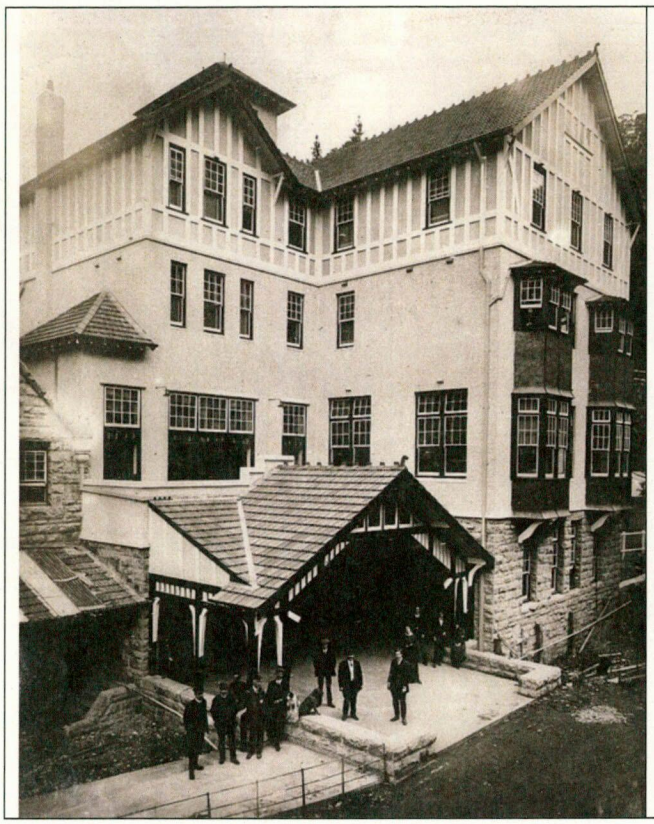
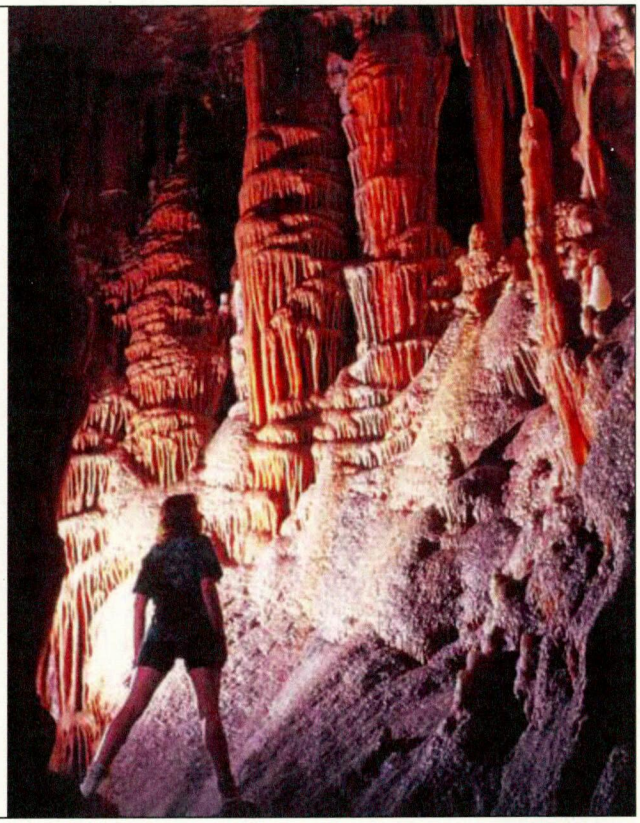
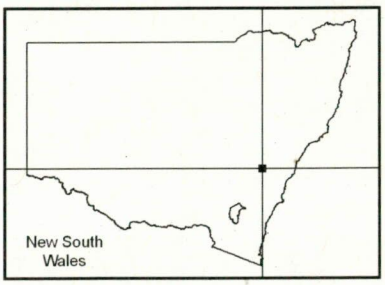
NSW GOVERNMENT | Office of Environment & Heritage
NSW National Parks & Wildlife Service

Draft Plan of Management





Jenolan Karst Conservation Reserve



PoM
Jenolan

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Draft Plan of Management

Jenolan Karst Conservation Reserve

NSW National Parks and Wildlife Service

October 2013

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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), Department of Premier and Cabinet.

NPWS acknowledges that the Jenolan Karst Conservation Reserve is in the traditional country of the Gundungurra and Wiradjuri Aboriginal people and within the area of the Pejar Local Aboriginal Land Council.

A preliminary draft plan of management for the reserve was prepared by Manidis Roberts Consultants on behalf of the Jenolan Caves Reserve Trust (the Trust) in 2004. The preliminary draft was expanded and updated by the Trust in collaboration with the Department of Environment and Conservation (DEC) and a draft plan of management was exhibited for public comment in 2005/2006. Following public exhibition DEC formally considered public comments on the draft plan. OEH, established in 2011, now performs many of the statutory roles of the former DEC.

Subsequently a range of documents have been produced of particular relevance to management of the reserve including the *Greater Blue Mountains World Heritage Area Strategic Plan* (Department of Environment & Climate Change 2009a), the *Jenolan Caves Reserve Trust Heritage Asset Management Strategy* (Godden Mackay Logan 2007), the *Jenolan Karst Conservation Reserve Fire Management Strategy* (Department of Environment & Climate Change 2009b), the *Jenolan Karst Conservation Reserve Draft Conservation Management Plan* (Urbis 2010) and *The Vertebrate Fauna of the Jenolan Karst Conservation Area* (OEH 2012a). A range of guidelines and policies have also been prepared by the OEH Karst and Geodiversity Unit which was established in 2006 to assist karst management.

OEH staff have reviewed the exhibited draft and updated the draft plan to include consideration of recent plans, strategies, reports and policies. The plan has been written in the current format for OEH plans of management.

Front Cover: Caves House, State Records NSW. Orient Cave. Photographer: S. Babka

For additional information about this park or this plan of management, contact NPWS Park Planner at PO Box 1020 Dubbo NSW 2830 or by telephone on (02) 6841 0921.

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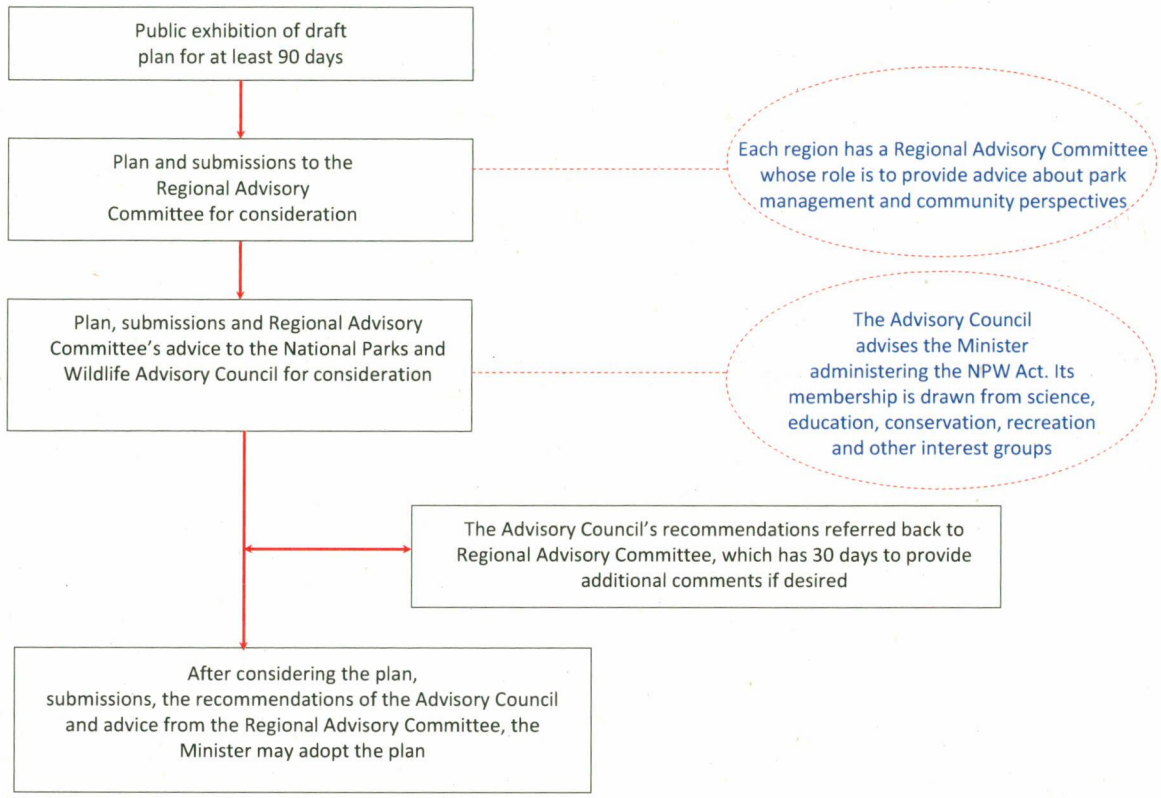
Invitation to Comment

The National Parks and Wildlife Act 1974 (NPW Act) requires that a plan of management be prepared that outlines how an area will be managed by the NSW National Parks and Wildlife Service (NPWS). The procedures for the exhibition and adoption of plans of management are specified under Part 5 of the NPW Act and involve the following stages:



In addition to the above process, the Greater Blue Mountains World Heritage Area (GBMWHA) Advisory Committee and the GBMWHA Management Committee may also provide advice to the Minister on the draft plan. The Karst Management Advisory Committee may also provide advice to National Parks and Wildlife Advisory Council on the draft plan.

Members of the public, whether as individuals or as members of community interest groups, are invited to comment in writing on this plan of management.

The draft plan is on exhibition until 23 January 2014.

Submissions can be made by:

i) Writing to: Planner, Jenolan Karst Conservation Reserve, PO Box 1020 Dubbo NSW 2830
ii) Submitting comments online at www.environment.nsw.gov.au

To make consideration of your submission as effective as possible it would help us if you:

- Identify the section heading and number to which your comment relates; and
- Briefly explain the reason for your comment and, if appropriate, suggest other ways to address the issue.

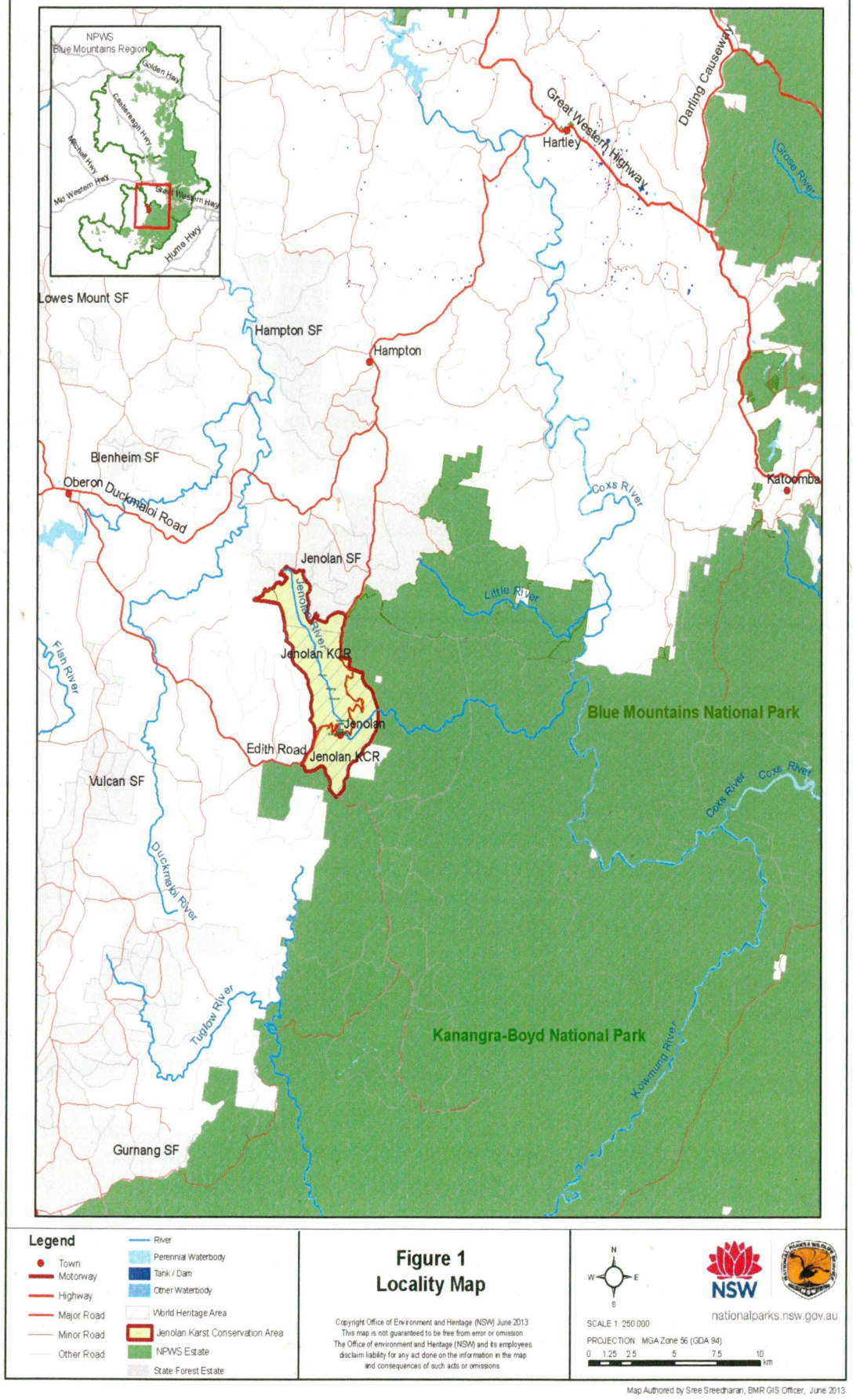
All submissions received by NPWS are a matter of public record and are available for inspection upon request. Your comments on this draft plan may contain information that is defined as 'personal information' under the NSW *Privacy and Personal Information Protection Act 1998*. The submission of personal information with your comments is voluntary.

Contents

1. Introduction

1.1 Location, Gazettal 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 20 kilometres south east of Oberon and 30 kilometres south west of Katoomba in the south eastern highlands of NSW.
Area	The reserve totals 3,083 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 at its highest point within the reserve reaches 1,320 metres above sea level.
Reservation Date	A total of 2,422 hectares was gazetted as reserve on 8 December 1997. Two additions were made to the reserve: 607 hectares was added in 2009 and 56 hectares was added in 2012. Both additions were in the north of the reserve.
Previous Tenure	The reserve was previously Crown land managed under the *Crown Lands Act 1989*. The 2009 addition was land managed by Forests NSW within Jenolan State Forest. The 2012 addition comprised Crown land. 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 biogeographic region. The southern two-thirds of the reserve form 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 (see Figure 1). Jenolan is one of four Karst Conservation Reserves in NSW. The others are Borenore, Abercrombie and Wombeyan.
Surrounding Land Use	State Forest borders the reserve in the north, Kanangra-Boyd National Park to the east and south; 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 Council local government area. Most of the reserve is located within the area of the Hawkesbury-Nepean Catchment Management Authority (CMA) and a small part in the north east of the reserve occurs in the Central West CMA. The reserve is within the operational area of the Sydney Catchment Authority as it is located within the Warragamba drinking water catchment but it is not part of a Special Area designated under the *Sydney Water Catchment Management Regulation 2008*.


NPWS
Blue Mountains Region
Golden Hwy
Castlereagh Hwy
Mitchell Hwy
Mid Western Hwy
Great Western Hwy
Hume Hwy
Lowes Mount SF
Hampton SF
Hampton
Hartley
Great Western Highway
Darling Causeway
Glose River
Blenheim SF
Oberon Duckmaloi Road
Coxs River
Katoomba
Jenolan SF
Jenolan River
Little River
Jenolan KCR
Fish River
Blue Mountains National Park
Jenolan
Edith Road
Jenolan KCR
Vulcan SF
Coxs River
Coxs River
Duckmaloi River
Tuglow River
Kanangra-Boyd National Park
Kowmung River
Gurnang SF
Legend
Town
Motorway
Highway
Major Road
Minor Road
Other Road
River
Perennial Waterbody
Tank / Dam
Other Waterbody
World Heritage Area
Jenolan Karst Conservation Area
NPWS Estate
State Forest Estate
Figure 1
Locality Map
Copyright Office of Environment and Heritage (NSW) June 2013
This map is not guaranteed to be free from error or omission.
The Office of environment and Heritage (NSW) and its employees
disclaim liability for any act done on the information in the map
and consequences of such acts or omissions.
N
W
E
S
NSW
nationalparks.nsw.gov.au
SCALE 1: 250 000
PROJECTION: MGA Zone 56 (GDA 94)
0 1.25 2.5 5 7.5 10
km
Map Authored by Sree Sreedharan, BMR GIS Officer, June 2013

1.2 Statement of Significance

The Jenolan Karst Conservation Reserve is considered to be of significance for:

World Heritage

The southern two-thirds of the reserve is 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; and
- 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 species within 20 plant families with many plants of conservation significance due to being relict species, endemic to the Blue Mountains, rare or threatened, or occupying a restricted range.

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 protects the upper catchment of the Jenolan River which is located within the Warragamba Catchment and the Mid Coxs River sub-catchment. 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 significance in terms of geomorphology. 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 cave entrances 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 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 endangered ecological communities, threatened and rare plants and threatened animals. The caves support a wide range of cave-dependent plants and animals. The reserve is likely to contain old growth 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 67 invertebrates recorded (DECC 2009a).

Aboriginal Heritage

A large number of Aboriginal sites have been recorded from the reserve including rock art and occupation sites highlighting the significance of the reserve to the Gundungurra and Wiradjuri peoples. Although limited research has been conducted into the reserve's Aboriginal heritage, the archaeological sensitivity of ridges, limestone slopes and creek and river flats is predicted to be high (Anutech Pty Ltd 1988).

Historic Heritage

The reserve is listed on the State Heritage Register for its historical, 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 are exemplified by its spectacular caves and cave formations, eucalypt-dominated setting, the Blue Lake and picturesque Caves House. The history of Jenolan Caves charts the early development of tourism in NSW. The creation of the Fish River Caves Reserve in 1866 (which now forms part of the reserve) represents the first time a nature feature in NSW was protected by gazettal of a public reserve.

Recreation and Tourism

The show caves are the reserve's principal visitor attraction due to the spectacular nature of the caves and cave formations which are located within a largely undisturbed nature reserve with high relief and are 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 change 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 NSW is in the context of a legislative and policy framework, primarily the *National Parks and Wildlife Act 1974* (NPW Act) and Regulation, the *Threatened Species Conservation Act 1995* (TSC Act) and the policies of the National Parks and Wildlife Service (NPWS). NPWS is part of the Office of Environment and Heritage (OEH).

Other legislation, strategies and international agreements may also apply to management of the reserve. In particular, the *Environmental Planning and Assessment Act 1979* (EPA Act) may require assessment of environmental impact of works proposed in this plan. The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) may apply in relation to actions that impact on matters of National Environmental Significance, such as World Heritage areas and migratory and threatened species listed under that Act. The *Heritage Act 1977* (Heritage Act) regulates activities in the reserve in relation to listed heritage items.

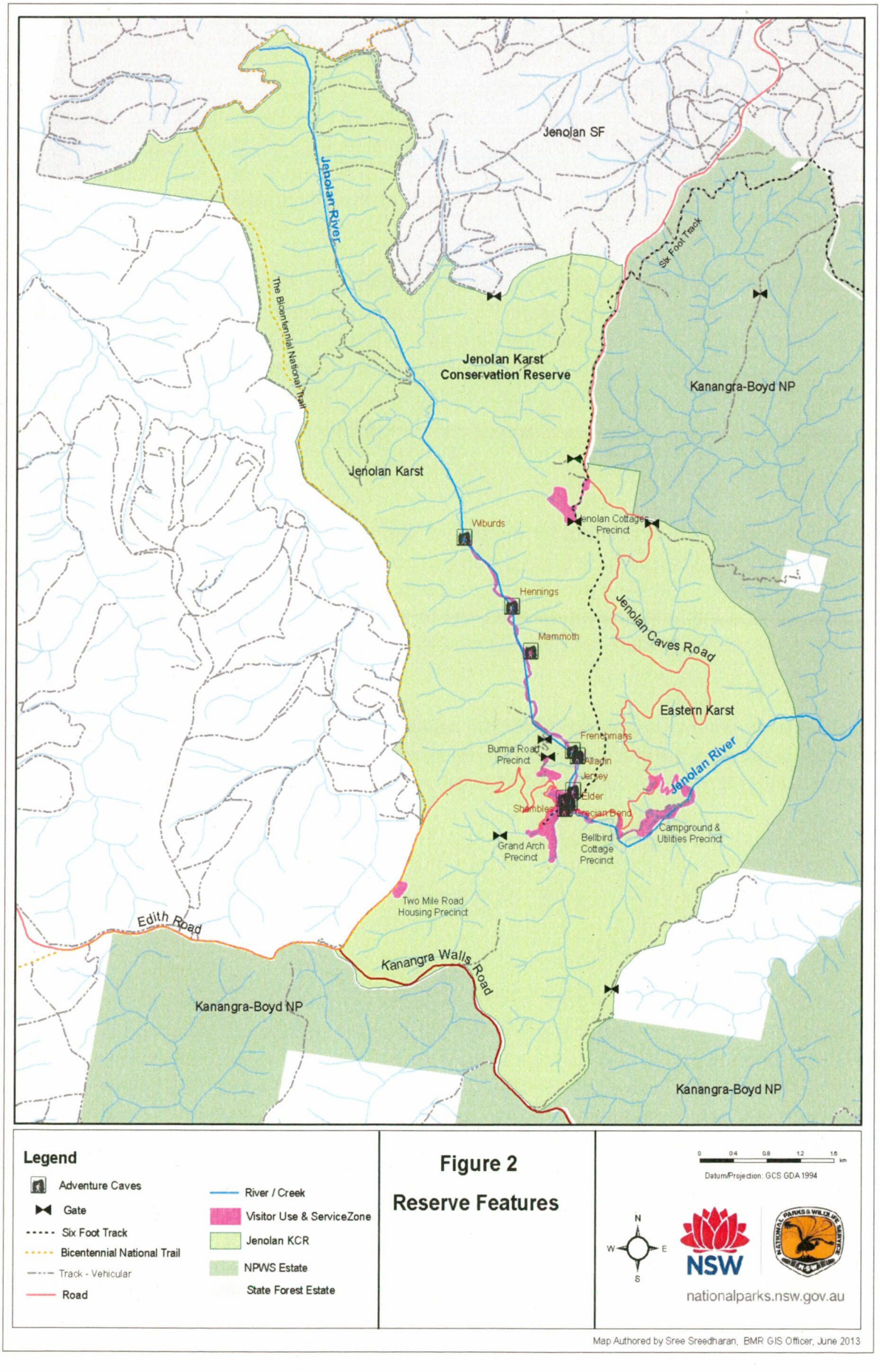
A plan of management is a statutory document under the NPW Act. Once the Minister has adopted a plan, the plan must be carried out and no operations may be undertaken in relation to the lands to which the plan relates unless the operations are in accordance with the plan. This plan will also apply to 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 gazettal as a Karst Conservation Reserve under the NPW Act, on behalf of the land managers at that time, the Tourism Commission and the Department of Lands.

In 1989 the Jenolan Caves Reserves Trust ('the Trust') was established under the *Crown Lands Act 1989* to manage Jenolan, Wombeyan and Abercrombie Caves. Prior to this Jenolan Caves were managed by the NSW Tourism Commission. Amendments to the NPW Act in 1997 established the Jenolan Caves as a karst conservation reserve and transferred its management from the *Crown Lands Act 1989.*

Amendments to the NPW Act in 2005 transferred management of the reserve from the Trust to the Director-General of the (then) Department of Environment and Conservation in two stages. OEH, established in 2011, now performs many of the statutory roles of the former DEC. A 50 hectare Jenolan Caves Visitor Use and Services Zone (Jenolan Caves VUSZ) was established (see Figure 2) which contains above and below ground tourism assets and staff accommodation in the following seven precincts (Figure 2): Grand Arch (Figures 3 & 4), Jenolan Cottages (Figure 5), Five Mile Road Housing (Figure 6), Burma Road Housing (Figure 7), Two Mile Road Housing (Figure 8), Campground and Utilities (Figure 9) and Bellbird Cottage Precinct (Figure 10).

A Trust Administrator was appointed to manage the VUSZ until the plan of management is adopted at which time management of the VUSZ will transfer to the Director-General of OEH. The remainder of the reserve has been managed by NPWS since 2006.


Jenolan SF
Jenolan River
The Bicentennial National Trail
Six Foot Track
Jenolan Karst Conservation Reserve
Kanangra-Boyd NP
Jenolan Karst
Wburds
Jenolan Cottages Precinct
Hennings
Mammoth
Jenolan Caves Road
Eastern Karst
Frenchmans
Burma Road Precinct
Aladin
Jersey
Elder
Shambles
Grecian Bend
Jenolan River
Campground & Utilities Precinct
Grand Arch Precinct
Bellbird Cottage Precinct
Two Mile Road Housing Precinct
Edith Road
Kanangra Walls Road
Kanangra-Boyd NP
Kanangra-Boyd NP
Legend
Adventure Caves
Gate
Six Foot Track
Bicentennial National Trail
Track - Vehicular
Road
River / Creek
Visitor Use & ServiceZone
Jenolan KCR
NPWS Estate
State Forest Estate
Figure 2
Reserve Features
0 0.4 0.8 1.2 1.6 km
Datum/Projection: GCS GDA 1994
N
W
E
S
NSW
nationalparks.nsw.gov.au
Map Authored by Sree Sreedharan, BMR GIS Officer, June 2013

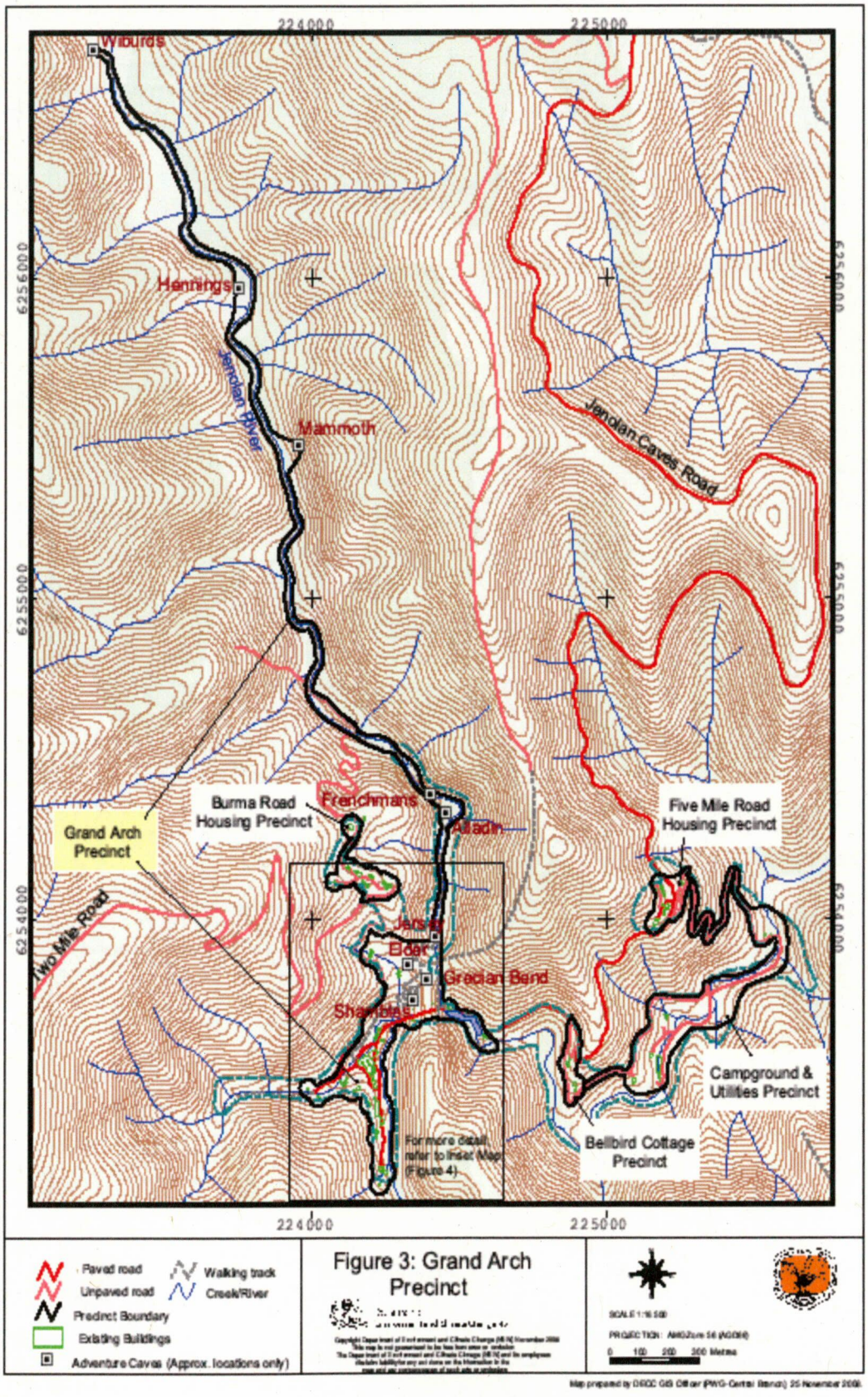
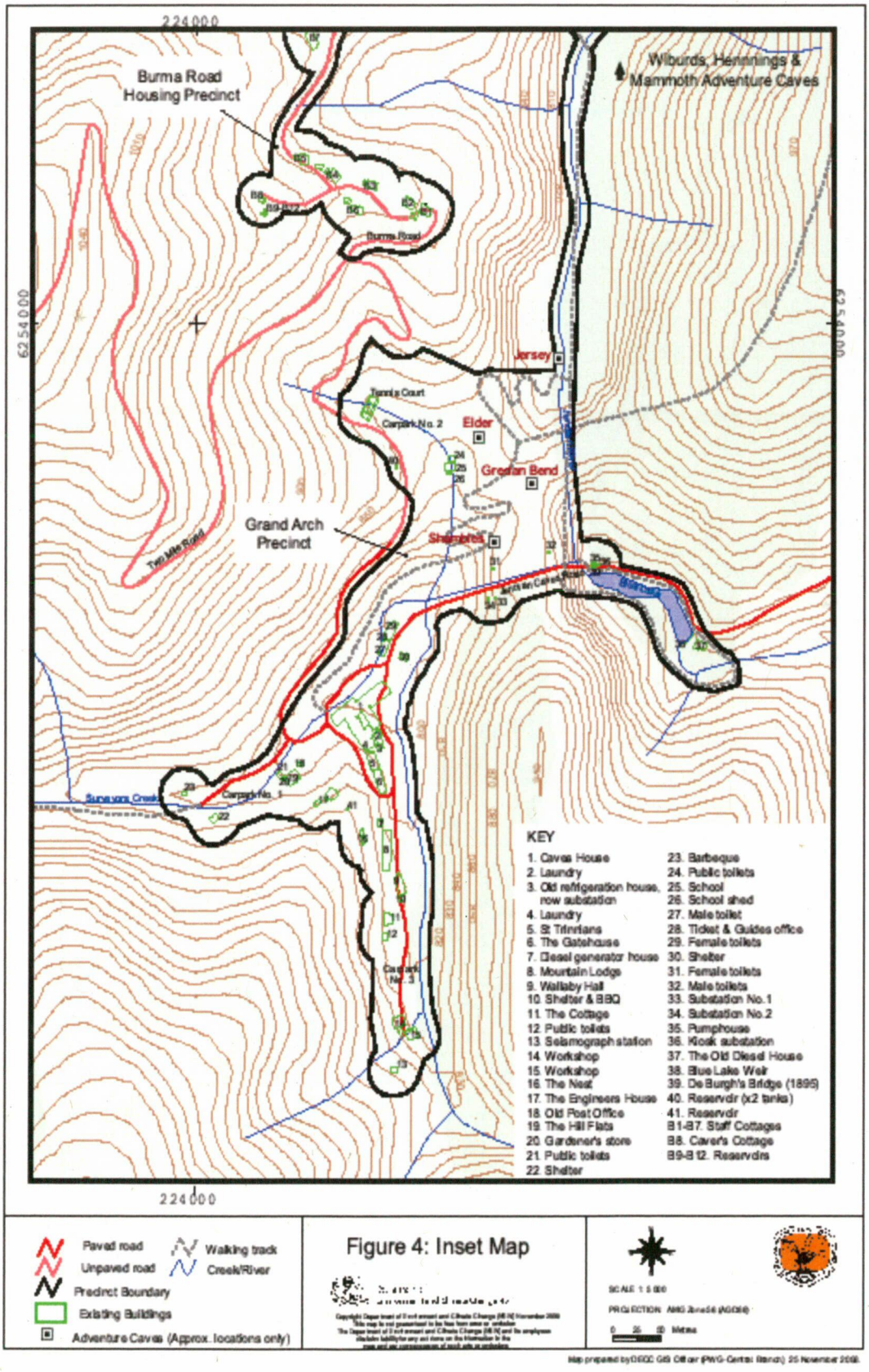


Figure 3: Grand Arch Precinct


224000
6254000
Burma Road
Housing Precinct
Wilburds, Henmings &
Mammoth Adventure Caves
Burma Road
Jersey
Tennis Court
Carpark No. 2
Elder
Grecian Bend
Grand Arch
Precinct
Two Mile Road
Shelter 31
Surveyors Creek
Carpark No. 1
Carpark No. 3
KEY
1. Caves House
2. Laundry
3. Old refrigeration house, now substation
4. Laundry
5. St Trinnians
6. The Gatehouse
7. Diesel generator house
8. Mountain Lodge
9. Wallaby Hall
10. Shelter & BBQ
11. The Cottage
12. Public toilets
13. Seismograph station
14. Workshop
15. Workshop
16. The Nest
17. The Engineers House
18. Old Post Office
19. The Hill Flats
20. Gardener's store
21. Public toilets
22. Shelter
23. Barbeque
24. Public toilets
25. School
26. School shed
27. Male toilet
28. Ticket & Guides office
29. Female toilets
30. Shelter
31. Female toilets
32. Male toilets
33. Substation No. 1
34. Substation No. 2
35. Pumphouse
36. Kiosk substation
37. The Old Diesel House
38. Blue Lake Weir
39. De Burgh's Bridge (1895)
40. Reservoir (x2 tanks)
41. Reservoir
B1-B7. Staff Cottages
B8. Caver's Cottage
B9-B12. Reservoirs
224000
Paved road
Unpaved road
Predrict Boundary
Existing Buildings
Adventure Caves (Approx. locations only)
Walking track
Creek/River
Figure 4: Inset Map
SCALE 1:5 000
PROJECTION: AMG Zone56 (AGD66)
0 25 50 Metres

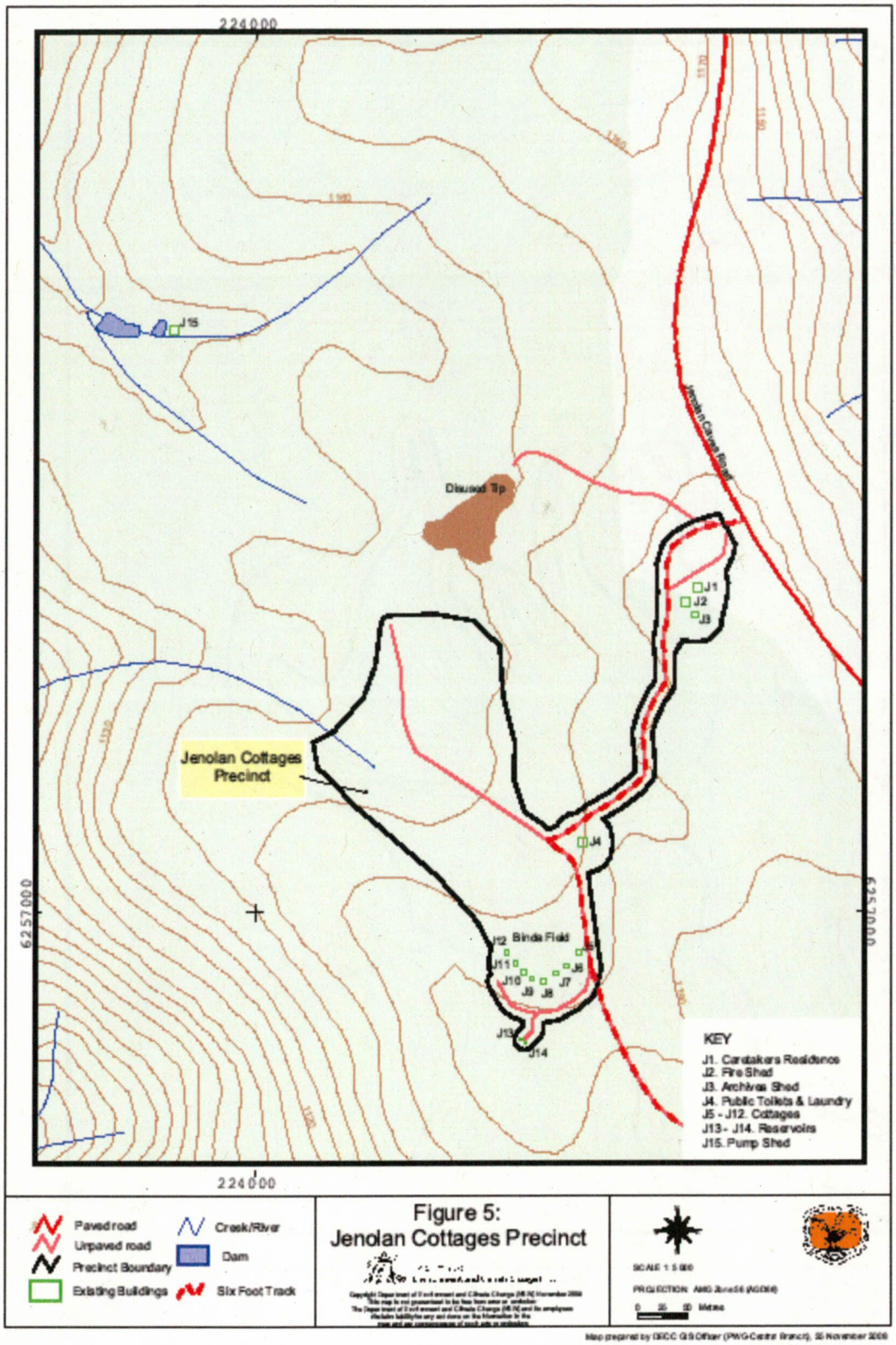
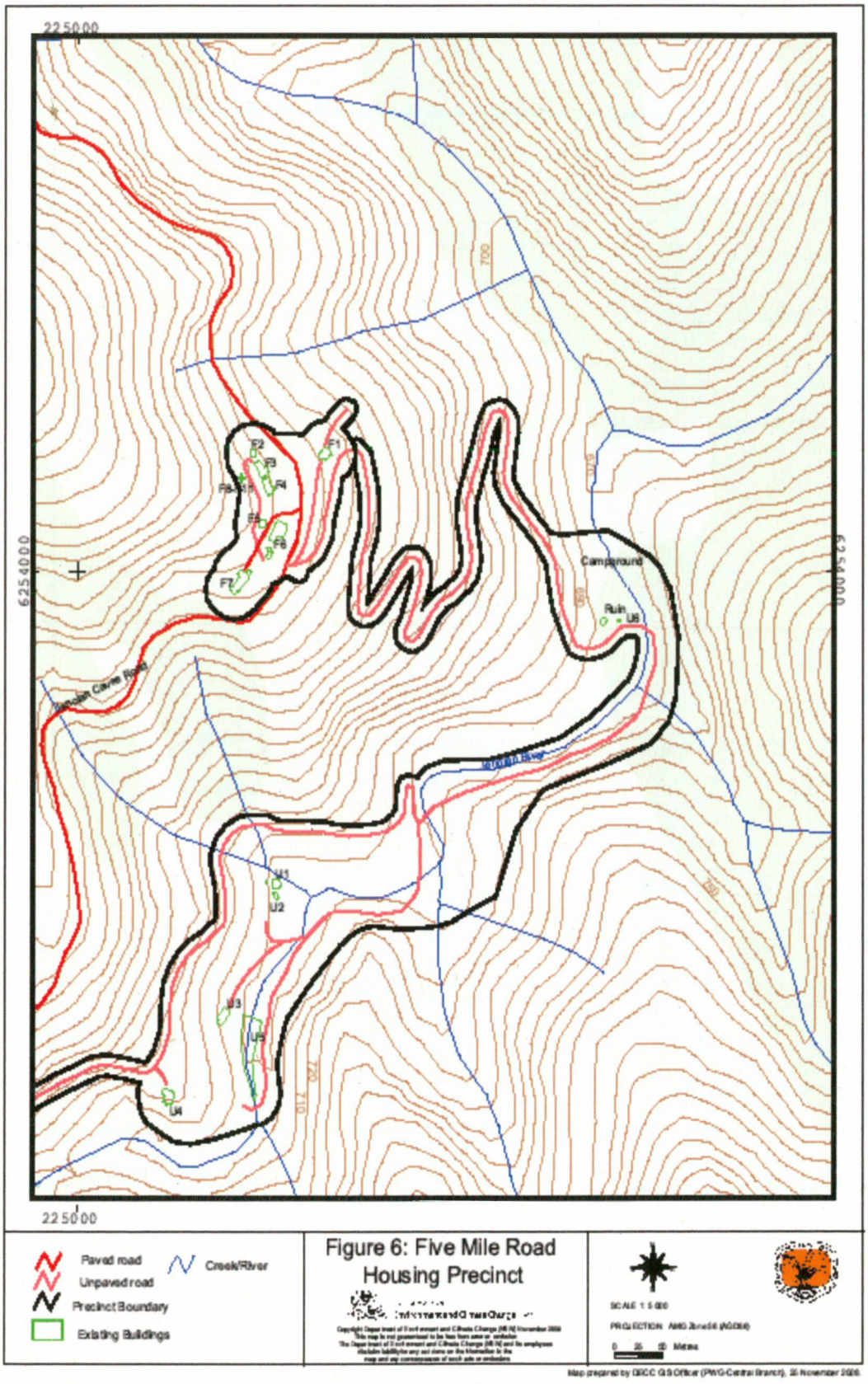
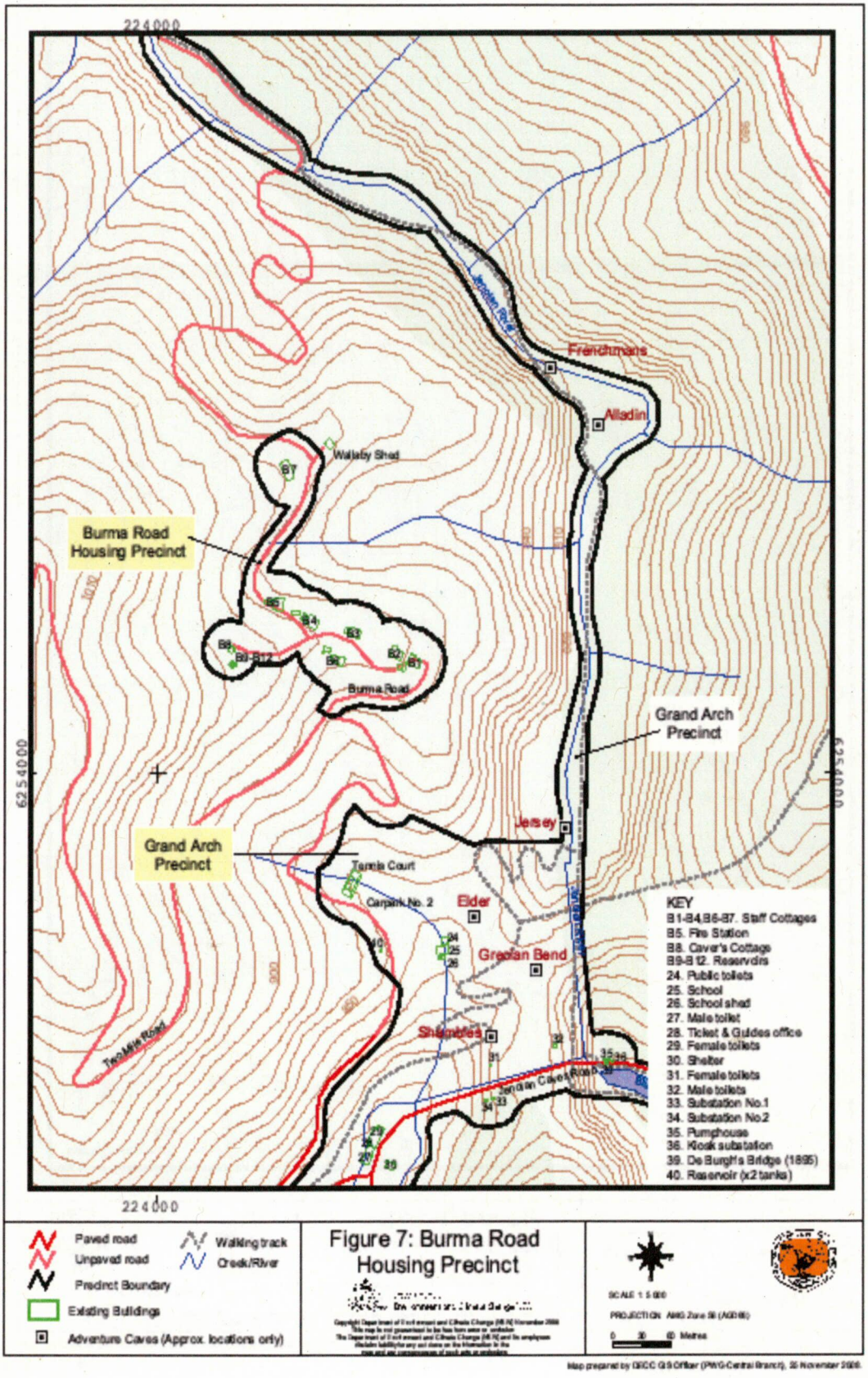
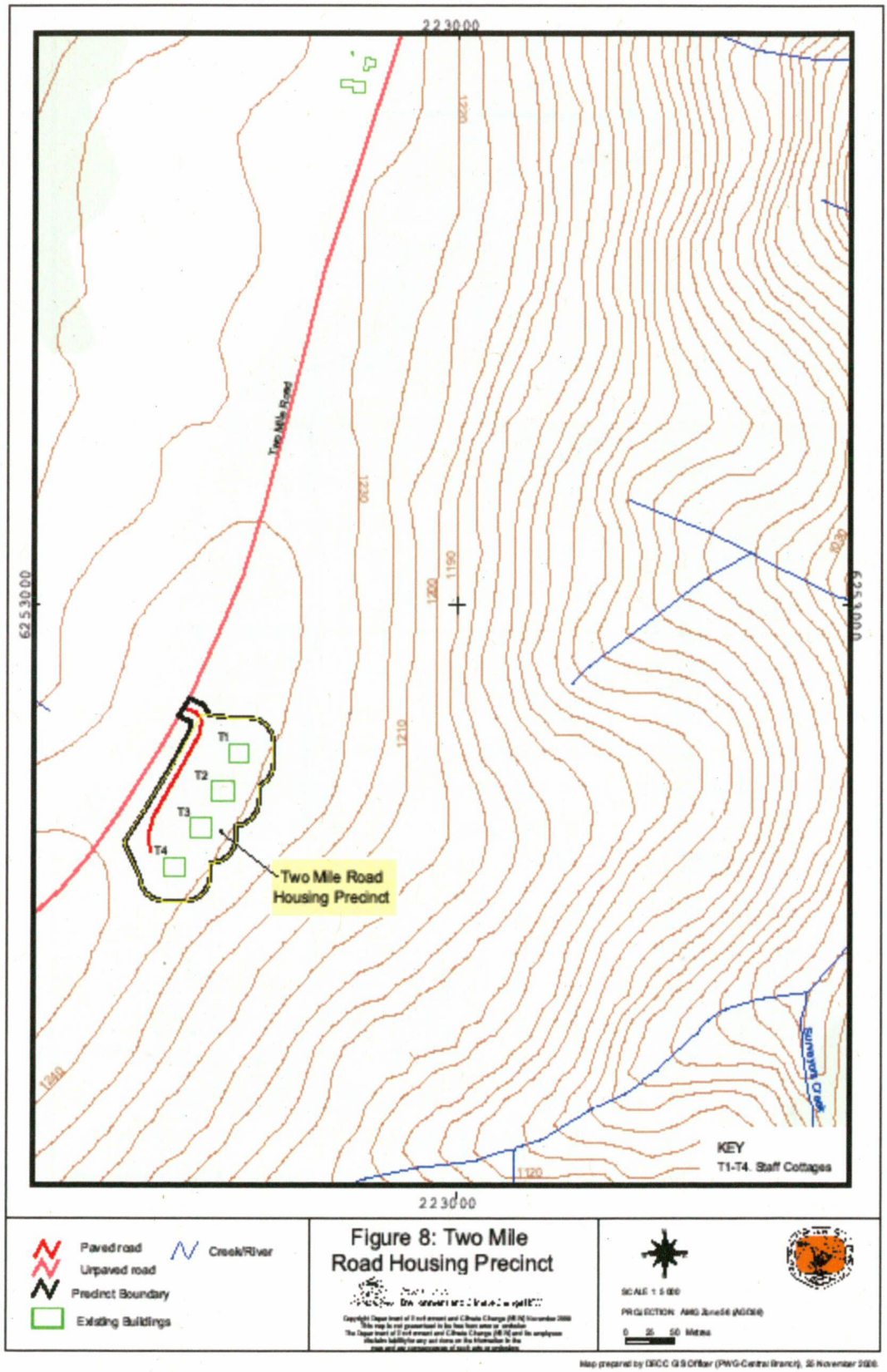


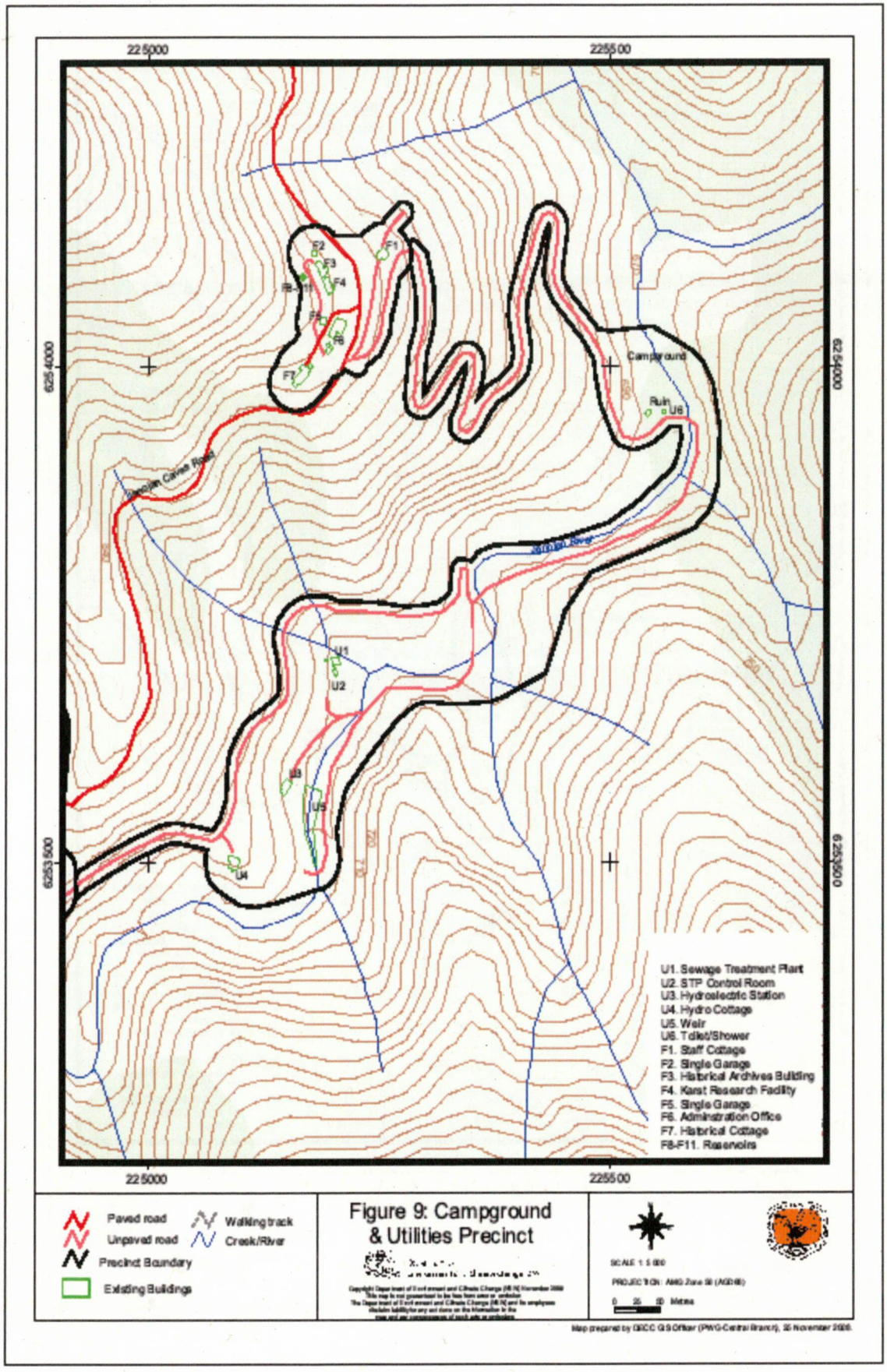
Figure 5:
Jenolan Cottages Precinct


22 50 00
6254000
6254000
22 50 00
Campground
Ruin
U5
F1
F2
F3
F4
F5
F6
F7
U1
U2
U3
U4
Paved road
Unpaved road
Precinct Boundary
Existing Buildings
Creek/River
Figure 6: Five Mile Road Housing Precinct
SCALE 1:5 000
PROJECTION AMG Zone 56 (AGD84)
0 25 50 Metres



Map prepared by DECC GIS Officer (PWG-Central Branch), 30 November 2006.


223000
6253000
Two Mile Road
T1
T2
T3
T4
Two Mile Road
Housing Precinct
KEY
T1-T4: Staff Cottages
Paved road
Unpaved road
Precinct Boundary
Existing Buildings
Creek/River
Figure 8: Two Mile
Road Housing Precinct
SCALE 1:5 000
PROJECTION: AMG Zone 56 (AGD66)
0 25 50 Metres


225000
225500
6254000
6253500
Campground
Ruin
U6
Jenolan Caves Road
U1
U2
U3
U4
U5
F1
F2
F3
F4
F5
F6
F7
F8-F11
U1. Sewage Treatment Plant
U2. STP Control Room
U3. Hydroelectric Station
U4. Hydro Cottage
U5. Weir
U6. Toilet/Shower
F1. Staff Cottage
F2. Single Garage
F3. Historical Archives Building
F4. Karst Research Facility
F5. Single Garage
F6. Administration Office
F7. Historical Cottage
F8-F11. Reservoirs
Paved road
Unpaved road
Precinct Boundary
Existing Buildings
Walking track
Creek/River
Figure 9: Campground & Utilities Precinct
SCALE 1:5 000
PROJECTION: AMG Zone 56 (AGD66)
0 25 50 Metres
Map prepared by OEC GIS Officer (PWG-Central Branch), 25 November 2008.

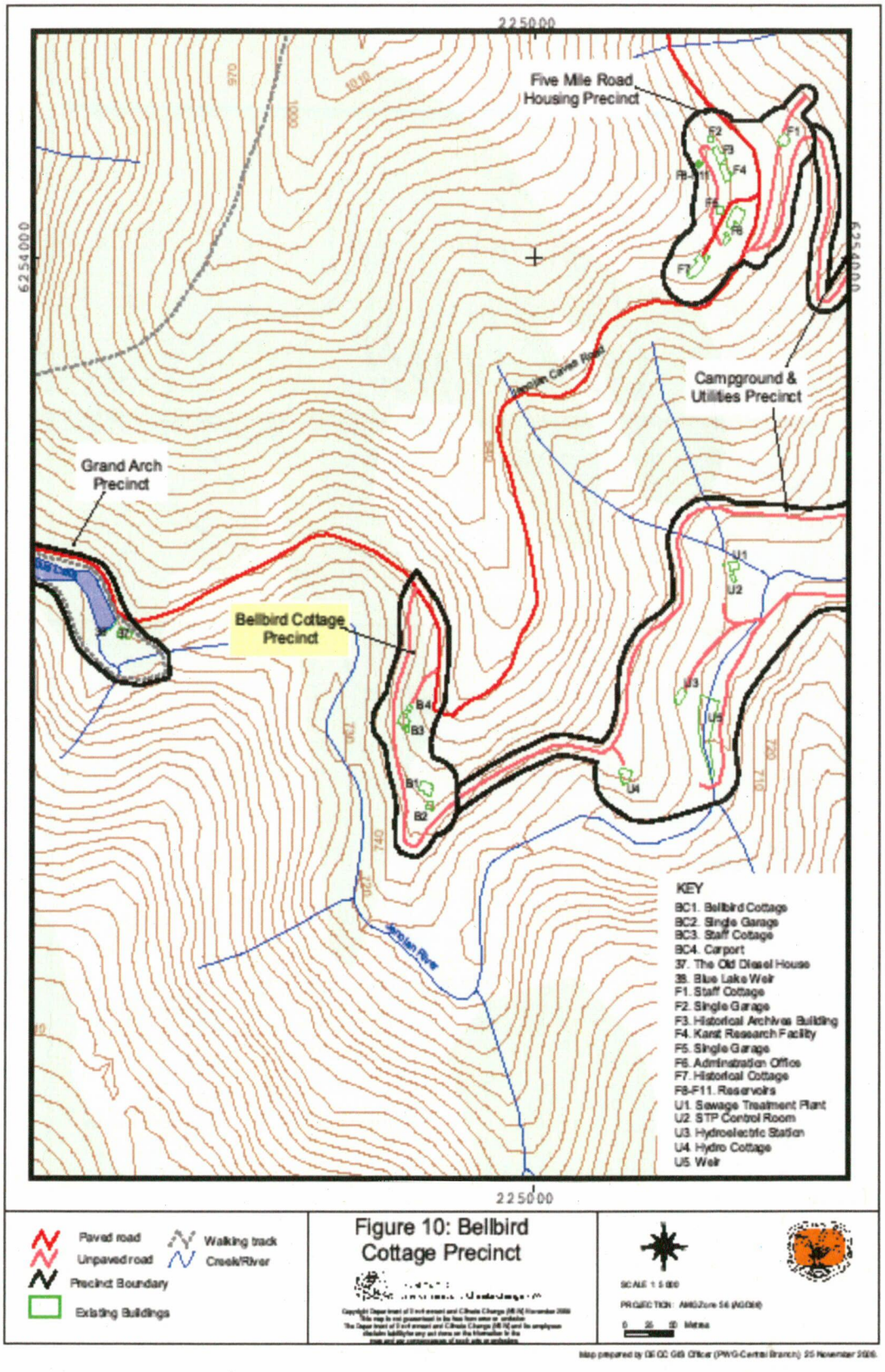


Figure 10: Bellbird Cottage Precinct

Map prepared by DECC GIS Officer (PWG-Central Branch) 25 November 2009.

The 2005 NPW Act amendments included a requirement that certain leases and licences granted in the Jenolan Caves VUSZ include conditions requiring the environmental performance of the lessee or licensee to be measured against environmental performance indicators set out in the plan of management.

The Director-General of OEH is required to monitor and report on environmental performance. The amendments also established a Karst Management Advisory Committee to provide advice to the National Parks & Wildlife Advisory Council.

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

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. 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 adopted the Australian 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, underlies the practice of heritage conservation in Australia with a number of its elements incorporated into the NSW State Heritage Manual. 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/assessments.

Australian Natural Heritage Charter

The Australian Natural Heritage Charter 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. 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 the national caving body in Australia and has developed standards and guidelines for conducting speleological activities including the Code of Ethics and Conservation, the Minimal Impact Caving Code and Cave Safety Guidelines.

2.2 Management Purposes and Principles

Karst Conservation Reserves

Karst environments are areas that contain landforms which are the product of rock material having been dissolved by water, such as limestone caves. Karst conservation reserves are reserved under the NPW 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; and
- 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.

World Heritage

The southern two-thirds 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 (refer to Section 1.2 Statement of Significance). World Heritage Management Principles (the 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 EPBC Act and in accordance with Australia's obligations under the World Heritage Convention. These 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 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 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 Sustainability, Environment, Water, Population and the Communities (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 New South Wales 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, including for historic, indigenous and broader natural values. If GBMWHA is listed nationally for these values it may be re-nominated for World Heritage listing for these values (DECC 2009a).

National Heritage Register

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 EPBC 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 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 a draft Jenolan Karst Conservation Reserve Conservation Management Plan (Urbis 2010) was prepared. If this plan 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.

2.3 Specific Management Directions

In addition to the general principles for the management of the karst conservation reserve (refer to 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.

3.1 Geology, Landscape and Hydrology

Geology

The reserve is located within a non-karst area of high relief close to the eastern edge of the 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 are developed in the Upper Silurian Jenolan Caves Limestone which formed 420 million years ago and outcrops continuously over a strike length of five kilometres in the Jenolan Caves area (see Figure 11), and then continues north as a series of discontinuous outcrops for a further four kilometres (Osborne et. al. 2006).

The limestone is 265 metres thick near Caves House. 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. The Siluro-Devonian sequence is unconformably overlain to the east by shallow-marine and terrestrial sediments of the Upper Devonian Lambie Group. Carboniferous granitic plutons intrude the sequence to the north, east, and south of Jenolan Caves.

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 life forms 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 (see Figure 11) 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 one kilometre north of the Grand Arch is the expression of a large-scale fold known as the Jenolan Mega-kink (Powell, Cole & Cudahy 1985).

Three types of palaeokarst (fossil karst) deposits have been identified at 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.

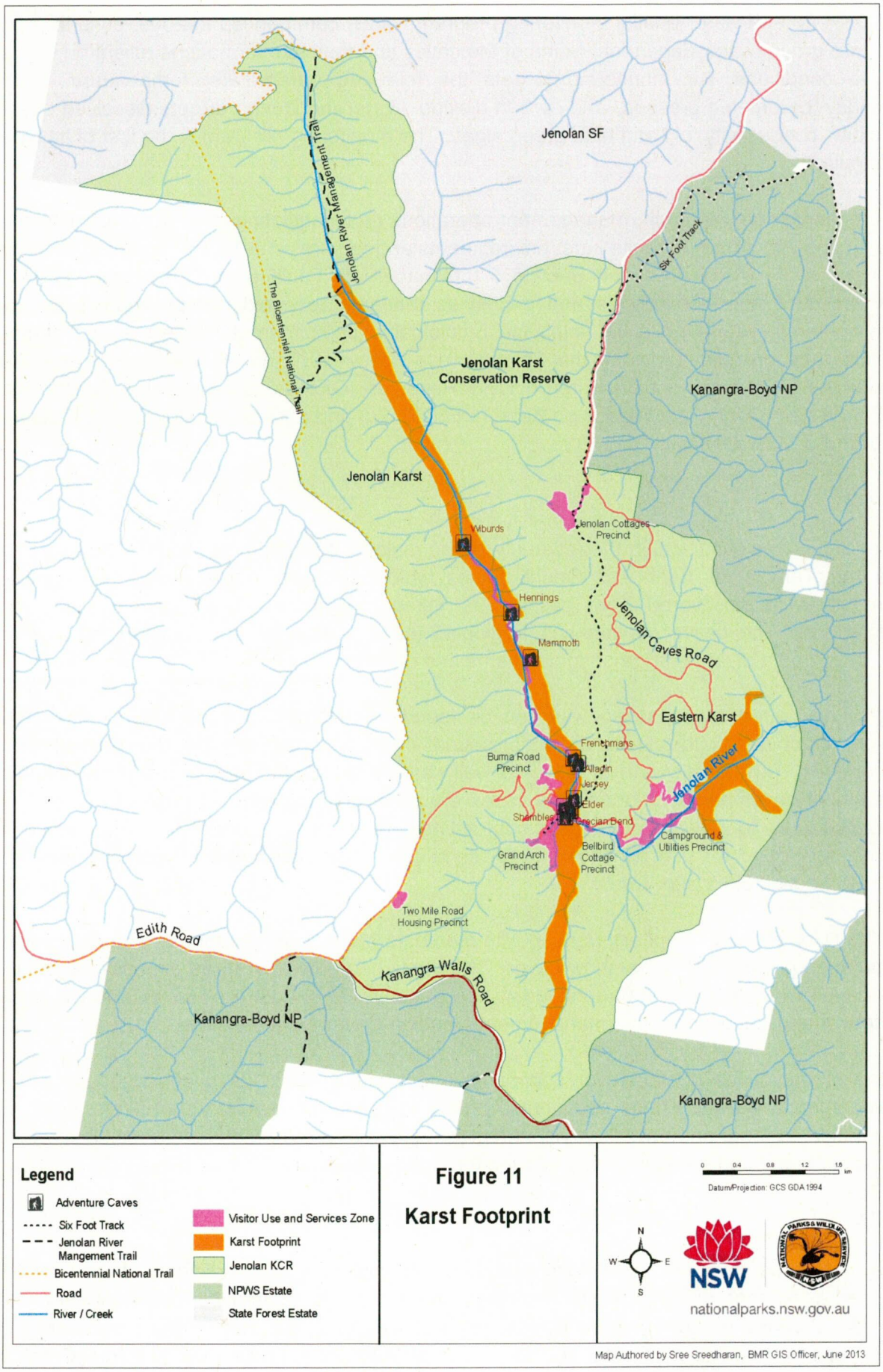
The most spectacular surface karst feature is the wall of limestone 90 metres high and 150 metres wide at the confluence of the Jenolan River, Surveyors Creek and Camp Creek. The reserve's three karst bridges: the Grand Archway, Devil's Coach House and Carlotta Arch are internationally renowned.

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 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 main cave system contains over 40 kilometres of passage developed in a one kilometre length of limestone body.

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.


Jenolan SF
Jenolan River Management Trail
The Bicentennial National Trail
Six Foot Track
Jenolan Karst Conservation Reserve
Kanangra-Boyd NP
Jenolan Karst
Jenolan Cottages Precinct
Wburds
Hennings
Mammoth
Jenolan Caves Road
Eastern Karst
Frenchmans
Burma Road Precinct
Aladin
Jersey
Elder
Shambles
Grecian Bend
Jenolan River
Campground & Utilities Precinct
Bellbird Cottage Precinct
Grand Arch Precinct
Two Mile Road Housing Precinct
Edith Road
Kanangra Walls Road
Kanangra-Boyd NP
Kanangra-Boyd NP
Legend
Adventure Caves
Six Foot Track
Jenolan River Mangement Trail
Bicentennial National Trail
Road
River / Creek
Visitor Use and Services Zone
Karst Footprint
Jenolan KCR
NPWS Estate
State Forest Estate
Figure 11
Karst Footprint
0 0.4 0.8 1.2 1.6 km
Datum/Projection: GCS GDA 1994
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NSW
nationalparks.nsw.gov.au
Map Authored by Sree Sreedharan, BMR GIS Officer, June 2013

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 reliant on specific, stable conditions. Air monitoring targets the following parameters: temperature, relative humidity, barometric pressure and carbon dioxide. Water monitoring targets dissolved oxygen, turbidity, conductivity, pH and blue green algae. The monitoring program is the first of its type in Australia.

Recreational use, research, management operations and installation of cave infrastructure has the potential to damage fragile karst environments and requires careful management (also refer to Section 3.5 Visitor Use and Section 5.1 Management Facilities & 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 the Cave Access Policy (DECCW 2010a) and guidelines for Undertaking Development on Karst in OEH Reserves (OEH 2013), Managing Fire on Karst (OEH 2012b), Controlling Weeds on Karst (OEH 2012c) and a Karst Monitoring and Evaluation Toolkit (DECCW 2010b).

Caves

Over 300 caves occur within the reserve with the majority oriented north-south. The exceptions are the Temple of Baal and Orient Caves which are oriented east-west. A significant percentage of discovered cave passage is linked forming one large system within three catchments. The caves contain rich troglobitic (cave-dwelling) fauna, outstanding aesthetic qualities, and a diverse range of speleothems and minerals.

Highly decorated cave passageway can be found in proximity to three natural rock arches which, combined with extensive underground river systems, provide the primary visitor experience. The construction of elevated walkways, viewing platforms and stairways within a number of developed/semi-developed caves enhances this experience, providing visitors with the opportunity to view speleothems of contrasting shape, form and decoration. Appendix A lists caves developed for use as show caves, semi-developed caves and adventure caves (also refer to Section 3.5 Visitor Use).

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 2012).

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. The remains of extinct fauna and flora can also be found throughout the caves.

Soils

The reserve contains five soil landscapes. The soil landscape of the majority of the reserve is classed as Kanangra Gorge. A much smaller area around the central west boundary and in the southwest 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. All these soil landscapes, except the Jenolan Caves soil landscape, produce acidic soils.

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 (Cameron, McNamara Consultants 1989).

Hydrology

The maintenance of natural hydrological processes and water quality is a key principle of karst management. Water helps shape and link karst systems, and is a fundamental element of their ecology. 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 1). 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 located within the Warragamba Catchment and the Mid Coxs River Sub-catchment.

Reservation of most of the upper catchment of the Jenolan River greatly assists managing water quality entering the caves. 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 managed as pine plantations.

The Jenolan River flows on the surface until it sinks into alluvial flats on the edge of the limestone. Below ground, the river flows through open and flooded cave passages before finally emerging in Blue Lake.

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). 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 two 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 hydroelectric system used to illuminate the caves. The lake is approximately 4000 m^2. 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, mostly recently in 2005. The Blue Lake Management Strategy (Jenolan Caves Reserve Trust 2006) has been prepared to guide management of the lake's natural, cultural, aesthetic and recreational values. The strategy proposes, among other actions, monitoring the lake and its hydrological inputs to determine whether pollutants enter the lake and the pattern of sediment deposition, that is, the contribution over time of sediment loads from the different catchments and the (developed) Grand Arch Precinct.

Downstream from Blue Lake the Jenolan River flows permanently on the surface and the sewage treatment plant (see Figure 9) discharges treated effluent into the river under licence from the Environment Protection Authority (refer to Section 5.1 Management Facilities and Operations).

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 hydroelectricity
- water extraction for the purposes of domestic water consumption
- changes in vegetation and an increase in impervious areas, altering runoff flow patterns
- the discharge of sewage treatment plant effluent
- storm water 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 on 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 speleothem health. 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.

OEH operates an environmental audit program of all major activities and development in the VUSZ. Bi-monthly audit inspections occur and reports are provided to the operator of the VUSZ, currently the Trust, for action. The audit program is based on International Standards Organisation 19011:2011 Guidelines and investigates these areas:

- 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.

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.

Management Response

3.1.1 Implement the Blue Lake Management Strategy.

3.1.2 Continue regular OEH environmental auditing of the VUSZ. Provide audit 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 Assess the structural integrity of Surveyors Creek Dam, determine the preferred management option and any implementation actions required.

3.2 Native Plants and Animals

3.2.1 Native Plants

The reserve supports eucalypt forests listed as part of the Greater Blue Mountains World Heritage Area (GBMWHA), the white box-yellow box-Blakely's red gum endangered ecological community (EEC), listed under the TSC Act and EPBC Act, the endangered mountain trachymene (*Trachymene scapigera*), listed under the TSC and the EPBC Act, rare plants and others plants of restricted distribution.

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 Greater Blue Mountains World Heritage Area (GBMWHA). The southern two-thirds 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).

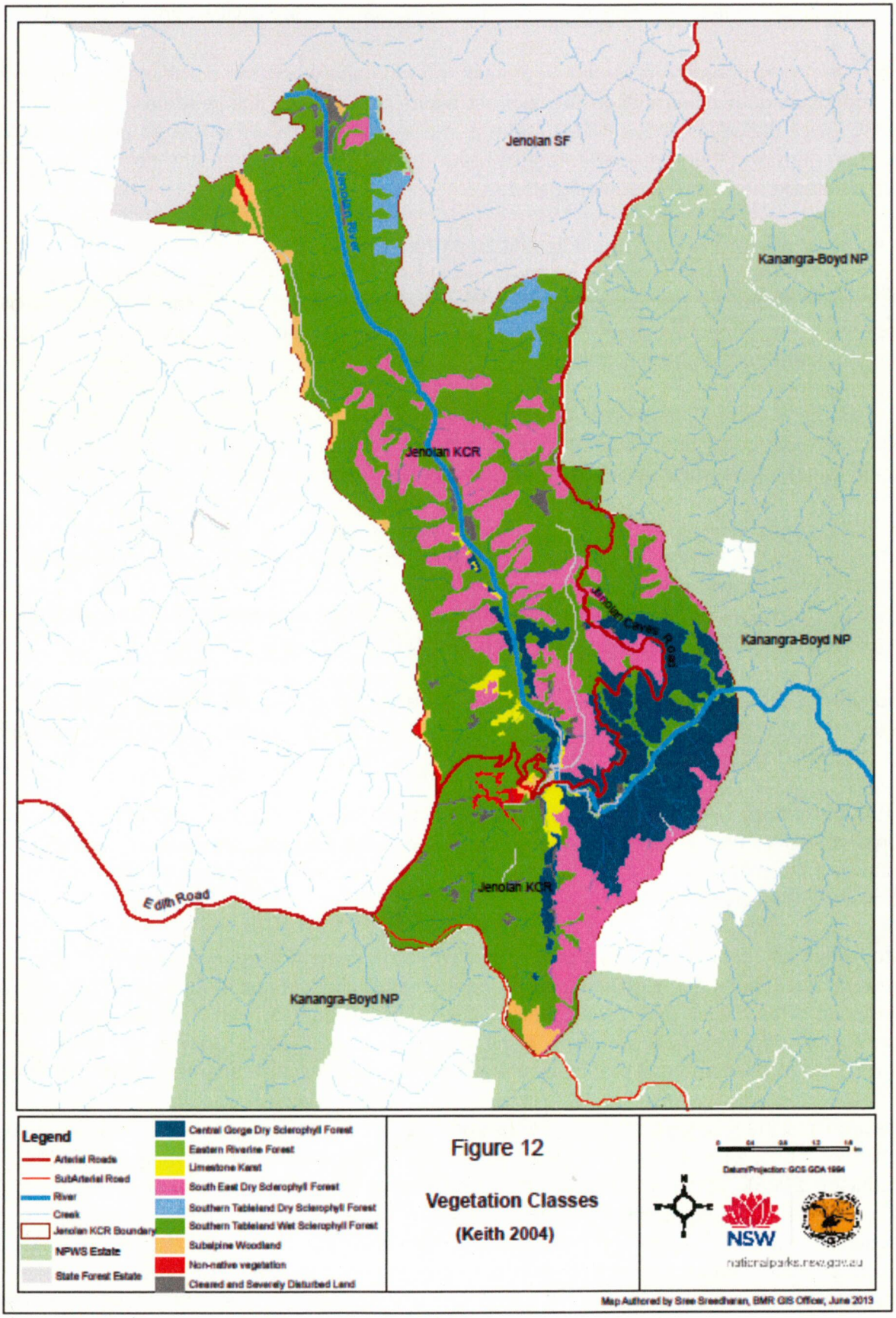
The GBMWHA is being assessed by the Australian Heritage Council for National Heritage listing for values other than those included in the existing listing, including for its broader natural values.

The reserve's vegetation was mapped as part of the Hawkesbury-Nepean Catchment Management Authority Western Blue Mountains mapping project (DEC 2006a). Six vegetation classes (Keith 2004) occur within the reserve (see Figure 12). The reserve is dominated by three of these: Southern Tableland Wet Sclerophyll Forest the reserve (60 percent), South East Dry Sclerophyll Forest (19 percent) and Central Gorge Dry Sclerophyll Forest (13 percent). The remaining three vegetation classes comprise less than 5 percent of the reserve: Southern Tableland Dry Sclerophyll Forest, Subalpine Woodland and Eastern Riverine Forest. Exposed limestone karst covers one precent of the reserve and non-native vegetation and cleared or severely disturbed land comprises two percent 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 percent of the GBMWHA: Blaxland's stringybark (*Eucalyptus blaxlandii*), broad-leaved peppermint (*Eucalyptus dives*), brown barrel (*Eucalyptus fastigata*), eurabbie (*Eucalyptus bicostata*), grey gum (*Eucalyptus punctata*), ironbark peppermint (*Eucalyptus smithii*), monkey gum (*Eucalyptus cypellocarpa*), mountain gum (*Eucalyptus dalrympleana* subsp. *dalrympleana)*, narrow-leaved peppermint (*Eucalyptus radiata*), narrow-leaved stringybark (*Eucalyptus sparsifolia*), red ironbark (*Eucalyptus fibrosa*), ribbon gum (*Eucalyptus viminalis*), silvertop ash (*Eucalyptus sieberi*), thin-leaved stringybark (*Eucalyptus eugenioides*), white sally (*Eucalyptus pauciflora*) and yellow box (*Eucalyptus melliodora*).

The recent additions in the northern part of the reserve include small areas of the white box-yellow box-Blakely's red gum endangered ecological community (EEC) listed under the TSC Act. The EEC is also listed as Critically Endangered under the EPBC Act. The EEC is associated with the Megalong Granite Box Woodland forest ecosystem (NPWS 2000). The recent additions also support the following forest ecosystems:

- Eastern Tablelands Shrub/Grass Moist Forest - an association of narrow-leaved peppermint, mountain gum, snowgrass (*Poa sieberiana*) and gorse bitter pea (*Daviesia ulicifolia*)
- Northern Plateau Moist Fern/Herb/Grass Forest - an association of brown barrel, mountain gum, blackwood (*Acacia melanoxylon*) and bracken fern (*Pteridium esculentum*).


Jenolan SF
Jenolan River
Kanangra-Boyd NP
Jenolan KCR
Jenolan Caves Road
Kanangra-Boyd NP
Edith Road
Jenolan KCR
Kanangra-Boyd NP
Legend
Arterial Roads
SubArterial Road
River
Creek
Jenolan KCR Boundary
NPWS Estate
State Forest Estate
Central Gorge Dry Sclerophyll Forest
Eastern Riverine Forest
Limestone Karst
South East Dry Sclerophyll Forest
Southern Tableland Dry Sclerophyll Forest
Southern Tableland Wet Sclerophyll Forest
Subalpine Woodland
Non-native vegetation
Cleared and Severely Disturbed Land
Figure 12
Vegetation Classes
(Keith 2004)
Datum/Projection: GCS GDA 1994
NSW
nationalparks.nsw.gov.au
Map Authored by Sree Sreedharan, BMR GIS Officer, June 2013

The inclusion of the Northern Plateau Moist Forest ecosystem in the reserve is important as only 24 percent of the pre-1750 extent of this ecosystem remains (NPWS 2000).

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 1,100 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.

On the drier western slopes at middle altitudes grow two woodland communities, dominated by silvertop ash and Blaxland's stringybark or 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*).

Two rare plants (Briggs & Leigh 1996) have been recorded in the reserve. In the 1990s, Professor David Gillieson of James Cook University commenced vegetation mapping and modelling of the reserve which resulted in the location of 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.

A number of other threatened and rare plants were recorded from 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.

Austral cornflower (*Stemmacantha australis*), which is listed under the TSC Act as presumed extinct in NSW, has been replanted on the reserve (I Eddison, 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 and therefore its conservation significance is enhanced as is likely to contain old growth forests and woodlands. This contention is supported by the range of fauna known from the reserve which depend on large tree hollows which form in over-mature trees, a prominent feature of old growth. Due to past land use practices, old growth vegetation is now scarce throughout NSW.

Research into the reserve's bryophyte flora (mosses, liverworts and hornworts) has recorded 98 species of moss, 21 species of liverworts and three 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 species are associated with certain fauna, for example, growing in bat guano or providing habitat for invertebrates sought after by short-beaked echidnas (*Tachyglossus aculeatus*). 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 (refer to Section 4.1 Pests) with inappropriate fire regimes posing a lesser threat (refer to Section 4.2 Fire).

3.2.2 Native Animals

A total of 233 native vertebrate fauna species are currently known from the reserve. This total comprises 11 frogs, 31 reptiles, 140 native birds and 51 native mammals (OEH 2012a). Thirty threatened animals are recorded (refer to Appendix B). Of these 30 species:

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

A comprehensive report on the vertebrate fauna of the reserve (OEH 2012a) has been 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 orianae oceanensis*), spotted-tailed quoll (*Dasyurus maculatus*), sooty owl (*Tyto tenebricosa*) 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 2012a).

The report (OEH 2012a) 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 2012a).

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.

The forests in the reserve were protected historically to safeguard the karst. This resulted in the maintenance of usually rare habitat features such as large hollow-bearing trees. The reserve's relatively high densities of nocturnal birds, such as sooty owl, powerful owl (*Ninox strenua*) and

barking owl (*Ninox connivens*), relate directly to the availability of the nest resource of tree hollows and caves, an abundance of arboreal prey and the reserve's linkage to contiguous high quality habitat in the GBMWHA (OEH 2012a).
The occurrence of brush-tailed phascogale (*Phascogale tapoatafa*) in the reserve is regarded as of high regional conservation significance as it is rare regionally and was recently listed as regionally extinct (DECC 2007).

The stuttering frog (*Mixophyes balbus*), 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 2012a).

The reserve is of regional importance to the eastern bentwing-bat (*Miniopterus orianae oceanensis*) 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 2012a).

The reserve is important to troglophile bats as karst has a highly restricted distribution in south-eastern 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 2012a) have recorded single locations of 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 2012a).

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 2012a).

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 TAP (refer to 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 40 individuals (OEH 2012a).

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*).

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. Kinghorn (1970) compiled a list of 367 species for the reserve including 23 species of terrestrial invertebrates, 147 species of cave-dwelling fauna, and a range of aquatic invertebrates.

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, and are therefore 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. Erosion and sedimentation resulting from various sources and causes has the potential to impact upon 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 state-wide Threatened Species Priorities Action Statement (PAS). Individual recovery plans may also be prepared for threatened species to consider management needs in more detail. Nine species have recovery plans adopted or have had draft recovery plans prepared under the TSC Act, the EPBC Act or both (refer to Appendix B). Twenty-five species are included in the PAS. Threatened species profiles have been developed listing threats and recovery strategies for the remaining species which do not have recovery plans and are not included in the PAS.

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 species are protected and maintained.
- Structural diversity of vegetation and habitat values are restored in degraded areas.

Management Response

3.2.1 Implement relevant strategies in the Priorities Action Statement and recovery plans for threatened species, populations and ecological communities present in the reserve.

3.2.2 Implement management recommendations in the vertebrate fauna report for fauna, including cave-dwelling fauna (OEH 2012a).

3.3 Aboriginal Heritage

The reserve lies in an area of overlap between the traditional country of the Gundungurra and Wiradjuri Aboriginal people, and within the area of the Pejar Local Aboriginal Land Council. The land, water, plants and animals within a landscape are central 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 that 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 2012a). Aboriginal sites in the reserve identified to date mainly occur along watercourses and in rock overhangs. The most common 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 sites located it appears the area was occupied during the Holocene period (up to 10,000 years before present (BP)). Research in the Blue Mountains indicates that there is the potential for extant Aboriginal sites to occur in the reserve dating from the end of the Pleistocene period (20,000 – 10,000 BP) (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 is summarised in Table 1.

Table 1: 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

Attenbrow (1994) and McDonald (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. It is therefore policy that 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 re-nominated 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 co-operation with local Aboriginal communities. The Mapping Country Project shares commonalities with the recommendation in the draft Jenolan Karst Conservation Reserve Conservation Management Plan (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.

There is currently a Native Title registered claim (NC1997/007) by the Gundungurra Tribal Council Aboriginal Corporation which is yet to be determined, over land from south of Katoomba to Goulburn, which includes the reserve. The strategic plan seeks to ensure valid native title is recognised and that Indigenous Land Use Agreements 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 and Wiradjuri 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 on 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; identifying areas of the reserve requiring further archaeological investigation and determining priorities for investigation within these areas, if required.

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 and social significance. NPWS conserves the significant heritage features of NSW parks and reserves.

The significance of the reserve's historic heritage to NSW 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:

Historical

The reserve demonstrates the significant historical activity of identifying and conserving the natural resources of NSW in relation to caves and karst landscapes. The reserve was the first area in NSW 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 is demonstrated in the aesthetic qualities of the caves and cave formations, the hamlet's setting in a valley with its buildings dwarfed by cliffs, the entrance through the 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

There 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 NSW and Australia, to benchmark protected karst landscapes in NSW, and for the hamlet's archaeology to provide information on early tourism in NSW.

Rarity

The reserve supports rare and uncommon flora and fauna, especially within the caves which includes NSW's greatest diversity of cave invertebrates. 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 (refer 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, Beaver & Betteridge 2006), it was unsuitable for coach travel (Smith 1985) and became an alternative route for walkers and travellers on horse back. Walkers continue to use the route today.

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 hydroelectric 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 hydroelectric 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), 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 Pomona Grove Farm (late 19th and early 20th century) and of three guest houses dating from the 1880s, Wallace's Guest House, Kiaora Guest House and Rose Cottage (also known as Rowe's Homestead), have been recorded and assessed for their heritage significance (Urbis 2010).

The historic landscapes and plantings in the reserve are considered 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 (refer to 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 a Heritage Asset Management Strategy (Godden Mackay Logan 2007) and a draft Conservation Management Plan (draft CMP) (Urbis 2010) have been prepared.

The Heritage Assets Management System (HAMS) (Godden Mackay Logan 2007) applies to the heritage assets of the Visitor Use and Services Zone (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 HAMS Summary Action Plan (Table 4.1) 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 reuse, 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 CMP will replace the previous conservation plan (Moore 1988) which will remain an important reference source. The draft CMP (p.113 & p.199) recommends the development of a masterplan 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 (p.108 & p.120) 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 (JCRT 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 Heritage Asset Management Strategy.

3.4.3 Finalise and implement a Conservation Management Plan.

3.4.4 Prepare and implement a Conservation Management Plan for cave heritage items.

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

3.5 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 parks system 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;
- recreational opportunities, including, bushwalking, guided adventure caving, recreational caving, cycling and horse riding
- visitor accommodation and hospitality services such as food, beverage and related retail outlets;
- function facilities; and
- events within the show caves, including concerts and weddings.

The reserve provides recreational opportunities for visitors in a natural highlands 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 at the Grand Arch Precinct (see Figures 3 & 4) and in the caves.

The reserve is located within the Blue Mountains Tourism Region. The population in the region is currently 102,630 and is projected to grow to 105,646 by 2016 (Destination NSW 2013). Cave tours attracted over 217,000 participants in 2011/12 (Jenolan Caves Reserve Trust 2012a) with an average of 224,800 participants annually since 2004/5. The Trust generated

over 10 million dollars in tourism revenue in 2011/12. Visitor accommodation, hospitality and interpretation/education services provide an important source of additional employment in a predominantly rural area.

The reserve is the most popular show cave destination in Australia (Charles Walsh Nature Tourism Services & Elanus Word and Image & Foxlee 2003a). Up to 90 percent of the visitors to the World Heritage Area visit the central Blue Mountains tourism precinct which includes Glenbrook, Echo Point, Jenolan Caves and the Bell's Line of Road (Charles Walsh Nature Tourism Services & Elanus Word and Image 2003b). 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.

The reserve is divided into two zones: the Visitor Use and Services Zone (VUSZ) and the Conservation Management Zone (CMZ) (see Figure 2). The VUSZ, comprising the following seven separate precincts, totals approximately 50 hectares:

- Grand Arch Precinct (see Figures 3 & 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).

The CMZ comprises the remainder of the reserve and surrounds the VUSZ.

Conservation Management Zone

The CMZ which is approximately 3,053 hectares 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. It includes undeveloped (or wild) caves, walking tracks, management trails, day use facilities, electricity and telecommunication infrastructure and operational infrastructure. Visitor services and operational management within the CMZ are provided by NPWS with some recreational opportunities provided by licensees.

Visitor Use and Services Zone

The VUSZ contains land above and below the surface in which infrastructure and associated activities occur related to the protection of the reserve's natural, cultural and recreational values, and the provision of visitor services and facilities. It includes the majority of the reserve's built heritage, infrastructure, utilities, and the primary points of access to developed and semi-developed caves and to caves used for adventure tours. Visitor services and operational management within the VUSZ is primarily provided by the Trust at this stage but will be provided by NPWS and/or lessees and licensees in future.

The major attraction of the zone is the system of show caves, where interpretive tours are conducted, and Caves House and associated historic infrastructure. Visitors may also bushwalk, undertake adventure or recreational caving 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 (refer to Section 3.1 Geology, Landscape and Hydrology).

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).

Visitation to the reserve needs to be carefully managed as visitors can negatively impact on 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.

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.

Visitor Accommodation and Hospitality Services

Visitor accommodation is offered in four accommodation units: Caves House (38 rooms), Mountain Lodge (30 motel-style studios), Gatehouse Backpacker Lodge (14 rooms accommodating 70 guests), Jenolan Cottages (8) and Binoomea Cottage (Jenolan Caves Reserve Trust 2012a). The Grand Arch Precinct is the primary focus of visitor accommodation in the reserve, however, accommodation is also provided eight 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, café, souvenir retail outlet and function facilities are provided at Caves House (Jenolan Caves Reserve Trust 2012a). The Trust currently operates visitor accommodation and hospitality services in the VUSZ.

Refer to 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 facilities 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, car parks, walking tracks and picnic facilities, in addition to the facilities of Caves House (see Figure 4).

There are three major car parks 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 (2 parking spaces) and behind Caves House (1 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. Picnic facilities in the reserve are detailed in Table 2.

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. In view of this, it is appropriate to reassess the type and location of day use facilities provided. Multiple pull-out facilities on Jenolan Caves Road will be rationalised and the facilities at the Playing Fields Trail will be removed subject to any environmental impact assessment required. The Inspiration Point picnic facilities on Jenolan Caves Road will be upgraded; however, wood barbeques and fireplaces will be discontinued in view of the attendant fire risk.

Table 2: Day use/Picnic areas

Designated Day Use Area and Type	Setting	Site Limit (vehicle spaces)	Vehicle Access	Site Features	General 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
Grand Arch Precinct	Adjacent to Guides Office	N/A	No	Central to precinct.	Shelter with tables
Jenolan Caves Road 1	Roadside	2	2WD	Pull-out on bend in road	Picnic table Barbecue (wood)
Jenolan Caves Road 2	Roadside	2	2WD	Pull-out on bend in road	Picnic table Barbecue (wood)

Jenolan Caves Road 3	Roadside	2	2WD	Katoomba view lookout Inspiration Point	Nil
Carlotta car park	Car park	N/A	2WD	Setting within Grand Arch Precinct	Barbecue (gas) Shelter
Cambridge car park	Car park	N/A	2WD	Setting within Grand Arch Precinct	Barbecue (gas) Shelter

The draft CMP (Urbis 2010) makes a range of recommendations regarding the Grand Arch Precinct, including its visitor amenities. The recommendations of an adopted CMP 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 re-development of the precinct in the context of its physical and heritage constraints.

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 with varying degrees of social interaction, physical challenge and self-reliance and within a range of environmental settings.

Walking opportunities provided in the reserve are detailed in Table 3. A small proportion of visitors who are experienced and equipped for self-reliant bushwalking also utilise remote areas of the reserve.

Table 3: Bushwalking in the reserve

Walking Track Name	Location	Setting	Distance (one way unless indicated)	Current Standard*	Proposed Standard*
Bicentennial National Trail	Western boundary of the reserve.	Great Dividing Range	8 kilometres	Class 3	Class 3
Six Foot Track	From Jenolan Caves Road follows Binoomea Ridge down to Grand Arch Precinct	Historic	1 kilometre 4.5 kilometres	Class 3 walking track Management trail	Class 3
McKeowns Valley Track	From Grand Arch precinct via Devils Coach House Cave along the Jenolan River	Karst, riparian, historic.	2 kilometres 1.2 kilometres	Class 3 walking track Management trail	Class 3
Carlottas Arch	From Caves House uphill to the Carlottas Arch karst feature	Karst, heritage	1 kilometre	Class 3	Class 3
Devils Coach House Lookout	From car park near Carlottas Arch uphill to the lookout to Devils Coach	Karst	750 metres	Class 3	Class 3

Walking Track Name	Location	Setting	Distance (one way unless indicated)	Current Standard*	Proposed Standard*
	House Cave.				
Jenolan River Walk	From Grand Arch via Blue Lake to hydro station.	Riparian, karst, heritage	3 kilometre loop	Class 3	Class 3
Blue Lake Loop	Blue Lake in Grand Arch precinct	Lake	700 metre loop	Class 2	Class 2

* The Australian Standard for walking tracks (AS156.1-2001) has been used as the basis for this track classification system. Refer to this standard for the complete details for each class of track. The names given to each class of track have been applied for ease of use and comprehension and are not derived from the standard.

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 (refer to 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 3,000 people walk the track annually.

The draft CMP (Urbis 2010) 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 Walks

In addition to walks above ground, guided walks below ground in the show caves (listed in Table 4) are very popular and one of the reserve's main attractions (also see 'Group Activities' below). There is a total of 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, and self-guided recreational caving are also popular pursuits. Guided adventure caving is offered on a fee-paying basis.

Table 4: Show cave walks in the reserve

Cave/Feature	Return length (metres)	Number of stairs/steps
Lucas	860	910
Imperial	1,070	358
Chifley	690	421

Orient	470	358
Temple of Baal	365	288
Diamond (via Imperial)	1,270	418
Jenolan River extension to Diamond	-	66
River	1,271	1,298
Ribbon (via Orient)	590	394
Jubilee (via Imperial)	1,575	679

Bicentennial National Trail

The Bicentennial National Trail (BNT) passes through the reserve (see Figure 2). The BNT is a 5,300 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.

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

Cycling

The reserve provides opportunities for cycling on public roads, the Bicentennial National Trail and the public road component of the Six Foot Track (refer Figure 2). Cycling may be permitted in other locations subject to strict 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 are not permitted.

Horse Riding

Horse riding is currently permitted in the reserve on the BNT (see Figure 2). In accordance with NPWS horse riding strategies, policies and directives (DEC 2006b; OEH 2012d, 2012e) aimed at improving horse riding opportunities in appropriate locations in the national park reserve system, it is proposed to investigate allowing horse riding access to the Jenolan River Trail, a dormant management trail, and the establishment of a new bridle trail extension to the Jenolan River Trail, to link it with existing trails (see Figure 11). The two proposals require environmental impact assessment in accordance with NPWS policy and procedures to ensure that horse riding in these locations does not have unacceptable impacts with respect to erosion, vegetation trampling, introducing weeds, increasing nutrient and sediment inputs into watercourses, or by causing conflicts with other reserve users.

Due to the potential impact of this activity on the reserve and its fragile karst environment and potential conflict with visitors on the reserve's narrow public roads, horse riding is not permitted in other areas of the reserve.

Horse riding activities on the BNT that are part of a competition or large-scale organised activity may require a licence or consent under the NPW 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 (refer to Table 4): Lucas, Chifley, Imperial, River, Orient, Temple of Baal, Pool of Cerberus, Jubilee, Diamond and Ribbon. Adventure caving tours currently operate in Mammoth Cave, The Plughole (Elder Cave) and Aladdin Cave (see Figure 3). Appendix A lists developed, semi-developed and adventure 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 activities in the reserve are popular and are regulated by OEH through the Cave Access Policy (DECCW 2010a). Caving activities with the potential to be highly impacting, such as racing within caves, are not permitted.

Group activities in caves have the potential to directly and indirectly impact on 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.

A 1998 study (James et. al. 1998) into the effect of surface vehicle emissions on the reserve's cave system 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 (refer to Section 3.1 Geology, Landscape and Hydrology).

Leasing and Licensing

Recreational Activities

Competitions, large-scale organised activities and commercial activities require consent or licensing under the NPW 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 commercial tourism operator is currently licensed to offer guided bushwalks and other recreational activities in the reserve. Operations are generally restricted to management trails and walking tracks.

Private Partnerships

As operating large tourism facilities is not a core capability of the NSW public sector the NSW government is seeking opportunities to partner with the private sector to deliver services and opportunities in the VUSZ. Leases for the adaptive reuse of existing buildings in the VUSZ may be granted for purposes consistent with the management principles of the reserve.

A licence to operate tours and other visitor experiences in the caves may be granted.

In addition, leases may authorise construction of new buildings in the VUSZ for purposes consistent with the management principles of the reserve. These purposes may include (but are not limited to):

- visitor and tourist accommodation
- retail outlets
- conferences and functions
- facilities to enable activities of a sporting nature to be carried out (ancillary to accommodation)
- information centres and booking outlets
- restaurants
- café
- kiosks and other food and beverage outlets.

Any proposals for adaptive reuse 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 2013).

Environmental Regulation, Monitoring and Review

The NPW 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 Director-General 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 under section 151J of the NPW Act and placed on the OEH website.

The environmental performance standards, indicators and monitoring requirements for the reserve are listed in Table 5.

Table 5: Environmental performance standards and indicators for leasing and licensing

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 species.	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
	Extent of weed cover	Progressive reduction in the extent of	Rapid condition assessment.	Every 6 months

		weed cover.	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 discernable 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 discernable 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
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 discernable 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

		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 license activities.	Review *Jenolan Environmental Complaints Register.*	Annually
	Quality of air in caves.	Air quality parameters for CO_2, temperature and relative humidity are conducive to natural cave development processes and visitor safety (based on past characterisation studies).	Spot checks of CO_2 levels in caves.	As required
			Monitoring of CO_2, 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

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.

Desired Outcomes

- Visitor use is appropriate, ecologically sustainable with 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 value 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 co-ordinated system for visitor use monitoring across the GBMWHA to assist in the development of visitor management strategies.

Day Use

3.5.2 Upgrade visitor facilities at the Inspiration Point lookout on Jenolan Caves Road (refer to Table 2 'Day use/Picnic areas'). Do not provide a wood barbeque or fireplace to minimise bushfire risk.

3.5.3 Remove day use visitor facilities at the Playing Fields Trail and at other locations on Jenolan Caves Road (refer to Table 2 'Day use/Picnic areas'), subject to any environmental assessment required and significance assessments under the Heritage Act.

3.5.4 Provide day use facilities within the Grand Arch Precinct in accordance with NPWS policy and any Conservation Management Plan, when adopted.

Bushwalking

3.5.5 Continue to provide bushwalking opportunities in accordance with Table 3 'Bushwalking in the reserve'.

3.5.6 Consider the Landscape Issues and Options Report and the accompanying Landscape Concept Plan (Hobley & Buchanan 2007) for the Blue Lake Loop when undertaking upgrading or maintenance.

Cycling

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

3.5.8 Adventure cycling, triathlons and other competitive cycling are not permitted.

Horse Riding

3.5.9 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 BNT at any one time.

3.5.10 Manage the Bicentennial National Trail in accordance with the Memorandum of Understanding.

3.5.11 Investigate permitting horse riding access to the Jenolan River Trail and the establishment of a new bridle trail extension to the Jenolan River Trail to link it with existing trails, subject to environmental impact assessment and in accordance with NPWS policies and procedures.

3.5.12 Horse riding will not be permitted in other areas of the reserve.

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

3.5.14 Horse riding that is part of a competition or large-scale organised activity (including non-commercial activities) will require written consent from NPWS. All commercial activities require a licence.

Group Activities

3.5.15 Monitor commercial and non-commercial group activities with respect to cumulative impacts, safety requirements, quality of information given and compliance with licence or consent conditions. Licences or consents may be cancelled if there is a breach of the conditions.

3.5.16 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

3.5.17 Regulate recreational caving activities in accordance with the Cave Access Policy. Caving activities with the potential to be highly impacting, such racing within caves, are not permitted.

Leasing/licensing

3.5.18 Leases for the adaptive reuse of existing buildings in the Visitor Use and Services Zone may be granted for purposes consistent with the management principles of the reserve.

3.5.19 New buildings may be constructed in the Visitor Use and Services Zone for purposes consistent with the management principles of the reserve. These purposes may include, but are not limited to: visitor and tourist accommodation, retail outlets, conferences and functions, facilities to enable activities of a sporting nature to be carried out (ancillary to accommodation), information centres and booking outlets, restaurants, café, kiosks and other food and beverage outlets.

3.5.20 Proposals for adaptive reuse of existing buildings or for new buildings in the Visitor Use and Services Zone are subject to environmental impact assessment in accordance with NPWS policy and procedures and the Heritage Act.

3.5.21 A licence may be granted to operate tours and other visitor experiences in the caves.

3.5.22 Lessees and licensees to whom Section 151D of the NPW Act applies are to comply with the relevant environmental performance standards in 'Table 5 Environmental performance standards and indicators for leasing and licensing'.

3.5.23 OEH will monitor and report on the environmental performance of any lessee or licensee (with respect to leases or leases to which Section 151D of the NPW Act applies) against the environmental indicators in 'Table 5 Environmental performance standards and indicators for leasing and licensing'.

3.5.24 OEH will report annually, in accordance with the NPW Act, on the monitoring of lessees and licensees (with respect to leases or licences to which Section 151D of the NPW Act applies).

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. Cave tours tailored to children are offered in school holidays. A school program and a corporate program of cave-based activities, abseiling, bushwalks and orienteering are also offered. Guided bushwalks offered as part of these programs attract a much lower patronage of 4,000 – 6,000 visitors annually (D. Cove 2013, pers. comm.) compared to cave tours. Orient Cave is wheelchair accessible and a special tour of the cave can be arranged. A self-guided cave walk is available with an audio commentary in a number of languages, a commentary for children and from an indigenous perspective. Three self-guided bushwalks are also available supported by a downloadable application which provides information, images and maps. A series of free information podcasts are available for download. New above ground walks and an indigenous cultural tour are being developed with the Gundungurra Tribal Council (Jenolan Caves Reserve Trust 2012a) which will include interpretation of indigenous values and of the industrial archaeological resource. A self-guided tour is currently being developed to interpret the heritage values of Caves House (D. Cove 2013, pers. comm.).

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 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 has been prepared for the GBMWHA (Charles Walsh Nature Tourism Services and Elanus Word & Image 2003b) which outlines objectives, themes and key messages for interpretation and general visitor communication within the GBMWHA. The plan (p.40) 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.

A Jenolan, Borenore, Abercrombie and Wombeyan Karst Conservation Reserves Interpretation and Visitor Orientation Plan has also been prepared (Charles Walsh Nature Tourism Services, Elanus Word & Image and Foxlee 2003a). 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 (Urbis 2010, vol.1, p.121) 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 Conservation Management Plan (Urbis 2010, p.113) also includes policy recommendations for interpretation, including signage.

On the internet, 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. There is little consistency in the presentation of this information, and the level of detail across different channels. A strategic and integrated approach to delivering visitor information around park conservation, safety and visitor facilities, is required within OEH to deliver visitor information.

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 (Charles Walsh Nature Tourism Services and Elanus Word & Image 2004) and NPWS has produced state-wide design guidelines, policy and procedures for the preparation of integrated signage plans (DECCW 2010c, OEH 2010). 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 (Urbis 2010, vol. 1 p.119) proposes development of a masterplan for the VUSZ to provide design and management guidelines for new built form elements including, signage, furniture, lighting and paving. The Trust recently upgraded signage on the Jenolan River, Carlotta Arch and McKeowns Valley Walks (D. Cove, 2013, pers. comm.).

Research helps OEH make well informed decisions about conserving and managing karst environments and World Heritage values. Much of this information is likely to come from scientists and researchers and there is a long history of valuable scientific research being undertaken in the reserve (refer Section 3.1 Geology, Landscape & Hydrology, Section 3.2 Native Plants & Animals, Section 3.3 Aboriginal Heritage and Section 3.4 Historic Heritage).

A Karst Research Prospectus (DECC 2008) has been prepared which explains the research themes of interest to OEH, how to apply for the necessary approvals under the NPW Act or NPW Regulations and 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, 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 and indigenous and 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.

Management Response

3.6.1 Implement the policy recommendations of any Conservation Management Plan adopted in relation to interpretation and signage, including updating the reserve's interpretation plan.

3.6.2 Incorporate consideration of the GBMWHA Interpretation and Visitor Orientation Plan 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 local Aboriginal community 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 Support research by the Blue Mountains World Heritage Institute in the reserve to address priority research areas for the GBMWHA.

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

3.6.8 Review the Jenolan Caves website, mobile apps and social media platforms, with a view to consolidating all digital information and facilities within the overarching NPWS digital engagement strategy.

3.6.9 Undertake research that allows a better and more up-to-date understanding of visitor awareness, behaviour and satisfaction with the Jenolan KCR experience.

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 park values, including impacts on biodiversity, cultural heritage, catchment and scenic values.

Regional pest management strategies are prepared for each NPWS region and identify pest species across that region's parks and priorities for control, including actions listed in the PAS, Threat Abatement Plans (TAPs) and other strategies (such as the NSW Biodiversity Priorities for Widespread Weeds).

The overriding objective of the pest management strategy is to minimise adverse impacts of introduced species on biodiversity and other reserve and community values while complying with legislative responsibilities. The strategy also identifies where other site or pest specific plans or strategies need to be developed to provide a more detailed approach. The maintenance of the reserve's World Heritage values is a primary objective of the reserve's local pest management strategies.

The draft Blue Mountains Region Pest Management Strategy (OEH 2012f) identifies six significant pest species as occurring in the park (refer to Table 6). An emerging weed species also likely to become a significant pest is the tree of heaven (*Ailanthus altissima*), a deciduous ornamental tree with a suckering habit.

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

Weed	Comment
English ivy (*Hedera helix*)	
radiata pine (*Pinus radiata*)	Recorded in northern and western boundary areas. Stands provide very little habitat for native fauna and can prevent almost all regeneration of other species thereby threatening World Heritage values.
tutsan (*Hypericum spp.*)	Highly invasive in both disturbed and undisturbed cool, moist bushland. Tolerates deep shade forming mono-specific stands on waterways excluding all native species thereby threatening world heritage values.
sycamore maple (*Acer pseudoplatanus*)	Forms a dense canopy preventing germination of native species thereby threatening World Heritage values and brush-tailed rock-wallaby habitat. Accompanying erosion risk and reduced water quality threatens karst values.
Pest Animal	
rabbit* (*Oryctolagus cuniculus*)	High priority - especially during drought and after fire to prevent grazing competition with brush-tailed rock-wallabies.
fox (*Vulpes vulpes*)	High priority - to safeguard recovery of the brush-tailed rock-wallaby population.

* Declared pest under the *Rural Lands Protection Act 1989.*

Pest species with the potential to threaten the survival or evolutionary development of species, populations or ecological communities listed under the TSC Act may be declared key threatening processes (KTPs) under the TSC Act and/or the EPBC Act. Table 7 lists KTPs relevant to the reserve and the priority of these threats to the reserve's priority native plants and animals.

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

Threat	Legislation (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	EPBC	Weed	High
Invasion and establishment of exotic vines and scramblers	TSC	Weed	High
Invasion of native plant communities by exotic perennial grasses	TSC	Weed	High
Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)	TSC/EPBC	Pest animal	High
Competition and habitat degradation by feral goats *(Capra hircus)*	TSC/EPBC	Pest animal	High
Competition from feral honeybees (*Apis mellifera*)	TSC	Pest animal	Moderate
Herbivory and environmental degradation caused by feral deer	TSC	Pest animal	
Predation and hybridisation by feral dogs (*Canis lupus familiaris*)	TSC	Pest animal	Moderate
Predation by feral cats (*Felis catus*)	TSC/EPBC	Pest animal	Very high
Predation by the European red fox (*Vulpes vulpes*)	TSC/EPBC	Pest animal	Very high
Predation by the plague minnow (*Gambusia holbrooki*)	TSC	Pest animal	-
Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)	TSC/EPBC	Pest animal	High
Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.	TSC	Habitat loss/change	Moderate
Ecological consequences of high frequency fires	TSC	Habitat loss/change	Moderate
Anthropogenic climate change	TSC/EPBC	Habitat loss/change	Future
Loss of hollow-bearing trees	TSC	Habitat loss/change	Moderate
Removal of dead wood and dead trees	TSC	Habitat loss/change	Moderate
Infection by Psittacine circoviral (beak & feather) disease affecting endangered *psittacine* species	TSC/EPBC	Disease	Moderate
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	TSC/EPBC	Disease	Moderate
Infection of native plants by *Phytophthora cinnamomi*	TSC/EPBC	Disease	Moderate

Source: OEH 2012b

4.1.1 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*), cat (*Felis catus*), fallow deer (*Dama dama*), feral goat (*Capra hircus*), house mouse (*Mus musculus*), pig (*Sus scrofa*), red deer (*Cervus elaphus*) and wild dog (*Canis lupus familiaris*). Pigs, cats, rabbits and introduced rodents are common in the reserve, dogs and foxes are in low numbers due to control programs and deer and goats are seen occasionally. Their numbers require monitoring due to their potential to threaten karst, biodiversity and World Heritage values. The brown hare (*Lepus capensis*) may also occur (OEH 2012a).

The Eurasian blackbird (*Turdus merula*) has been recorded in the reserve (Eddison 2008) however it was not detected in recent surveys (OEH 2012a). 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 2012a).

The reserve vertebrate fauna survey (OEH 2012a) 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 in 1998 under the TSC Act. The NSW Fox Threat Abatement Plan (Fox TAP) was initiated in 2001 (and revised in 2010) with the primary objective of establishing long-term control programs to protect priority threatened fauna species and populations. Foxes are being controlled at priority sites across NSW, including Jenolan KCR to protect biodiversity.

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 2012a). Fox control and monitoring is undertaken in accordance with the site plan under the Fox TAP.

Wild Dogs

Wild dogs, including dingoes, are a declared pest under the *Rural Lands Protection Act 1998* (RLP Act) due to their impacts on livestock. NPWS therefore has a statutory obligation to control wild dogs on its estate. Wild dogs may also have significant impacts on the distribution and abundance of native wildlife. Wild dogs are also listed as a KTP under the TSC Act (refer to Table 7).

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 dingoes and feral dogs as the reserve borders a Schedule 2 Dingo Conservation Area (NPWS et al. 2000 cited in OEH 2012a) which includes a significant dingo population within the southern Blue Mountains. In view of the likelihood that dingoes and wild dogs co-occur, dingo conservation also requires consideration in the design and implementation of control programs (OEH 2012a). Wild dogs pose a particular threat to the threatened brush-tailed rock-wallaby population.

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 from burrows. Rabbits are listed as a KTP under the TSC Act and the EPBC Act and are a declared pest species throughout NSW under the RLP Act. The selective grazing pressure of rabbits particularly impacts on native plants recovering from fire, and may also favour a number of weeds. Rabbits threaten brush-tailed rock-wallabies through direct dietary competition (OEH 2012b).

Feral rabbit control is a high priority in the reserve especially in periods of drought and after fire where grazing competition with brush-tailed rock-wallabies may increase (OEH 2012b).

Cats

Recent surveys indicate that cats are abundant in the reserve. Cats are listed as a KTP under the TSC Act and EPBC Act. 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 at risk from cat predation include brush-tailed phascogales, eastern horseshoe bats, eastern bentwing-bats, squirrel gliders (*Petaurus norfolcensis*), brush-tailed rock-wallaby young and the flame robin (*Petroica phoenicea*) and scarlet robin (*Petroica boodang*) (OEH 2012b). Opportunistic trapping of cats occurs.

Deer

Red and fallow deer occur in the reserve. Deer are listed as a KTP under the TSC Act (refer Table 7). Feral deer impact on water quality through erosion and faecal contamination. Erosion causes cave sedimentation which alters hydrology and impacts on 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.

Pigs

The impact of feral pigs on conservation values is substantial as they forage, wallow and root 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 TSC Act and the EPBC Act (refer to Table 7). A Threat Abatement Plan (TAP) has been prepared under the EPBC Act which sets out a national framework to guide coordinated actions to address this threatening process.

During recent surveys (OEH 1012a) pigs and evidence of pigs were frequently observed. Pigs disturb soil resulting in pollution, erosion and sedimentation with impacts observed at Surveyors Creek weir and Blue Lake. Impacts extend to dependent aquatic species such as platypus and frogs. Sedimentation and hydrological changes can cause impacts on the karst and on cave-dwelling fauna and water quality (OEH 2012a).

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.

Feral 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. Congregation of goats in favoured locations can result in erosion and impacts on amenity. Goats are listed as a KTP and under the TSC Act and the EPBC Act.

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 2012a).

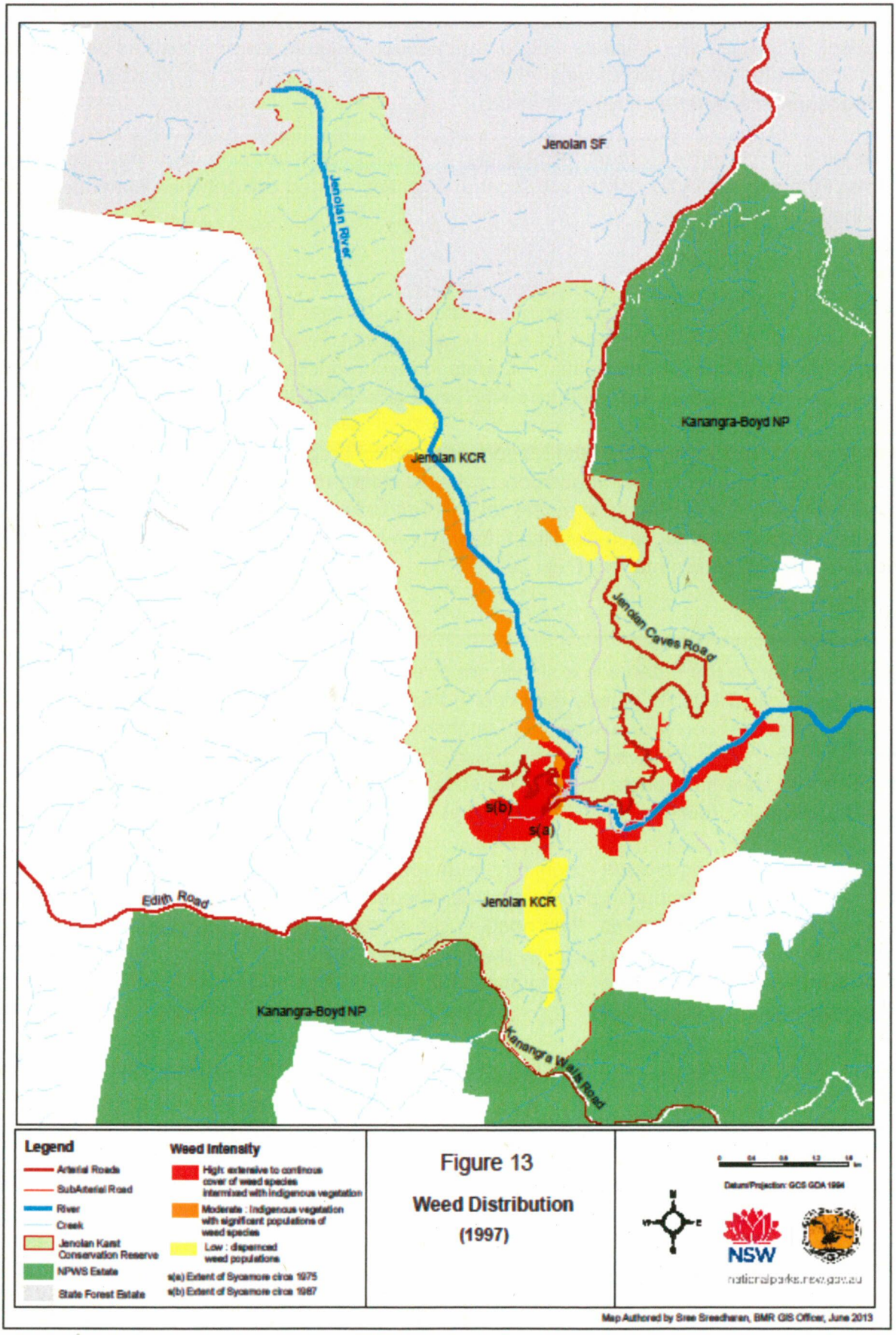
4.1.2 Weeds

Weed infestation in the reserve is a significant threat to biodiversity, karst and World Heritage values. Appendix C 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 periwinkle (*Vinca major*). 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 2012a) (see Figure 13).

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 on 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 2012a).

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 2012a).

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, Murray & Hose 2007).


Jenolan SF
Jenolan River
Kanangra-Boyd NP
Jenolan KCR
Jenolan Caves Road
s(b)
s(a)
Edith Road
Jenolan KCR
Kanangra-Boyd NP
Kanangra Walls Road
Legend
Arterial Roads
SubArterial Road
River
Creek
Jenolan Karst Conservation Reserve
NPWS Estate
State Forest Estate
Weed Intensity
High: extensive to continous cover of weed species intermixed with indigenous vegetation
Moderate : Indigenous vegetation with significant populations of weed species
Low : dispersed weed populations
s(a) Extent of Sycamore circa 1975
s(b) Extent of Sycamore circa 1997
Figure 13
Weed Distribution
(1997)
Datum/Projection: GCS GDA 1994
NSW
nationalparks.nsw.gov.au
Map Authored by Sree Sreedharan, BMR GIS Officer, June 2013

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 50 hectares of the reserve (M Jones, 2013, 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 (M Jones 2013, pers. comm.).

Tutsan 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 (M Jones, 2013, pers. comm.).

Weeds are prevalent on most drainage lines in the 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 2012a).

A sycamore and woody weed eradication project is being implemented in partnership with the Hawkesbury Nepean Catchment Management Authority and the Lithgow Oberon Landcare Association. Since 2008, Spring and Autumn 'Sycamore Weedbusting Weekends' involving volunteers have been held over four weekends per year. In 2012/13, 160 volunteers contributed approximately 1,600 hours of labour to treat over 60,000 m^2 of weeds (M Jones, 2013, pers comm.).

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

OEH (2012c) has produced guidelines for weed control in karst environments to provide a consistent and best practice approach. The guidelines recognise that the shallow soils of the karst make them highly susceptible to erosion and underground streams, water channels and conduits can quickly transport pollutants from the surface to the subterranean water bodies critical for karst development (OEH 2012c).

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 on 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 the regional pest management strategy. Priority will be given to foxes, pigs, sycamore maple, tutsan, English ivy and the emerging significant weed species tree of heaven.

4.1.2 Prepare and implement a reserve weed management strategy which includes monitoring, to guide weed management programmes. Incorporate strategies in OEH Guidelines for Controlling Weeds on Karst.

4.1.3 Prepare and implement a Jenolan Karst Conservation Reserve Sycamore Control Strategy to prioritise and guide control of this highly invasive pest plant.

4.1.4 Implement recommended management responses for pest plants and animals in Section 7 of the vertebrate fauna report (OEH 2012a).

4.1.5 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.

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

4.1.7 Undertake pest plant and animal control in cooperation with Local Land Services, Landcare groups, Hawkesbury-Nepean Catchment Management Authority, Forests NSW and volunteers.

4.2 Fire

The primary fire management objectives of NPWS are to protect life, property and community assets from the adverse impacts of fire, while managing fire regimes to maintain and protect biodiversity and cultural heritage.

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, threatening World Heritage values, and high frequency fires have been listed as a KTP under the TSC Act.

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 (OEH 2012a) and in 1942 a fire destroyed the Kia Ora Guest House and burned close to Caves House (*Canberra Times* 15 January 1942, p.4). More recently, a 10 hectare fire occurred adjacent to a waste disposal site on Kia Ora Hill in 2004. 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 (see Figure 14) indicated the following fire hazard levels: low 4 percent, medium 26 percent, high 70 percent. Fire risk is heightened in some areas by buildings being located on steep slopes and by fuel accumulation.

A separate Reserve Fire Management Strategy (RFMS) which defines the fire management approach for the reserve has been prepared (DECC 2009b). The RFMS 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.

The RFMS maps the reserve as a Land Management Zone (LMZ). The objectives of the LMZ are to conserve biodiversity, to protect cultural and historic heritage and to manage fire consistent with set fire thresholds of vegetation communities. The RFMS is being reviewed to incorporate Asset Protection Zones (APZ) in appropriate locations. The purpose of an APZ is to protect human life, property and highly valued public assets and values.

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 (Chifley BFMC). Cooperative arrangements include fire planning, fuel management and information sharing. Prescribed burning proposals and fire trail works are submitted annually to the BFMC. The Jenolan Bushfire Brigade, comprising members of the local Jenolan community, supports fire suppression activities when required.

Fire in limestone-dominated areas can cause 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 2012a, 2012b). Sedimentation can also adversely affect water quality, dependent aquatic life and domestic water supplies.

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

Recent fire suppression related works on the reserve include the construction of a new fire shed (Jenolan Caves Trust 2010) and the creation of 20 - 50 metre wide fuel reduced zone along the majority of the reserve's northern boundary with Jenolan State Forest, by removing pine wildings (M Jones 2013, pers. comm.). The reserve's steep topography restricts access for fire-fighting 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 (RFMS) in accordance with NPWS policy. Consideration will be given to strategies in the OEH Guidelines for Managing Fire on Karst.

4.2.2 Continue to be involved in the Chifley BFMC and maintain cooperative arrangements with the Oberon RFS, the Jenolan Bushfire Brigade and other fire authorities, including Forest NSW, and surrounding landowners, including Hume Forests Ltd.

4.2.3 Identify and upgrade strategic fire 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

Anthropogenic climate change has been listed as a KTP under the TSC Act. Projections of future changes in climate for NSW include higher temperatures, increasing sea levels and water temperatures, more intense but possibly reduced annual average rainfall, increased temperature extremes and higher evaporative demand. These changes are likely to lead to greater intensity and frequency of fires, more severe droughts, reduced river runoff and water availability, regional flooding and increased erosion.

Climate change may significantly affect biodiversity by changing population size and distribution of species, modifying species composition, and altering the geographical extent of habitats and ecosystems. The potential impact of climate change is difficult to assess since it depends on the compounding effects of other pressures, particularly barriers to migration and pressure from feral animals. Species most at risk are those unable to migrate or adapt, particularly those with small population sizes or with slow growth rates.

The threatened flame robin and gang-gang cockatoo (*Callocephalon fimbriatum*), which are altitudinal migrants, may be particularly at risk from climate change, based on overseas research. Changing rainfall patterns and distribution will be important determinants of species distribution. The drying pattern in south-eastern 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 2012a).

A study by researchers from the Australian Nuclear Science and Technology Organisation's Institute for Environmental Research is monitoring trace gas and CO^2 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).

Programs to reduce the pressures arising from other threats, such as habitat fragmentation, invasive species, bushfires and pollution, will help reduce the severity of the effects of climate change.

Desired Outcomes

- The effects of climate change on natural systems are reduced.

Management Response

4.3.1 Continue existing fire, pest and weed management programs to increase the reserve's ability to cope with future disturbances, including climate change.

4.3.2 Encourage research into appropriate indicators to monitor the effects of climate change.

5. Management Operations and Other Uses

5.1 Management Facilities and Operations

Management operations within the VUSZ are primarily provided by the Trust at this stage but will be provided by NPWS and/or lessees and licensees in future. Management operations in the CMZ 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). The Grand Arch Precinct provides:

- visitor accommodation (including the Caves House Complex and Gatehouse) and associated facilities, such as the laundry
- visitor facilities including a café, public amenities, picnic facilities, ticket office, signage, roads and car parks
- walking tracks
- plantings and gardens
- seismograph station
- workshops and other operational buildings
- infrastructure within the caves such as walkways and stairs/steps.

OEH conducts an environmental audit program of all major activities and development in the VUSZ (refer to Section 3.1 Geology, Landscape and Hydrology).

Visitor and staff accommodation is provided in the Jenolan Cottages Precinct and staff accommodation is located 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 hydroelectric 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 Grand Arch Precinct, Burma Road Housing Precinct, Jenolan Cottages Precinct and the Five Mile Road Housing Precinct. Operational buildings are located in a number of precincts including for archival, administrative and research purposes. Operational buildings include the 'Wallaby Shed', currently in poor condition, which supports the brush-tailed rock wallaby recovery program and is located in the CMZ adjacent to the Burma Road Housing Precinct VUSZ. A Caver's Cottage is located at the Burma Road Housing Precinct.

The heritage significance of the reserve's buildings, facilities, infrastructure and landscapes is documented comprehensively in the draft CMP (Urbis 2010) (also refer to Section 3.4 Historic Heritage). The reserve includes items of State heritage significance, including Caves House. Conservation Management Plans and the HAMS (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 CMZ. The condition of buildings, facilities and infrastructure varies with a proportion requiring repair and/or refurbishment.

The draft CMP (p.112) 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 (p.120) recommends that existing conservation and maintenance works schedules are updated to include works identified in the Conservation Policies (CMP Volume 1) and in the Inventory Forms (CMP Volume 2). Implementation of the CMP's conservation 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.

A Risk Management Plan (Jenolan Caves Reserve Trust 2004) has been prepared which provides a framework for identifying, managing and reviewing risk in all areas of Trust operations. All risk assessments and emergency operating procedures are updated annually (D. Cove 2013, pers. comm.). The draft CMP (p.120) 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 (refer to Section 3.1 Geology, Landscape and Hydrology). OEH has produced guidelines (OEH 2013) 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 car parks 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 car park furthest from the visitor centre. Designated disabled parking spaces are located adjacent to the Guides Office (2) and behind Caves House (1).

Impacts of vehicles in the Grand Arch Precinct, which is located at the base of the valley, are environmental, such as noise, air and water pollution, and safety risks to pedestrians and cyclists. The car parks also impact on the visual amenity of the precinct. The draft CMP (Urbis 2010) proposes development of a masterplan for the precinct to address, among other issues, vehicle circulation and future car parking. It also makes a number of policy recommendations for management of other areas of the reserve used for car parking in relation to their potential impacts on heritage values.

Sewage Treatment Plant

The Jenolan Sewage Treatment Plant (Jenolan STP) is located approximately one kilometre downstream of the caves. The STP discharges tertiary treated effluent to the Jenolan River, which forms part of the Warragamba Catchment. The Trust operates the Jenolan STP under an Environment Protection Licence issued in accordance with the *Protection of the Environment Operations Act 1997*. The Jenolan STP is licensed to discharge up to 200 kilolitres per day. The average discharge rate of treated effluent from the STP for 2011/12 was 20.4 kilolitres per day (D. Cove 2013, pers. comm.).

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

On-site septic systems service the Two Mile & Five Mile Road Housing Precincts and the Jenolan Cottages Precincts. 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 fire-fighting purposes. The reservoirs are constructed from steel, with the exception of the No. 2 Car Park 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 Burgh's 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 (refer Section 5.2 Non-NPWS Uses/Operations) and is supplemented by the reserve's hydroelectric system. A generator is used to supply power to the Grand Arch Precinct in the event of network supply failure and when there is insufficient water to operate the hydroelectric system.

The hydroelectric 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 hydroelectricity turbines to form Blue Lake. Water is piped approximately one kilometre from Blue Lake to the turbines (P. Williams 2003, pers. comm.). The hydraulic ram and the turbine within the Coach House have been restored and the Leffel turbine is still in existence (Urbis 2010). The hydroelectricity system was repaired and recommissioned in 2008 (Jenolan Caves Reserve Trust 2008). 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 (see Figure 15). 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 (P. Williams 2013, pers. comm.).

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 (refer to 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 (D. Cove 2013, pers. comm.). 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, stormwater runoff and gases produced by waste have the potential to pollute the reserve's sensitive environment, waste material may 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 audit program of the VUSZ (refer to 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

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 aims 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.
- Operation of roads and car parks meets visitor and operational needs and minimises impact on heritage values and landscapes.
- Effluent disposal does not cause environmental harm.
- The water supply is safe for human consumption.
- Water and electricity is used efficiently.
- Environmental impact of 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 STP. All other waste is disposed of at licensed landfill sites outside the reserve.
- Illegal hunting and off-road vehicle use is controlled through monitoring and enforcement.

Management Response

5.1.1 Continue implementing the maintenance program for reserve assets. Update the program in line with the requirements of the 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 Implement recommendations of any Conservation Management Plan adopted, in relation to car parking and traffic planning to protect heritage assets.

5.1.4 Comply with the requirements of the Environment Protection Licence for effluent discharge from the Jenolan Sewerage Treatment Plant.

5.1.5 Ensure that areas serviced by septic systems are regularly inspected and maintained to minimise potential for environmental pollution.

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

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

5.1.8 Continue to implement programs to maximise the efficient use of water and electricity.

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

5.1.10 Continue regular patrols to apprehend illegal hunters and to stop the illegal use of off-road vehicles.

5.2 Non-NPWS Uses/Operations

Leasing and Licensing

Due to the nature and diversity of visitor operations within the Jenolan Karst 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 on 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 licenses 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 this time these leases are administered by the Trust. Most of these leases relate to the use of buildings for staff accommodation. Staff are also accommodated within staff flats and in the Vernon Wing of Caves House. Leases are not currently in place for use of these areas. A speleologist society also leases one of the cottages.

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

As set out in section 3.5 Visitor Use – 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 licenses of the VUSZ being granted to private operators.

Easements and rights of way

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

Fishing Activities

The Jenolan River was historically stocked with the introduced angling species brown trout (*Salmo trutta*) and rainbow trout (*Oncorynchus mykiss*) (Eddison 2008). All fishing activities in NSW waters are regulated under *Fisheries Management Act 1994*. Both commercial and

recreational fishing must be in accordance with licence conditions specified by the Department of Primary Industries. Recreational fishing is popular in the reserve and anglers are required to hold a Recreational Fishing Licence.

Transmission Lines

Network operators Essential Energy and Endeavour Energy have powerlines traversing the reserve (see Figure 15). 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 clearings and vehicle trails along the power lines 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 NPW Act and Regulations 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 & Utilities Precincts. Power is supplied to substations in the reserve from which the reserve's power infrastructure distributes it within the reserve (refer to Section 5.1 Management Facilities and Operations). The powerlines are approximately three kilometres in total and are mainly located above ground.

The Endeavour Energy power line is located in the northeast corner of the reserve and is approximately one kilometre in length. The power line 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 is supplemented by the reserve's hydroelectricity system (refer to Section 5.1 Management Facilities and Operations). A generator is used to supply power to the Grand Arch Precinct in the event of network supply failure and when there is insufficient water to operate the hydroelectricity system.

Telecommunications

There is a telecommunications tower site at the flagpole in the Grand Arch Precinct (D. Cove, 2013, pers. comm.). Current occupancy agreements are in place between Telstra and the Trust for this facility. The Sydney Catchment Authority has a transmitter at the seismic station adjacent to the technical services workshop. There is no occupancy agreement currently in place for this facility.

Establishment, maintenance and operation of telecommunications infrastructure has the potential to adversely impact on 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 NPW 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.
- Fishing activities are appropriately licensed.

Management Response

5.2.1 New leases and licenses may be granted in the VUSZ to enable private operators to provide services in the VUSZ.

5.2.2 Work cooperatively with the Department of Primary Industries to ensure that activities licensed under the Fisheries Management Act have minimal impact on reserve values.

5.2.3 Formalise agreements with Essential Energy and Endeavour Energy for the maintenance of their power lines in the reserve.

5.2.4 Monitor the implementation of the maintenance agreement with energy providers to maintain adequate vegetation cover and minimise erosion potential.

5.2.5 Determine the status of the Sydney Catchment Authority telecommunication infrastructure in the reserve and negotiate an occupancy agreement if required.

6. Implementation

This plan of management establishes a scheme of operations for the Jenolan Karst Conservation Reserve. Implementation of this plan will be undertaken within the annual program of NPWS Blue Mountains Region.

Identified activities for implementation are listed in Table 8. Relative priorities are allocated against each activity as follows:

- **High priority** activities are those imperative to achievement of 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.

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

Table 8: List of management responses

Action no.	Management response	Priority
Aboriginal Heritage		
3.3.1	Continue to consult and involve the Pejar Local Aboriginal Land Council, the Gundungurra and Wiradjuri 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 on 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; identifying areas of the reserve requiring further archaeological investigation and determining priorities for investigation within these areas, if required.	High
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 Heritage Asset Management Strategy.	High

Action no.	Management response	Priority
3.4.3	Finalise and implement a Conservation Management Plan.	High
3.4.4	Prepare and implement a Conservation Management Plan for cave heritage items.	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
Pests & Weeds		
4.1.1	Manage pest species in accordance with the regional pest management strategy. Priority will be given to foxes, pigs, sycamore maple, tutsan, English ivy and the emerging significant weed species tree of heaven.	High
4.1.2	Prepare and implement a reserve weed management strategy which includes monitoring, to guide weed management programmes. Incorporate strategies in OEH Guidelines for Controlling Weeds on Karst.	High
4.1.3	Prepare and implement a Jenolan Karst Conservation Reserve Sycamore Control Strategy to prioritise and guide control of this highly invasive pest plant.	High
4.1.4	Implement recommended management responses for pest plants and animals in Section 7 of the vertebrate fauna report (OEH 2012a).	Medium
4.1.5	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
4.1.6	Seek the cooperation of neighbours in implementing weed and pest control programs, as required.	Ongoing
4.1.7	Undertake pest plant and animal control in cooperation with Local Land Services, Landcare groups, Hawkesbury-Nepean Catchment Management Authority, Forests NSW and volunteers.	Ongoing
5.1.10	Continue regular patrols to apprehend illegal hunters and to stop the illegal use of off-road vehicles.	High
Native Plants, Animals & Threatened Species		
3.2.1	Implement relevant strategies in the Priorities Action Statement 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 report for fauna, including cave-dwelling fauna (OEH 2012a).	High
4.3.1	Continue existing fire, pest and weed management programs to increase the reserve's ability to cope with future disturbances, including climate change.	Ongoing
4.3.2	Encourage research into appropriate indicators to monitor the effects of climate change.	Ongoing

Action no.	Management response	Priority
4.2.5	Monitor the ability of threatened flora to recover between fires and review regimes where relevant.	Ongoing
Landscapes, Soils & Water		
3.1.1	Implement the Blue Lake Management Strategy.	Medium
3.1.2	Continue regular OEH environmental auditing of the VUSZ. Provide audit 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 cave-dependent fauna and cave formation processes. Ensure any recommended remedial actions are implemented.	High
Fire & Incident Management		
4.2.1	Update and implement the Reserve Fire Management Strategy (RFMS) in accordance with NPWS policy. Consideration will be given to strategies in the OEH Guidelines for Managing Fire on Karst.	High
4.2.2	Continue to be involved in the Chifley BFMC and maintain cooperative arrangements with the Oberon RFS, the Jenolan Bushfire Brigade and other fire authorities, including Forest NSW, and surrounding landowners, including Hume Forests Ltd.	High
4.2.3	Identify and upgrade strategic fire 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
4.2.6	Rehabilitate areas disturbed by fire suppression operations as soon as practical after the fire.	Ongoing
Education & Interpretation		
3.6.1	Implement the policy recommendations of any Conservation Management Plan adopted, in relation to interpretation and signage, including updating the reserve's interpretation plan.	Medium
3.6.2	Incorporate consideration of the GBMWHA Interpretation and Visitor Orientation Plan and the GBMWHA Strategic Plan in the recommended update of the reserve's interpretation plan (see Management Response 3.6.1).	Medium
3.6.3	Continue to involve the local Aboriginal community 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	Ongoing

Action no.	Management response	Priority
	the GBMWHA Strategic Plan when determining research applications.	
3.6.7	Develop and implement a strategic approach to create public-focused information which communicates visitor experiences alongside core values of park conservation, whilst proactively delivering safety information relating to specific attractions, for all NPWS customers, for inclusion on NPWS website and other digital channels.	Medium
3.6.8	Review the Jenolan Caves website, mobile apps and social media platforms, with a view to consolidating all digital information and facilities within the overarching NPWS digital engagement strategy.	Medium
3.6.9	Undertake research that allows a better and more up-to-date understanding of visitor awareness, behaviour and satisfaction with the Jenolan KCR experience.	Medium
3.6.6	Support research by the Blue Mountains World Heritage Institute in the reserve to address priority research areas for the GBMWHA.	Ongoing
Visitor Events & Activities		
3.5.1	Support the development and implementation of a co-ordinated system for visitor use monitoring across the GBMWHA to assist in the development of visitor management strategies.	Ongoing
3.5.7	Permit cycling on the Bicentennial National Trail, Six Foot Track and Jenolan Caves Road.	Ongoing
3.5.8	Adventure cycling, triathlons and other competitive cycling are not permitted.	Ongoing
3.5.9	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 BNT at any one time.	Ongoing
3.5.14	Horse riding that is part of a competition or large-scale organised activity (including non-commercial activities) will require written consent from NPWS. All commercial activities require a licence.	Ongoing
3.5.15	Monitor commercial and non-commercial group activities with respect to cumulative impacts, safety requirements, quality of information given and compliance with licence or consent conditions. Licences or consents may be cancelled if there is a breach of the conditions.	High
3.5.16	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
3.5.17	Regulate recreational caving activities in accordance with the Cave Access Policy. Caving activities with the potential to be highly impacting, such racing within caves, are not permitted.	Ongoing
5.2.2	Work cooperatively with the Department of Primary Industries to ensure that activities licensed under the *Fisheries Management Act* have minimal impact on reserve values.	Ongoing

Action no.	Management response	Priority
3.5 Visitor Facilities & Accommodation		
3.5.2	Upgrade visitor facilities at the Inspiration Point lookout on Jenolan Caves Road (refer to Table 2 'Day use/Picnic areas'). Do not provide a wood barbeque or fireplace to minimise bushfire risk.	Low
3.5.3	Remove day use visitor facilities at the Playing Fields Trail and at other locations on Jenolan Caves Road (refer to Table 2 'Day use/Picnic areas'), subject to any environmental assessment required and significance assessments under the Heritage Act.	Low
3.5.4	Provide day use facilities within the Grand Arch Precinct in accordance with NPWS policy and the recommendations of any Conservation Management Plan, when adopted.	Ongoing
3.5.5	Continue to provide bushwalking opportunities in accordance with Table 3 'Bushwalking in the reserve'.	Ongoing
3.5.6	Consider the Landscape Issues and Options Report and the accompanying Landscape Concept Plan (Hobley & Buchanan 2007) for the Blue Lake Loop when undertaking upgrading or maintenance.	High
3.5.10	Manage the Bicentennial National Trail in accordance with the Memorandum of Understanding.	Ongoing
3.5.11	Investigate permitting horse riding access to the Jenolan River Trail and the establishment of a new bridle trail extension to the Jenolan River Trail to link it with existing trails, subject to environmental impact assessment and in accordance with NPWS policies and procedures.	Medium
3.5.12	Horse riding will not be permitted in other areas of the reserve.	Ongoing
3.5.13	Camping with horses will not be permitted and facilities such as holding yards will not be provided.	Ongoing
3.5.19	New buildings may be constructed in the Visitor Use and Services Zone for purposes consistent with the management principles of the reserve. These purposes may include, but are not limited to: visitor and tourist accommodation, retail outlets, conferences and functions, facilities to enable activities of a sporting nature to be carried out, information centres and booking outlets, restaurants, café, kiosks and other food and beverage outlets.	Ongoing
3.5.20	Proposals for adaptive reuse of existing buildings or for new buildings in the Visitor Use and Services Zone are subject to environmental impact assessment in accordance with NPWS policy and procedures and Heritage Act.	Ongoing
Infrastructure & Utilities Management		
3.1.4	Assess the structural integrity of Surveyors Creek Dam, determine the preferred management option and any implementation actions required.	High
5.1.3	Implement recommendations of any Conservation Management Plan adopted, in relation to car parking and traffic planning to protect heritage	Medium

Action no.	Management response	Priority
	assets.	
5.1.4	Comply with the requirements of the Environment Protection Licence for effluent discharge from the Jenolan Sewerage Treatment Plant.	High
5.1.5	Ensure that areas serviced by septic systems are regularly inspected and maintained to minimise potential for environmental pollution.	High
5.1.6	Continue monitoring the domestic water supply to the Grand Arch Precinct and providing monitoring results to NSW Health.	High
5.1.7	Ensure domestic water supplies to precincts in the reserve not serviced by the reticulated water supply meet domestic water quality standards.	High
5.1.8	Continue to implement programs to maximise the efficient use of water and electricity.	Ongoing
5.1.9	Investigate old waste disposal sites in the reserve to determine their status in terms of the *Contaminated Land Management Act 1997* and undertake any remediation required.	Medium
5.2.3	Formalise agreements with Essential Energy and Endeavour Energy for the maintenance of their power lines in the reserve.	Medium
5.2.4	Monitor the implementation of the maintenance agreement with energy providers to maintain adequate vegetation cover and minimise erosion potential.	Medium
5.2.5	Determine the status of the Sydney Catchment Authority telecommunication infrastructure in the reserve and negotiate an occupancy agreement if required.	Low
Portfolio and Property Management		
5.1.1	Continue implementing the maintenance program for reserve assets. Update the program in line with the requirements of the 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
Commercial Relationships		
3.5.14	Horse riding that is part of a competition or large-scale organised activity (including non-commercial activities) will require written consent from NPWS. All commercial activities require a licence.	Ongoing
3.5.15	Monitor commercial and non-commercial group activities with respect to cumulative impacts, safety requirements, quality of information given and compliance with licence or consent conditions. Licences or consents may be cancelled if there is a breach of the conditions.	High
3.5.18	Leases for the adaptive reuse of existing buildings in the Visitor Use and Services Zone may be granted for purposes consistent with the	Ongoing

Action no.	Management response	Priority
	management principles of the reserve.	
3.5.21	A licence may be granted to operate tours and other visitor experiences in the caves.	Ongoing
3.5.22	A cave management plan will be prepared in accordance with the OEH Cave Access Policy to guide sustainable management of commercial recreational usage of the cave system.	High
3.5.22	Lessees and licensees to whom Section 151D of the NPW Act applies are to comply with the relevant environmental performance standards in 'Table 5 Environmental performance standards and indicators for leasing and licensing'.	High
3.5.23	OEH will monitor and report on the environmental performance of any lessee or licensee (with respect to leases or leases to which Section 151D of the NPW Act applies) against the environmental indicators in 'Table 5 Environmental performance standards and indicators for leasing and licensing'.	High
3.5.24	OEH will report annually, in accordance with the NPW Act, on the monitoring of lessees and licensees (with respect to leases or licences to which Section 151D of the NPW Act applies).	High
5.2.1	New leases and licenses may be granted in the VUSZ to enable private operators to provide services in the VUSZ.	High

Glossary

Adaptive re-use:
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.

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.

Doline
A closed depression draining underground in karst.

Dolomite
(1) A mineral consisting of the double carbonate of magnesium and calcium, $2CaMg(CO_3)$.
(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 on account 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.

Phosphatic
Containing high concentrations of phosphate minerals.

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

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

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

Show Cave
A cave that has been made accessible to the public for guided visits/tours.

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.

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APPENDIX A: DEVELOPED, SEMI-DEVELOPED AND ADVENTURE CAVES OF THE RESERVE

Developed caves

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

Semi-developed caves

- Arch
- Grecian Bend
- Jersey
- Red and White Temples Extension
- Shambles Extension and Architects Studio
- Wilkinsons Terraces (currently closed)

Adventure caves (access restricted to approved routes)

- Aladdin
- Bushrangers
- Elder (i.e. Plughole Tour)
- Hennings (currently closed)
- Mammoth (being those parts of the cave which enter into the Central and Lower Rivers) (currently closed)
- Wiburds Lake (currently closed)

APPENDIX B: THREATENED ANIMALS OF THE RESERVE AND THEIR LISTING AND RECOVERY PLANNING STATUS

Common Name	Scientific Name	Listing Status TSC/EPBC Act	Recovery Planning Status	Record Source and Notes
Amphibians				
stuttering frog	*Mixophyes balbus*	E - TSC V - EPBC	Priorities Action Statement (PAS)	Atlas. *May no longer occur* (OEH 2012a).
Birds				
barking owl	*Ninox connivens*	V - TSC	Draft recovery plan (2003) PAS	Atlas
diamond firetail	*Stagonopleura guttata*	V - TSC	PAS	Eddison (2008) in OEH (2012a)
flame robin	*Petroica phoenicea*	V - TSC	Threatened species profile	Atlas
gang-gang cockatoo	*Callocephalon fimbriatum*	V - TSC	PAS	Atlas
glossy black-cockatoo	*Calyptorhynchus lathami*	V - TSC	PAS	Eddison (2008) in OEH (2012a). *Rare visitor.*
hooded robin	*Melanodryas cucullata cucullata*	V - TSC	PAS	Eddison (2008) in OEH (2012a)
little eagle	*Hieraaetus morphnoides*	V - TSC	Threatened species profile	Atlas
powerful owl	*Ninox strenua*	V - TSC	Recovery plan (2006) PAS	Atlas
red-backed button-quail	*Turnix maculosus V*	V - TSC	PAS	OEH (2012a). *Rare visitor/vagrant.*
regent honeyeater	*Xanthomyza phrygia*	CE - TSC E - EPBC	PAS	Eddison (2008) in OEH (2012a). *Rare visitor.*
scarlet robin	*Petroica boodang*	V - TSC	Threatened species profile	Eddison (2008) and others in OEH (2012a).
sooty owl	*Tyto tenebricosa*	V- TSC	Recovery plan (2006) PAS	Atlas
speckled warbler	*Chthonicola sagittata*	V - TSC	PAS	Eddison (2008) and others in OEH (2012a)
swift parrot	*Lathamus discolor*	E - TSC E - EPBC	National recovery plan (2011) PAS	Eddison (2008) in OEH (2012a)
varied sittella	*Daphoenositta chrysoptera*	V - TSC	Threatened species profile	Atlas
Mammals				
brush-tailed phascogale	*Phascogale tapoatafa*	V -TSC	PAS	Eddison (2008) in OEH (2012a)
brush-tailed rock-wallaby	*Petrogale penicillata*	E - TSC V - EPBC	PAS Recovery plan (2008) National recovery plan (2010)	Atlas

Common Name	Scientific Name	Listing Status TSC/EPBC Act	Recovery Planning Status	Record Source and Notes
eastern bentwing-bat	*Miniopterus orianae oceanensis*	V - TSC	PAS	Atlas
eastern false pipistrelle	*Falsistrellus tasmaniensis*	V - TSC	PAS	Atlas
eastern pygmy-possum	*Cercartetus nanus*	V - TSC	PAS	Eddison (2008) in OEH (2012a). *Rare resident.*
greater broad-nosed bat	*Scoteanax rueppellii*	V - TSC	PAS	Atlas
grey-headed flying-fox	*Pteropus poliocephalus*	V - TSC V - EPBC	PAS Draft national recovery plan (2009)	Atlas
koala	*Phascolarctos cinereus*	V - TSC V - EPBC	PAS Recovery plan (2008)	Atlas
large-eared pied bat	*Chalinolobus dwyeri*	V - TSC V - EPBC	PAS National recovery plan (2011)	Atlas
New Holland mouse	*Pseudomys novaehollandiae*	V - EPBC		OEH (2012a). *From sooty owl pellets only.*
spotted-tailed quoll	*Dasyurus maculatus*	E - TSC E - EPBC	PAS	Atlas
southern myotis	*Myotis macropus*	V - TSC	PAS	OEH (2012a). *Requires confirmation.*
squirrel glider	*Petaurus norfolcensis*	V- TSC	PAS	OEH (2012a). *Requires confirmation.*
yellow-bellied glider	*Petaurus australis*	V - TSC	PAS Recovery plan (2003)	Atlas

Key:

CE Critically Endangered

E Endangered

V Vulnerable

APPENDIX C: WEEDS OF THE RESERVE

Scientific Name	Common Name
Acer pseudoplatanus	sycamore maple
Acer spp.	maple
Acetosella vulgaris	sorrel
Ailanthus altissima	tree of heaven
Amaranthus viridis	green amaranth
Anagallis arvensis	scarlet pimpernel
Anthoxanthum odoratum	sweet vernal grass
Argemone mexicana	Mexican poppy
Bidens pilosa	cobblers pegs
Briza minor	shivery grass
Bromus catharticus	prairie grass
Bromus diandrus	great brome
Bromus molliformis	soft brome
Cardamine hirsuta	common bittercress
Carduus pycnocephalus	slender thistle
Carduus tenuiflorus	winged slender thistle
Centaurium erythraea	common centaury
Centranthus ruber	valerian
Centranthus ruber subsp. *ruber*	red valerian
Cirsium vulgare	spear thistle
Conium maculatum	hemlock
Conyza bonariensis	flaxleaf fleabane
Conyza sumatrensis	tall fleabane
Cotoneaster spp.	cotoneaster
Crepis capillaris	smooth hawksbeard
Cyperus eragrostis	umbrella sedge
Deutzia crenata	pride of Rochester
Deutzia gracilis	slender deutzia
Echium plantagineum	Patersons curse
Ehrharta erecta	panic veldtgrass
Erigeron karvinskianus	bony-tip fleabane
Euphorbia peplus	petty spurge
Galium aparine	goosegrass
Galium murale	small bedstraw
Hedera helix	English ivy
Hesperis matronalis	sweet rocket
Holcus lanatus	Yorkshire fog
Hypericum androsaemum	tutsan
Hypochaeris glabra	smooth catsear
Hypochaeris radicata	catsear
Ilex aquifolium	English holly
Lactuca serriola	prickly lettuce
Leontodon taraxacoides subsp. *taraxacoides*	lesser hawkbit
Lepidium bonariense	Argentine peppercress
Ligustrum lucidum	large-leaved privet
Lonicera japonica	Japanese honeysuckle
Lunaria annua	honesty
Marrubium vulgare	white horehound

Scientific Name	Common Name
Oxalis sp.	wood sorrel
Paronychia brasiliana	Chilean whitlow wort
Paspalum dilatatum	paspalum
Petrorhagia nanteuilii	proliferous pink
Phytolacca octandra	inkweed
Pinus radiata	radiata pine
Poa annua	winter grass
Prunella vulgaris	self-heal
Robinia pseudoacacia	black locust
Rorippa nasturtium-aquaticum	watercress
Rosa rubiginosa	sweet briar
Rubus fruticosus sp. agg.	blackberry complex N WONS
Rubus ulmifolius	blackberry N WONS
Rumex brownii	swamp dock
Rumex cripus	curled dock
Silene noctiflora	night-flowering catchfly
Solanum nigrum	blackberry nightshade
Sonchus asper subsp. *asper*	prickly sowthistle
Sonchus oleraceus	common sowthistle
Sporobolus africanus	Parramatta grass
Stellaria media	common chickweed
Taraxacum officinale	dandelion
Tradescantia fluminensis	trad
Trifolium arvense	haresfoot clover
Trifolium dubium	yellow suckling clover
Trifolium repens	white clover
Verbascum thapsus	Aarons rod
Verbascum thapsus subsp. *thapsus*	great mullein
Verbascum virgatum	twiggy mullein
Verbena bonariensis	purple top
Vicia sativa	common vetch
Vinca major	greater periwinkle
Vulpia bromoides	silver grass

Sources:
Weeds recorded since 1980 in Atlas of NSW Wildlife (2013); Taylor (1999); Jenolan Caves Reserve Trust (2006); Baker, Murray & Hose (2007).

Key:
N – Listed under the *Noxious Weeds Act* - Class 4: Locally Controlled Weeds – the growth and spread of the plant must be controlled according to measures specified in a management plan.

WONS – Weed of National Significance.