on the SSR courts, with lights for night games and a playground. Netball was played at the SSR until the mid 1990s, but the club is now part of the Serpentine Jarrahdale Netball Association which uses alternative grounds.

The Paul Robinson Reserve was named after a Serpentine volunteer fire-fighter who was just 22 when he lost his life fighting a bushfire. Paul Robinson had helped to revegetate the reserve as part of the Landcare and Environmental Action Program. The Serpentine Bushland Group Inc. was actively involved for many years in the Paul Robinson Reserve and other bushland areas, through weed control, revegetation and education. The Serpentine Enviro Group has now taken the place of the SBG.

There are no obvious historical remains on the reserve, but visitor experience could be enriched by signage on site, displays at the local museum, school programs and other publications. The names of buildings and grounds, plus the sawmill site, would provide interesting focal points.

4.3. Recreation

4.3.1. Description

The SSR is a multi-use facility, and is recognised as a hub in the Shire's Equine Strategy, with excellent facilities and the capacity for additional usage beyond the regular user groups and casual bookings.

The SSR golf course is the only course within the Shire, and is important for the whole district. The golfing facilities are well developed, and a small area is leased for a communications facility.

There are five organised groups whose members regularly use the SSR:

- Serpentine and Districts Golf Club Inc. (SDGC);

- Serpentine Horse and Pony Club Inc. (SH&PC);
- Serpentine/Foothills Polocrosse Club Inc. (SFPC);
- Serpentine Enviro Group (SEG) (previously Serpentine Bushland Group Inc. (SBG)); and
- Serpentine Primary School (SPS).

Apart from providing physical health benefits, the clubs provide a way for people to meet others with similar interests, both locally and from other areas. The reserve also has a broader social and environmental function in providing and maintaining bushland areas.

4.3.2. User Groups

Serpentine and Districts Golf Club Inc. (SDGC)

The SDGC was developed and is managed by volunteers. The course has 18 holes with irrigated grass fairways, turf tees and oil-sand greens. The first 9 holes are in the southern section and holes 10 to 18 in the north. The Club leases the land, and is responsible for its management and improvement.

The SDGC was formed in 1955, disbanded in 1958, and reformed in 1967. Members have carried out all of the work to create the course. Holes one to nine were developed by 1971, competitions began in 1972, and holes 10 to 18 were developed with Alcoa in 1976. Irrigation was installed on the fairways of holes one to nine in 1999, and holes 10 to 18 in 2004. Members carry out all maintenance, including mowing and servicing of the irrigation system.

The SDGC has a private membership of between 180 and 200 people, drawn mostly from the local community and adjoining shires, with membership currently stable. Public players are welcome, and with low green fees the course is popular with non-members. The SDGC is affiliated with Golf WA, and linked to national and international golf associations.

The golf course is used all year, but members are more active during the cooler months. Formal competitions are held on four separate days each week for the entire year. A major competition is held during the long weekend in June, and again in November, which attracts around 140 players. There are open days for men and women once a year, which attract 100 to 140 players from over 15 different clubs. The SDGC held the State Sand Green Championships in 2008.

Social clubs from around the metropolitan area use the golf club facilities for the occasional function in a rural setting. Golfers from other clubs also use the course for scheduled fixtures. The clubhouse is occasionally used by the local community for meetings and social events.

The facilities are just adequate for the current use, but a number of issues with size and condition of the clubhouse restrict the ability to cater for additional activities. The club holds a Restricted Liquor Licence that constrains the number of people who can use the clubhouse. Upgrades to facilities would be required to cater for more than 100 people. Improvements occur as materials and funds become available.

The course fairways are generally in very good condition, but with winter drainage problems in some areas. The club has worked over many years to create drainage alternatives with the Shire and Water Corporation to improve outflows. Flooding in the southeast near the wetland has been addressed with drainage reservoirs dug and fairways raised. In the far north of the course work has also been done by the club to mitigate the effects of occasional flooding.

Serpentine Horse & Pony Club Inc. (SH&PC)

The SH&PC seeks to be a leading and innovative pony club. It has been active at the SSR since 1956 and affiliated with the Pony Club Association of Western Australia since 1964. Membership is over 100 riding members, coming from all over the Peel region.

The pony club season runs from February to November and includes a variety of events. The David Butfield Equestrian Park is an irrigated turf surface that was substantially remodelled to improve drainage. The club also uses a national standard 3000 m one day event track, which traverses the bushland and is used three times a year for events and once for training. The dimensions and features of this cross-country course are defined by the Pony Club Association.

One rally for members is held every month during pony club season (10 per year). There are three one day events, three gymkhanas, two dressage testing sessions and up to four closed training sessions for members. These events are very popular, with all open events attracting participants from as far as Geraldton and Esperance. The One Day Events generate a principal income stream for the SH&PC.

Camping occurs three to five times a year, associated with major events, when up to 50 people use the club house and shed facilities.

Serpentine/Foothills Polocrosse Club Inc. (SFPC)

The club has been operating at the reserve since 1986, seeks to be recognised as the leading polocrosse club in the Central Zone and constantly sets new benchmarks when developing its resources and facilities.

The John Lyster Polocrosse Ground is in the northeast corner of the southern section of the reserve. The polocrosse season runs from February to November, although the SSR is not used during the wettest months when the ground is inundated. The ground accommodates four polocrosse fields.

The SFPC has 50 playing members, about one third of whom are juniors under sixteen. Membership has been steadily increasing, and several SFPC members have progressed to State and national teams.

The SFPC hosts three major carnivals during the season, which attract people from as far as Geraldton and Albany. These carnivals run across a weekend and twenty teams, each with six players, participate in the competition. Members practice at least once per week during the season and this includes coaching of individual members.

The polocrosse grounds are of sufficient standard to be used for State and national competitions, and it is the goal of the club to host these competitions in the future. The pavilion provides ample facilities for the club's activities, in particular providing for the training of umpires. Over the longer term, members hope that the drainage problems can be solved so that the grounds can be used year round. The club has put substantial work into improving the grounds, with the latest being the installation of yards and water points.

Overnight camping on-site occurs in association with major events.

Serpentine Enviro Group (formerly Serpentine Bushland Group Inc.)

The SBG formed in response to concern over degradation in the SSR, and in recognition of the unique ecosystem of the banksia woodland. The SBG had a core membership who regularly conducted activities focused on Serpentine's bushland and was aligned with other groups through Landcare SJ Inc. Activities ceased in 2012.

The SBG mainly centred on the SSR, the Lambkin and Bradby Nature Reserves, and the railway reserve. Most of these areas are recognised as regionally significant bushland under *Bush Forever*, and contain State and Federal listed threatened ecological communities and threatened flora.

The SBG's activities included revegetation, fauna surveys, remnant fencing, weed management, and working with school groups. Fauna trapping surveys were conducted in the SSR. The SBG focused on three revegetation projects in and around the bushland, in the Paul Robinson Reserve, the disused go-cart track area, and the sandpit. The SBG was also active in weed control.

The SBG had a close relationship with the Serpentine Primary School. Students and some parents were involved in the fauna surveys, seeding and revegetation projects.

The SBG ceased activities in 2012, and in 2016 the Serpentine Enviro Group was formed with a similar focus. Request from Landcare are carried out in the areas they are focused on, lifting covers, weeding, planting and checking on plantings throughout the year. The SEG has planted in Paul Robinson Reserve and maintained the sites, and also works in Federation Park, Arnold Road, Punrak Road, the Rail Reserve near Leslie Road/Hall Road, and the River end of Baldwin Road.

Serpentine Primary School

The Serpentine Primary School used the SSR as a focus for social, civic and environmental responsibility. The students took measurements of environmental variables between 1996 and 2001 in and around the SSR. The bushland area is an important resource for the school, with the accessibility and variety of environmental values a great asset to teaching and education. The school's last planting day in SSR was in 2014.

Potential Uses

Other uses include a small lease for a communications facility. Organised group recreation has included netball, football, cricket and go-kart racing. Although more activities occurred in the past, the potential for expansion is limited as most sporting groups now use other facilities. There is some potential to involve other community groups in activities on the reserve and to expand its use to include a greater range of organised group recreation activities.

Informal Recreation

SSR offers opportunities for recreation by individuals and small informal groups, for both active uses, such as walking, jogging and companion animal exercise, and passive uses. The pavilion provides a facility for private and community group events. The use of public open space by the community plays an important role in generating a sense of place and ownership.

It is proposed that the reserve be linked to other areas of public open space and bushland through a system of multiple-use trails. An existing trail connects with the southern boundary of the reserve.

4.3.3. Threats and Pressures

Risk Management

Increasing insurance premiums and stricter attitudes to liability have made risk management plans mandatory for recreational facilities and clubs. Even the SEG needs to consider risks like the use of chemicals and snake bites. Formal risk management plans must be developed by each user group in cooperation with the Shire to avoid exposing participants to unacceptable levels of risk.

Membership and Member Involvement

The club committees have a general problem with attracting and maintaining motivated volunteers to fill positions and undertake other tasks. A few people tend to do most of the work. The SEG finds inadequate membership a problem as low numbers limit activities. Individual groups may benefit from reviewing activities to identify the obstacles for volunteers in joining groups or participating more fully in club management. Strategies to overcome these barriers can then be considered.

Conflict Among User Groups

Conflict among user groups can lead to a lack of cooperation in management of the reserve, and conflicts over the use of resources can lead to ineffective use and possibly degradation. The committed volunteers in all user groups are continually defending their interests. This management plan is intended to facilitate broad community input, provide an acceptable level of certainty for all stakeholders, and ensure that Council is fully informed. The Reserves Advisory Group provides a focus for community input.

Flooding

Flooding during winter affects the golf course. The areas worst affected are the first fairway, the southeast corner of the southern section near the wetland, and the most northerly section of the golf course. The first fairway is crossed by a drain which historically backed up and gradually filled in, until works were carried out to improve outflows from the reserve. Players tolerate the flooding, and treat it as a water feature.

Flooding in the southeast corner of the course near the wetland has been mitigated by digging drainage reservoirs and raising the fairways. An increase in capacity of the drain would pose an additional threat to the wetland. Preferably, all water from the golf course should be diverted away from the wetland.

The northern section of the reserve floods occasionally, with water covering fairways 13 and 16, and works have been carried out to mitigate the effects. This land and its surrounds are all low-lying, so drainage off-site is difficult. Proposals to further alleviate flooding at all three sites require assessment of environmental impacts and funding sources.

The John Lyster Polocrosse Ground is generally of a high standard, but poor drainage causes flooding during winter. There is no natural fall that would allow for drainage off-site. The most effective, but expensive, method of improving drainage would be levelling and resurfacing with high quality sand.

Pressure to Exclude Horses from the Bushland

The SH&PC have used the bushland track for many years and has built and maintains jumps along the required 3000 m length. Historical use infers a right to continue using the area, and suggestions for moving the course would leave the club feeling that they have wasted previous investments.

When the cross-country course was first constructed, there was significantly more bushland on the Swan Coastal Plain than there is today. As more remnant bush is cleared, the pressure to preserve what is left has increased. The sustainability of cross-country riding within the bushland area has been debated,

particularly due to the potential for spreading dieback, but the SH&PC has the opportunity to demonstrate that this activity can be carried out safely by monitoring use, impacts and management.

Compliance with Health and Camping Legislation

Both the pony club and the polocrosse club need permission from the Shire for camping on the SSR. Licensing allows the Shire to assess compliance with legislation. It also ensures that the locations used, management of pets, numbers of people per ablution facility, litter and other waste management issues are considered. Participants wishing to stay more than three nights must move to the local caravan park.

Inadequate Parking Facilities

The lack of organised parking areas is a problem. Large numbers of vehicles and floats park in a haphazard manner which results in inefficient use of space and increases the risk of injury. Redesign and construction of car and horse float parking would reduce risks.

Security of Tenure for the Golf Club

Ongoing lease agreements for the golf club are routine. The golf club has been developed and is maintained entirely by volunteers, whose work and the low lease payments enable the course to offer a valuable service to the local community by providing affordable access.

4.4. Infrastructure

4.4.1. Description

The SSR has open space used for active recreation, and an area of bushland. The grounds contain about 39 hectares of irrigated turf, of which 9.5 hectares is used by the Serpentine/Foothills Polocrosse Club (SFPC), 9.5 hectares by the Serpentine Horse and Pony Club (SH&PC), and 20 hectares by the Serpentine and Districts Golf Club (SDGC). The main buildings include club-houses for the user groups, an ablution block, various sheds and a wooden toilet with historical value. Other infrastructure includes fences, gates, drains, dams, an artificial wetland, horse pens, loading ramps and a cross-country trail with jumps.

Turf Surfaces

The central infrastructure for the three active recreation clubs is the turf surfaces. These range from high quality active turf used by the SH&PC to lower quality turf on the golf fairways.

The SH&PC uses the David Buttfield Equestrian Park, which was substantially remodeled to improve drainage and turf quality in 1999. This is now a high quality active turf surface that is well drained and can be used throughout the year. Maintenance is managed by the Shire within water license allocations.

The SFPC uses the John Lyster Polocrosse Ground during summer. The grounds have been modified in attempts to decrease winter waterlogging, but the surface is still very poorly drained. During summer, the turf is of reasonable quality for active use and is adequate for polocrosse. Improving the drainage would make the grounds useable all year. Maintenance is managed by the Shire.

The golf course fairways are a lower quality turf suitable for passive use, while the tees are higher quality. The fairway turf is generally in very good condition. The irrigation system only waters the centre of each

fairway, and the edges become degraded during summer. There are several sections that become waterlogged and sometimes flooded during winter. Flooding occurs next to the wetland, and near the drain across fairway one. In the northern section several fairways are waterlogged for extended periods, particularly numbers 13 and 16. The depression between fairways 12 and 13 was enlarged to create a new dam to reduce waterlogging and provide a backup to the current irrigation dam.

The SDGC maintains its grounds and facilities by volunteer labour plus membership and other fees. Maintenance and improvement of the grounds is a lease condition. The club funded the construction and improvement of its fairways and facilities with the assistance of Alcoa, its members and Shire loans.

Irrigation water is supplied by two bores, used by the golf club to fill their dam and by Shire staff to water the equestrian grounds. All 18 fairways are irrigated by pop-up sprinklers down the middle. The course uses sand greens that do not require watering. Water is pumped from a bore to the dam, and the irrigation system draws water from the dam. The equestrian grounds are watered by in-ground reticulation which connects directly to the bore pump.

Buildings

Eric Senior Pavilion

This multi-purpose building used by the SH&PC is rammed earth with a covered veranda. It has a general purpose hall, a meeting room, a kitchen with kiosk and servery, and an office and commentators' room. The SH&PC has a steel shed near the arena, used to store equipment.

Ivan Elliott Pavilion

Used by the SFPC, this brick building is mostly used for storage, except for a kitchen area and toilets. Waste water and sewage discharge into the Biomax system for the ablution block.

Serpentine & Districts Golf Club Buildings

The SDGC club-house has toilet and change facilities, a kitchen and bar, and a covered patio with barbecue facilities. The club holds a restricted liquor licence which puts constraints on the number of people who can use the clubhouse. Upgrades of conveniences and other facilities would be required to cater properly for more than 100 people. The building is only just adequate for current use, but there are a number of issues with the size and condition of the building that restricts the Club's ability to cater for planned additional activities. Ongoing improvements are carried out by the club as materials and funds become available. The Shire owns the building and funds insurance and some repairs as necessary.

The SDGC has a machinery shed in good condition, made of steel-framed galvanised iron. A small fibro-cement shed houses the irrigation controls and members' buggies. The original toilet from the Whittaker's sawmill has been relocated nearby, in fair condition and made of jarrah boards. Another shed houses equipment, of similar construction to the machinery shed. The SDGC has organised and financed the construction of all of their facilities over an extended period.

Ablution Facility

In 2002 an ablution facility was built of rammed earth and provides toilets and change and shower facilities. The clubs are responsible for cleaning, but maintenance and insurance are the responsibility of the Shire. Waste water is processed by a Biomax alternative treatment unit (ATU) which has a capacity of up to 700 people per day. The discharge area is a fenced row of trees along the Karnup Road boundary. The club-houses, ablution blocks and associated facilities are connected to the mains water supply.

Equine Facilities

Wash Bays

Four sets of wash bays, used to wash and cool down horses after activities, are connected to the surface drainage system. One set of bays is located west of the pavilion near the equipment shed, one on the eastern side near the netball courts, one in the northeast and one on the south of the polocrosse grounds.

Horse Yards

Horse yards have been constructed by both equine clubs near the northern and southern edges of the polocrosse grounds. There are around 60 yards on the south consisting of three sets of 20 yards in double rows, and a similar arrangement of 60 yards on the northern edge.

Stock Ramp

There is a ramp for loading stock west of the SH&PC club-house. It is a double ramp with higher and lower sections made from laterite rock and cement with a gravel surface, and is used to unload horses from trucks. It has historic value as part of the facilities dating from the Serpentine Show.

Cross-Country Track

A cross-country track extends for 3000 m around the edges of the equestrian ovals, through the two revegetation areas, the bushland and the central sandpit. Sections have been surfaced with bluemetals within the bushland and in several other places to prevent erosion, but some continued wear shows as channelling and mounding. There are about 25 sets of jumps, each of which has two or three different heights, totalling about 80 jumps. There is a water jump in the southwest corner of the pony club grounds, which is about 200mm deep. The basin is full in winter and dry in summer, and is filled twice a year for events. The specifications for the course are set by the State Pony Club Association, which must be met in order to retain the event and the substantial income it provides to the club.

Arena

The SH&PC has developed and uses a fenced, surfaced arena located in the northwest of the David Butfield Equestrian Park.

Waste Facilities

The rubbish bins used by the equestrian clubs are stored in a cyclone fencing cage behind the Ivan Elliot Pavilion, adjoining Karnup Road. The cage has a locked gate on either side, storing twelve standard and recycling bins between events. Waste management services and the clubs have keys to the cage. There is a manure bay near the old netball courts.

Gates and Fences

The reserve has about 20 km of fencing. Fences adjoining the golf course along Karnup and Hall Roads and on the southern boundary were replaced in 2002 by the golf club. These fences consist of wooden strainers and steel posts with ringlock and a single strand of barbed wire, and are in good condition. An older fence runs along the western boundary of the golf course and part of the southern boundary, consisting of wooden posts with ringlock, plain and barbed wire. It is in poor to reasonable condition but adequately contains the cattle in the adjoining property. A small section of low cyclone fencing in front of the golf club-house is in good condition. Gates on either side of Karnup Road near the club-house provide access to the northern and southern sections of the golf course.

There are two sets of gates into the equestrian areas on Karnup Road, and another gate on Hall Road provides access to the Paul Robinson Reserve and bushland. Gates to the reserve are padlocked, with keys limited to the user groups, and are in good condition. A pedestrian access point is adjacent to the gate to the Paul Robinson Reserve, consisting of wooden posts. There is a horse maze for equestrian access on Hall Road, constructed when the fence was replaced after a fire.

The fence around the banksia bushland has wooden strainers and steel posts with three strands of plain wire, and was replaced in 2020. There are two gates in the northwest and southeast corners. A fence along the southern edge of the go-kart track and Paul Robinson Reserve separates the golf course from the revegetation.

Other Facilities

Netball Courts

There are two degraded, unused netball courts west of the equestrian facilities near Karnup Road. The bitumen surface is cracked and uneven. Use is currently restricted to intermittent storage.

Signs

There are signs at each entry gate that detail the types of activities that occur on the reserve. There is a “welcome” sign on the corner of Karnup and Hall Roads, and “condition of entry” signs at each of the three entrances along Karnup Road. All are aluminium with non-reflective backgrounds and the Shire logo. Signs throughout the reserve are aluminium or wood, and range in style, age and condition.

Parking Facilities

There are no formal parking areas, with space limited to an informal area near the pony club and golf club entrances with little shade and bare soil surfaces. The equestrian clubs have indicated that the informal parking areas are inadequate and need to be organised more effectively.

Walking Tracks

A number of tracks were created through the bushland and revegetation areas. Many of the tracks through the banksia bushland have been closed and have revegetated well. The SEG is keen to continue rehabilitation and establish a marked walking track through the revegetation areas and the bushland.

Drainage Network

There is an extensive system of artificial drains traversing and surrounding the reserve, as well as an artificial wetland designed to improve water quality.

4.4.2. Threats and Pressures

Building Maintenance

The Shire has an established inspection and maintenance program. Inadequate maintenance would lead to accelerated deterioration and increased risk. Poorly maintained facilities also tend to attract vandalism.

Vandalism and Theft

Vandalism and theft are constant but low-level threats. The design of buildings and other structures should incorporate vandalism-resistant features. Use of tough materials, protection of vulnerable surfaces with resistant barriers, visibly high maintenance, removal of objects likely to be used by vandals, high security and appropriate lighting all decrease the likelihood of theft and damage.

Surveillance is an effective deterrent. The local community is well placed to keep an eye on facilities and report unlawful activities. Community use of appropriate areas for a range of activities is likely to improve security.

Vehicles, including two or four wheel motorbikes, can cause a great deal of damage to irrigation infrastructure, turf and bushland. Stock can cause minor damage to turf surfaces and may also cause a nuisance. Strong fencing and locked gates will exclude most vehicles and stock, while pedestrian access can be maintained through openings with narrowly spaced posts to exclude motorbikes.

Fire Damage

Fire can threaten people, property and conservation values. Prevention and resistance needs to be incorporated into the design and management of buildings, other structures and their surrounds. Fires can start inside or adjacent to buildings and structures, and are often the result of vandalism, kitchen accidents or electrical faults. Bush or grass fires threaten buildings and structures through embers, radiant heat and direct contact.

Cleared areas around buildings limit the opportunity for bush and grass fires to reach them. No flammable material should be stored close to buildings, and gutters kept clear. Strategies to limit the frequency and severity of vandalism will reduce the likelihood of arson. Irrigated turf is unlikely to carry a fire, but a hot fire close to turf areas could produce enough radiant heat to severely damage it. Fire in nearby bushland has the potential to damage infrastructure.

Limited Access to Water

The water allocation is insufficient to maintain 39 hectares of turf in a lush condition. High quality turf is not required for most purposes in the reserve, so an assessment of water use requirements plus minimising evaporation and reusing water will facilitate the maintenance of turf to minimum standards.

Inadequate Car Parking Facilities

During major sporting events, informal car parking arrangements lead to the damage of soil, vegetation, infrastructure and personal property. A clearly marked and structured parking area with a modified surface to prevent erosion would significantly improve reserve facilities. For large competitions, areas for overflow parking need to be designated and clearly marked or directed.

Lack of Designated Camping Areas

During equestrian events that are held over two or more days, participants regularly camp on the reserve. Camping is haphazard, which poses risks to property and campers. Designated event camping areas are limited to turf borders, with low fire risk and (ideally) close to ablution facilities. This minimises impacts on the bush and facilities and improves safety for participants, but degrades turf areas which costs the Shire for maintenance and upgrades. Alternative camping areas are being explored as horse floats and recreational camping vehicles are getting larger and heavier, causing greater degradation to the turf areas.

Winter Drainage

Waterlogging and flooding affect several areas of the golf course and most of the polocrosse ground. Poor drainage can reduce utility and value, by restricting use during certain periods and affecting turf health. On clay soils, poor infiltration and long periods of inundation can lead to secondary salinity. The impacts of waterlogging on turf health can be managed to a great extent by selecting appropriate turf species. Raising the levels of recreation surfaces or constructing alternative drainage and irrigation systems would be dependent on detailed design, feasibility studies, and analysis of needs, benefits and costs.

Community Use of Reserve Areas and Lease/License Arrangements

Fostering community ownership of the reserve has a number of benefits, including surveillance and support for reserve improvements. An increase in ownership could be achieved by increasing usage, encouraging the use of facilities by other clubs and individuals, and by additional facilities that encourage passive and active use, such as interpretive signage. License arrangements with the SH&PC and the SFPC for use of the reserve will be facilitated, linked to the management plan and a Memorandum of Understanding for some ongoing contribution toward reserve management requirements.

4.5. Social and Economic Characteristics: Actions

Table 10 – Social and Economic Actions for Management of Serpentine Sports Reserve
(Short Term actions, Long Term actions, and Business as Usual)

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
Aboriginal Heritage					
25	Establish and implement an effective process for ongoing Aboriginal liaison.	High Long Term	Not Yet Implemented	Environmental Services	Staff time
26	When naming a place, structure or event, give consideration to Aboriginal names.	Medium Long Term	Not Yet Implemented	Environmental Services	Staff time
27	Develop an interpretation plan for the reserve that takes account of Aboriginal heritage values.	High Long Term	Not Yet Implemented	Environmental Services	Staff time Funding for signage
European Heritage					
28	All developments and activities to be documented and archived.	Medium Business as Usual	Ongoing	Natural Reserves Coordinator User groups	Staff time
29	Develop an interpretation plan for the reserve that takes account of European heritage values.	Medium Long Term	Not Yet Implemented	Community Development	Staff time Funding for signage
Recreation					
30	An appropriate application is to be submitted and assessed prior to any event camping.	Key Business as Usual	Ongoing	Environmental Health, Development Services	Staff time
31	Maintain the turf areas at an acceptable standard.	Key Business as Usual	Ongoing	Parks and Gardens	Staff time Funding for turf maintenance
32	Formalise and designate existing tracks and jumps and locations, restrict horse access to demarcated tracks, and require the Pony Club to possess and consult a map showing the designated tracks.	High Business as Usual	Ongoing	Natural Reserves Coordinator User Groups	Staff time
33	Trimming of trees or vegetation may only occur with approval from the Shire and, if required, a State clearing permit..	High Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time
34	Consider and document access issues, and develop and implement an access policy.	High Short Term	Implemented in Part	Natural Reserves Coordinator	Staff time Funding for signage
Infrastructure					

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
35	Estimate the cost for raising the height of the polocrosse ground, and prepare and submit a business case for improvement of the turf area.	Medium Long Term	Not Yet Implemented	Infrastructure Services	Staff time Funding for turf improvement
36	Review potential solutions to flooding on the golf course, and prepare and submit a business case for golf course flooding solutions.	Medium Long Term	Not Yet Implemented	Infrastructure Services	Staff time Funding for golf course flooding solutions
37	Investigate and implement a long-term plan to increase, renovate or upgrade reserve facilities.	Medium Long Term	Ongoing	Infrastructure Services	Staff time

5. Implementation, Monitoring and Review

5.1. Introduction

An implementation plan is provided in this section. Various divisions within the Shire are responsible for implementation and it is anticipated that the actions will be implemented over several years. All actions in this plan are reproduced in a single table below, along with priorities, responsibilities and requirements.

5.2. Priorities and Status

Priorities for implementation of the actions have been classified as follows:

- Key – an essential action for successful management of the reserve (9 actions);
- High – an important action which should be implemented in the short term (15 actions); and
- Medium – a longer-term action (16 actions).

The status of each action has been assessed as Implemented, Implemented in Part, Not Yet Implemented, and Ongoing. In addition, each action has been classified as:

- Business as Usual – an ongoing action that occurs as a matter of course (19 actions);
- Short Term – to be implemented within three years of adoption of the management plan (6 actions); and
- Long Term – a desired action that is funding dependent and may be implemented within ten years of adoption (15 actions).

5.3. Responsibilities, Monitoring and Review

The Shire of Serpentine Jarrahdale is responsible for actions within this plan. In some instances, the Shire may be assisted in implementing an action by a partner who has an interest or responsibility, and there may be opportunities for grants to implement actions. The management plan actions will be monitored and reviewed, and the management plan will be revised if necessary.

Divisions within the Shire with responsibilities for implementation, sometimes in collaboration with Landcare SJ Inc., Fire Brigades, User Groups or Community, are as follows:

- Environmental Services;
- Natural Reserves Coordinator;
- Operations;
- Parks and Gardens;
- Emergency Services;
- Corporate Services;
- Community Development;
- Development Services; and
- Environmental Health.

Requirements are designated as staff time and/or funding, which is dependent on business cases or grants.

Monitoring consists of regular reviews of the implementation of this management plan by an internal working group, which will meet quarterly to review short term actions, with an overall annual review. Additional meetings may be triggered by grant opportunities.

5.4. Implementation, Monitoring and Review Actions

Table 11 – Implementation, Monitoring and Review Actions for Management of Serpentine Sports Reserve (Short Term actions, Long Term actions, and Business as Usual)

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
38	Implement actions according to priority and status, and source external funding for implementation.	Medium Business as Usual	Implemented in Part	Natural Reserves Coordinator	Staff time
39	Monitor implementation of actions through regular reviews.	Medium Business as Usual	Implemented in Part	Environmental Services Natural Reserves Coordinator	Staff time
40	Periodically review the efficiency and effectiveness of management plan implementation and revise if necessary.	Medium Business as Usual	Implemented in Part	Environmental Services	Staff time

5.5. Action Plan

Table 12 – Actions for Management of Serpentine Sports Reserve (Short Term actions, Long Term actions, and Business as Usual)

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
Governance					
Governance					
1	An appropriate application is to be submitted and assessed prior to improvement, development or requests for works.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time
2	Change vesting purpose to recognise “conservation” as a purpose for the southern section of the reserve.	Medium Short Term	Not Yet Implemented	Environmental Services	Staff time
3	Periodically monitor and review leases and licence use of the reserve.	Key Business as Usual	Ongoing	Infrastructure Services	Staff time
Environmental Characteristics					
Land Resources					
4	Monitor the profile of the sand pit wall, determine whether soil erosion remediation is required, and take action if required.	Medium Long Term	Implemented in Part	Environmental Services	Staff time Funding for erosion action
5	Monitor turf cover, and manage adaptively to meet appropriate targets.	Medium Business as Usual	Ongoing	Parks and Gardens	Staff time
Water Resources					
6	Audit water use, prepare a water conservation	Key	Implemented in	Environmental	Staff time

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
	and reuse plan, and apply best management practices for water use on turf surfaces.	Long Term	Part	Services, Parks and Gardens	
7	Design and implement a water quality monitoring program, including nutrient export targets, and develop and monitor nutrient stripping features.	Key Long Term	Implemented in Part	Natural Reserves Coordinator, User Groups	Staff time Funding for monitoring and nutrient stripping
8	Monitor water quality entering the conservation category wetland, and filter or redirect golf course runoff if water quality exceeds target levels.	High Long Term	Implemented in Part	Environmental Services	Staff time Funding for monitoring and runoff diversion
Fire					
9	Liaise with Emergency Services to prepare/update and implement a Fire Management Plan that prioritises conservation alongside people and property.	High Short Term	Not Yet Implemented	Emergency Services, Environmental Services	Staff time Funding for fire management plan preparation
10	Carry out mosaic burns if any control burning is required, allowing habitat restoration before burning the next area.	Medium Short Term	Not Yet Implemented	Emergency Services, Environmental Services	Staff time
11	Follow up any burning with weed control measures.	High Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for weed control
Dieback					
12	Map and treat dieback every three years, according to best management practice.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for dieback mapping and treatment
13	Adopt and implement dieback hygiene procedures for all users.	High Short Term	Not Yet Implemented	Natural Reserves Coordinator, User Groups	Staff time Funding for hygiene procedures
14	Surface tracks with appropriate materials, as required.	Medium Long Term	Implemented in Part	Natural Reserves Coordinator, User Groups	Staff time Funding for track materials
Weeds					
15	Map and monitor weed distribution, and prepare and implement a weed control program.	Key Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time Funding for weed mapping and control
16	Minimise disturbance and weed introduction through maintaining the number and width of tracks.	High Business as Usual	Ongoing	Natural Reserves Coordinator, User Groups	Staff time
17	Pick up all traces of manure, bedding and stock feed from all parts of the reserve within 12 hours.	High Business as Usual	Ongoing	User Groups	Staff time Funding for signage
Revegetation					
18	Prepare and implement a bushland rehabilitation and revegetation plan.	High Long Term	Implemented in Part	Natural Reserves	Staff time Funding for

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
		Term		Coordinator Landcare SJ Inc User Groups	revegetation
19	Continue to prohibit use of marri woodland for stock yards, camping and parking, and establish alternative overflow facilities for polocrosse club.	High Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time
Biodiversity					
20	Monitor track width within bushland and adjust access through demarcation and barrier installation as appropriate.	High Short Term	Ongoing	Natural Reserves Coordinator User Groups	Staff time Funding for barriers
21	Review all fencing and replace if necessary with a design that will not form a barrier to wildlife.	Medium Long Term	Ongoing	Natural Reserves Coordinator	Staff time Funding for fencing
22	Identify and protect threatened and priority flora and vegetation communities.	Key Business as Usual	Ongoing	Environmental Services	Staff time Funding for signage
Fauna					
23	Review fauna surveys, gather additional information, and monitor Black Cockatoos' usage of the reserve.	Medium Long Term	Implemented in Part	Environmental Services	Staff time
24	Monitor feral animals and undertake control programs as required, while complying with all safety and accreditation procedures.	High Business as Usual	Ongoing	Natural Reserves Coordinator Landcare SJ Inc	Staff time Funding for feral animal control
Social and Economic Characteristics					
Aboriginal Heritage					
25	Establish and implement an effective process for ongoing Aboriginal liaison.	High Long Term	Not Yet Implemented	Environmental Services	Staff time
26	When naming a place, structure or event, give consideration to Aboriginal names.	Medium Long Term	Not Yet Implemented	Environmental Services	Staff time
27	Develop an interpretation plan for the reserve that takes account of Aboriginal heritage values.	High Long Term	Not Yet Implemented	Environmental Services	Staff time Funding for signage
European Heritage					
28	All developments and activities to be documented and archived.	Medium Business as Usual	Ongoing	Natural Reserves Coordinator User groups	Staff time
29	Develop an interpretation plan for the reserve that takes account of European heritage values.	Medium Long Term	Not Yet Implemented	Community Development	Staff time Funding for signage
Recreation					
30	An appropriate application is to be submitted and assessed prior to any event camping.	Key Business as Usual	Ongoing	Environmental Health, Development Services	Staff time
31	Maintain the turf areas at an acceptable standard.	Key Business as Usual	Ongoing	Parks and Gardens	Staff time Funding for turf maintenance

No.	Action	Priority & Status	Implementation	Responsibility	Requirements
32	Formalise and designate existing tracks and jumps and locations, restrict horse access to demarcated tracks, and require the Pony Club to possess and consult a map showing the designated tracks.	High Business as Usual	Ongoing	Natural Reserves Coordinator User Groups	Staff time
33	Trimming of trees or vegetation may only occur with approval from the Shire and, if required, a State clearing permit..	High Business as Usual	Ongoing	Natural Reserves Coordinator	Staff time
34	Consider and document access issues, and develop and implement an access policy.	High Short Term	Implemented in Part	Natural Reserves Coordinator	Staff time Funding for signage
Infrastructure					
35	Estimate the cost for raising the height of the polocrosse ground, and prepare and submit a business case for improvement of the turf area.	Medium Long Term	Not Yet Implemented	Infrastructure Services	Staff time Funding for turf improvement
36	Review potential solutions to flooding on the golf course, and prepare and submit a business case for golf course flooding solutions.	Medium Long Term	Not Yet Implemented	Infrastructure Services	Staff time Funding for golf course flooding solutions
37	Investigate and implement a long-term plan to increase, renovate or upgrade reserve facilities.	Medium Long Term	Ongoing	Infrastructure Services	Staff time
Implementation, Monitoring and Review					
38	Implement actions according to priority and status, and source external funding for implementation.	Medium Business as Usual	Implemented in Part	Natural Reserves Coordinator	Staff time
39	Monitor implementation of actions through regular reviews.	Medium Business as Usual	Implemented in Part	Environmental Services Natural Reserves Coordinator	Staff time
40	Periodically review the efficiency and effectiveness of management plan implementation and revise if necessary.	Medium Business as Usual	Implemented in Part	Environmental Services	Staff time

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Appendix 1 – Flora of Serpentine Sports Reserve

Three permanent flora monitoring quadrats were set up in 2008, one within each of the three floristic communities present in Serpentine Sports Reserve, which have been resurveyed periodically since. The species recorded (including introduced weeds) are shown in Table 13.

Table 13 – Plant Species Recorded in Serpentine Sports Reserve

Plant species	Banksia woodland (20b)	Wetland heath	Marri woodland (3b)
<i>Acacia alata</i>			X
* <i>Acacia iteaphylla</i>	X		
<i>Acacia lasiocarpa</i>			X
<i>Acacia pulchella</i>			X
<i>Acacia sessilis</i>	X		X
<i>Acacia willdenowiana</i>	X		X
<i>Adenanthos meisneri</i>	X		X
<i>Agrostocrinum hirsutum</i>	X		X
* <i>Aira cupaniana</i>	X	X	
<i>Allocasuarina humilis</i>	X		X
<i>Amphipogon turbinatus</i>	X		
<i>Anigozanthos manglesii</i>	X		X
* <i>Arctotheca calendula</i>	X	X	
<i>Austrostipa compressa</i>	X		
* <i>Avena barbata</i>	X	X	X
<i>Baeckea camphorosmae</i>	X		
<i>Banksia attenuata</i>	X		
<i>Banksia grandis</i>	X		X
<i>Banksia menziesii</i>	X		
<i>Banksia nivea</i>	X		X
<i>Billardiera</i> sp.	X		
<i>Bossiaea eriocarpa</i>	X		X
* <i>Briza maxima</i>	X	X	X
* <i>Briza minor</i>	X		X
<i>Burchardia congesta</i>	X		X
<i>Caesia micrantha</i>	X		X
<i>Caladenia discoidea</i>	X		
<i>Caladenia flava</i>	X	X	X
<i>Calectasia grandiflora</i>	X		
<i>Calytrix flavescens</i>	X		
<i>Calytrix fraseri</i>	X		
<i>Centrolepis aristata</i>		X	
<i>Chaetanthus aristatus</i>		X	
<i>Chamaescilla corymbosa</i>	X		X
* <i>Cicendia filiformis</i>	X	X	
<i>Comesperma calymega</i>	X		
<i>Conospermum stoechadis</i>	X		
<i>Conostephium preissii</i>	X		

Plant species	Banksia woodland (20b)	Wetland heath	Marri woodland (3b)
<i>Conostylis aculeata</i>			X
<i>Conostylis juncea</i>	X		X
<i>Conostylis setigera</i>	X		X
<i>Corymbia calophylla</i>			X
* <i>Cotula turbinata</i>	X	X	
<i>Cristonia biloba</i>			X
<i>Cyathochaeta avenacea</i>	X		X
<i>Cyathochaeta clandestina</i>	X		
<i>Dampiera alata</i>			X
<i>Dampiera linearis</i>			X
<i>Dasypogon bromeliifolius</i>	X		X
<i>Daviesia nudiflora</i>	X		
<i>Daviesia physodes</i>	X		X
<i>Desmocladius fasciculatus</i>	X		X
<i>Dianella revoluta</i>	X		X
* <i>Disa bracteata</i>		X	
<i>Drosera erythrorhiza</i>	X		X
<i>Drosera gigantea</i>		X	X
<i>Drosera glanduligera</i>		X	
<i>Drosera menziesii</i>	X	X	
<i>Drosera pallida</i>		X	X
<i>Drosera porrecta</i>			X
* <i>Ehrharta calycina</i>	X		X
* <i>Eragrostis curvula</i>		X	X
<i>Eremaea pauciflora</i>	X		
<i>Eucalyptus marginata</i>	X		X
<i>Eutaxia virgata</i>		X	
<i>Gastrolobium capitatum</i>	X		X
* <i>Gladiolus caryophyllaceus</i>			X
<i>Gnephosis angianthoides</i>	X	X	
<i>Gompholobium polymorphum</i>	X		
<i>Gompholobium tomentosum</i>	X		X
<i>Haemodorum laxum</i>	X		X
<i>Haemodorum simulans</i>			X
<i>Hakea prostrata</i>			X
<i>Hakea ruscifolia</i>	X		X
<i>Hakea sulcata</i>		X	
<i>Hakea varia</i>		X	
<i>Hemiandra pungens</i>			X
<i>Hibbertia diamesogenos</i>	X		
<i>Hibbertia huegelii</i>	X		
<i>Hibbertia vaginata</i>	X		
<i>Hovea trisperma</i>	X		
<i>Hyalosperma cotula</i>	X	X	
* <i>Hypochaeris glabra</i>	X	X	X
* <i>Hypochaeris radicata</i>	X	X	X
<i>Hypolaena exsulca</i>	X	X	X
<i>Isolepis cernua</i>		X	

Plant species	Banksia woodland (20b)	Wetland heath	Marri woodland (3b)
<i>Juncus kraussii</i>		X	
<i>Kennedia prostrata</i>	X		X
<i>Kunzea micrantha</i>	X	X	X
<i>Labichea punctata</i>	X		
<i>Lachnagrostis filiformis</i>	X		
<i>Lepidosperma leptostachyum</i>	X		X
<i>Lepidosperma pubisquameum</i>	X		
<i>Lepidosperma scabrum</i>	X		X
<i>Lepidosperma squamatum</i>	X		X
<i>Lepidosperma</i> sp. E Perth Flora	X		X
<i>Leucopogon</i> sp.	X		
<i>Lomandra caespitosa</i>	X		X
* <i>Lotus angustissimus</i>		X	
<i>Loxocarya cinerea</i>		X	
<i>Lyginia barbata</i>	X		
<i>Lyginia imberbis</i>	X		
<i>Melaleuca preissiana</i>		X	
<i>Melaleuca viminea</i>		X	
<i>Mesomelaena pseudostygia</i>	X		X
<i>Mesomelaena tetragona</i>	X		X
* <i>Monopsis debilis</i>		X	
<i>Neurachne alopecuroidea</i>	X		
<i>Patersonia occidentalis</i>	X		X
* <i>Pennisetum villosum</i>		X	
<i>Pericalymma ellipticum</i>	X		X
<i>Petrophile linearis</i>	X		
<i>Petrophile macrostachya</i>	X		
<i>Phlebocarya ciliata</i>	X		X
<i>Pimelea sulphurea</i>	X		
* <i>Poa annua</i>		X	
<i>Pterochaeta paniculata</i>	X		
<i>Pterostylis vittata</i>	X		X
<i>Pyrorchis nigricans</i>	X		X
<i>Scaevola calliptera</i>			X
<i>Schoenus curvifolius</i>	X		
<i>Scholtzia involucrata</i>			X
<i>Senecio hispidulus</i>	X		
<i>Siloxerus humifusus</i>	X	X	
<i>Sphaerolobium</i> aff. <i>Macranthum</i>			X
<i>Stachystemon vermicularis</i>	X		
<i>Stirlingia latifolia</i>	X		X
<i>Stylidium brunonianum</i>	X		
<i>Stylidium calcaratum</i>		X	
<i>Stylidium piliferum</i>	X		
<i>Synaphea</i> sp.		X	
<i>Tetragia australiensis</i>			X
<i>Tetragia octandra</i>	X		X
<i>Tetragia hirsuta</i>	X		

Plant species	Banksia woodland (20b)	Wetland heath	Marri woodland (3b)
<i>Thelymitra crinita</i>	X		
<i>Thelymitra macrophylla</i>	X		X
<i>Thelymitra vulgaris</i>		X	
<i>Thysanotus sparteus</i>	X		
<i>Thysanotus triandrus</i>	X		X
<i>Trachymene pilosa</i>	X		
<i>Tribonanthes australis</i>		X	
<i>Tricoryne elatior</i>	X		X
<i>Triglochin incurva</i>		X	
<i>Tripterococcus brunonis</i>	X		
* <i>Ursinia anthemoides</i>	X		
* <i>Watsonia meriana</i>	X	X	X
<i>Xanthorrhoea brunonis</i>	X		X
<i>Xanthorrhoea gracilis</i>	X		X
<i>Xanthorrhoea preissii</i>	X		X
<i>Xanthosia huegelii</i>	X		
<i>Xylomelum occidentale</i>	X		

*Introduced species (weed)

Appendix 2 – Drainage of Serpentine Sports Reserve

In 1999, a report was prepared for the Shire of Serpentine Jarrahdale by Therese Wade and Jim Elliot entitled *Nutrient, Water and Drainage Management in the Serpentine Recreation Area*. Included in the report are three maps, one of which shows the patterns of drainage and the locations of the Water Corporation drains in the SSR. This map is reproduced on the following page.

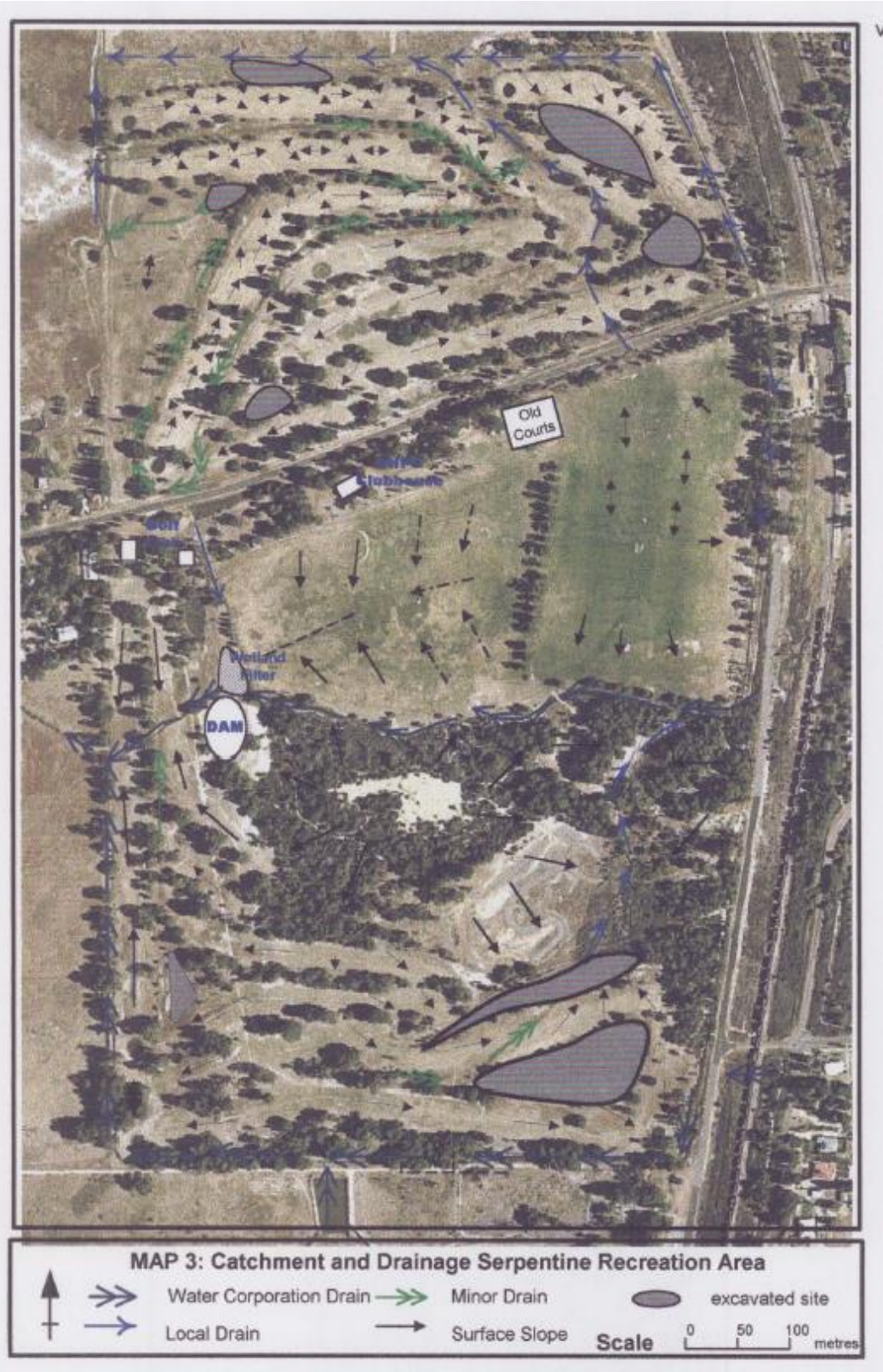


Figure 4: Drainage of Serpentine Sports Reserve (from Wade & Elliot, 1999)

Appendix 3 – Serpentine Sports Reserve Fire Management Strategy

A3.1. Introduction

The Serpentine Sports Reserve in Serpentine is managed by the Shire of Serpentine Jarrahdale. It covers some 70 hectares, of which around 11 hectares is bushland. The bushland has extremely high conservation value.

The challenge for the Shire is to develop an approach to fire risk management that reduces the risk of wildfire without significantly impacting on the biodiversity values of the bushland. Too frequent fires will lead to both a decline in the biodiversity of the reserve and an increase in the extent and density of weed populations, which thrive on disturbance. This in turn would increase the risk of wildfire, as weeds provide an ideal fuel load to initiate and spread a fire. Therefore an essential element of fire risk reduction is effective weed management. A detailed weed management plan has been prepared for this reserve, which includes post fire impacts.

Any strategies or actions applied to this reserve also need to consider dieback management and hygiene.

This report presents strategies for the following aspects of fire management:

1. Fire prevention and preparedness
2. Fire response
3. Fire recovery

There are two attachments which can be used to guide actions undertaken in the reserve:

- The Fire Response Plan
- A schedule of actions to reduce fire risk and support fire response arrangements

A3.2. Fire Management Objectives

Fire prevention and preparedness strategies proposed in this plan have the dual and equal objectives of:

- Protection of life and property, and
- Conservation of Biodiversity

The fire suppression strategies have the overriding objective of “Protection of life and property”, with conservation of biodiversity being considered when determining appropriate tactics.

A3.2.1. Fire Prevention and Preparedness Strategies and Tactics

The Shire of Serpentine-Jarrahdale has a legal and moral obligation to protect the biodiversity values of this bushland as well as the life and property of the community. Managing biodiversity values in an urban setting is a difficult balancing act. The following strategies have been decided on in consultation with Shire Officers.

- Maintain “low-fuel” buffer zones adjacent to conservation areas.

- In vegetation communities outside the buffer zones, fire intervals should exceed 12 years. No prescribed burning to take place in these areas.
- Undertake comparative monitoring of fuel buffer zones and protected zones to determine impacts of fire and other disturbances.
- Use the results of the monitoring to review this strategy after 3 to 5 years.
- Ensure lower densities of future residential developments adjacent to the reserve, including road buffers between houses and bushland.
- Maintain good access into and through the reserve for firefighting crews.
- Maintain firebreaks around the perimeter of the reserve.
- Clean soil and plant material from all vehicles before entering and after leaving the reserve.
- Avoid traversing the dieback (*Phytophthora cinnamomi*) free zone of the reserve, where possible.
- Continue to undertake regular weed control, especially in areas of dense weed infestation.
- Limit opportunities for unofficial vehicles to access the reserve while maintaining adequate access for fire response crews.
- Limit community access to bushland to selected walking paths.
- Review efficacy of all strategies and actions after unplanned fire events.
- Ask neighbours to report any smoke or fires immediately by dialling 000.

A3.2.2. Fire Suppression Strategies and Tactics

- Manage fire suppression activities according to the Incident Control System.
- Contain wildfires to the smallest possible area.
- Consider requesting aerial fire suppression support in preference to risking creating a situation where further clearing or disturbance of the bushland is necessary.
- Do not use water containing additives to assist in fire control (foams, wetting agents, retardants) through the bushland area. The volunteer fire brigades will be advised that Serpentine Sports Reserve is a 'NO FOAM ZONE'.
- Consider biodiversity impacts in deciding on fire suppression tactics so that the damage caused does not exceed the values protected.
- Prioritise objectives and reassess with weather changes.
- Consider evacuating residents and closing roads if fire intensity necessitates. Request police assistance for such actions.
- Avoid creating new fire breaks, unless essential. Particularly, avoid traversing the dieback (*Phytophthora cinnamomi*) free area.
- Maintain all vehicles free of soil and plant matter. Clean down all machinery before moving to other areas.
- Ensure adequate mop-up and control actions.

A3.2.3. Fire Recovery Strategies

- Conduct post fire reviews to assess causes of wildfire and conduct during suppression activities.
- Implement targeted and focussed weed control after burns.
- Spread local seed if appropriate and available in highly disturbed areas where large bare patches may exist following recovery of native plants after fire.

A3.3. Fire Management Zones

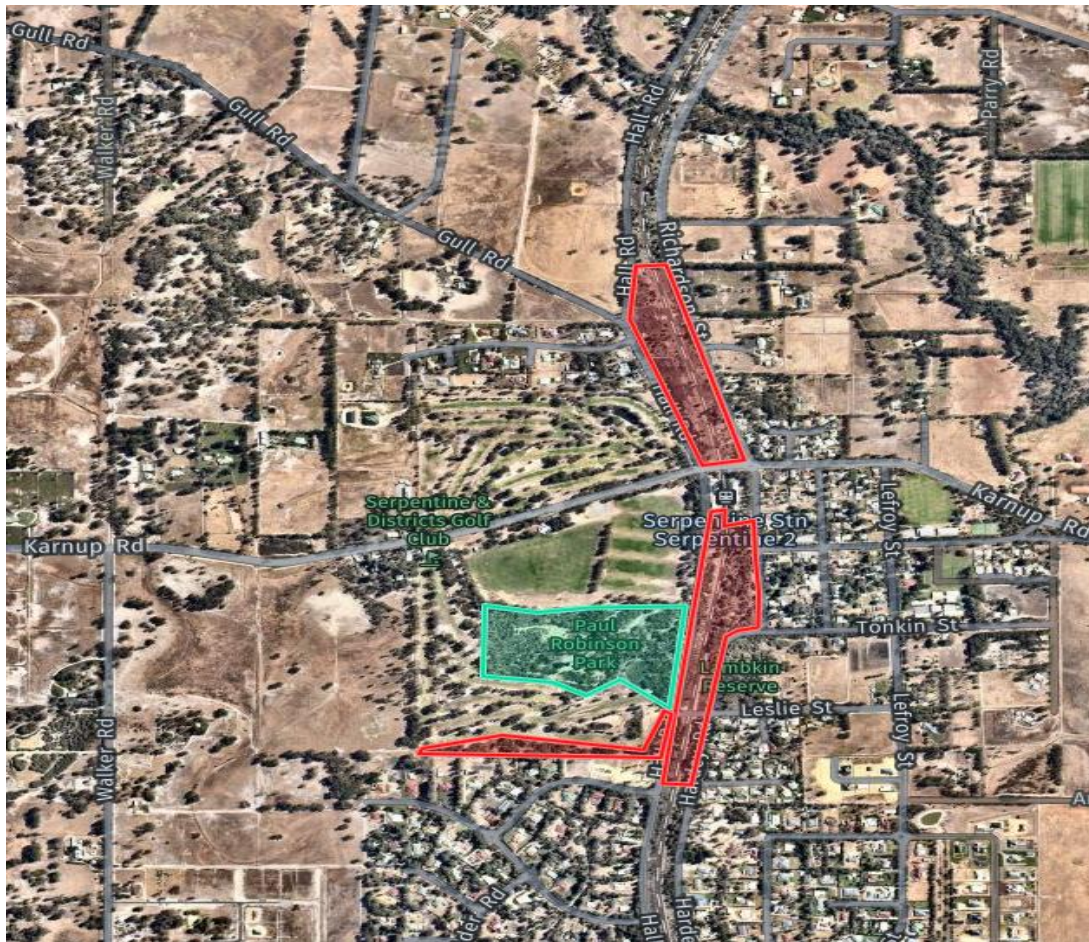


Figure 5 – Fire Management Zones (Fire Buffer Zones shaded in red and Scientific Reference Zone in Green)

Vegetation Management Zone (Fire Buffer Zone) – Areas that will be managed by maintaining lower fuel levels through the use of a combination of hazard reduction burning prescriptions and weed control

Scientific Reference Zone (No planned burn) – areas where there are no current prescription burns planned so comparisons in the vegetation can occur

A3.4. Fire Management Schedule Of Works

Action	Responsibility
Undertake controlled, mosaic burns in buffer zones with the timing to be determined by combination of fuel loads exceeding 8 to 12 tonne per hectare and years since last fire.	Public Transport Authority of WA
Gates to be kept locked and keys provided to combat agencies.	Fire and Emergency Services Officer & Natural Reserves Coordinator
Collect seed from native plants in the reserve and store appropriately.	Natural Reserves Coordinator / Landcare Officers
Spread reserve-sourced seed in disturbed areas (especially areas of high weed infestation) prior to controlled burns or after major unplanned fires.	Natural Reserves Coordinator
Continue the bi-annual program of weed control to reduce the extent and density of weed populations with emphasis on the aggressive weeds.	Natural Reserves Coordinator
Schedule weed control activities and revegetate at appropriate intervals after fires.	Natural Reserves Coordinator / Landcare Officers

A3.5. Fire Management Response Plan

Description	Location	Serpentine Sports Reserve		
	General	Maintained golf course, Equine facility and bushland		
	Terrain	flat		
	Fuel	Tree Grass Scrub		
Values at risk	➤ Power poles	➤ Golf club	➤	
	➤ Fences	➤ Polocrosse club	➤	
	➤ Pony club	➤	➤	
Hazard Identification	➤ LV power lines	➤	➤	
	➤ Karnup Road	➤	➤	
	➤ Public Place	➤	➤	
HMA	Department of Fire and Emergency Services			
Controlling agency	Shire of Serpentine Jarrahdale			
Incident control point locations	Level 1 & 2	Primary	Karnup Road x Hall Road	ESD 490 F-13

	Level 1 & 2	Alternative	Serpentine BFB – Karnup Road				ESD 490 H-13	
	Level 3	Primary	Mundijong BFB – Cockram Street Mundijong				UBD 471 N-4	
Mobilisation	Fire Danger Rating	Catastrophic			Three BFB's, shire CBFCO, Or shire DCBFCO.			
		Extreme						
		Severe						
		Very High						
		High			Serpentine BFB.			
	Low/Moderate							
Note 1:- Fixed/rotary wing water bomber turnout is only available during the contracted period and is subject to availability.								
Note 2:- When making recommendations for back up resources to the incident controller, Heli/Air attack supervisors should take into consideration assets at risk, fuel types and water penetration requirements.								
Access	Roads	Karnup Road, Hall Road						
	Gates	Type 1						
	Padlocks/Keys	N/A						
	Firebreaks	Firebreaks are maintained in accordance with Council's Firebreak Notice, i.e. 3m trafficable surface with 4m trimmed vegetation.						
Communication Plan	MSE1	40/221	360-365	46-49	MSE2	36/139	360-365	46-49
Communications		ComCen	ComCen	BFB	BFB	PAW	Paw	
		6IP	6AR	Duplex	Simplex	Duplex	Simpex	
	WAERN	220	371	139	360-365			
				221				
Mid-Band	55	80	36	46-49				
			40					
Public Assembly Areas	Serpentine Oval Karnup Road Serpentine – ESD 490 I-13							
Water points	Air Support	Spencer road Dam				ESD 490 O-10		
		Elliot Road dam				ESD 519 N-10		
	Ground Crews	Lot 103 Hall Road				ESD 490 G-12		
		Lot 112 Wendowie Pl				ESD 490 H-12		

A3.6. Environmental Advice

Phytophthora hygiene

All vehicles and machinery are to be "clean" prior to entering into reserves. "Clean" means free from clods or collections of soil and plant material. Particular attention should be paid to the undercarriage and

mudguards of light vehicles and trucks and to belly plates, buckets, rakes and tracks of heavy plant. This may entail wash-down or brush-down at the entrance to the reserve, or alternatively wash-down at a formal wash-down point prior to arrival at the workplace.

Weed Hygiene

Prevent the introduction and spread of weeds by keeping machinery clean and not moving soil from weed affected areas to non-affected areas.

Protection of Threatened Flora and Threatened Ecological Communities

Caution is required when constructing fire breaks in the vicinity of known populations of rare flora, known Threatened Ecological Communities, and habitat of threatened fauna species. It is preferable for a population of Threatened Flora or a Threatened Ecological Community to be burnt than to be damaged by machinery.

Protection of soil, vegetation and habitat disturbance

Use existing breaks/tracks to contain the fire where possible.

Avoid damage to known rehabilitation sites.

Protect mature trees alongside internal tracks to prevent falls over track.

Use of fixed/rotary wing water bomber

Water containing additives to assist in fire control (foams, wetting agents or retardant) should not be applied on, or near, riparian zones around watercourses including wetlands.

Check and confirm if the status of the area is wet or dry.

Use of Appropriate Machinery

Consider smaller machines or rake trails in environmentally significant bushland areas.

Clear firebreaks to minimum suitable width, taking into account fire behaviour, vegetation type, and resources available.

When using earthmoving equipment for fire suppression, avoid unnecessary clearing and minimise environmental impacts.

Contacts	Agency	Position	Phone
	Shire of Serpentine Jarrahdale	SJ Chief	0409 080 778
		Natural Reserves Coordinator	0488 572 946
	Department of Fire and Emergency Services	ComCen	9395 9209
		Media Alerts and Warnings	0427 479 499
Parks and Wildlife	South Coastal Region	9405 0700	
Recommended Suppression Strategy	Work to contain the fire using only existing mineral earth tracks. Use aerial suppression platforms to decrease forward RoS and deploy ground crews to suppress the fire as it burns out to tracks. Defensive strategies such as RUI firefighting are to be used where fire behaviour is extreme in order to protect vulnerable assets indicated on map and adjoining properties.		



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