

## HERITAGE ASSESSMENT REPORT

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**NAME:** Naracoorte Caves Complex

**PLACE NO.:** 26459

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**Address:** 8kms south of Naracoorte, south-eastern South Australia

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### STATEMENT OF HERITAGE SIGNIFICANCE

The Naracoorte Caves Complex is an iconic assembly of 37 large and small caves that demonstrate a wide range of significant stages in South Australian geological history. The complex provides a World Heritage palaeontological record, early European regional settlement history, the development of cave tourism from 'wild caves' to government and professional interpretation, attractive cave decoration recording climate change history, close association with a very significant early South Australian naturalist/priest and the output of a specialised speleological culture of exploration, discovery and documentation.

The limestone landscape and caves contain many significant geological elements demonstrating two very important geological phases in the formation of coastal South Australia – the developing of the new Southern Ocean limestone sea floor (37-12 million years ago) in the Palaeogene and Neogene Periods following separation of Australia from Antarctica, and the commencement of the thirteen ancient coastlines across the region resulting from the Quaternary global Ice-age cycles in the last million years. Evidence of past climates and environmental changes are obtained from dating and chemical analysis of the many speleothems (stalactites, stalagmites and flowstone) and deep sediment sequences contained within multiple caves. The special combination of the Naracoorte ridge and caves within it which record this geological history is not repeated in South Australia or indeed on the Australian continent. Such a dense combination of varied but linked natural cave features set in a unique geological sequence does not occur elsewhere in South Australia.

Directly associated with the sediments, the world's largest and most comprehensive assemblage of Australian mammal fossils dating from 0.5 million years ago is excellently preserved within Victoria Fossil Cave and other sites. These are recognised by UNESCO World Heritage and Australian Natural Heritage designations and are on display to the public with high-quality scientific interpretations. Rated among the world's 10 greatest fossil sites, the Naracoorte fossils are a superb illustration of the key stages in the evolution of the unique fauna of Australia - the world's most isolated continent.

The Naracoorte Caves Complex also has a special association with the life and work of significant South Australian scientists and explorers Father Julian Tenison-Woods, William Redden and Professor Rod Wells.

## STATEMENT OF GEOLOGICAL DESIGNATION

Through their specific location and mode of formation, the local geological setting of the Naracoorte Caves demonstrates two very important geological phases in the formation of coastal South Australia – the separation of Australia from Antarctica in the Palaeogene and Neogene Periods (37-12 million years ago) and the commencement of the thirteen Quaternary global Ice-age cycles in the last million years. The landscape and the caves contain many significant geological elements demonstrating evidence of these events. The coastal marine fossil-rich limestone is abundant in South Australia but rare worldwide. The sequence of thirteen Ice-Age coastal limestone ridges across the South East commencing with the Naracoorte Caves ridge is a major and very rare global record of the Quaternary Ice Age sea level fluctuations. Approximately 1 million years ago the Naracoorte Caves Complex began developing along the Kanawinka Fault because the sea was located along its edge.

The limestone landscape of the Naracoorte area and the Naracoorte Caves themselves preserve –

- Extensive horizontal maze cave passage systems developed due to the proximity of the original coastline.
- The remnants of the original coastal dune which was deposited prior to the last reversal of the earth's magnetic field 780,000 years ago.
- The Stoney Point gorge cut through the Naracoorte Caves range by Mosquito Creek when the Kanawinka Fault movement deflected its course.
- A comprehensive sequence of sediments in the caves which preserve at least the past 500,000 years of the Quaternary period's environmental, zoological, botanical, biological and climatic history.
- An outstanding geological record of the significant effects of the first Quaternary Ice Age at the beginning of South Australia's modern coastal development.
- The caves themselves contain an array of evidence which combines to explain the geological story (in Time order) –

Fox Cave	Kanawinka Fault fracturing
Blanche Cave	Large fault-oriented series of halls
Wet Cave	Deep fault line cave connecting with older upper level cave system
Sand Cave	Deepest exposed vertical transect through the depth of range
Victoria Fossil Cave	Longest South Australian groundwater maze passage system
Cathedral Cave	Large 'cupola-formation' passage development
Sand Funnel Cave	Ancient dune sands of the previous magnetic reversal
Alexandra Cave	Exposure of deep sedimentary infill sequence
Bat Cave	Bio-chemical wall weathering and guano minerals from bat colonies
All caves	Stalactites, stalactites, flowstone; these also provide geological dates

## STATEMENT OF PALAEOLOGICAL DESIGNATION

The Naracoorte Caves Complex contains one of two outstanding Pleistocene fossil localities in Australia. Both sites are formally and collectively described as the Australian Fossil Mammal Sites (Naracoorte/Riversleigh), and were inscribed on the World Heritage List in 1994 and the National Heritage List in 2007. Rated among the world's ten greatest fossil sites, the Naracoorte fossils are a superb illustration of the key stages in the evolution of the unique fauna of Australia – the world's most isolated continent.

The entrances of many Naracoorte Caves are a wide diversity of types, shapes and sizes which have closed and reopened many times over at least half a million years (the late Quaternary period). These have trapped comprehensive sequences of Australian mammals, birds, reptiles, amphibians and vegetation which had evolved on an isolated continent. Their fossils are excellently preserved in deep multi-layered sediment cone infills which indicate past environmental and climatic variability. The most significant of these are represented in time order –

- Oligocene-Miocene marine species (37-12 Ma) throughout the limestone cave walls and roofs
- Oldest confirmed fossil deposits to date (528 ka) in the Inner Chamber of Cathedral Cave
- Megafauna fossils and Type Locality (500-213 ka) in Victoria Fossil Cave Tourist Chamber
- Vast Megafaunal reference deposit (untouched\*\*) in Victoria Fossil Cave Inner Ossuary Chamber
- Pre-LGM (last Ice Age) fossil sequence (90-70 ka) in Grant Hall, Victoria Fossil Cave
- Faunal/vegetation sequence - last Ice Age (50-14 ka) in Blanche Cave – Third Entrance Chamber
- Ice Age-Holocene faunal/vegetation sequence (50-1 ka) in Wet Cave – flood-sealed upper room
- Megafauna extinction boundary (45-42 ka) in Blanche Cave Third Entrance Chamber
- Megafauna extinction boundary (45-42 ka) in Wet Cave – flood-sealed upper room
- Ice Age-Holocene faunal/vegetation sequence (24-1 ka) in Robertsons Cave
- Undisturbed deposit in Wet Cave sealed lower room (untouched\*\*)
- Reported fossil deposit in Saddle Cave sand beyond rockpile (untouched\*\*)

\*Ma = million years

\*ka = thousand years

\*\*Several sites within caves are almost untouched, in particular some fossil beds. Science recognises the intrinsic value of preserving certain important elements of the caves in their original (pre-human) condition. This provides a significant undisturbed record of the State's palaeo-environment. Science also recognises that such preservation may enable future non-invasive examination and enhanced interpretation using techniques not yet devised or invented for understanding our State's past environment.

## STATEMENT OF SPELEOLOGICAL DESIGNATION

The Naracoorte Caves Complex represents the values of Speleology as both a science and an adventurous culture. Caves can provide significant scientific evidence of a previous ages, including for anthropology, palaeontology, geology and environmental change. Speleology is the culture of exploration and scientific discovery within caves. In this spirit, South Australia's community of speleologists (the Cave Exploration Group of South Australia (CEGSA), affiliated with the South Australian Museum) has explored, mapped and documented all the Naracoorte Caves over 60 years, with its greatest contribution being the discovery of the World Heritage Fossils in 1969.

The significant speleological features contained within the Naracoorte Caves are -

- large chambers with extensive daylight zones and 'roof windows'
- marine fossils within the limestone walls
- extensive low-level phreatic (groundwater-dissolved) tunnel and maze systems
- significant sediment accumulations spanning hundreds of thousands of years
- special geological features eg 'avens', 'phytokarst', 'scalloping', sand cones etc
- enclosed rock collapse passages with zones of decoration and columns
- an abundant variety of excellent examples of stalactites, stalagmites and flowstone
- some outstanding assemblages of pristine straws, helictites and dogtooth spar crystal
- sand/silt floors containing abundant excellently-preserved vertebrate fossils
- fossil deposits covering ~0.5 million years of South Australian marsupial megafauna and diverse associated species. The World Heritage listing identifies this as the most significant assemblage of its kind.
- several chambers are critical bat maternity or winter hibernating chambers

The Naracoorte Caves Complex also has strong associations with the development of the discipline of speleology in South Australia. This is demonstrated by a number of significant records developed CEGSA during the past few decades. In addition, many of the chambers and passages in the caves at Naracoorte have names that reflect speleological culture and their time of discovery, including 'Strawhaven', 'Great Hall', 'The Endless Crawls', 'Upside-Down Chamber', 'The Contrary Leg' and 'Starburst Chamber'.

# 1. BRIEF HISTORY OF NARACOORTE CAVES COMPLEX

## Geological History

The Naracoorte Caves Complex is located along the East Naracoorte Range ~8kms south of the town of Naracoorte in the South East of South Australia. The region is known as the 'Limestone Coast' after the extensive sheet of Gambier Limestone which covers the area and was laid down as a sea floor in the Palaeogene and Neogene Periods (37-12 million years ago). Through their specific location and mode of formation, the Naracoorte Caves demonstrate two very important geological phases in the formation of coastal South Australia.

Approximately 45 million years ago, Australia had finally separated from Antarctica. The Southern Ocean filled the rift and deposited vast deep sheets of marine-fossil limestone across the South East of South Australia, the Murray Plains and the Nullarbor Plain. The Naracoorte region is widely covered by this limestone which contains the caves. Approximately 1 million years ago in the mid-Quaternary period these plains began to be slowly uplifted, a process that continues today. At that time, the sea was located along a coastal limestone ridge at Naracoorte associated with the large Kanawinka Fault.

Due to the proximity of the sea, the Naracoorte Caves Complex began to develop along this fault. At the same time, the first of 13 Quaternary global Ice-age cycles commenced. These caused the sea to withdraw and return approximately every 80,000 years or so. However due to the land's uplift, the sea left 13 progressively younger coastal limestone ridges in a sequence across the limestone plain of the South East to the west of the Naracoorte Caves ridge. These are a major and very rare global record of the Quaternary Ice Age sea level fluctuations.

The geological name for the regional limestone sheet is the Gambier Karst Province. 'Karst' is the scientific name for the particular geological features developed by water on soluble rocks such as limestone. Three major fault lines run across the limestone region and the largest of these, the Kanawinka Fault, runs underneath the length of the East Naracoorte Range. ~1MY ago its movements fractured the limestone in the Naracoorte area and a series of caves developed as local groundwater subsequently dissolved and widened the fractures. The caves contain large chambers interconnected by base-level flat 'phreatic' passageways (dissolved laterally by groundwater).

The oldest date so far obtained from flowstone within the caves is 528,000 years but older dates may be expected from future research. Multiple entrances have opened up episodically over this time period acting as natural pitfall traps, resulting in an extensive fossil assemblage of Australian marsupials, mammals, birds, reptiles and amphibians, excellently preserved in the extensive dry sands and soil contained within many cave chambers. While all fossil remains are considered important, bones of the Australian 'Megafauna' (creatures of body mass >40kgs) are of great scientific and public interest. Of major significance within the fossil timeline is repeated evidence in the fossil beds of the 'Megafauna extinction event' ~45,000 years ago when most of these creatures died out, broadly coincident with the arrival of humans on the Australian continent.

## **European Discovery and early Visitation**

European settlers began arriving in the Naracoorte region from westward expansion of squatter runs across Victoria in the early 1840's. At approximately the same time, Scottish settlers began arriving from Adelaide to take up land in the region which was then known as Mosquito Plains. The first discovery by Europeans of caves at Naracoorte is generally accepted as that of Big Cave (later renamed Blanche Cave) in 1845 by stockmen associated with the Struan run at Mosquito Creek. Local folklore has it that a group of Aboriginal men had driven some sheep into the cave and the stockmen were searching for them. Several other caves were subsequently found close by. In the inner reaches of Blanche Cave the desiccated or calcified body of an Aboriginal man showing evidence of a wound was discovered. This later became the object of a widely-publicised court case in Adelaide. Many local caves contain smoked or carved names from the 19<sup>th</sup> century indicating that the community were aware of the caves and explored some reasonably remote passage systems in several caves with quite primitive lighting such as candles, kerosene lamps and miners' carbide lamps.

The largest and most obvious caves are clustered around the Blanche Cave where the limestone was heavily geologically fractured. This area became popular for public visits and local hotels and private operators in Naracoorte advertised daily trips by horse-drawn trap to visit them. The large open daylight chambers of Blanche Cave in particular became popular as a picnic place and ballroom! One event was reported to have had 1,000 candles installed around the walls of the big room for a dance evening which was attended by the Governor of South Australia.

## **Early Scientific Documentation – Father Julian Tenison-Woods**

Father Julian Tenison-Woods made a notable contribution to the scientific and cultural development of South Australia, particularly after his arrival as a Catholic diocesan priest in Penola in 1857. His parish covered much of the South East region where he was responsible for establishing churches and schools. From 1867 he was entitled '*The Very Reverend*' in his roles in Adelaide as Director of Catholic Education in Adelaide, secretary to Bishop Sheil and as the Administrator of the newly-erected cathedral. Tenison-Woods was a friend and contemporary of the poet Adam Lindsay Gordon, corresponded with the South Australian Surveyor-General George Goyder and is famed for being the mentor of Sister Mary McKillop (Australia's first saint).

As a young man, Tenison-Woods had developed a strong interest in science and the pursuit of knowledge in the emerging and exciting age of scientific enlightenment. He had been born and raised in London society where his father had been a sub-editor of 'The Times'. Later in life he became a Fellow of the Geological Society of London and eventual President of the Linnaean Society of New South Wales.

Using his scientific training as a Naturalist and in the new fields of geology and mineralogy, he travelled widely across the South East examining and interpreting the landscape in possibly SA's first regional geological study, including a special focus on the Naracoorte Caves. His

*Geological Observations in South Australia, and History of the Discovery and Exploration of Australia* were published in London by the Royal Society in 1862 and 1865.

Tenison-Woods' observations of the caves together with several woodcuts (from photographs thought to be the first taken in Australian caves) are a high-quality primary source of information on the Naracoorte Caves and are utilised in modern rehabilitation projects there. His description of the then-existent aboriginal body has contributed to our understanding of that event. Importantly, and despite the doctrines of the Catholic Church, Tenison-Woods began elementary excavations of bone accumulations in the caves from which he began contemplating that occasional fossils may have been from creatures that no longer existed and that their evolution (a radical concept at the time) had been interrupted/terminated with no apparent extant living relatives, at variance with his biblical instruction. Equally, his interpretations of the origins of the limestone sheet with its ancient marine fossils and associations with Mount Gambier volcanoes and large sinkholes were prescient scientific concepts.

### **Bat Colonies and the Guano-mining Industry**

The wide circular open entrances of Blanche Cave, Bat Cave, Wet Cave, Cathedral Cave and Robertson's Cave allowed major bat populations to access the large, quiet safe chambers within them. Recent research has shown that the distribution of the local species known as the Southern Bent Wing Bat, *Miniopterus schreibersii bassanii*, reaches as far as Warrnambool and Skipton in Victoria to Bordertown, Kingston, Robe and Mount Gambier in South Australia but that they all assembled in the large caves at Naracoorte for breeding every summer. Hundreds of thousands of years of this aggregation produced underground hills of bat guano which is very rich in nitrates and was the prime fertiliser available to early settlers. Thus a guano-mining industry began in the 1860's where teams of workers quarried the guano in all caves, bringing large-scale noise, heat, disruption and damage into the quiet breeding environments and in several cases broke open the roofs of vital breeding chambers to crane out the guano sacks. This had a devastating effect upon the regional bat population which is now listed as 'Critically Endangered' and only breeds in one cave at Naracoorte - Bat Cave - which is off limits to all but very specialised researchers.

Guano mining was originally unregulated but from 1876 became part of the operations of the Forest Board, later to become the South Australian Government Woods and Forests Department (W&FD). The Board established a pine plantation in the sandy soils covering the East Naracoorte Range and kept commercial records of the guano-mining operations.

### **William Reddan's role and his cave discoveries**

As the guano stocks began to dwindle, the W&FD charged its local overseer Mr William Reddan with finding other caves that might be a guano source. This proved a challenge as the more obvious caves with larger entrances had already been discovered. However, Reddan was able to locate several new caves with smaller entrances by digging. The most important of these were Victoria Cave (1894) and Alexandra Cave (1908), both featuring attractive areas of pristine cave decoration. Reddan persuaded W&FD that these attractive caves could be

developed for public viewing at a time when the guano reserves were no longer commercially viable and that pine forestry was not successful in the immediate area of the large-entrance caves which were in a localised zone of exposed limestone sheets with little or no suitable sand and soil remaining for successful plantation growth.

The W&FD subsequently relinquished this zone to the SA Tourist Bureau as a 'Public Pleasure Resort' and William Reddan became employed as Curator of the caves. Over a 30-year period, he developed several underground tours, 'beautified' the three large entrances of Blanche Cave with European fern gardens, hosted a Governor's visit to open Alexandra Cave in 1909 and conducted cave tours with other supporting staff. With one of these in particular, James Mason, Reddan systematically explored many local caves and discovered inner passages by excavation. Recently it has been recognised that the appearance in many local caves of the smoked initials 'JM 1908' records the thorough explorations by James Mason during a period of major cave passage discovery. The Tourist Bureau continued management of the Naracoorte Caves Complex until it was transferred to National Parks and Wildlife in 1972.

### **Post-War Organised Speleology**

The formalised sport of cave exploring began in France and Britain in the 1890's and developed significantly there between WW1 and WW2. After WW2 and with the increasing wealth and leisure time available in western societies, cave exploration boomed and quickly developed into Speleology (the science of caves) and Karst studies (the scientific term for limestone). In Australia, the third speleological society to form was the Cave Exploration Group of South Australia (CEGSA) in 1955, affiliated with the South Australian Museum. Using cave surveying standards newly-developed in Britain, CEGSA members began systematic mapping of the caves across the Naracoorte region, with ~250 karst features recorded to date. Many are minor landscape features and blocked tubes but ~20 are large, deep major cave systems and another 20 or so are shallower smaller caves. DEWNR's Naracoorte Caves National Park contains 12 of the major caves and four shallower ones in various land parcels along the East Naracoorte Range, an excellent regional sample of both types. Most were thoroughly or adequately mapped by 1975, with maps provided by CEGSA to NPWS in recognition of cave ownership and inter-organisational cooperation regarding access, exploration and scientific contributions.

In 1969, the longest major cave system at Naracoorte was Sand Cave with 2.5kms of multiple passages (a privately-owned cave later acquired by DEWNR). However, in that year CEGSA speleologists including Professor Rod Wells of the Flinders University Department of Biological Sciences discovered a vast extension in the Victoria (tourist) Cave leading to over 4kms of passage systems with two superlative world-class chambers containing an extensive fossil assemblage of Australian marsupials, mammals, birds, reptiles and amphibians, excellently preserved in the extensive dry sands and soil.



## **Development of the World Heritage Fossil discoveries and Innovative Interpretation**

Professor Well recognised that this discovery in the Victoria cave was of international significance, and was instrumental in the SA Tourist Bureau development of one of the two fossil chambers for public display as part of the cave tour, preserving the other one as an undisturbed reference site. In further recognition of their importance, the Naracoorte Caves were transferred from the Tourist Bureau to the management of DEWNR (National Parks and Wildlife Service at that time) in 1972. In 1994, the re-named Victoria Fossil Cave was successfully nominated as a World Heritage site in conjunction with Riversleigh Mammal Fossil Site in Queensland.

World Heritage status facilitated the provision of Australian Government funding to develop the innovative Wonambi Interpretation Centre (named after a large extinct snake discovered amongst the fossils). This centre recreates a walk-through diorama cave site set in the Naracoorte environment of around 250,000 years ago when the megafauna dominated the landscape and the caves were trapping unfortunate animals.

A second interpretive innovation is an interactive display room above the large remaining maternity/breeding chamber in Bat Cave. The South Australian Tourist Bureau had re-sealed the chamber roof breached by the guano miners a century earlier and the cave is the only breeding chamber left for this bat species. The Bat Interpretation Centre features five infra-red cameras installed underground in and near the large bat maternity chamber beneath the centre. These can be operated silently and remotely by Cave Guides above, displaying the bat clusters to visitors on a series of large screens.

High-level magnification in the cameras allows ground invertebrates in the guano piles and individual bat behaviour to be studied in great detail without human intervention, contributing significantly to efforts for re-establishing this Critically Endangered species and enhancing vital public awareness of the need for their conservation.

## **Research and Scientific Partnerships – Past and Future**

As a World Heritage Area, the Naracoorte Caves Complex provides a broad diversity of research opportunities undertaken by a wide range of scientists and research organisations. In cooperation with DEWNR management over almost 50 years, the contribution of the scientific research community has been outstanding and continues in several specialist fields and themes –

### ***Geology***

Geology and geomorphology of the Naracoorte Caves Complex and regional karst systems, karst processes, tectonic history, past coastal landscape development, cave formation, cave entrance variability and development, palaeo-groundwater interpretation, geochronology, sedimentation processes, sedimentary profiling, past climate reconstruction.

### ***Palaeontology***

Taxonomy, taphonomy, functional morphology, species occurrence, megafaunal biology, extinction events, palaeoecology, palaeoclimates, environmental change over the last 500,000 years, evolution and diversity of past animal and plant life in southern Australia. Paleontological research over the last 50 years has led to the discovery of 23 fossil deposits in 13 of the Park's caves and over 60 scientific papers, 17 student theses, numerous book chapters and other publications.

### ***Bat Research and Biology***

Population dynamics and biology of the critically endangered Southern Bent-winged Bat, guano-living invertebrates, cave cricket populations and behaviour; animal populations and communities - species population monitoring, understanding decline, distribution, habitat preferences, biology, genetics, health and potential effects of future climate change.

### ***Speleology***

Ongoing underground exploration and discovery, cave mapping and documentation, detailed 3D mapping, environmental track marking, evaluation of access zoning, search and rescue training. This work has been generally undertaken by the Cave Exploration Group of South Australia (CEGSA), Flinders University Speleological Society Inc (FUSSI) and teams from Adelaide, Flinders and Latrobe Universities.

### ***Photography***

An excellent, detailed and comprehensive private photographic record of the Naracoorte Caves has been assembled by Steve Bourne, a previous Manager of the Park. A selection of these has generously been made available for this report. Together with historical photos, these form a valuable visual basis for Naracoorte Caves publicity and future reference.

### ***Management, Education and Interpretation***

Research has contributed to Naracoorte Caves Management Plans over five decades including best practice cave and fossil conservation methods and understanding of the natural and cultural values of the site. Educational initiatives have provided a teaching laboratory based at the Naracoorte Caves, a dedicated vertebrate palaeontology undergraduate field course and related courses in evolution, animal behaviour, conservation biology and ecotourism, extending to interpretation material for cave visitors and schools.

Research at Naracoorte provides a critical ongoing contribution to Australia's obligations to UNESCO as a host nation in providing education and protection of a World Heritage site. The Naracoorte Caves Complex has become a best-practice centre for multi-disciplinary research, open to researchers from a wide range of fields, backgrounds and institutions. A bibliography representing this broad research is included in this Assessment Report.

## **Chronology**

### **Geology**

- 160 Ma Australia began separating from Antarctica
- 60 Ma Final separation of the two continents; Australia began moving northwards  
Southern Ocean became an unrestricted circumpolar ocean
- 37-15 Ma Limestone sea floor developed during the Palaeogene – Neogene periods
- 15-10Ma South-eastern Australia underwent a large regional tectonic activation (the Neogene Tectonics) and the limestone seafloor adjacent to the southern continent began to be lifted from the sea
- 5 Ma Volcanoes began appearing across Western Victoria, culminating in Mount Gambier's Blue Lake crater
- 1 Ma The Kanawinka Fault at Naracoorte fractured the limestone allowing groundwater to begin the development of the Naracoorte Caves to begin
- 870 ka The Southern Ocean shoreline was located along the foot of the Kanawinka Fault line, leaving a sand dune along the ridgetop above the developing caves  
A series of ancient dune ridges have been deposited parallel to the coast from Naracoorte to Robe after each of 13 Ice Age cycle sea level fluctuations.  
The dunes are preserved because the limestone landscape continues to rise steadily.
- 528 ka Oldest dated fossil records so far confirmed at Naracoorte
- 60 ka Approximate time of arrival of indigenous peoples on the Australian continent
- 45-42 ka Megafaunal extinction event
- 6-5 ka Mount Schank and Mount Gambier erupt, becoming the most recent volcanoes on the Australian continent

### **European Settlement**

- 1845 First settlers began arriving in the District.  
Pastoral Lease for "Mosquito Plains" granted to Mr. John Robertson. The lease included the Caves Range area.
- ~1845 Blanche Cave first discovered by Mr. Benjamin Sanders, while searching for stolen sheep.  
Discovery of a calcified body of an Aboriginal adult male in Blanche Cave.
- 1857 Body examined in situ by Government Interpreter.
- 1857-58 Blanche Cave visited by Rev. J. Tenison-Woods, who later published a very detailed account of his experience in his book "Geological Observations of South Australia".
- 1861 Theft of Aboriginal body from Blanche Cave. Court case in Adelaide over theft.  
Body replaced in Blanche Cave by court order, but stolen again.
- 1862 Report that the body had been taken overseas to London.  
Publication of Tenison-Wood's book.  
First of many "New Year Parties" held in Blanche Cave.

- 1866 Report from England that "Petrified Native's" body had been auctioned.
- 1869 Last report of body
- 1871 Government permitted mining of Guano from caves for use as fertilizer.
- 1879 Lengthy complaints about vandalism in Blanche Cave. Caves Reserve was as yet unsupervised.
- 1886 William Reddan appointed as Forester-in-Charge, guide for the Caves and to beautify the area.
- 1894 S.A. Government voted funds to search Reserve area and surrounding district for more caves and more guano.
- 1894 Mr. William Reddan discovered Victoria Cave.
- 1897 S.A. Government Caves Regulation Act, Forest Act 252/82 for the "preservation of the stalactites and stalagmites".
- 1897 Victoria Cave opened to public inspection by Woods and Forests Department.
- 1908 Alexandra Cave discovered by William Reddan.
- 1909 Alexandra Cave opened to tourists. Visiting days extended to 5 days per week.
- 1915 Electric Lighting installed by Woods and Forests Department  
Visiting hours extended- All caves on Saturdays, Alexandra on Sundays.  
Tickets 1/- on weekdays and 1/6d on Sundays
- 1917 Caves Reserve handed over to S.A. Tourist Bureau. William Reddan resigned from Woods and Forests Department to become curator of the caves for the Tourist Bureau.
- 1920's Sawmill run by Forests Department when trees reached maturity.
- 1943 Bat Cave guano deposits re-assessed for possible war use.
- Mid-50's Victoria Cave entrance extended to more accessible sinkhole nearby. .
- 1969 New Ticket Office and Kiosk replaced tin shed above Alexandra Cave after 60 years.  
Fossil Chambers Chamber discovered in Victoria Cave by Dr Grant Gartrell, Dr Rod Wells and other CEGSA members.
- 1972 Fossil Chamber included as Victoria Cave tour highlight.  
Naracoorte Caves Reserve transferred to National Parks and Wildlife Service.
- 1975 Victoria Cave name changed to Victoria Fossil Cave.
- 1977 Booklet "Discover Naracoorte Caves" published and released by CEGSA.
- 1984 Blanche and Victoria Fossil Caves registered on State Heritage list
- 1994 World Heritage designation for Naracoorte Fossil deposits
- 1994 Infra-red Camera Bat Observation Centre opened to the public
- 1995 Wonambi Fossil and Megafauna Interpretation Centre opened
- 2001 *Miniopterus schreibersii bassanii* bats declared a 'Conservation Dependent' species
- 2004 *Miniopterus schreibersii bassanii* bats declared a 'Critically Endangered' species
- 2008 Centenary Celebrations for the opening of Alexandra Cave
- 2015 New DEWNR Master Plan in preparation

## 2. DESCRIPTION

The South East of South Australia is covered by the Gambier Limestone sheet from Bordertown and Kingston southwards to Mount Gambier, the Glenelg River and Nelson area in western Victoria and the southern coastline of SA. 13 long parallel former beach ridges run the length of the region from north to south, representing 13 past stages where the sea reached inland between successive Ice Ages in the last million years. The most easterly of these ridges is the East Naracoorte Range where the ancient Kanawinka Fault broke the limestone sheet and raised its eastern side by ~30m. The major caves of Naracoorte are oriented along this fault line in the limestone.

Of ~1,000 recorded caves and karst (limestone) features in the South East region, ~250 are found in the Naracoorte region with 20 of these being major cave systems. Naracoorte Caves National Park contains 28 caves which include 12 of the major caves. These are located on ~29 land parcels of varying area but mostly adjacent and running NNW-SSE along the scrub-covered crest of the East Naracoorte Range. Major caves are >200m in length, 20-30m deep and contain large chambers interconnected by base-level flat phreatic passageways dissolved laterally by groundwater. The many caves contain different combinations of stalactites, stalagmites, flowstone and other ornate micro-decoration, extensive sediment thicknesses, marine fossils in the limestone and World Heritage vertebrate fossil deposits in a number of inner chambers, most of which are barely touched by palaeontologists.

Four of the major caves are Tourist Caves – Blanche Cave, (large open chambers with huge columns, settler history and a fossil excavation interpretation site), Alexandra Cave (red sediment chambers with beautiful speleothem decorations), Wet Cave (a self-guided large-room cave with adventure passages and geological features) and Victoria Fossil Cave (several decorated chambers and the World Heritage Fossil Beds display used for on-site interpretation). Associated with these is the innovative Wonambi Interpretation Centre with life-sized models of the extinct creatures in a recreated environmental setting and a bat-viewing infra-red multi-camera installation for the public to observe the bat breeding chamber functioning for the local ‘Critically Endangered’ bat species.

## 3. ASSESSMENT OF HERITAGE SIGNIFICANCE

### Identification of South Australian Historical Themes:

The Naracoorte Caves Complex encompasses South Australian geological history, early settlement history, cave tourism history and ancient and modern environmental history, spanning approximately 25 million years.

The breadth of natural and *historical geography* is recorded in the geology and environmental evidence of the Tertiary and Quaternary limestones, Ice Age landscape and climate changes, cave inception and development, the bio-history of the cave rangeland ecology from animal fossils, vegetation and ‘threatened’ bat species.

In developing a limestone landscape, South-eastern **social history/development** is reflected in stages - indigenous association with the caves, early settler adaptation to limestone and groundwater agriculture and an increasingly strong local identification with the reputation of the caves including a long history of tourism development and local tourism economy.

**Political/Government and Economic History:** The South Australian Surveyor-General George Goyder guided initial early preservation efforts for the caves and associated woodlands after 40 years of unregulated public access. The establishment of the Caves Range Forest stabilised their management although also contributing to the detriment of the bat species through several decades of guano mining, run as a government enterprise. Conservation and beautification projects for the Naracoorte Caves by the Woods and Forests Department over 30 years eventually led to more than a century of cave tourism development under the South Australian Tourist Bureau. Identification of the fossil site's importance by Professor Rod Wells culminated in a World Heritage nomination and improved interpretation to the public in recent decades.

The discovery of Blanche Cave in 1845 initiated a series of **Notable Events** important to the Naracoorte region and the caves. Father Julian Tenison-Woods, while mentoring Sister Mary McKillop during her development of religious and social ideas, travelled the Naracoorte region extensively. After discussion with his friend Goyder, his observations as a Naturalist were recorded and then published in two books in London in 1862 and 1865.

In 1897 and 1908, the discovery of two major caves of tourism interest and usage (Victoria Cave and Alexandra Cave) led to prominent local events including formal openings by the Governors of the time and an increase in public attention for the Naracoorte Caves. In 1969 this tradition of exciting exploration was crowned with the discovery of the Victoria Cave Quaternary fossil deposits by Professor Rod Wells and South Australian speleologists. This later led to the achievement of World Heritage status – the only such rated site in the State.

#### **Comparability / Rarity / Representation:**

#### **Comparability with the quality of other similar places entered in the South Australian Heritage Register**

Two caves at Naracoorte are currently included in the South Australian Heritage Register: Blanche Cave and Victoria Cave (SHP 11604).

Other cave-related features also included in the Register are Engelbrecht Cave (SHP 14733), Umpherston Sinkhole (SHP 14734), Cave Gardens complex (SHP 14727) (all in Mount Gambier), Menge's Cave (SHP 14532 - Barossa), and Koonalda Cave (SHP 14250 - Nullarbor Plain). [Note: Although some caves can be described as blowholes and Rockholes, Boandik Terrace Blowhole (SHP 14115) and Refuge Rockholes (SHP 14251) are not cave features.] These caves are all of a different geological origin and form to those of the Naracoorte Caves Complex and a comparison is therefore not appropriate.

Blanche Cave and Victoria Fossil Cave are closely associated with the assembly of neighbouring caves contained in the Naracoorte Caves National Park that is the subject of this Assessment Report. The Naracoorte Caves Complex is situated along a major regional fault line in a Tertiary limestone ridge which signifies the commencement of the Quaternary Ice Age sequence of 13 cycles of sea-level retreat and return that has developed the modern South Australian coastline. The ridge and caves record this natural history. The special combination of the Naracoorte ridge and caves that records this geological history is not repeated in South Australia or indeed on the Australian continent. Thus the Naracoorte Caves Complex contributes a unique view of the State's geology, palaeontology, speleology and natural history over the last one million years.

### **Comparability with the quality of other similar places entered in the heritage registers of other Australian States**

The southern and western coastline of the Australian continent is of largely Tertiary and Quaternary limestone derived from the Southern Ocean after Australia separated from Antarctica. No other coastlines of the continent have such geological deposits and there are very few in the world. Inland limestones of Australia are far older, usually crystalline and folded in mountain ranges. They generate very different cave forms compared to those of the southern coastline. The only caves developed in similar limestones and appearing on other heritage listings are located in Western Australia and are all small, younger and acknowledged as generally in a more degraded condition due to nearby quarrying works. Koonalda Cave on the South Australian portion of the Nullarbor Plain (National Heritage List ID 106022) is a large and splendid example of a southern coastal limestone cave system but is isolated, not associated with other caves in a complex and is highly-restricted regarding access due to National Heritage Indigenous flint-mining and rock art petroglyph (rock art) preservation regulations.

In addition to recording the late Quaternary geological history described above, the Naracoorte Caves Complex contains one of the most outstanding fossil collections in the world - a comprehensive sequence of sediments in the caves which preserve ~20% of the Quaternary period's environmental, zoological, botanical, biological and climatic history. These fossil beds are formally and collectively described as the Australian Fossil Mammal Site (Riversleigh/Naracoorte), inscribed on the World Heritage List in 1994 and included in the National Heritage List in 2007. Rated among the world's 10 greatest fossil sites, the Naracoorte fossils are a superb illustration of the key stages in the evolution of the unique fauna of Australia - the world's most isolated continent.

### **The rarity (uniqueness) or commonness of the Place in South Australia**

The Naracoorte Caves Complex records the South Australian Ice Age geological setting and environmental cycles and its individual but closely-associated caves contribute to a 1-million-year natural history record of geology, palaeontology, biology, botany and speleology. Such a dense combination of varied but linked natural cave features set in a unique geological sequence does not occur elsewhere in South Australia.

## **Assessment against Criteria (Under Section 16 of the *Heritage Places Act 1993*):**

Applying the guidelines for State heritage significance discuss whether the Place meets one or more criteria under section 16 of the *Heritage Places Act 1993*.

### **(a) it demonstrates important aspects of the evolution or pattern of the state's history.**

In considering this criterion, I have had regard to the provided Guidelines for State Heritage Places that note:

*The place should be closely associated with events, developments or cultural phases which have played a significant part in South Australian history. Ideally it should demonstrate those associations in its fabric.*

*Places will not normally be considered under this criterion if they are of a class of things that are commonplace, or frequently replicated across the State, places associated with events of interest only to a small number of people, places associated with developments of little significance, or places only reputed to have been the scene of an event which has left no trace or which lacks substantial evidence.*

The discovery of the Naracoorte area and its Caves in the early 1840's began 170 years of adaptation and utilisation of a distinctive South Australian limestone landscape and its natural cave features. The caves became a major local attraction, developed into an iconic South Australian tourism destination and eventually attained national and global significance through UNESCO World Heritage status. Many 'firsts' (listed below) have contributed directly to developing the special culture of South Australian cave tourism - a combination of history, showmanship, conservation, cutting-edge science and interpretation.

#### **1 Early Naracoorte Settlement and Adaptation to Limestone**

Early settlement in South Australia began in a number of places, including Kangaroo Island, Encounter Bay, Holdfast Bay and in the south-eastern regions of the colony with an expansion of pioneer sheepmen from Western Victoria across the then-undefined South Australian border. The latter followed the three flowing creeks to the Mosquito Plains – Naracoorte's original name – where they encountered average soils on wide limestone plains with shallow groundwater and crossed by long, low limestone ridges containing a series of prominent large-roomed caves.

The development of local farming in the Upper South East of South Australia was hard and depended on adapting to the limited resources of a limestone landscape – hand-dug wells to the groundwater, cutting stone from the caves for building blocks, dredging rough channels to drain the swamps and fertilising the thin low-quality soil with bat guano – an unexpected resource also from the caves. Terra-rossa soils draining into the limestone in particular areas led to the development of vineyards at nearby Wrattenbully, Coonawarra and Padthaway.



## 2 Cave Tourism and Interpretation History in South Australia

After discovery in approximately 1845, Blanche Cave suffered unregulated public access for 40 years which including parties and souveniring damage. In 1885 the SA Woods and Forests Department took over the caves area and appointed a dedicated cave manager who over 30 years formalised cave tours, cleaned up the caves and introduced fern gardens within them in a European gardening tradition. Around 1900 he discovered two more major caves which have been tourist features ever since, one containing the World Heritage fossil beds. The range of this history allows comprehensive interpretation of the Naracoorte Caves by comparing early visitation effects, the story of progressive discoveries, tourism themes and modern scientific understanding of Australian climatic, floral and faunal evolution of the South Australian environment. The recent acquisition by DEWNR of the major 2.5km Sand Cave in woodland further down the range adds a significant large system which is relatively untouched internally and for this quality is likely to be rated as a very important 'Reference Cave' for comparison purposes.

1840's	First discovered caves in the State
1861	Site of calcified body of an Aboriginal man, subject of a prominent Adelaide court case
1862's	First scientifically-assessed region and caves in SA history (Rev Julian Tenison-Woods - two books published in London)
1860's	Guano mining industry commenced (until 1900)
1885	First Tourist Caves in South Australia - Woods & Forests Department
1897	First SA Government regulation "For the preservation of the stalactites and stalagmites"
1917	First rural tourism site operated by SA Government Tourist Bureau
1970	South Australia's only working fossil excavation site open to public view
1994	South Australia's only Bat interpretation centre opened to the public
1994	UNESCO World Heritage status granted

The place may fulfil this criterion.

### **(b) it has rare, uncommon or endangered qualities that are of cultural significance.**

In considering this criterion, I have had regard to the provided Guidelines for State Heritage Places, that note:

*The place should demonstrate a way of life, social custom, industrial process or land use which is no longer practised, is in danger of being lost, or is of exceptional interest. This encompasses both places which were always rare, and places which have become scarce through subsequent loss or destruction.*

*Places will not normally be considered under this criterion if their rarity is merely local, or if they appear rare only because research has not been done elsewhere, or if their distinguishing characteristics have been degraded or compromised, or if they are at present common and simply believed to be in danger of becoming rare in future.*

The Naracoorte Caves are the only complex in Australia formed along a major fault line in a coastal limestone sheet. The open nature of their entrances has admitted 0.5 million years of surface soils and sediments, providing a unique environmental and climatic record for this time period from which multiple past climate changes can be interpreted. The entrances acted as natural pitfall traps for prehistoric Australian mammals, marsupials, birds, reptiles and amphibians whose fossils are of rare quality and so excellently preserved within several inner cave chambers that they are designated as a UNESCO World Heritage site. Amongst a rich variety of speleothem (decoration) formations, a number of special features – large columns bearing phytokarst (algae/calcite growth combinations), black speleothems and avens (bell-shaped indentations in some cave roofs) – are as yet to be adequately explained by science; all are uncommon in the State but best represented at Naracoorte.

The place may fulfil this criterion.

**(c) it may yield information that will contribute to an understanding of the state's history, including its natural history.**

In considering this criterion, I have had regard to the provided Guidelines for State Heritage Places that note:

*The place should provide, or demonstrate a likelihood of providing, information that will contribute significantly to our knowledge of the past. The information should be inherent in the fabric of the place. The place may be a standing structure, an archaeological deposit or a geological site.*

*Places will not normally be considered under this criterion simply because they are believed to contain archaeological or palaeontological deposits. There must be good reasons to suppose the site is of value for research, and that useful information will emerge. A place that will yield the same information as many other places, or information that could be obtained as readily from documentary sources, may not be eligible.*

The Naracoorte Caves Complex contains diverse excellently-preserved natural features whose interpretation provides a lengthy and detailed record of important past phases in South Australia's environmental and landscape development.

Geological, paleontological, biological, environmental and climatic information are able to be interpreted from an abundance of elements protected within a series of natural

time capsules and the setting in which they are found, which are unrepeated in South Australia. Research into many such themes has been continuing at Naracoorte for over 50 years (and indeed began over 150 years ago – see Criterion (g)).

## **1 Important elements in the Geological setting of the Naracoorte Caves area**

The cave systems at Naracoorte are located in a limestone range which records a series of specific geological events that document the important Quaternary phase of cave and coastal development in south eastern South Australia -

- 37-12Ma\* Extensive Tertiary period marine transgression and seafloor deposition of a series of vast limestone sheets across southern South Australia.
- 1-1.5Ma The large, ancient regional Kanawinka Fault reactivated and fractured the limestone that runs along the caves ridge, allowing cave development by groundwater solution to commence.
- 1Ma Stoney Point Gorge at the Naracoorte Caves is cut by Mosquito Creek when the Kanawinka Fault movement tilted the landscape and deflected its course.
- 1Ma Mosquito Creek flooded the limestone fractures and contributed to cave development by dissolving the interior of the rock, particularly in the major Victoria Fossil Cave.
- 870ka\* The ocean which was at the foot of the Naracoorte Caves range at this time began the first of 13 Ice-age cycles of retreat and return, leaving the first dune of the Ice-age sequence on the range itself above the caves.

\*Ma = million years    \*ka = thousand years    Dates approximate but scientifically determined

The significance of the Naracoorte Caves in this geological setting is their capacity to provide physical evidence within their structure and sediments spanning one million years. This directly informs a better understanding about the special coastal building sequence of the modern South Australian South-eastern and Coorong coastline and the environmental and climatic conditions under which this occurred.

## **2 Important natural elements contained within the Naracoorte Caves themselves**

The Naracoorte Caves Complex is a comprehensive and unique natural data source. The caves themselves are a direct product of the geology and groundwater of the locality. Various caves within the array show many differing aspects and phases of cave development including:

- large chambers with extensive daylight zones and ‘roof windows’
- marine fossils within the limestone walls
- extensive low-level phreatic (groundwater-dissolved) tunnel and maze systems
- significant sediment accumulations spanning hundreds of thousands of years

- special geological features eg 'avens', 'phytokarst', 'scalloping', sand cones etc
- enclosed rock collapse passages with zones of decoration and columns
- an abundant variety of excellent examples of stalactites, stalagmites and flowstone
- some outstanding assemblages of pristine straws, helictites and dogtooth spar crystal
- sand/silt floors containing abundant excellently-preserved mammal fossils
- fossil deposits covering ~0.5 million years of South Australian marsupial megafauna and diverse associated species, the best such assemblage on the planet.
- several chambers are critical bat maternity or winter hibernating rooms
- Nearly all the above-listed features are available and interpreted for the public.

(Features of prominence within individual caves are tabled on the next page.)

(Comparative) The regional geology examples together with aspects regarding the fossils, bats and the Mosquito creek cutting are unique to Naracoorte and are not repeated elsewhere in Australia. All the above features are contained within a coherent group of caves within the Naracoorte Caves National Park, administered by DEWNR. Some aspects of the cave development processes and decoration contents are found in other South Eastern caves and at Kelly Hill on Kangaroo Island but not as comprehensively, nor as better examples.

The place may fulfil this criterion.

**(d) it is an outstanding representative of a particular class of places of cultural significance.**

In considering this criterion, I have had regard to the provided Guidelines for State Heritage Places that note:

*The place should be capable of providing understanding of the category of places which it represents. It should be typical of a wider range of such places, and in a good state of integrity, that is, still faithfully presenting its historical message.*

*Places will not be considered simply because they are members of a class, they must be both notable examples and well-preserved. Places will be excluded if their characteristics do not clearly typify the class, or if they were very like many other places, or if their representative qualities had been degraded or lost. However, places will not be excluded from the Register merely because other similar places are included.*

The category of the Place is 'Cave Complex'. Other cave occurrences and complexes exist across South Australia but the localised concentration and extent of the Naracoorte Caves Complex, together with the wide variety and quality of features contained within them make the Naracoorte Caves Complex an outstanding example of this category in the State. The significance of this category to South Australia is its notable and well-preserved multiple contents, many of which are well-recognised in scientific literature. Outstanding examples are -

- The cave themselves are directly derived from the unique association of a coastal Limestone platform and large regional fault line within the South Australian landscape.
- The geological ridge in which the caves are contained is the first of a world-recognised sequence of stranded Ice-age coastal dune systems which commenced ~1 million years ago. These particular geological circumstances directly contributed to the caves' formation.
- Complex sedimentary sequences are found in staggered overlaps within many of the caves. The sequences cover different environmental phases of the mid-late Quaternary period (from 0.5 million years ago to the present) and provide an outstanding continuous interpretable record of South Australia's climate and landscape changes.
- Directly associated with the sediments, the world's largest and most comprehensive assemblage of Australian Mammal fossils dating from 0.5 million years ago is excellently preserved within Victoria Fossil Cave and across many caves within the Place. These are recognised by UNESCO World Heritage and Australian Natural Heritage designations and are on display to the public with high-quality scientific interpretations.
- The rich, varied and delicate array of speleothem (decoration) formations are among the best in South Australia. Many large columns bearing phytokarst (algae/calcite growth combinations) are represented at Naracoorte in the greatest and best-preserved concentration in the State.
- A single large chamber within the Bat Cave is one of only two remaining rooms on the Australian continent and the only chamber in South Australia where the endangered Southern Bent-wing bat species *Miniopterus schreibersii bassanii* is able to continue to breed. This is a vital location deserving the highest order of protection.

The place may fulfil this criterion.

- (e) it demonstrates a high degree of creative, aesthetic or technical accomplishment or is an outstanding representative of particular construction techniques or design characteristics.**

In considering this criterion, I have had regard to the provided Guidelines for State Heritage Places that note:

*The place should show qualities of innovation or departure, beauty or formal design, or represent a new achievement of its time. Breakthroughs in technology or new developments in design would qualify, if the place clearly shows them. A high standard of design skill and originality is expected.*

*Places would not normally be considered under this criterion if their degree of achievement could not be demonstrated, or where their integrity was diminished so that the achievement, while documented, was no longer apparent in the place, or simply because they were the work of a designer who demonstrated innovation elsewhere.*

Particular construction techniques with some creative design characteristics were required to prepare several of the caves intended for public access and visitation. Within two of the three public tourist caves at Naracoorte can be found remnants of South Australia's last remaining examples of the Victorian and Inter-War cave tourism eras which, featured obvious human modifications to the cave environment, typical of their times. These contrast with modern attempts to restore the natural underground environment as well as possible while allowing public access.

Items of creative, aesthetic or technical accomplishment –

1880's	Remnant fern gardens in Blanche Cave entrances
1900's	Stone walls within Victoria Fossil Cave
1880-1900	Steep wooden ladders for early public access (Victoria Fossil Cave and Cathedral Cave)
1880-1900	Remains of early cave lighting technology - copper cables, insulators and large switches
1885-1960's	Remains of early cave tourism approaches - chicken wire barriers, lampenflora, figurines, stories

While these are of interest –

- The fern gardens were largely removed and are only recently being considered for reconstruction.
- The stone walls have been modified several times, particularly after the fossil discoveries.
- The single wooden ladder in Victoria Fossil Cave is no longer used but is a feature of the tour.
- The wooden ladder and access platform in Cathedral Cave have been modified for safety reasons.
- The early lighting technology remains and wire barriers are disused and restricted to a side passage.

All these items are representative of historical 19th century cave tourism practices which are not represented elsewhere in South Australia. However, they are dilapidated and would require restoration to be worthy of public display and interpretation. They are therefore not considered to demonstrate an outstanding degree of technical or aesthetic accomplishment.

The place may not fulfil this criterion.

**(f) it has strong cultural or spiritual associations for the community or a group within it.**

In considering this criterion, I have had regard to the provided Guidelines for State Heritage Places that note:

*The place should be one which the community or a significant cultural group have held in high regard for an extended period. This must be much stronger than people's normal attachment to their surroundings. The association may in some instances be in folklore rather than in reality.*

*Places will not be considered if their associations are commonplace by nature, or of recent origin, or recognised only by a small number of people, or not held very strongly, or held by a group not widely recognised, or cannot be demonstrated satisfactorily to others.*

### **1. The Culture of Speleology and Associations with a Group**

Speleologists around the world have a very strong culture of the excitement of exploration and discovery. Part of this culture is a droll shared sense of humour that humans should enjoy dark, confined, muddy and remote places which most people would shun but the rewards of finding amazing underground beauty and hidden secrets await them. Speleology can be accurately described as an obsession and no cave explorer would disagree! This culture also extends to a sense of responsibility for valuing and conserving such unique and remote treasures.

The Cave Exploration Group of South Australia (CEGSA), an associate society of the South Australian Museum, has for 60 years administered the South Australian database for all caves discovered, explored and recorded in this State and across the entire Nullarbor Plain as part of the Australian Speleological Federation's national cave recording system. In this time, CEGSA has produced many hundreds of cave maps for its library, some of which are sophisticated, complex and of very high quality, and 10 scientific 'Occasional Paper' publications. This information has been used many times to conserve South Australian caves.

The study of limestone areas is a specific branch of geology known as 'karst science' and speleologists are its practitioners. In the spirit of the speleological culture since they formed in 1955, from the outset CEGSA members have enthusiastically explored, documented and scientifically assessed several thousand caves in the different limestone regions across South Australia, including the spectacular underwater sinkholes which are exclusive to this State. Among its members were/are palaeontologists, geologists, hydrologists, meteorologists, anthropologists, archaeologists, biologists and a range of skilled technical people including surveyors. Underground mapping is central to speleology and a specialised skill - it is crucial to furthering the sport and the science.

## **2. CEGSA's special contribution to the Naracoorte Caves**

The Naracoorte Caves Complex has significant primary associations with CEGSA. In its first decade CEGSA focused on the Naracoorte and South East region to systematically explore, map and document the cave systems there. CEGSA's first maps of Blanche and Bat Caves were surveyed in 1956 and are still used.

In 1969, CEGSA members discovered the World Heritage fossil sites at Naracoorte and have been involved for decades in the Endangered Species bat research there. Both endeavours have transformed tourism for the caves complex. From cave studies and underwater explorations in the South East, CEGSA scientists have contributed to the emergence of groundwater management and pollution legislation to protect the community's water resource.

CEGSA's involvement with the Naracoorte Caves Complex has elevated the value of South Australian karst knowledge, informed DEWNR of many important aspects of its karst assets, and provided abundant information for World Heritage interpretation at the Naracoorte tourist caves. The Naracoorte Caves are fundamental to the origins and future of the Cave Exploration Group (SA) and its members, whose discoveries are a contribution to the identity of the Naracoorte's regional community as a whole.

The place may fulfil this criterion.

**(g) it has a special association with the life or work of a person or organisation or an event of historical importance.**

In considering this criterion, I have had regard to the provided Guidelines for State Heritage Places that note:

*The place must have a close association with a person or group which played a significant part in past events, and that association should be demonstrated in the fabric of the place. The product of a creative person, or the workplace of a person whose contribution was in industry, would be more closely*



*associated with the person's work than would his or her home. Most people are associated with many places in their lifetime, and it must be demonstrated why one place is more significant than others.*

*Places will not generally be considered under this criterion if they have only a brief, incidental or distant association, or if they are associated with persons or groups of little significance, or if they are associated with an event which has left no trace, or if a similar association could be claimed for many places, or if the association cannot be demonstrated. Generally the home or the grave of a notable person will not be entered in the Register unless it has some distinctive attribute, or there is no other physical evidence of the person's life or career in existence.*

The Naracoorte Caves Complex has a special association with the life and work of three significant early South Australian scientist/explorers, namely Father Julian Tenison-Woods (Naturalist, Cleric, Mentor of Mary McKillop), William Reddan (Cave Explorer, Discoverer, Developer and Cave Manager) and Professor Rod Wells (Palaeontologist, notable Naracoorte World Heritage Fossil authority).

## **1 Early Scientific Documentation – Father Julian Tenison-Woods**

An early South Australian Naturalist of renown, Father Julian Tenison-Woods used his scientific training in the new fields of geology and mineralogy as he travelled widely across the South East of the State for a decade in the 1850's and 60's. He interpreted the landscape in the first regional geological study of that region with a special examination of the Naracoorte Caves. His *Geological Observations in South Australia*, and *History of the Discovery and Exploration of Australia* were published in London by the Royal Society in 1862 and 1865. His friendship with George Goyder contributed to his observations.

- Tenison-Woods' written records of the Naracoorte Caves together with several of his woodcuts are a primary source of high-quality information on the state and contents of the caves and are utilised in modern rehabilitation projects there.
- His description of the then-existent aboriginal body in Blanche Cave has contributed to our understanding of that event.
- Importantly, and despite the doctrines of the Catholic Church, Tenison-Woods began elementary excavations of bone accumulations in the caves from which he began recognising that fossils were from creatures that no longer existed and that their evolution (a radical concept at the time) had been interrupted/terminated with no apparent extant living relatives.
- From observations of the Naracoorte limestone sheet and countryside which differed so greatly from Europe, he began to formulate new geological concepts of sedimentary basins and groundwater and communicated these ideas to Goyder in a mutual consideration of inland South Australia's possible groundwater resources.

- Equally, his interpretations of the origins of the limestone sheet with its ancient marine fossils and associations with Mount Gambier volcanoes and large sinkholes were prescient scientific concepts.

## **2 William Reddan's Cave Discoveries and Cave Tourism Development**

In 1885 under direction from the South Australian Surveyor-General, George Goyder, the newly-formed Forest Board (later the SA Woods & Forests Department) took up the land along the ridge containing the Naracoorte Caves which had remained unallotted and unregulated for 40 years since the first settlers arrived. The Board appointed Mr William Reddan as its Forestry Overseer to manage the new Caves Range Forest and the previously unregulated guano mining operations. Crucially, the Board also charged him with responsibility for the rehabilitation, beautification and visitation of caves.

Reddan was a vigorous, focused and dedicated manager of the caves for 30 years and is responsible for their good condition and reputation today. It is possible that when younger in the small community school at Naracoorte he was influenced to value the natural world and the caves by Father Tenison-Woods and by Goyder on his South East field trips in the 1860's when assessing Naracoorte lands for forestry prospects. Reddan developed several underground tours, 'beautified' the five large entrances of Blanche Cave and Wet Cave with European fern gardens, hosted a Governor's visit in 1909 and conducted cave tours with other supporting staff.

As the guano stocks finally began to dwindle, Reddan was directed to find more caves that might be a guano source. While this was unsuccessful, Reddan discovered two exceptional new caves - Victoria Cave (1897) and Alexandra Cave (1908), both featuring many attractive areas of pristine cave decoration. Reddan persuaded the Woods & Forests Department to formalise protection of these caves under a Forestry Regulation and develop them as commercial attractions to replace the declining guano industry. This was achieved and in 1917, the SA Tourist Bureau took over the management with William Reddan appointed as 'Curator of the Caves'. He was a larger-than-life personality known throughout the region for his constructive role and retired in 1919. His grave is in the Naracoorte cemetery and in 2008 a celebration was held at the caves and the cemetery in honour of the centenary of his discovery of Alexandra Cave. The Tourist Bureau continued management of the Naracoorte Caves until transferred to National Parks & Wildlife in 1972.

## **3 Professor Rod Wells – Discoverer and UNESCO Proponent of the World Heritage Fossil Sites**

Rod Wells has been a pivotal contributor to the significance of the Naracoorte Caves in the latter half of the 20<sup>th</sup> century with his direct role in the elevation of the fossil deposits to World Heritage status. He grew up in the Blue Mountains west of Sydney,

developing an early interest in bushwalking, rockclimbing, caving and natural history and became an engineer working with British Motor Corporation in Sydney and with the construction arm of United Oil Products of America in the 1950's and 60's.

At this time he was involved with the first exploration of the Nullarbor Caves in South Australia and became a member of CEGSA. This interest in speleology and cave biology was developed at Naracoorte and culminated in his discovery with Dr Grant Gartrell of the spectacular fossil deposits in Victoria Fossil Cave (then only known as Victoria Cave). This was an event that led to significant career change with Rod completing a PhD in Zoology in 1974 studying the Southern Hairy-nosed Wombat and subsequently joining the School of Biological Sciences at Flinders University, where he helped in the formation of the Flinders University Speleological Society and the mapping of Victoria Fossil Cave.

After Rod Wells' instrumental role in achieving World Heritage listing for the Naracoorte Caves fossil deposits in 1994, he was commissioned by UNESCO to write the international guidelines for future listings of fossil sites. His contribution is internationally significant and he is well recognised for these achievements in Australia and overseas. His major interests of Vertebrate Palaeontology and Vertebrate Ecology has entailed expeditions to the Lake Eyre Basin, Kangaroo Island, Burra and the caves of southeastern Australia and Papua New Guinea, encompassing exploration and description of vertebrate fossils leading to reconstruction of ancient environments and faunas.

At a State level, he established the first dedicated vertebrate palaeontology undergraduate field course and teaching laboratory in SA and Australia, based at Naracoorte, and has taught courses in evolution, animal behaviour and conservation biology. In 1995 he convened a new degree in Ecotourism aimed at producing a small number of multidisciplinary graduates for Australia's fast developing nature-based tourism industry. Rod Wells is also a past Vice-President of the Royal S.A. Zoological Society which owns and manages the Adelaide and Monarto Zoos and his wombat research led to the establishment of the Brookfield Wombat Reserve, now Brookfield Conservation Park. Rod was a principal advisor to David Attenborough's 'Life on Earth' series when it focused on Naracoorte.

The achievements of these men are recounted in the cave guide interpretations today as a tribute to their important roles in the history of the Naracoorte Caves Complex

The place may fulfil this criterion.

### **Extent of Listing / Significant Fabric / Curtilage:**

The extent of this listing includes all geological, palaeontological and speleological features and excludes any built feature or infrastructure in the 22 land parcels administered by DEWNR within in the Naracoorte Caves National Park.

Given that the Naracoorte Caves Complex meets one or more of the criteria under section 16 of the Heritage Places Act 1993, the components/elements which are crucial to the heritage significance of this place are listed below –

- Victoria Fossil Cave (U1) (SHP 11604)
- Bat Cave (U2) (includes roof slab replaced over maternity chamber)
- Alexandra Cave (U3)
- Blanche Cave (U4-5-6) (SHP 11604)
- Appledore Cave (U7)
- Blackberry Cave (U8-9)
- Wet Cave (U10-11)
- Cathedral Cave (U12-13)
- Brown Snake Cave (U14)
- Sand Cave (U16)
- Robertson's Cave (U17)
- Fox Cave (U22)
- Little Victoria Cave U44)
- Wombat Cave (U58)
- Saddle Cave (U62)
- Sand Funnel Cave (U72)
- Little Cathedral (U98)
- Six linear dolines (XKRM174, 175, 182, 183, 184 and 185)
- Karst pavement (XKRM521) (area over Cathedral Cave)
- Stoney Point Cutting - 'Old Swimming Hole' at Stoney Point, Mosquito Creek

The extent of listing excludes:

- Man-made structures, including buildings and structures.

## REFERENCES:

Research at Naracoorte is a crucial contribution to Australia's obligations to UNESCO as a host nation of a World Heritage site. A great deal of research on the Naracoorte Caves Complex has been conducted and published. This bibliography has been selected to represent the wide range of studies across several specialist fields -

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**NAME:** Naracoorte Caves Complex

**PLACE NO.:** 26459

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**SITE RECORD:**

**FORMER NAMES:** Mosquito Plains Caves, The Big Cave, The Old Caves, The Caves, Cave Range

**DESCRIPTION OF PLACE:** 37 caves on 22 adjacent land parcels in three groups managed by DEWNR along the centre of the East Naracoorte Range, Naracoorte, South Australia

**DATE OF COMPLETION:** Natural Heritage - not applicable

**REGISTER STATUS:**

**Description:** Blanche Cave and Victoria Fossil Cave are jointly listed as SHP #11604. They are located on two separate land parcels in the middle group.

**Date:** January 1984

**CURRENT USE:**

**Description:** World Heritage Tourist Area, National Park, Academic Research area

**Dates:** 1972 and ongoing

**PREVIOUS USE(S):**

**Description:** Unrestricted public visitation (1845-1885)  
Guano mining (1860's-1900)  
Forestry Site (1880's-1925)  
SA Tourist Bureau (1925-1972)

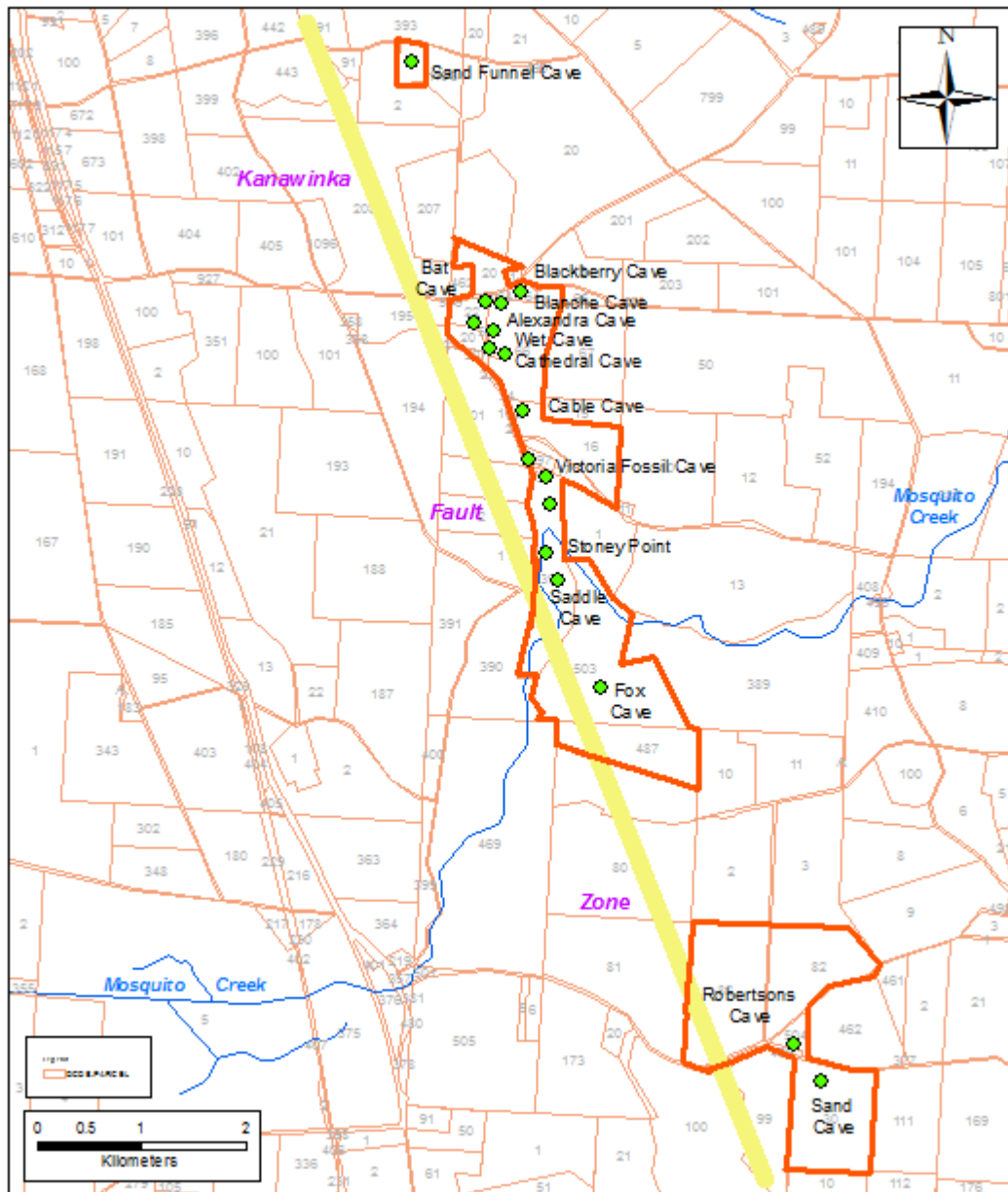
**Dates:** See above



# SITE PLAN




**NAME:** Naracoorte Caves Complex

**PLACE NO.:** 26459



Site plan generally indicating the boundary of the place. All components are contained within the orange boundary, with key components indicated by dots

## LEGEND

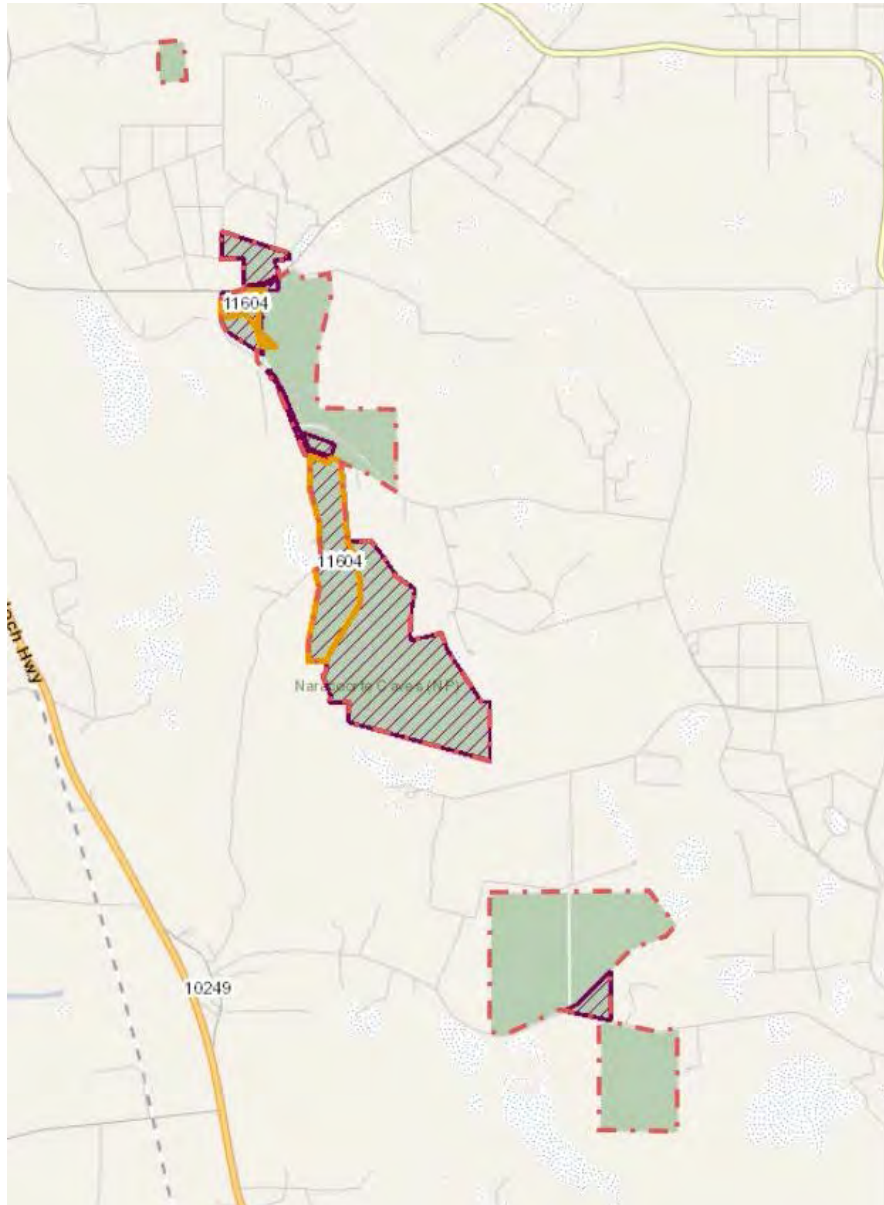
-  Proposed boundary of place
-  Prominent cave-systems of the place
-  Location of the ancient Kanawinka fault Zone

N ↑

## HERITAGE LISTING (NATIONAL, WORLD & STATE)




Naracoorte Caves Complex  
8kms south of Naracoorte

PLACE NO: 26459



Plan generally indicating the boundaries of the various heritage protection relevant to this place.

### LEGEND

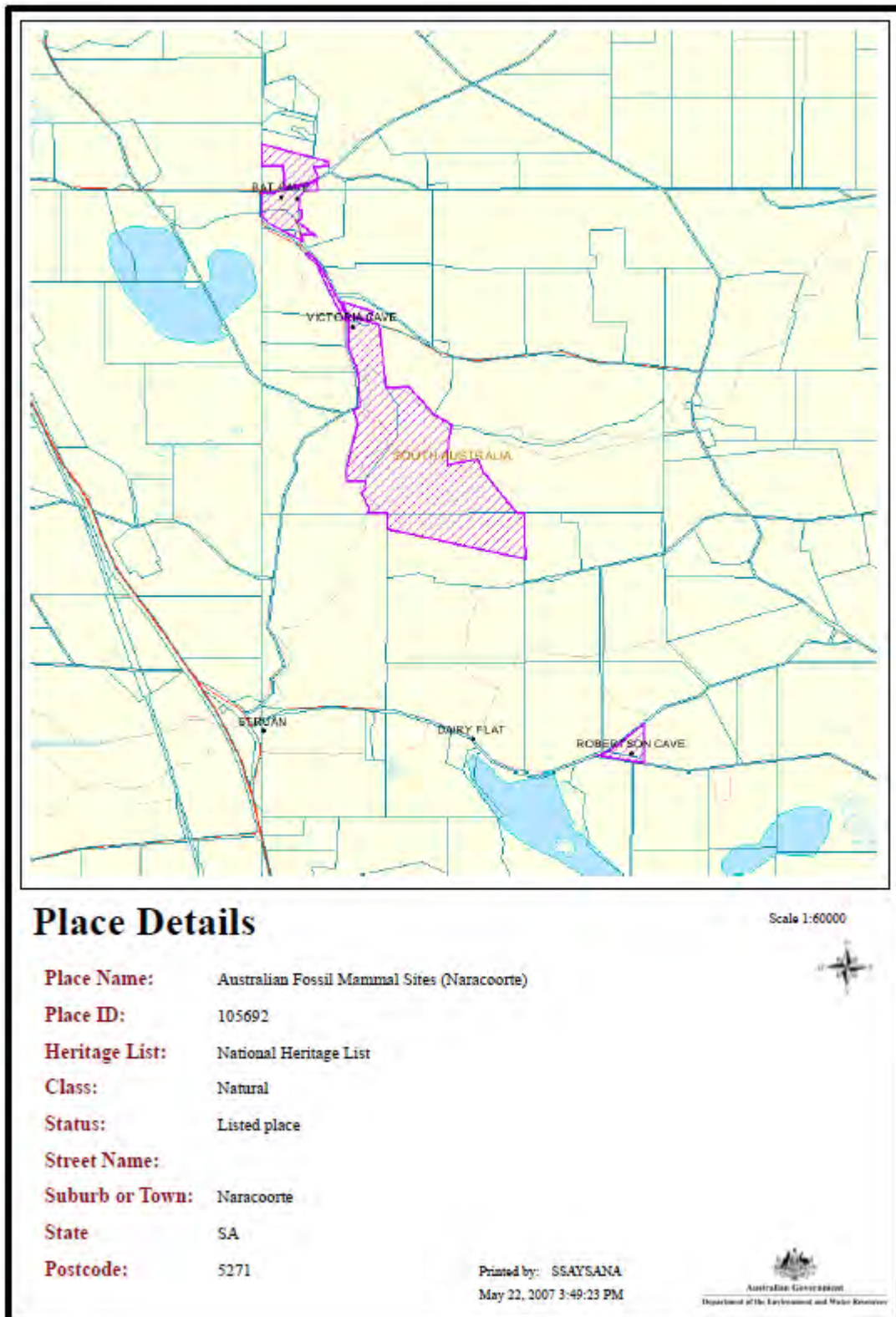
-  Boundary of proposed Naracoorte Caves Complex State Heritage Place
-  Existing State Heritage Place within boundary of Naracoorte Cave Complex
-  Boundary of **World** and **National** heritage listings

N ↑

## IMAGES

**NAME:** Naracoorte Caves Complex

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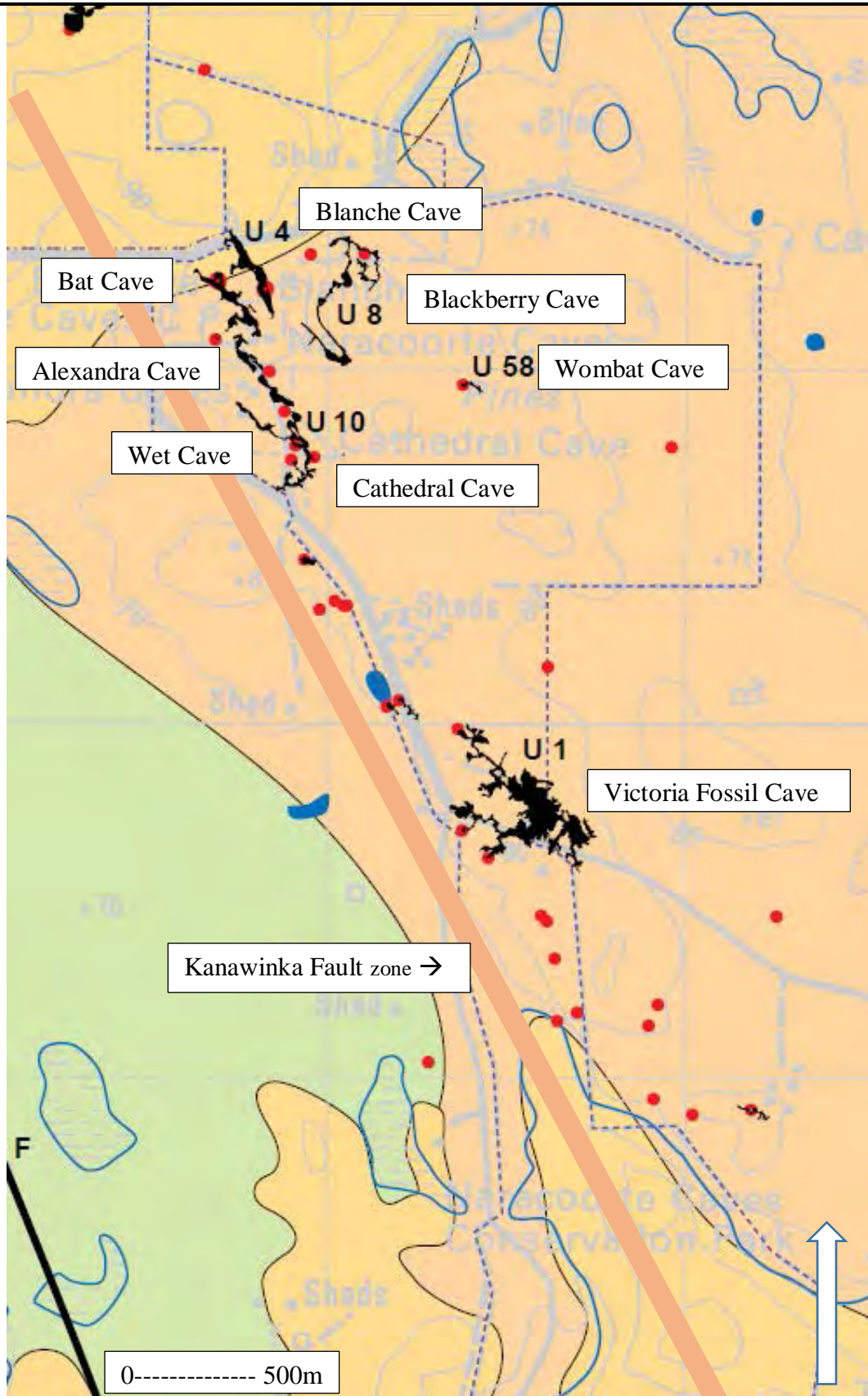
Australian Government Department of Environment map indicating National Heritage areas listed in 2007.



Google Earth image looking northwest along the West and East Naracoorte Ranges to the town and beyond. The Naracoorte Caves Complex extends from the large native forest parcel in the foreground northwards for 10kms along the range top. The Tourist Caves and Interpretation Centres are at the central cluster of red dots. The native forest remnants form partial vegetation corridors along the range tops. Bats have been detected and monitored flying from Bat Cave southwards along the range above the forest before turning westwards out on to the plain to their insect feeding grounds above Bool Lagoon (just west of the image). Far to the northwest can be seen the Stewart Range, the third of thirteen low-level ancient dune ridges deposited by Pleistocene marine transgressions forming early shorelines between past Ice Ages. The East and West Naracoorte Ranges were first and second in this series.

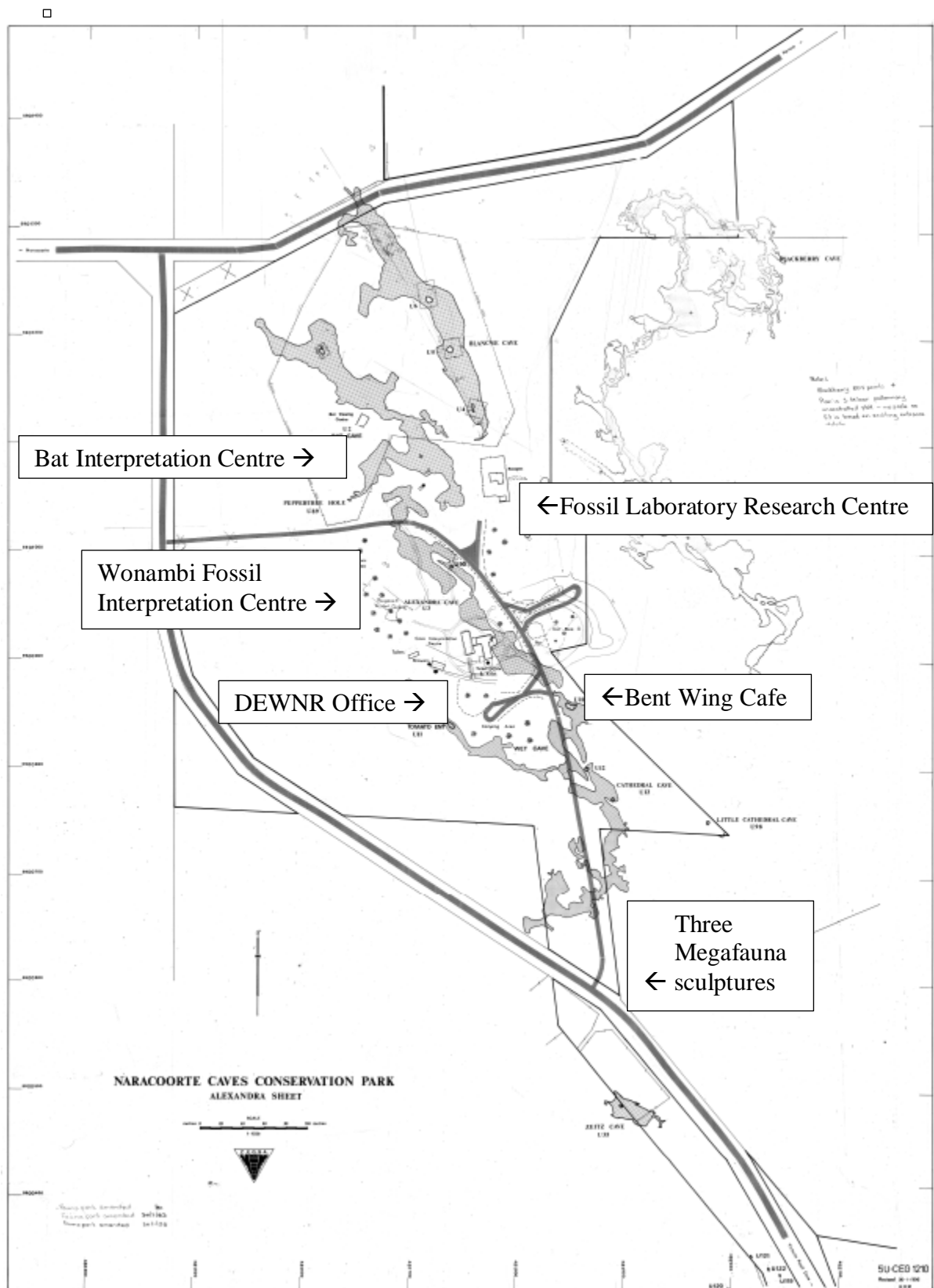
**NAME:** Naracoorte Caves Complex

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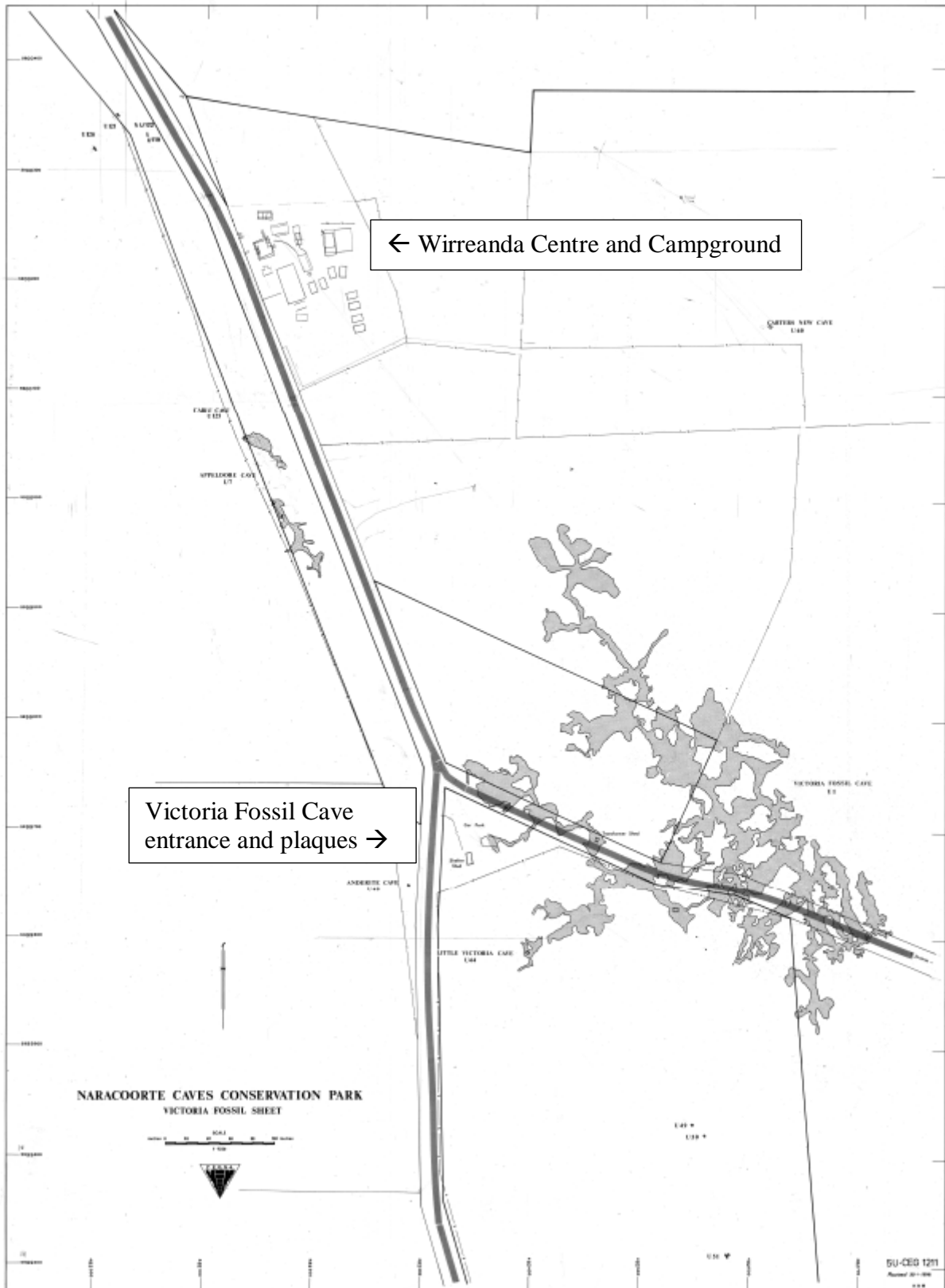


Relationship of major cave passage systems in the central Tourist Cave area at Naracoorte. They are located along and above the Kanawinka Fault, running parallel to it in a northwest-southeast direction. Source: White S.Q., 2005

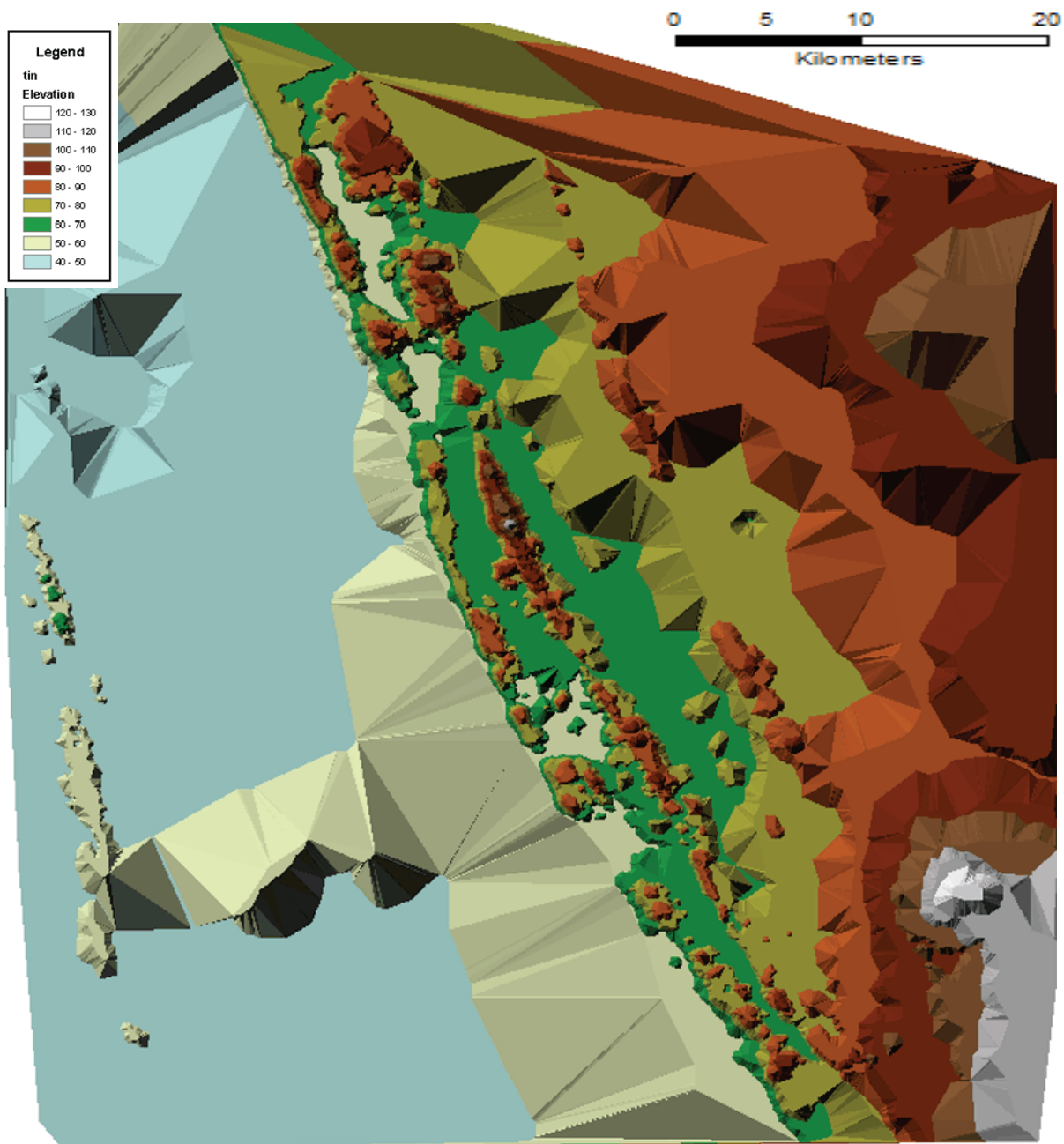




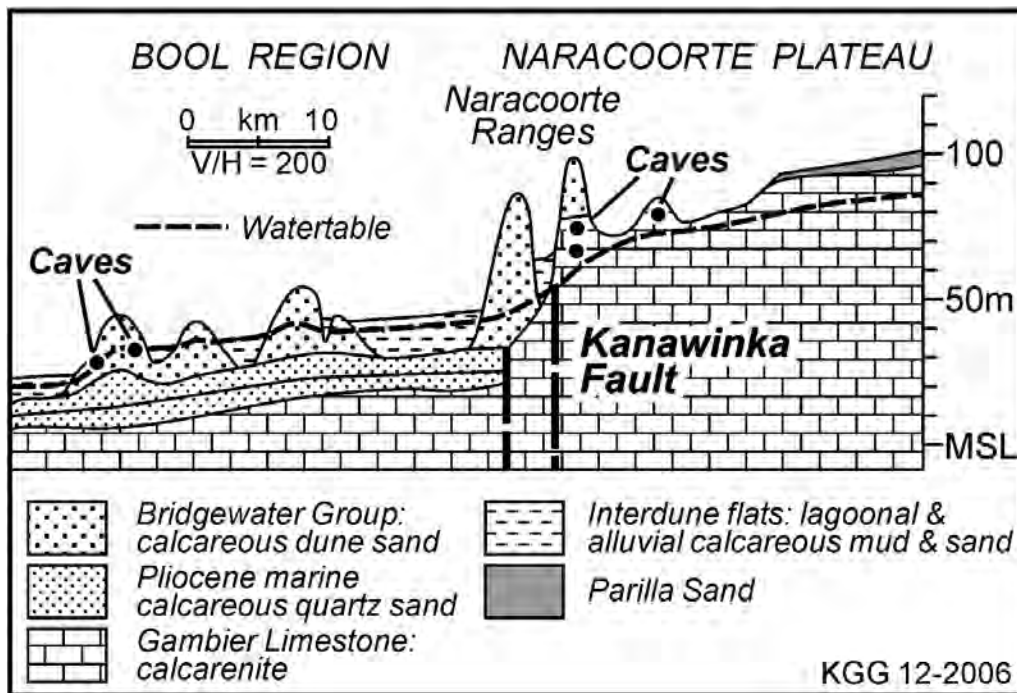
Detailed map of the Northern section of the Tourist Cave Area in the vicinity of the Wonambi and Bat Interpretation Centres, Bent Wing Café and DEWNR offices. A surface walking trail is planned to follow the cave outlines from above with interpretation signage on the theme of – “What is beneath your feet?” Source: CEGSA Map Records.



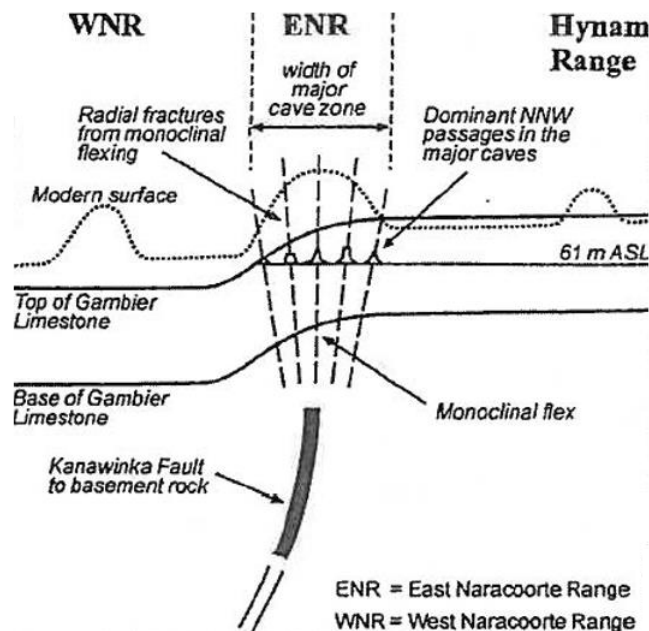
Detailed map of the Southern section of the Tourist Cave Area showing the extent of 4 kilometres of complex cave passages of Victoria Fossil Cave and four nearby small caves – Cable Cave, Appledore Cave, Anderite Cave and Little Victoria Cave. The road over the top of Victoria Fossil Cave has since been re-routed, bypassing it to the north to further protect it. A surface walking trail with interpretation signage links all these caves through native woodland. Source: CEGSA map records.



Digital elevation model of the Naracoorte Caves Complex area. The two lengthy narrow broken ranges (orange) along the flat limestone country (green) are the West and East Naracoorte Ranges. These are first and second remnant dune coastlines of thirteen Ice Age marine transgression cycles deposited across the South East during the last million years of the Pleistocene period. Remnants of the third (later) coastline appear as the light grey broken range 20 kms to the west. The ten subsequent coastlines continue in parallel formation westwards and southwards to the modern coastline at Kingston, Robe and Beachport. The Naracoorte Caves Complex occurs entirely in the East Naracoorte Range in the centre of the image. Source: Mustafa S and Mott K, 2004 (unpublished data).



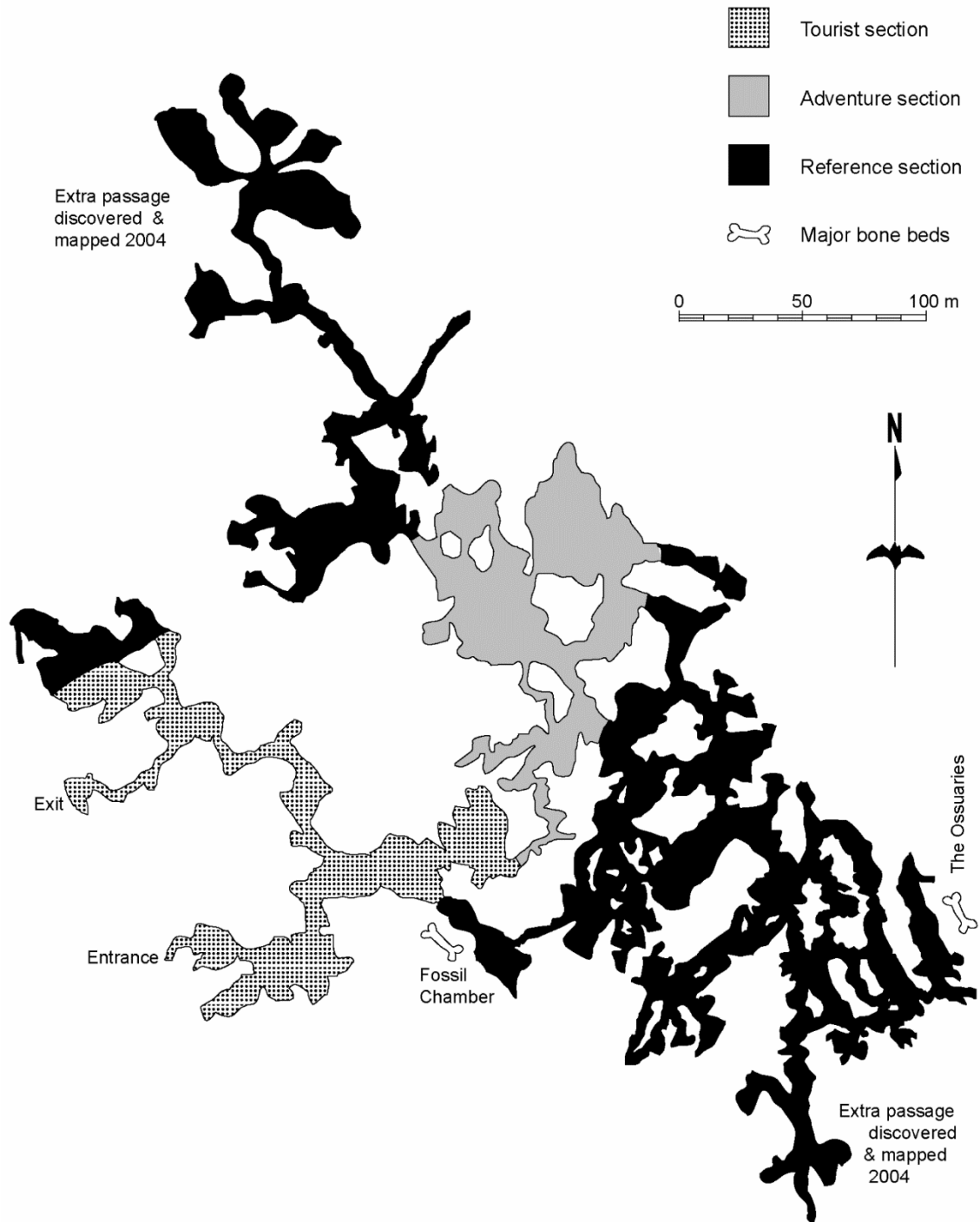
Geological cross-section of the previous image showing the West and East Naracoorte Ranges and Caves locality. The higher of the two peaks indicated above the Kanawinka Fault is the East Naracoorte Range where the tourist caves and other major caves of the Naracoorte Caves Complex are located. The smaller caves to the west and the east are shallower and have different origins. Source: Grimes K.G. and White S.Q., 2006.



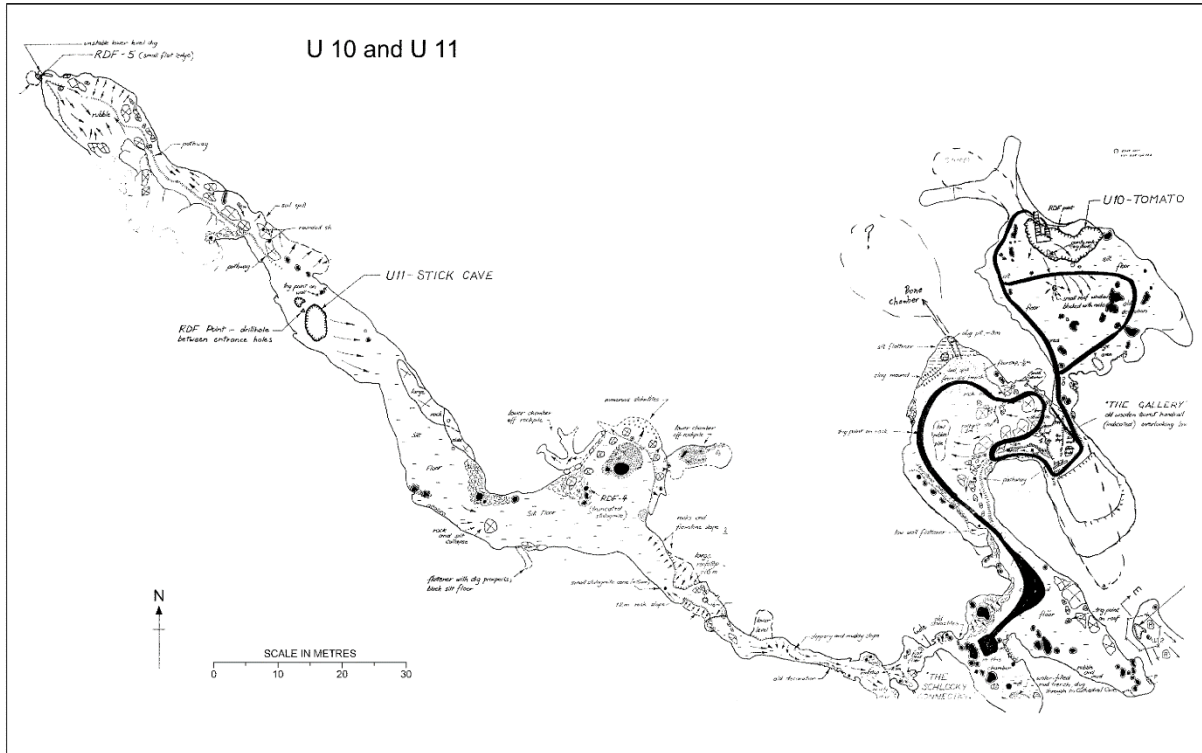
Geological cross-section diagram indicating the monoclinical ('buckling') effect of the Kanawinka Fault which developed large original fractures in the Gambier Limestone. Groundwater then entered these fractures approximately one million years ago and began the development of the Naracoorte Caves Complex. Source: Lewis I.D, Lawrence R. and Mott, K., 2006.



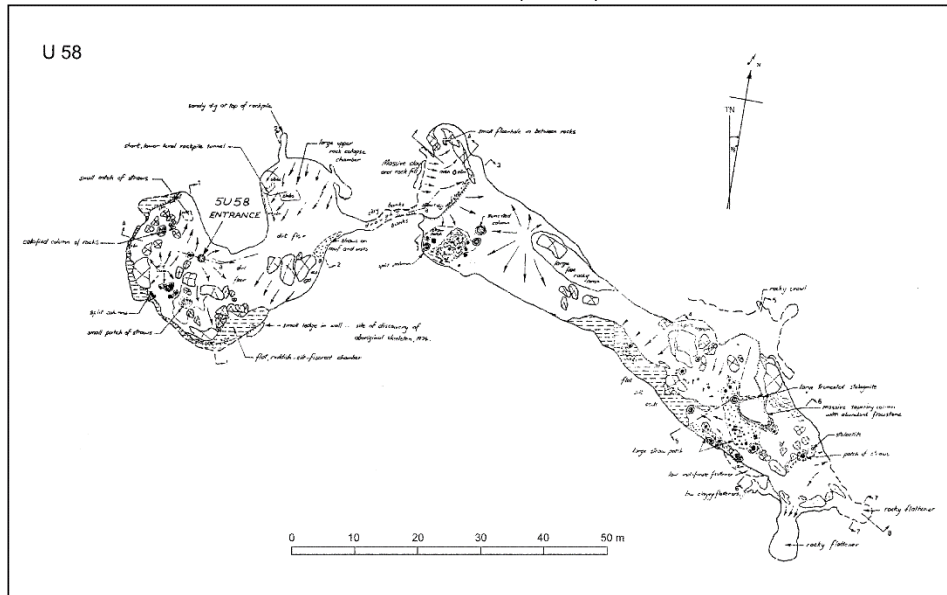
U 1 Victoria Fossil Cave



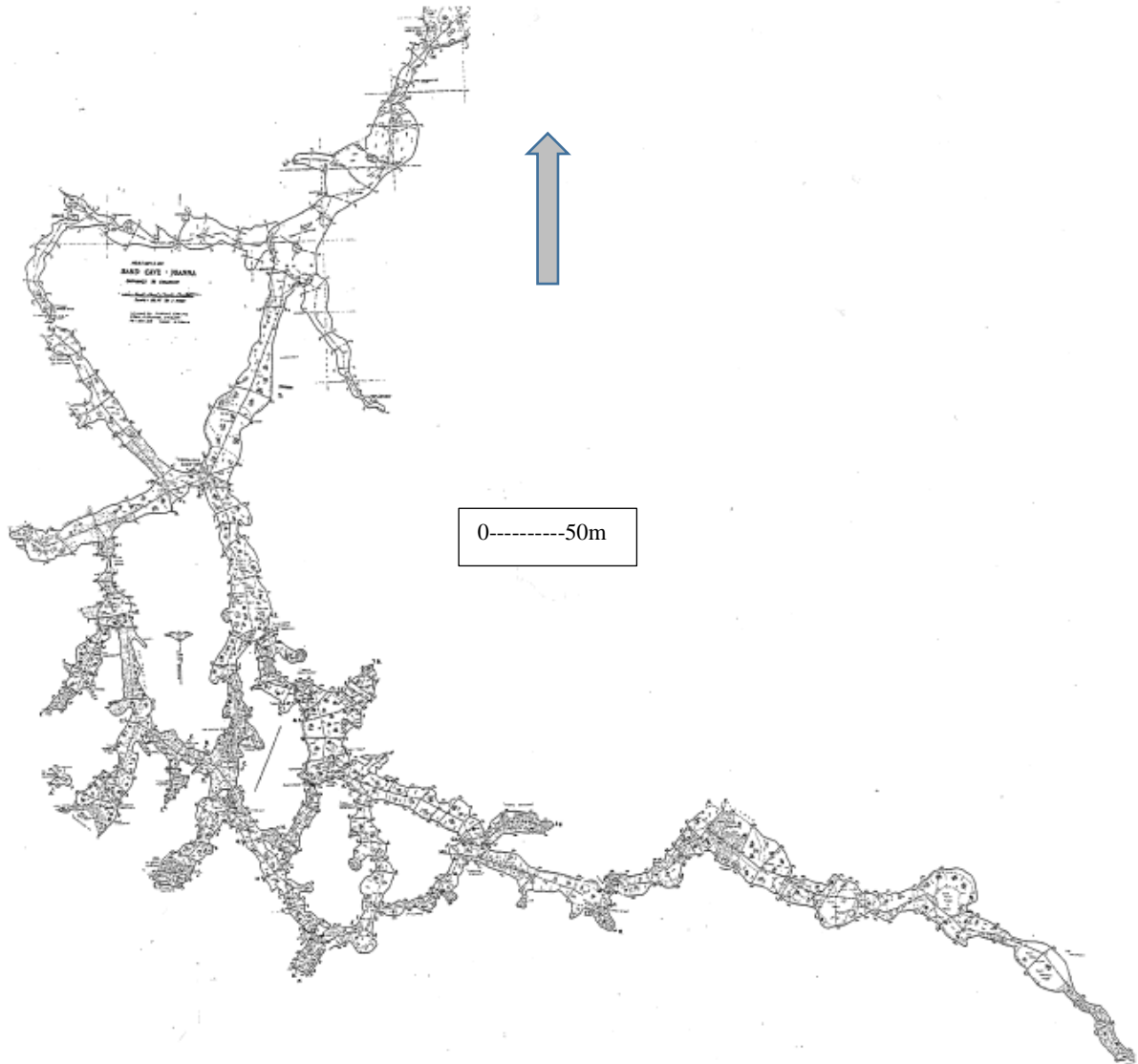
Compilation of CEGSA's detailed VICTORIA FOSSIL CAVE 40-sheet map series (I Lewis and D Arnett 1976). This cave exceeds 4 kilometres of maze passages and hallways and took many years to explore and map in the 1970's after the 1969 discovery through the Fossil Chamber by Professor Rod Wells. Different shades indicate access zones rated for tourists, speleologists, palaeontologists and off-limit 'reference' zones. The Fossil Chamber in the centre and the Ossuaries to the right are the most abundant fossil accumulations, for which this cave was listed under World Heritage in 1994. Source: CEGSA map records.



CEGSA map of Wet Cave, showing the public self-guided pathway through the two large chambers of the eastern section of the cave (black loop). Beyond here, the western section of the cave is an 'Adventure Cave' for speleological exploration in small groups by the public under leadership of a DEWNR Guide. This cave has two entrances which were known for many decades as 'Stick Cave' and 'Tomato Cave' as indicated, but the original name of 'Wet Cave' as it was known in Tenison-Woods' time (1850's) has been reinstated.



Example of a CEGSA map of a smaller cave. Wombat Cave is nearby to the main tourist caves but shorter and shallower. It is not for public access. Cave maps use symbols recognised internationally among speleologists although they contain varying amounts of detail, often depending on the intended use of the map. In both these maps above, recording the cave morphology and detailed documentation of the speleothems (stalactites, stalagmites and flowstone etc) has been important for ongoing monitoring purposes. Both maps are to the same scale. Source: CEGSA map records.



Sand Cave was recently acquired by DEWNR and is a large cave system 2.5 kilometres long. Mapping by speleologists was a major project over a decade coordinated by W Goedecke and completed in 1971 on a large number of highly-detailed map sheets (here amalgamated and reduced)

Due to vertical access requirements, this cave has been relatively unvisited since European settlement. As such, portions of this cave system are considered to be 'reference' areas to allow scientific assessment of undisturbed passages and their contents in comparison to other heavily-visited caves across the Naracoorte Caves Complex.

The branching patterns of Sand Cave's southern passages differ from other caves at Naracoorte as they were partially-developed by streamways from the surface draining into the cave from a nearby shallow valley to the east. This is very unusual for Naracoorte Caves as they are commonly dissolved by groundwater. Source: CEGSA map records.



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Blanche Cave - large columns in the first chamber approaching the second (middle) entrance. The wooden benches are reminiscent of picnics and public gatherings in this chamber in the 19th and early 20th centuries. The large irregularly-surfaced columns are rare in Naracoorte caves but are a major feature in the daylight zones of Blanche Cave. Photo: Steve Bourne



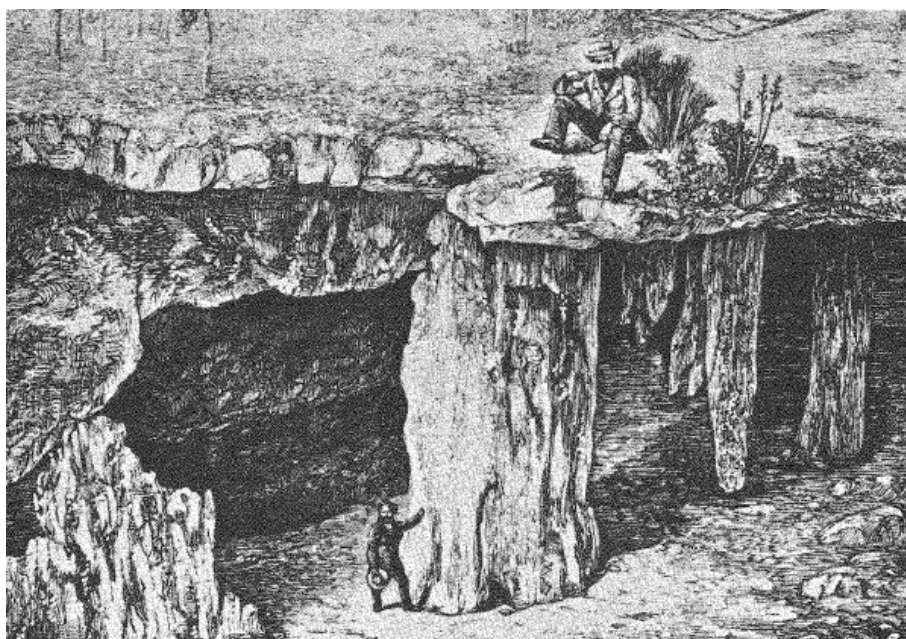
Blanche Cave Third (northern) entrance at the commencement of the enclosed cave tour section. The two historical images on the following page were taken looking down into this entrance. Photo: Kate Hill; Source: ABC Mount Gambier Local Radio website

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1856 Woodcut reputedly showing the Reverend Julian Tenison-Woods above Blanche Cave's third (northern) entrance. Tenison-Woods undertook some shallow excavations near the base of the large column in his early scientific investigations of fossils and contemporary animal remains. Source: SA Library collection



1890 photograph of Blanche Cave's third (northern) entrance 40 years later showing original vegetation cover. From about this time onward, William Reddan adorned this entrance area with ivy and ferns and the landscape with a forest of Monterey pines. Source: SA Library collection

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Reverend Julian Tenison-Woods. Source: SA Library collection.



but particularly as Caretaker of the Naracoorte Caves (which was combined with that of Forester), he was well known, for his ready wit and attractive personality made him an ideal guide. He it was who discovered in 1896 the Victoria Cave and in 1908 the Alexandra Cave, fine acquisitions to the already far-famed Caves. Many people will remember him as an entertainer of no mean order in his capacity of guide, and his extensive repertoire of original stories appertaining to the Caves made a tour through them an interesting experience. His garden surrounding the Cave cottage was from its beginning made shortly after he took up his residence there a thing of beauty. He had the finest show of roses in the district and in chrysanthemum

▪ *Naracoorte Herald (SA)*, 27 March 1923, p 2

William Reddan and a portion of his obituary, 1923. Photo: WA Francis.  
Source: the late Agnes Needham (one of Reddan's daughters)

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Weddings, Parties, Anything – Blanche Cave has been a very novel and popular venue for countless social gatherings of all kinds since its discovery by European settlers in 1845. It has hosted conferences, celebrations, dances, Governor's receptions, operas, Shakespearean plays and saw the Olympic Torch Relay through the cave in 2000. Blanche Cave has continued to be an important icon of the Naracoorte community for 170 years. Photo: Steve Bourne



Carols by Candlelight in the Blanche Cave Entrance Chamber, 2010. Photo: Steve Bourne



Dr Liz Reed excavating in a palaeontological pit site in the third chamber of Blanche Cave. White labels indicate different sediment and environmental change horizons including the megafaunal extinction event approximately halfway down. The roof of the cave at this point has been an owl roost for tens of thousands of years and the bones of their small creature prey have provided a unique sequence of evidence for ecological niches and variations within small species down the food chain over geological time. Photo: Steve Bourne

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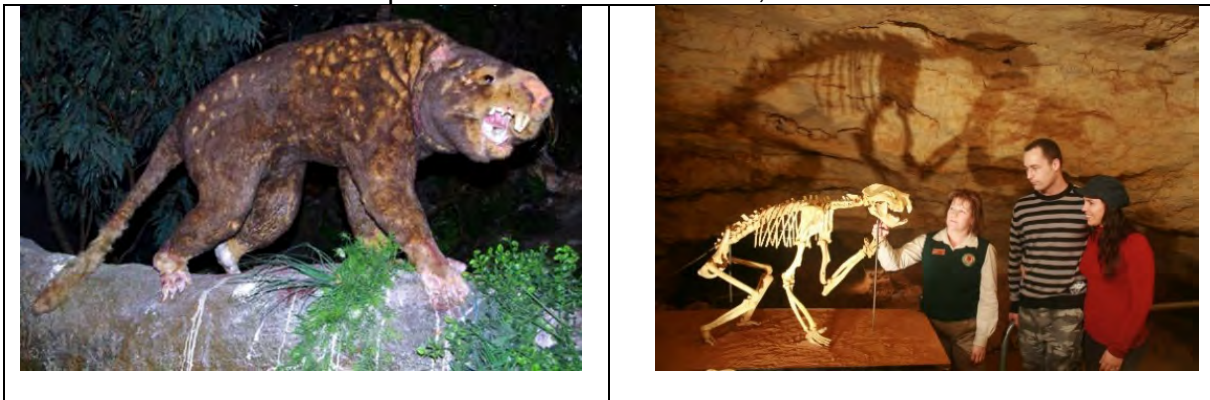
View from the public seating area of the Fossil Chamber showing the front area of the World Heritage fossil assembly in Victoria Fossil Cave. The skeleton is a reconstruction of *Sthenurus occidentalis*, a large slow-moving leaf-eating kangaroo ancestor. Photo: Department of Environment, Water and Natural Resources



Undisturbed fossil bones on the surface of the Inner Ossuary, Victoria Fossil Cave. Photo: Department of Environment, Water and Natural Resources



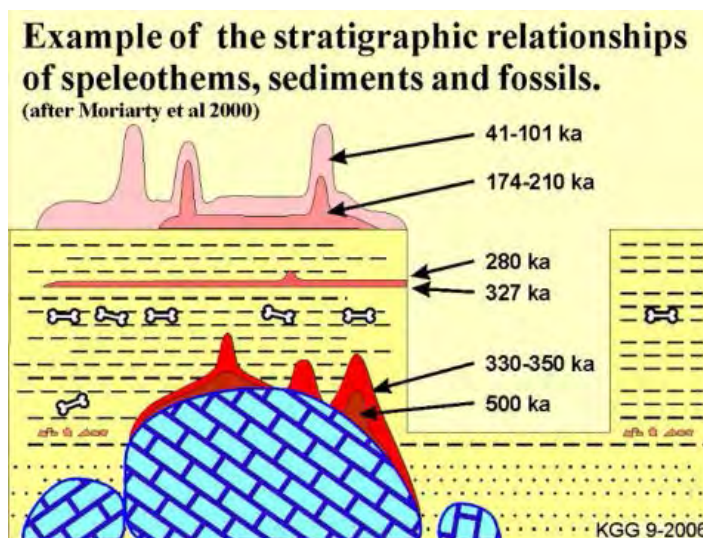
The Wonambi Interpretation Centre contains a large walk-through reconstruction of the local environment of Mosquito Creek, the caves and the animals of several hundred thousand years ago at a stage when the climate was slightly wetter. Palaeontologist field notes provide information on the various creatures and their environment. Photo: Department of the Environment, Australian Government.



Life-sized reconstructions of *Thylacoleo carnifex* ('Marsupial Lion') and skeleton at the Wonambi Interpretation Centre and on display for the public at the World Heritage Fossil site in Victoria Fossil Cave. Although given the common nickname, *Thylacoleo* was not a 'Lion' of any kind but a distinctive mammal predator with large shearing teeth that may have preyed upon large animals from trees above. Photo (L): Department of Environment, Water and Natural Resources. Photo (R): Steve Bourne



Life-size replicas of *Procoptodon* ('Giant Kangaroo') and *Zygomaturus* ('Giant Wombat') with guides for scale. These are likely to have been prey for *Thylacoleo*.  
Photos: Ian D Lewis



Fossils within a cave can be dated from associated geological and sedimentological evidence recorded carefully during excavation. This diagram shows a series of dated environmental events which 'constrain the age of the fossils between them'. The oldest dates are from stalagmites and flowstone which grew over a boulder that had fallen in from the roof more than half a million years ago. Fossils found in sediment above this but beneath the next thin flowstone layer (327-280 thousand years old) fell into the cave before then but after the lower stalagmites were buried by sediment. Data from: Moriarty et al 2000; Diagram source: Grimes 2006



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Professor Rod Wells demonstrating evidence at the public display area of the fossil assembly in Victoria Fossil Cave, for which he was instrumental in obtaining World Heritage status in 1994. The fossils have appeal to all ages, particularly children. Photos: Steve Bourne



Three recreations of *Megalania* ('Giant Goanna'), *Thylacoleo* ('Marsupial Lion') and *Procoptodon* ('Giant Kangaroo') skeletons at the entrance to the Naracoorte Caves National Park. Photo: Steve Bourne

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Alexandra Cave Mirror Pool – straws and helictites in the centre chamber. This beautiful cave was discovered by William Reddan in 1908 and named after Queen Alexandra, wife of Edward V111 of Britain. After a Gala Event and special Opening Ceremony performed by SA Governor Sir Day Hort Bosanquet in May, 1909, Alexandra Cave was opened to the public for viewing and tours. It is the most attractively-decorated of the Tourist caves. Photo: Steve Bourne

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An assembly of delicate 'straws' in Alexandra Cave. These features are hollow and slightly wider than the diameter of a water drop. Water seeps through the rock from above, deposits a small ring of calcite around the edge of each drop when it enters the airspace of the cave and the straw develops downward. Almost all stalactites commence from straws, only thickening when the water flow inside them becomes blocked by crystal growth. [www.tripadvisor.com.au](http://www.tripadvisor.com.au) (currently obtaining DEWNR photograph in preference)



Large ornate columns, stalactites and stalagmites in Alexandra Cave, known in earlier Tourist periods as the 'Wedding Cake'. The columns are 3m high. Earlier protective chicken-wire enclosures were removed for better public display when the Naracoorte Caves came under management by National Parks and Wildlife from 1972.

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Tree roots in Fox Cave penetrating into a large cave chamber through fractures in the limestone searching for groundwater. The arch-shaped chamber roof is a stable passage form in the local horizontally-layered Naracoorte limestone. Fox Cave is a non-tourist cave but is available for visitation by speleological groups, researchers and limited public groups under supervision. Photo: Steve Bourne



A group of 'Adventure Cavers' on a 'Wild Cave' tour run by DEWNR Guides. These trips provide access to caves generally unavailable to the public but capable of being explored under qualified leadership. This 'experience' tourism caters for exploration and a deeper understanding of the fragility of the cave environment and the principles of cave conservation. Photo: Steve Bourne



A typical passage of major caves in the Naracoorte Caves Complex. This chamber in Fox Cave contains a large sand cone which has accumulated progressively through a small circular 'solution tube' entrance above. Sand cones are of particular interest to palaeontologists as they contain the remains of many creatures which have fallen into the tube entrances (known as 'pitfall traps'). Sand layering within the sand cone structure is complex and contains much environmental information. Track marking – in this case by small stones - guide cave visitors away from sand cones to avoid treading on fossil accumulations within the sand. Photo: Steve Bourne



The unusual shapes and structures of these stalactite- and column-like features are thought to be influenced by bacterial and algal growth interspersed with calcite deposition. They are known as 'biothems' and occur principally within the daylight and twilight zones of Blanche, Wet, Cathedral and Robinsons Caves and require further study. Photo: Steve Bourne.

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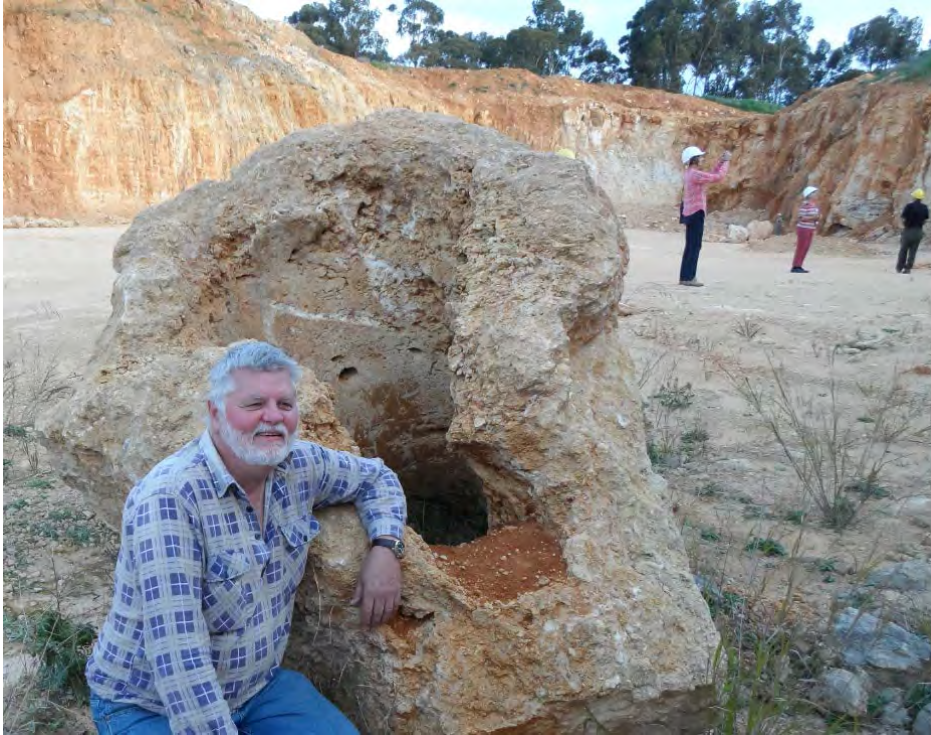
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A close-up photo of a cluster of hibernating Southern Bent Wing bats (*Miniopterus schreibersii basanii*) in the roof of Cathedral Cave. Each bat is the size of a mouse. Clustering together allows the group to share warmth as their body temperatures drop during winter hibernation periods. Ears and nose leaves are small in this species as they principally navigate by radar, not by sight and sound like some larger bat species. Photo: Steve Bourne



Southern Bent-Wing Bat (*Miniopterus schreibersii bassanii*) in flight in Cathedral Cave bat chamber. Wingtip span is approximately 30 centimetres. Unlike most bats, the wingtips have a third segment which is attached to an elongated 'little finger', giving this species exceptional manoeuvrability in flight to catch fast-moving insects. They are listed by the Commonwealth of Australia as a Critically Endangered Species and only breed in one cave – Bat Cave – in the Naracoorte National Park . Photo: Steve Bourne



A Naracoorte Limestone block in Henschke's Quarry, east of Naracoorte containing a 'solution pipe'. These form naturally in limestone and dissolve downwards along weaknesses into the rock. Where they intersect a cave beneath, they form the most common type of 'pitfall' fossil trap in the Naracoorte region. They are typically up to 1 meter in diameter so larger animals rarely fall into them. This leads to 'pitfall bias' in the fossil assemblages found beneath. Photo: Frances Williams



An array of developing solution pipes exposed in Gartners Quarry, south of Naracoorte. As these pipes develop deeper, they are being filled with red terra-rossa soil. Chemical interaction between the soil and limestone is thought to enhance this process. In this locality, the solution pipes have not yet intercepted a cave beneath. Photo: Steve Bourne