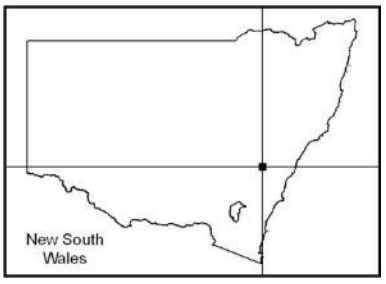
Plan of Management



Jenolan Karst Conservation Reserve



This plan of management was adopted by the Minister for the Environment on 21 February 2019.

Acknowledgments
This plan of management was prepared by staff of the NSW National Parks and Wildlife Service (NPWS), part of the Office of Environment and Heritage (OEH).

NPWS acknowledges that the Jenolan Karst Conservation Reserve is in the traditional Country of the Gundungurra and Wiradjuri peoples.

For additional information about this reserve or this plan of management contact: Jenolan Caves, 4655 Jenolan Caves Road NSW 2790, telephone 1300 76 33 11; or NPWS Kanangra Area, PO Box 330 Oberon NSW 2787, telephone +61 2 6336 1972.

Front cover photographs: Left**,** Pool of Reflections in the River Cave (Jenolan Caves Reserve Trust/OEH). Centre, Brush-tailed rock-wallaby, *Petrogale penicillata* (Rosie Nicolai/OEH). Right, Historic Jenolan Caves House (Rosie Nicolai/OEH).

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Foreword

The Jenolan Karst Conservation Reserve is part of the Greater Blue Mountains World Heritage Area and located in the south-east highlands of New South Wales, near Oberon and south-west of Katoomba. The reserve covers an area of 3,085 hectares and is part of the traditional Country of the Gundungurra and Wiradjuri Aboriginal People.

The reserve protects important and iconic caves, State heritage-listed buildings, the upper reaches of Sydney's drinking water catchment, threatened plant and animal species, as well as a wide range of cave-dependent plants and animals. The reserve also protects several Aboriginal sites and provides the opportunity to study landscape formation processes.

The NSW *National Parks and Wildlife Act 1974* requires that a plan of management be prepared for each karst conservation reserve. A draft plan of management for the reserve was placed on exhibition from 25 October 2013 until 23 January 2014. The submissions received on the draft plan were carefully considered before adopting this plan.

The plan contains several actions to protect our natural environment, including actions to monitor the karst system's health, assist the recovery of threatened species and to control weeds and pest animals. The plan also provides for a range of sustainable recreation opportunities, including camping, bushwalking, caving, cycling and horse riding.

This plan of management establishes the scheme of operations for the Jenolan Karst Conservation Reserve. In accordance with section 73B of the *National Parks and Wildlife Act 1974*, this plan is hereby adopted.

Gabrielle Upton MP

Minister for the Environment

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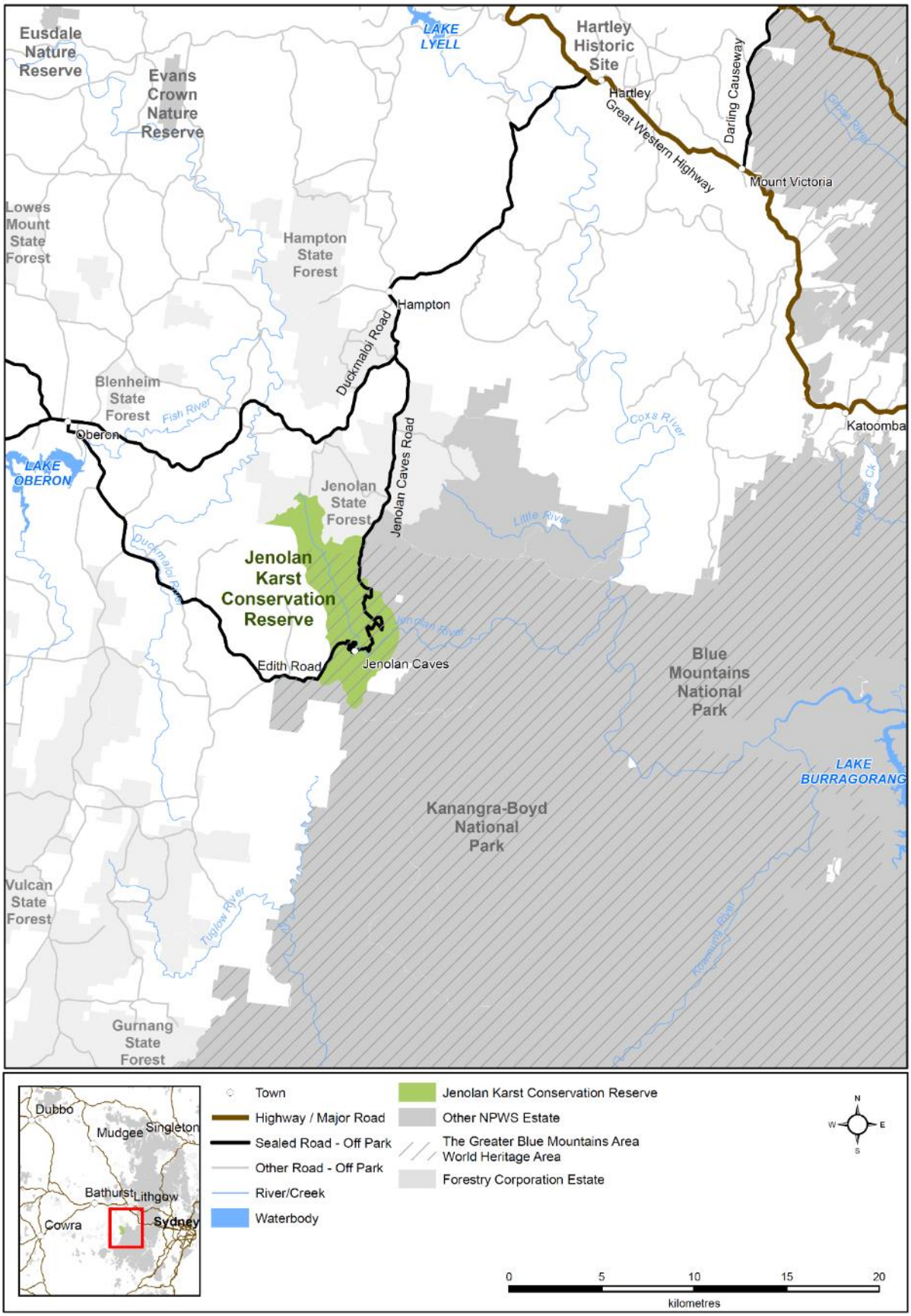

Figure 1: Locality map

1. Introduction

1.1 Location, reservation and regional setting

Features	Description
Location	The Jenolan Karst Conservation Reserve (also referred to as the reserve) is located on the western edge of the Blue Mountains, 29 kilometres south-east of Oberon and 74 kilometres south-west of Katoomba by road, in the south-east highlands of NSW (see Figure 1).
Area	The reserve totals 3085 hectares and is bordered by Jenolan State Forest in the north and Kanangra-Boyd National Park to the east and south. To the west lies the Great Dividing Range which reaches 1320 metres above sea level at its highest point within the reserve.
Reservation date	A total of 2422 hectares were reserved on 8 December 1997. Two additions were made to the reserve: 607 hectares were added in 2009, and 56 hectares were added in 2012. Both additions were in the north of the reserve.
Previous tenure	Original reservation of the Jenolan Caves site occurred in 1866 for the 'preservation of caves'. Immediately prior to reservation under the *National Parks and Wildlife Act 1974* it was Crown land managed under the *Crown Lands Act 1989*. The 2009 addition was land managed by Forestry Corporation of NSW within Jenolan State Forest. The 2012 addition was Crown land managed under the Crown Lands Act. These additions were identified as important for their biodiversity and catchment values through a public land assessment process in the Goulburn Region (Goulburn Region Working Group 2002).
Regional Context	
Biogeographic region	The reserve is located in the South Eastern Highlands Bioregion (Thackway & Cresswell 1995). The reserve forms part of a suite of significant protected areas which comprise the Greater Blue Mountains World Heritage Area encompassing Blue Mountains, Gardens of Stone, Kanangra-Boyd, Nattai, Thirlmere Lakes, Wollemi and Yengo national parks. Jenolan is one of four karst conservation reserves in New South Wales; the others are Borenore, Abercrombie and Wombeyan.
Surrounding land use	State forest borders the reserve in the north; Kanangra-Boyd National Park lies to the east and south; private land borders the reserve in the south-east; and to the west, partially cleared rural land and pine plantations occur.
Other authorities	The reserve is located within the areas of the Pejar Local Aboriginal Land Council and the Oberon Local Government Area. The reserve is located within the area of the Central Tablelands Local Land Services. The reserve is within the Sydney drinking water catchment where Water NSW is the water authority (see section 2.2).

1.2 Statement of significance

The Jenolan Karst Conservation Reserve protects a range of significant World Heritage, landscape, catchment, geological, biological, Aboriginal, historic heritage, research, education, recreational and tourism values. The most significant attribute of this reserve, however, is its karst environment which significantly contributes to the attribution of all other determinations of significance for this site.

World Heritage

In 2000 the southern three-quarters of the current reserve were recognised as part of the Greater Blue Mountains World Heritage Area (GBMWHA) (see Figure 1). The GBMWHA was inscribed on the World Heritage List due to its:

- outstanding examples of ongoing ecological and biological processes significant in the evolution of Australia's highly diverse ecosystems and communities of plants and animals, particularly eucalypt-dominated ecosystems
- significant natural habitats for the in situ conservation of biological diversity, including the eucalypts and eucalypt-dominated communities, taxa with Gondwanan affinities, and taxa of conservation significance.

This includes a very high diversity of scleromorphic (hard-leaved) species within 20 plant families. Many of these plants are of conservation significance due to being either relictual species (such as the Wollemi pine which has persisted in highly restricted sites), endemic to the Greater Blue Mountains, rare or threatened, or occupying a restricted range.

Since the 2000 listing of the GBMWHA, the northern quarter of the reserve has been added to the national park estate. While currently unrecognised under the GBMWHA inscription, it should be recognised that this area contains values which would support its inclusion within the GBMWHA, including the presence of a range of scleromorphic species and rare eucalypts.

The reserve forms part of the area of highest eucalypt diversity in Australia and provides a record of the outcomes of evolutionary processes caused by global climate change in the late Tertiary and the Quaternary geological time periods.

Landscape/Catchment

The reserve is one of several national parks and reserves which straddle the Great Dividing Range and it forms an important part of the Kanangra-Boyd to Wyangala Link of the Great Eastern Ranges corridor.

The reserve protects most of the upper catchment of the Jenolan River which is located within the Warragamba catchment and the Mid Coxs River subcatchment. Water from the Warragamba catchment supplies Lake Burragorang, the largest urban water supply in Australia and the primary source of domestic water for the Sydney region, and a major water source for the Blue Mountains. The reserve was also designed to include the upper catchment of the Jenolan River to assist in managing water quality and other biological processes important for the maintenance of karst landscapes.

Geological

The reserve occupies a significant geological boundary between the Lachlan Fold Belt and the Sydney Basin. The reserve protects an ancient landscape of significant geodiversity value. The exceptional diversity of karst and cave types in the reserve alongside non-karst environments highlights its geomorphological significance. The cave systems of the karst landscape are important for their antiquity and their aesthetic, scientific and recreational values. The reserve's karst contains over 300 'tagged' caves and karst features, and a

significant percentage of the discovered cave passage is linked, forming a single system within three catchments. McKeowns Valley arguably contains some of the pre-eminent assemblages of karst features in Australia, demonstrating changes in land formation and life over an extended period. The fossil record of the caves provides insight into ancient environments that once existed. The landscape tells a story of ongoing and long-term changes to the geology, climate and landform, and past and present life systems and processes. The caves contain sites which provide evidence of the once widespread Gondwanan flora and fauna.

Biological

The reserve supports rare and threatened plants, animals and ecological communities. The caves support a wide range of cave-dependent plants and animals. The reserve contains forests and woodlands which are important habitat for a suite of hollow-dependent animals. The reserve's distinct ecological environment integrates above- and below-ground systems to produce an environment particular to only a few places in the world. The reserve has one of the richest cave invertebrate taxa in temperate Australia with 126 invertebrates recorded (Thurgate et al. 2001). Located within the Kanangra-Boyd to Wyangala Link of the Great Eastern Ranges Initiative, the reserve contributes to the increased opportunities for species to move, adapt and survive threatening environmental events.

Aboriginal heritage

There are a large number of Aboriginal sites in the reserve, many of which are known to the traditional owners. A limited number have been recorded to date. The archaeological sensitivity of ridges, limestone slopes and creek and river flats is predicted to be high (Anutech 1988). The Aboriginal community continue their strong connection to the land.

Historic heritage

The reserve is listed on the State Heritage Register in recognition of its historical, social, aesthetic, research and rarity values. The reserve includes a range of built heritage items including the 19th century Caves House, the Six Foot Track and Australia's first hydro-electric scheme. The reserve's aesthetic values include its spectacular caves and cave formations; the dramatic setting of the caves hamlet and picturesque Caves House dwarfed by the surrounding cliffs of the Jenolan Valley; the entrance to the hamlet through the fortress-like Grand Arch; and the distinctive Blue Lake. The history of Jenolan Caves charts the early development of tourism in New South Wales and demonstrates a long and significant association with tourists, speleologists and guides. The creation of the Fish River Caves Reserve in 1866 (which now forms part of the reserve) represents the first time a natural feature in New South Wales was protected by gazettal of a public reserve.

Recreation and tourism

The show caves are the reserve's principal visitor attraction. This is due to the spectacular nature of the caves and cave formations located within a largely undisturbed nature reserve with high relief and set within a valley with significant heritage buildings and structures. The reserve is situated close to the major and growing population centre of Greater Sydney. The reserve's recreational opportunities complement other opportunities provided in natural settings within the GBMWHA. Tourism operations in the reserve provide employment in a rural area with few employment opportunities.

Research and education

The reserve is important as a place to interpret and educate visitors about the karst landscape, World Heritage values, and historic and Indigenous heritage. There is a long and celebrated history of research in the reserve, particularly associated with the caves and the karst landscape. The reserve provides the opportunity to study landscape formation processes, including how climate has changed over geological time, and provides a window into the past and its ancient plants and animals, some of which are preserved as fossils in the caves.

2. Management context

2.1 Legislative and policy framework

The management of karst conservation reserves in New South Wales is in the context of a legislative and policy framework, primarily the *National Parks and Wildlife Act 1974* and Regulation, the *Biodiversity Conservation Act 2016* and the policies of the National Parks and Wildlife Service (NPWS). NPWS is part of the Office of Environment and Heritage (OEH). The area is also governed by the *Water NSW Act 2014* and *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (referred to in this plan as 'the Sydney Drinking Water Catchment SEPP').

Other legislation, strategies and international agreements may also apply to management of the reserve. In particular, the *Environmental Planning and Assessment Act 1979* may require assessment of the environmental impact of works proposed in this plan. The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* may apply in relation to actions that impact matters of national environmental significance, such as World Heritage Areas and migratory and threatened species listed under that Act. The *Heritage Act 1977* regulates activities in the reserve in relation to listed heritage items. The Sydney Drinking Water Catchment SEPP requires that a public authority (such as NPWS) must, before it carries out or consents to any activity in the catchment, consider whether the activity would have a neutral or beneficial effect on water quality.

A plan of management is a statutory document under the National Parks and Wildlife Act. Once the Minister has adopted a plan, the plan must be carried out and no operations may be undertaken in relation to the lands to which the plan relates unless the operations are in accordance with the plan. This plan will also apply to any future additions to the reserve. Should management strategies or works be proposed in future that are not consistent with this plan, an amendment to the plan will be required.

A plan of management was prepared for the reserve (Cameron McNamara Consultants 1988) prior to its reservation as a karst conservation reserve under the National Parks and Wildlife Act. That plan was prepared on behalf of the land managers at that time, the Tourism Commission and the Department of Lands.

National Parks and Wildlife Act amendments

In 1989 the Jenolan Caves Reserves Trust ('the Trust') was established under the Crown Lands Act to manage Jenolan, Wombeyan and Abercrombie caves. Amendments to the National Parks and Wildlife Act in 1997 established the Jenolan Caves as a karst conservation reserve and transferred its management from the Crown Lands Act.

In 2005, in accordance with the *National Park and Wildlife Amendment (Jenolan Caves Reserves) Act 2005*, the management of the reserve transferred from the Trust to the Director-General of the (then) Department of Environment and Conservation in two stages. All but 50 hectares of the reserve was transferred to the department in 2006. The Trust has retained interim care, control and management of the remaining 50 hectares of the reserve, called the Jenolan Visitor Use and Services Zone (see Figure 2 and Zoning subsection below).

An administrator has been appointed by the Minister to manage the affairs of the Trust during this interim period. Once this plan is adopted and future management arrangements for the provision of visitor services within the Zone are finalised, then in accordance with the National Parks and Wildlife Act, a proclamation may be issued declaring an end to the interim period, abolishing the Trust and transferring management responsibility of the Visitor Use and Services Zone to the Director-General (now Chief Executive).

The 2005 amendments to the National Parks and Wildlife Act also established a karst management advisory committee which provides advice to the National Parks and Wildlife Advisory Council on the protection and conservation of karst environments in New South Wales, including the Jenolan Karst Conservation Reserve.

Zoning within the reserve

In accordance with the National Parks and Wildlife Amendment (Jenolan Caves Reserves) Act, the Jenolan Karst Conservation Reserve is divided into two zones: the Visitor Use and Services Zone (VUSZ) and the Conservation Management Zone (see Figure 2).

Both zones are within the karst conservation reserve and as such are reserved under the National Parks and Wildlife Act to protect and conserve areas, including subterranean land, outstanding or representative karst landforms and natural phenomena.

The VUSZ comprises the following seven separate precincts and totals approximately 50 hectares:

- Grand Arch Precinct (see Figures 3 and 4)
- Jenolan Cottages Precinct (see Figure 5)
- Five Mile Road Housing Precinct (see Figure 6)
- Burma Road Housing Precinct (see Figure 7)
- Two Mile Road Housing Precinct (see Figure 8)
- Campground and Utilities Precinct (see Figure 9)
- Bellbird Cottage Precinct (see Figure 10).

Please note that Figures 3 to 10 are included in Appendix A of this plan.

The VUSZ contains land above and below the surface in which infrastructure and associated activities occur which are related to the protection of the reserve's natural, cultural and recreational values, and the provision of visitor services and facilities. This zone includes:

- the majority of the reserve's built heritage
- infrastructure and utilities
- the primary points of access to developed caves (i.e. 'show caves'), semi-developed caves and to caves used for adventure tours.

Subterranean (cave) features which may extend beyond the surface boundary of the VUSZ and those caves which have their opening in the VUSZ are managed consistent with the VUSZ. Currently visitor services and operational management within the VUSZ are primarily provided by the Trust, but may be provided by NPWS and/or lessees and licensees in future.

The Conservation Management Zone comprises the remainder of the reserve and is approximately 3035 hectares and surrounds the VUSZ. The Conservation Management Zone comprises lands above and below the surface in which infrastructure and management activities occur related to the protection of the reserve's natural, cultural and recreational values and to the provision of appropriate recreational opportunities. This zone includes:

- undeveloped (or wild) caves
- walking tracks
- management trails
- day use facilities
- electricity and telecommunication infrastructure
- operational infrastructure.

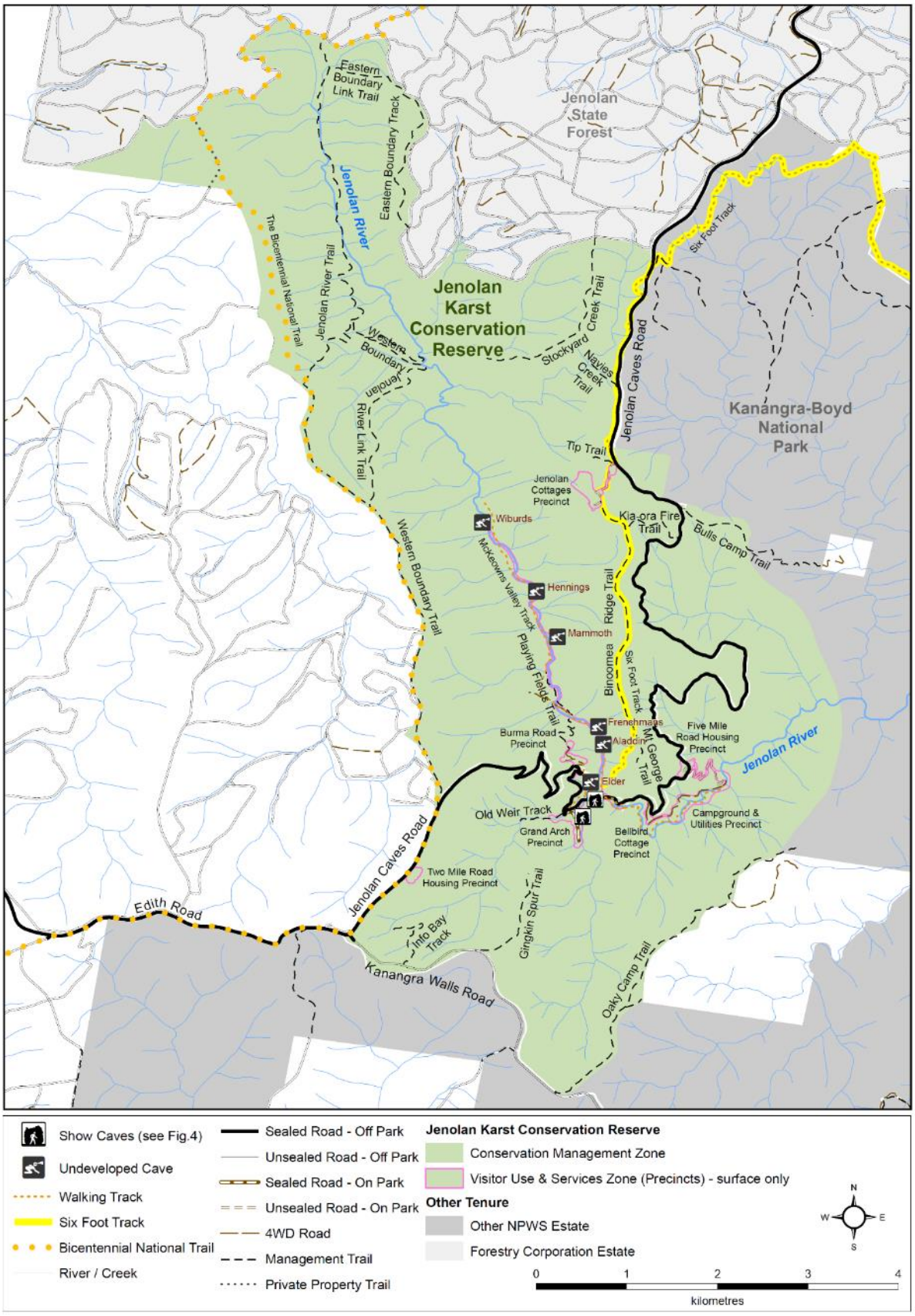

Figure 2: Reserve features

Visitor services and operational management within the Conservation Management Zone are provided by NPWS with some recreational opportunities provided by licensees.

Other policies and guidelines

A range of other policies and guidelines are particularly relevant to management of the reserve's significant natural and cultural values.

Environmental impact assessment of activities

Activities on land reserved under the National Parks and Wildlife Act do not require development consent under Part 4 of the Environmental Planning and Assessment Act.

The environmental impact of activities, such as building and other physical works, is assessed in accordance with the requirements of Part 5 of the Environmental Planning and Assessment Act. This usually occurs via the preparation of a review of environmental factors, which ensures potential impacts are considered before an activity is authorised to proceed. OEH procedures and guidelines detail the specific requirements for environmental impact assessment of activities in land reserved under the National Parks and Wildlife Act.

IUCN Guidelines for Cave and Karst Conservation 1997

The International Union for Conservation of Nature and Natural Resources (IUCN), also known as the World Conservation Union, is an international agency of which Australia is a member. The IUCN seeks to conserve the integrity and diversity of nature, and to ensure that any use of natural resources is equitable and ecologically sustainable.

In 1997 the World Commission on Protected Areas, a commission of the IUCN, developed guidelines for cave and karst protection (IUCN World Commission on Protected Areas 1997). These guidelines recognise the unique management requirements for caves and karst environments and provide the basis for their ongoing protection and conservation.

Burra Charter

In 1979 the Australian branch of the International Council on Monuments and Sites (ICOMOS) adopted the *Australian ICOMOS Charter for the Conservation of Places of Cultural Significance* (called the 'Burra Charter' after the place where it was signed).

The Burra Charter, as amended (see Australia ICOMOS 2013), underlies the practice of heritage conservation in Australia with a number of its elements incorporated into the *State Agency Heritage Guide* (NSW Heritage Office 2005). The Burra Charter defines the basic principles and procedures to be observed in the conservation of important cultural sites, and includes guidelines for establishing cultural significance, conservation policy and the preparation of heritage reports and assessments.

Australian Natural Heritage Charter

The *Australian Natural Heritage Charter for the Conservation of Places of Natural Heritage Significance* was prepared under the auspices of the Australian Heritage Commission. It was adopted in 1996 by the Australian Committee for IUCN to provide guidelines for making sound decisions on the conservation of natural heritage. It was reviewed and updated in 2002 (Australian Heritage Commission 2002). The *Natural Heritage Charter* relates closely in its structure and purpose to the Burra Charter.

Australian Speleological Federation Standards and Guidelines

The Australian Speleological Federation is a registered environmental organisation with primary objectives relating to protection of Australia's cave and karst environment. The Speleological

Federation is also the national body that represents 28 caving clubs and represents Australia on the International Union of Speleology. The federation has developed standards and guidelines for conducting speleological activities, including the *ASF Code of Ethics* (ASF 2014), the *Minimal Impact Caving Code* (ASF 2010) and *ASF Cave Safety Guidelines* (ASF 2011).

2.2 Management purposes and principles

Karst conservation reserves

Karst is a distinct landform which is largely shaped by the dissolving action of water on carbonate rock such as limestone, dolomite and marble. This process typically occurs over thousands or millions of years, resulting in a variety of surface and below-ground features such as arches, gorges, sinkholes, underground streams, passageways and caves. Karst conservation reserves are reserved under the National Parks and Wildlife Act to protect and conserve areas, including subterranean land, containing outstanding or representative examples of karst landforms and natural phenomena.

Under the Act (section 30I), karst conservation reserves are managed to:

- conserve the karst environment, including the protection of catchment values such as hydrological processes and water quality
- conserve cultural values
- protect natural water movement and air movement regimes and processes within the karst environment
- provide for research and monitoring
- conserve biodiversity, maintain ecosystem functions, protect geological and geomorphological features and natural phenomena and maintain natural landscapes, cave functions and fossil deposits
- promote public appreciation and understanding of the reserve's natural and cultural values
- provide for sustainable visitor or tourist use and enjoyment that is compatible with the reserve's natural and cultural values
- provide for the sustainable use (including adaptive reuse) of any buildings or structures or modified natural areas having regard to conservation of the reserve's natural and cultural values.

Reservation of land as a karst conservation reserve places additional management emphasis on the conservation of subterranean ecosystems and the water catchment on which the karst environment depends.

Recreational use, research, management operations and installation of cave infrastructure have the potential to damage fragile karst environments and require careful management (see also Section 3.5 Visitor use and Section 5.1 Management facilities and operations). OEH has developed a range of policies and guidelines that aim to avoid human impacts on karst environments where possible, minimise unavoidable impacts and remediate any damage. Policies and guidelines include:

- *Cave Access Policy* (OEH 2018a)
- ‘Guidelines for Undertaking Development on Karst in OEH Reserves’ (OEH 2013a)
- ‘Guidelines for Managing Fire on Karst’ (OEH 2012b)
- ‘Guidelines for Controlling Weeds on Karst’ (OEH 2012a)
- ‘Karst Monitoring and Evaluation Toolkit’ (DECCW 2010b).

World Heritage

The southern three-quarters of the reserve is part of the World Heritage–listed Greater Blue Mountains World Heritage Area (GBMWHA) (see Figure 1). The GBMWHA was inscribed on the World Heritage List in 2000 as an area of international significance (see Section 1.2 Statement of significance). At that time, only the southern three-quarters of the reserve were part of the national park estate. The addition of new lands to the reserve since 2000 has enhanced protection of World Heritage values. NPWS will work with the NSW and Commonwealth governments to pursue the inclusion of this land to the existing GBMWHA listing.

World Heritage Management Principles and responsibilities are detailed in the Australian World Heritage Intergovernmental Agreement. It includes agreement to manage World Heritage properties in accordance with the World and National Heritage provisions of the Environment Protection and Biodiversity Conservation Act and in accordance with Australia's obligations under the *Convention Concerning the Protection of the World Cultural and Natural Heritage* (UNESCO 1972), called the World Heritage Convention. These obligations are to identify, protect, conserve, present and transmit to future generations Australia's cultural and natural heritage of outstanding universal value. Management arrangements must also ensure that the integrity and authenticity of World Heritage properties at the time of their inscription are maintained. The World Heritage Principles also describe a number of components that management arrangements should contain, including identifying community and stakeholders and how they will participate in property management and decision-making.

A *Greater Blue Mountains World Heritage Area Strategic Plan* has been prepared (DECC 2009a) and was considered in the preparation of this plan. A GBMWHA Management Committee facilitates cooperative management of the GBMWHA at strategic policy and operational levels and one of its primary roles is to oversee the implementation of the *GBMWHA Strategic Plan*. This includes coordinating operational matters between the various land management agencies with responsibilities within the GBMWHA for fire, introduced plants and animals, visitor management and threatened species. The committee comprises representatives of OEH, Jenolan Caves Reserve Trust and the Australian Government Department of the Environment (DECC 2009a).

A GBMWHA Advisory Committee provides advice on planning and management of the GBMWHA in relation to matters that directly relate to the obligations of the Australian and NSW governments arising from World Heritage listing (DECC 2009a).

The GBMWHA is being assessed by the Australian Heritage Council for National Heritage listing for values other than those included in the existing listing (see below), including for historic, Indigenous and broader natural values. If GBMWHA is listed nationally for these values, it may be renominated for World Heritage listing for these values (DECC 2009a).

National Heritage List

The GBMWHA was added to the National Heritage List along with other World Heritage properties in 2007. The GBMWHA was listed for the natural heritage criteria that resulted in its inscription on the World Heritage List.

Management principles for National Heritage places are established under regulations to the Environment Protection and Biodiversity Conservation Act. These principles state that the primary objectives for the management of National Heritage places are to identify, protect, conserve, present and transmit National Heritage values to future generations.

State Heritage Register

The reserve was listed on the State Heritage Register in 2004. OEH policy requires all items listed on the State Heritage Register to have a conservation management plan and to be maintained in accordance with best practice management principles. Under the Heritage Act, all buildings listed on the State Heritage Register (other than ruins) must meet minimum standards of maintenance and repair.

The basis for the reserve's heritage listing, as cited in the State Heritage Register, is:

> Jenolan Caves Reserve is of state significance for its historical, aesthetic, research and rarity values. The caves and karst landscapes developed as important scientific and tourist destinations throughout the late 19th and 20th centuries, and the Reserve is highly significant as the first public reserve set aside in NSW for the protection of a natural resource, in this case, the Jenolan Caves.

Heritage listing regulates activities in the reserve in relation to heritage items. In practice this affects how heritage items are managed, maintained and documented. The Heritage Act establishes an approval process for works likely to affect heritage items. NPWS is required to maintain a Heritage and Conservation Register that details the environmental heritage items under its care and control.

The *Caves House Precinct, Jenolan Caves Reserve: Conservation Plan (Built Environment)* (Moore 1988), the *Jenolan Caves Reserve Heritage Asset Management Strategy* (Godden Mackay Logan 2007), and this plan of management provide a basis and operating framework for managing the reserve's heritage. In 2010 the *Jenolan Karst Conservation Reserve Draft Conservation Management Plan* (Urbis 2010) was prepared). If the draft conservation management plan (CMP) or an alternative is finalised and adopted, it will guide how the reserve's heritage is managed. The previous plan (Moore 1988) will remain an important reference resource.

Leases and licences

Events and commercial activities

Competitions, large-scale organised activities and commercial activities require consent or licensing under the National Parks and Wildlife Act or Regulation. All activities must be consistent with the management principles and the natural and cultural heritage values of the reserve. Applications are assessed in accordance with relevant NPWS policies and procedures.

A licence to operate tours and other visitor experiences in the caves may be granted. Licensing of commercial operators will be in accordance with section 152 of the National Parks and Wildlife Act, the *Parks Ecopass – NPWS's commercial recreational and tour operator licensing system* and associated operating procedures (see OEH 2011c) and the OEH *Cave Access Policy* (OEH 2018a).

Private partnerships

Partnering with private sector enterprises provides opportunities to expand visitor facilities and experiences, support local economies and allow NPWS to focus on conservation and protection of reserve values. Comprehensive legislative and policy provisions enable these partnerships to be regulated in accordance with management objectives.

Leases for the adaptive re-use ('adaptive reuse' as defined by the National Parks and Wildlife Act) of existing buildings in the VUSZ may be granted under the Act provided that the modification and use are carried out in a sustainable manner, are consistent with the

conservation of the natural and cultural values of the land and the retention of the cultural significance of the building.

Leases or licences may authorise the construction of new buildings only in the VUSZ. Leases or licences that authorise the construction of a new building will be limited to the following purposes:

- accommodation for visitors and tourists and associated ancillary retail outlets and facilities to enable conferences, functions and sporting activities
- facilities or amenities for visitors and tourists including information centres, booking outlets, restaurants, cafes, kiosks and other food outlets and associated ancillary retail outlets, and facilities to enable conferences or functions.

Any proposals for adaptive re-use of existing buildings or for new buildings in the VUSZ would be subject to NPWS environmental impact assessment policies and approvals under the Heritage Act. Consideration would also be given to 'Guidelines for Undertaking Development on Karst in OEH Reserves' (OEH 2013a).

Public consultation will be undertaken according to the provisions under section 151F of the National Parks and Wildlife Act before granting a lease or licence.

Environmental regulation, monitoring and review

Section 151D of the National Parks and Wildlife Act requires the Minister to include in any lease or licence of lands within a karst conservation reserve conditions which require the lessee or licensee to comply with the relevant environmental performance standards set out in the plan of management for the reserve. It also requires the environmental performance of any lessee or licensee (in relation to the lands leased or licensed) to be measured against the environmental indicators set out in the plan of management.

The Chief Executive is responsible for monitoring and reporting the environmental performance and compliance of any lessee or licensee (in relation to a lease or license to which section 151D applies) against the environmental performance standards and indicators identified in the plan of management for the reserve.

The reporting of monitoring results is to be undertaken annually, recorded in a register kept in accordance with section 151J of the National Parks and Wildlife Act and placed on the OEH website.

The environmental performance standards, indicators and monitoring requirements for the reserve are listed in Appendix B.

Sydney drinking water catchment

The reserve is within the Warragamba catchment, part of the larger Sydney catchment area as defined by the Water NSW Act and listed in the Water NSW Regulation 2013. Water NSW is the water authority made under the Act. This declared catchment area is referred to as the Sydney drinking water catchment in the Sydney Drinking Water Catchment SEPP (see Figure 11).

The Sydney Drinking Water Catchment SEPP requires public authorities to consider whether a proposed activity would have a neutral or beneficial effect on water quality prior to the carrying out of any activity to which part 5 of the Environmental Planning and Assessment Act applies.

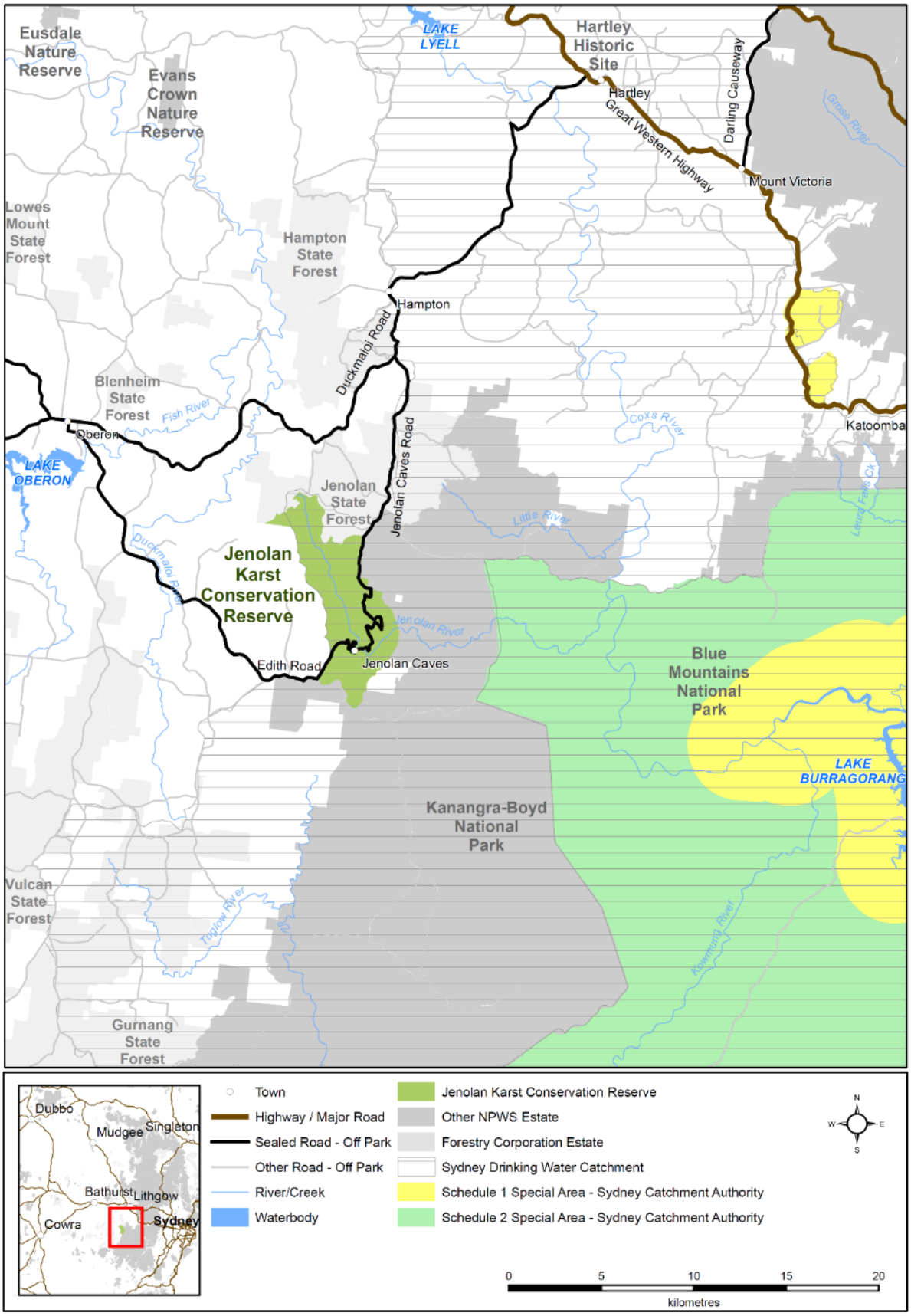

Figure 11: Sydney Drinking Water Catchment

The Sydney Drinking Water Catchment SEPP has three main aims, they are to:

- support healthy water catchments that deliver high quality water and permit development that supports that goal
- ensure that consent authorities only allow proposed developments that have neutral or beneficial effect on water quality
- support water quality objectives in the drinking water catchment.

Gundungurra Indigenous Land Use Agreement

As traditional custodians of the land, Aboriginal people have a unique role to care for and manage Country. This role overlaps with NPWS's legislative responsibilities to manage land for conservation. Partnerships recognise and capitalise on these mutual interests and responsibilities, including recognising that:

- All parks are part of Aboriginal peoples' Country and are places where Aboriginal people can access and care for their Country and its resources. Given the history of dispossession in New South Wales, public lands and parks play an important role in the maintenance of Aboriginal culture and connection to Country. Meaningful engagement with Aboriginal communities on the management and use of parks is essential to ensure that their needs in relation to their Country are met.
- Aboriginal communities obtain cultural, social and economic benefits through being involved in park management.
- OEH, in partnership with the Aboriginal Community, is better able to protect and interpret cultural heritage and to apply Aboriginal knowledge to land management and the conservation of cultural and natural heritage values.
- Visitors to parks have an enriched experience through interaction with Aboriginal people and an understanding of Aboriginal cultural values.

Indigenous land use agreements (ILUA) are agreements made under the Commonwealth *Native Title Act 1993* between a native title group and a relevant Government (either the Commonwealth Government or relevant state or territory government) and other parties (e.g. a native title claimant). These agreements may be used to resolve native title claims and establish access and management arrangements between native title claimants and other land owners within a claim area.

The Gundungurra ILUA was registered with the National Native Title Tribunal on 27 February 2015. The agreement area encompasses 21 parks. The parties to the ILUA include:

- two individuals (Elsie Stockwell and Mervyn Trindall) on their behalf and on the behalf of Gundungurra People
- two Gundungurra organisations: the Gundungurra Tribal Council Aboriginal Corporation and the Gundungurra Aboriginal Heritage Association Inc.
- and the Attorney General, Minister of the Environment, Minister for Primary Industries, OEH, Sydney Catchment Authority (now part of Water NSW), NSW Trade and Investment, and Forestry Corporation of NSW.

A ceremonial signing and celebration was held in Katoomba in June 2015.

The Conservation Management Zone of the Jenolan Karst Conservation Reserve is land covered under Clause 10.1 in Schedule G of the ILUA. While the VUSZ is not currently part of lands covered by the ILUA, the inclusion of it is a future option, providing it meets the conditions of Section 10.1 of the ILUA.

The ILUA is a 'non-native title' agreement, with the claimants agreeing to withdraw their native title claim on registration of the agreement. The Gundungurra People are non-exclusively

recognised as being appropriate people to be engaged to provide heritage advice to NSW Government authorities for land covered by the agreement area.

The ILUA has established a Gundungurra Consultative Committee that may make recommendations to NPWS on the care, control and management of the 21 parks and reserves in the agreement area. The Trust is additionally represented on this committee for the function of consultation in relation to initiatives and plans encompassing the VUSZ. The Gundungurra ILUA parties must be notified of:

- the compulsory acquisition of all interests including native title rights and interests where the Right to Negotiate does not apply
- the grant of a lease or licence other than a lease or licence to which subdivisions G, H and I of the Native Title Act applies
- construction or establishment of public works
- the preparation, adoption and implementation of a plan of management for any part of the agreement area.

The Gundungurra ILUA parties have been appropriately consulted regarding this plan of management.

Wilderness areas

Wilderness areas are large natural areas of land that, together with their native plant and animal communities, are essentially unchanged by human activity. Wilderness areas provide opportunities for solitude and appropriate self-reliant recreation.

Under section 9 of the *Wilderness Act 1987*, wilderness areas will be managed according to the following management principles:

- to restore (where applicable) and to protect the unmodified state of the area and its plant and animal communities
- to preserve the capacity of the area to evolve in the absence of significant human interference
- to provide opportunities for solitude and appropriate self-reliant recreation.

Management of natural and cultural heritage and of introduced species and fire is carried out in wilderness areas as for the other reserves, with special attention paid to minimising impacts on wilderness values.

While no areas within the Jenolan Karst Conservation Reserve are currently declared as wilderness, an area within the reserve has been identified as satisfying the wilderness criteria and consideration is to be given to its declaration in the future. Where appropriate, the principles of section 9 of the Wilderness Act will be applied.

2.3 Specific management directions

In addition to the general principles for the management of the karst conservation reserve (see Section 2.2), the following specific management directions apply:

- Conservation of the reserve's World Heritage values is the primary consideration in their management.
- Support efforts to research, record and assess the significance of the natural and cultural heritage values of the GBMWHA against state, national and World Heritage listing criteria and to seek their formal recognition.
- Develop infrastructure and maintenance regimes to protect the karst environment while meeting visitor needs.

- Prevent or minimise unnatural chemical and mechanical weathering and other damage to geological features/diversity through intervention, monitoring and stabilisation.
- Ensure that management activities and visitor use have minimal impacts on the area's scenic and aesthetic values.
- Support research programs to assist managers, particularly in relation to threatened species, monitoring, fire management, pest species control and impacts of visitor use.

3. Values

This plan aims to conserve both natural and cultural values of the reserve. The location, landforms and plant and animal communities of an area have determined how it has been used and valued by both Aboriginal and non-Aboriginal people. These values may be attached to the landscape as a whole or to individual components, for example to plant and animal species used by Aboriginal people. To make the document clear and easy to use, various aspects of natural heritage, cultural heritage, threats and ongoing use are dealt with individually, but their interrelationships are recognised.

3.1 Geology, landscape and hydrology

Geology

The regional geology surrounding the Jenolan karst area is rugged and structurally complex. The geological context in which Jenolan Caves formed is key to understanding how the cave system evolved and has taken a long time to unravel and still requires further study. Geological mapping, largely by the University of Sydney over the past 30 years, has greatly improved knowledge of rock types, their distribution and relationships in the vicinity of Jenolan (Branagan et al. 2014). The geomorphology of Jenolan includes a variety of non-karstic phenomena that are significant in their own right and in some cases are also important because they have a systemic relationship with the karst (Kiernan 1988).

The reserve occupies a significant geological boundary between the Lachlan Fold Belt and the Sydney Basin. It is located within a non-karst area of high relief close to the eastern edge of the south-east highlands plateau, where deeply incised valleys cut through a variety of mostly Palaeozoic rocks. Colluvial deposits are common on the steep slopes of the valleys, particularly on the volcanics, where rudimentary grez litees indicative of cold climate processes have developed. The reserve's geology comprises a series of Upper Silurian andesitic to rhyolitic pyroclastics, cherts, shales and limestone units.

The Jenolan Caves themselves are located in the Silurian (mid Wenlockian) Jenolan Caves Limestone which formed around 430 million years ago and outcrops continuously in a north–south linear belt for some 11 kilometres (Branagan et al. 2014) (see Figure 12). A large number of marine invertebrate fossils have been discovered in the Silurian limestone and adjoining sediments. These include corals, conodonts, stromatoporoids, algae, brachiopods, trilobites, gastropods and straight nautiloids (Chalker 1971; Pickett 1981).

The limestone is 350 metres thick near Caves House (Doughty, cited in Branagan et al. 2014). It has a steep and variable dip, ranging from almost vertical to steeply westwards near the Grand Arch, to steeply eastwards just north of the Devils Coach House. In the south along Camp Creek, and in the north along the Jenolan River the limestone dips westwards. These changes in dip have been attributed to folding along sub-horizontal axes. To the west, the limestone is faulted against Ordovician andesite and laminated siliceous mudstone, while to the east it is overlain by silicic volcaniclastics. To the east is the newly-defined unit, the Inspiration Point Formation, conformably overlying the Jenolan Caves Limestone. It is characterised by felsic volcanics and associated sedimentary rocks and includes limestone that contains rare corals and brachiopods of probable late Silurian age (Branagan et al. 2014). Carboniferous granitic plutons intrude the sequence to the north, east and south of Jenolan Caves (Kiernan 1988).

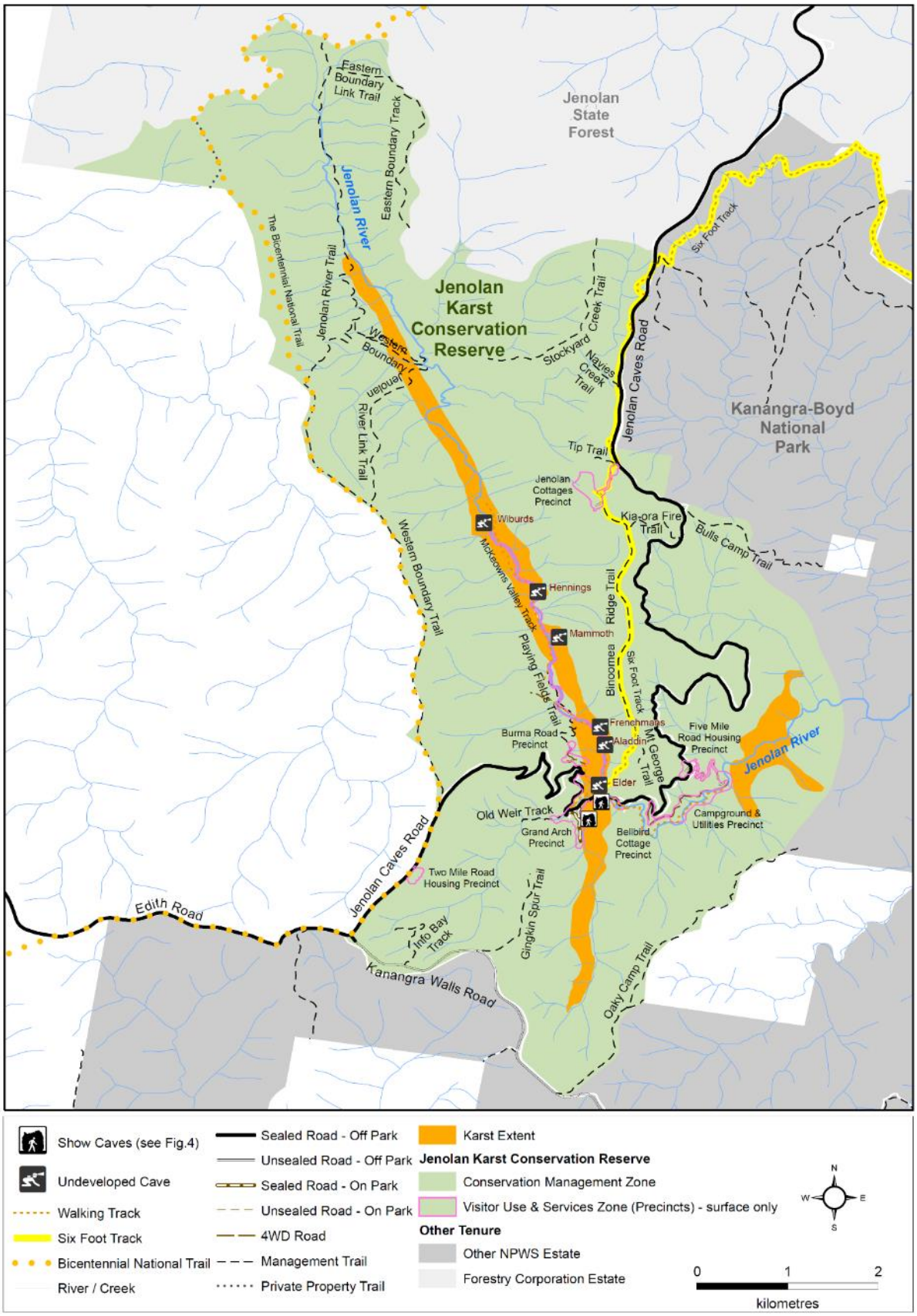

Figure 12: Karst extent

Karst

Karst is a distinct landform, shaped largely by the dissolving action of water on carbonate rock such as limestone, dolomite and marble. Selective chemical dissolution of the Jenolan Caves limestone by naturally acidic waters has resulted in the formation of karst landscape. This process typically occurs over thousands or millions of years, resulting in a variety of surface and below-ground features, including bare rock surfaces, gorges, enclosed depressions, sinkholes, underground streams and caves.

Karst features interact with the environment to produce complex ecosystems supporting highly specialised plants, animals and micro-organisms. These species contribute to biodiversity and, in many cases, are unable to survive elsewhere.

The reserve's karst has significant geodiversity value. Geodiversity is the variety of rocks, minerals, soils and landforms, along with the processes that have shaped these features over time. Geodiversity provides the foundation for life: ecosystems and the lifeforms within them depend on bedrock, soils, landforms and other geological features and processes for their survival. It is also important in understanding the way in which many of the Earth's systems and processes work.

NSW karst environments are of outstanding national and international importance and are recognised as having one of the most complex processes of cave evolution and development yet demonstrated.

The reserve's karst has resulted from two periods of major folding and a number of faulting events. In addition to many smaller-scale structures, a change in the strike of the limestone 1 kilometre north of the Grand Arch is the expression of a large-scale fold known as the Jenolan Mega-kink (Powell et al. 1985). The reserve's karst extent as shown in Figure 12 refers to the main limestone belt and eastern limestone deposits and includes all caves that occur in the reserve. It is an area of high sensitivity with potential for impact from inappropriate development.

Three types of palaeokarst (fossil karst) deposits have been identified in the reserve:

- crystalline palaeokarst consisting of coarse void-filling calcite crystals
- laminated palaeokarst consisting of graded bedded limestone
- clastic palaeokarst consisting of coarse highly cemented gravels.

Secondary pyrite is found in both the clastic and laminated palaeokarst, and dolomite is common in the laminated palaeokarst.

The most spectacular surface karst feature is the wall of limestone 90 metres high and 150 metres wide at the confluence of the Jenolan River, Surveyors Creek and Camp Creek. The reserve's three karst bridges and arches: the Grand Archway; Devils Coach House; and Carlotta Arch are internationally renowned.

Dolines are not common, however, alluvial flats, presumably filled dolines, are significant features of the valley. Rillenkarren is the most common form of subsurface solution sculpture and is particularly well developed on Lucas Rocks.

The Jenolan Caves are not the product of a single recent event during which a single process operated, but rather are the product of a number of different events during which a variety of processes operated. These events took place over a geologically significant period of time (Osborne, cited in Branagan et al. 2014).

The extent of cave development in a relatively thin body of steeply dipping limestone, with an outcrop width of 300 metres, is regarded as an outstanding feature. The Jenolan Caves system contains approximately 20 kilometres of passage. The connected passages are contained in a

1.5-kilometre strike of limestone outcrop which runs in a predominantly north–south direction (Figure 12).

The reserve is renowned for its range and profusion of calcite speleothems (cave formations), including examples of less common forms such as helictites, ribbon helictites, shields, monocrystalline stalagmites and sub-aerial stromatolites. Aragonite speleothems, often with spectacular morphology, are also found in restricted localities. Gypsum speleothems are significant and include forms not reported elsewhere. The reserve also contains a variety of phosphatic, ferrous and manganiferous minerals. These are predominantly of biogenic origin. There is a substantial range of clastic cave sediments, including sand, gravels, laminated clays, red cave earths and a variety of facies deposits, occurring in a variety of relationships at all levels within the cave system.

Karst environments were among the earliest protected areas in the world. The Wombeyan Caves were reserved for the purposes of leisure and cave preservation in 1865, followed by the Jenolan Caves in 1866, both preceding the declaration of the world's first national park, Yellowstone, in 1872.

High quality air and water are essential for groundwater-dependent fauna in the caves and the cave formations. An OEH air and water quality monitoring program, which commenced in 2009, aims to protect the rare cave fauna and the cave formations reliant on specific, stable conditions. Air monitoring targets the following parameters: temperature, relative humidity, barometric pressure and carbon dioxide. Water monitoring targets dissolved oxygen, temperature, turbidity, conductivity, pH (i.e. acidity/alkalinity) and blue-green algae. The monitoring program is the first of its type in Australia.

Caves

Over 300 caves occur within the reserve. A significant percentage of discovered cave passage is linked forming one large system within three catchments. The caves contain rich cave-dwelling (troglobitic) fauna, outstanding aesthetic qualities, and a diverse range of speleothems and minerals.

Highly decorated passages and chambers are found in a number of the caves and combined with the spectacular arches and underground river systems, provide the primary visitor experience. The construction of elevated walkways, viewing platforms and metal stairways within a number of developed/semi-developed caves has enhanced this experience, providing visitors with the opportunity to view speleothems of contrasting shape, form and decoration. Visitor infrastructure in the show caves also includes lights, artificial cave openings, ladders and railings. Appendix C lists caves developed for use as show caves (referred to as ‘developed’; see glossary), semi-developed caves and undeveloped caves (also known as ‘wild’ caves; see Section 3.5 Visitor use).

For many decades, speleologists have made an important contribution to the understanding and extent of the karst system within the reserve. NPWS considers the ongoing contribution of their expertise will benefit reserve management into the future. Sydney University researchers working with members of the caving community have completed a mapping project within the show caves. The study has produced three-dimensional plans of the caves which will assist understanding the geophysical structure of caves and will have a variety of applications for cave management (Jenolan Caves Reserve Trust 2012a).

Many of the caves contain river sediments and surface in-fills as a consequence of past environmental events. These sediments contain valuable information about past climate and vegetation change and provide a visual representation of pre-existing landforms. Numerous caves contain sub-fossil bone deposits that are thousands of years old and include the remains of extinct megafauna. Commonly, the deposits form where animals have fallen into pit-like

caves or beneath cave ledges, or where birds of prey have roosted and regurgitated digested bones of animals they have eaten (owl pellets). Some caves have eroded away over time leaving the erosion-resistant, bone-rich deposits laying on the limestone surface as 'unroofed cave' deposits. Only a small number of the bone deposits at Jenolan have been studied to date (Morris et al. 1997; Willis 1993).

Soils

The reserve contains five soil landscapes. The majority of the reserve is classed as Kanangra Gorge soil landscape. A much smaller area around the central-west boundary and in the south-west corner of the reserve is classed as Gum Valley. Small areas of the Black Range soil landscape occur in the north-east and southernmost areas of the reserve. The Boggy Creek soil landscape occurs along the Jenolan River in the central part of the reserve. The exposed karst is mapped as the Jenolan Caves soil landscape. The Jenolan soil landscape includes a range of soils including terra rossas (red dermosols) and rendzinas (renic calcarosols). Unmodified examples of these limestone soils are rare in New South Wales and few are protected within the national park estate (Wilson et al. 2012).

The reserve's soils are predominantly shallow with uniform texture profiles. They range from lithosols to yellow-brown earth, depending on the underlying geology, and are highly susceptible to erosion. The extent and severity of erosion is dependent on the intensity and duration of rainfall, the extent of vegetation cover and the prevailing topography, which ranges from river flats to mountainous slopes (Coffey Partners International 1989).

Soils of the reserve are subject to sheet and gully erosion and minor rilling. Erosion has resulted in sedimentation of waterbodies in the reserve, such as Blue Lake. Inadequate drainage and construction and maintenance of roads have caused erosion around developed areas of the reserve. Aside from impacts on water quality, erosion has the potential to block conduits and solution cavities integral to local hydrology and the formation of karst (OEH 2013a; Cameron McNamara Consultants 1988).

Minerals

Twenty-five types of minerals have been confirmed or identified at Jenolan Caves (Pogson et al. 2014). Their chemical groups include carbonates, silicates, phosphates, oxides and a sulfate (gypsum), hydroxide (goethite), nitrate (niter) and chloride (sylvite). The cave clays have diverse origins. Some are recent sedimentary debris. Older clays (from the Carboniferous age, 358.9–298.9 million years ago), contain altered volcanic particles washed or blown into the caves. Some of the clays may have formed from rising hydrothermal fluids. The phosphates and gypsum formed when bat guano reacted with limestone and cave clays. The niter and sylvite have crystalised from the breakdown of wallaby guano products (Pogson et al. 2014).

Hydrology

The maintenance of natural hydrological processes and water quality is a key principle of karst management. Water (including quantity, flow and composition) is a key element and transport medium for the chemical and biological processes which create and maintain karst environments. The Jenolan karst contains a small, largely unstudied aquifer that supplies the reserve's domestic water. The aquifer eventually drains into Lake Burragorang, part of the Sydney water catchment, and has values associated with its water quality and flow volumes.

The reserve includes the upper catchment of the Jenolan River which flows into the Coxs River in the adjacent Kanangra-Boyd National Park (see Figure 11). The Coxs River flows into Lake Burragorang which is the urban water supply for Sydney and a major water source for the Blue Mountains. The reserve is almost entirely located within the Warragamba catchment and the Mid Coxs River subcatchment. Only the 56 hectare addition to the reserve which occurred in 2012 is within the McKeown Creek catchment, part of the Macquarie River catchment.

Reservation of most of the upper catchment of the Jenolan River greatly assists managing water quality entering the caves. The karst catchment, however, is considered likely to extend well beyond surface catchment boundaries. On the reserve's western boundary, the Great Dividing Range separates the reserve from adjacent private land. However, in the north-west of the reserve the headwaters of Terrace Creek and smaller areas of the Stockyard Creek and Navies Creek catchments (all tributaries of the Jenolan River) are located in the adjacent Jenolan State Forest. The adjacent areas of state forest are pine plantations managed by Forestry Corporation of NSW. Without careful management, forestry operations can pose a potential risk to water quality of the Jenolan River and Jenolan karst through pollution and the adverse impacts of soil erosion and sedimentation.

The Jenolan River commences in McKeowns Valley on the west side of the Jenolan Caves limestone, flowing southerly until it sinks into alluvial flats and continues underground through the limestone belt. Below ground, the river flows through open and flooded cave passages before emerging on the east side of the Grand Arch (Branagan et al. 2014).

Camp Creek and Surveyors Creek flow north toward the Grand Arch Precinct in the southern part of the reserve. Surveyors Creek flows down a valley to the rear of Car Park No. 1 (see Figure 4 in Appendix A). It then enters a below-surface drainage system which extends to the western entry of the Grand Arch. At this point the drain disappears before finally emerging at the eastern entry to the Arch, where it flows into Blue Lake.

Camp Creek flows down the Camp Creek valley to a point above Car Park No. 3. It then joins a series of drains before sinking into the southern limestone, approximately 2 kilometres from the Grand Arch. After passing through a series of caves, the water finally surfaces at Blue Lake.

Blue Lake was created in 1908 by damming the Jenolan River to secure the water supply to the hydro-electric system used to illuminate the caves. The lake is approximately 4000 square metres. The lake's blue colour is the product of the action of sunlight on the lake's waters which have a high concentration of calcium carbonate. Sediments transported by the Jenolan River and Camp and Surveyors creeks accumulate in Blue Lake. Problems with algal blooms and the lake changing colour have resulted in the lake being drained sporadically and the sediment build-up and other debris being removed.

There are also some small dams in the reserve including on Surveyors Creek, around the northern section of the Jenolan River Trail, and adjacent to Binoomea Ridge Trail.

The Jenolan River is impacted by:

- electricity production from hydro-electricity
- water extraction for the purposes of domestic water consumption
- changes in vegetation and an increase in impervious areas which alter runoff flow patterns
- the discharge of sewage treatment plant effluent
- stormwater runoff from developed precincts.

Due to development of the Visitor Use and Services Zone (VUSZ, see Figure 2) there is potential for stormwater runoff from these areas to adversely impact above- and below-ground water quality. There are preventative measures in place to mitigate these impacts, particularly in the Grand Arch Precinct, including steel grills installed in creeks and waterways to capture rubbish, and filters placed in drains to trap sediment and absorb fuel and oil residue. Regular maintenance of these preventative measures is crucial to their ability to reduce environmental impacts.

The quality and composition of water entering subterranean karst environments has direct impacts on cave biota and cave-forming processes. Their maintenance is dependent on biological and chemical processes influenced by the extent of surface vegetation cover and natural water infiltration and drainage. Chemical spills, sewage overflow, the use of pesticides and herbicides, oil leaks and other forms of surface pollution have the potential to alter natural biological and chemical processes, adversely impacting on speleothem growth and subterranean ecosystems.

The Trust administrator is responsible for ensuring that quarterly inspections are undertaken by independent karst and environmental specialists. Inspections of key operations that have the potential to adversely impact karst values if not properly managed are typically focused on the following:

- chemical storage and containment
- drainage and water storage
- waste storage and removal
- cave security, maintenance and development.

Over time, Surveyors Creek Dam (upstream of Car Park No. 1) has filled with sediment and rubble debris. Access to the site for remediation works is difficult. In addition to regular inspections to check on the dam's structural integrity, an assessment of the how the dam is to be managed in the longer term is required.

Landscape and scenic features

The reserve is one of several national parks and reserves which straddle the Great Dividing Range and it forms an important part of the Kanangra-Boyd to Wyangala Link of the Great Eastern Ranges corridor. On a regional scale, the landform of the reserve is distinct, being the deeply incised river valley of the Jenolan River and its tributaries.

The reserve has unique aesthetic appeal that incorporates the most important and visually sensitive natural features together with elements of the built environment. It has steep slopes and high ridgelines covered in eucalypt forests. Small buildings, predominantly houses, are speckled throughout the view but are largely dominated by the landform. Views are distant and consist mainly of rugged forested slopes. Views of the Grand Arch Precinct can only be gained by descending the Two Mile or Five Mile roads taking in the steep, forested slopes. On entering the Grand Arch Precinct, visitors are provided views of Caves House and the surrounding valley.

Scenic natural features can be viewed from its walking tracks (above and below ground), access roads or on entering the Grand Arch Precinct. These features include:

- blind valleys, cliffs and gorges
- arches and karst bridges
- caves and associated formations
- blue-green colour of the Jenolan River, its tributaries and lakes
- diverse forests and woodlands.

The distinctive 'European resort' atmosphere of Caves House and associated architectural features are important elements of the built environment. Caves House is a visually and architecturally grand building of Federation Arts and Crafts character situated at the base of the valley.

Wilderness

The term ‘wilderness’ is used to describe large, natural areas of land that, together with their native plant and animal communities, remain essentially unchanged by modern human activity. Wilderness areas represent the largest, most pristine areas in the NSW national park estate. Wilderness areas are those lands that have been least modified by modern technological society; they represent the most intact and undisturbed expanses of our remaining natural landscapes. All such places on the Australian continent have been occupied and used by Aboriginal people for many thousands of years.

Many such areas, including all of those within the reserve, have also been modified to some degree by past land uses and practices of non-Aboriginal people. Most wilderness areas also contain infrastructure that has been developed and maintained for contemporary management purposes.

Wilderness areas permit the natural processes of evolution to continue with minimal interference, ensuring that different environments are conserved as functioning natural systems. They may also protect already rare and threatened plant and animal species, provide clean air and water, act as storehouses of genetic material and provide benchmarks against which the impacts on more modified landscapes can be measured. Wilderness can also provide places of inspiration, renewal and self-reliant recreation far from the hustle and bustle and pressures of modern life.

The Wilderness Act affords declared wilderness the most secure level of protection, requiring it to be managed in a way that will maintain its wilderness values and pristine condition by limiting activities likely to damage flora, fauna and cultural heritage.

Wilderness assessment has three stages:

- consideration of proposals (or nominations for wilderness)
- wilderness identification
- wilderness declaration.

Identified wilderness is an area of land that meets the criteria of naturalness, size and opportunities for self-reliant recreation and solitude as set out in section 6 of the Wilderness Act.

There are approximately 350 hectares within the reserve which NPWS has identified as meeting the criteria for wilderness. This area is located on the reserve’s eastern boundary, adjoining the Kanangra-Boyd declared wilderness area (see Figure 13). It was identified in 1991 as part of the Kanangra-Boyd identified wilderness area, however, the area was excluded from declaration at the time due to its management under the Crown Lands Act. As the land is now managed under the National Parks and Wildlife Act, its inclusion as part of the Kanangra-Boyd declared wilderness area will be investigated.

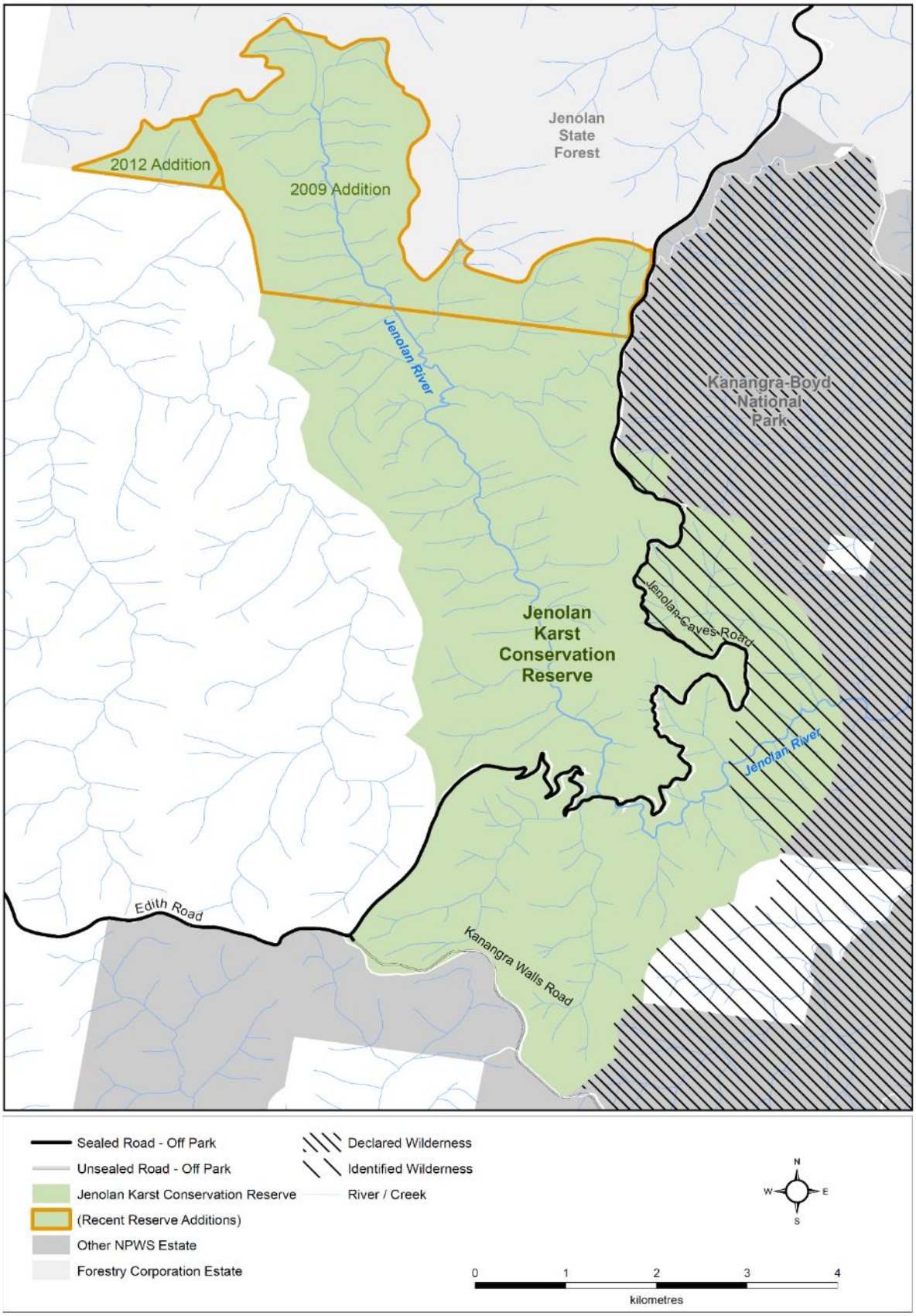

Figure 13: Wilderness and reserve additions

Desired outcomes

- Karst systems and terrestrial and aquatic flora and fauna are protected through maintenance of hydrological processes and water quality.
- Any adverse impacts from visitor use and NPWS operations on the reserve's hydrological systems (including on groundwater-dependent fauna), on its geology (including the significant karst environment), and on its soils are eliminated or at least minimised.
- The management of geology, karst, caves, soils and hydrology is informed by scientific research.

Management response

3.1.1 Implement the Blue Lake Management Strategy.

3.1.2 Continue regular independent environmental inspections of the VUSZ. Provide inspection reports to the operator of the VUSZ and ensure any recommended remedial actions are implemented.

3.1.3 Continue OEH air and water quality monitoring targeting subterranean ecosystems, including cave-dependent fauna and cave formation processes. Ensure any recommended remedial actions are implemented.

3.1.4 Within the VUSZ, continue the program of cave cleaning and upgrading of existing cave infrastructure including lights, stairs, steps, ladders and railings.

3.1.5 Assess the structural integrity of Surveyors Creek Dam, determine the preferred management option and any implementation actions required.

3.1.6 Continue to liaise with the Forestry Corporation of NSW in relation to mitigating potential adverse erosion and sedimentation impacts within the Jenolan River catchment.

3.1.7 Continue ongoing maintenance of sediment traps and drain filters to minimise the transfer of sediment and contaminants into the Jenolan karst environment.

3.1.8 Investigate the gazettal of the identified wilderness in the reserve as declared wilderness, part of the Kanangra-Boyd Wilderness Area.

3.1.9 Encourage and support scientific research that aligns with OEH's Karst Research Prospectus.

3.2 Native plants and animals

3.2.1 Native plants

The reserve supports threatened and significant plants and communities including:

- eucalypt forests listed as part of the GBMWHA
- the Biodiversity Conservation Act–listed White Box Yellow Box Blakely's Red Gum Woodland Endangered Ecological Community; equivalent to the Environment Protection and Biodiversity Conservation Act–listed White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland Critically Endangered Ecological Community
- the endangered mountain trachymene (*Trachymene scapigera*), listed under the Biodiversity Conservation Act and the Environment Protection and Biodiversity Conservation Act (see Table 1 below)
- a number of rare plants and other plants of restricted distribution.

Table 1: Threatened plants recorded in the reserve

Scientific name	Common name	BC Act status	EPBC Act status
Eucalyptus aggregata^	Black gum	Vulnerable	
Euphrasia scabra^	Rough eyebright	Endangered	
Persoonia acerosa^	Needle geebung	Vulnerable	Vulnerable
Rhaponticum australe^ (*Stemmacantha australis*)	Austral cornflower	Presumed extinct in NSW	
Trachymene scapigera	Mountain trachymene	Endangered	Endangered

^ Record is old or historic, may no longer occur in the reserve.

The reserve is located in highly dissected, mountainous country supporting a mosaic of eucalypt woodland, open forest, closed forest and tall shrubland vegetation communities. The species composition of plant communities is greatly influenced by underlying geology and position in the landscape, particularly aspect and altitude.

The range of plant communities within the reserve provides an example of the diversity of sclerophyll communities which is the prime World Heritage value of the GBMWHA. The southern three-quarters of the reserve is part of the GBMWHA. The GBMWHA is of international significance because it contains:

- outstanding examples of ongoing ecological and biological processes significant in the evolution of Australia's highly diverse ecosystems and communities of plants and animals, particularly eucalypt-dominated ecosystems
- significant natural habitats for the in situ conservation of biological diversity, including the eucalypts and eucalypt-dominated communities, taxa with Gondwanan affinities, and taxa of conservation significance (DECC 2009a).

The GBMWHA is being assessed by the Australian Heritage Council for National Heritage listing for values other than those included in the existing listing, including for its broader natural values.

The reserve's vegetation was mapped as part of the Hawkesbury-Nepean Catchment Management Authority Western Blue Mountains mapping project (DEC 2006). Six vegetation classes (Keith 2004) occur within the reserve (see Figure 14). The reserve is dominated by three of these: Southern Tableland Wet Sclerophyll Forest (60%), South East Dry Sclerophyll Forest (19%) and Central Gorge Dry Sclerophyll Forest (13%). The remaining three vegetation classes comprise less than 5% of the reserve: Southern Tableland Dry Sclerophyll Forest, Subalpine Woodland, and Eastern Riverine Forest. Exposed limestone karst covers 1% of the reserve and non-native vegetation and cleared or severely disturbed land comprises 2% of the reserve.

A small sample of the diversity of eucalypts found within the World Heritage Area is found within the reserve where 16 eucalypt species occur within 0.3% of the GBMWHA: Blaxland's stringybark (*Eucalyptus blaxlandii*), broad-leaved peppermint (*E. dives*), brown barrel (*E. fastigata*), eurabbie (*E. bicostata*), grey gum (*E. punctata*), ironbark peppermint (*E. smithii*), monkey gum (*E. cypellocarpa*), mountain gum (*E. dalrympleana* subsp. *dalrympleana)*, narrow-leaved peppermint (*E. radiata*), narrow-leaved stringybark (*E. sparsifolia*), red ironbark (*E. fibrosa*), ribbon gum (*E. viminalis*), silvertop ash (*E. sieberi*), thin-leaved stringybark (*E. eugenioides*), snow gum (*E. pauciflora*) and yellow box (*E. melliodora*).

The reserve additions (see Figure 13) in the northern part of the reserve include small areas of the White Box Yellow Box Blakely's Red Gum Endangered Ecological Community.

King (1994) describes the reserve's vegetation as montane woodland dominated by snow gum and mountain gum occurring on the highest elevation ridges of the reserve. This merges at slightly lower altitudes (above 1100 metres) into woodland of narrow-leaved peppermint and mountain gum and then an open forest of brown barrel, mountain gum and ribbon gum on the more sheltered north and east facing slopes.

Two woodland communities grow on the drier western slopes at middle altitudes: one is dominated by silvertop ash and Blaxland's stringybark; and the other by eurabbie, thin-leaved stringybark and ribbon gum. The gentle slopes of the upper Jenolan River valley support a woodland of broad-leaved peppermint and mountain gum, while steeper valley slopes support a grey gum – thin-leaved stringybark and red ironbark woodland.

Some of these communities occur on both limestone and metasediment geology, but the most distinctive local community is restricted to parts of the limestone. This is a tall shrubland of blackthorn (*Bursaria spinosa*) and sticky hop-bush (*Dodonea viscosa*).

Four rare plants (Briggs & Leigh 1996) have been recorded in the reserve in recent times. In the 1990s, Professor David Gillieson of James Cook University commenced vegetation mapping and modelling of the reserve which found over 40 new locations of the rare plant *Geranium graniticola.* A 2005 vegetation survey located the rare plant *Senecio macranthus* in the reserve for the first time since being recorded there in the early 20th century. The rare plants *Gonocarpus longifolius* and *Pseudanthus divaricatissimus* have also been recorded relatively recently.

A number of other threatened and rare plants were recorded in the reserve by botanists JH Maiden and WF Blakely in the late 19th and early 20th century, however, these plants have not been recorded since. Rare plants recorded include Australian anchor plant (*Discaria pubescens*) and winged everlasting (*Ozothamnus adnatus*) (see Table 1 for historic records of threatened plants).

Austral cornflower (*Stemmacantha australis*), which is listed under the Biodiversity Conservation Act as presumed extinct in New South Wales, has been replanted on the reserve (I Eddison [former Cave Guide, Jenolan Caves Reserve Trust] 2013, pers. comm.). It is unknown if the plants have survived. The only previous record of this plant for the reserve is by botanist WF Blakely in 1899.

Historically, the reserve has been protected from large-scale disturbance such as logging. As a consequence, its conservation significance is enhanced as it contains and protects many old hollow-bearing trees and a large range of hollow-dependent fauna. Due to land-use practices, old-growth vegetation is now scarce throughout New South Wales.

Research into the reserve's bryophyte flora (i.e. mosses, liverworts and hornworts) has recorded 98 species of moss, 21 species of liverworts and 3 hornwort species (Downing & Oldfield, cited in Eddison 2008). Some species found in the reserve are usually associated with rainforest environments. This suggests that the karst may be a refuge for these species. Mosses associated with arid, southern Australian environments also occur. Some bryophytes are associated with certain fauna, for example, species growing in bat guano or providing habitat for invertebrates sought after by short-beaked echidnas (*Tachyglossus aculeatus*).

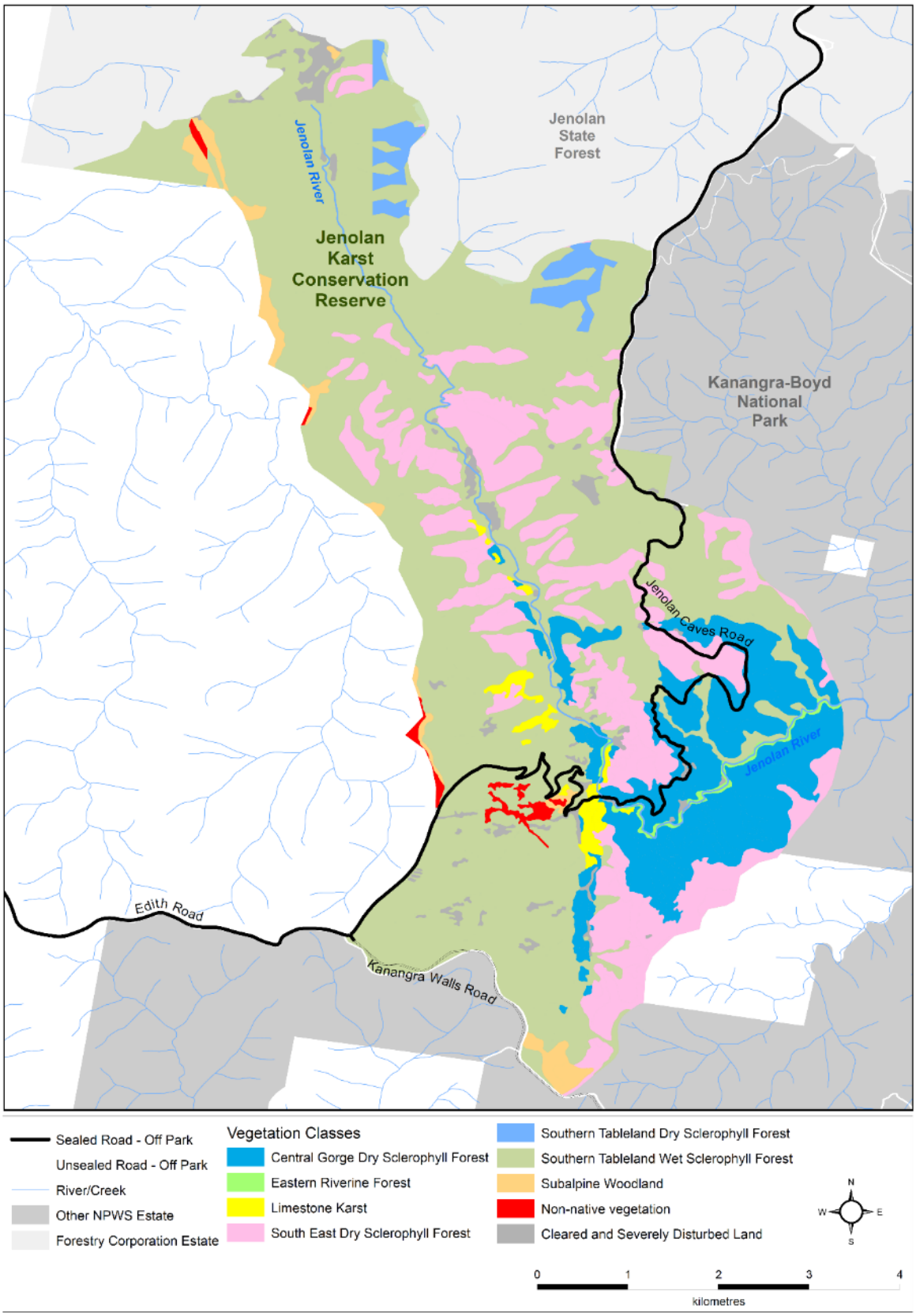

Figure 14: Vegetation classes

A range of introduced species also occur but are mainly restricted to disturbed areas. The study suggested that human influence has caused significant changes to bryophyte habitat in the reserve, including the introduction of exotic bryophyte species as has occurred at Yarrangobilly Caves.

Weeds pose the greatest threat to native plants and plant communities within the reserve (see Section 4.1 Pests) with inappropriate fire regimes posing a lesser threat (see Section 4.2 Fire). Climate change may also significantly affect flora by changing the size and distribution of populations and modifying the composition of vegetation communities (see Section 4.3).

3.2.2 Native animals

A comprehensive study conducted by OEH, *The Vertebrate Fauna of the Jenolan Karst Conservation Area* (OEH 2012f), recorded 233 native vertebrate fauna species including: 140 birds, 51 mammals, 31 reptiles and 11 frogs. Thirty threatened animals are recorded in the reserve (see Appendix D). Of these 30 species:

- the stuttering frog (*Mixophes balbus*) may no longer occur in the reserve
- four species are rare visitors, rare residents or vagrants
- the New Holland mouse (*Pseudomys novaehollandiae*), which is listed only under the Environment Protection and Biodiversity Conservation Act, has only been recorded from sooty owl (*Tyto tenebricosa*) pellets in the reserve
- two species require further confirmation (OEH 2012f).

The *Vertebrate Fauna of Jenolan* report (OEH 2012f) was prepared to assist in managing priority fauna. The report profiles all threatened species detailing their conservation status, distribution, threats and makes management recommendations. Threats and mitigating actions are prioritised and the significance of cave-dwelling fauna is highlighted.

The reserve's highest priority cave-dwelling fauna are the threatened brush-tailed rock-wallaby (*Petrogale penicillata*), large-eared pied bat (*Chalinolobus dwyeri*), eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), spotted-tailed quoll (*Dasyurus maculatus*), sooty owl and the protected eastern horseshoe bat (*Rhinolophus megaphyllus*). Some species, such as the large-eared pied bat, require caves to complete their life cycles and are known as troglophiles. Others, such as the brush-tailed rock-wallaby use caves opportunistically and are known as trogloxenes. The shelter and protection from predators afforded by the caves is likely to be one reason why spotted-tailed quoll and brush-tailed rock-wallaby still occur in the reserve despite having disappeared from large areas of their former range (OEH 2012f).

The *Vertebrate Fauna of Jenolan* report details extinct species which have been identified from sub-fossil sooty owl pellet deposits that are up to 20,000 years old. The deposits help to chart ecosystem change over time in response to various factors including climate change and the arrival of Europeans. Due to the significant scientific value of this resource it is regarded as a pre-eminent faunal value of the reserve (OEH 2012f).

Recent preliminary investigations of vertebrate bones in the caves have confirmed the remains of megafauna (Musser 2013). It is likely that *Zygomaturus*, a large wombat-like animal and one of the largest marsupials to have lived, occurred here 50,000 years ago. Thylacine bones have also been identified.

Historically, the forests in the reserve were protected to safeguard the karst. This resulted in the maintenance of habitat features, such as large hollow-bearing trees, which are now usually rare. The reserve's relatively high densities of nocturnal birds, such as sooty owl, powerful owl (*Ninox strenua*) and barking owl (*N. connivens*), relate directly to the availability of key nesting resources (i.e. tree hollows and caves), an abundance of arboreal prey and the reserve's linkage to contiguous high-quality habitat in the GBMWHA (OEH 2012f).

The occurrence of brush-tailed phascogale (*Phascogale tapoatafa*) in the reserve is of high conservation significance as it is rare regionally and was recently listed as regionally extinct (DECC 2007).

The stuttering frog is the only threatened frog known from the reserve. It was recorded in the reserve in 1974. Targeted surveys in 1999 were unable to locate the frog which may be locally extinct. The species has experienced a dramatic decline in its southern range which may be linked to frog chytrid fungus which has been associated with the decline of many Australian frogs and is likely to occur in the reserve (OEH 2012f).

The reserve is of regional importance to the eastern bentwing-bat as it supports a large population of the species, contains two regionally important roost sites, and the karst provides a vital north–south movement corridor between maternity sites in the northern and southern parts of the species' range (OEH 2012f).

The reserve is important to troglophile bats as karst has a highly restricted distribution in south-east Australia which forces bats to use alternate roosts such as mines, tunnels and culverts. The abundant available habitat within the caves provides roosting habitat for thousands of bats. Recent surveys (OEH 2012f) have recorded single locations supporting over 1000 individuals of the threatened eastern bentwing-bat. Communal maternity roosts have not been recorded but may occur. The large population of the threatened large-eared pied bat indicates that the reserve's caves are an important maternity site. This is particularly significant as little is known about the species' breeding ecology (OEH 2012f).

The number of bats roosting in the caves has declined since the 1970s. This parallels declines across Australia over this time and may be unrelated to karst management. However, removal and modification of gates on caves in the 1980s has benefitted cave-dwelling bats, and as a result bats have recolonised some caves (OEH 2012f).

The reserve is of very high conservation significance for the brush-tailed rock-wallaby population. Initial attempts at their recovery included establishing a semi-captive colony within an enclosure built to exclude predators. In 1984 the animals were released to disperse but declined dramatically as a result of fox predation. More recently, captive breeding was re-instigated in an enclosure and in 2007, following several years of predator control, the animals were again allowed to disperse. Intensive fox baiting in accordance with the fox threat abatement plan (see Section 4.1 Pests) and introduction of animals from other populations to mitigate against inbreeding has now succeeded in increasing the population to an estimated 100 individuals (D Ashworth [Senior Threatened Species Officer, OEH] 2017, pers. comm.).

A national review of bird records identified species that appear to be declining (Barrett et al. 2003). Birds known from the reserve identified as declining, although not listed as threatened, include the red-browed treecreeper (*Climacteris erythrops*), rockwarbler (*Origma solitaria*), spotted quail-thrush (*Cinclosoma punctatum*), southern boobook (*Ninox novaeseelandiae*) and eastern barn owl (*Tyto javanica*) (OEH 2012f).

Karst environments contain habitat for a diverse range of aquatic and terrestrial fauna. The reserve's karst is particularly rich in subterranean life having been previously identified as an important focal point for subterranean biodiversity (Thurgate et al. 2001). Dominated by insects and arachnids, the reserve's cave-dwelling fauna includes gastropods, myriapods, amphipods, syncarids, flatworms and mites, with many of these of particular scientific interest displaying ancient attributes and relictual distribution.

The reserve's cave-dwelling fauna display high levels of endemism, with close to half of the recorded species restricted to the reserve's karst and some, such as the spider *Laetesia weburdi*, restricted to a single cave (Thurgate et al. 2001). Most recorded species are totally reliant on food sources brought into their low-energy habitat by water flow, air movement and

other animals. As such, these species are extremely susceptible to changes in the higher food chain and disturbance from human activity. It is estimated that biological diversity in the subterranean ecosystems of the reserve is far greater than represented in the existing literature due to inaccessibility of the environment, lack of study and resultant gaps in available data (Thurgate et al. 2001).

The ecology of the cave systems is linked to, and dependent on, surface environmental conditions. The cave invertebrate community is of particular importance as it contains rare species and biogeographical and phylogenetic relicts not common to other karst areas in the State. Eberhard et al. (2014) found at least 136 individual taxa with less than one half (43%) assigned to described species. In terms of ecological dependence on caves, 53% of collected taxa comprised typically above-ground species with the remainder considered to be habitual cave-dwellers. Erosion and sedimentation resulting from various sources and causes has the potential to impact the integrity of the karst's ecology.

Recovering threatened species

Strategies for the recovery of threatened species, populations and ecological communities have been set out in a statewide *Biodiversity Conservation Program* (formerly known as the *Threatened Species Priorities Action Statement*). These actions are currently prioritised and implemented through the *Saving our Species* program which aims to maximise the number of threatened species that can be secured in the wild in New South Wales for 100 years (OEH 2018b).

Nine threatened species known from the reserve have recovery plans adopted or have had draft recovery plans prepared under the repealed Threatened Species Conservation Act, the Environment Protection and Biodiversity Conservation Act or both (see Appendix D). Twenty-nine species are included in the *Biodiversity Conservation Program*. Threatened species profiles have been developed listing threats and recovery strategies for the species.

Desired outcomes

- Populations of significant plant and animal species and ecological communities are conserved.
- Negative impacts on threatened species are minimised.
- The habitat and populations of all threatened plant and animals are protected and maintained.
- Structural diversity of vegetation and habitat values are restored in degraded areas.
- The management of natural values of the reserve, including cave-dwelling plants, animals and ecosystems is informed by scientific research.

Management response

3.2.1 Implement relevant strategies in the *Biodiversity Conservation Program* and recovery plans for threatened species, populations and ecological communities present in the reserve.

3.2.2 Implement management recommendations in *The Vertebrate Fauna of the Jenolan Karst Conservation Area*, including cave-dwelling fauna.

3.2.3 Ensure all management decision-making in relation to the management of native plants and animals supports the maintenance or enhancement of World Heritage values.

3.2.4 Seek inscription of the remaining area of the reserve as part of the Greater Blue Mountains World Heritage Area in consultation with the NSW and Commonwealth governments.

3.2.5 Encourage and support scientific research that safeguards natural values and assists with reserve management.

3.3 Aboriginal heritage

The land, water, plants and animals of the reserve are integral to Aboriginal spirituality and contribute to Aboriginal identity. Aboriginal communities associate natural resources with the use and enjoyment of foods and medicines, caring for the land, passing on cultural knowledge, kinship systems and strengthening social bonds. Aboriginal heritage and connection to nature are inseparable and need to be managed in an integrated manner across the landscape.

Aboriginal sites are places with evidence of Aboriginal occupation or are related to other aspects of Aboriginal culture. They are important as evidence of Aboriginal history and as part of the culture of local Aboriginal people. Aboriginal sites recorded in the reserve and Dreaming stories indicate that the land which now forms the reserve was known to and visited by Aboriginal people for many thousands of years and has special meaning to Aboriginal people.

The Burragorang Valley was accessed by Aboriginal people via a route along the Jenolan River and the Coxs River. Historically, people bathed in the waters of the caves as they were considered to have healing qualities (Gemmell-Smith, cited in OEH 2012f). Aboriginal sites in the reserve identified to date mainly occur along watercourses and in rock overhangs. The most frequently recorded site type is an artefact scatter, also known as an open camp site. No detailed survey of Aboriginal sites has occurred, however, based on the previously located sites it appears the area was occupied during the Holocene period (up to 10,000 years before present). Research in the Blue Mountains indicates that there is the potential for Aboriginal sites to occur in the reserve dating from the end of the Pleistocene period (20,000–10,000 before present) (Urbis 2010).

Anutech (1988) developed a methodology for predicting sensitive archaeological zones and site densities in the reserve based on previous research carried out in the Blue Mountains. The results of Anutech's analysis are summarised in Table 2.

Table 2: Archaeological sensitivity of reserve landforms

Landform	Archaeological sensitivity
Creek and river flats of McKeowns Creek and the Jenolan River	High archaeological sensitivity
Mid-slopes (limestone) outcropping along McKeowns Creek and the Jenolan River	Occupation sites and cave art in this zone are of very high significance
Mid-slopes (other sediments)	Low archaeological sensitivity
Ridge tops	Moderate to high archaeological sensitivity

Source: Anutech 1988.

Attenbrow (1994) and McDonald (cited in NPWS & EA 1998) have completed more detailed analyses of the archaeology of the Blue Mountains as part of the Blue Mountains World Heritage nomination. This work indicates that the Indigenous heritage of the Sydney sandstone plateau is of high scientific value and unlike other cultural complexes and landscapes found within previously listed areas, however, karst areas remain poorly understood.

While the NSW Government has legal responsibility for the protection of Aboriginal sites and places, NPWS acknowledges the right of Aboriginal people to make decisions about their own heritage. NPWS will ensure Aboriginal communities are consulted and involved in the management of Aboriginal sites, places and related issues, and the promotion and presentation of Aboriginal culture and history.

The *GBMWHA Strategic Plan* (DECC 2009a) proposes co-managing the World Heritage Area with local Aboriginal people. To this end, a co-management strategic plan has been developed to guide the process. OEH is focussing on a range of actions in the plan, for example, capacity building and developing consultation protocols.

The GBMWHA is being assessed by the Australian Heritage Council for National Heritage listing for values other than those for which it is already listed, including for its Indigenous values. If GBMWHA is listed nationally for these values, it may be renominated for World Heritage listing for its Indigenous values (DECC 2009a). The strategic plan also proposes to use the Mapping Country Project to document the Indigenous values of the GBMWHA in cooperation with local Aboriginal communities. The Mapping Country Project shares commonalities with the recommendation in the draft CMP (Urbis 2010) to prepare a detailed Aboriginal heritage management and conservation strategy for the reserve, in consultation with the Aboriginal community, to identify Aboriginal heritage values and management options, and to assess areas yet to be formally investigated.

In 2009 a Living Culture Camp was held at Jenolan Caves to continue building and strengthening relationships, provide for wellbeing and to connect people to Country as part of meeting some of the co-management aspirations of the Aboriginal people within and surrounding the GBMWHA. The Greater Blue Mountains Aboriginal Reference Group, which is made up of representatives of the six language groups who are the traditional custodians of the area, supported the event.

The NSW Government is party to the non-native title Gundungurra ILUA in which the Agreement area includes part of the reserve (see section 2.2). The State of New South Wales acknowledges that the Gundungurra People identify as descendants of the traditional inhabitants of the agreement area. This ILUA reflects the value of the heritage contained in their Country, including the plants, animals, materials, objects, places, landscapes and associated stories, relationships, traditions and customs. The *GBMWHA Strategic Plan* (DECC 2009a) seeks to ensure valid native title is recognised and that ILUAs are negotiated consistent with World Heritage obligations.

Desired outcomes

- Significant Aboriginal places and values are identified and protected.
- Aboriginal people are involved in management of the Aboriginal cultural values of the reserve.
- Impacts on Aboriginal heritage values are minimised.
- The cultural, traditional and social significance to Aboriginal people of the landscapes within the reserve which form part of the GBMWHA is widely acknowledged and respected.

Management response

3.3.1 Continue to consult and involve the Pejar Local Aboriginal Land Council, the Gundungurra Aboriginal People, other relevant Aboriginal community organisations and custodial families in the management of their Country, including the management of Aboriginal sites, places and cultural and natural values.

3.3.2 Undertake an archaeological survey and cultural heritage assessment prior to all works with the potential to impact Aboriginal sites or values.

3.3.3 Support initiatives in the *Greater Blue Mountains World Heritage Area Strategic Plan* in relation to Indigenous cultural heritage including documenting Indigenous values and involving Indigenous communities in reserve management.

3.3.4 Consult with the Aboriginal community about preferred management options for known Aboriginal sites and documenting their cultural heritage value (for example developing a detailed Aboriginal heritage management and conservation strategy for the reserve); identifying areas of the reserve requiring further archaeological investigation and determining priorities for investigation within these areas, if required.

3.3.5 Where identified as appropriate or desirable by the Aboriginal community, targeted survey and recording of Aboriginal sites will be undertaken.

3.4 Historic heritage

Heritage places and landscapes are made up of living stories as well as connections to the past which can include natural resources, objects, customs and traditions that individuals and communities have inherited from the past and wish to conserve for current and future generations. Cultural heritage comprises places and items that may have historic, scientific, aesthetic, cultural, social, archaeological, architectural, natural or aesthetic significance. NPWS conserves the significant heritage features of NSW parks and reserves.

The significance of the reserve's historic heritage to New South Wales is recognised by its protection under the Heritage Act and listing on the State Heritage Register. Assessment of the reserve's heritage values in relation to state heritage listing criteria identified the following important values.

Historic

The reserve demonstrates the significant historical activity of identifying and conserving the natural resources of New South Wales in relation to caves and karst landscapes. The reserve was the first area in New South Wales reserved to protect a natural resource (in 1866). The development of the hamlet illustrates how travellers and tourists were accommodated since the 1890s in romantic buildings purpose-designed by the Government Architect.

Associative

The reserve demonstrates significant associations with Government Architect, Walter Vernon. His plans for Caves House have been largely respected in terms of the building's setting and style.

Aesthetic

The reserve has elements which combine to form a landmark landscape of great beauty and distinctiveness. This reserve's aesthetic values include its spectacular caves and cave formations, the dramatic setting of the caves hamlet and picturesque Caves House dwarfed by the surrounding cliffs of the Jenolan Valley, the entrance to the hamlet through the fortress-like Grand Arch and the distinctive Blue Lake. Technological development is demonstrated by the first use of electric cave lighting in the 1880s and the first use of hydro-electric power.

Social

This is demonstrated by association with groups, particularly tourists, speleologists and guides within the reserve.

Research

The reserve has the ability to yield information on the geological history of New South Wales and Australia, to benchmark protected karst landscapes in the State, and for the hamlet's archaeology to provide information on early tourism in New South Wales.

Rarity

The reserve supports rare and uncommon flora and fauna, especially within the caves, which includes the greatest diversity of cave invertebrates in the State. It provides evidence of mountain and cave tourism over 150 years.

The GBMWHA is being assessed by the Australian Heritage Council for National Heritage listing for values other than those for which it is already listed, including for its historic values.

Prior to the arrival of Europeans, the caves were known to and visited by Aboriginal people for thousands of years (see Section 3.3 Aboriginal heritage). It is generally accepted that the first Europeans to see the caves were members of the local Whalan family around 1838. James and Charles Whalan and Jeremiah Wilson began exploring and guiding visitors to the caves and in 1866 an area was reserved to protect the caves and Jeremiah Wilson was appointed 'keeper' of the caves. By the 1880s the reserve had become a well-known tourist destination and a track leading to the caves, the Six Foot Track, was constructed. Although originally built for the Jenolan tourist market (Smith et al. 2006), it was unsuitable for coach travel (Smith 1985) and became an alternative route for walkers and travellers on horseback. The Six Foot Track continues in use as a popular walking track and is also used for the annual Six Foot Track charity marathon. However, only a small section of the Six Foot Track is within the reserve and therefore covered by this plan of management.

The reserve's physical European heritage assets include buildings and their remains, and plantings, gardens and landscapes. Other structures or structural remains of significance include weirs, bridges, cave infrastructure (ladders, walkways, lighting systems), retaining walls, paths, roads, remains of early hydro-electric and sewage systems and the site of the Vertical Steam Dynamo used to run electric lighting in the caves from 1887 until 1889 when the use of hydro-electric power commenced (Urbis 2010).

In terms of built heritage, Caves House with its distinctive early Federation Arts and Craft architecture dominates the Grand Arch Precinct (see Figure 4 in Appendix A). However, there are also service buildings, groups of small cottages in the housing precincts and accommodation buildings from various periods which exhibit a range of styles. The remains of other buildings have been recorded and assessed for their heritage significance (Urbis 2010), including Pomona Grove Farm (late 19th and early 20th century) and three guest houses (dating from the 1880s): Wallace's Guest House, Kiaora Guest House and Rowe Cottage.

The historic landscapes and plantings in the reserve are of local and state heritage significance. The gardens around Caves House are of particular significance. In the late 19th and early 20th century the Director of the Royal Botanic Gardens, Joseph Maiden, supervised remodelling and terracing of the slopes around Caves House to provide a park-like setting (Urbis 2010). Maiden was a major influence on public landscapes in New South Wales from the late 1890s through to the 1930s and was Director of the Royal Botanic Gardens from 1896 to 1924. A range of non-native species planted in the gardens have invaded surrounding areas and pose a serious

threat to the reserve's native plants and animals, including threatened species, and to World Heritage values (see Section 4.1 Pests).

OEH policy requires all items listed on the State Heritage Register to have a conservation management plan and be maintained in accordance with best practice management principles. Under the Heritage Act, all buildings listed on the State Heritage Register, other than ruins, must meet minimum standards of maintenance and repair. To address these requirements and to effectively manage the reserve's significant cultural heritage resources, the *Jenolan Caves Reserve Trust Heritage Asset Management Strategy* (Godden Mackay Logan 2007) and a draft CMP (Urbis 2010) have been prepared.

The *Heritage Assets Management Strategy* applies to the heritage assets of the VUSZ (see Figure 2) and includes a management action plan, asset maintenance plan, asset transfer plan, redundant assets transfer plan, and a performance and reporting plan. The strategy also identifies actions, performance indicators and accountabilities.

The draft CMP (Urbis 2010) incorporates conservation policies and prioritised strategies and actions for their implementation which aim to ensure the heritage significance of the reserve is retained while permitting adaptive re-use, possible future development, and ongoing management and maintenance. To this end, surveys and inventories were made of all buildings, structures, archaeological features and sites, recorded Aboriginal sites, planted/designed landscape elements and infrastructure of cultural heritage value in the seven VUSZ precincts, and of some items in the Conservation Management Zone. The scope of the project did not permit a detailed inventory of cave heritage items.

The draft CMP provides an analysis of documentary and physical evidence and identifies heritage items and features for conservation and retention, potential demolition, further research, and conservation and maintenance works. An adopted conservation management plan will replace the previous conservation plan (Moore 1988) which will remain an important reference source. The draft CMP recommends the development of a master plan to determine design envelopes, heights and footprints for future development, and development of design and management guidelines for new built form elements, such as signage, furniture, lighting and paving.

The draft CMP also recommends preparing a landscape management plan and concept plan to protect cultural landscapes, permit removal of invasive non-native vegetation and protect significant views and vistas. A preliminary landscape concept plan and a landscape issues and options report (Hobley & Buchanan 2007) have been produced for Blue Lake as an action arising from the Blue Lake Management Strategy (Jenolan Caves Reserve Trust 2006). Eddison (n.d.) has collated historical information on the gardens of the Grand Arch Precinct and contemporary commentary by botanists and academics presenting a case for garden restoration and the attendant need for control of invasive garden escapees.

Desired outcomes

- Negative impacts on historic heritage values are minimised.
- Understanding of the cultural values of the reserve is improved.
- Significant historic heritage is appropriately conserved and managed.
- Ensure recognition of non-Aboriginal heritage values, including art inspired by the landscape, relationships between people and the environment, early conservation campaigns, built heritage, and recreational activities and infrastructure.
- The social and historical significance to non-Aboriginal people of the landscapes within the reserve which form part of the GBMWHA is acknowledged and respected.

Management Response

3.4.1 Undertake environmental impact assessment in accordance with OEH policy and legislative responsibilities for works with the potential to impact on the reserve's historic heritage.

3.4.2 Implement the *Jenolan Caves Reserve Trust Heritage Asset Management Strategy*.

3.4.3 Finalise and implement a conservation management plan for above-ground built heritage. The plan will be made available for public comment prior to finalisation.

3.4.4 Prepare and implement a conservation management plan for cave heritage items. The plan will be made available for public comment prior to finalisation.

3.4.5 Encourage cultural heritage research projects in the reserve which assist the protection and management of the GBMWHA's cultural heritage values.

3.4.6 Facilitate the ongoing involvement of volunteers in the identification, management and preservation of historic heritage within the reserve.

3.5 Visitor use

NPWS parks and reserves provide a range of opportunities for recreation and tourism, including opportunities for relaxation and renewal as well as appropriate active pursuits. Visitor opportunities provided in the natural and undeveloped settings afforded by the national park estate are mostly those at the low-key end of the spectrum. NPWS aims to ensure that visitors enjoy, experience and appreciate the parks while park values are conserved and protected.

Planning for visitor use of the reserve focuses on interpreting the significant natural and cultural values of the caves and the broader reserve, including World Heritage and karst landscapes. This is undertaken directly through interpretive activities and through the provision of opportunities for recreational experiences and the provision of visitor facilities and hospitality services to enhance the visitor experience of the reserve which currently includes:

- guided interpretive tours of the show caves
- other recreational experiences, including, bushwalking, guided adventure caving, non-commercial recreational caving (in undeveloped caves with authorising permits issued by OEH), cycling and horse riding
- visitor accommodation and hospitality services such as food, beverage and related retail outlets
- function facilities
- events within the show caves, including concerts and weddings.

The reserve provides recreational opportunities for visitors in a natural highland setting within a significant karst landscape in a World Heritage Area, and in smaller, modified areas which include important heritage-listed buildings and settings. Most visitor activity in the reserve is concentrated in the Visitor Use and Services Zone (VUSZ), specifically the Grand Arch Precinct (see Figures 3 and 4) and in the caves (*Please note that Figures 3–10 are included in Appendix A*).

The system of show caves is the major attraction of the VUSZ and the reserve. Within the Grand Arch Precinct there is the heritage Caves House and other heritage buildings and infrastructure. Visitors may bushwalk, join show cave tours or guided adventure tours of semi-developed and undeveloped caves, and use the picnic facilities. Accommodation is provided in a range of styles and settings. OEH operates an environmental audit program of all major activities and development in the VUSZ (see Section 3.1 Geology, landscape and hydrology).

The reserve is located within the 'Country and Outback NSW' Destination Network (Destination NSW 2016). Visitor use of Jenolan Caves amounted to over 230,000 visits in 2016–17 (Jenolan Caves Reserve Trust 2017) which has been maintained annually over the previous 3 financial years. The Trust has consistently generated over $10 million in annual tourism revenue over the last several years. Visitor accommodation, hospitality and interpretation/education services provide an important source of additional employment in a predominantly rural area.

Currently, peak visitation coincides with the NSW school holidays. The number of cave tour participants on weekends is generally double that of weekdays, and families comprise the majority of visitors on holidays and weekends. The reserve's location three hours' drive from Sydney (and Canberra) means that demand for reserve visitation is likely to remain strong.

Jenolan Caves Road is a sealed, all-weather public road and is the main public access to the reserve (see Figure 2). Its route bisects the central part of the reserve from north-east to south-west. Jenolan Caves Road is a public road maintained by Roads and Maritime Services and does not form part of the reserve. In the interest of road safety, part of Jenolan Caves Road is currently operated as a one-way road during the middle of the day to ensure vehicles, including coaches, arrive safely.

The loop road within the Grand Arch Precinct (see Figure 4) is a sealed, all-weather park road open to the public and maintained by the Trust/NPWS. Kanangra Walls Road (see Figure 2) connects with Jenolan Caves Road in the south-west of the reserve and is an unsealed public road owned and maintained by Oberon Council. Management trails provide vehicular access to the reserve for management purposes and are not open to the public (see Figure 2 and Section 5.1).

Visitation to the reserve needs to be carefully managed as visitation, if not appropriately managed, can negatively impact the reserve's significant natural and cultural values. The nature and severity of potential visitor impacts depend on the type, frequency and interaction of activities, visitor numbers and behaviour, site capacity, and durability and the sensitivity of the site's natural and cultural values.

Visitor accommodation and hospitality services

Visitor accommodation is offered in five accommodation units: Caves House (38 rooms), Mountain Lodge (30 motel-style studios), Gatehouse Backpacker Lodge (14 rooms accommodating 70 guests), Binoomea Cottage (two-storey, 12 guests each storey) and Jenolan Cottages (8 cottages) (Jenolan Caves Reserve Trust 2012a). The Grand Arch Precinct is the primary focus of visitor accommodation in the reserve, however, additional accommodation is also provided 8 kilometres away in the Jenolan Cottages Precinct (see Figure 5).

Visitor accommodation was constructed at different times and reflects a variety of architectural styles of varying heritage and aesthetic significance. Caves House is the outstanding architectural feature of the Grand Arch Precinct and is of state heritage significance (Urbis 2010). Dating from 1889, it is one of the few surviving mountain guesthouses that were popular in the Victorian era. It was designed by Government Architect, Walter Vernon, in a distinctive early Federation Arts and Crafts architectural style. A restaurant, cafe, souvenir retail outlet and function facilities are provided at Caves House. The Trust currently operates visitor accommodation and hospitality services in the VUSZ.

See Section 3.4 Historic heritage for a discussion of the heritage values of the reserve's visitor accommodation and the role of the draft CMP (Urbis 2010) in the sustainable management of these values.

Day use

The Grand Arch Precinct, located on the Jenolan River valley floor, is the central hub for visitor in the reserve and provides easy access to the caves. The precinct is dominated by Caves House and associated buildings and this defines the access points to the caves. This part of the precinct offers a range of visitor services including food and beverages, toilets, tickets for caves tours, interpretation, carparks, walking tracks and picnic facilities, in addition to the facilities of Caves House (see Figure 4).

There are three major carparks within the Grand Arch Precinct (see Figure 4) providing parking for 330 cars augmented by a further 150 car spaces in busy periods (Urbis 2010). Coach parking is also provided. Designated parking for people with disabilities is available at the Guides Office (two parking spaces) and behind Caves House (one parking space).

Day use areas — typically picnic facilities or sites for interpretation and education — are often the main destination for the vast majority of visitors to parks. The Grand Arch Precinct performs this function within the reserve. Day use facilities outside this precinct are old, in poor condition and are mainly located along Jenolan Caves Road, often on bends in the road. Picnic facilities in the reserve are detailed in Table 3.

The Grand Arch Precinct provides a range of well-used visitor facilities. In comparison, picnic facilities in other locations have a low level of use and lack general amenity. Accordingly, it is appropriate to reassess the type and location of day use facilities provided. Multiple roadside (pull-in area) facilities along Jenolan Caves Road will be rationalised and the facilities at the Playing Fields Trail will be removed subject to any required environmental impact assessment and heritage assessments. The Inspiration Point picnic facilities on Jenolan Caves Road will be upgraded, however, wood barbecues and fireplaces will be discontinued to minimise bushfire risk.

Table 3: Day use facilities

Designated day use area and type	Setting	Site limit (vehicle spaces)	Vehicle access	Site features	General facilities
Grand Arch Precinct facilities:					
Central Grand Arch Precinct	Opposite Ticket/Guides Office	N/A	No	Central to accommodation and cave tours	Shelter with tables Toilets at guides office
Car Park No. 1 / Cambridge Car Park	Adjacent to Caves House	N/A	2WD	Setting within Grand Arch Precinct	Barbecue (gas) Shelter
Car Park No. 2 / Carlotta Car Park	Near Carlotta Arch	N/A	2WD	Setting within Grand Arch Precinct	Barbecue (gas) Shelter
Car Park No. 3	Behind Caves House	N/A	2WD	Setting within Grand Arch Precinct	Toilets
Other facilities:					
Playing Fields Trail (Burma Road)	Open space	N/A	No	Site of historic playing fields on Jenolan River near trackhead to McKeowns Valley Walk	Shelter

Designated day use area and type	Setting	Site limit (vehicle spaces)	Vehicle access	Site features	General facilities
Jenolan Caves Road 1	Roadside (pull-in area on bend in road)	2	2WD	Picnic area	Picnic table Barbecue (wood)
Jenolan Caves Road 2	Roadside (pull-in area on bend in road)	2	2WD	Picnic area	Picnic table Barbecue (wood)
Inspiration Point lookout	Roadside	2	2WD	Katoomba view lookout	Nil

The draft CMP (Urbis 2010) makes a range of recommendations regarding the Grand Arch Precinct, including its visitor amenities. The recommendations of an adopted conservation management plan will guide decision-making regarding existing visitor day use facilities in the VUSZ and planning for any future facilities. The draft CMP acknowledges constraints to further development and redevelopment of the precinct in the context of its physical and heritage constraints.

Camping

A campground in the riparian zone of the Campground and Utilities Precinct (see Figure 9) was closed in 2005. A significant factor in its closure was the failure of effluent discharged from the on-site sewerage treatment system to meet current environment standards.

The level of visitor demand for camping facilities in the reserve is unquantified. A few public and private camping opportunities exist in nearby locations adjacent to the reserve (between 14 and 44 kilometres away). The potential to increase and diversify accommodation options such as camping in response to visitor demand may be considered appropriate in the future in the context of the development of a master plan. Such development is only appropriate within the VUSZ.

Bushwalking

Bushwalking allows visitors to be in close contact with the environment and can increase understanding and enjoyment of parks and the environment generally. The reserve provides a range of bushwalking opportunities within a range of environmental settings with varying degrees of social interaction, physical challenge and self-reliance.

Walking opportunities provided in the reserve are detailed in Table 4. A small proportion of visitors who are experienced and equipped for self-reliant bushwalking also utilise remote areas of the reserve.

Table 4: Bushwalking in the reserve

Walking track name	Location	Setting	Distance (one way unless indicated)	Current grade*	Proposed grade*
Bicentennial National Trail	Western boundary of the reserve	Great Dividing Range	8km	Grade 4	Grade 4
Six Foot Track	From Jenolan Caves Road follows Binoomea Ridge down to Grand Arch Precinct	Historic	1km 4.5km	Grade 3 Mgt trail	Grade 3 Mgt trail
McKeowns Valley Track	From Grand Arch precinct via Devils Coach House Cave along the Jenolan River	Karst, riparian, historic	2km 1.2km	Grade 3 Mgt trail	Grade 3 Mgt trail
Carlottas Arch	From Caves House uphill to the Carlottas Arch karst feature	Karst, heritage	1km	Grade 3	Grade 3
Devils Coach House Lookout	From carpark near Carlottas Arch uphill to the lookout to Devils Coach House Cave	Karst	750m	Grade 3	Grade 3
Jenolan River Walk	From Grand Arch via Blue Lake to hydro station	Riparian, karst, heritage	3 km (loop)	Grade 3	Grade 3
Blue Lake Loop	Blue Lake in Grand Arch precinct	Lake	700 m (loop)	Grade 2	Grade 2

* The Australian Walking Track Grading System has been used as the basis for this track classification system. For further information on these grades please refer to the *Users Guide to the Australian Walking Track Grading System* (DSE no date). Mgt = Management.

Walks commencing in the Grand Arch Precinct and sampling various karst features, the Blue Lake and historic sites are popular with visitors. The annual Six Foot Track Marathon, a charity event run over the 45-kilometre length of the historic track, commences at Katoomba and concludes at Caves House (see Section 3.4 Historic heritage). NPWS has an informal agreement with the Catchment and Lands Division of the Department of Primary Industries regarding maintenance of the section of the Six Foot Track within the reserve (see Figure 2). Approximately 3000 people walk the track annually.

The draft CMP includes information on the historic use of walking tracks within the reserve and recommends that they remain open to the public and are closed cyclically to permit maintenance, if required.

A landscape issues and options report and a landscape concept plan (Hobley & Buchanan 2007) have been prepared for the Blue Lake Loop. The development of the plan was a recommendation of the Blue Lake Management Strategy (Jenolan Caves Reserve Trust 2006). The recommendations of the report and the proposed plan should be considered when upgrading or maintaining the Blue Lake Loop.

Cave tours

Figures 2 and 4 show the location of the show caves (developed and semi-developed caves) and undeveloped or wild caves in the reserve (see Glossary). In addition to walks above ground, guided show cave tours (see Table 5 and Appendix C) are very popular and one of the reserve's main attractions (also see Group activities below). There are 3.5 kilometres of pathways and associated infrastructure in the show caves. Currently, fees are charged for cave tours, however, free public access is provided to the Devils Coach House Cave. Guided adventure caving in Mammoth Cave, The Plughole (Elder Cave) and Aladdin Cave can be undertaken by visitors on a fee-paying basis. Recreational caving is limited to speleological societies and groups with an authorising permit from OEH and in accordance with the OEH *Cave Access Policy* (OEH 2018a).

Table 5: Show cave tours in the reserve

Cave/Feature	Return length (metres)	Number of stairs/steps
Lucas	860	910
Imperial	1070	358
Chifley	690	421
Orient	470	358
Temple of Baal	365	288
Diamond (via Imperial)	1270	418
Nettle (self-guided)	Approx. 550	476
Pool of Cerberus	1017	722
River	1271	1298
Ribbon (via Orient)	590	394
Jubilee (via Imperial)	1575	679

Bicentennial National Trail

The Bicentennial National Trail (BNT) passes through the reserve (see Figure 2). The BNT is a 5300-kilometre continuous route through the Great Dividing Range of eastern Australia. It is available for various forms of non-motorised transport including walkers, horse riders and cyclists. A memorandum of understanding (MoU) between NPWS and the Bicentennial National Trail Ltd sets out principles for management and use of the trail where it traverses national park estate.

The BNT traverses the reserve's western boundary for approximately 8 kilometres following the Great Dividing Range and Western Boundary Trail and connecting to Jenolan Caves Road in the south-west of the reserve.

Cycling

The reserve provides opportunities for cycling on public roads, the BNT and the public road component of the Six Foot Track (see Figure 2). Cycling may be permitted in other locations subject to environmental and heritage assessment that considers track suitability, including potential impacts on the fragile karst environment due to steep terrain and highly erodible soils. Adventure cycling, triathlons and other competitive cycling events are not permitted.

Horse riding

Horse riding is permitted in the reserve on the BNT (see Figure 2). Due to the potential impact of this activity on the reserve, its fragile karst environment, catchment values and potential conflict with other visitors on the reserve's narrow public roads, horse riding is not permitted in other areas of the reserve.

Horse riding interest groups have raised issues associated with some sections of the BNT such as lack of defined trail, difficult navigation and associated visitor safety risk, and the lack of vehicle access.

In accordance with the horse riding policy directive and strategy (OEH 2012c, 2012e) aimed at improving horse riding opportunities in appropriate locations in the national park estate, NPWS will work in partnership with Bicentennial National Trail Ltd to investigate improving the trail condition and directional signage on the BNT route in the reserve.

NPWS will manage the trail in accordance with the MoU between NPWS and the Bicentennial National Trail Ltd. This includes meeting statutory and policy obligations, maintaining a quality experience for trekkers, and ensuring consistency with the conservation purpose of the national park estate.

Horse riding activities on the BNT that are part of a competition or large-scale organised activity require a licence or consent under the National Parks and Wildlife Act.

Group activities

Group activities can provide opportunities for people who would otherwise not be able to experience the reserve and can promote environmental understanding and support for conservation. Large groups can, however, have an environmental impact and can restrict opportunities for independent visitors.

Interpretive show cave tours, adventure caving and events in the show caves are popular group activities in the reserve. The following caves are promoted as show caves (see Table 5 and Figure 2): Lucas, Chifley, Imperial, River, Orient, Temple of Baal, Pool of Cerberus, Jubilee, Diamond and Ribbon. Adventure caving tours currently operate in undeveloped caves including Mammoth Cave, The Plughole (Elder Cave) and Aladdin Cave (see Figure 3). Appendix C lists developed (show), semi-developed and undeveloped (wild) caves in the reserve.

Show cave tours occur regularly throughout the day and are offered most nights year-round. Adventure cave tours are regular but run less frequently than show cave tours. Events, such as concerts and plays, are held in the caves regularly throughout the year. The school education program and corporate program includes cave-based activities, abseiling, bushwalks and orienteering. Weddings are permitted at various locations within the caves and at Caves House, Blue Lake and Carlotta Arch. The Trust currently operates tours, events and educational and corporate activities.

Recreational caving is regularly undertaken by speleological societies in the undeveloped caves and is regulated by OEH through the *Cave Access Policy* (OEH 2018a). Many of these caves are highly fragile, where every visit has an impact. For this reason, access conditions are in place to limit the size and frequency of groups that can enter individual caves.

Group activities in caves have the potential to directly and indirectly impact the caves and their dependent fauna and flora, including through the following:

- pollution of caves with litter, lint, skin particles and hair
- direct damage to cave formations
- atmospheric changes

- disturbance of rare and threatened fauna utilising or dependent on the cave environment (see Section 3.2.2 Native animals).

The use of a permit system to manage non-commercial recreational access to caves is an accepted approach to mitigating the impacts of human activity. Under this approach, visitors are required to apply for cave access at which time NPWS can set appropriate conditions. The relatively remote locations of many caves mean that security measures, such as the installation of gates, fences and signs, may also be required to manage cave access and prevent vandalism. These measures are particularly important where the potential for mishap, damage or harm is high (OEH 2018a). Competitive activities (e.g. races) are not permitted within the caves.

A study into the effect of surface vehicle emissions on the reserve's cave system (James et al. 1998) concluded that the level of carbon dioxide, sulphur oxide and nitrogen oxide in the caves was insufficient to cause damage to speleothems. Radon levels within the caves fall within approved national parameters and are monitored on an ongoing basis.

Specialist vacuuming and water cleaning techniques are used to clean the caves, including cleaning of lampenflora which grows in response to artificial lighting. An OEH air and water quality monitoring program which commenced in 2009 aims to protect the rare groundwater-dependent fauna of the caves and the cave formations which rely on specific, stable conditions (see Section 3.1 Geology, landscape and hydrology).

Desired outcomes

- Visitor use is appropriate, ecologically sustainable and has minimal impact on the reserve's World Heritage and other natural and cultural values.
- Visitor opportunities encourage appreciation and awareness of the reserve's natural and cultural values and their conservation, including World Heritage values and values associated with the karst landscape.
- Group activities facilitate a quality experience for participants enhancing their understanding and appreciation of the natural and cultural heritage values of the reserve.
- A range of recreational opportunities are provided while avoiding or minimising negative impacts of visitors on reserve values.
- There are no unacceptable impacts on the natural and cultural heritage values of the reserve or other users from the operations of lessees or licensees.
- Monitoring and review of the impact of visitor activities and the operation of visitor facilities and supporting infrastructure reduces impacts on reserve values and improves the operation of visitor activities and visitor facilities.

Management response

3.5.1 Support the development and implementation of a coordinated system for visitor use monitoring across the GBMWHA to assist in the development of visitor management strategies.

3.5.2 Prepare, exhibit and finalise a draft master plan for the reserve with a focus on the VUSZ to guide future provision of visitor facilities and services including day use activities, camping, traffic management, landscape and signage.

<u>Visitor accommodation and hospitality services</u>

3.5.3 Refurbish, and where necessary redesign, accommodation offerings, visitor services and the provision of food and beverage within the VUSZ to meet visitor needs consistent with the approved reserve master plan and conservation management plan.

Day use

3.5.4 Upgrade visitor facilities at the Inspiration Point lookout on Jenolan Caves Road (see Table 3). In order to minimise bushfire risk, do not provide a wood barbecue or fireplace.

3.5.5 Remove day use visitor facilities at the Playing Fields Trail and at the two other locations on Jenolan Caves Road (see Table 3), subject to any environmental assessment required and significance assessments under the Heritage Act.

3.5.6 Provide day use facilities within the Grand Arch Precinct in accordance with NPWS policy and any conservation management plan, when adopted.

Camping

3.5.7 Investigate the appropriateness of developing camping within the VUSZ in the context of preparing a reserve master plan. Environmental assessment and the provisions of relevant legislation is required prior to the development of any camping facility.

3.5.8 Camping in the reserve will only be permitted in designated areas or with prior written consent of the Park Authority.

Bushwalking

3.5.9 Continue to provide bushwalking opportunities in accordance with Table 4 and in line with the approved reserve master plan.

3.5.10 Consider the approved reserve master plan, the 'Landscape Issues and Options Report' and the accompanying landscape concept plan for the Blue Lake Loop when undertaking upgrading or maintenance.

Cycling

3.5.11 Permit cycling on the Bicentennial National Trail, Jenolan Caves Road and the public road component of the Six Foot Track.

3.5.12 Adventure cycling, triathlons and other competitive cycling events are not permitted.

Horse riding

3.5.13 Permit horse riding in the reserve on the Bicentennial National Trail. In order to maintain conservation values and visitor experience, allow a maximum of 10 horses (including packhorses) on the Bicentennial National Trail at any one time.

3.5.14 Manage the Bicentennial National Trail in accordance with the memorandum of understanding.

3.5.15 In consultation with Bicentennial National Trail Ltd, investigate improving the sustainable use, navigability and safety of the Bicentennial National Trail route including additional signage where required.

3.5.16 With the exception of the Bicentennial National Trail, horse riding will not be permitted in the reserve.

3.5.17 Camping with horses will not be permitted and facilities such as holding yards will not be provided.

3.5.18 Horse riding that is part of a competition or large-scale organised activity (including non-commercial activities) will only be permitted on the Bicentennial National Trail and will require written consent from NPWS. All commercial activities will only be permitted on the Bicentennial National Trail and will require a licence from NPWS.

Group activities

3.5.19 Monitor commercial and non-commercial group activities and events with respect to cumulative impacts, impacts on threatened species, safety requirements, quality of information given and compliance with licence or consent conditions. See the NPWS Events and Venues Framework and DECCW (OEH) 'Karst Monitoring and Evaluation Toolkit'.

3.5.20 Allow group educational activities consistent with the management principles and values of the reserve, subject to conditions on group size, activities and location to protect reserve values.

3.5.21 Regulate caving activities in accordance with the approved list of caves in Appendix C and the Cave Access Policy. Access to undeveloped (wild) caves will be in accordance with cave access prescriptions. Caving activities with high-impact potential, such as large groups or competitive events, are not permitted. Prepare and implement a cave management plan for the reserve.

3.6 Information, education and research

Information provision assists the protection of natural and cultural heritage, promotes support for conservation, and increases the enjoyment and satisfaction of visitors. Currently, the Trust operates interpretive and educational activities in the reserve.

Show cave and adventure cave tours are a major interpretive focus and attract over 200,000 visitors annually. Cave tours tailored to children are offered in school holidays. A school program and a corporate program of cave-based activities, abseiling and bushwalks are also offered. Bat End, the first small chamber of Orient Cave, is wheelchair accessible and a special tour of the cave can be arranged. A self-guided tour of Nettle Cave is available with an audio commentary in a number of languages, a commentary for children and from an Aboriginal perspective. Self-guided bushwalks are also available, supported by a downloadable mobile phone app which provides information, images and maps including Aboriginal cultural heritage interpretation.

The Trust trains guides on-site and has developed a training manual for this purpose and also provides other resources including specialist reference material to assist guides to deliver interpretive cave tours. The guide training and assessment program has been developed with NSW Technical and Further Education Commission, known as TAFE NSW, and meets national competency frameworks. Guides are also encouraged to obtain industry certification by completing the 'Certificate III in Guiding' (Jenolan Caves Reserve Trust 2012b). The Trust produces an interpretation plan summary annually.

An *Interpretation and Visitor Orientation Plan – Greater Blue Mountains World Heritage Area* has been prepared (CWNTS & EWI 2003b) which outlines objectives, themes and key messages for interpretation and general visitor communication within the GBMWHA. The plan states that the long-term goal of information programs is:

> that anyone visiting or residing in the GBMWHA and its environs has a sense of being in a special place - a place where the broader mountains community has taken custodianship of the GBMWHA to the extent that it becomes a unifying motif for the region and a cultural asset in its own right.

An *Interpretation and Visitor Orientation Plan for Abercrombie, Borenore, Jenolan and Wombeyan Karst Conservation Reserves* (CWNTS et al. 2003a) has also been prepared. The GBMWHA and karst reserves interpretation plans and the *GBMWHA Strategic Plan* (DECC 2009a) are primary sources for the development of interpretation programs for the reserve. The draft CMP proposes a review of the reserve's 2003 interpretation plan and of visitor surveys to further define the Jenolan 'brand' and to reflect this in written and visual communication

materials, staff uniforms etc. The draft CMP also includes policy recommendations for interpretation, including signage.

Public information about the reserve is currently distributed across several websites, including the NSW National Parks website, the OEH website and a separate Jenolan Caves website. Greater consistency in the presentation of information across the various communication channels and a more integrated approach to delivering information would improve visitor experiences in the reserve.

Aligned with providing appropriate interpretation and interpretive material for visitors, effective signage is essential to enhance visitor experiences and assist visitor management. A draft signage plan has been developed for the reserve (CWNTS & EWI 2004) and NPWS has produced statewide design guidelines, policy and procedures for the preparation of integrated signage plans (DECCW 2010d; OEH 2011b). The design guidelines do not apply to lessees, apart from the hazard signage provisions, however, the guidelines are considered by OEH when assessing signage proposed by lessees. The draft CMP proposes development of a master plan for the VUSZ to provide design and management guidelines for new built form elements, including signage, furniture, lighting and paving.

Research helps OEH make well-informed decisions about conserving and managing karst environments and World Heritage values. The recognition of the reserve as a place of natural and cultural significance is largely the result of a long history of research carried out by scientists, speleologists and the Jenolan Caves Historical and Preservation Society. These groups have worked cooperatively with management to ensure the values of the reserve are appropriately acknowledged, protected and conserved and have provided invaluable technical expertise over a period of more than 40 years (see Sections 3.1, 3.2, 3.3 and 3.4 of this plan).

A *Karst Research Prospectus* (DECC 2008) explains the research themes of interest to OEH, how to apply for the necessary approvals under the National Parks and Wildlife Act or Regulation, and what assistance OEH can provide. Encouraging and assisting scientific research also helps meet Australia's obligations under the World Heritage Convention to identify, conserve and rehabilitate GBMWHA's World Heritage values, to promote best management practice and to reduce threatening processes (DECC 2009a). The Blue Mountains World Heritage Institute, a collaborative research and education organisation, has developed a strategic research framework based on the *GBMWHA Strategic Plan* (DECC 2009a) which identifies priority research areas for the GBMWHA. The Institute is an initiative of OEH, the Royal Botanic Gardens Trust, the Australian Museum, Blue Mountains City Council, the Sydney Catchment Authority (now called Water NSW), Sydney University, University of Western Sydney and the University of New South Wales.

Desired outcomes

- There is widespread community understanding and appreciation of the reserve's natural and cultural values, including values associated with World Heritage, the karst landform, Aboriginal heritage and European historic built heritage.
- Reserve visitors understand the potential impacts of their actions on the area's World Heritage and other related values.
- Visitors are aware of the reserve's recreation opportunities and can easily find their way to facilities.
- Information is presented in a coherent way across different channels (web, social media, face-to-face etc.) in a way that is consistent with NPWS brand.
- The reserve is a useful educational resource for local schools and community organisations.
- The contribution of volunteers and enthusiasts to the collation and communication of knowledge about the reserve is supported.

- Research continues to contribute to a greater understanding of reserve values and their management.

Management response

3.6.1 Implement the policy recommendations of any adopted conservation management plan and reserve master plan in relation to interpretation and signage, including updating the reserve's interpretation plan.

3.6.2 Incorporate consideration of the *Interpretation and Visitor Orientation Plan for Abercrombie, Borenore, Jenolan and Wombeyan Karst Conservation Reserves* and the *GBMWHA Strategic Plan* in the recommended update of the reserve's interpretation plan (see management response 3.6.1).

3.6.3 Continue to involve the Gundungurra People in development of material and programs for interpretation of Aboriginal culture.

3.6.4 Continue to support and assist educational use of the reserve by schools, community groups and individuals through provision of information and programs such as guided and self-guided walks and talks.

3.6.5 Encourage research that safeguards World Heritage values and assists reserve management. Consider the OEH *Karst Research Prospectus* and the *GBMWHA Strategic Plan* when determining research applications.

3.6.6 Develop and implement a strategic approach to create public-focused information which communicates visitor experiences alongside core values of park conservation, while proactively delivering safety information relating to specific attractions, for all NPWS customers, for inclusion on NPWS website and other digital channels.

3.6.7 Continue to make digital information and facilities available within the overarching NPWS digital engagement strategy.

3.6.8 Continue to monitor visitor awareness, behaviour and satisfaction with the Jenolan Karst Conservation Reserve experience.

3.6.9 Support the ongoing involvement of volunteers in the accumulation and dissemination of knowledge, particularly where this knowledge contributes to a greater understanding of reserve values and their management.

3.6.10 Facilitate the provision of a suitable place to store historic and scientific collections.

4. Issues

4.1 Pests

Pest species are plants and animals that have negative environmental, economic and social impacts and are most commonly introduced species. Pests can have impacts across the range of reserve values, including impacts on biodiversity, World Heritage, cultural heritage, catchment and scenic values.

The *Biosecurity Act 2015* and its regulations provide specific legal requirements for the response, management and control of biosecurity risks, including weeds and pest animals. These requirements apply equally to public and privately-owned land. Under this framework, Local Land Services has prepared regional strategic weed management plans and regional strategic pest animal management plans for each of its 11 regions, including Central Tablelands Region (Central Tablelands LLS 2017; Central Tablelands LLS 2018).

Local Land Services plans identify priority weeds and pest animals in each of the regions, plus the appropriate management response for the region (i.e. prevention/alert, eradication, containment or asset protection).

NPWS prepares regional pest management strategies (OEH 2012d) which identify the operations and control actions undertaken by NPWS to meet the priorities from regional strategic pest and weed management plans. This also includes other important programs such as the *Biodiversity Conservation Program* (see Section 3.2).

The overriding objective of the NPWS regional pest management strategies is to minimise adverse impacts of introduced species on biodiversity and other park and community values while complying with legislative responsibilities. These strategies are regularly updated. Reactive programs may also be undertaken in cooperation with neighbouring land managers, in response to emerging issues. Significant pest species recorded in the park are listed in Table 6 and discussed below.

Table 6: Significant weeds and pest animals recorded in the reserve

Species	Priority	Site name	Assets at risk
Weeds:			
Blue periwinkle (*Vinca major*)	Critical	Jenolan River downstream of Grand Arch	Brush-tailed rock-wallaby, World Heritage values
Honeysuckle	Critical	Southern limestone	Brush-tailed rock-wallaby, World Heritage values
	High	VUSZ	VUSZ
	Medium	Grand Arch	Grand Arch
English ivy (*Hedera helix*)	Critical	Southern limestone	Brush-tailed rock-wallaby, World Heritage values
	High	VUSZ	VUSZ
	Medium	Grand Arch	Grand Arch
Sycamore maple (*Acer pseudoplatanus*)	Critical	Two Mile Hill	Brush-tailed rock-wallaby, World Heritage values
	High	Jenolan KCR	World Heritage values

Species	Priority	Site name	Assets at risk
Radiata pine (*Pinus radiata*)	High	Northern and western boundaries	World heritage values
Tutsan [C] (*Hypericum androsaemum*)	Critical	Two Mile Hill	Brush-tailed rock-wallaby, World Heritage values
	High	Tutsan biological control program	World heritage values
Serrated tussock [A, B, C] (*Nassella trichotoma*)	Low	Jenolan River catchment	Natural ecosystem
Tree of heaven (*Ailanthus altissima*)	Critical	Two Mile Hill	Brush-tailed rock-wallaby, World Heritage values
	High	The Nest	World Heritage values
Blackberry [A, B, C] (*Rubus fruticosus* agg.)	High	Jenolan River catchment	World heritage values
Box elder (*Acer negundo*)	High	The Nest	World heritage values
Riparian (willows)	High	Jenolan River	World heritage values
Pest animals:			
European red fox [D] (*Vulpes vulpes*)	Critical	Jenolan	Brush-tailed rock-wallaby, World Heritage values
Feral cat [D] (*Felis catus*)	Critical	Jenolan	Brush-tailed rock-wallaby, World Heritage values
Feral goat [D] (*Capra hircus*)	Critical	Limestone and Upper Jenolan River	Brush-tailed rock-wallaby, World Heritage values
Feral deer [D] (*Cervus elaphus* and *Dama dama*)	Critical	Limestone and Upper Jenolan River	Brush-tailed rock-wallaby, World Heritage values
Wild dog [D] (*Canis lupus* subspp.)	Critical	Oberon Wild Dog Management Plan	Neighbouring stock
Feral pig [D] (*Sus scrofa*)	High	Jenolan	World heritage values
Feral rabbit [D] (*Oryctolagus cuniculus*)	High	Jenolan	World heritage values
	Low	Reserve boundaries	Neighbouring production

Notes:
[A] Declared Weed of National Significance.
[B] Statewide priority weed under the Biosecurity Act.
[C] Regional priority weed (LLS 2017).
[D] Regional priority pest animal (LLS 2018).

Pest species that are also key threatening processes may be managed under the Biodiversity Conservation Program where it includes key threatening processes (KTP) strategies.
The *Saving our Species* program has developed targeted strategies for managing key threatening processes using the best available information to minimise current and future impacts of key threatening processes on priority biodiversity values, including threatened species and ecological integrity.

Table 7 lists KTPs relevant to the reserve and the priority of these threats to the reserve's priority native plants and animals. Some of the more significant KTPs are discussed in 4.1.1 and 4.1.2 below.

NPWS is supporting research to understand the interaction between climate change, pests and biodiversity.

Table 7: Key threatening processes identified for the reserve and their priority

Threat	Act	Threat type	Priority of threat to priority fauna
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	BC & EPBC	Weed	High
Invasion and establishment of exotic vines and scramblers	BC	Weed	High
Invasion of native plant communities by exotic perennial grasses	BC	Weed	High
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	BC & EPBC	Pest animal	High
Competition and habitat degradation by feral goats (*Capra hircus*)	BC & EPBC	Pest animal	High
Competition from feral honeybees (*Apis mellifera*)	BC	Pest animal	Moderate
Herbivory and environmental degradation caused by feral deer	BC	Pest animal	
Predation and hybridisation by feral dogs (*Canis lupus familiaris*)	BC	Pest animal	Moderate
Predation by feral cats (*Felis catus*)	BC & EPBC	Pest animal	Very high
Predation by the European red fox (*Vulpes vulpes*)	BC & EPBC	Pest animal	Very high
Predation by the plague minnow (*Gambusia holbrooki*)	BC	Pest animal	
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	BC & EPBC	Pest animal	High
Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands	BC	Habitat loss/change	Moderate
Ecological consequences of high frequency fires	BC	Habitat loss/change	Moderate
Anthropogenic climate change	BC & EPBC	Habitat loss/change	Future
Loss of hollow-bearing trees	BC	Habitat loss/change	Moderate
Removal of dead wood and dead trees	BC	Habitat loss/change	Moderate

Threat	Act	Threat type	Priority of threat to priority fauna
Infection by psittacine circoviral (beak & feather) disease affecting endangered psittacine species and populations	BC & EPBC	Disease	Moderate
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	BC & EPBC	Disease	Moderate
Infection of native plants by *Phytophthora cinnamomi*	BC & EPBC	Disease	Moderate

Source: OEH 2012f.

4.1.1 Weeds

A regional strategic weed management plan prepared under the Biosecurity Act identifies those pest plants that are being prioritised for management action, investment and compliance effort within the Central Tablelands Local Land Services region (Central Tablelands LLS 2017). These priorities will be implemented via the relevant NPWS pest management strategy.

Weed infestation in the reserve is a significant threat to biodiversity, karst and World Heritage values. Appendix E lists 81 weeds recorded in the reserve. Many weeds are restricted to the karst environment. There are extensive infestations in karst environments of sycamore maple, tutsan, English ivy and blue periwinkle. These species can fully or partially block cave entrances with adverse impacts on caves, cave fauna and flora, and other fauna utilising caves, such as brush-tailed rock-wallabies (OEH 2012f).

Weeds can also change water chemistry with resulting impacts on water entering caves. Sycamore maple, an introduced deciduous tree, sheds its leaves over a short period releasing a high nutrient load into streams. Pine needles can also potentially impact the water quality of streams which flow into caves. Cave-dwelling invertebrates are the organisms most likely affected, however, there may be wider impacts on the sensitive subterranean environment and its dependent fauna (OEH 2012f).

Areas around the Grand Arch Precinct support significant weed infestations, particularly escapees from the ornamental gardens established in the late 19th and early 20th centuries which have invaded surrounding native vegetation. Sycamore maple and tutsan are high priorities for removal from natural areas. Radiata pine grown on private land and state forest bordering the reserve is expanding into the reserve (OEH 2012f). A study on the impact of radiata pine on native vegetation in the reserve found a strong relationship between pine litter penetrating reserve vegetation, lower native plant species richness and higher weed species richness, suggesting that adjacent pine plantations may have an adverse effect on native vegetation within the reserve (Baker et al. 2007). Further research indicates that pine litter penetrating the reserve reduces availability of nitrogen (thereby limiting plant growth), alters leaf litter invertebrate communities, increases fire intensity and alters microclimates (Baker & Murray 2012).

NPWS has undertaken mapping of sycamore maple since 2010 as a basis for developing a control strategy. Sycamore maple is regarded as an ecosystem-transforming plant and currently infests 5 hectares of the reserve (M Jones [Ranger, NPWS Kanangra Area] 2017, pers. comm.). Infestations can cause erosion, sedimentation and landslip. Broad-scale treatment has occurred in some areas and in more sensitive areas mature trees are targeted to limit the available seed source.

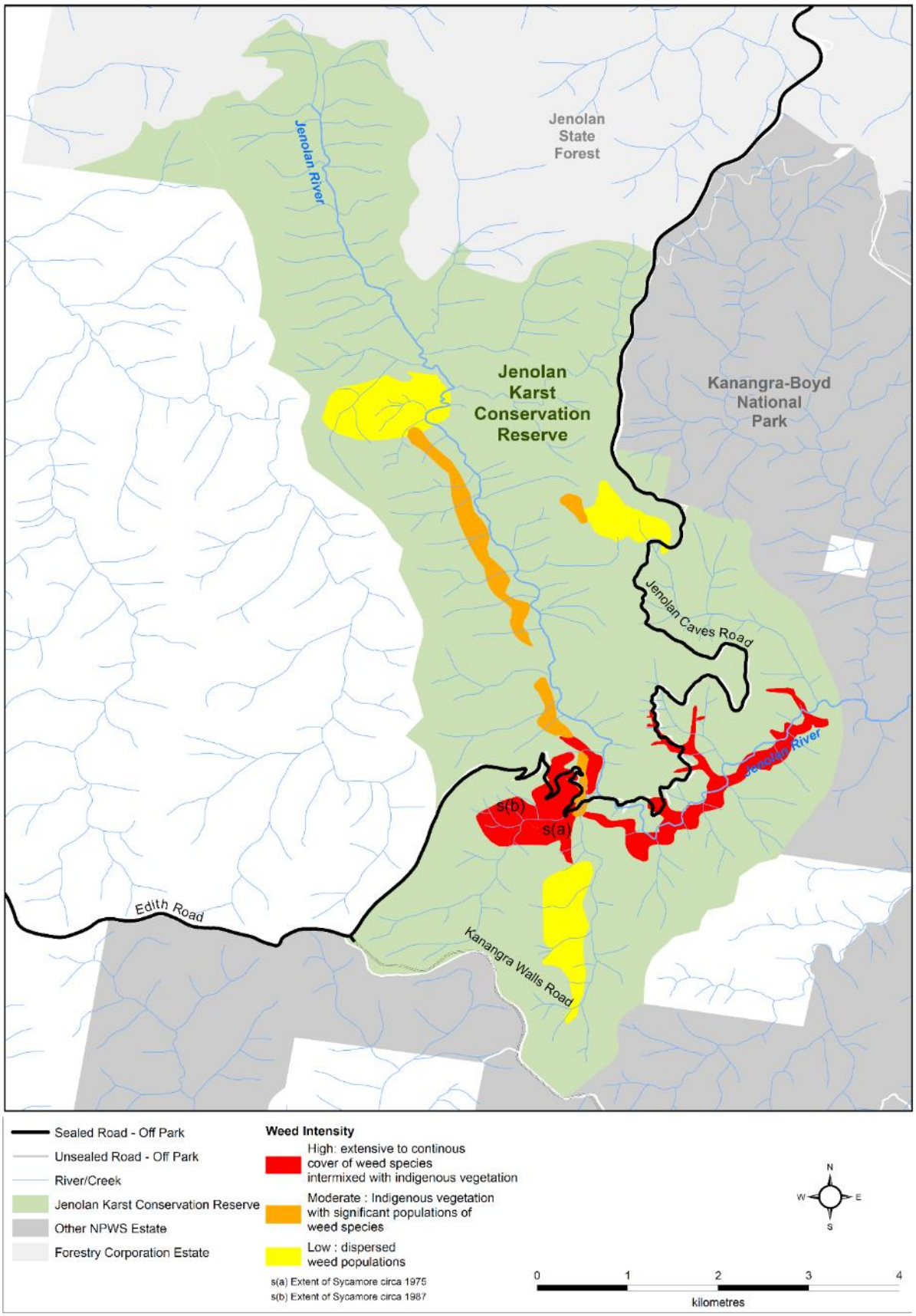

Figure 15: Weed mapping

Tutsan, a semi-evergreen shrub, is the subject of ongoing biological control research. It currently infests hundreds of hectares of the reserve. A biological control agent was released unsuccessfully, however, research is continuing, and it is hoped that a new strain of myosporum rust can be developed which is specific to the type of tutsan in the reserve.

Weeds are prevalent on most drainage lines in the reserve (see Figure 15). In some cases, these infestations can have downstream effects both within and outside this reserve. Weed survey and mapping undertaken by Lembit (1988) and Taylor (1999) divided the reserve into precincts, produced profiles for the reserve's weed species, and derived strategies to mitigate or control weed infestation.

Downstream of Blue Lake, periwinkle and other riparian weeds form dense infestations, excluding native riparian plants and potentially impacting on the use of the area by brush-tailed rock-wallabies (OEH 2012f).

NPWS has undertaken a sycamore control project since 2005 with funds provided by Local Land Services, Environmental Trust and Biofund programs. Ongoing treatment by volunteers, contract bush regenerators and NPWS staff, has resulted in the area infested by sycamores reduced from 60 hectares in 2005 to less than 5 hectares in 2017. Ongoing follow-up work will be required for several years to prevent reinfestation.

There are opportunities to integrate control strategies for riparian weeds in the reserve with strategies in the adjacent Kanangra-Boyd National Park, for example completing a weed survey and management plan for the Jenolan River, downstream of the reserve.

The Guidelines for Controlling Weeds on Karst (OEH 2012a) provide a consistent and best practice approach. The guidelines recognise that the shallow soils of the karst make them highly susceptible to erosion, and that underground streams, water channels and conduits can quickly transport pollutants from the surface to the subterranean water bodies critical for karst development.

4.1.2 Pest animals

In addition to the vertebrate pest species listed in Table 6, the following pest animals have been recorded in the reserve: black rat (*Rattus rattus*), brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*). Pigs, cats, rabbits and introduced rodents are common in the reserve; wild dogs and foxes are in low numbers due to control programs; and deer and goats are seen occasionally. Numbers of vertebrate pest species require monitoring due to their potential to threaten karst, biodiversity and World Heritage values. The brown hare (*Lepus capensis*) may also occur (OEH 2012f).

The Eurasian blackbird (*Turdus merula*) has been recorded in the reserve in the past (Eddison 2008), however it was not detected in recent surveys (OEH 2012f). The reserve has suitable habitat and is within its predicted range. Eurasian blackbirds can occupy undisturbed forest, competing with native species and spreading fruiting weeds. Populations of the species require monitoring (OEH 2012f).

The *Vertebrate Fauna of Jenolan* report (OEH 2012f) lists important threats to vertebrate fauna, recommends management actions and target areas or habitats, and details fauna that will benefit from management actions.

Foxes, wild dogs, rabbits, cats, deer, pigs and goats are the focus of specific management programs in the reserve due to the threat they pose to significant reserve values.

Foxes

Foxes suppress native animal populations, particularly medium-size ground-dwelling and semi-arboreal mammals, ground-nesting birds and freshwater turtles. Foxes have also been implicated in the spread of a number of weed species, such as blackberry, and are known to prey on domestic stock, including lambs and poultry.

Predation by the European red fox was declared a KTP under the Biodiversity Conservation Act in 1998 (NSW SC 1998) and under the Environment Protection and Biodiversity Conservation Act two years later (TSSC 2000b). The NSW fox threat abatement plan (Fox TAP) was initiated in 2001 (and revised in 2010, see OEH 2011a) with the primary objective of establishing long-term control programs to protect biodiversity and priority threatened fauna species and populations. Foxes are being controlled at priority sites across New South Wales, including Jenolan Karst Conservation Reserve. The fox is now a declared pest throughout New South Wales.

Foxes are currently uncommon in the reserve due to intensive fox control to protect the brush-tailed rock-wallaby population as part of the Fox TAP. Fox control is the largest pest program undertaken in the reserve. Baiting commenced in 2002 and occurs on a fortnightly basis. The program is supplemented by trapping and off-site baiting and has been expanded to adjoining pine plantations and private property (OEH 2012f). Fox control and monitoring is undertaken in accordance with the site plan under the Fox TAP.

Wild dogs

Wild dogs (*Canis lupus* subspp.) include any wild-living dog in New South Wales, including dingos (*Canis lupus dingo*), feral dogs (*Canis lupus familiaris*) and their hybrids. Wild dogs may have significant impacts on the distribution and abundance of native wildlife. Feral dogs are also listed as a KTP under the Biodiversity Conservation Act (NSW SC 2009).

The *Pest Control Order for Wild Dogs* requires public land managers, such as NPWS, to assist in the preparation of wild dog management plans to identify methods for the control of wild dogs and the conservation of dingos. A wild dog plan has been prepared which covers the majority of the reserve.

Wild dogs occur in low densities in the reserve as a result of control programs in and around the reserve. Wild dogs in the reserve are likely to be comprised of dingos and feral dogs as the reserve borders a dingo management area (NPWS et al. 2000, cited in OEH 2012f) which includes a significant dingo population within the southern Blue Mountains. In view of the likelihood that dingos and wild dogs co-occur, dingo conservation also requires consideration in the design and implementation of control programs (OEH 2012f). Wild dogs pose a particular threat to the population of threatened brush-tailed rock-wallaby that occurs in the reserve.

Rabbits

Feral rabbits graze native vegetation, reduce regeneration and cause serious soil erosion, modifying entire landscapes and threatening karst, biodiversity and World Heritage values. They compete for habitat with native animals, reduce food sources and displace small animals. Feral rabbit control in this reserve is a high priority especially in periods of drought and after fire where grazing competition with brush-tailed rock-wallabies may increase (OEH 2012d).

Cats

Recent surveys indicate that cats are abundant in the reserve. Cats are listed as a KTP under the Biodiversity Conservation Act and Environment Protection and Biodiversity Conservation Act (NSW SC 2000c; TSSC 2000c). Cats may benefit from the local reduction in fox numbers due to baiting. Cats prey on small- to medium-sized native species and compete with the threatened spotted-tailed quoll. Threatened species known from the reserve that are at risk from cat

predation include brush-tailed phascogales, eastern horseshoe bats, eastern bentwing-bats, squirrel gliders (*Petaurus norfolcensis*), young brush-tailed rock-wallaby and the flame robin (*Petroica phoenicea*) and scarlet robin (*Petroica boodang*) (OEH 2012f). Opportunistic trapping of cats occurs in the reserve.

Deer

Red and fallow deer occur in the reserve. Deer are listed as a KTP under the Biodiversity Conservation Act (NSW SC 2004b). Feral deer impact water quality through erosion and faecal contamination. Erosion causes cave sedimentation which alters hydrology and impacts cave-dwelling fauna. Brush-tailed rock-wallabies and geodiversity values can be adversely affected by deer sheltering in caves. When food is scarce, competition from deer can adversely affect brush-tailed rock-wallabies and other native herbivores. Opportunistic culling of deer occurs in the reserve.

Pigs

The impact of feral pigs on conservation values is substantial as they forage, wallow and dig in wetland areas, and cause major disturbance and damage to soils, roots, sensitive ground flora and wetland environments. Areas disturbed by feral pigs are at risk from subsequent weed invasion and soil erosion. They are also potential hosts for a number of exotic diseases.

Pigs are listed as a KTP under both the Biodiversity Conservation Act and the Environment Protection and Biodiversity Conservation Act (NSW SC 2004c; TSSC 2001b). A threat abatement plan has been prepared under the Environment Protection and Biodiversity Conservation Act (DEH 2005) which sets out a national framework to guide coordinated actions to address this threatening process.

Pigs and evidence of pigs were frequently observed in the reserve during surveys carried out in 2012 (OEH 2012f). Pigs disturb soil resulting in pollution, erosion and sedimentation with impacts observed at Surveyors Creek weir and Blue Lake. Impacts extend to water-dependent species such as platypus (*Ornithorhynchus anatinus*) and frogs. Sedimentation and hydrological changes can cause impacts on the karst and on cave-dwelling fauna and water quality (OEH 2012f).

An ongoing pig control program comprising monitoring and trapping is undertaken in the reserve. Pigs are surveyed in May with control activities carried out between May and August when they are most active.

Goats

The impact of feral goats on conservation values is substantial because they graze native plants, compete with native animals for shelter, spread weeds, trample vegetation and damage Aboriginal heritage sites. The congregation of goats in favoured locations can result in erosion and impacts on amenity. Goats are listed as a KTP under the Biodiversity Conservation Act and Environment Protection and Biodiversity Conservation Act (NSW SC 2004a; TSSC 2000a).

Goats occur at low density within the reserve and control programs are ongoing. Goats pose a particular threat to maintaining vegetation cover on steep, rocky slopes which are particularly prone to erosion. Goats directly compete for food and shelter with brush-tailed rock-wallabies. Goats can adversely affect cave-dwelling fauna in common with many other feral animals which cause erosion and sedimentation (OEH 2012f).

Desired outcomes

- Pest plants and animals are controlled and where possible eliminated.
- Negative impacts of pest plants and animals on World Heritage and other natural and cultural values are minimised.

- Methods used to control pest plants and animals do not adversely impact the reserve's values, including karst values.
- No new exotic plantings occur within the reserve.

Management response

4.1.1 Manage pest species in accordance with pest management strategies relevant to the reserve.

4.1.2 Prepare and implement reserve-specific weed management strategies as required to guide programs to monitor and control high priority (e.g. sycamore), current and emerging weeds. Incorporate adaptive weed management strategies and relevant strategies in the OEH 'Guidelines for Controlling Weeds on Karst'.

4.1.3 Implement recommended management responses for pest plants and animals in Section 7 of *The Vertebrate Fauna of the Jenolan Karst Conservation Area*.

4.1.4 Continue to implement fox control programs in accordance with the NSW Fox TAP and the local site plan to limit fox predation on brush-tailed rock-wallaby. Continue implementing cooperative fox control programs with neighbours.

4.1.5 Seek the cooperation of neighbours in implementing weed and pest control programs, as required.

4.1.6 Undertake pest plant and animal control in cooperation with Local Land Services, Landcare groups, Forestry Corporation of NSW and volunteers.

4.2 Fire

The primary objectives of NPWS fire management are to protect life, property, community assets and cultural heritage from the adverse impacts of fire, while also managing fire regimes in parks to maintain and enhance biodiversity. NPWS also assists in developing fire management practices that contribute to conserving biodiversity and cultural heritage across the landscape and implements cooperative and coordinated fire management arrangements with other fire authorities, neighbours and the community (OEH 2013b).

Fire is a natural feature of many environments and is essential for the survival of some plant communities. However, inappropriate fire regimes can lead to loss of particular plant and animal species and communities (which in turn threatens World Heritage values), and high frequency fires have been listed as a KTP under the Biodiversity Conservation Act (NSW SC 2000b).

Prior to a major fire in 1956–57, fire history of the reserve is only partially known. A major fire was reported in the media in 1902, and in 1942 a fire destroyed the Kia Ora Guest House and burned close to Caves House (*Canberra Times* 15 January 1942, p. 4). In 2004, a 10-hectare fire occurred adjacent to a waste disposal site on Kia Ora Hill. Fire frequency on karst is thought to be low. An interval of 35 to 50 years or greater is recommended in the absence of more definitive data and fires should be maintained at low intensity wherever possible (OEH 2012b).

Fire frequency in both the reserve and the adjacent Kanangra-Boyd National Park is naturally low. Wildfires in the area are generally ignited by lightning strike during summer. The nature of the vegetation throughout the reserves and local climatic conditions mean that under benign conditions most fires self-extinguish or can be contained to a small area. However, under higher fire danger conditions they have the potential to escalate rapidly to form large, high intensity wildfires.

Vulnerable assets on and adjacent to the reserve are historic heritage buildings and items, staff accommodation and operational buildings (workshops, stores etc.), visitor facilities, signage, utilities and services infrastructure, adjacent national park estate and adjacent pine plantations.

Fire hazard mapping of the reserve undertaken in 1989 indicated the following fire hazard levels: low (4% of the reserve), medium (26%), and high (70%). Fire risk is heightened in some areas by buildings being located on steep slopes and by fuel accumulation.

A reserve fire management strategy which defines the fire management approach for the reserve has been prepared (DECC 2009b) and will updated as required. The strategy outlines the recent fire history of the reserve, key assets within and adjoining the reserve (including sites of natural and cultural heritage value), fire management zones and fire control advantages such as management trails and water supply points. It also contains fire regime guidelines for conservation of the reserve's vegetation communities. It should be noted, however, that determination of appropriate fire regimes in karst areas is poorly understood.

In the majority of situations, conducting prescribed burns on karst is considered unnecessary and a potential risk to karst and cave values such as cave-dwelling bats and those communities potentially impacted by changes in sedimentation. Where appropriate, other methods of hazard reduction will be employed giving consideration to the protection of karst and other natural and cultural values.

Under future predicted climate change it is predicted that temperatures will be higher and seasonal rainfall patterns will change (see Section 4.3 Climate change). It is unknown how predicted changes in climate in this region will affect fire frequency. However, it is predicted that there will be an intensification of fire danger levels within the existing season and an extension of its span (DECCW 2010a).

The fire management strategy maps the majority of the reserve as a land management zone. The objectives of this zone are to conserve biodiversity, to protect cultural and historic heritage, and to manage fire consistent with set fire thresholds of vegetation communities. The existing fire management strategy is being reviewed to incorporate asset protection zones in appropriate locations. The purpose of these zones is to protect human life, property and highly valued public assets and values.

The area around the Grand Arch Precinct is zoned as asset protection zone. The objective of this zone is to protect human life and property. This will have precedence over guidelines for the management of biodiversity.

NPWS maintains cooperative arrangements with surrounding landowners, including Hume Forests Ltd (owners of pine plantations west of the reserve) and the Rural Fire Service (RFS), and is actively involved with the Chifley Bush Fire Management Committee. Cooperative arrangements include fire planning, fuel management and information sharing. Prescribed burning proposals and management trail works are submitted annually to the committee. The Jenolan Bushfire Brigade, comprising members of the local Jenolan community, supports fire suppression activities when required.

Fire in bushland areas can result in erosion and landslips which can destroy habitat. Apart from direct impacts on biodiversity values at the surface, smoke, decreased oxygen and elevated temperatures associated with fire can affect cave-dwelling fauna. Erosion and sedimentation caused by fire can block cave passages and significantly alter environmental conditions, and fire can directly change the physical structure of karst, causing it to fracture or powder (OEH 2012b, 2012d). Sedimentation can also adversely affect water quality, water-dependent plants and animals, and domestic water supplies.

The sensitivity of karst environments to frequent fire requires ongoing monitoring and review. The OEH Guidelines for Managing Fire on Karst (2012b) provide a best practice approach to managing fire on karst by incorporating adequate consideration of karst values in prescribed burning and fire suppression activities.

The reserve's steep topography restricts access for firefighting activities. A review of the reserve's management trails is required to identify those strategically important for fire suppression activities and to undertake upgrades.

Further consideration needs to be given to emergency fire planning to ensure the safety of visitors and staff in the popular Grand Arch Precinct.

Desired outcomes

- Negative impacts of fire on life, property and the environment are minimised.
- The potential for spread of bushfires on, from, or into the reserve is minimised.
- Fire regimes are appropriate for conservation of native plant and animal communities.

Management response

4.2.1 Update and implement the reserve fire management strategy in accordance with NPWS policy. Consideration will be given to strategies in the OEH 'Guidelines for Managing Fire on Karst'. An adaptive management approach to fire management will be adopted as the effects of climate change are realised or as new information on best practice management of fire on karst becomes available.

4.2.2 Continue to participate in the Chifley Bush Fire Management Committee and maintain cooperative arrangements with the Oberon Rural Fire Service, the Jenolan Bushfire Brigade and other fire authorities, including Forestry Corporation of NSW, and surrounding landowners, including Hume Forests Ltd.

4.2.3 Identify and upgrade strategic management trails.

4.2.4 Prepare an emergency plan for the Grand Arch Precinct to address visitor and staff safety in the event of bushfire.

4.2.5 Monitor the ability of threatened flora to recover between fires and review regimes where relevant.

4.2.6 Rehabilitate areas disturbed by fire suppression operations as soon as practical after the fire.

4.3 Climate change

Human-induced climate change is listed as a key threatening process on the Biodiversity Conservation Act (NSW SC 2000a) and the associated loss of habitat is listed on the Environment Protection and Biodiversity Conservation Act (TSSC 2001a).

Information on projected changes to climate are from the NSW and ACT Regional Climate Modelling (NARClim) project (OEH 2014). The climate projections for 2020–2039 are described as 'near future'; and projections for 2060–2079 are described as 'far future'. The snapshot shown in Table 8 is for the Central West and Orana Region which includes Jenolan Karst Conservation Reserve (OEH 2014).

The projected increases in temperature, number of hot days and severe fire weather days (OEH 2014) are likely to influence bushfire frequency and intensity across the Central West and Orana Region. This projected climate change will result in both an earlier start to, and an extended length of, the bushfire season (DECCW 2010a). Higher rainfalls in autumn are likely to accelerate all forms of soil erosion across the region and increase runoff at these times of year which, in turn, is likely to impact the stormwater system and, where capacity is reached, cause flooding (DECCW 2010a).

Table 8: Central West and Orana Region climate change snapshot

Projected temperature changes	
Maximum temperatures are projected to **increase** in the near future by 0.4–1.0°C	Maximum temperatures are projected to **increase** in the far future by 1.8–2.7°C
Minimum temperatures are projected to **increase** in the near future by 0.5–0.9°C	Minimum temperatures are projected to **increase** in the far future by 1.5–2.6°C
The number of hot days (i.e. > 35°C) will **increase**	The number of cold nights (i.e. < 2°C) will **decrease**
Projected rainfall changes	
Rainfall is projected to **decrease** in spring	Rainfall is projected to **increase** in autumn
Projected Forest Fire Danger Index changes	
Average fire weather is projected to **increase** in summer, spring and winter	Number of days with severe fire weather is projected to **increase** in summer, spring and winter

Source: OEH 2014.

Climate change may significantly impact the karst environment. More variable and extreme rainfall and wildfire events can directly damage surface karst features and alter the hydrological regimes and chemical processes which are crucial to the maintenance of a healthy karst environment (ANU 2009). Assessment of climate change impacts on flood-producing rainfall events is necessary for specific locations such as this reserve. Research needs to be undertaken to provide more specific advice on the potential scale of changes to flood-producing rainfall events and potential changes to likely antecedent conditions within catchments (DECCW 2010a). With regard to fire frequency, detailed analysis of current fire regimes is required for this region and future, quantitative projections are also required. Major research effort is required to resolve future effects of changes in moisture and elevated carbon dioxide on vegetation fuel characteristics. The degree to which these characteristics will change and affect fire regimes is unknown (DECCW 2010a).

A study by researchers from the Australian Nuclear Science and Technology Organisation's Institute for Environmental Research is monitoring trace gas and carbon dioxide levels in caves to compare with and supplement similar studies at Wombeyan and Yarrangobilly caves. The project is expected to provide further insight into past and future fluctuations in climate and their impacts on speleothem development (Jenolan Caves Reserve Trust 2012a).

Climate change may significantly affect biodiversity by changing the size of populations and the distribution of species and altering the geographical extent and species composition of habitats and ecosystems. Species most at risk are those unable to migrate or adapt, particularly those with small population sizes or with slow growth rates (DECCW 2010c).

Given that the reserve is located within topography of significant altitudinal range, it may include areas that provide important refugia as climate temperatures increase. This is demonstrated by the presence of several plant species within the reserve with disjunct distributions (other than limestone associated species) (R Lembit [Convenor Park Management Committee, National Parks Association] 2014, pers. comm.).

The potential impact of climate change on the park is difficult to assess since it also depends on the compounding effects of other pressures, particularly barriers to migration and pressure from

introduced animals. Highly cleared and fragmented ecosystems, such as the endangered White Box Yellow Box Blakely's Red Gum Woodland, are likely to be at greater risk than more intact ecosystems (DECCW 2010c).

Based on overseas research, the threatened flame robin and gang-gang cockatoo (*Callocephalon fimbriatum*), both altitudinal migrants, may be particularly at risk from climate change. Changing rainfall patterns and distribution will be important determinants of species distribution. The drying pattern in south-east Australia is likely to continue and intensify. Preliminary modelling suggests that of the reserve's suite of threatened bats, the eastern bentwing-bat, eastern false pipistrelle and greater broad-nosed bat (*Scoteanax rueppellii*) are likely to be most impacted (OEH 2012f).

Climate change also has the potential to affect other values in the reserve including tourism, recreation, heritage sites and infrastructure. For instance, more severe or frequent extreme weather events and bushfires could reduce the number of people choosing to visit, limit the places they can visit and the kinds of recreational activities they undertake, and possibly compromise visitor safety in some circumstances. Maintenance requirements for walking tracks and other assets and infrastructure could also be affected by extreme weather events and lead to additional loads on resources.

NPWS will continue to manage threats from climate change in a collaborative way with other land managers, such as Forestry Corporation of NSW and with park neighbours. Furthermore, programs to reduce the pressures arising from other threats, such as invasive species, bushfires and pollution, will also help reduce the severity of the effects of climate change.

Desired outcomes

- The effects of climate change on natural systems are reduced through mitigation measures from other threats such as pests, weeds and fire.
- The potential negative impacts of climate change on tourism, recreation, heritage and other reserve values are recognised and managed.

Management response

4.3.1 Continue fire, pest and weed management programs and, where required, adapt to improve the resilience of species and ecosystems to climate change–induced threats in accordance with best practice management approaches when the information becomes available.

4.3.2 Encourage research into appropriate indicators to monitor the effects of climate change on reserve values including karst environments and processes, riparian areas, refuge areas or habitat linkages for species migration.

4.3.3 Align reserve management with the intent of relevant climate change strategies.

4.3.4 Strengthen partnerships with other land management agencies and organisations and work cooperatively on programs that will build biodiversity resilience to climate change.

5. Management operations and other uses

5.1 Management facilities and operations

Management operations within the Visitor Use and Service Zone (VUSZ) are primarily provided by the Trust at this stage but may be provided by NPWS and/or lessees and licensees in the future. Management operations in the Conservation Management Zone are provided by NPWS. A wide range of reserve infrastructure supports reserve management operations with a major focus on the main visitor hub at the Grand Arch Precinct (see Figure 4 in Appendix A). The Grand Arch Precinct provides:

- visitor accommodation (including the Caves House complex, Mountain Lodge and Gatehouse Backpacker Lodge) and associated facilities, such as the laundry
- visitor facilities including a cafe, gift shop, bar, restaurant, public amenities, picnic facilities, ticket office, signage, roads and carparks
- walking tracks
- plantings and gardens
- reservoirs, tanks and reticulation
- seismograph station
- workshops and other operational buildings
- infrastructure within the caves such as walkways and stairs/steps.

OEH conducts an environmental inspection program of all major activities and development in the VUSZ (see Section 3.1 Geology, landscape and hydrology).

Apart from facilities in the Grand Arch Precinct outlined above, other management facilities include visitor and staff accommodation in the Jenolan Cottages Precinct and staff accommodation in all precincts other than the Campground and Utilities Precinct. A fire station is located in the Burma Road Housing Precinct and a fire shed in the Jenolan Cottages Precinct. The sewage treatment plant and hydro-electric station are located in the Campground and Utilities Precinct. Public amenities are located in the Campground and Utilities Precinct and the Jenolan Cottages Precinct. Reservoirs are located in the Burma Road Housing Precinct, Jenolan Cottages Precinct and the Five Mile Road Housing Precinct.

Operational buildings for archival, administrative and research purposes are located in a number of precincts. Operational buildings include the Wallaby Shed, currently in poor condition, which supports the brush-tailed rock-wallaby recovery program and is located in the Conservation Management Zone adjacent to the Burma Road Housing Precinct VUSZ. A cottage known as the Cavers Cottage is used by speleological groups and is located in the Burma Road Housing Precinct.

The heritage significance of the reserve's buildings, facilities, infrastructure and landscapes is documented comprehensively in the draft CMP. The reserve includes items of state heritage significance, including Caves House. Conservation management plans and the *Heritage Asset Management Strategy* (Godden Mackay Logan 2007) are the primary guidance documents for ongoing heritage management of the VUSZ and for some heritage items included in the draft CMP that are located in the Conservation Management Zone. The condition of buildings, facilities and infrastructure varies with a proportion requiring repair and/or refurbishment.

The draft CMP recommends assessing the environmental impacts of the Burma Road Housing Precinct on the karst. Removal, relocation or appropriate remedial works are recommended if an assessment determines that buildings are having an adverse impact.

The draft CMP also recommends that existing conservation and maintenance works schedules are updated to include works identified in the conservation policies (draft CMP Volume 1) and in the inventory forms (draft CMP Volume 2). Implementation of the finalised conservation management plan's policies and prioritised strategies and actions will ensure appropriate ongoing management of the significant state and local heritage assets and heritage values of the reserve.

The Trust has in place an Audit and Finance Committee which meets regularly to review and manage risks. Independent audits and assessments are undertaken to mitigate risk across its operations (Jenolan Caves Reserve Trust 2017). The draft CMP proposes preparing a risk management strategy for the Grand Arch Precinct which will include assessing existing and potential recreational activities.

Cave infrastructure

There is a total of 3.5 kilometres of cave pathways and associated infrastructure in the reserve's show caves. Upgrading of this infrastructure is ongoing, with a primary focus on pathways (including handrails) and lighting systems in line with risk assessments. The draft CMP recommends retention of a sample of cave infrastructure from all periods, unless it is damaging the karst. Cave infrastructure removed from the caves should be inventoried and stored safely with information about its origins.

The caves are maintained with specialist vacuuming and water cleaning techniques. OEH conducts air and water quality monitoring of the show caves (see Section 3.1 Geology, landscape and hydrology). OEH has produced guidelines (OEH 2013a) to address development on karst, including minor cave development. Development within OEH reserves generally is subject to environmental impact assessment in accordance with NPWS policy and procedures.

Roads and parking

Jenolan Caves Road is a sealed, all-weather public road owned and maintained by Roads and Maritime Services and provides the main public access to the reserve (see Figure 2). The road is narrow with sharp bends and steep drop-offs. It was temporarily closed in 2004 and has been upgraded to alleviate the risk of landslip. In the interest of road safety, part of Jenolan Caves Road is operated as a one-way road during the middle of the day to permit vehicles, particularly coaches, to arrive safely. The loop road within the Grand Arch Precinct is a sealed, all-weather park road open to the public and is currently maintained by the Trust. Kanangra Walls Road connects with Jenolan Caves Road in the south-west corner of the reserve and is an unsealed public road owned and maintained by Oberon Council. A series of management trails provide vehicular access to the reserve for management purposes and are not open to the public (see Figure 2).

There are three major carparks within the Grand Arch Precinct (see Figure 4). Parking for 330 cars is available, augmented in busy periods with a further 150 parking spaces in various locations, for example, on side roads. There is a designated coach parking bay which accommodates six large coaches and two mini-buses. These facilities are currently maintained by the Trust. Coaches also park on the roadside outside the Guides Office. During peak periods a shuttle bus moves visitors to and from the carpark furthest from the visitor centre. Designated disabled parking spaces are located adjacent to the Guides Office (two spaces) and behind Caves House (one space).

Impacts of vehicles in the Grand Arch Precinct, which is located at the base of the valley, include environmental impacts (such as noise, air and water pollution), and safety risks to pedestrians and cyclists. The carparks also impact the visual amenity of the precinct. The draft CMP proposes development of a master plan for the precinct to address, among other issues, vehicle circulation and future carparking. It also makes a number of policy recommendations for

management of other areas of the reserve used for carparking in relation to their potential impacts on heritage values.

Sewage treatment plant

The Jenolan Sewage Treatment Plant is located approximately 1 kilometre downstream of the caves. The plant discharges tertiary treated effluent to the Jenolan River, which forms part of the Warragamba Catchment. The Trust operates the treatment plant under an environment protection licence issued in accordance with the *Protection of the Environment Operations Act 1997*. The Jenolan Sewage Treatment Plant is licensed to discharge up to 200 kilolitres per day.

Effluent discharged from the treatment plant must comply with Environment Protection Authority licence conditions and guidelines. The environment protection licence sets concentration limits for the following pollutants which are monitored monthly:

- biochemical oxygen demand
- nitrogen (ammonia)
- total nitrogen
- total phosphorus
- total suspended solids
- faecal coliforms
- oil and grease.

The sewage treatment plant was upgraded in 2004 and 2009 with a focus on reducing nutrient levels of effluent discharged to the river and converting from chlorination to ultra violet disinfection. The installation of eight waterless public urinals has helped to save water and reduce sewage.

On-site septic systems service the Two Mile Road and Five Mile Road housing precincts and the Jenolan Cottages Precinct. A septic system serviced the campground which is currently closed, but it is of limited capacity and is poorly sited in a riparian zone.

Water supply

A limited number of reservoirs provide water for domestic consumption and firefighting purposes. The reservoirs are constructed from steel, with the exception of the Car Park No. 2 reservoir which is constructed from concrete. The reservoirs are regularly inspected to assess their structural integrity.

Domestic water is supplied to the Grand Arch Precinct from a 182-kilolitre concrete tank which is fed from an aquifer located near De Burghs Bridge. Water is subsequently fed via main and arterial lines through the reserve. The reserve's water reticulation system has recently been upgraded, including replacement of aged steel and asbestos water supply pipes, provision of three new pumps and a new sand filter. Results of monitoring of the domestic water supply are supplied to NSW Health.

A bore, installed in 2010, supplies the Jenolan Cottages with water for domestic purposes (Jenolan Caves Reserve Trust 2010).

Electricity supply

The state electricity grid is the reserve's primary source of power (see Section 5.2 Non-NPWS uses/operations) and was previously supplemented by the reserve's hydro-electric plant until it fell into disrepair in 2013. A generator is used to supply power to the Grand Arch Precinct in the event of network supply failure.

The hydro-electric system in the reserve is reputed to be the first of its kind in Australia. The current system replaced the original Leffel Wheel and is driven by the Jenolan River which is dammed upstream of the hydro-electricity turbines to form Blue Lake. Water is piped approximately 1 kilometre from Blue Lake to the turbines. The hydraulic ram and the turbine within the Coach House have been restored and the Leffel turbine is still in existence. Although the hydro-electric plant was repaired and recommissioned in 2008 it has again fallen into disrepair and options are being investigated to recommission it and to interpret the site. Energy-efficient lighting is being installed in caves and buildings to reduce power consumption.

Essential Energy's infrastructure delivers power to three points within the south-west part of the reserve. From these points, reserve infrastructure distributes supply within the reserve to various locations. Some reserve powerlines are underground, as is the case for much of the Grand Arch Precinct.

Waste disposal sites

Historically, waste was disposed of on the reserve at various locations. In 2004 a fire occurred adjacent to the former waste disposal site on Kia Ora Hill (see Section 4.2 Fire). Former waste disposal sites are also located in gullies adjacent to the Jenolan Cottages Precinct (see Figure 5), on Two Mile Hill and at the Five Mile Precinct. Some of the sites have been covered in soil and the Kia Ora site was revegetated. Waste is now disposed of at the Oberon Waste Facility.

Old waste disposal sites can pose a threat to the reserve's significant natural values and to staff and visitor health and safety. Apart from the potential for increased fire risk; leachates, weed incursions, surface and groundwater contamination, stormwater runoff and gases produced by waste have the potential to pollute the reserve's sensitive environment. Waste material may also litter the landscape and waterways, and staff and visitors may come into contact with waste materials that may pose a health or safety risk unless managed appropriately. Depending on the type of waste materials, how they are managed in situ and their inherent risk profile, site remediation may be required to avoid or mitigate any adverse impacts.

The OEH environmental inspection program of the VUSZ (see Section 3.1 Geology, landscape & hydrology) has not identified issues associated with the waste disposal sites currently monitored. However, due to a lack of comprehensive information on waste disposal on the reserve and the historic nature of some sites, it would be prudent to collect further information to assess their risk in terms of OEH obligations under the *Contaminated Land Management Act 1997.*

Illegal activities

Illegal entry into caves may result in damage to or a loss of cave values such as damage to the cave walls (e.g. scratching of arrows in the rock and other graffiti), breaking of speleotherms and disturbance of cave fauna. In the reserve, there have been reports of unauthorised access into a number of undeveloped (wild) caves, especially Wiburds cave. Ongoing measures to manage illegal access, including cave security and surveillance, will continue to be implemented in accordance with the *Cave Access Policy* (OEH 2018a) and its 'Guidelines for Assessing, Implementing and Monitoring Cave Security Measures'. Consent to undertake recreational caving in undeveloped caves is regulated through a permit system managed by OEH in line with the *Cave Access Policy*.

There is a history of illegal hunting of pigs and deer and the use of hunting dogs in the reserve. Some dogs escape their handlers and may attack and kill native wildlife. Vehicles used by illegal hunters have also damaged management trails and vegetation, and rubbish has been left in the reserve. Illegal hunters also pose a safety risk to visitors, staff and non-target animals. Regular patrols of parts of the reserve known to be used for this purpose aim to reduce the incidence of illegal hunting.

Trail bike riding has decreased significantly since the closure of a campsite on land in the northern part of the reserve that was formerly part of Jenolan State Forest. Weed control has been undertaken in the area, large quantities of rubbish and abandoned vehicles were removed, and informal trails were rehabilitated. The campsite was closed following an intensive but unsuccessful public awareness campaign about the impacts of off-road vehicle use on the area and the rules in place to protect the environment.

Desired outcomes

- The reserve's assets are included in a maintenance program which safeguards heritage values.
- Risks are identified, appropriately managed, eliminated where possible, or mitigated.
- Unauthorised entry into caves is controlled through ongoing cave security and surveillance measures.
- Operation of roads and carparks meets visitor and operational needs and minimises impacts on heritage values and landscapes.
- Effluent disposal does not cause environmental harm.
- The water supply is safe for human consumption.
- Water and electricity are used efficiently.
- Environmental impact of former waste disposal sites is minimised, and sites are effectively remediated, as required.
- No waste is disposed of on the reserve, other than vegetation which can be used safely as mulch and licensed discharge through the sewage treatment plant. All other waste is disposed of at licensed landfill sites outside the reserve.
- Illegal hunting and off-road vehicle use are minimised.

Management response

5.1.1 Continue implementing the maintenance program for reserve assets. Update the program in line with the requirements of the *Jenolan Caves Reserve Trust Heritage Asset Management Strategy* and to include works recommended in any conservation management plan.

5.1.2 Continue to review and update the risk management strategy regularly and to implement corrective actions. Incorporate the risk management recommendations of any conservation management plan adopted.

5.1.3 Continue to implement cave security measures and surveillance in accordance with OEH policy and guidelines to minimise the occurrence of illegal entry into caves.

5.1.4 As part of the preparation of a master plan (referred to in the draft conservation management plan), vehicular traffic movement should be monitored on an ongoing basis to ensure that transport arrangements over time do not detract from the visitor experience or the presentation of the heritage of the reserve.

5.1.5 Investigate alternative options for traffic management in order to reduce impacts on karst and find ways to reduce or eliminate vehicle traffic through the Grand Arch if possible.

5.1.6 Maintain and monitor the operation of the sewerage treatment plant in accordance with the environment protection licence and review the existing capacity to ensure it is adequate to meet demand.

5.1.7 Ensure that areas serviced by on-site septic systems comply with contemporary standards of operations and monitoring to minimise potential for environmental pollution and review the existing capacity to ensure it is adequate to meet demand.

5.1.8 Continue monitoring the domestic water supply to the Grand Arch Precinct and providing monitoring results to NSW Health.

5.1.9 Ensure domestic water supplies to precincts in the reserve not serviced by the reticulated water supply meet domestic water quality standards.

5.1.10 Continue to implement programs to maximise the efficient use of water and electricity including the recommissioning and presentation of the hydro-electric plant.

5.1.11 Investigate old waste disposal sites in the reserve to determine their status in terms of the *Contaminated Land Management Act 1997* and undertake or organise remediation as required.

5.1.12 Continue regular patrols in response to unauthorised uses of the reserve.

5.2 Non-NPWS uses and operations

Leases and licences

Due to the nature and diversity of visitor operations within the Jenolan Karst Conservation Reserve, a number of leasing and licensing instruments are in place to allow for use of the reserve by third parties. Such instruments form the basis of ongoing relationships with parties and define the minimum requirements to be upheld by licensees in ensuring the protection of the natural and cultural values of the reserve. All leases and licences pertaining to buildings relate to the VUSZ. Licensing of commercial activities such as tours and guiding may include areas within the Conservation Management Zone.

Over 20 buildings within the VUSZ, made up of one-, two- or three-bedroom cottages, are currently managed by lease. At the time of publication, these leases are administered by the Trust. Most of these leases relate to the use of buildings for staff accommodation, however, some of the use has also been by speleological groups and scientists. Staff are also accommodated within staff flats and in the Vernon Wing of Caves House. Leases are not currently in place for use of this area.

A number of licences held by the Trust to facilitate operations within the VUSZ are consistent with requirements of other legislation. Examples of this include operation of the sewage treatment plant and licences for the public performance, broadcast or communication of music.

As set out in Section 2.2 (see Leases and Licences – Private partnerships), the Government is seeking opportunities to partner with the private sector to deliver services in the VUSZ. This may result in leases and licences being granted to private operators.

Easements and rights of way

There are no easements or rights of way in the reserve.

Transmission lines

Network operators Essential Energy and Endeavour Energy have powerlines traversing the reserve. These power lines are not covered by a formal easement. In accordance with the *Electricity Supply Act 1995* a network operator can operate and use the existing powerlines whether or not there is a formal easement in place.

Maintenance, including maintenance of clearings and vehicle trails along the powerlines, has the potential to create significant environmental and visual impacts. No access or maintenance agreement currently exists with either network operator, but the companies must comply with the National Parks and Wildlife Act and Regulation when carrying out any maintenance or replacement work and will require NPWS consent for certain works.

Essential Energy’s powerlines enter the western part of the reserve around Jenolan Caves Road and service the following precincts: Grand Arch, Burma Road Housing, Bellbird Cottage, and Campground and Utilities. Power is supplied to substations in the reserve from which the

reserve's power infrastructure distributes it within the reserve (see Section 5.1 Management facilities and operations). The powerlines are approximately 3 kilometres in length and are mainly located above ground.

The Endeavour Energy powerline is located in the north-east corner of the reserve and is approximately 1 kilometre in length. The powerline follows the Jenolan Caves Road reserve and enters the Jenolan Karst Conservation Reserve adjacent to the Jenolan Cottages Precinct, which it services.

The electricity grid provides the reserve's primary source of power and was supplemented by the reserve's hydro-electricity plant (see Section 5.1). A generator is used to supply power to the Grand Arch Precinct in the event of network supply failure.

Road works stockpile sites

A stockpile site exists in the park in the vicinity of Kiaora Hill, next to Jenolan Caves Road and the Six Foot Track. It is comprised of local excavated material and other unknown material. It is contained by a temporary fence and locked gate. The legal status of this stockpile is unclear and further discussion is required with Roads and Maritime Services to determine its future existence and operation in the park.

Telecommunications

There is a telecommunications tower site at the flagpole in the Grand Arch Precinct. Current occupancy agreements are in place between Telstra and the Trust for this facility. Water NSW has a transmitter at the seismic station adjacent to the technical services workshop. There is no occupancy agreement currently in place for this facility. There is also a Telstra optic fibre and cable and associated equipment along the Binoomea Ridge Trail and through the vegetation in the reserve. It is unclear whether this infrastructure is appropriately licensed under the National Parks and Wildlife Act.

Establishment, maintenance and operation of telecommunications infrastructure has the potential to adversely impact natural and cultural values and visual amenity. Any new telecommunications facilities proposed (including additional antennae on existing towers) require NPWS consent. Any new users would require a licence under the National Parks and Wildlife Act and be subject to OEH environmental impact assessment policy and procedures.

Desired outcomes

- Non-NPWS uses and operations have minimal impact on the reserve's World Heritage values and other natural and cultural values, scenic and aesthetic values and reserve infrastructure.
- Agreements are in place with external service providers with infrastructure in the reserve to adequately protect reserve values.

Management response

5.2.1 New leases and licences may be granted in the VUSZ to enable private operators (including non-commercial and community groups) to provide services in the VUSZ.

5.2.2 Leases for the adaptive re-use of existing buildings in the VUSZ may be granted for purposes consistent with the management principles of the reserve.

5.2.3 Where leases or licences are granted for the adaptive re-use of existing buildings in the VUSZ for purposes consistent with the management principles of the reserve, groups or individuals affected by such change will be consulted.

5.2.4 New buildings may be constructed in the VUSZ for purposes consistent with the management principles of the reserve, including for the following purposes that support sustainable visitor and tourist use:

- accommodation for visitors and tourists and associated ancillary retail outlets and facilities to enable conferences, functions and sporting activities
- facilities and amenities for visitors and tourists including information centres, booking outlets, restaurants, cafes, kiosks and other food outlets and associated ancillary retail outlets and facilities to enable conferences or functions.

5.2.5 Proposals for any new building will be subject to environmental impact assessment and the requirements under section 151 of the National Parks and Wildlife Act for new buildings that include:

- compatibility with natural and cultural values
- application of the sustainability assessment criteria
- application, measurement and monitoring of performance standards and indicators set out in a plan of management.

5.2.6 Proposals for adaptive re-use of existing buildings or for new buildings in the VUSZ are subject to environmental impact assessment in accordance with NPWS policy and procedures, the Heritage Act and the 'Guidelines for Undertaking Development on Karst in OEH Reserves'.

5.2.7 Licences may be granted to operate tours and other visitor experiences in the caves and for other areas of the reserve. Licensing of commercial operators will be in accordance with the *Parks Ecopass – NPWS commercial recreational and tour operator licensing system* and associated operating procedures.

5.2.8 Lessees and licensees under section 151D of the National Parks and Wildlife Act are to comply with the relevant environmental performance standards in Appendix B.

5.2.9 In accordance with section 151D of the National Parks and Wildlife Act, OEH will monitor and report annually on the environmental performance of any lessee or licensee holding a lease or licence. Environmental performance will be measured against the standards and indicators in Appendix B. Monitoring results will be recorded in the section 151J register and published on the OEH website.

5.2.10 Undertake a review of all existing energy and telecommunication infrastructure including lines, sub-stations, towers and associated infrastructure; road works stockpile sites; and access routes; and determine management actions to reduce the impacts associated with the maintenance of these facilities in accordance with the following principles:

- Formalise licence agreements for external provider infrastructure on the reserve.
- Co-locate facilities at shared sites where feasible; or locate infrastructure underground where possible; or seek to relocate off the reserve if appropriate.
- Remove all redundant infrastructure and rehabilitate disturbed sites and access roads that are no longer required.
- Undertake regular monitoring and adaptive management of environmental impacts associated with their maintenance and operation.

6. Implementation

This plan of management establishes a scheme of operations for the park. Implementation of this plan will be undertaken within the annual program of the NPWS.

Identified activities for implementation are listed in Table 9 below.

*Relative priorities are allocated against each activity as follows:

> **High priority** activities are those which are imperative to achieving the objectives and desired outcomes. They must be undertaken in the near future to avoid significant deterioration in natural, cultural or management resources.
>
> **Medium priority** activities are those that are necessary to achieve the objectives and desired outcomes but are not urgent.
>
> **Low priority** activities are desirable to achieve management objectives and desired outcomes but can wait until resources become available.
>
> **Ongoing** is for activities that are undertaken on an annual basis or statements of management intent that will direct the management response if an issue that arises.
>
> **As required** activities are those that are actioned on an as needs basis.

This plan of management does not have a specific term and will stay in force until amended or replaced in accordance with the National Parks and Wildlife Act.

Table 9: List of management responses

Plan reference	Management response	Priority*
3.1 Geology, landscape and hydrology		
3.1.1	Implement the Blue Lake Management Strategy.	Medium
3.1.2	Continue regular independent environmental inspection of the VUSZ. Provide inspection reports to the operator of the VUSZ and ensure any recommended remedial actions are implemented.	High
3.1.3	Continue OEH air and water quality monitoring targeting subterranean ecosystems, including cave-dependent fauna and cave formation processes. Ensure any recommended remedial actions are implemented.	High
3.1.4	Within the VUSZ, continue the program of cave cleaning and upgrading of existing cave infrastructure including lights, stairs, steps, ladders and railings.	
3.1.5	Assess the structural integrity of Surveyors Creek Dam, determine the preferred management option and any implementation actions required.	High
3.1.6	Continue to liaise with the Forestry Corporation of NSW in relation to mitigating potential adverse erosion and sedimentation impacts within the Jenolan River catchment	Medium
3.1.7	Continue ongoing maintenance of sediment traps and drain filters to minimise the transfer of sediment and contaminants into the Jenolan karst environment	High
3.1.8	Investigate the gazettal of the identified wilderness in the reserve as declared wilderness, part of the Kanangra-Boyd Wilderness Area	Medium

Plan reference	Management response	Priority*
3.1.9	Encourage and support scientific research that aligns with OEH's Karst Research Prospectus	Ongoing
3.2 Native plants and animals		
3.2.1	Implement relevant strategies in the *Biodiversity Conservation Program* and recovery plans for threatened species, populations and ecological communities present in the reserve.	High
3.2.2	Implement management recommendations in *The Vertebrate Fauna of the Jenolan Karst Conservation Area*, including cave-dwelling fauna.	High
3.2.3	Ensure all management decision-making in relation to the management of native plants and animals supports the maintenance or enhancement of World Heritage values.	Medium
3.2.4	Seek inscription of the remaining area of the reserve as part of the Greater Blue Mountains World Heritage Area in consultation with the NSW and Commonwealth governments.	Medium
3.2.5	Encourage and support scientific research that safeguards natural values and assists with reserve management	Low
3.3 Aboriginal heritage		
3.3.1	Continue to consult and involve the Pejar Local Aboriginal Land Council, the Gundungurra Aboriginal People, other relevant Aboriginal community organisations and custodial families in the management of their Country, including the management of Aboriginal sites, places and cultural and natural values	High
3.3.2	Undertake an archaeological survey and cultural heritage assessment prior to all works with the potential to impact Aboriginal sites or values.	Ongoing
3.3.3	Support initiatives in the *Greater Blue Mountains World Heritage Area Strategic Plan* in relation to indigenous cultural heritage including documenting indigenous values and involving indigenous communities in reserve management.	Ongoing
3.3.4	Consult with the Aboriginal community about preferred management options for known Aboriginal sites and documenting their cultural heritage value (for example developing a detailed Aboriginal heritage management and conservation strategy for the reserve); identifying areas of the reserve requiring further archaeological investigation and determining priorities for investigation within these areas, if required.	High
3.3.5	Where identified as appropriate or desirable by the Aboriginal community, targeted survey and recording of Aboriginal sites will be undertaken.	High
3.4 Historic heritage		
3.4.1	Undertake environmental impact assessment in accordance with OEH policy and legislative responsibilities for works with the potential to impact on the reserve's historic heritage.	Ongoing
3.4.2	Implement the *Jenolan Caves Reserve Trust Heritage Asset Management Strategy*.	High
3.4.3	Finalise and implement a conservation management plan for above-ground built heritage. The plan will be made available for public comment prior to finalisation.	High

Plan reference	Management response	Priority*
3.4.4	Prepare and implement a conservation management plan for cave heritage items. The plan will be made available for public comment prior to finalisation.	High
3.4.5	Encourage cultural heritage research projects in the reserve which assist the protection and management of the GBMWHA's cultural heritage values.	Medium
3.4.6	Facilitate the ongoing involvement of volunteers in the identification, management and preservation of historic heritage within the reserve.	Medium
3.5 Visitor use		
3.5.1	Support the development and implementation of a coordinated system for visitor use monitoring across the GBMWHA to assist in the development of visitor management strategies.	Ongoing
3.5.2	Prepare, exhibit and finalise a draft master plan for the reserve with a focus on the VUSZ to guide future provision of visitor facilities and services including day use activities, camping, traffic management, landscape and signage.	High
3.5.3	Visitor accommodation and hospitality services Refurbish, and where necessary redesign, accommodation offerings, visitor services and the provision of food and beverage within the VUSZ to meet visitor needs consistent with the approved reserve master plan and conservation management plan.	High
3.5.4	Day use Upgrade visitor facilities at the Inspiration Point lookout on Jenolan Caves Road (see Table 3). In order to minimise bushfire risk, do not provide a wood barbecue or fireplace.	Low
3.5.5	Remove day use visitor facilities at the Playing Fields Trail and at the two other locations on Jenolan Caves Road (see Table 3), subject to any environmental assessment required and significance assessments under the Heritage Act.	Low
3.5.6	Provide day use facilities within the Grand Arch Precinct in accordance with NPWS policy and any conservation management plan, when adopted.	Ongoing
3.5.7	Camping Investigate the appropriateness of developing camping within the VUSZ in the context of preparing a reserve master plan. Environmental assessment and the provisions of relevant legislation is required prior to the development of any camping facility.	Low-medium
3.5.8	Camping in the reserve will only be permitted in designated areas or with prior written consent of the Park Authority.	Ongoing
3.5.9	Bushwalking Continue to provide bushwalking opportunities in accordance with Table 4 and in line with the approved reserve master plan.	Ongoing
3.5.10	Consider the approved reserve master plan, the 'Landscape Issues and Options Report' and the accompanying landscape concept plan for the Blue Lake Loop when undertaking upgrading or maintenance.	High
3.5.11	Cycling	

Plan reference	Management response	Priority*
	Permit cycling on the Bicentennial National Trail, Jenolan Caves Road and the public road component of the Six Foot Track.	Ongoing
3.5.12	Adventure cycling, triathlons and other competitive cycling events are not permitted.	Ongoing
3.5.13	Horse riding Permit horse riding in the reserve on the Bicentennial National Trail. In order to maintain conservation values and visitor experience, allow a maximum of 10 horses (including packhorses) on the Bicentennial National Trail at any one time.	Ongoing
3.5.14	Manage the Bicentennial National Trail in accordance with the memorandum of understanding.	Ongoing
3.5.15	In consultation with Bicentennial National Trail Ltd, investigate improving the sustainable use, navigability and safety of the Bicentennial National Trail route including additional signage where required.	Medium
3.5.16	With the exception of the Bicentennial National Trail, horse riding will not be permitted in the reserve.	Ongoing
3.5.17	Camping with horses will not be permitted and facilities such as holding yards will not be provided.	Ongoing
3.5.18	Horse riding that is part of a competition or large-scale organised activity (including non-commercial activities) will only be permitted on the Bicentennial National Trail and will require written consent from NPWS. All commercial activities will only be permitted on the Bicentennial National Trail and will require a licence from NPWS.	Ongoing
3.5.19	Group activities Monitor commercial and non-commercial group activities and events with respect to cumulative impacts, impacts on threatened species, safety requirements, quality of information given and compliance with licence or consent conditions. See the NPWS Events and Venues Framework and DECCW (OEH) 'Karst Monitoring and Evaluation Toolkit'.	High
3.5.20	Allow group educational activities consistent with the management principles and values of the reserve, subject to conditions on group size, activities and location to protect reserve values.	Ongoing
3.5.21	Regulate caving activities in accordance with the approved list of caves in Appendix C and the *Cave Access Policy*. Access to undeveloped (wild) caves will be in accordance with cave access prescriptions. Caving activities with high-impact potential, such as large groups or competitive events, are not permitted. Prepare and implement a cave management plan for the reserve.	Ongoing
3.6 Information, education and research		
3.6.1	Implement the policy recommendations of any adopted conservation management plan and reserve master plan in relation to interpretation and signage, including updating the reserve's interpretation plan.	Medium
3.6.2	Incorporate consideration of the *Interpretation and Visitor Orientation Plan for Abercrombie, Borenore, Jenolan and Wombeyan Karst Conservation Reserves* and the *GBMWHA Strategic Plan* in the recommended update of the reserve's interpretation plan (see management response 3.6.1).	Medium

Plan reference	Management response	Priority*
3.6.3	Continue to involve the Gundungurra People in development of material and programs for interpretation of Aboriginal culture.	High
3.6.4	Continue to support and assist educational use of the reserve by schools, community groups and individuals through provision of information and programs such as guided and self-guided walks and talks.	High
3.6.5	Encourage research that safeguards World Heritage values and assists reserve management. Consider the OEH *Karst Research Prospectus* and the *GBMWHA Strategic Plan* when determining research applications.	Ongoing
3.6.6	Develop and implement a strategic approach to create public-focused information which communicates visitor experiences alongside core values of park conservation, while proactively delivering safety information relating to specific attractions, for all NPWS customers, for inclusion on NPWS website and other digital channels.	Medium
3.6.7	Continue to make digital information and facilities available within the overarching NPWS digital engagement strategy.	Medium
3.6.8	Continue to monitor visitor awareness, behaviour and satisfaction with the Jenolan Karst Conservation Reserve experience.	Medium
3.6.9	Support the ongoing involvement of volunteers in the accumulation and dissemination of knowledge, particularly where this knowledge contributes to a greater understanding of reserve values and their management.	Medium
3.6.10	Facilitate the provision of a suitable place to store historic and scientific collections.	Medium
4.1 Pests		
4.1.1	Manage pest species in accordance with the regional pest management strategy. Priority will be given to programs as per the strategy.	High
4.1.2	Prepare and implement reserve-specific weed management strategies as required to guide programs to monitor and control high priority (e.g. sycamore), current and emerging weeds. Incorporate adaptive weed management strategies and relevant strategies in the OEH 'Guidelines for Controlling Weeds on Karst'.	High
4.1.3	Implement recommended management responses for pest plants and animals in Section 7 of *The Vertebrate Fauna of the Jenolan Karst Conservation Area*.	Medium
4.1.4	Continue to implement fox control programs in accordance with the NSW Fox TAP and the local site plan to limit fox predation on brush-tailed rock-wallaby. Continue implementing cooperative fox control programs with neighbours.	High
4.1.5	Seek the cooperation of neighbours in implementing weed and pest control programs, as required.	Ongoing
4.1.6	Undertake pest plant and animal control in cooperation with Local Land Services, Landcare groups, Forestry Corporation of NSW and volunteers.	Ongoing
4.2 Fire		
4.2.1	Update and implement the reserve fire management strategy in accordance with NPWS policy. Consideration will be given to strategies	High

Plan reference	Management response	Priority*
	in the OEH 'Guidelines for Managing Fire on Karst'. An adaptive management approach to fire management will be adopted as the effects of climate change are realised or as new information on best practice management of fire on karst becomes available.	
4.2.2	Continue to participate in the Chifley Bush Fire Management Committee and maintain cooperative arrangements with the Oberon Rural Fire Service, the Jenolan Bushfire Brigade and other fire authorities, including Forestry Corporation of NSW, and surrounding landowners, including Hume Forests Ltd.	High
4.2.3	Identify and upgrade strategic management trails.	High
4.2.4	Prepare an emergency plan for the Grand Arch Precinct to address visitor and staff safety in the event of bushfire.	High
4.2.5	Monitor the ability of threatened flora to recover between fires and review regimes where relevant.	Ongoing
4.2.6	Rehabilitate areas disturbed by fire suppression operations as soon as practical after the fire.	Ongoing
4.3 Climate change		
4.3.1	Continue fire, pest and weed management programs and, where required, adapt to improve the resilience of species and ecosystems to climate change–induced threats in accordance with best practice management approaches when the information becomes available.	Ongoing
4.3.2	Encourage research into appropriate indicators to monitor the effects of climate change on reserve values including karst environments and processes, riparian areas, refuge areas or habitat linkages for species migration.	Ongoing
4.3.3	Align reserve management with the intent of relevant climate change strategies.	Medium
4.3.4	Strengthen partnerships with other land management agencies and organisations and work cooperatively on programs that will build biodiversity resilience to climate change.	Medium
5.1 Management facilities and operations		
5.1.1	Continue implementing the maintenance program for reserve assets. Update the program in line with the requirements of the *Jenolan Caves Reserve Trust Heritage Asset Management Strategy* and to include works recommended in any conservation management plan.	High
5.1.2	Continue to review and update the risk management strategy regularly and to implement corrective actions. Incorporate the risk management recommendations of any conservation management plan adopted.	High
5.1.3	Continue to implement cave security measures and surveillance in accordance with OEH policy and guidelines to minimise the occurrence of illegal entry into caves.	Ongoing
5.1.4	As part of the preparation of a master plan (referred to in the draft conservation management plan), vehicular traffic movement should be monitored on an ongoing basis to ensure that transport arrangements over time do not detract from the visitor experience or the presentation of the heritage of the reserve.	Medium

Plan reference	Management response	Priority*
5.1.5	Investigate alternative options for traffic management in order to reduce impacts on karst and find ways to reduce or eliminate vehicle traffic through the Grand Arch if possible.	Low-medium
5.1.6	Maintain and monitor the operation of the sewerage treatment plant in accordance with the environment protection licence and review the existing capacity to ensure it is adequate to meet demand.	High
5.1.7	Ensure that areas serviced by on-site septic systems comply with contemporary standards of operations and monitoring to minimise potential for environmental pollution and review the existing capacity to ensure it is adequate to meet demand.	High
5.1.8	Continue monitoring the domestic water supply to the Grand Arch Precinct and providing monitoring results to NSW Health.	High
5.1.9	Ensure domestic water supplies to precincts in the reserve not serviced by the reticulated water supply meet domestic water quality standards.	High
5.1.10	Continue to implement programs to maximise the efficient use of water and electricity including the recommissioning and presentation of the hydro-electric plant.	Ongoing
5.1.11	Investigate old waste disposal sites in the reserve to determine their status in terms of the *Contaminated Land Management Act 1997* and undertake or organise remediation as required.	High
5.1.12	Continue regular patrols in response to unauthorised uses of the reserve.	Ongoing
5.2 Non-NPWS uses and operations		
	<u>Leases and licences</u>	
5.2.1	New leases and licences may be granted in the VUSZ to enable private operators (including non-commercial and community groups) to provide services in the VUSZ.	Ongoing
5.2.2	Leases for the adaptive re-use of existing buildings in the VUSZ may be granted for purposes consistent with the management principles of the reserve.	Ongoing
5.2.3	Where leases or licences are granted for the adaptive re-use of existing buildings in the VUSZ for purposes consistent with the management principles of the reserve, groups or individuals affected by such change will be consulted.	Ongoing
5.2.4	New buildings may be constructed in the VUSZ for purposes consistent with the management principles of the reserve, including for the following purposes that support sustainable visitor and tourist use: • accommodation for visitors and tourists and associated ancillary retail outlets and facilities to enable conferences, functions and sporting activities • facilities and amenities for visitors and tourists including information centres, booking outlets, restaurants, cafes, kiosks and other food outlets and associated ancillary retail outlets and facilities to enable conferences or functions.	Ongoing
5.2.5	Proposals for any new building will be subject to environmental impact assessment and the requirements under section 151 National Parks and Wildlife Act for new buildings that include: • compatibility with natural and cultural values	Ongoing

Plan reference	Management response	Priority*
	• application of the sustainability assessment criteria • application, measurement and monitoring of performance standards and indicators set out in a plan of management.	
5.2.6	Proposals for adaptive re-use of existing buildings or for new buildings in the VUSZ are subject to environmental impact assessment in accordance with NPWS policy and procedures, the Heritage Act and the 'Guidelines for Undertaking Development on Karst in OEH Reserves'.	Ongoing
5.2.7	Licences may be granted to operate tours and other visitor experiences in the caves and for other areas of the reserve. Licensing of commercial operators will be in accordance with the *Parks Ecopass – NPWS commercial recreational and tour operator licensing system* and associated operating procedures.	Ongoing
5.2.8	Lessees and licensees under section 151D of the National Parks and Wildlife Act are to comply with the relevant environmental performance standards in Appendix B.	High
5.2.9	In accordance with section 151D of the National Parks and Wildlife Act, OEH will monitor and report annually on the environmental performance of any lessee or licensee holding a lease or licence. Environmental performance will be measured against the standards and indicators in Appendix B. Monitoring results will be recorded in the section 151J register and published on the OEH website.	High
5.2.10	Undertake a review of all existing energy and telecommunication infrastructure including lines, sub-stations, towers and associated infrastructure; road works stockpile sites; and access routes and determine management actions to reduce the impacts associated with the maintenance of these facilities in accordance with the following principles: • Formalise licence agreements for external provider infrastructure on the reserve. • Co-locate facilities at shared sites where feasible; or locate infrastructure underground where possible; or seek to relocate off the reserve if appropriate. • Remove all redundant infrastructure and rehabilitate disturbed sites and access roads that are no longer required. • Undertake regular monitoring and adaptive management of environmental impacts associated with their maintenance and operation.	Medium

Appendix A: Precinct maps

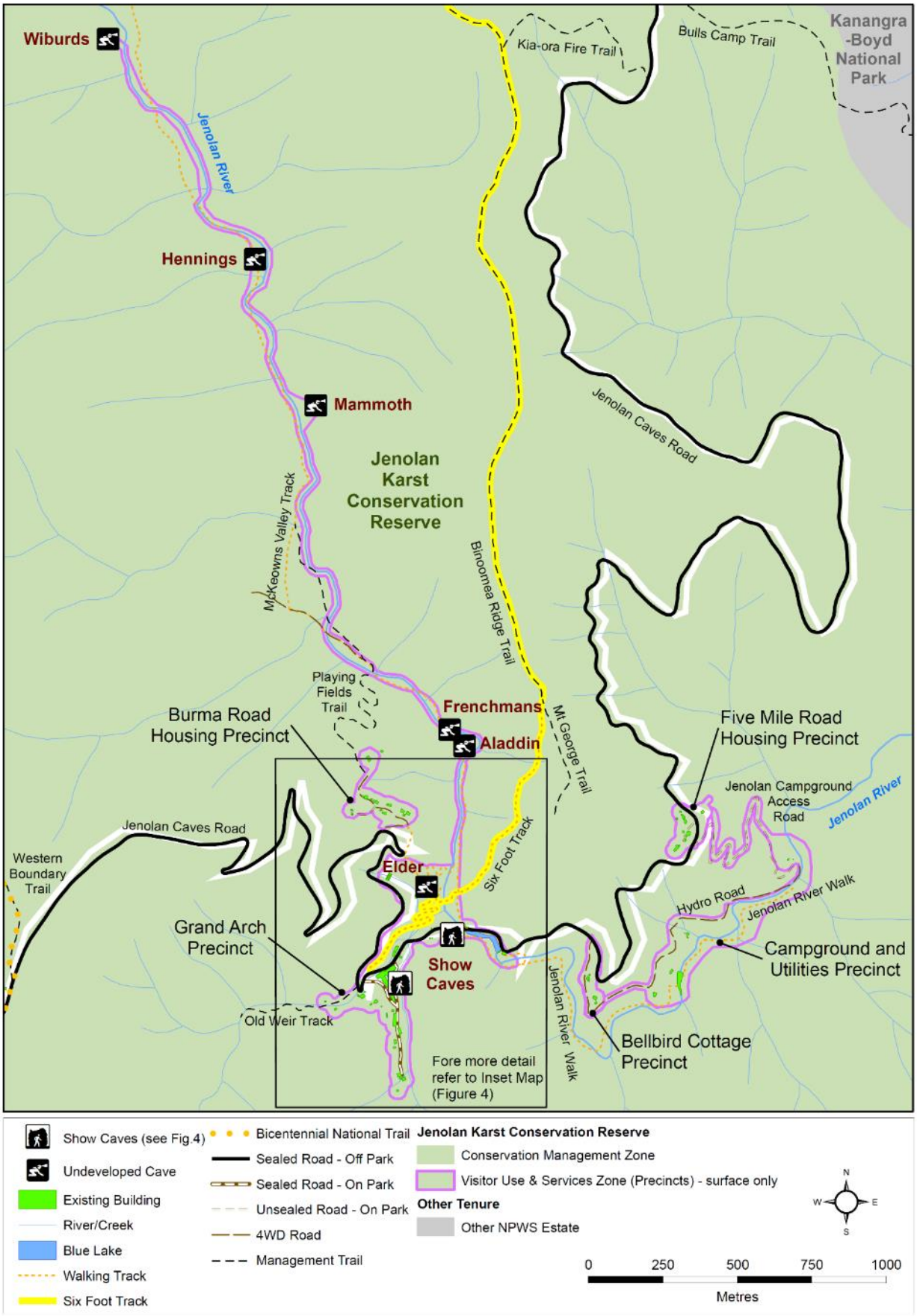

Figure 3: Grand Arch Precinct

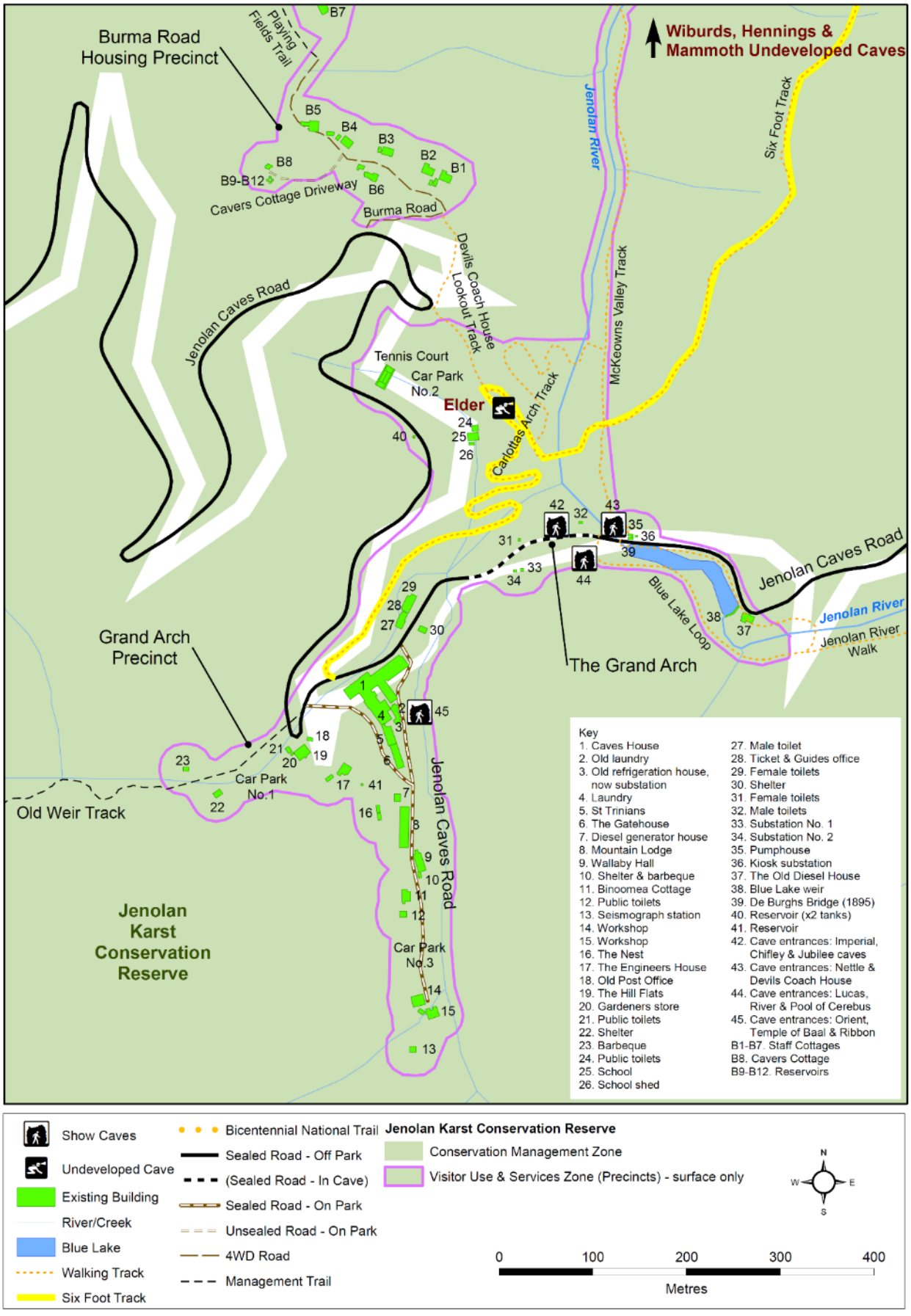

Figure 4: Grand Arch Precinct inset map

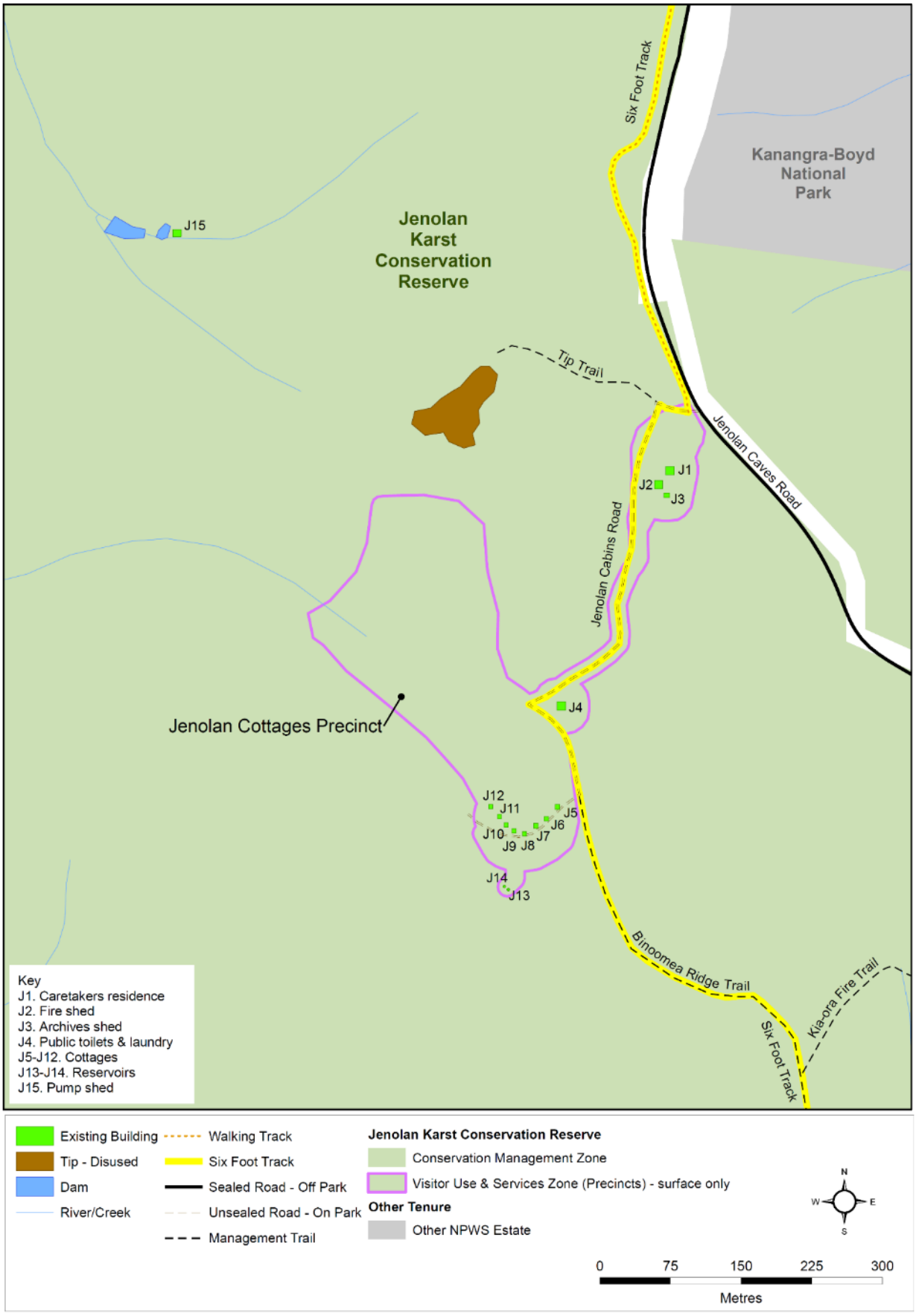

Figure 5: Jenolan Cottages Precinct

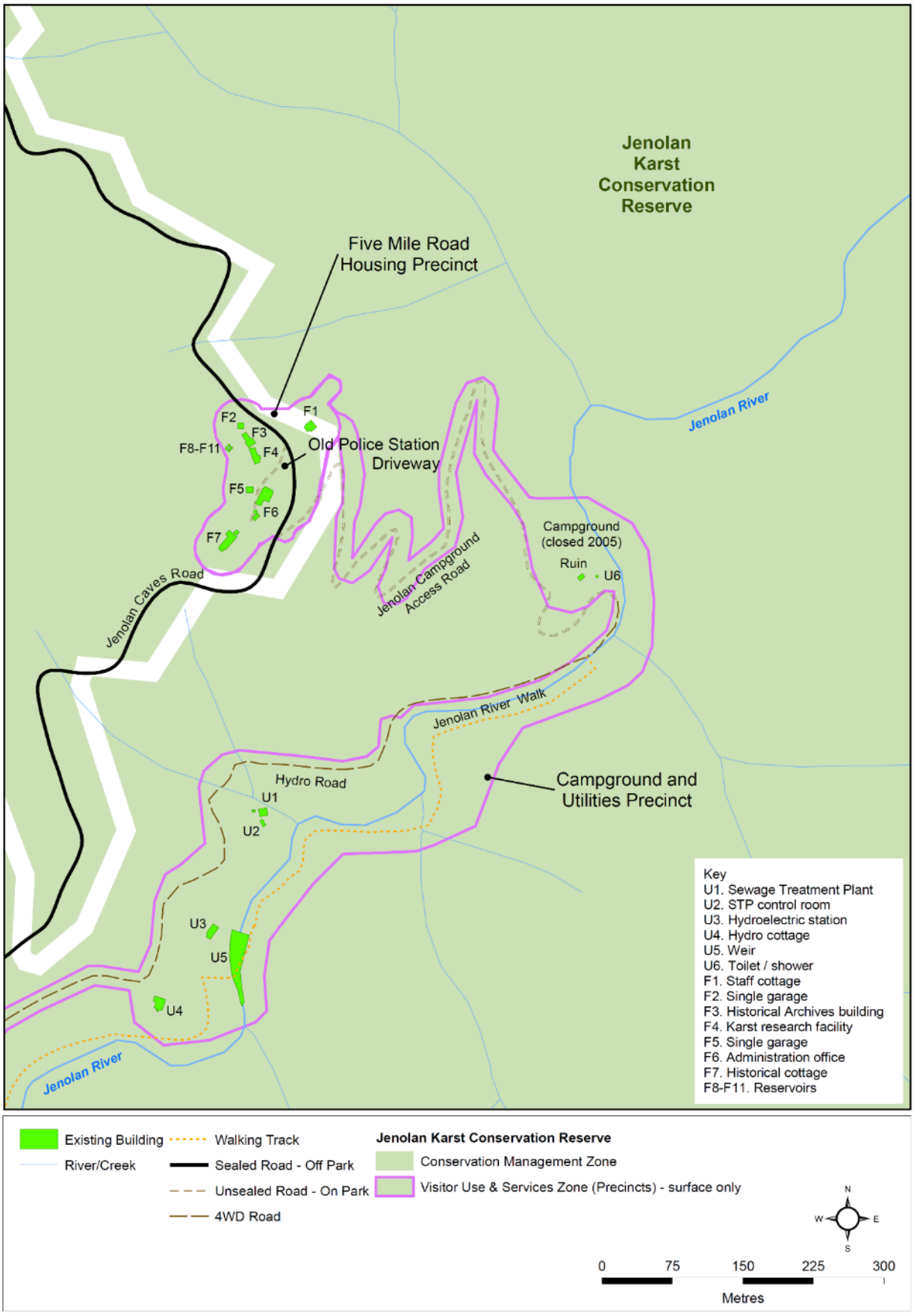

Figure 6: Five Mile Road Housing Precinct

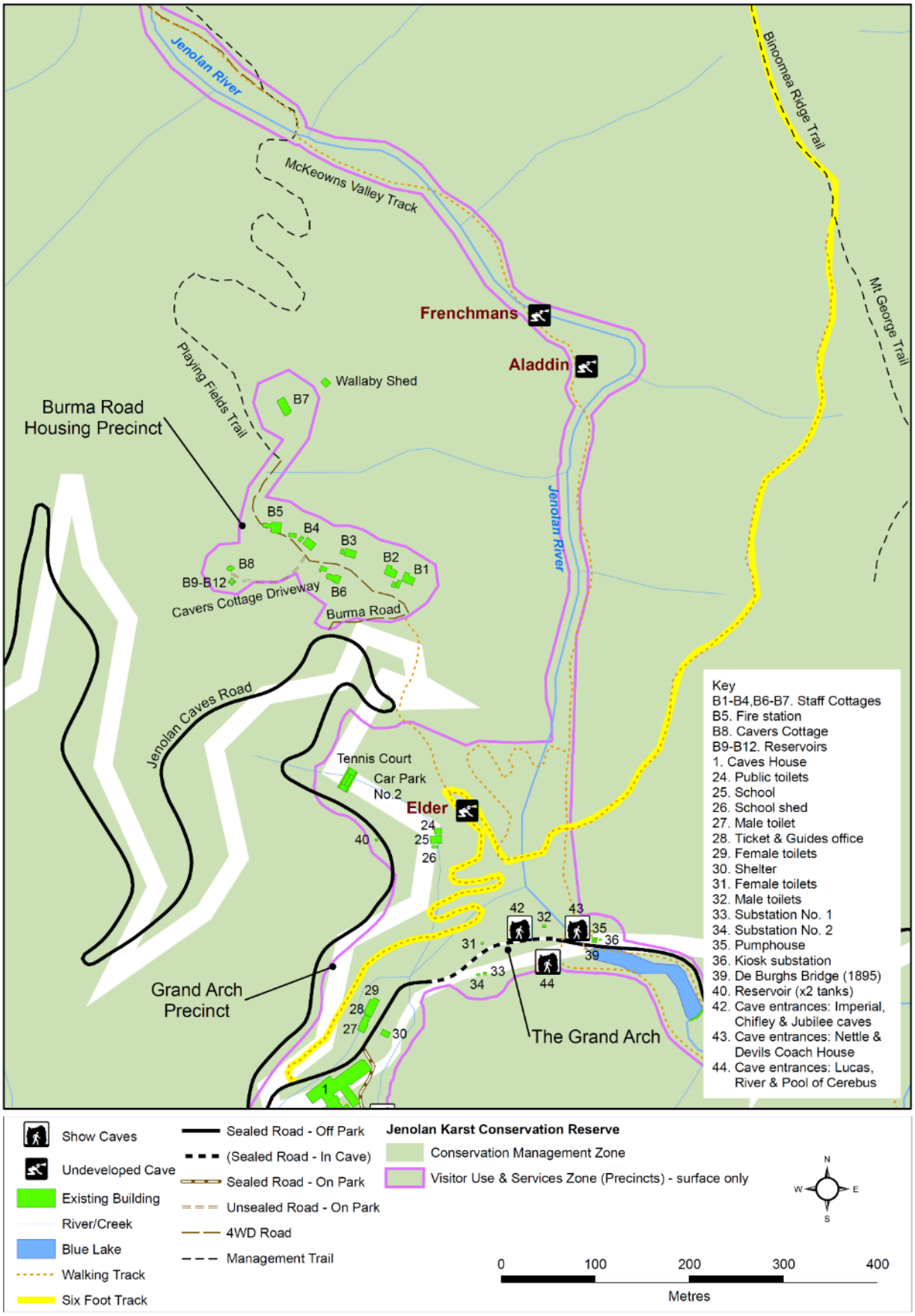

Figure 7: Burma Road Housing Precinct

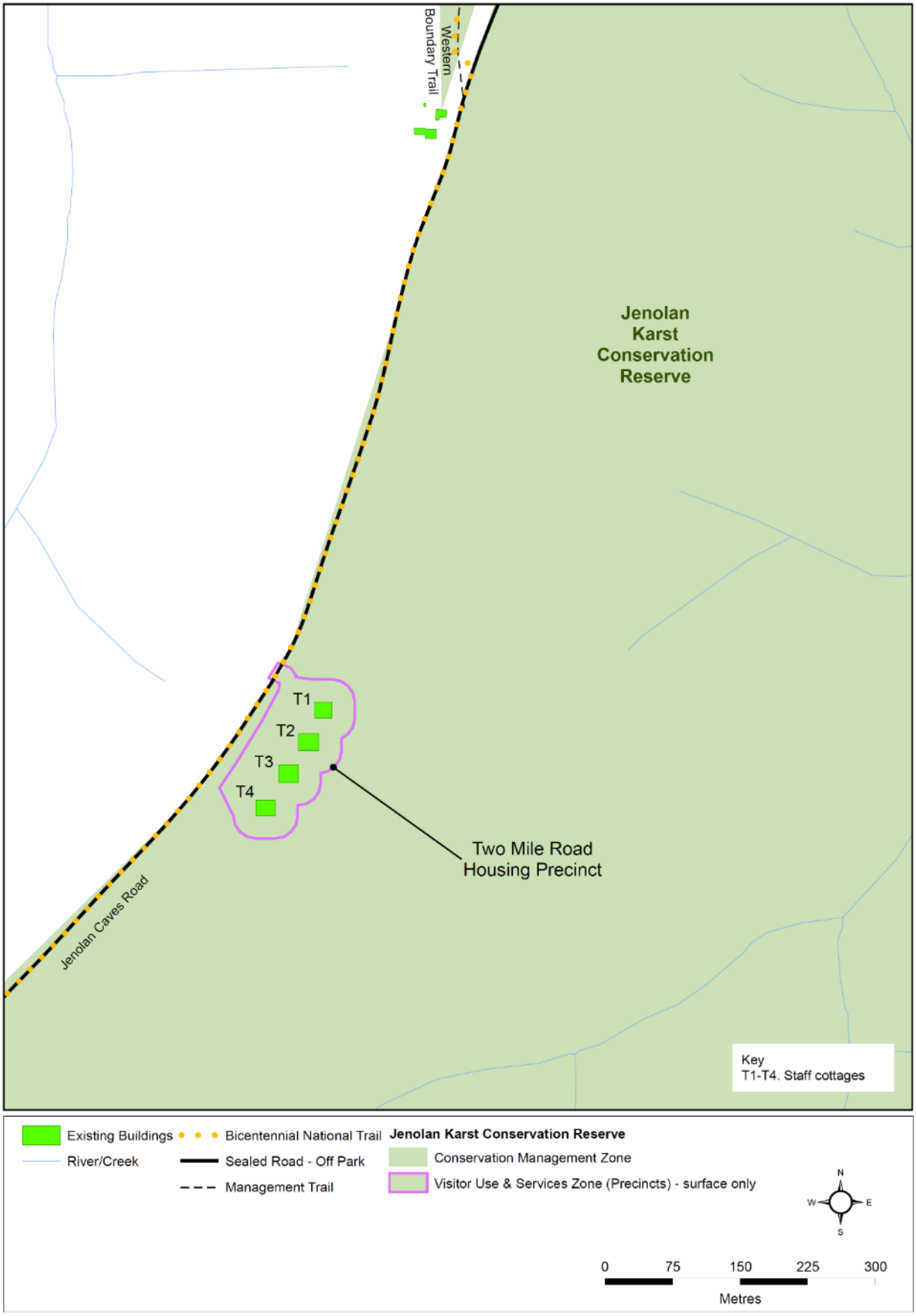

Figure 8: Two Mile Road Housing Precinct

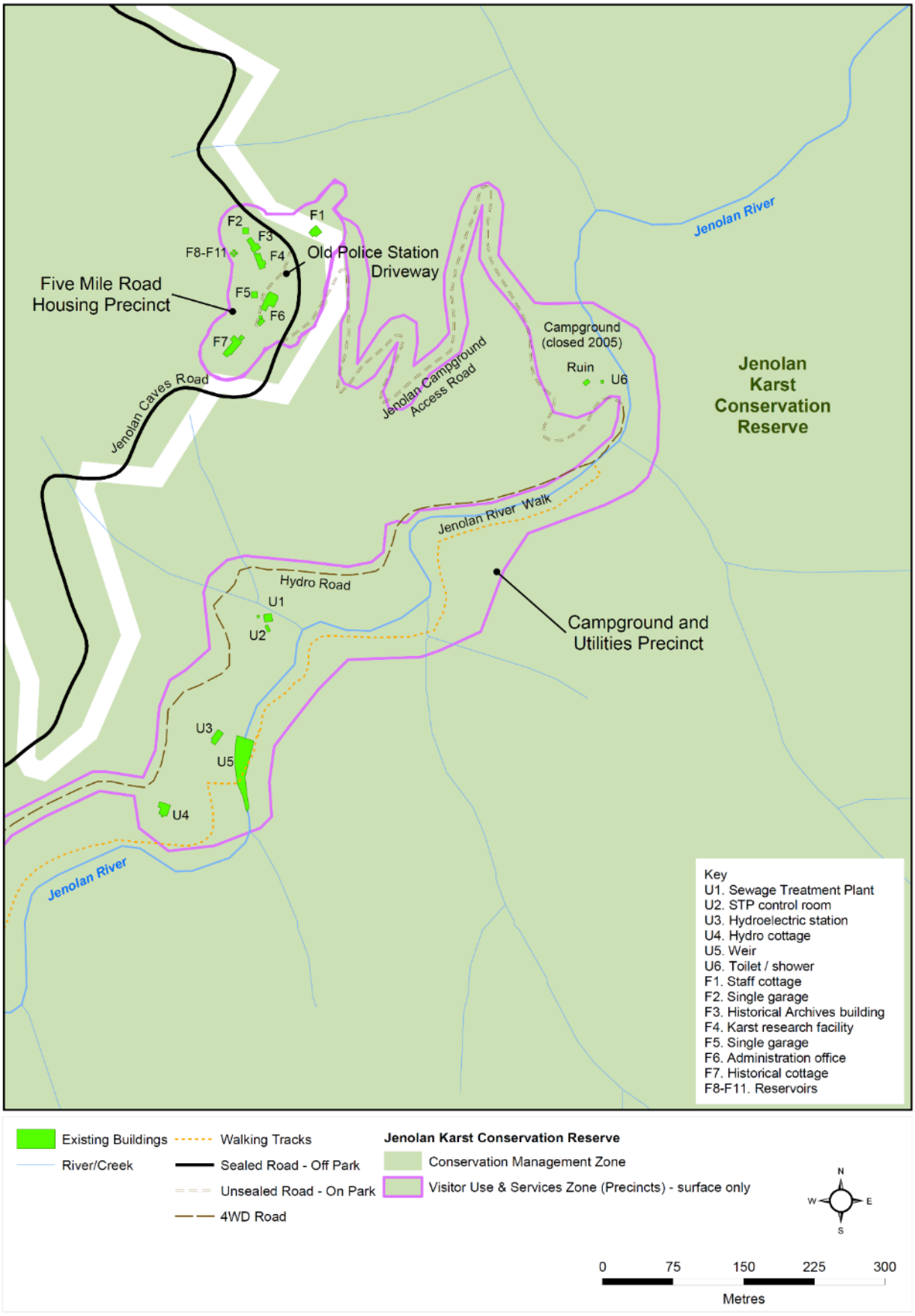

Figure 9: Campground and Utilities Precinct

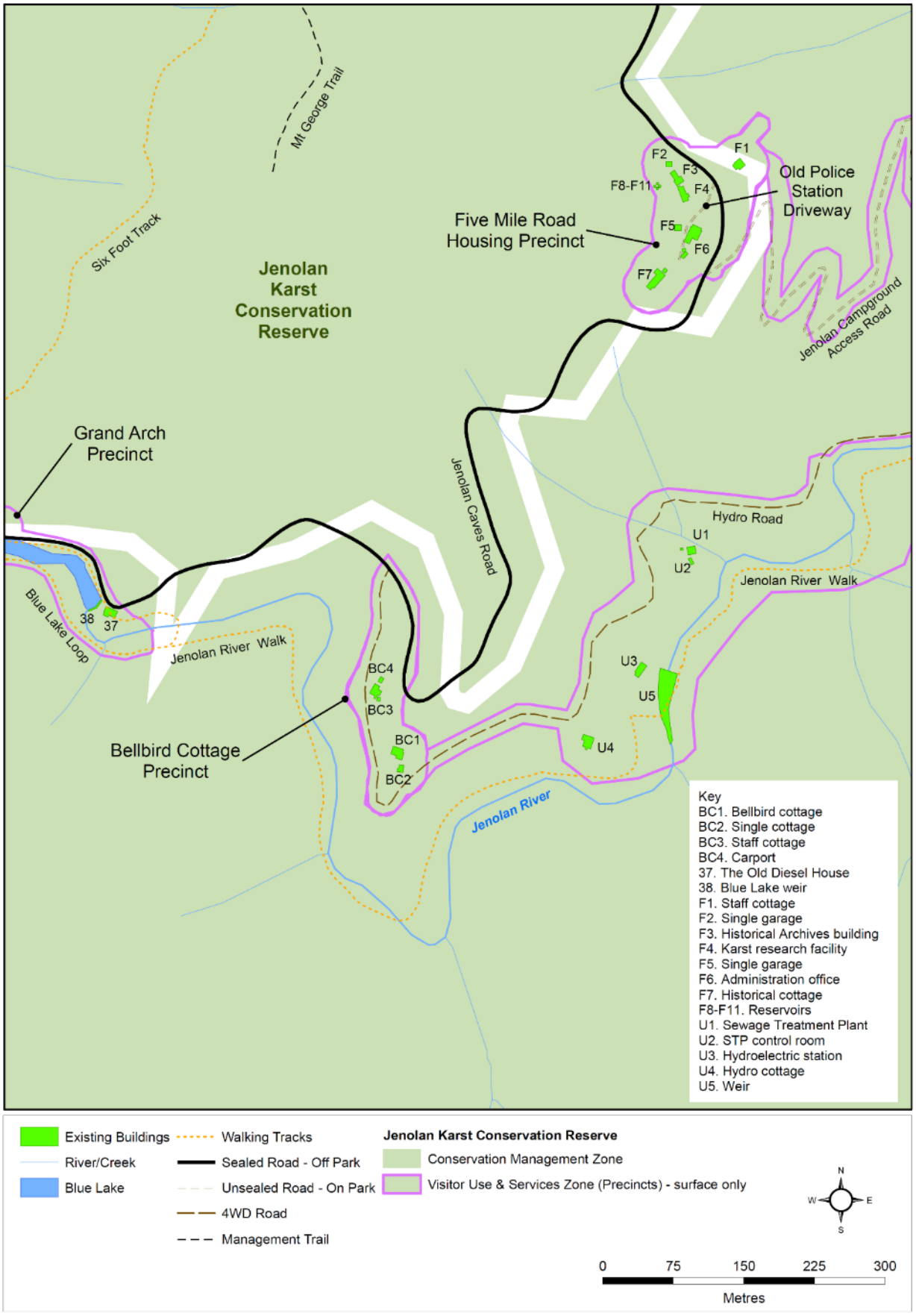

Figure 10: Bellbird Cottage Precinct

Appendix B: Environmental performance standards and indicators for leases and licences (See National Parks and Wildlife Act Section 151D)

Theme	Performance indicator	Performance standard	Method of measurement	Timeframe
Biodiversity	Extent of native vegetation cover.	No adverse change in the extent of native vegetation cover.	Rapid condition assessment.	Every 6 months
			Broad-based analysis using remote imagery.	Every 5 years
	Abundance, condition and distribution of native vegetation species and communities.	No adverse change in the abundance, condition and distribution of native vegetation species and communities.	Targeted flora surveys.	Tri-annually
			Broad-based analysis using remote imagery.	Every 5 years
	Abundance, health and distribution of native fauna species and populations.	No adverse change in the viability of native fauna populations.	Rapid condition assessment.	Every 6 months
			Review Animal Injury Register.	Annually
			Review *Atlas for NSW Wildlife*, *NSW Bionet* website and other relevant data management systems.	Bi-annually
			Targeted fauna survey.	Every five years
			Broad-based analysis of native fauna habitat using remote imagery.	Every 5 years
Pest and Weeds	Abundance, type and distribution of pest animals.	Progressive reduction in the abundance, type and distribution of pest animals.	Review *Jenolan Pest Animal Register*.	Annually
		Progressive reduction in the extent of native fauna habitat damaged by pest animals.	Rapid condition assessment of native vegetation cover and niche habitat areas (e.g. riparian zones).	Every 6 months
			Broad-based analysis of native fauna habitat using remote imagery.	Every 5 years

Theme	Performance indicator	Performance standard	Method of measurement	Timeframe
	Extent of weed cover	Progressive reduction in the extent of weed cover.	Rapid condition assessment.	Every 6 months
			Broad-based analysis using remote imagery.	Every 5 years
	Abundance and type of weed species	Progressive reduction in the abundance and type of weed species.	Targeted weed surveys.	Tri-annually
			Review OEH *Pest and Weeds Information System* and other relevant data management systems.	Annually
Geodiversity	Condition of geological and geomorphological features in caves.	No discernible change in the condition of geological and geomorphological features in caves, including to their physical structure and surface appearance.	Rapid condition assessment to establish the extent of any direct physical damage and/or the presence of lampenflora, lint, dust or other surface material.	Every 6 months
		Compliance with the requirements of the *National Parks and Wildlife Act 1974* (and associated Regulation) and relevant licence conditions.	Review breaches to *National Parks and Wildlife Act 1974* (and associated Regulation) and license conditions.	Annually
	Condition of geological and geomorphological features on the land surface.	No discernible change in the condition of geological and geomorphological features on the land surface, including to their physical structure and surface appearance.	Rapid condition assessment of representative features and sites.	Every 6 months
		Compliance with the requirements of the *National Parks and Wildlife Act 1974* (and associated Regulation) and relevant lease and licence conditions.	Review breaches to the *National Parks and Wildlife Act 1974* (and associated Regulation) and relevant lease and license conditions.	Annually

Theme	Performance indicator	Performance standard	Method of measurement	Timeframe
Water	Quality, volume and flow of surface and subterranean waters.	No adverse change in the quality of water entering and leaving the leased and licensed areas.	Monitoring of water quality at points up and downstream of the leased area and within nominated caves.	Every 2 months
		No adverse change in the natural volume and seasonal flow of water entering and leaving the leased and licensed areas.	Inspection of key water entry/recharge points to determine the cause of any unexplained change in the volume and flow of water entering leased or licensed areas.	As required
		Compliance with the requirements of the *Jenolan Environment Protection License 1962* (JEPL); *Protection of the Environment Operations Act 1997;* and relevant lease and license conditions.	Review the results of relevant water monitoring data in accordance with the requirements of the JEPL.	Annually
			Review breaches to the JEPL, *Protection of the Environment Operations Act 1997* and relevant lease and license conditions.	Annually
			Inspection of leased and non-leased areas to identify the unauthorised discharge of substances, or dumping of materials, into surface or subterranean waters	Every 6 months
			Assessment of all water quality data obtained through site-based monitoring/testing, to identify trends and the effectiveness of lessee and licensee responses.	Annually
		Progressive reduction in the number and severity of erosion hazards.	Inspect identified erosion hazards to determine the success of remedial actions.	As required.
Air	Quality of air above the land surface	No discernible difference in the ambient quality of air between the leased area and greater Reserve.	Environmental audit of leased area to identify potential pollution generating activities.	Every 6 months

Theme	Performance indicator	Performance standard	Method of measurement	Timeframe
		Type, level and duration of emissions comply with the requirements of the *Protection of the Environment Operations Act 1997,* the *Protection of the Environment Operations (Clean Air) Regulation 2010,* other industry standards and relevant lease and license conditions.	Audit of plant and equipment log books.	Annually
			Review breaches to the *Protection of the Environment Operations Act 1997, Protection of the Environment Operations (Clean Air) Regulation 2010* and relevant lease and license conditions.	Annually
		All burning is undertaken in accordance with the requirements of the *Protection of the Environment Operations Act 1997,* the *Protection of the Environment Operations (Clean Air) Regulation 2010* and relevant lease and license conditions.	Review approvals granted for burning (other than that involving vegetation).	Annually
		No complaints arising from lease or licence activities.	Review *Jenolan Environmental Complaints Register*.	Annually
	Quality of air in caves.	Air quality parameters for carbon dioxide, temperature and relative humidity are conducive to natural cave development processes and visitor safety (based on past characterisation studies).	Spot checks of carbon dioxide levels in caves.	As required
			Monitoring of carbon dioxide, temperature and relative humidity in nominated show caves.	Every 6 months
		No storage of pollution-generating materials or substances in caves.	Inspection of relevant caves.	Every 6 months
		Suitable protocols for undertaking pollution generating activities are in place.	Review cave operation and development protocols.	Every 5 years

Theme	Performance indicator	Performance standard	Method of measurement	Timeframe
Noise	Duration and intensity of noise.	Compliance with the requirements of the *Protection of the Environment Operations Act 1997;* the *Protection of the Environment Operations (Noise Control) Regulation 2008; NSW Industrial Noise Policy 2000* and relevant lease and license conditions.	Review breaches to the *Protection of the Environment Operations Act 1997,* the *Protection of the Environment Operations (Noise Control) Regulation 2008,* the *NSW Industrial Noise Policy 200* and relevant lease or license conditions.	Annually
		No complaints arising from lease or license activities	Review *Jenolan Environmental Complaints Register*	Annually
Waste	Type, quantity and distribution of waste.	Efficient recycling and management of waste materials	Review of waste recycling and management strategies	Annually
		Minimal, or no litter, within leased and licensed areas.	Environmental audit to establish cleanliness of lease and licensed areas.	Every 6 months
		No complaints in relation to excessive litter or waste.	Review *Jenolan Environmental Complaints Register*	Annually

For the purpose of this plan the following definitions apply:

Annual monitoring: monitoring which is undertaken once per year.

Baseline condition assessment: the initial condition assessment of a particular environmental aspect or feature to enable future comparisons of condition through long term monitoring.

Bi-annual monitoring: monitoring which is undertaken once every two years.

Performance indicator: a selected measure which provides information about an organisation's environmental performance.

Performance standard: the optimum condition.

Rapid condition assessment: a basic visual assessment of the condition of a particular environmental aspect or feature, using limited resources and conducted within a relatively short period of time.

Targeted flora and fauna monitoring: are monitoring programs which are focused on, one or a number of species, within a specified area which enable conclusions to be made on the viability of these and associated species, communities and populations.

Tri-annual monitoring: monitoring which is undertaken once every three years.

Appendix C: Developed, semi-developed and undeveloped caves of the reserve

Developed caves

These are defined as caves, also referred to as ‘show caves’, where infrastructure including permanent lighting and pathways, has been installed to meet the needs of visitors.

- Chifley
- Imperial/Diamond
- Jubilee
- Lucas including Mafeking Branch
- Nettle (self-guided)
- Orient
- Orient to River Connection (‘extended Orient Tour’)
- Pool of Cerberus
- Ribbon
- River
- Temple of Baal
- Temple of Baal to River Connection (‘extended Temple of Baal Tour’).

Semi-developed caves

These are defined as caves that have both developed and undeveloped sections.

- Arch
- Grecian Bend
- Jersey
- Lily of the Valley
- Red and White Temples Extension
- Shambles Extension and Architects Studio
- Wilkinsons Terraces.

Undeveloped caves (access restricted to approved routes)

Also referred to as ‘wild’, these are caves which do not contain infrastructure such as permanent lighting and pathways. Visitors undertake the sport of ‘adventure caving’ in this type of cave.

- Aladdin
- Bushrangers
- Elder (ie. Plughole)
- Frenchmans
- Hennings
- Mammoth (including Central and Lower Rivers)
- Wiburds Lake.

Note: This is not an exhaustive list of all caves within the reserve.

Appendix D: Threatened animals of the reserve and their listing and recovery planning status

Common name	Scientific name	Listing status BC/EPBC Act	Recovery planning status	Record source and notes
Amphibians				
Stuttering frog	*Mixophyes balbus*	E - BC V - EPBC	*Biodiversity Conservation Program* (BCP)	Atlas. *May no longer occur* (OEH 2012f).
Birds				
Barking owl	*Ninox connivens*	V - BC	Draft recovery plan (2003) BCP	Atlas
Diamond firetail	*Stagonopleura guttata*	V - BC	BCP	Eddison (2008) in OEH (2012f)
Flame robin	*Petroica phoenicea*	V - BC	BCP	Atlas
Gang-gang cockatoo	*Callocephalon fimbriatum*	V - BC	BCP	Atlas
Glossy black-cockatoo	*Calyptorhynchus lathami*	V - BC	BCP	Eddison (2008) in OEH (2012f). *Rare visitor.*
Hooded robin	*Melanodryas cucullata*	V - BC	BCP	Eddison (2008) in OEH (2012f)
Little eagle	*Hieraaetus morphnoides*	V - BC	BCP	Atlas
Powerful owl	*Ninox strenua*	V - BC	Recovery plan (2006) BCP	Atlas
Red-backed button-quail	*Turnix maculosus*	V - BC	BCP	OEH (2012f). *Rare visitor/vagrant.*
Regent honeyeater	*Anthochaera phrygia*	CE - BC CE - EPBC	BCP	Eddison (2008) in OEH (2012f). *Rare visitor.*
Scarlet robin	*Petroica boodang*	V - BC	BCP	Eddison (2008) and others in OEH (2012f).
Sooty owl	*Tyto tenebricosa*	V- BC	Recovery plan (2006) BCP	Atlas
Speckled warbler	*Chthonicola sagittata*	V - BC	BCP	Eddison (2008) and others in OEH (2012f)
Swift parrot	*Lathamus discolor*	E - BC CE - EPBC	National recovery plan (2011) BCP	Eddison (2008) in OEH (2012f)
Varied sittella	*Daphoenositta chrysoptera*	V - BC	BCP	Atlas

Common name	Scientific name	Listing status BC/EPBC Act	Recovery planning status	Record source and notes
Mammals				
Brush-tailed phascogale	*Phascogale tapoatafa*	V -BC	BCP	Eddison (2008) in OEH (2012f)
Brush-tailed rock-wallaby	*Petrogale penicillata*	E - BC V - EPBC	Recovery plan (2008) National recovery plan (2010); BCP	Atlas
Eastern bentwing-bat	*Miniopterus schreibersii oceanensis*	V - BC	BCP	Atlas
Eastern false pipistrelle	*Falsistrellus tasmaniensis*	V - BC	BCP	Atlas
Eastern pygmy-possum	*Cercartetus nanus*	V - BC	BCP	Eddison (2008) in OEH (2012f). *Rare resident.*
Greater broad-nosed bat	*Scoteanax rueppellii*	V - BC	BCP	Atlas
Grey-headed flying-fox	*Pteropus poliocephalus*	V - BC V - EPBC	BCP Draft national recovery plan (2017)	Atlas
Koala	*Phascolarctos cinereus*	V - BC V - EPBC	BCP Recovery plan (2008)	Atlas
Large-eared pied bat	*Chalinolobus dwyeri*	V - BC V - EPBC	BCP National recovery plan (2011)	Atlas
New Holland mouse	*Pseudomys novaehollandiae*	V - EPBC		OEH (2012f). *From sooty owl pellets only.*
Spotted-tailed quoll	*Dasyurus maculatus*	V - BC E - EPBC	BCP	Atlas
Southern myotis	*Myotis macropus*	V - BC	BCP	OEH (2012f). *Requires confirmation.*
Squirrel glider	*Petaurus norfolcensis*	V- BC	BCP	OEH (2012f). *Requires confirmation.*
Yellow-bellied glider	*Petaurus australis*	V - BC	BCP Recovery plan (2003)	Atlas

Source:
OEH (2012f)

Key:
CE Critically Endangered
E Endangered
V Vulnerable

Appendix E: Weeds of the reserve

Common name	Scientific name
Argentine peppercress	*Lepidium bonariense*
Black locust	*Robinia pseudoacacia*
Blackberry * WONS	*Rubus ulmifolius*
Blackberry complex * ~ WONS	*Rubus fruticosus* sp. agg.
Blackberry nightshade	*Solanum nigrum*
Blue Periwinkle	*Vinca major*
Bony-tip fleabane	*Erigeron karvinskianus*
Box elder	*Acer negundo*
Catsear	*Hypochaeris radicata*
Chilean whitlow wort	*Paronychia brasiliana*
Cobblers pegs	*Bidens pilosa*
Common bittercress	*Cardamine hirsuta*
Common centaury	*Centaurium erythraea*
Common chickweed	*Stellaria media*
Common sowthistle	*Sonchus oleraceus*
Common vetch	*Vicia sativa*
Cotoneaster	*Cotoneaster* spp.
Curled dock	*Rumex cripus*
Dandelion	*Taraxacum officinale*
English holly	*Ilex aquifolium*
English ivy	*Hedera helix*
Flaxleaf fleabane	*Conyza bonariensis*
Goosegrass	*Galium aparine*
Great brome	*Bromus diandrus*
Great mullein	*Verbascum thapsus*
Greater periwinkle	*Vinca major*
Green amaranth	*Amaranthus viridis*
Haresfoot clover	*Trifolium arvense*
Hemlock	*Conium maculatum*
Honesty	*Lunaria annua*
Inkweed	*Phytolacca octandra*
Japanese honeysuckle	*Lonicera japonica*
Large-leaved privet	*Ligustrum lucidum*
Lesser hawkbit	*Leontodon taraxacoides* subsp. *taraxacoides*
Maple	*Acer* spp.
Mexican poppy	*Argemone mexicana*
Night-flowering catchfly	*Silene noctiflora*
Panic veldtgrass	*Ehrharta erecta*
Parramatta grass	*Sporobolus africanus*
Paspalum	*Paspalum dilatatum*
Patersons curse	*Echium plantagineum*
Petty spurge	*Euphorbia peplus*
Prairie grass	*Bromus catharticus*
Prickly lettuce	*Lactuca serriola*
Prickly sowthistle	*Sonchus asper*
Pride of Rochester	*Deutzia crenata*

Common name	Scientific name
Proliferous pink	*Petrorhagia nanteuilii*
Purple top	*Verbena bonariensis*
Radiata pine	*Pinus radiata*
Red valerian	*Centranthus ruber* subsp. *ruber*
Scarlet pimpernel	*Anagallis arvensis*
Self-heal	*Prunella vulgaris*
Serrated tussock * WONS	*Nassella trichotoma*
Shivery grass	*Briza minor*
Silver grass	*Vulpia bromoides*
Slender deutzia	*Deutzia gracilis*
Slender thistle	*Carduus pycnocephalus*
Small bedstraw	*Galium murale*
Smooth catsear	*Hypochaeris glabra*
Smooth hawksbeard	*Crepis capillaris*
Soft brome	*Bromus hordeaceus*
Sorrel	*Acetosella vulgaris*
Spear thistle	*Cirsium vulgare*
Sweet briar	*Rosa rubiginosa*
Sweet rocket	*Hesperis matronalis*
Sweet vernal grass	*Anthoxanthum odoratum*
Sycamore maple	*Acer pseudoplatanus*
Tall fleabane	*Conyza sumatrensis*
Trad	*Tradescantia fluminensis*
Tree of heaven	*Ailanthus altissima*
Tutsan	*Hypericum androsaemum*
Twiggy mullein	*Verbascum virgatum*
Umbrella sedge	*Cyperus eragrostis*
Valerian	*Centranthus ruber*
Watercress	*Rorippa nasturtium-aquaticum*
White clover	*Trifolium repens*
White horehound	*Marrubium vulgare*
Willow	*Salix spp.*
Winged slender thistle	*Carduus tenuiflorus*
Winter grass	*Poa annua*
Wood sorrel	*Oxalis* sp.
Yellow suckling clover	*Trifolium dubium*
Yorkshire fog	*Holcus lanatus*

Sources:
Weeds recorded since 1980 in Atlas of NSW Wildlife (2013 search); Taylor (1999); Jenolan Caves Reserve Trust (2006); Baker et al. (2007).

Key:
* State level priority weed under the *Biosecurity Act 2015*
~ identified as a regional level priority weed
WONS – Weed of National Significance.

Glossary

Adaptive reuse
The modification of a building or structure to suit an existing or proposed use, and that use of the building or structure, but only if:

(a) the modification and use is carried out in a sustainable manner

(b) the modification and use are not inconsistent with the conservation of the natural and cultural values of the land, and

(c) in the case of a building or structure of cultural significance, the modification is compatible with the retention of the cultural significance of the building or structure.

Adventure caving
The sport of adventure caving is undertaken in undeveloped or 'wild' caves.

Aragonite
A polymorph (different crystal structure) of the mineral calcium carbonate. A major skeletal component of many modern invertebrates and so a major component of modern carbonate accumulations.

Calcite
The most common calcium carbonate mineral and the main constituent of limestone.

Cave
A natural cavity in rock large enough to be entered by humans. It may be water-filled.

Cave system
A collection of caves interconnected by enterable passages or linked hydrologically, or a cave with an extensive complex of chambers and passages.

Clastic palaeokarst
Fossil karst derived by weathering processes.

Colluvial deposit
A sediment deposit which has resulted from mass wasting and slope wash.

Developed cave
A cave also referred to as a 'show cave', where infrastructure including permanent lighting and pathways, has been installed to meet the needs of visitors.

Doline
A closed depression draining underground in karst.

Dolomite
(1) A mineral consisting of the double carbonate of magnesium and calcium, $CaMg(CO_3)_2$.
(2) A rock made chiefly of dolomite crystal.

Erosion
The wearing away of bedrock or sediment at the surface or in caves by the mechanical and chemical action of all moving agents, such as water runoff, rivers, wind and glaciers.

Fault
A fracture separating two parts of a once continuous rock body with relative movement along the fault line.

Ferrous
Containing iron.

Fold
A curved or angular shape of an originally planar geological surface.

Fossil
The remains or traces of animals and plants preserved in rocks or sediments.

Geodiversity
The range and variation in geological structure and composition.

Grez litees
A bedded scree of angular rock debris whose dip is parallel to the bedrock slope, probably formed by nivation and down-wash processes.

Gypsum
The mineral hydrated calcium sulphate (i.e. $CaSO_4.2H_2O$).

Helictite
A speleothem, which at one or more stages of its growth, has changed its axis from the vertical to give a curving or angular form.

Hydrology
The scientific study of the nature, distribution and behaviour of water.

Karst
Terrain with special landforms and drainage characteristics because of greater solubility of certain rocks in natural waters than is common.

Lampenflora
Flora growing entirely under the influence of artificial light.

Limestone
A sedimentary rock consisting mainly of calcium carbonate.

Manganiferous
Containing high concentrations of manganese.

Modified Natural Area
An area of land where the native vegetation cover has been substantially modified or removed by human activity (other than activity relating to bushfire management or wild fire management), and that is defined in a plan of management as not being appropriate or capable of being restored.

Palaeokarst
Fossil karst.

Park Authority
As per clause 3 of the National Parks and Wildlife Regulation 2009, this is referring to either the administrator of the Visitor Use and Services Zone or the Director-General of NPWS (current equivalent to the Chief Executive of OEH) depending on the relevant zone within the reserve.

Phosphatic
Containing high concentrations of phosphate minerals.

Proclamation
A public and official announcement of the Governor published in the Gazette or on the NSW legislation website.

Pyrite
The mineral iron pyrite (FeS_2), the most common sulphide mineral.

Relict
A plant or animal species living in an environment which as changed from that which is typical for it.

Rillenkarren
Solution depressions found on steep or vertical surfaces with sharp ridges between the flutes.

Semi-developed cave
A cave that has both developed and undeveloped sections (see 'Developed cave' and 'Undeveloped cave').

Shields
An extensive area of exposed bedrock with long-term tectonic stability, generally of Pre-cambian age and forming the central core of a continent.

Show Cave
A cave that has been made accessible to the public for guided visits and tours (see 'Developed cave').

Speleology
The systematic study of caves, especially in relation to their geological structure, flora, fauna; and the sport of exploring caves.

Speleothems
A secondary mineral deposit formed in caves, most commonly of calcium carbonate.

Stalagmite
A speleothem consisting of two parallel plates separated by a medial planal crack and formed by water seeping through the medial crack.

Strike
The direction of a horizontal line in a bedding plane on rocks inclined from the horizontal. On level ground it is the direction of outcrop of inclined beds.

Stromatolite
An organo-sedimentary deposit within an internal structure of fine, more or less planar laminations. Forms as the result of benthic microbial mats trapping detritus and/or forming the locus for mineral precipitation.

Undeveloped cave
A cave, also referred to as 'wild', which does not contain infrastructure such as permanent lighting and pathways. Visitors undertake the sport of 'adventure caving' in this type of cave.

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