

Scrivener Road Gravel Reserves Draft Management Plan

Draft 1d (Amendments from version 1c are underlined in the text)
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1. Executive Summary

1.1 Introduction

Scrivener Road Gravel Reserves (also referred to as 'the reserves'), located at the top of the scarp south of Serpentine, are biodiverse and environmentally significant local natural area reserves, particularly valuable as they are one of only a few locations where all three protected black cockatoo species have been recorded nesting. The reserves are managed by the Shire of Serpentine Jarrahdale for the purpose of gravel and conservation and it has been recommended that the Scrivener Road Reserves eventually be added to the Serpentine National Park. Gravel supplies from the existing pits have been exhausted, and permission has not been granted at the current time to clear further areas of vegetation to extend the pits. Recently the Shire has been purchasing gravel for road construction from distant expensive sources. It is now supported more widely by State government agencies such as the Department of Mines and Petroleum that available gravel reserves are utilized before areas are included into national parks subject to the creation of value adding rehabilitation offsets. The Scrivener Road Gravel Reserves area is recognised as a Regionally Significant Basic Raw Material location for gravel. The Government of Western Australia, Office of the Environmental Protection Authority also supports the concepts of rehabilitation and the inclusion of the reserves into the Serpentine National Park.

1.2 Objectives

Information for a management plan for the Scrivener Road Gravel Reserves was collated in 2008. This information has been incorporated into this management plan. The objectives of this management plan are to:

- Provide the necessary background information and site descriptions for informed management of the reserve;
- Provide a plan for including the reserve into Serpentine National Park following mining and progressive offset rehabilitation;
- Define specific management objectives for maintaining and improving the conservation values of the reserves:
 1. Assess higher conservation value areas as part of scientific reference buffer areas;
 2. Assess the vegetation quality and potential for rehabilitation;
 3. Assess the major problems affecting safety, aesthetics, fire management and weed control;
 4. Assess the types and degree of environmental degradation and possible ways to address these; and
 5. Provide plans to follow when mining, processing, stockpiling and rehabilitating Scrivener Road Gravel Reserves;
- Document the actions required to successfully enhance and manage the reserves;
- Identify any management constraints and possible ways to overcome them;
- Ensure continuity of management in the future, so that the goal or focus is clearly defined and easy to follow; and
- Provide the community with the opportunity to become involved in the decision-making process for the reserve.

1.3 Location and Description

The Scrivener Road Gravel Reserves are located at the top of the scarp south of Serpentine, and consist of two reserves, R26080 and R26079. R26080 contains the two historical gravel pits and is divided into three parcels of land, two of which adjoin Scrivener Road (L1913) while the third lies to the south (L2272). R26079, to the southwest of R26080 also consists of three parcels of land, dissected by Firms Road (see Figures 1 - 3). The reserves adjoin Serpentine National Park to the west and east, and Karnet Nature Reserve to the south.

Two tributaries of the Serpentine River run to the north and west of the reserve; the river empties into the Peel Harvey Estuary. The total area of the two reserves is approximately 120 hectares.

1.4 Report Structure

The report is structured into the following sections:

- Legislative and policy framework (Governance):
 - *Identifies the existing tenure, legislation and policies that apply and therefore have management implications for the reserve.*
- Physical and biological characteristics (Environmental):
 - *Identifies landform, land, water and biodiversity features of the Study Area. Threats to these features have also been considered.*
- Cultural and social characteristics (Social and Economic):
 - *Identifies the main human land uses of the Study Area, with consideration given to issues such as historical current and future land uses, access, scientific interest and heritage.*
- Implementation:
 - *Provides guidance to Council and the community on implementation mechanisms for each management action and priorities, responsibilities and potential costs and partners.*

1.5 Community Workshop and Key Priority Actions

A Community Workshop was held on the 17th September 2015 from 7:00 pm till about 9:00 pm at Saint John's Hall in Serpentine. The workshop was facilitated by the Shire of Serpentine Jarrahdale staff and in attendance were about 30 people.

The planning process for the preparation of draft and final management plans was discussed in terms of its transparency and opportunity for public participation in the planning process. The participants were informed that a Summary of the Proceedings of the Community Workshop would be emailed to all participants and email addresses of the participants were gathered. The Black Cockatoo Species protected under the federal EPBC Act legislation were discussed along with the research and monitoring carried out by the Western Australian Museum over the last 15 years. The involvement by the Serpentine Jarrahdale Landcare and their 8 "cockatubes" in the Scrivener Road vicinity currently were discussed in terms of additional "cockatubes" being installed in addition to offsets of rehabilitation focusing on Black Cockatoo feeding habitat plant species.

The history of not being successful with finding alternative sources of gravel either on private property or in other Department of Parks and Wildlife managed lands was discussed. The turnaround by the Department of Parks and Wildlife for supporting a management plan approach for facilitating offset revegetation associated with gravel extraction and in other areas in the Scrivener Road Gravel Reserves was also discussed.

The Workshop then moved into a brainstorming session identifying issues associated with values followed by threats and opportunities:

Values and Issues Associated with the Scrivener Road Gravel Reserves gravel extraction proposal:

- Loss of habitat.

- Dust management.
- Compatibility and Revegetation.
- Buffer Zones to private properties.
- Run off and tunnel erosion.
- Noise.
- Working days. Will this include weekends?
- Road Safety.
- Will the road be upgraded prior to mining (timing).
- Use of the gravel within shire only.
- Water Management.
- Spread of dieback.
- Timber Ownership.
- Change to ground water.
- Cost benefit analysis.
- Alternatives to Gravel.

Order of Priority was not considered appropriate in this case with the participants considering that all issues are a high priority to be addressed. Although letters were sent to adjacent landholders, a number of residents in the general vicinity of the area who will be effected by the proposal did not all receive notification of the proposal so participants considered that the public submission period should be extended for a longer period.

Questions were also recorded during the proceedings.

Q: Should the Shire do more surveys to see animal activity?

This will be done as part of the Fauna Survey requirements of the Department of Environment Regulations conditional to any possible clearing purpose permit being received.

Q: Is the Shire going to upgrade Scrivener Road and if so when? What are the time frames?

The Shire and the elected members are taking this into consideration in the context of budgetary review processes.

Opportunities were discussed - many local residents expressed preference for the existing vegetation and the existing road to any revegetation in the area and road upgrade

- DPaW support offset rehabilitation so the reserves can become more worthy of adding to the Serpentine National Park
- Scrivener Road possibly getting upgraded before any operation may commence was expressed.

Threats associated with the Scrivener Road Gravel Reserves gravel extraction proposal:

- Disruption to way of life.
- Road Safety (truck traffic).
- Cockatoos and other fauna.
- Environmental damage created from road widening.
- Financial Risk to the Shire and Ratepayers.
- Risks associated with an already dangerous road.
- Truck arrester bed would be needed.
- Contractor compliance.
- Hydrological impacts.
- Dieback spread.

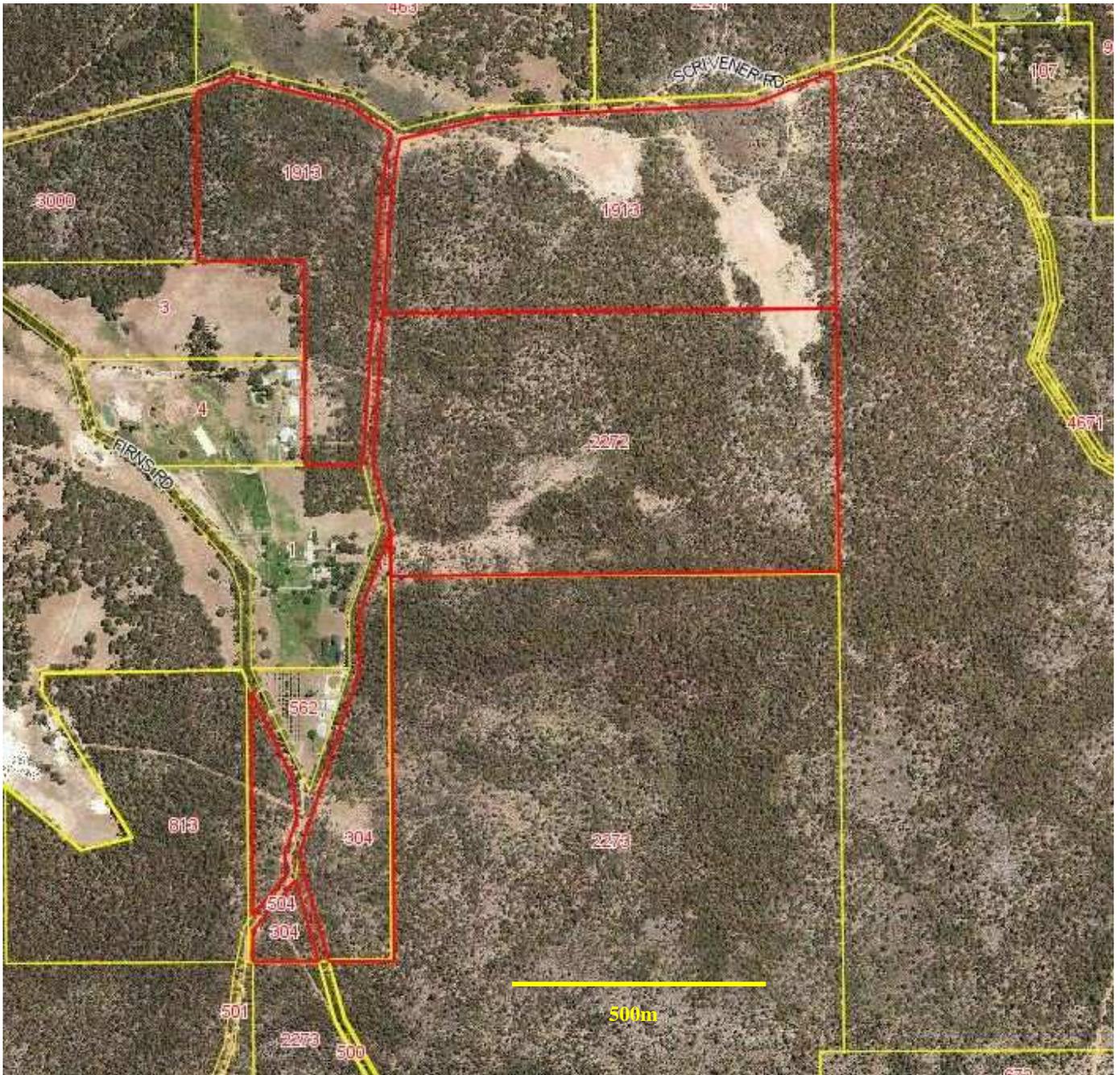
Requests and Commitments:

Black Cockatoo publications from the WA Museum Researchers were emailed to the workshop participants. An extension on the submission date deadline from the 30th of September 2015 to the 31st December 2015 was discussed. This was granted based on the length of time the State government allows for public submissions on the management plans and the number of people who have only recently become aware of the opportunity to provide comment on the draft management plan. This will also provide an opportunity for the Shire to more comprehensively address values, threats opportunities and issues raised at the Community Workshop. In addition to the Draft Management Plan currently included on the Shire's website, there will be a number of updated Figures and Appendices included with the final management plan.

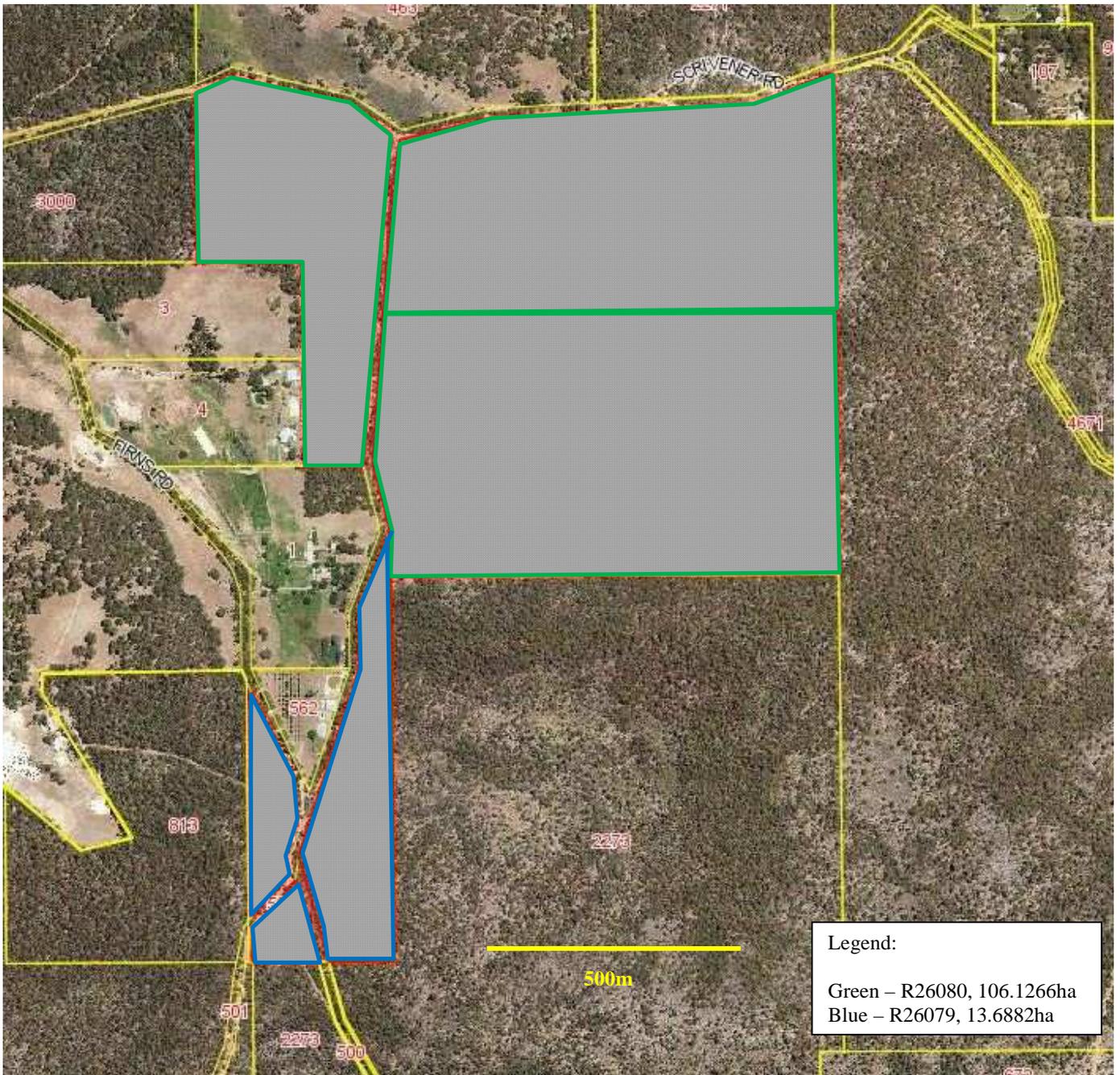
Key Strategies of the Scrivener Road Gravel Reserve Draft Management Plan follow:

- Rehabilitate the reserves in accordance with the approved management plan, manage the reserves with an additional management purpose for conservation, add this purpose to the management orders to each of the reserves and plan and progress staged gravel extraction and rehabilitation through clearing application and offset provisions.
- Implement the approved Water Management Plan through monitoring water erosion including in-stream structures to assist in slowing down water velocity.
- Prepare and monitor the implementation of the Operation Management Strategy, Heritage Survey, Dust, Noise, Dieback, Cockatoo Habitat and Other Fauna and Transport Management Plans.
- Conduct annual audits and improvement works for meeting management plan targets and maintaining appropriate surface water management standards.
- Monitor the establishment of plant communities in meeting the completion criteria and review supplemental planting requirements as necessary.
- Review annually and implement a Weed Control Plan that maps and identifies weed species within the reserve, and identify target areas and appropriate techniques and strategies to reduce weed density and weed seed sources in the gravel pit and surrounds.
- Seek approval for a Fire Management Plan in conjunction with the Department of Parks and Wildlife. Ensure any prescribed burning in the reserve conforms to the Fire Management Plan.
- Control access through the provision of gates, barriers or trenches to the reserve's pit area.
- Report before the end of each financial year to the Reserves Advisory Group, Department of Environment Regulation and Department of Parks and Wildlife on fauna species contacts and rehabilitation offset plantings accompanied by a completion criteria, description of the planting, the number of plants and the species composition, structure and density.
- Refer the proposal to State government and the Federal Department of Sustainability, Environment, Water, Population and Community (SEWPaC) for their consideration.

Map 2: Scrivener Road Gravel Reserve Outline



Map 3: Scrivener Road Gravel Reserve Sections



2. Governance

2.1 Vesting

Scrivener Road Gravel Reserves are vested with the Shire of Serpentine Jarrahdale for the purpose of gravel. Owing to the biodiverse flora and significant fauna communities inhabiting the reserves, it is recommended that the vesting be changed to include conservation as a purpose for the reserves and eventually inclusion into the Serpentine National Park following further mining and rehabilitation offset provision.

Table 2: Scrivener Road Gravel Reserve Characteristics

	R26080			R26079		
	L1913 west	L1913 east	L2272	L304 north	L304 south	L303
MRS Zoning	Parks & Recreation					
TPS Category	Not within TPS2					
Lot Type	Crown Reserve					
Native Vegetation ID	1905	1905	1905	993	993	993
Bush ID	6931	6931	6931	6931	6931	6931
SWBP	PSLNA	PSLNA	PSLNA	PSLNA	PSLNA	PSLNA
Reserve Class	C	C	C	C	C	C
Heritage Features	No	No	No	No	No	No
Landscape Protection Policy Draft Area	Yes	No	No	No	No	No

2.2 Land Tenure

The land tenure and vesting purpose of the several sections of Scrivener Road Gravel Reserves (as shown in Figures 1 - 3) are shown in Table 3. Conservation is proposed to be added as a reserve purposes for each of the Scrivener Road Gravel Reserves.

Table 3: Scrivener Road Gravel Reserve Locations and Uses

Reserve Name	Reserve Number	Area (ha)	Land Transfer Date	Purpose	Current Use
L1913 west	R26080	18.5252	1961	Gravel	Conservation
L1913 east		37.3095	1961	Gravel	Conservation
L2272		50.2919	1961	Gravel	Conservation
L304 north	R26079	9.6619	1961	Gravel	Conservation
L304 south		1.4076	1961	Gravel	Conservation
L303		2.6187	1961	Gravel	Conservation

2.3 History

Prior to reservation with the Shire, Scrivener Road Gravel Reserves were part of the State Forest, and historically harvested for timber and managed for various uses. In 1961, the reserves were vested with the Shire of Serpentine Jarrahdale for the purpose of gravel. Two gravel pits were

established, and the extracted gravel was used for the Shire's road construction, road maintenance and upgrading of the existing road network.

In 1995, the Western Australian Planning Commission granted planning approval for the extraction of gravel for a period of 10 years. By 2003 it was evident that the two existing pits would soon be exhausted. In 2006, extraction and crushing operations from the floor of the pits occurred, and the gravel was stockpiled for later use. An application to clear 2.3 ha of vegetation between the existing pits for the further extraction of gravel was refused, and the Shire was informed by the State that operations at the reserve must cease until which time as a management plan could be put into place.

The reserves have been identified for future inclusion into the Serpentine National Park, in a number of important forest management and planning documents. The proposed inclusion was investigated to be in exchange for another area suitable for the extraction of gravel, with the resource to be of similar volume and condition. An area off Admiral Road was offered but considered to be unsuitable due to its smaller area and volume of resource. No other reserves have been identified or offered for gravel extraction, no areas of private property are available for lease, and in 2015 the Shire is obtaining gravel from distant locations, entailing considerable transportation costs.

From 2001 to 2007, the Shire provided funding to the Western Australian Museum for the purpose of cockatoo monitoring on the reserves. Scrivener Road Gravel Reserves is one of only a few areas where all three species of threatened black cockatoos have been recorded nesting, and as such is highly significant for their conservation. More recently, artificial nest boxes (cockatubes) have been installed at the reserves by SJ Landcare Inc in numerous locations.

2.4 Bush Forever

The reserves have not been recognised as regionally significant through Bush Forever, as they lie outside the area considered for Bush Forever status; they are not known to contain threatened or priority flora, although two threatened and one priority species have been recorded within the adjacent Serpentine National Park. Local government and State government flora surveys have occurred in this area and the local government flora survey results are included in the Appendices of this management plan. There are records of threatened and priority fauna (black cockatoos) nesting within the reserves, quenda (priority 5 fauna) are likely to occur in the area, and chuditch (priority 1 fauna) may occur in the national park.

3. Environmental Characteristics

3.1 Physical Features

3.1.1 Land

Description

The soils of Scrivener Road Gravel Reserves are part of the Darling Plateau system, consisting of lateritic soils and gravels (Table 5) and represent the remnants of an ancient soil horizon developed on the granites and gneisses of the Western Gneiss Terrane that underlie the area. The typical profile of the deposit is a grey brown sand loam soil over yellow brown pisolitic gravels and laterite cap rock of up to 5 metres thick. Under the cap rock lies 1-2 metres of gibbsite (aluminium hydroxide) which in turn overlay variable depths of clay typically 10-20 metres thick. The clay is mottled red, yellow and brown in the upper region, but white below the water table nearer the granite basement. The ferricrete raw material is a combination of the gravels, lateritic cap rock and gibbsite layers. This soil and the Mediterranean-type climatic zone both influence the dominant vegetation types in the area.

The Darling Plateau is ancient. The basement rocks are around three billion years old and are deeply weathered in the upland areas and eroded along the western edge. The part of the Plateau lying within the Shire boundaries has an elevation of between 250 and 350 metres above sea level. The reserves rises from 248 metres in the northwest to 318 metres in the southeast. The western edge of the plateau drops away steeply to meet the coastal plain at about 60 metres above sea level.

Table 5: Landform and Soil Classifications

Geomorphic Region	Soil Landscape Zone	Soil Landscape System	Soil Group
Darling Plateau	Western Darling Range	Darling Plateau	Dwellingup 2
		Murray Valleys	Yarragil 1

The Darling Plateau and Scarp

The Plateau is part of the Yilgarn Craton, one of the oldest landscapes in the world, with basement rocks of granite and gneiss with some dolerite intrusions. The granitic rocks have been extensively weathered into laterite formations, and the less eroded parts of this landscape usually have gravel in the surface profile.

The Plateau is a gently undulating land form. The gently undulating upland soils belong to the Dwellingup Subsystem, and consist of well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands over the weathered laterite base. The colluvial soils of the river and stream valleys and surrounds belong to the Murray Valley System which includes the Helena, Murray and Myara subsystems.

Condition and Status

The condition of the land through most of the plateau is good to excellent, as vegetation cover of the forest and woodland has been retained. Most of this area is managed as State Forest, water catchment or for conservation purposes.

Along the Scarp, areas of the slopes have been cleared for agricultural use, mining, quarrying and rural and residential use. This has exposed the land surface to wind and water erosion, and led in some areas to loss of sediments, nutrients, organic matter, and soil water retention capabilities. Impacts to soil have resulted from overly intensive grazing, inappropriate excavation, landfill and machinery use.

Major Threats and Pressures

Poorly managed human activities can lead to degradation of the soils. The range of degrading processes include phosphorus (and other nutrient) export, water and wind erosion, secondary salinity, soil structure decline, subsurface acidification, waterlogging and flood. Land degradation is a result of a complex interplay between land and soil properties and their management. Good land management requires a range of highly developed knowledge and practical skills. Excavation for extraction of gravel can cause degradation and significant alteration of the soils. Inappropriate access by vehicles and motorcycles to the gravel pit area can also introduce weeds and disease and can cause further land degradation to vegetation. Further extraction of gravel can also spread and intensify dieback impacts so hygienic mining operations and a commitment to a Dieback Management Plan are critical along with up to date dieback surveys.

Erosion

Erosion is the removal of topsoil, and in extreme cases (often including along fire breaks), deeper layers of the soil profile by the action of water or wind. This means a permanent loss of part of the land asset. The risk of erosion depends on the stability of the surface soil, often affected by the amount and type of vegetation cover (such as native perennial, pasture annual, or pasture perennial) and the force of the wind or water moving across the surface. Water speed is largely determined by slope, although level areas may be affected by water flowing from adjacent land. Water erosion is an accelerating process, as bare eroded areas generate more surface runoff, increasing the volume and speed of water movement downslope. Bare areas such as the slopes and floors of gravel pits can also be at risk of erosion and it is critical with any further extraction rehabilitation methodology that a minimal footprint area is maintained along with good water management.

Grazing

Scrivener Road Gravel Reserves have not been grazed by stock, but significant impacts from kangaroos and rabbits grazing are evident on the native vegetation. This can result in land degradation and erosion, which can impact on the reserve's conservation values. Grazing can contribute to soil compaction, tree ringbarking, altered patterns of run-off, nutrient build-up in the soil, introduction of weeds, and consumption of the valuable leaf litter which normally provide the soil with essential nutrients. A combination of these problems may lead to a decline in understorey vegetation and associated fauna. Generally speaking however, kangaroo grazing can in many cases help to keep weeds down in the forest.

Salinity

Surface salinity is a condition where the level of soluble salts in the surface soil is high enough to affect plant growth. It can be natural or anthropogenic, and can be caused by rising water tables or evaporation of surface water. Salinity alters the chemical balance of the soil and limits plant growth. This leads to the secondary impacts of bare sealed surfaces with low infiltration and increased runoff and erosion. Salinity is not currently known to affect the reserve.

Acid Sulphate Soils

Acid sulphate soils are sediments containing iron sulphides, which occur naturally in layers of waterlogged soils and are benign until disturbed. This is unlikely to be a problem in the reserve, as the soils are well-drained (not waterlogged) for the most part and soil disturbance to the level of the

water table is minimal. As such, the reserve is classed as acid sulphate soil category 3, with no known risks.

Gravel Extraction

Lateritic (ferricrete) soils and gravels cover the surface of the reserve and represent the remnants of an ancient soil horizon developed on the granites and gneisses of the Western Gneiss Terrane that underlie the area. The typical profile of the deposit is a grey brown sand loam soil over yellow brown pisolitic gravels and laterite cap rock of up to 5 metres thick. Under the cap rock lies 1-2 metres of gibbsite (aluminium hydroxide) which in turn overlay variable depths of clay typically 10-20 metres thick. The clay is mottled red, yellow and brown in the upper region, but white below the water table nearer the granite basement.

The ferricrete raw material is a combination of the gravels, lateritic cap rock and gibbsite layers. Removal of these layers causes significant and irreversible alteration of the soil profile, leaving bare areas which can be problematic to rehabilitate due to the altered conditions and consequent differing survival of the usual species present in the area. Acknowledging this and monitoring the impact of gravel extraction, it is expected that all possible means will be taken on board to minimize the extent of impacts associated with any future possible gravel mining activity.

3.1.2 Water

Description

Water assets provide a variety of ecosystem services, such as draining the excess surface water from the landscape and minimising flooding. The groundwater resources provide a water storage function that interacts with the surface waterways and wetlands. During long dry spells the groundwater supports surface water and wetland ecosystems as well as its own unique ecosystem. Dams can create important reservoirs of water for a range of uses, but can result in loss of important riparian areas required for wildlife habitat and loss of important environmental down stream flow needed for the sustainability of riparian and river bed habitat.

There are no stream courses on the reserve and most of the precipitation penetrates the gravels and cap rock to flow to the north and west as shallow ground water through the surface layers of soil. Runoff occurs more commonly in the gravel pits which are bottomed in clay and cap rock with no or little vegetation. In general this drainage follows the remaining surface flow with the exception of the gravel pit to the east where some ponding of precipitation occurs. A low lying area to the north east of the reserve shows intermittent wetland features and vegetation.

Surface Water

Scrivener Road Gravel Reserves are within the Serpentine Catchment, which contributes around 15 percent of the total annual surface inflow to the internationally significant Peel Harvey Yalgorup Ramsar Wetland Site. Maintaining and improving the quality of the catchment runoff is vitally important to protecting the health of the estuary. With climate change considerations there will be a fine line between providing adequate runoff in the right directions and the percolation of surface runoff within the mined area. Monitoring will be critical to review and address surface water flow impacts.

Serpentine River and Dams

The Serpentine River is the most significant natural waterway in the Shire of Serpentine Jarrahdale. It rises to the east of the Shire and traverses the Shire from the southeast corner to the western boundary where it discharges to a large artificial drain. The River is dammed at two points in its upper reaches on the Darling Plateau. The smaller pipehead dam was completed in 1957 and the larger dam upstream in 1961. These reservoirs are an important source of water for the

metropolitan region and their catchments are carefully managed to maximise water supply and quality. Environmental flow requirements are also important so any impact from a gravel extraction proposal should consider monitoring to ensure the maintenance of important environmental flows are maintained.

Drainage Network

Overly efficient drains and clearing in and around streams has resulted in excessive loads of silt and nutrients being transported from the Shire's land surface into drains, streams and the estuary. The severity of this problem was recognised in the 1980s when the Peel-Harvey Estuary's ecosystem came close to collapse because of high nutrient levels. Most of these nutrients and eroded sediments come from the coastal plain and impact from extractive industries would not be expected to add to nutrient level increases if managed correctly.

Wetlands

Wetlands are, in general, expressions of the groundwater table and play an important role in the water cycle. In winter they store surface water, and in summer water evaporates from the surface. Many wetlands have been drained and filled, so they are a diminishing and threatened asset. Wetlands have an intrinsic place in the regional ecology and this role is discussed under biodiversity Any proposal for gravel extraction needs to consider the wider environment so that it will have a minimal impact on the intrinsic value of wetlands.

Groundwater

There is a natural variation in groundwater salinity. It is possible that lower groundwater tables and excavations could have exposed acid sulphate soils and released acid plumes into the groundwater of the coastal plain. It is also probable that there has been some level of nitrogen and phosphorus enrichment of groundwater in places, especially beneath the sands of the coastal plain. The information on groundwater quality in the area of the reserve is limited but there are no hydrological ground water problems which are currently thought to affect the area.

Major Threats and Pressures

The most significant threats to the water asset relate to both lower recharge rates and higher demand for use. The predicted climate changes, leading to significantly lower rainfall, would have a major effect on recharge, while the expanding population is likely to increase the demand for use. Other significant threats to the asset are actions that reduce water quality, including soil sediment erosion resulting in soil and nutrient export and potentially chemical pollutants through oil or fuel spillage in the gravel pit areas. Acid sulphate soils have a low probability of occurring in this area.

Climate Change

Current models suggest that rainfall will decrease by as much as 20 percent by the year 2030, while temperatures will increase. The exact impact on water assets is still unknown because of the complex processes involved. However, it is anticipated there will be significantly less water entering the system, and the higher temperatures will lead to higher levels of evapotranspiration as well as higher demand for human uses.

Eutrophication (Nutrient Enrichment of Aquatic Ecosystems)

Scrivener Road Gravel Reserve falls within the catchment of the Peel-Harvey Estuary, an ecosystem which has been under extreme pressure from eutrophication. Many land uses continue to contribute significant nutrient loads to this estuary. These nutrients also impact directly on the ecology of the Serpentine River and other waterways.

Broad acre agriculture currently makes up about 90 percent of land use within the Peel Harvey Catchment and is the source of the majority of nutrients reaching the estuary. At present, urban and rural living land uses make up only 6 percent of the catchment area, but these land uses contribute

much more than 6 per cent of nutrient loads. Possible sources of nutrients from urban and rural living land uses include the gravel extraction process, septic tanks, eroded soil particles and over-fertilising of small areas of pasture or lawn. All of these possible sources are cumulative and likely from the area surrounding the reserve.

Siltation and Pollution of Surface Waters

Allied to the export of nutrients from the land surface is the export of soil particles and organic matter. The soil particles are often the carrier for nutrients, thereby creating part of the threat discussed above. They also directly impact on the water systems by increasing the turbidity of the water, filling pools and sometimes creating barriers to drainage that can lead to flooding. Erosion is known to be a problem within the reserve, and thus the area is likely to be a contributor of soil particles, and potentially nutrients, to downstream areas.

Salinity

Salinity is not a major problem for the reserve as it (and its upstream catchment area) does not suffer from rising saline groundwater. However, some areas of the Shire are affected by surface salinity, so it is likely that there has been some effect on the salinity of other waterways. The salinity of the groundwater varies and is high in some places due to the high salt content of the aquifer sediments. The salinity of wetland systems generally increases through the summer due to high evaporation and decreases when flushed by the winter rains. Salinity is much less of a problem in western high rainfall zone areas.

Over-Use of Groundwater

Groundwater levels across the Shire are declining in both the deeper and surface aquifers. The greatest declines are consistent with the areas of most intensive development and particularly with a high number of domestic water bores.

3.1.3 Climate, Rainfall and Air Quality

Description

The climate of this region is described as Mediterranean-type, because of the similarity to weather patterns experienced in the region of that name. It is a mild climate with hot, dry summers and cool, wet winters. The average annual rainfall varies from 800 to 1000 mm on the coastal plain area, increasing to 1200 mm on parts of the Darling Plateau. Most of the rain falls during the winter. Decaying tropical thunderstorms occasionally bring heavy rainfall to the region during summer or autumn.

The climate is currently much drier than it has been since the beginning of the last century. The innate variability of the climate makes it difficult to make long term predictions and climatic models also vary. Since the 1950s there has been a substantial decline in rainfall coupled with a slight increase in temperature. It is uncertain how much of this decrease in rainfall is due to natural variability and how much is caused by greenhouse effect. Nevertheless, current studies strongly suggest that winter rainfall will continue to decline putting greater pressure on this reserve.

Prevailing winds are generally easterly in the morning and westerly in the afternoon. The dominant wind flows are katabatic easterly winds in winter which flow down valleys of the Darling Scarp on winter mornings, and strong sea breezes from the south west on summer afternoons. These winds can be quite strong and are capable of blowing dust and carrying it further from any active site, dust associated with any extractive gravel operations is therefore an important management consideration.

Major Threats and Pressures

CSIRO studies predict that Western Australia will be much warmer and drier by 2030. Autumn and winter rainfall is likely to decrease by around 20 percent from 1990 values. Spring rainfall also is also expected to decrease somewhat and temperatures may rise by up to 2 degrees. The higher temperatures will cause higher evaporation and, coupled with decreased rainfall, will significantly affect the water balance. Rainfall events are expected to become more intense, leading to higher runoff generation, especially on soils with low infiltration rates. The development therefore of water holding soil layers associated with furrows on the contour is therefore important.

Loss of Vegetation

Vegetation plays an important role in creating a healthy ecosystem. This includes agricultural areas and remnant vegetation. Vegetation cycles carbon and nutrients, filters the air and modifies the local climate through evapotranspiration, shading and windbreak effects. Clearing of vegetation for urban and more intensive development needs to be balanced by revegetation and remnant vegetation protection. Revegetation efforts by the Shire to date have not been very extensive or successful and further operations in this area could address this.

3.2 Biodiversity

Description

Protecting biodiversity means conserving the full range of genes, species and ecosystems into the future. Protecting biodiversity is essential, as biodiversity underpins the processes that support life, including human life, on this planet.

A variety of strategies have been adopted to protect biodiversity at State and Federal levels. One strategy is to conserve adequate areas of the full range of natural ecosystems. The assumption is that preserving representative ecosystems will also preserve the full variety of species and genes. This strategy needs to be supplemented by other approaches such as recovery projects for threatened flora and fauna.

The State Government manages a system of national parks, nature reserves and conservation parks that aims to be comprehensive, adequate and representative. It also conducts a number of recovery programs for threatened species and communities.

This Shire is part of the Southwest Botanical Province, which has been recognised as a global biodiversity hotspot. Not only does this area boast a high diversity of species, but many of these plants and animals are found nowhere else in the world. The management and protection of many parts of this internationally important asset falls to local government and private landholders. The local community also has the responsibility to ensure that adjacent land uses do not damage the biodiversity assets.

3.2.1 Flora

Remnant Vegetation Communities

The vegetation of the Jarrah Forest bioregion, which includes the geophysical regions of Plateau and Scarp, is still dominated by its namesake (*Eucalyptus marginata*). This vegetation covers the laterite plateaus. The forested area also includes other tree species such as marri (*Corymbia calophylla*), blackbutt (*Eucalyptus patens*), flooded gum (*Eucalyptus rudis*) and wandoo (*Eucalyptus wandoo*). Smaller tree species such as bull banksia (*Banksia grandis*), sheoak (*Allocasuarina fraseriana*) and snottygobble (*Persoonia longifolia*) form a lower layer with an understorey of varied sclerophyll shrubs. Open areas of granite outcrop support species such as pincushions (*Borya* spp.), fuchsia grevillea (*Grevillea bipinnatifida*), hakeas (such as *Hakea elliptica* and *Hakea*

undulata), rock sheoak (*Allocasuarina huegeliana*) and Darling Range Ghost Gum (*Eucalyptus laeliae*). On the younger red soils of the Darling Scarp there is a marri-wandoo woodland with occasional Darling Range Ghost Gums on the granite outcrops.

The Darling Plateau area has been greatly impacted by timber harvesting, bauxite mining and dieback disease but retains much of the original vegetation structure. Dieback (*Phytophthora cinnamomi*) has affected vast tracts of the Jarrah Forest across the Plateau. It is spread through water and the transport of infected soil, gravel and other materials. The disease is known to occur throughout the Shire.

Many Shire reserves with high biodiversity values have been invaded by the aggressive weeds watsonia (*Watsonia* spp.) and lovegrass (*Eragrostis curvula*). Despite ongoing programs of weed control the populations are spreading. The problem, particularly related to the spread of lovegrass, can usually be linked to either direct disturbance by humans, animals or machines or indirect disturbance such as stormwater runoff or effluent disposal. Unfortunately many Shire reserves are still subject to high levels of disturbance, often by recreation groups, which encourages weed invasion.

Landcare groups, working with the Community Landcare Centre, have restored areas of remnant vegetation and have revegetated large areas. These revegetation projects have used predominantly locally occurring species.

Scrivener Road Gravel Reserves have a highly diverse understorey in very good condition in the undisturbed areas, with minimal weed invasion except around the edges of the gravel pits. The flora species occurring in three monitoring quadrats in the reserve are shown in Appendix 1, with the quadrats located in the wetland in the northeast of the reserve, lateritic woodland south of the gravel pits, and jarrah forest at the western end of the reserve. There are indications that dieback may be present in the vicinity of the gravel pits, such as deaths of indicator species, and may be spreading south into the forest.

No threatened or priority species of flora have been recorded in the reserve, but two threatened and one priority species occur within the adjacent Serpentine National Park (see Table 6).

Table 6: Threatened and Priority Flora, Serpentine National Park

Species	Category under State <i>Wildlife Conservation Act 1950</i>	Category under Commonwealth <i>Environmental Protection and Biodiversity Act 1999</i>
<i>Acacia horridula</i>	P3	
<i>Lasiopetalim pterocarpum</i>	R	Endangered
<i>Pimelea rara</i>	R	Vulnerable

The Priority 3 species *Acacia horridula* has previously been recorded in the area, but was not found during these surveys.

Weeds

A weed can be described as any plant growing where it is not wanted, where it is not naturally occurring or where it is severely out-competing other species. Weeds may be a problem around the gravel pits at Scrivener Road Gravel Reserve for two main reasons:

1. Weeds are a fire hazard, which affects landholder safety in the area, as well as the fauna of the reserve; and
2. Weeds suppress native plant growth and recruitment into the gravel pits, affecting biological diversity and pit rehabilitation when weeds monopolise the sun, space, soil and water.

Weeds can provide habitat for native fauna such as quenda, which are likely to occur within the reserve, but the adjacent expanses of dense native vegetation mean that the small areas of weeds around the pits are unlikely to be critical. Weed control is periodically carried out (every few years) within and around the pits.

Flora, Vegetation and Tree Management

Flora management is essential for increasing and maintaining biodiversity as a component of conserving natural heritage. The vegetation of Scrivener Road Gravel Reserve is in very good condition, but under threat from weed invasion and dieback. Natural regeneration of the gravel pits is likely to be ineffective due to the slow rate of recruitment to such a highly disturbed area which has no soil seed bank. It is therefore more productive to plant and direct seed the area, with concurrent necessary weed control. Species which provide feeding habitat for the Black Cockatoos are likely to be used with species such as *Acacia saligna* being valuable as an early coloniser. Tree Species will also be planted including *Banksia littoralis*, *Corymbia calophylla*, *Eucalyptus marginate* and *Eucalyptus rudis*.

Tree management including retaining habitat trees for breeding cockatoos will be critical along with installing further “cockatubes” for black Cockatoo Breeding to replace any habitat trees lost.

Revegetation of Native Flora Species

Revegetation of Scrivener Road Gravel Reserves have not been a priority in the past, due to ongoing gravel extraction from the pit floors. The first area to be exhausted, at the far south of the pits, was ripped and revegetated in 2006 and 2007. Revegetation has been successful to a point and included in the rehabilitation has been some Cockatoo feeding habitat species but there is a need to do supplemental planting to increase the species richness to bring it up to satisfactory completion criteria.

The current use of the reserve has turned towards conservation. Additionally, further revegetation of the pits has been advanced as a precondition of inclusion of the reserve into Serpentine National Park. Revegetation with Cockatoo feeding habitat species will continue to occur in stages as further areas are mined.

Nearby local vegetation communities will be used as a guide to the local flora when revegetating the reserve. This information is available from the three monitoring quadrats, whose species lists are provided in Appendix A. A variety of understorey vegetation should be planted, along with local trees, which will provide Quenda habitat and food sources for the black cockatoos. Concurrent weed control where necessary is an essential component of a revegetation plan. Rehabilitation will be in accordance with DPaW Guidelines for the Management and Rehabilitation of Basic Raw Material Pits, 2008.

Dieback and Weed Prevention

Scrivener Road Gravel Reserves have not been assessed for the presence of dieback disease (*Phytophthora cinnamomi*). A weed survey in 2009 also noted the deaths of some indicator species around the pits, and suspected that the dieback may be spreading south into the forest. Until dieback mapping can occur, and possibly testing of the soil within the pits, it is best to assume that the reserve is infected.

The 2009 weed survey mapped populations of cottonbush (*Gomphocarpus fruticosus*), lavender (*Lavendula stoechus*), pelargonium (*Pelargonium capitatum*) and watsonia (*Watsonia* sp.) within and around the pits. These weeds have been periodically controlled (every few years) by a spraying contractor. Weed control should be carried out in conjunction with any future revegetation programs. Chemical control should be carefully considered so as to not harm the native fauna; for example, as glyphosate kills amphibians, Bioactive glyphosate should be used instead, or manual removal.

3.2.2 Fauna

In Western Australia, rare or endangered species are protected by the *Wildlife Conservation Act (1950)*. Protected fauna are listed in four schedules under the *Wildlife Conservation (Specially Protected Fauna) Notice*. Parks and Wildlife also maintain lists of Priority fauna species which require active conservation efforts or further study. The fauna recorded in the Shire (as of 2015) from these lists are identified in Table 7.

Table 7: Threatened and Priority Fauna, Shire of Serpentine Jarrahdale^a

Species Name	Known from the plateau	Known from the plain	Probability of Occurrence Elsewhere^b
Schedule 1 – Fauna that is rare or likely to become extinct			
Chuditch - <i>Dasyurus geoffroii</i>	X	X	Low
Numbat – <i>Myrmecobius fasciatus</i>	X		Low
Western Ringtail Possum – <i>Pseudocheirus occidentalis</i>	X		
Quokka – <i>Setonix brachyurus</i>	X		Low
Mallee Fowl – <i>Leipoa ocellata</i>	X		
Forest Red-tailed Black-Cockatoo - <i>Calyptorhynchus banksii naso</i>	X	X	High
Baudin’s Black Cockatoo – <i>Calyptorhynchus baudinii</i>	X	X	High
Carnaby’s Black-Cockatoo - <i>Calyptorhynchus latirostris</i>	X	X	High
Schedule 4- Other Specially Protected Fauna			
Peregrine Falcon - <i>Falco peregrinus</i>			High
Carpet Python – <i>Morelia spilota imbricata</i>	X		
Priority Two – Taxa with few, poorly known populations on conservation lands			
<i>Glacidorbis occidentalis</i> (a freshwater snail)	X		
Priority Three – Taxa with several, poorly known populations, some on conservation lands			
Wambenger (Brush-tailed Phascogale) - <i>Phascogale tapoatafa</i>	X	Lowlands	Moderate
Priority 4 – Taxa in need of monitoring			
Western Brush Wallaby - <i>Macropus Irma</i>	X	Lowlands	Low
Water Rat – <i>Hydromys chrysogaster</i>	X	Lowlands	Low
Carpet Python – <i>Morelia spilota imbricata</i> (also listed in Schedule 4)	X		
Quenda (Southern Brown Bandicoot) – <i>Isodon obesulus fusciventer</i>	X	X	High

a : Based on records supplied by Parks and Wildlife from the Threatened Fauna Database

b: Based on a report by J.Henry, Ninnox Wildlife Consulting (2000)

The reserves are adjacent to a large area of national park (over 4000 ha) (Serpentine National Park) and State Forest. This provides the potential for habitat for a number of species in the Darling Scarp. In addition to the list above the Echidna has also been seen in this area by local residents.

Fauna species that have the potential to occur in the reserve are those existing in the adjacent Serpentine National Park. It has been found that the Serpentine National Park has “eight species of native mammal (including one threatened species), 70 species of birds (including two threatened species), 24 species of reptiles and three species of frogs. Feral animals that have become established in the park include six mammal and two bird species.” (CALM: 2000).

Table 8 details the threatened species occurring in or likely to occur within the reserve.

Table 8: Threatened and Priority Fauna, Scrivener Road Gravel Reserve

Species	Category under <i>State Wildlife and Conservation Act 1950</i>	Category under <i>Commonwealth Environmental and Biodiversity Act 1999</i>
<i>Calyptorhynchus baudinii</i>	R	Vulnerable
<i>Calyptorhynchus latirostris</i>	R	Endangered
<i>Calyptorhynchus banksii naso</i>	P3	
<i>Isoodon obesulus fusciventer</i>	P5	

Over 100 bird species have been recorded in the Serpentine National Park and therefore likely to occur in Scrivener Road Gravel Reserve; these, three are protected under the *Wildlife and Conservation Act 1950* and the *Environmental Protection and Biodiversity Conservation Act 1999*. The reserve is one of only a few locations where all three protected black cockatoo species have been recorded to nest. It has been reported by Mr Ron Johnson, Curator, Ornithology Western Australian Museum that previous clearing and gravel extraction in the area did not adversely impact the cockatoos.

The Southern Bandicoot or Quenda (*Isoodon obesulus fusciventer*) is a nocturnal species inhabiting areas with dense vegetation cover, such as the margins of wetlands and Banksia woodland/Jarrah forest. This species is listed by CALM under the *Wildlife and Conservation Act 1950* as a priority 5 species, conservation dependent and in need of monitoring.

It is believed that the Chuditch (*Dasyurus geoffroii*), a threatened species under the *Wildlife and Conservation Act 1950*, may also occur in the Serpentine National Park.

Widespread grazing and droppings indicate that kangaroos are using the reserve on a regular basis, and placing pressure on the native plants which they are eating.

Feral Animals

Feral animals found in the area of Scrivener Road Gravel Reserves include domestic cats, foxes, rabbits and the common house mouse. Feral animals are detrimental to native animal populations for several reasons, including:

1. Preying on native fauna;
2. Out-competing native species for resources such as food and space;
3. Spreading diseases and weeds (in their excrement); and
4. Damaging native flora and thus habitats for the native animals.

Foxes and rabbits can be baited with 1080, a naturally occurring chemical in Australian plants. 1080 is not harmful to native animals, as they have built up a natural resistance, whereas the poison affects feral animals. However, feral animals are not considered a major problem, although there is evidence of significant grazing of native plants by rabbits.

Fauna Management

As more development occurs within the Shire, habitat for native animals is rapidly disappearing. Thus, the maintenance of existing remnant vegetation is of high importance in the protection of declining native fauna species. Low shrubs provide cover from predators, shelter and food for local fauna species. Management considerations for fauna protection include fire management, weed control, feral animal control, minimisation of human disturbance, and revegetation.

Protection of Native Fauna

Planting of local native plants, as described in the section on revegetation actions above, would help to provide habitat for native fauna. Control of feral animals must be carried out if they become an obvious threat. It would be wise to undertake further investigation into the presence of feral animals to establish whether they are causing more damage than is apparent.

3.2.3 Major Threats and Pressures

Clearing and Disturbance

Passive clearing can be caused by grazing by stock, overly frequent fires, polluted runoff or high impact recreation activities. Recreation activities located in or adjacent to bushland can lead to high levels of disturbance, weed and disease invasion and more frequent fires.

Despite gates on the reserve, the pits are regularly accessed by off-road vehicles and trail bikes, while dumping of rubbish (including asbestos, paint tins and car bodies) is a regular issue with regular clean ups and surveillance required. Active clearing has occurred historically to establish the gravel pits. With further gravel extraction and rehabilitation reactivation, there will need to be reactivation of ongoing management of the site blocking off inappropriate access with boulders and fallen trees where necessary and an ongoing removal of any dumping to discourage others from dumping.

Fire Management

Fire is an important tool for stimulating regrowth and regeneration in many Australian ecosystems. However, unplanned burns can have a catastrophic impact on vegetation and cause high mortality of fauna. The reserve is adjacent to a large area of national park (over 4000 ha) (Serpentine National Park) and State Forest, allowing for better conditions for natural recolonization than in most of the highly fragmented bushland within the Shire. The long hot summers create conditions in which there is a high fire risk. The predictions of longer drier periods and higher temperatures will increase the period of risk each year.

Control burning is sometimes required to reduce fuel load and protect homes. Mosaic burns are a good way to reduce fuel load and also leave some habitat for native fauna. The Quenda, for example, would suffer greatly from loss of habitat after fire. Thus maintaining good fire breaks and the removal of weeds is likely to be the most environmentally beneficially action for the local fauna of the reserve.

The reduction of fire hazard, while simultaneously maintaining biodiversity values, can be achieved by:

- Maintaining existing fire breaks to slow any potential fires and to provide access for fire fighting vehicles, to be undertaken by the Shire each year;
- Strategic removal of weeds to lower the fuel load; and
- Ongoing mosaic burning of the reserve, allowing habitat recovery before burning of the next area.

Dieback (*Phytophthora cinnamomi*)

Dieback is a disease that affects many of the native plant species in Western Australia, often causing death. It is caused by *Phytophthora cinnamomi*, an introduced soil-borne pathogen that attacks the roots of plants. It is having serious impact on the biodiversity of the State and is listed by the *Commonwealth Endangered Species Protection Act (1992)* as one of five Key Threatening Processes. Plant species vulnerable to *Phytophthora* include jarrah, the banksia family, the heath family, pea family, hibbertia family, balga and zamia. Marri, kangaroo paws, reeds and rushes are

not affected. The pathogen spreads through the soil in surface or subsurface flows and by the movement of soil or plant material from infected sites.

There is no known mechanism for eliminating the disease once an area is infected. The objective for managing the disease is to prevent any further spread of infection and to minimise the impact of existing infections.

Scriver Road Gravel Reserve has not yet been assessed in any level of detail recently for the presence of dieback disease (*Phytophthora cinnamomi*). Some deaths of the plant species which are most affected by dieback have been observed within the reserve, indicating that dieback mapping and soil testing within the pits should be a priority before any activity occurs. A Dieback Management Plan will be prepared as required.

Weeds

Introduced flora comprises up to 11 per cent of the plant species found in Western Australia. These plants pose a significant threat to native species through competition for limited resources, particularly space, light and water. Weeds flourish in disturbed sites and have been assessed at the Scriver Road Gravel Reserves. Weeds often out-compete the remaining native understorey and alter local nutrient recycling. Weed invasion is one of the major threats to remnant native vegetation.

Understanding of Biodiversity

It is not possible to put an economic value on biodiversity. The value of something unique and irreplaceable cannot be calculated. In a market driven society, it is difficult to convey the message of the necessity of protecting this biodiversity asset. Often people are unaware of actions that cause damage, such as the weed seeds in horse manure or the dieback spores in soil clods. Many residents of the Shire have a good understanding of biodiversity and environmental management while new residents may not. Conversely, there are also likely to be many enthusiastic nature lovers among the expanding population who could become powerful advocates for the Shire's natural ecosystems.

4. Social and Economic Characteristics

4.1 Land Uses and Management

The traditional owners of the South West of Western Australia are collectively known as the Noongar people. Within this South West region there are 13 tribal areas of Indigenous people. With European settlement Indigenous people have been forced to alter their traditional semi-nomadic hunting and gathering lifestyle.

A Native Title claim of the Gnaala Karla Boodja Land exists over the South West geographical province. Native title claims are coordinated by the South West Land and Sea Council (SWALSC), the representative body for Noongar people. Although no specific information has been found on the use of this area by Aboriginal peoples it is likely to have occurred in a transient manner and comments on this draft management plan will be sought from the South West Aboriginal Land and Sea Council. A Heritage Survey has been requested and this will be prepared and implemented as required.

The major uses of Scriver Road Gravel Reserves more recently included gravel extraction. Following exhaustion of the resource from the existing pits permission for clearing additional areas has not been received. The current use includes management as multiple use State Forest and has

turned more towards conservation particularly with the wider pressures of developments on the various Cockatoo species habitats.

Discussions with the Department of Parks and Wildlife have resulted in a course of action including the development of a management plan for the reserves, resuming mining as a possibility and including offset rehabilitation with local native species. There are few local gravel sources on Department of Parks and Wildlife land, none of which to date are both suitable and available to the Shire for gravel. Alternative sources of gravel on private property have also been exhausted.

Stages of rehabilitated gravel pit areas are proposed to be used as revegetation offsets in exchange for areas proposed to be cleared and mined. This will be achieved through identifying cockatoo habitat trees in the area and locating new gravel source areas for excavation and progressive offset rehabilitation in appropriate locations. In order to keep the Scrivener Road residents and other stakeholders of the area informed of the mining proposal and any ongoing operations consultation will include this draft management plan, mail drops and other forms of consultation.

Community Aspirations and Community Consultation

Community aspirations for this area reflect the conservation values of the area being adjacent to the Serpentine National Park. A local government conservation zoned property located nearby which is both a National Trust Covenanted property and Land for Wildlife property adds to the conservation value of the area. Other property uses include equestrian or other production farming properties such as those developed for fruit orchards. Minimization of any impacts to these properties will be a focus with inviting the community to participate in the planning process and decision making for the proposed activity.

Notification of those property owners who live in the area which could be affected by mining activities has occurred in the past and will reoccur in the future with any proposal of reopening of mining activities in this area. Every effort will be made to minimise any impacts through careful planning and restrictions on operational times or activities and notification of truck movements proposed on Scrivener Road, should further gravel extraction proceed.

Heritage

The reserve is not recorded as having any specific significant European history, and was most likely harvested for timber in the past, while being managed for multiple uses including water catchment management. The closest recorded Aboriginal site is the Serpentine River as a ceremonial and mythological site. A Heritage Survey is being undertaken to ensure all Heritage values are carefully investigated.

Zoning

The Metropolitan Regional Scheme identifies the reserves' zoning as Parks and Recreation. Land uses on reserves and their considerations are based on the multiple use values of the land and ultimate purpose intended for the reserves.

Scrivener Road Gravel Reserves are crown reserves vested with the Shire of Serpentine Jarrahdale for the purpose of gravel extraction. The reserves have been identified for inclusion into the Serpentine National Park. The Black Cockatoo feeding, roosting and breeding habitat value of the area is well known. It is recommended that the current vesting be changed to include conservation as an additional purpose for the reserves.

Zoning will also be done in the context of the management plan which will recognise high conservation value areas used for the Cockatoos breeding areas of extraction in strategic locations, and offset rehabilitation which will provide important feeding habitat to compliment the roosting and breeding habitat values. 'Cockatubes' for nesting will also be included as part of any offset package to replace any lost habitat.

Accessibility

Locked gates have been placed to prevent access to the reserve, but despite this, the pits are regularly accessed by off-road vehicles and trail bikes, while dumping of rubbish has occurred historically. The site has been reactivated and the inclusion of further barriers and trenches to restrict inappropriate access has been put in place. Progressive rehabilitation will take into consideration site security and exposed areas in need of screening will be rehabilitated first. This will also assist in minimising impacts from dust and noise to Scrivener Road users and local residents.

Gravel Requirements

The Shire of Serpentine Jarrahdale is responsible for the care, control and management of approximately 732km of roads, of which about 596km are sealed and 136km unsealed. Responsibilities include road construction and maintenance (including grading, safety and roadside drainage) as well as footpaths and other infrastructure in urban areas.

Annual use expectations for gravel for shoulder re-sheeting both sides are being determined so that gravel extraction amount can match requirements on an annual basis. Preliminary estimates of gravel required is being provided for with this carefully staged operation.

Gravel Extraction Processes and Habitat Trees

Cockatoo roosting and breeding habitat trees are well documented by the Western Australian Museum and department of Parks and Wildlife. New extractive industry cells have been identified and located to minimize any negative impacts to these important areas.

Gravel Extraction operations will keep adequate buffers from the root systems of identified Cockatoo Habitat Trees in accordance with Australian Standards for Trees in Development Areas.

Equipment required for proposed operations would include a large dozer, a loader feeding crusher hopper and a conveyer for stockpiling.

Professional and Natural Area Management Expertise

In order to get the best possible outcome collaboration is occurring with a Professional operator and various specialist consultants. Gravel extracted from Scrivener Road Gravel Reserves will be used within the Shire only and not sold commercially. This will enable the best possible strategic approach to gravel extraction, storage and export including minimizing the footprint through higher stockpiles and combining extraction and rehabilitation operations. The Department of Parks and Wildlife and the Western Australian Museum are assisting with planning and management to allow for the incorporation of critical environmental baseline information such as the location of habitat tree(s) (trees that have a diameter, measured at 1.5 metres from the base of the tree, of 50 cms or greater, containing or having the potential to develop hollows or roosts suitable for native fauna). Only in the Scrivener Road Gravel Reserves area will the incorporation of the WA Museum expertise be included with relation to trees with hollows that are specifically important for the Black Cockatoo species.

Clearing Permit and its Requirements

Clearing permits for progressive staged clearing for mining will be through application to the Native Vegetation Conservation Branch of the Department of Environment Regulation with the first stage area proposed for a purpose permit clearing for mining being 12 hectares in two stages of 6 hectares each..

Dieback Control

The risk of introduction and spread of dieback (effect of *Phytophthora* species on native vegetation) will be minimised through:

- Earth-moving machinery clean of soil and vegetation prior to entering and leaving the mine site
- Soils only be moved out of the site in dry conditions (when soils do not freely adhere to rubber tyres, tracks, vehicle chassis or wheel arches) and
- No dieback-affected soil, mulch, fill or other material brought into or out of the area
- Dieback areas to be mapped and soil movement from these areas to be restricted in its use and location

Currently there is likely to be dieback in the gravel pit areas. Once gravel from dieback free areas in higher elevation areas has been extracted, use of this gravel to build up the road elevation through the gravel pit areas should be done to provide access in and out to minimise any possibility of dieback spread. Clean down areas should be outside the gate into the pit area near Scrivener Road. It is important that dieback assessments are done which are current and take advantage of the greatest possible scientific research advancements in the context of the proposed Dieback Management Plan.

Fauna and Revegetation

The Shire understands that the Department of Environment Regulation (DER) requires inspection by a fauna specialist (person with training and specific work experience in fauna identification or faunal assemblage surveys of Western Australian fauna) one week prior to any excavation for the presence of fauna listed in the Wildlife Conservation Act (Specially Protected Fauna) Notice. Where fauna is identified, no taking of identified fauna will occur unless first approved by the DER CEO. The name and location of each identified fauna species and the location of any area planted will be recorded using a Global Positioning System (GPS) unit set to Geocentric Datum Australia 1994 (GDA94), expressing the geographical coordinates in Easting and Northings or decimal degrees. This will be accompanied by a description of the planting activities undertaken, the number of trees planted and the species composition, structure and density of planting. Pit offset area plantings for establishment, maintenance & management will be included comprehensively in annual reports to the Department of Environment Regulation (DER).

Reporting

The Shire also understands that before the 30th of June each year a written report to DER will need to be provided reporting on activities done by any possible successful permit holder between 1 January to 31st of December of the proceeding calendar year. If no authorised clearing was undertaken between 1st of January to the 31st of December, of the preceding year, a written report confirming that no clearing undertaken under this permit has been carried out, will be provided to the DER CEO on or before 30 June each year. Parks and Wildlife will also be party to the reporting to enable the agreement on and reporting on achieving acceptable offsets.

Restoration/Offset Area Planting

The Shire of Serpentine Jarrahdale proposes to apply to the Department of Environment and Regulation for a purpose permit for progressive clearing of 12 hectares in two hectare stages. In order to avoid, minimize or offset the negative environmental issues associated with this proposed clearing on the conservation value particularly for Black Cockatoos the following avoidance, minimization and offset actions are proposed. The offset terminology is used loosely in this context and specific formal offset requirements are still to be determined through the purpose permit application process.

- To rehabilitate offset areas greater than the area which is proposed to be cleared utilizing a range of local native species including Black Cockatoo feeding habitat attracting species

- To satisfy completion criteria and eventually add the reserves to the Serpentine National Park.
- To install artificial nesting “cockatubes” as replacements for habitat trees lost
- To plant local native species elsewhere on the reserves for various biodiversity and screening purposes.

A referral of the proposal is also being prepared for the Federal Department of Sustainability, Environment, Water Population and Community (SEWPaC).

Extraction, Rehabilitation and Maintenance

The laterite gravel layer is relatively deep with an average depth of between 2 and a half meters. Extraction will be conducted using a bull dozer and front end loader. Rock breakers may from time to time be required and the use of these should be sensitive to the local residents in the area to minimize noise impacts. This will be addressed in a proposed Dust and Noise Management Plan.

Proposed mining actions are as follows:

- The site will be progressively cleared of vegetation with cleared trees cleaned up as logs, stockpiled and used for ground habitat or for site security barrier purposes.
- The area will be stripped of topsoil and placed in windrows around the edge of the working area.
- Within the cell, a bulldozer will rip and blade material to a crusher, with crushed materials being stockpiled. Trucks will enter the pit to be loaded from the stockpiles by a front end loader.
- Excavation will proceed until the laterite has been removed and this will result in lowering the contour level of the soil surface by approximately 4 meters.
- Where possible topsoil will be replaced and seeded in worked out areas just prior to the wet season.
- Ripping and mounding will be done in preparation for the local native planting and seeding
- Batters of 1:6 will be maintained

Rehabilitation goals will include creating a landform that is stable, erosion resistant, aesthetically pleasing and safe for humans and animals and to create an offset area where local native species are planted so that habitat for Black Cockatoos is replaced and enhanced as quickly as possible. Seed will also be collected from this area to be used directly for rehabilitation.

Extraction Site

Ripping, blading and crushing will be done to create stockpiles with a small footprint.

Rehabilitation will take place as follows:

- All slopes behind the working face will be contoured to achieve a slope 1:6 vertical to horizontal taking care not to impact on fringing vegetation.
- The quarry floor will be ripped along the contour to remove potential compaction and to establish low mounds for storm water management purposes.
- Stockpile topsoil/overburden will be reshaped to create a land surface which is aesthetically pleasing and easily trafficable.
- A mixture of suitable local native species will be planted and seeded.
- Rehabilitation work will only be carried out just prior to or during the wet winter season.
- Integrated weed management will be undertaken periodically. A contractor specializing in weed management will be used to conduct the herbicide applications.
- Monitoring and maintenance will occur to identify any erosion, and any areas for supplemental reseeding or replanting.

Completion Criteria

The site is to be safe to humans and animals at all times. The site will be designed to be sustainable in the long term without any additional management inputs and suitable for conservation purposes and visual amenity purposes particularly because the Scrivener Road Gravel Reserves are proposed to be added to the Serpentine National Park.

The completion criteria will be agreed to by the Department of Parks and Wildlife and will be detailed to be specific, measurable, achievable, relevant and time bound with acceptable rehabilitation outcomes:

- Each of six two hectare cells will have a completion criteria which is specific to the site elevation and its hydrology
- Measuring will be done with the most acceptable techniques of the day likely to include randomly selected one meter quadrants and associated seedling counts
- Other case studies in nearby similar situations will be assessed to include the latest in technique and research maximizing success likelihood and best management practice dieback management
- Time bound monitoring will be included at a minimum of once a year
- Twelve hectares are proposed to be mined in two, six hectare stages with six, two hectare cells. Each cell will be progressively mined, rehabilitated and monitored for achieving completion criteria with preexisting mined areas rehabilitated up front in the first stage of operations.

Rehabilitation is to be at an industry standard comparable to Alcoa's rehabilitation completion criteria standards with an even higher standards for conservation reservation following achieving an acceptable conservation based completion criteria. "State of the Art", rehabilitation will include minimal footprint of the activity with the progressive mining and rehabilitation including top soil movement from one site to the next in minimal timeframes for maximum naturally occurring seed within newly relocated top soil.

Supplemental seedling plantings will be at 1 x 2 m spacing at the commencement of winter and these will include species important to Black Cockatoo feeding such as: *Acacia saligna*, *Banksia littoralis*, *Banksia nivea*, *Banksia sessilis*, *Corymbia calophylla*, *Eucalyptus marginate*, *Eucalyptus rudis*, *Hakea lissocarpha*, *Hakea prostrate*, *Hakea stenocarpa* and *Xanthorrhoea preissii*. Seeding will also occur to help with maximising the possibilities of success with one or the other methods of rehabilitation increasing the likelihood of overall success. The existing rehabilitation species successes will be assessed to help determine the best possible revegetation strategy to adopt. Completion Criteria acceptable to the Department of Environment Regulation and Department of Parks and Wildlife will be prepared, implemented monitored, reviewed and revised annually as required with subsequent supplemental planting each year until the completion criteria is reached.

"Offset" Rehabilitation Local Native Species Plantings would include a selection of between twelve and fifteen species found in local nurseries from the following:

Early Colonizers

Acacia pulchella (coloniser)
Acacia saligna (coloniser)
Acacia urophylla (coloniser)
Adenanthos barbiger (coloniser)
Allocasuarina huegeliana
Mirbelia dilatata (coloniser)
Hibbertia commutata (coloniser)
Kennedia prostrata (coloniser)

Wet Areas

Banksia littoralis (wet areas only)
Eucalyptus rudis (wet areas only)

Pericalymma ellipticum (wet areas only)
Taxandria linearifolia (wet areas only)
Viminaria juncea (wet areas only)

Dryer Areas

Banksia nivea
Corymbia calophylla
Dampiera linearis
Hakea lissocarpa
Hovea trisperma
Hypocalymma angustifolium
Hypocalymma robustum
Lechenaultia biloba
Scaevola calliptera
Xanthorrhoea preissii

Maintenance will include repair of any damage, replanting and weed control and monitoring will continue until the completion criteria has been fulfilled. Seedlings and/or direct seeding will be monitored on a weekly basis within the first 6 weeks after planting and any dead plants will be replaced immediately. Weed management will be undertaken twice a year in spring and in autumn.

For completion criteria to be satisfied, a 75% survival rate will be needed at the end of the first winter with all dead seedlings replaced the following wet season. Reporting will be on an annual basis to the Department of Environment Regulation and Department of Parks and Wildlife. After a five year period an attrition process will be allowed to enable the plant density to be determined by natural factors leaving a sustainable self-perpetuating ecosystem.

4.2 Operations Management Strategy

The Operations Management Strategy for Scrivener Road Gravel Reserves has the following objectives to:

- Ensure the biodiversity values of the area are conserved with adequate protective management particularly in Scientific Reference Buffer Areas and that in Mine/ Rehabilitation areas, offsets will provide flora and fauna habitats generally and specifically for feeding, breeding and roosting Cockatoos.
- Extract gravel in the Scrivener Road Gravels Reserves with minimum footprint, maximum successful rehab, and safe travel for Scrivener Road users.
- Ensure operational hours, noise, dust, dieback spread, and water management are state of the art with the best possible management in particular to minimize impact to those living in or visiting the area
- To conduct operations to produce gravel product in a cost effective manner for use only in the Shire with justification for the operation in terms of cost benefit analysis, investment return, with consideration of alternative sites for current or the future sources of gravel or alternatives to gravel such as crushed concrete which may come on the market sometime in the future.

Loss of habitat

With the proposed gravel extraction area, trees have been measured and mapped above 50 cms in diameter and those which have habitat value have been recorded. Offsets are proposed to include "cockatubes" within Scientific Reference Buffer areas along with offset revegetation favoring feeding

habitat species attractive to Black cockatoos. The proposed area for extraction of gravel has been selected to avoid any known and new breeding habitat trees and particularly those that the WA Museum have been monitored for 15 or more years. The Scientific Reference Buffer areas will facilitate good protection and management of Black Cockatoos.

All woody debris will be used within rehabilitation providing habitat for small animals as much as possible with excess timber sold and other woody debris mulched and used for Shire purposes. All rehabilitation whether from topsoil, planted or seeded, will be selected to be compatible with the ecosystem within which the revegetation is being introduced. Operations are proposed to proceed with a focus for rehabilitation in the most exposed gravel pit areas first using top soil directly from new gravel extraction areas. Maximum effectiveness of the rehabilitation and cost effectiveness will be achieved through combining extractive and rehabilitation operations.

Dieback

Dieback has been assessed and will be accurately mapped. A different use location and approach to mining will be used in dieback infested areas as opposed to dieback free areas. Hygienic operations will occur as a matter of course in the context of a proposed Dieback Management Plan including washing down or using compressed air to make sure all vehicles are clean on entry and clean on leaving the operations area.

Hours of Operation, Dust and Noise

Days and Hours of Operation will not include weekends and will be standard Shire Operating hours with contractors complying with these hours for consistency and transparency across the board.

The area proposed for mining will be in one of the most remote parts of Scrivener Road Gravel Reserves surrounded by Scientific Reference Areas to minimise any dust and noise impacts to Scrivener Road users. The nearest residence is over 1,000 meters away from the proposed crusher site.

The two or three month maximum mining extraction and processing period is proposed to occur in late autumn when light rains can reduce any possible dust being produced. Dust Guidelines by the Department of Environment and Conservation 2011 will be adhered to in the context of a proposed Dust Management Plan. Off sight water supply sites in State Forest normally used for fire suppression and in private property used for fire suppression will be used for water truck filling. Dispensing of the water will be done to dampen roads and areas generally where operations or truck movements are occurring.

Noise impact will be managed by having Scientific Reference Buffer areas surrounding the operations as well as complying with working hours and other day and notified hour limitations. Environmental Protection Noise Regulations will be adhered to at all times and will be addressed in the context of a Noise Management Plan. Wherever possible the latest technology will be used to minimise noise such as selected less offensive reversing noises and liaison with the community with emails and flyers for notification of operating times.

Safety

Safety will be addressed in the context of a Traffic Risk Assessment Transport Management Plan through adequate signage for truck movement, management and road maintenance or upgrades where necessary. Maps and figures include mining, processing and stockpiling locations. Dust, noise and safety managed through road maintenance, treatment and other management to allow for best possible safe traffic movements. Hydrological design considerations as well as requirements for road safety will be met in accordance with Australian Road Safety Standards.

Water Management

A Department of Water approved Water Management Plan has been included on the Shire's website. The water management design allows for maximum penetration of water with least possible runoff and associated soil erosion. Given that industry professional input has been included in the preparation of the Water Management Plan and the Department of Water has also had their input, there should be confidence that a well-designed and functional operations outcome will result. Individual submission value adding has also been taken on board from local residents.

Cost Benefit Analysis: investment/return, alternative gravel sources or alternative products

As the Shire does not have a crusher or a large enough dozer, contractors and their equipment will be used in conjunction with Shire Operational staff. The investment and return will be closely scrutinized. For example an estimation has been made that the Shire's net benefit will be between \$300,000 and \$350,000 a year based on:

An estimated extraction of 75,000 tones per year

We are currently paying about \$14 per ton

Cost of contractors to the Shire would be about \$8 per ton with for this local gravel source

Gross benefit is \$6 per ton with \$6 multiplied by 75,000 giving a Gross of \$450,000 per year

It is estimated that the costs will be about \$100,000 a year for environmental offsets and to pay for operations and road maintenance

This brings the net benefit down to about \$350,000

Over 12 years of operation multiplied by \$300,000 it would come to about \$3.6 million

Alternative products will continue to be researched such as red sand and crushed recycled concrete. Alternative Sources of Gravel in either private property or State Forest will also continue to be investigated for current and future gravel requirements. The Scrivener Road Gravel Reserve area is the only area within the Shire that was mapped as Regionally Significant Basic Raw Materials during the 2013 Geological Survey of Western Australia and is deep and of good quality.

Arrangements between the Shire and mining service providers are being developed with careful consideration for cost effectiveness. The Shire knows how much gravel it will need each year. The most economical scale of operation to deliver the most cost effective operation will be adopted and cost benefit analysis will take into consideration the cost of getting up and running the operation as opposed to the continuation of importing gravel from outside the Shire. The first rehab will take an initial four or five years to establish cockatoo feeding habitat benefit. The benefit will increase every two years by about 2 hectares giving a cumulative benefit to the cockatoos of 19.72 hectares of cockatoo feeding habitat established in 17 years. Alternatives products to gravel which may come onto the market will also be taken into consideration. The use of alternatives to Scrivener Road Gravel Reserves gravel, will continue to be explored and reviewed annually so the least expensive and most environmentally acceptable option can be pursued.

5. Implementation

5.1 Introduction

An implementation plan is provided in this section. Various business units within the Shire will be responsible for the management's implementation and it is anticipated that the actions will be acted on over several years.

All actions in the report are reproduced in a single table below, along with priorities, responsibilities and potential partners.

5.2 Priorities

Priorities have been classified as follows:

- Key – within the next financial year;
- High – within the next five years;
- Medium – within the next ten years; and

5.3 Responsibilities, Monitoring and Review

The Shire of Serpentine Jarrahdale is responsible for recommendations within this plan. In some instances, the Shire may be assisted in implementing a recommendation by a relevant partner who has an interest or responsibility in the recommendation being considered, 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.

5.4 Implementation Plan

Divisions within the Shire with responsibilities for implementation sometimes in collaboration with SJ Landcare, other agencies, organizations, Fire Brigade or Community are as follows:

- Engineering Services
 - Operations
 - Natural Reserves Coordinator
 - WSUD Project Manager
 - Fire and Emergency Services
 - Environmental Services
- Corporate and Community Services
 - Community Development
 - SJ Landcare
- Planning Services
 - Planning
 - Building
 - Health
 - Ranger Services

Actions Table

Governance

No.	Action	Priority Status	Responsibility	Cost Estimates
1	Rehabilitate the reserves in accordance with the approved management plan, manage the reserves with an additional management purpose for conservation, <u>add this purpose to the management orders of each of the reserves and</u>	Key Implemented in Part	Environmental Services	Costs of offset provision and other DER tree hollow survey

No.	Action	Priority Status	Responsibility	Cost Estimates
	plan and progress staged gravel extraction and rehabilitation through clearing application and offset provisions.			requirements are estimated at \$6,000

Environmental

No.	Action	Priority Status	Responsibility	Cost Estimates
2	<u>Implement the approved Water Management Plan through monitoring water erosion including in-stream structures to assist in slowing down water velocity.</u>	Key Implemented in Part	Eng, Services WSUD Officer	Consultant Estimate is \$2,500
3	<u>Prepare and monitor the implementation of the Operation Management Strategy, Heritage Survey, Dust, Noise, Dieback, Cockatoo Habitat and Other Fauna and Transport Management Plans.</u>	Key Implemented in Part	Operations, Parks and Natural Reserves Coordinator	Consultant Estimate is \$40,000
4	Conduct annual audits and improvement works for meeting management plan targets and maintaining appropriate storm water management standards.	Key Implemented in Part	Environmental Services	Staff Time \$1,000 per annum
5	Monitor the establishment of plant communities in meeting the completion criteria and review supplemental planting requirements as necessary.	Key Implemented in Part	Environmental Services	Staff Time \$2,000
6	Review annually and implement a Weed Control Plan that maps and identifies weed species within the reserve, and identify target areas and appropriate techniques and strategies to reduce weed density and weed seed sources in the gravel pit and surrounds.	Key Implemented in Part	Environmental Services Natural Reserves Coordinator	Staff Time & Action \$5,000 per annum
7	Seek approval for a Fire Management Plan in conjunction with the Department of Parks and Wildlife. Ensure any prescribed burning in the reserve conforms to the Fire Management Plan.	Key Implemented in Part	Engineering Services Fire and Emergency Services	\$4,000 for the plan and \$1,000 per annum to implement
8	Determine management zones for habitat conservation and protection of trees for Cockatoo Breeding and continue monitoring including "Cockatube" use in the area.	High Implemented in Part	Environmental Services Natural Reserves Coordinator and SJ Landcare	\$5,000 per annum

Social and Economic Recommendations

No.	Action	Priority Status	Responsibility	Cost Estimates
9	Investigate developing appropriate signage to advise users of the proposed activity, environmental values, restricted use of the area, history and management of the reserves.	Medium Not Yet Implemented	Natural Reserves Coordinator Environmental Services	Staff Time \$1,000 per annum

No.	Action	Priority Status	Responsibility	Cost Estimates
10	Notify residents who live in the area through letter box drops and various community consultation measures of the extractive industry operational activity proposals.	Medium Not Implemented Yet	Natural Reserves Coordinator Environmental Services	Staff Time \$1,000 per annum
11	Control access through the provision of gates, barriers or trenches to the reserve's pit area.	Key Implemented in Part	Operations Parks and Natural Reserves Coordinator	Maintenance \$2,000 per annum
12	Minimise the risk of introduction and spread of dieback through a dieback management plan and up to date mapping of dieback and ensuring earth-moving machinery is clean on entry and when leaving the area (moving soil in dry conditions only and restricting any incoming materials to be clean).	Medium Not Implemented Yet	Natural Reserves Coordinator Environmental Services	Consultant estimate \$3,000 per annum
13	<u>Report before the end of each financial year to the Reserves Advisory Group, Department of Environment Regulation and Department of Parks and Wildlife on fauna species contacts and rehabilitation offset plantings accompanied by a completion criteria, description of the planting, the number of plants and the species composition, structure and vegetation density.</u>	Key Not Implemented Yet	Natural Reserves Coordinator Environmental Services	Staff Time \$1,000 per annum
14	Avoid, minimize and offset actions with rehabilitation areas for areas proposed to be cleared and mined utilizing a range of local native species including Black Cockatoo feeding habitat, attracting species, installing artificial nesting "cockatubes" and planting local native species elsewhere on the reserves for conservation and amenity.	Medium Not Implemented Yet	Natural Reserves Coordinator Environmental Services	Staff Time \$5,000 per annum
15	Refer the proposal to the State government and Federal Department of Sustainability, Environment, Water, Population and Community (SEWPaC) for their consideration.	Key Not Implemented Yet	Natural Reserves Coordinator Environmental Services	Staff Time \$1,000 per annum
16	Ensure that development pressures from inappropriate uses such as dumping rubbish, use by motorcycles or horses are monitored and managed with rubbish removal taking place, signage and surveillance as required.	High Implemented in Part	Natural Reserves Coordinator Operations	Staff Time \$2,000 per annum

Implementation, Monitoring and Review

No.	Action	Priority Status	Responsibility	Cost Estimates
17	Implement, monitor and review and revise the management plan details as necessary including achievements of staged completion criteria, new completion criteria determinations for achieving clearing offset requirements.	Medium Implemented in Part	Environmental Services Operations, Parks and Reserves Officer	Staff Time \$1,000 per annum

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Appendix A – Flora Survey Data

Scrivener Road Gravel Reserve (R26079/26080) 2015

Three permanent monitoring quadrats were set up on 3/11/08, one within each of the three floristic communities present in Scrivener Road Gravel Reserve (A in swamp, B in lateritic woodland, C in jarrah forest). These were resurveyed on 12/10/09 and additional species from near the quadrats were added to the list. Repeat surveys occurred on 14/10/10 and 17/9/12. A walk-through survey occurred on 21/9/15.

Flora List for Scrivener Road Gravel Reserve (number refers to year of survey)

Plant species	Quadrat A	Extras near A	Quadrat B	Extras near B	Quadrat C	Extras near C	Extras in walk-through
<i>Acacia alata</i>					*	*	
<i>Acacia extensa</i>		*					*
<i>Acacia lasiocarpa</i>	*						
<i>Acacia lateritica</i>		*	*				
<i>Acacia pulchella</i>	*				*	*	
<i>Acacia saligna</i>				*			
<i>Acacia urophylla</i>			*	*			
<i>Adenanthos barbiger</i>					*		
<i>Agrostocrinum hirsutum</i>			*		*		
<i>Allocasuarina fraseriana</i>		*		*			*
<i>Asplenium trichomanes</i>	*						
<i>Astartea scoparia</i>	*						
<i>Astroloma pallidum</i>	*		*		*		
<i>Austrodanthonia acerosa</i>			*				
<i>Baeckea camphorosmae</i>		*			*		
<i>Banksia grandis</i>							*
<i>Banksia littoralis</i>	*	*					
<i>Banksia nivea</i>		*	*		*		
<i>Banksia sessilis</i>		*	*		*		
<i>Billardiera heterophylla</i>			*		*		
<i>Boronia fastigiata</i>	*						
<i>Bossiaea ornata</i>			*		*		
<i>Burchardia congesta</i>	*		*		*	*	
<i>Caesia micrantha</i>					*	*	
<i>Caladenia flava</i>	*		*		*		
<i>Caladenia longicauda</i>			*		*		
<i>Cassytha pomiformis</i>	*		*		*		
<i>Chamaescilla corymbosa</i>	*		*		*		
<i>Chorizema rhombeum</i>			*				
<i>Clematis pubescens</i>							*
<i>Conostylis setigera</i>			*		*		
<i>Conostylis setosa</i>			*		*		
<i>Corymbia calophylla</i>	*		*		*		
<i>Craspedia variabilis</i>			*		*		
<i>Cyrtostylis huegelii</i>							*
<i>Dampiera alata</i>	*						
<i>Dampiera linearis</i>			*		*		
<i>Daucus glochidiatus</i>							*
<i>Daviesia preissii</i>					*		*

Plant species	Quadrat A	Extras near A	Quadrat B	Extras near B	Quadrat C	Extras near C	Extras in walk-through
<i>Diuris</i> sp.					*		
<i>Drosera erythrorhiza</i>			*				
<i>Drosera gigantea</i>	*	*					
<i>Drosera glanduligera</i>	*	*					
<i>Drosera menziesii</i>			*				
<i>Drosera pallida</i>			*	*	*		
<i>Elythranthera brunonis</i>			*		*		
<i>Eriochilus</i> sp.			*		*		
<i>Eucalyptus marginata</i>	*		*		*		
<i>Eucalyptus rudis</i>	*						
<i>Gastrolobium capitatum</i>					*		
<i>Gompholobium knightianum</i>	*		*		*		
<i>Gompholobium marginatum</i>	*						
<i>Gompholobium polymorphum</i>					*		
<i>Gompholobium preissii</i>			*				
<i>Gonocarpus pithyoides</i>			*		*		
<i>Goodenia pulchella</i>							*
<i>Grevillea pilulifera</i>					*		
<i>Haemodorum laxum</i>	*	*					
<i>Haemodorum simplex</i>	*						
<i>Hakea amplexicaulis</i>							*
<i>Hakea lissocarpha</i>			*		*		
<i>Hakea prostrata</i>		*			*		
<i>Hakea stenocarpa</i>			*		*		
<i>Hibbertia amplexicaulis</i>				*	*		
<i>Hibbertia commutata</i>			*	*	*		
<i>Hibbertia diamesogenos</i>		*	*				
<i>Hibbertia hypericoides</i>		*	*		*		
<i>Hibbertia lasiopus</i>				*			
<i>Homalosciadium homalocarpum</i>							*
<i>Hovea chorizemifolia</i>			*				
<i>Hovea trisperma</i>			*		*		
<i>Hyalosperma cotula</i>		*	*				
<i>Hypocalymma angustifolium</i>	*		*				
<i>Hypocalymma robustum</i>		*					
* <i>Hypochoeris glabra</i>			*		*		
* <i>Hypochoeris radicata</i>							*
<i>Hypolaena exsulca</i>	*						
<i>Isopogon sphaerocephalus</i>			*		*		
<i>Isotoma hypocrateriformis</i>			*				
<i>Kennedia prostrata</i>					*		
<i>Kunzea micrantha</i>		*					
<i>Labichea punctata</i>					*		
<i>Lagenophora huegelii</i>			*		*		*
<i>Lasiopetalum bracteatum</i>							*
<i>Laxmannia squarrosa</i>		*					
<i>Lechenaultia biloba</i>		*	*		*		
<i>Lepidosperma leptostachyum</i>			*		*		
<i>Lepidosperma pubisquameum</i>							*

Plant species	Quadrat A	Extras near A	Quadrat B	Extras near B	Quadrat C	Extras near C	Extras in walk-through
<i>Lepidosperma scabrum</i>						*	
<i>Lepidosperma</i> sp. E Perth Flora			*		*		
<i>Leptospermum erubescens</i>							*
<i>Leucopogon capitellatus</i>			*		*		
<i>Leucopogon</i> sp.	*		*		*		
<i>Levenhookia pusilla</i>			*				
<i>Lomandra capitellatus</i>					*		
<i>Lomandra purpurea</i>			*		*		
<i>Loxocarya</i> sp.			*				
<i>Macrozamia riedlei</i>		*		*		*	
<i>Melaleuca preissiana</i>	*						
<i>Millotia tenuifolia</i>							*
<i>Mirbelia dilatata</i>	*						
<i>Neurachne alopecuroidea</i>	*		*	*	*		
<i>Nuytsia floribunda</i>		*					
<i>Opercularia hispidula</i>			*				
<i>Opercularia vaginata</i>			*		*		
<i>Orthrosanthus laxus</i>							*
<i>Patersonia occidentalis</i>					*		
<i>Pentapeltis peltigera</i>			*		*		
<i>Pericalymma ellipticum</i>	*						
<i>Persoonia elliptica</i>							*
<i>Persoonia longifolia</i>							*
<i>Phyllanthus calycinus</i>				*	*		
<i>Pimelea preissii</i>					*		
<i>Pimelea suaveolens</i>			*		*	*	
<i>Platysace filiformis</i>			*				
<i>Pterostylis barbata</i>			*				
<i>Pterostylis nana</i>			*		*		
<i>Pterostylis recurva</i>			*		*		
<i>Ptilotus manglesii</i>			*		*		*
<i>Pyrorchis nigricans</i>				*		*	
<i>Scaevola calliptera</i>			*		*		
<i>Schoenus</i> sp.	*						
<i>Senecio hispidulus</i>							*
<i>Sphaerolobium</i> aff. <i>macranthum</i>	*				*		
<i>Stylidium brunonianum</i>			*		*		
<i>Stylidium bulbiferum</i>		*	*				
<i>Stylidium hispidum</i>		*	*		*		
<i>Stylidium junceum</i>	*		*		*		
<i>Stylidium piliferum</i>			*		*		
<i>Stylidium schoenoides</i>				*			
<i>Stylidium striatum</i>			*		*		
<i>Synaphea petiolaris</i>			*				
<i>Taxandria linearifolia</i>	*						
<i>Tetraria octandra</i>	*				*		
<i>Tetrarrhena laevis</i>			*		*		
<i>Tetratheca hirsuta</i>					*		
<i>Thelymitra antennifera</i>		*					

Plant species	Quadrat A	Extras near A	Quadrat B	Extras near B	Quadrat C	Extras near C	Extras in walk-through
<i>Thelymitra crinita</i>	*		*		*		
<i>Thelymitra macrophylla</i>			*				
<i>Thelymitra vulgaris</i>					*	*	
<i>Thysanotus manglesianus</i>							*
<i>Thysanotus tenellus</i>	*		*				
<i>Thysanotus thyrsoides</i>					*		
<i>Trachymene pilosa</i>			*				
<i>Trichocline spathulata</i>			*		*		
<i>Tricoryne elatior</i>	*				*		
<i>Trymalium ledifolium</i>			*		*		
<i>Verticordia huegelii</i>		*					
<i>Viminarea juncea</i>	*	*					
<i>Xanthorrhoea gracilis</i>					*		
<i>Xanthorrhoea preissii</i>	*		*		*		
<i>Xanthosia huegelii</i>			*		*		

* Introduced species

Appendix B

WATER MANAGEMENT PLAN

Lots 1913 and 2272 Scrivener Road, Serpentine Shire of Serpentine Jarrahdale

PREPARED FOR

SHIRE OF SERPENTINE JARRAHDAL

BY

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Introduction

This Water Management Plan (WMP) relates to an application for gravel extraction on Lots 1913 and 2272 Scrivener Road, Serpentine, Shire of Serpentine Jarrahdale and should be read in conjunction with the report entitled "Scrivener Road Gravel Reserves, Management Plan".

This report provides the following information:

- A description of the property and surrounds indicating the current contours
- A description of the proposed extraction program
- Storm water and erosion management measures
- A description of the groundwater hydrology in the area
- A description of the potential for acid sulphate soil impacts

Property Description and Locality

Property Description: Lot 1913 East and Lot 2272 Scrivener Road, Serpentine, Shire of Serpentine Jarrahdale

Area: 37.3095 hectares Lot 1913 East
50.2919 hectares Lot 2272

Lot Type: Crown Reserve (vested with the Shire of Serpentine Jarrahdale)

Lots 1913 and 2272 are situated southeast of the town of Serpentine, on the southern side of Scrivener Road, approximately 4km by road east of South Western Hwy.

Background

Land Use

The property has been used for gravel extraction and conservation. Properties in the nearby area are mainly conservation or farming.

Topography and Drainage

The property is located at the top of the Darling Scarp, in the Peel Estuary-Serpentine River Catchment within the Murray River Basin. The Serpentine River lies at closest approximately 1.5km north of the property. The Serpentine River flows west then south towards Mandurah where it discharges into the Peel Harvey Inlet.

The elevation of Lot 1913 East ranges from 270 to 316m AHD from north to south, with Stage 1 (see Section 4 and Figure 1) between 285 and 315m AHD and with medium slopes averaging 10%. Elevation of Stage 2 is between 280 and 316m AHD with medium slopes averaging 13%. Drainage within the property is generally north-westwards towards a streamline running along Scrivener Road which discharges north into the Serpentine River. At the closest point the extraction area (Stage 2) is approximately 130m from this streamline. Any proposed water extraction for dust suppression will be considered in a context not to contribute to any drying up of a streamline or a spring system.

There are Conservation and Multiple Use wetlands located approximately 320m to the west and 600m to the east of the proposed extraction area (Western Australian Land Information System [WALIS] 2015). These wetlands will not be impacted by the proposed extraction activities. There are no RAMSAR wetlands or Environment Protection Policy (EPP) lakes or wetlands within the site or within 1 500 m of the proposed extractive operations (WALIS 2015).

On the northwest of the R1 rehabilitation area there is an existing damp land affected by the past extractive operations. Impoundment for storm water management for past extractive operations on site has been accommodated in this area in the past. Aside from this impoundment, the properties do not include any expressions of surface water such as lakes, wetlands, dams, rivers or creeks, and no surface drainage lines have been identified within the proposed project areas.

The property falls within a *Rights in Water Irrigation Act 1914* (RIWI) Surface Water Proclamation Area (Serpentine River System). The property does not fall into a RIWI Groundwater Proclamation Area or a Public Drinking Water Source Area (WALIS 2015).

Surface runoff within the proposed project area will require management and this is discussed later in this document.

Geology and Soils

The soils of Scrivener Road Gravel Reserve are part of the Darling Plateau system, consisting of lateritic soils and gravels and represent the remnants of an ancient soil horizon developed on the granites and gneisses of the Western Gneiss Terrane that underlie the area. The typical profile of the deposit is a grey brown sand loam soil over yellow brown pisolitic gravels and laterite cap rock of up to 5 metres thick. Under the cap rock lies 1-2 metres of gibbsite (aluminium hydroxide) which in turn overlay variable depths of clay typically 10-20 metres thick. The clay is mottled red, yellow and brown in the upper region, but white below the water table nearer the granite basement. The ferricrete raw material is a combination of the gravels,

lateritic cap rock and gibbsite layers.

Groundwater Hydrology

The underlying rock in the proposed extraction area is granitic which has weathered to clays. Groundwater reserves within this material are very limited and have no regional significance. Generally the water table in these materials occurs at approximately 20m below ground level, which is directly above the unweathered granite. Rainfall is discharged mainly by runoff, with some infiltration into the shallow clays which discharge lower down the scarp as springs. It is noted that there has already been some significant runoff coming from the previous extraction operation but that this will be addressed with the new operations which will concentrate on rehabilitating existing disturbed areas first and then through minimal operational footprint in new areas. Mined areas will be rehabilitated with existing topsoil straight away minimizing any top soil storage periods and all topsoil redistribution will be done with furrowing following the contours for maximum infiltration and minimal runoff.

Groundwater quality in the Shire is generally good, although there is limited information on which to base an analysis. There is little information on groundwater quality in the area of the reserve, but although groundwater quantity is limited, its quality is believed good. There are no problems which are currently thought to affect the area. Salinity is not a major problem for the reserve as it (and its upstream catchment area) does not suffer from rising saline groundwater.

Rainfall

The closest rainfall recording station is Serpentine and data from this station has been downloaded from the Bureau of Meteorology (BoM). Table 1 shows the average monthly rainfall, and a mean annual rainfall of 930.3mm, for Serpentine (BoM 2015a). The wettest months are June, July and August and the driest months are December, January and February. The highest recorded annual rainfall was 1 389.0mm in 1926 and the lowest was 500.4mm in 2006.

Table 1: Mean Rainfall Data (mm) for Serpentine 9039 for Period 1905 to 2015

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9.5	11.7	17.3	48.5	128.1	188.0	180.9	139.2	90.2	56.7	24.6	13.6	930.3

For the design of stormwater management, rainfall intensity has been calculated using the BoM's Intensity-Frequency-Duration (IFD) data system (BoM 2015b), which yields the two hour 10 year average return interval (ARI) storm event for the property as 19.9mm/hr. The Department of Water (DoW) recommends that surface water runoff produced within the mined area from this rainfall event should be contained within the pit (DoW 2014). This aspect is discussed in Section 5.2 of this document.

The Development Proposal

It is proposed to extract gravel from 12ha, in two equal 6ha stages, by using a front-end loader, bulldozer and crusher/screening plant. This will result in the extraction of approximately 1 600 000 tonne of material over a period of twenty years (between \$75 000 and \$80 000 tonne per year). The Shire of Serpentine Jarrahdale intends to obtain a Contractor to help mine the resource and it is proposed that the resource will be used within the Shire only.

Proposed mining actions are as follows:

- The extraction of gravel from an area of 12ha in two equal stages as shown on Figure 1.
- Prior to extraction taking place, clearing of native vegetation will be undertaken by mechanical means. Cleared vegetation will be windrowed and stockpiled for redistribution in the rehabilitation process.
- Topsoil and overburden will be removed from the extraction area in stages with only the areas targeted for immediate extraction being opened. Topsoil and over-burden will be stockpiled separately, with stockpiles being no higher than three metres.
- Extraction activity will result in the lowering of the ground level by between 3 and 5m, depending on the depth of the laterite gravel layer.
- Crushing and screening will be undertaken in campaigns of 100 000m³ every three years.
- There will be no blasting.
- The completion of rehabilitation commitments (See “Scrivener Road Gravel Reserves, Management Plan” report).

Dust management will be undertaken by the use of a water cart to damp down areas that may generate dust from time to time. This will be the only water requirement for the operation, and it is proposed to source the water from external sources.

The property falls within a RIWI Surface Water Proclamation Area (Serpentine River System) (WALIS 2015). According to the DoW a licence is required if surface water is utilised or diverted. The Shire of Serpentine Jarrahdale do not intent to utilise or divert surface water for the proposed mining, therefore no surface water licence is required.

The site is located within an un-proclaimed Groundwater Area under the Rights in Water and Irrigation Act 1914. The hydrogeology is quite variable and difficult to define and therefore the Department of Water does not have extensive information regarding groundwater depths or aquifer parameters. In the absence of on-site groundwater information, excavation will be restricted to the laterite gravel layer and further excavation will be avoided to minimize the potential of intersecting groundwater. Should groundwater be intersected the area will be backfilled to achieve a separation distance of 2 metres from the water table.

There are no licensed production bores within 100 metres of the pit operations.

Water Management

In all mining operations the potential exists for impacts to be incurred on surrounding water resources, or by storm water erosion of exposed areas. The water management strategies outlined below will ensure the mitigation of potential impacts.

Surface Water Management

There are a number of Conservation and Multiple Use wetlands near the property. However, the closest wetland is approximately 320m from the extraction area, which is outside of the DoW guidelines recommend buffer distance of 200m from sensitive water resources. Adequate top soil of gravel will be redistributed to recreate the sponge effect of the gravel layers proposed to be removed.

There is a streamline that runs from Scrivener Road (northwest of Lot 1913 East) to the Serpentine River. At the closest point the extraction area (Stage 2) is approximately 130m from this streamline. On the northwest of the R1 rehabilitation area there is an existing impoundment that was created for stormwater management for past extractive operations. Aside from this impoundment, the properties do not include any expressions of surface water such as lakes, wetlands, dams, rivers or creeks, and no surface drainage lines have been identified within the proposed project areas.

The stormwater management measures described below will ensure that there is no un-managed surface water runoff from the excavation area.

Stormwater Management

The DoW recommends that surface water runoff produced within the mined area from the two hour 10 year ARI Design Storm should be contained within the pit¹. As shown in Section 3.5, this equates to a rainfall intensity of 19.9mm/hr. Runoff generated from this event has been calculated using the Rational Method over a two hour period. The runoff coefficient used for the calculation is 0.6 for disturbed areas (ODOT 2014). Since each stage is 6ha in area, it is calculated that a holding volume of approximately 1 432m³ is required per stage. The subsurface flow will be minimized and the water retained maximized through the furrows created on the contours and the immediate soil humus, mulch and debris used in the rehabilitation.

Stormwater management structures will be designed to manage at minimum this runoff. Two detention ponds will be excavated per stage, located at the base of the pits (at the northern boundaries) and midway down the pits on the eastern boundaries. The detention ponds will be 1m deep and cut-off drains will ensure all runoff is diverted into the ponds (Figure 2). The detention pond at the base of Stage 2 will be located on the northwest of the R1 rehabilitation area where there is an existing impoundment that was created for stormwater management for past extractive operations (the impoundment will be modified to fit the increased capacity requirement).

The DoW recommends that runoff from undisturbed areas is diverted away from disturbed areas¹. The topography of the property means most runoff generated from areas outside the proposed extraction area will not enter the pit. Some runoff could enter the pits at the southern boundary of the stages, and either a diversion trench will be dug along these boundaries or stockpiles will be placed to divert any runoff away from the extraction area. There is potential at

¹ As recommended by the DoW wrd.237672 guideline document (DoW 2014)

the western boundary of Stage 1 for runoff to enter the pit. If this is found to occur, a diversion trench will be dug along this boundary to divert any runoff away from the extraction area.

There will be no un-managed surface water runoff from the proposed operations. After completion of the extraction phase, the base of the pit will be deep ripped along the contour and the low mounds that this creates will be retained after rehabilitation to serve as erosion control. Surface water detention ponds and cut-off drains will be maintained until regenerated vegetation is sufficient to stabilise the ground surface and prevent erosion.

Groundwater Management

No dewatering activities will be undertaken. The project does not involve abstracting groundwater for operational purposes. Predicted water supply requirements are minor and restricted to localised dust suppression, with all water requirements sourced from external sources.

Due to the hydrogeology of the area (see Section 3.4), it is expected no groundwater will be exposed by this development. Furthermore, previous extraction operations adjacent to the proposed extraction area have not encountered groundwater. Soil water flow above the impermeable layer may have occurred in the past through previous extraction operations, but is not expected with the mining rehabilitation monitoring methodology proposed with the inclusion of ripping mounding and furrowing.

Due to the low scale nature of the operations, no groundwater contamination is anticipated. No fuel or lubricant storage will occur on the site. Refuelling will take place using a mobile refuelling vehicle which is equipped with a “snap-on snap-off, fast-fill and auto shut-off” facility. Additionally a Fuel Spill kit will be available on site at all times.

The plant will be refuelled each morning, leaving the vehicles almost empty overnight. No major servicing, which could lead to fuel and oil spills, will take place on the site. Once the proposed extraction is approved, the Shire of Serpentine Jarrahdale will obtain a Contractor to mine the resource. Hence all major servicing will be undertaken off-site at the Contractor’s premises. The Shire of Serpentine Jarrahdale will also ensure the Contractor has a suitable Hydrocarbon Spill Management Plan.

The use of fertilisers may be necessary during the rehabilitation process. At this time, the Department of Agriculture and Food will be consulted as to the appropriate levels of fertiliser requirement. The correct application of these products will serve to control leaching of nutrients into the groundwater.

Herbicides will be used only as required and their use is expected to reduce as vegetation is established. In choosing herbicides, preference will be given to substances that strongly adsorb to soil and have low potential to leach into groundwater.

Monitoring and Management Measures

During the extraction and early rehabilitation phase, the pit will be inspected after every significant rainfall event to check erosion damage. If any repairs are required, this will be attended to immediately.

After pit closure and rehabilitation, monitoring of rehabilitated areas will ensure that any areas requiring remedial work are identified. Monitoring will be carried out on an annual basis to assess:

- The physical stability of the landform in the rehabilitated areas.

- The success of the native vegetation rehabilitation actions.
- The emergence of weeds.

Monitoring will continue until the completion criteria have been fulfilled. Maintenance procedures will be carried out where necessary and may include:

- Repair of any erosion damage.
- Replanting/seeding areas that may not have regenerated.
- Weed control.

Acid Sulphate Soils

A search of the CSIRO's Australian Soil Resource Information System (ASRIS) database determined there were no acid sulphate soil (ASS) sites identified in the proposed extraction area with the area being classified as having an 'Extremely Low Probability of Occurrence' of ASS (ASRIS 2015).

Acid sulphate soils are sediments containing iron sulphides, which occur naturally in layers of waterlogged soils and are benign until disturbed. This is unlikely to be a problem in the reserve, as the soils are well-drained (not waterlogged) and soil disturbance to the level of the water table is improbable.

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