

## **MANAGEMENT, MONITORING AND EVALUATION OF THE CRADLE OF HUMANKIND FOSSIL SITES**



**UPDATED FOSSIL SITE MANAGEMENT PLAN  
FOR**

**WONDER CAVE**

**2009 - 2013**



## UPDATED SITE MANAGEMENT PLAN FOR PERIOD

2009 - 2013

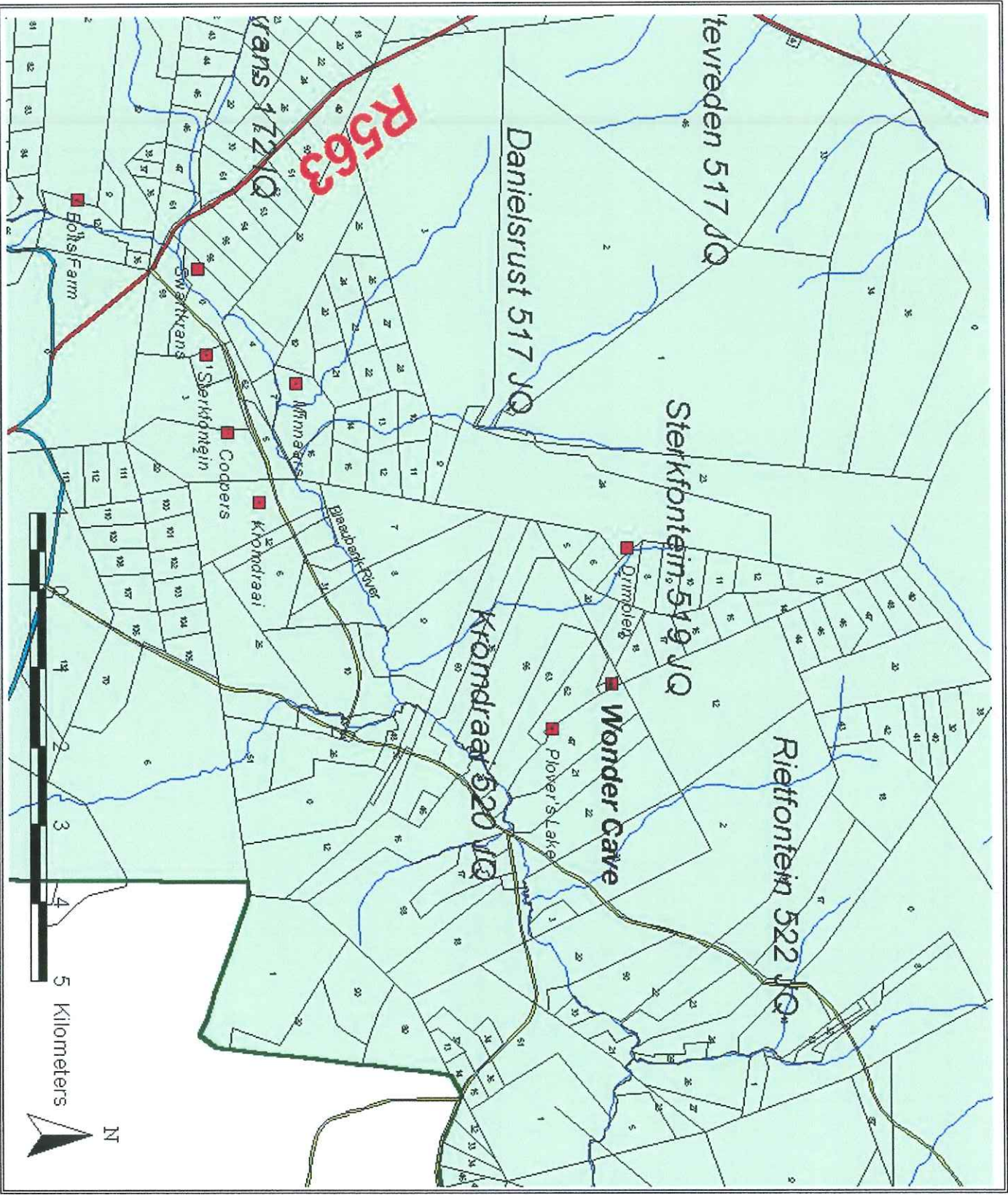
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## **SUMMARY OF KEY ISSUES**

- Wonder Cave is not yet gazetted as a National Heritage site.
- There is no Heritage Agreement in place with the landowner.
- The general provisions of the NHRA and NEMPAA provide legal protection for the site
- The site is the only dolomitic cave besides Sterkfontein which is open to the general public and which provides a modern analogue for what the weathering remnants of ancient caves elsewhere in the COH WHS must once have looked like millions of years ago.
- Unlike Sterkfontein, Wonder Cave has excellent examples of stalactites and stalagmites besides a whole range of other speleothem types. The variety, beauty and relatively undamaged state of the calcite decorations are unsurpassed by any known accessible cave in the Cradle of Humankind
- This fact – accessibility plus modern analogue with intact beauty – provide the site with its most significant attributes
- The subterranean environment may be at risk due to desiccation, changed air flow, increased CO<sub>2</sub> levels, and floor compaction
- The site is run as a commercial enterprise.
- Wonder Cave, next to Sterkfontein, is the main cave-related tourism attraction in the Cradle of Humankind.
- The tourist infrastructure including restaurant and restroom burnt down recently and has not yet been replaced
- The site is managed by the landowner and his employees.
- There is little management role for the COH WHS MA
- There is no active excavation in progress at the site
- The proximity of the Rhino and Lion Park, Wonder Cave itself and the nearby hominin site of Drimolen together provide excellent opportunities for a tourism package that would be unique in the Cradle of Humankind.
- Carbon dioxide levels in the cave need to be monitored and if found unacceptably high, steps will need to be taken to reduce it to within acceptable limits.
- The conditions of the “permit to develop” issued 18 years ago (issued by the Transvaal Provincial Administration ) need to be monitored and compliance assessed
- The safety of the electric hoist used to move tourists into and out of the cave falls under its own safety inspection regulations, and is not part of the safety inspections organized by the COH WHS MA.



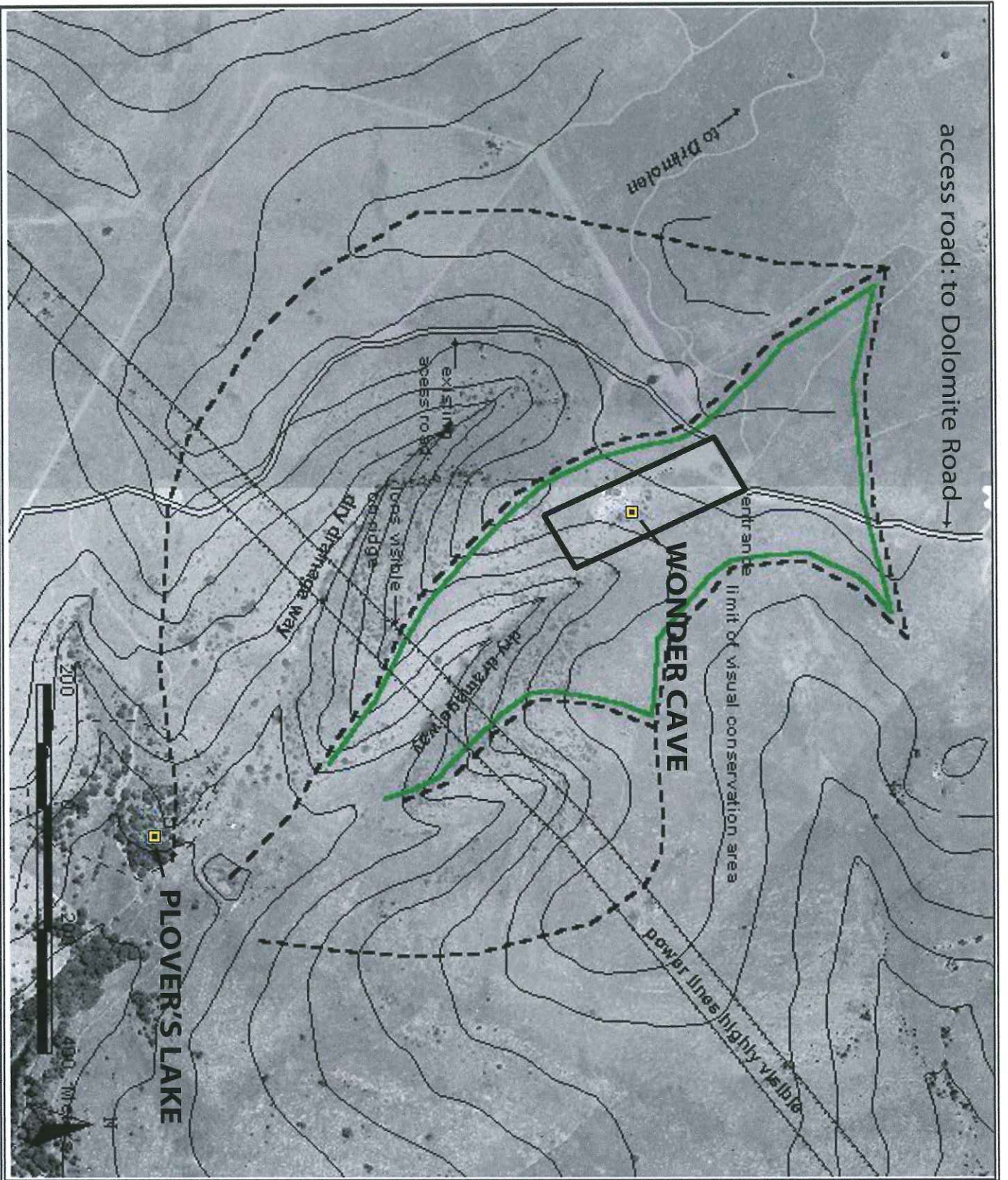
**WONDER CAVE SITE  
MANAGEMENT  
PLAN**

**Legend**

- Fossil sites
- Arterial Road
- National Road
- Secondary Raod
- Farm boundaries
- ~ River
- World Heritage Site





**WONDER CAVE**

**Figure 1**  
Locality map



**WONDER CAVE SITE  
MANAGEMENT  
PLAN**

**Legend**

-  proposed position of site boundary
-  visual boundary
-  contours
-  palaeontological site

**WONDER CAVE**

Figure 2  
Aerial view  
of site

# 1 INTRODUCTION

Wonder Cave is about 3 km east of Drimolen, situated near the crest of a hill overlooking Plover's Lake on a 'landlocked' property access to which is indirect, via an adjacent privately owned property known as 'The Rhino and Lion Nature Reserve' (Fig 1). The cave was formerly known as Van Wyk's Cave or Pothole.

## 1.1 Objectives

- To preserve the full range of natural and cultural heritage values, the site significance and authenticity of the Wonder Cave geological site
- To identify and understand the issues that threaten site significance and to provide management measures and monitoring to address them
- To balance opportunities for research, education and tourism without compromising the integrity of the site or the aspirations of the landowner
- To recommend appropriate infrastructure and management strategies to achieve the above goals
- To preserve as much as possible of site context and sense of place in an area that is subject to unprecedented development. Wonder Cave is excellently situated to demonstrate cave formation and the processes of sedimentation and calcification, an opportunity which can be had nowhere else as effectively in the Cradle of Humankind.
- To foster and maintain communication links between management bodies, landowners and researchers as partners in management and conservation of the fossil site.

## 1.2 Method

- Consultation with landowners, researchers, repository institutions and support institutions to reveal concerns, contentious issues, requirements and future plans
- Research and understand the full range of natural, cultural, scientific, educational and ecological values of the site. Collation of information gained from a series of fossil site inspections has been incorporated.
- Provide an updated list of site values
- Refresh statement of site significance, in consultation with scientists
- Provide an illustrated status quo report against which change can be assessed
- Update the list of risks and threats
- Articulate a set of desired states and management outcomes and strategies by means of which desired states might be achieved
- Provide a new management table with management strategies backed, where possible, by operational guidelines for use in the field
- Monitor and evaluate progress at each fossil site inspection, review management strategies where necessary

## 1.3 Administrative information and legal status

<b>Site:</b>	Wonder Cave
<b>Name &amp; No.:</b>	Portion 24 of Sterkfontein 519 JQ (Figs 1, 2)
<b>Owner:</b>	Ed Hern (60%) Mr. van Wyk (40%) – holds "servitude usufruct rights"?
<b>Legal Status</b>	Proposed National Heritage Site, not yet gazetted
<b>Servitudes &amp; Restrictions</b>	To be investigated. (40% holder also has servitude usufruct rights – for a lifetime? Landowner to comment please)

<b>Proposed NHS Boundaries</b>	See Figure 2
<b>Contacts:</b>	Ed Hern P O Box 5616 Cresta T 011 888 6688 C 083 250 5887
<b>Locality:</b>	25° 58' 8" S 27° 46' 17" E
<b>Co-ordinates:</b>	Not yet proclaimed, so not yet available
<b>Altitude:</b>	1512m
<b>Permit Holders:</b>	Permit previously held by F. Durand, Rand Afrikaans University, dates unknown. No current permit holder
<b>Designated Repository:</b>	Univ. of Johannesburg (RAU) & Univ. of Pretoria (?)
<b>Access to Public:</b>	Access to the general public for a fee, under the control of tour guide

**LEGAL STATUS (Query: Have these issues reached a conclusion? If so, delete up to Existing site management. Landowner's comment please)**

There are several legal issues affecting the Wonder Cave site, which will have to be addressed before an acceptable Heritage Agreement with the landowner can be signed.

- A Permit to develop Wonder Cave was issued by the then TPA Chief Directorate: Nature & Environmental Conservation in 1991 (see text box below), but it appears that several of the permit conditions have not been fulfilled
- An application has been lodged for rezoning the site some years after the change in land use had already taken place.
- There are disagreements with neighbouring landowners regarding access through their properties
- A number of site safety issues were identified during a Site Safety Audit carried out under the present project.

In addition to the above, site sanitation arrangements are unacceptable in terms of environmental best practice for dolomitic terrain.

Excerpts from the letter granting "Permission to develop the Kromdraai Wonder Cave" from TPA Chief Directorate: Nature & Environmental Conservation dated 27.9.1991, and Development Conditions attached.

*"...the Administrator in Executive Committee has agreed to waive Section 99 (3) (a) of the Transvaal Nature Conservation Ordinance...thereby permitting you to proceed with the development of the cave."*

*"This permission is granted on understanding that the conditions attached hereto will be strictly abided by. Should atmospheric conditions deteriorate in the cave to an extent that this Management Authority is of the opinion that it is to the detriment of the cave, steps will be taken to ensure the redemption of pristine conditions which could lead to the closure of the cave for an indefinite period. In such an event any expense incurred in the closure of the cave will be borne by the developer/s."*

*"The elements of the Kromdraai Wonder Cave that are of particular concern are the atmosphere, cave formations and the biological organisms together with their habitats."*



The following components of the atmosphere in the cave must be monitored monthly...and the data submitted quarterly to the Chief Director...temperature, carbon dioxide and humidity. **Have these data ever been submitted?**

"Should the concentrations of the CO<sub>2</sub> at point X (on the map) exceed 0.1% provision must be made for the extraction of air from the lower levels of the cave...using a chimney."

"Before the implementation of the above air extraction apparatus a comprehensive report and design specifications must be submitted to this authority for approval."

A number of measures regarding access to the cave and cave formations are also specified.

It is recommended that the following actions will need to take place in terms of legislation before a Heritage Agreement can be signed:

#### **Actions to address important legal issues at Wonder Cave**

##### *Development permit*

1. Prepare a report on which of the Permit conditions have been fulfilled, and which not
2. Take a series of **measurements of CO<sub>2</sub> levels at the point X** marked on the map forming part of the Permit.
3. If the Permit conditions have clearly not been complied with, and/or the CO<sub>2</sub> levels are unacceptably high, take a decision on whether to close down the operation based on the old permit, or issue a revised permit based on a revised management plan.

##### *Re-zoning application*

4. This must be finalized

##### *Roads*

5. Resolve **disputes of access with neighbours**, including an investigation of the options for road access, including the possibility of upgrading the "Dolomite Road".

##### *Tourism management plan*

6. Linked to the Development Permit, and as part of the present Management Plan, the developer should present a Tourism Management Plan that adequately addresses problems of **access, site safety, sanitation and limits on tourist numbers**.

## **1.4 Existing site management**

The site is managed on a day to day basis by the landowner and his staff. There is a groundsman, kiosk attendants (the restaurant burnt down), several tour guides and a manager. The electric lift is subject to regular inspections independent of the site safety inspections organized by the Management Authority.

**Access to the property is by way of a road belonging to the Rhino and Lion Park. Vehicles have to pass through a manned boom. Because there is a fee, unauthorized vehicles are not a problem. However, there have been concerns around the use of the Rhino and Lion Park road by other property users, the same problem affects the adjacent Drimolen site. – what is the situation now?**

Access to the caves is by means of tickets purchased from the kiosk. All visitors are under the supervision of a full-time guide. Guides spoken to had the necessary qualifications and appeared to be reasonably well informed about the site values.

Additional existing site management includes:

- Tourists are confined to a mainly non-sensitive route through the site, and are under constant supervision of a professional tourist guide
- The site is open to the general public. Visitors are under the full-time supervision of a trained tourist guide
- A SAHRA Permit Committee member inspects the old excavation site on a twice-annual basis.
- The site inspection team, including COH WHS MA, SAHRA and GDACE officials, plus a contracted specialist service provider, inspects the entire site on a twice-annual basis, monitoring the management criteria noted in the generic site management plan (see Table 1, generic management plan) and particularly Table 1 of this document.
- The COH WHS MA monitors development within the surrounding COH WHS properties with a view to protecting heritage values such as sense of place and visual aesthetics..
- A site safety inspection has been provided for. This is meant to take place on an annual basis. It excludes inspection of the mechanical safety of the lift.
- GDACE is available for advice to landowners regarding erosion control, fire management, alien vegetation and weed clearance, and preservation of biodiversity
- The landowner burns firebreaks from time to time, but uncontrolled fires sometimes occur and these have the potential to cause extensive and expensive damage
- The Heritage Agreement and appended MOU between landowners and permitted scientists addresses issues of mutual management concern and is an important management tool.

## **2 SITE DESCRIPTION: PHYSICAL FEATURES, VALUES AND SIGNIFICANCE**

The fossil site management plan adopts a values-based approach and seeks to ensure that the many and various values of the site are conserved. Site values extend beyond those formally recognized as being of 'universal value' and this section seeks to provide an updated list of old, new and previously unrecorded or unrecognized values (3.1). Section 3.2 provides an updated statement of site significance which was prepared in consultation with permitted scientists working on site.

### **2.1 General site description**

The immediate environs of the Wonder Cave site are fenced off from the adjacent Rhino and Lion Park. The site is deep within private property and situated near the crest of a prominent dolomitic ridge overlooking the Cradle of Humankind. The owner has taken advantage of the fine view and established a thatched-roof restaurant (burnt down in 2007) and small site museum with sales point close to the cave entrance. The facilities have not yet been replaced.

There is a car park which is thinly paved with loose gravel and a pathway leads to the restaurant. Dust from cars entering and leaving the car park can easily be drawn into the cave, thus resulting in discolouration of the speleothem decorations. Erosion is becoming a problem.

The rest of the enclosed area is informally landscaped and there are chairs and thatched umbrellas where people can sit. There is no 'rangeland' within the Wonder Cave precinct,







although the entrance area to the cave has some fine examples of Highveld trees, and there are more trees just beyond the fence.

There are good toilets but no holding tank was visible: It appears that environmentally hazardous septic tanks and "soakaways " have been constructed. These pose a problem for groundwater contamination, and cannot be considered as acceptable in a dolomitic environment.

The Wonder Cave ecosystem was the subject of an EIA by Batchelor (1980) (mentioned in a DEAT text but reference not given).

A partially-cemented pathway with a low, bricked parapet on either side leads visitors to the gated cave entrance. The sloping entrance driveway and path creates an automatic channel for water (Figs 3,4 and 5), which would normally be directed into the cave during rainstorms, but the flow has been deflected away from the visitor entrance. Water abstraction combined with redirection of rainwater which would normally enter the cave, is contributing to the desiccation of the cave.



*Fig 3: Erosion of the Wonder cave driveway, 2008*



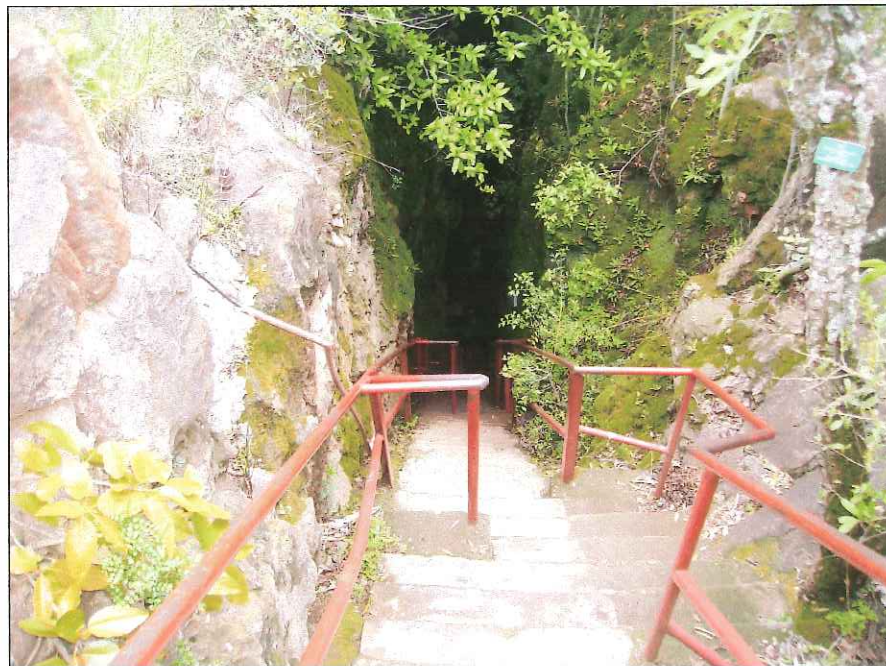
*Fig 4: Erosion of the entrance pathway, Wonder cave, 2008*



*Fig. 5: Ruptured sandbagging on entrance pathway, Wonder Cave*



*Fig 6 Ruin of restaurant after the fire, 2007*



*Fig 7: The narrow shaft-like aven providing access into the Wonder Cave. From the bottom of the steps, an electric lift takes visitors down to the top of the debris cone which formed beneath the aven, which is still many metres above the true cavern floor.*

The cave is accessed through a vertical shaft with a very steep and long staircase (Fig 7) and an electric elevator or lift. The shaft opens into a large cavern about 125 x 50 m with a ceiling height of up to 40 m. It is artificially lit with electric lighting. There are several deposition cones below avens that are now choked with surface-derived material. One is partly calcified and fossilized primate remains and other small mammals can be seen on the surface at the apex. Another is unconsolidated and appears to be stable with a slope of about 70 degrees.



The cave appears to be in the process of desiccating as a result of altered airflow and other factors. Carbon dioxide levels can be expected to be unduly high due to the high tourist throughput. CO<sub>2</sub> is generated by progressively rotting wooden railway sleepers that have been used as a structural material throughout the cave.

Desiccation, flaking and dust pollution of speleothems was observed during the course of the site visit, as was the algal growth on speleothems situated below electric lights. Biologically, the cave is compromised, particularly by the compaction of the substrate on the tourist pathway, which inhibits the genesis and movement of cave microbiota. The lighting and regular tourist visits have displaced the bat colony that formerly used the cave as a roost, and whose excreta replenished the nutrient status of the cave.

Wonder Cave, previously known as Van Wyk's Pothole or Cave, represents a younger generation of caves than the Sterkfontein, Swartkrans, Coopers and Kromdraai Caves. It has not yet developed a large opening to the surface and has therefore not yet been as extensively filled with surface-derived soil, rock and other debris. Neither has weathering proceeded to the stage where the cave, its roof and its infill are in the process of being destroyed by natural erosive forces.

Wonder Cave therefore preserves its attractive speleothem linings and decorations, which formed when the cave, still subterranean and largely sealed from the exterior, first became aerated, following its initial dissolution, by a lowering of the groundwater table. Furthermore, the Wonder Cave speleothem decorations have been relatively little damaged by early lime-mining activities, and the cave retains enough of them to be a tourist attraction. It is arguably the most accessible and attractive 'view cave' in the Cradle of Humankind.

It is important to ascertain whether or not the terms and conditions of the original permit issues continue to be met because it would appear that there are reasons to suppose that the site values may be at risk from increased CO<sub>2</sub> levels from tourist throughput (Needs MA Input)

The cave possesses an interesting debris cone of surface-derived material that has developed beneath a small aven or shaft which broke through to the surface, forming an entrance. It includes partially fossilized and fossilized bone in a matrix which is as yet incompletely calcified by percolating lime-charged solutions. The bones include, amongst others, those which are easily recognizable as baboon bones, and can be viewed by making a short detour from the normal tourist route. The baboon skull was subsequently removed, but some limb bones are still visible.

The cave therefore possesses both educational and research potential as it serves as a useful and easily demonstrable modern analogue for ancient processes of sedimentation, calcification and fossilization that took place in other more ancient caves a long time ago, and preserves a variety of different types of speleothems.

However, changed air flow and raised CO<sub>2</sub> levels as well as desiccation are threatening the cave environment and compaction of the floor is an additional problem. The cave is accessed through a vertical shaft with a very steep and long staircase and an electric elevator or lift. The shaft opens into a large cavern about 125 x 50 m with a ceiling height of up to 40 m. It is artificially lit with electric lighting. There are several deposition cones below avens that are now choked with surface-derived material. One is partly calcified and fossilized primate remains and other small mammals can be seen on the surface at the apex. Another is unconsolidated and appears to be stable with a slope of about 70 degrees. The tourist guides do interpret the interesting remains of mining activity at the base of the cave.

The fossilized and partially fossilized bone material has been the subject of studies undertaken by Dr. Francois Durand of Rand Afrikaans University, now the University of Johannesburg.

## **2.2 Site values**

Certain values, particularly the World Heritage Values are well documented but others have not been sufficiently recognized until now. Seven sets of values have been identified: landscape values, palaeontological and archaeological values, mining and historical values, research values, biodiversity and ecological values, educational and tourism values, and finally, social values. The relative importance of these values differ – there are several that have allowed for World Heritage Status and National Heritage Site status while others are of a more regional or local value.

### **2.2.1 Landscape: Geological and geomorphological values**

The subterranean environment is the reason for the existence of the Wonder Cave as a tourist attraction. The entire site significance rests on this environment. The cave has considerable educational and tourism value and is a useful comparative cave in the scientific sense, even if its fossil potential is not great. Therefore, it is worth conserving and rehabilitating, as far as this is possible. The well-preserved travertine linings and the ease of access make it an important component in the suite of COH tourism options on offer. It is the best preserved, most accessible speleothem-decorated cave in the Cradle of Humankind.

It is recommended that the well preserved natural environment in which Wonder Cave is situated be utilised, in conjunction with the Drimolen Fossil Site to offer a unique interactive and authentic tourist experience.

#### Summary of values:

- The Wonder Cave is a younger cave than many others in the COH and provides many educational and research opportunities as it presents an analogous situation by which past processes can be elucidated and explained.
- Although the cave was mined for its calcite deposits, most of the speleothems have remained intact, probably on account of their inaccessibility – most of them are out of reach, hanging from the ceiling.
- The chamber shows a dome-like roof structure which is characteristic of dolomitic solution caverns (Brain, 1958)
- There are magnificent examples of curtain stalactites, which unfortunately have become sullied by a combination of 'inhaled' dust and algal growth, the latter being the result of inappropriate lighting.
- The well-preserved travertine linings and the ease of access make it an important component in the suite of COH tourism options on offer
- The main chamber of the cave was briefly mined around the turn of the century and the relics of this mining activity are preserved in the depth of the cave. This is impressive because it demonstrated the lengths to which people were prepared to go in order to get supplies of lime.
- There are two debris cones, one of them enormous, which have developed under some avens (vertical solution cavities, developed along joints).
- One of the debris cones preserves the remains of baboons which fell or were washed into the cave

- There is a neat archaeological 'dig' cut into the wall of a debris cone which is also of educational interest.
- The entrance steps negotiate a spectacular example of a vertical shaft type of cavern entrance (an enlarged aven) typical of hilltop or flat country entrances. The lift starts where the aven intersects with the ceiling of the underground chamber

### **2.2.2 Palaeontological and archaeological values**

- The cave has not yielded important fossils as yet. It is a younger cave than the very ancient caves encountered elsewhere in the COH and the fauna retrieved so far does not indicate a great age.
- An archaeological excavation into the side of a debris cone did not encounter any significant fossils although some sub-fossil bones were found.
- No stone tools have been encountered
- The final report by Dr Durand should provide full details on the outcome of the excavation.
- The excavation is relatively minor and the archaeological and palaeontological values of the site are poorly understood as yet

### **2.2.3 Mining and historical values**

- The floor of the cavern, reached after a major descent in a lift, and further descent via steps, preserves interesting relics of the mining activities carried out during the early part of the last century. The astounding thing is the effort to which miners were prepared to go in order to get at the limestone. There are cocopan tracks and the remains of a haulage ramp which are astonishing in that at that time, there was no electricity and everything had to be done by lamplight and with winches.
- At the aven-like entrance, are the remains of a lime-burning kiln

### **2.2.4 Research values**

- Younger cavern systems than other Cradle of Humankind fossil sites
- Provides an accessible modern analogue for past processes such as sedimentation, the breccia cementation process, fossilization and speleothem growth.
- Comparatively modern sub-fossil and fossil material present.
- Good examples of a young, partially calcified, bone-bearing talus cone with incipient fossils of rodents, frogs, lizards, birds and baboons.

### **2.2.5 Biodiversity and ecological values**

- The surrounding vegetation is typical of that of the higher, more open dolomite ridges with larger shrubs and trees found choking the mouths of sinkholes and avens, where they find extra moisture and protection from fire and frost.
- Key tree species include the white stinkwood, the wild olive and the cabbage tree. Apart from these tree clumps, the hillside is open and covered with short highveld grasses.
- The sense of openness and freedom is marred by the need (in the transit experience from gate to site) to have both sides of the access road and the immediate surrounds of the Wonder Cave site heavily fenced with rhino-proof fencing; a difficult visual impediment to mitigate.
- The heritage site itself is very small and the entire fenced off area is artificial in that it is landscaped

## 2.2.6 Educational, tourism and economic values

- Best preserved, most accessible speleothem-decorated cave in the Cradle of Humankind.
- It is recommended that the well preserved natural environment in which Wonder Cave is situated be utilised, in conjunction with the Drimolen Fossil Site to offer a unique interactive and authentic tourist experience. Museums have their place in the presentation of the Cradle of Humankind, but nothing can replace a first-hand experience of live animals, real plants, a real cave and an active fossil dig (at Drimolen). The juxtaposition of these four components in close proximity is unique in the Cradle and allows for the development of a diverse and exciting tourist product.
- Planning should include the provision of an educational package that incorporates aspects of the geological and topographical landscape, the vegetation, the animal populations resident on the property, cavern formation and filling and the excavation and the scientific recovery and interpretation of fossils. Of all the sites in the Cradle, the Wonder Cave property (combined with Drimolen and the Rhino and Lion Park) offers the best opportunity to present and interpret the significance of the Cradle as an actuality experience.
- This concept needs further development, and planning of the different elements is necessary. Management of Wonder Cave and Drimolen needs to be discussed as a pair. The planning of trails therefore does not fit into the site-specific plan for Wonder Cave, but needs to be planned with other elements.

## 2.2.7 Social values

- The site is used as a recreational area which is quite apart from the heritage values. For most visitors, a tour which focuses on anthropomorphic features of stalactites and stalagmites has nothing 'wrong' with it. The mere excitement of going down a cave and eating out is sufficient. The fun rather than the academic element is significant.

## 2.3 Original statement of site significance (J Deacon 2002)

There is no active research at this site at present and the Statement of Site Significance remains unchanged:

*"Wonder Cave is a large solution cavity with more intact speleothems and younger fossils than the other known sites in the Cradle of Humankind. The fossils include primates, but no hominins, and probably date to less than 10 000 years. The cave is significant as a component of the World Heritage Site because it provides a living model of the natural process of breccia formation that led to the preservation of hominin fossils at the older sites.*

*It was recommended by ICOMOS in 1999 that the fossil sites in the Cradle of Humankind be declared a World Heritage Site because they "contain an exceptionally large and scientifically significant group of sites which throw light on the earliest ancestors of humankind. They constitute a vast reserve of scientific information, the potential of which is enormous."*

*In terms of the criteria set out in Section 3(3) of the National Heritage Resources Act (Act No. 25 of 1999), and specified for Grade I national heritage resources in the draft SAHRA Regulations on Grading System and Heritage Resources Assessment Criteria, Wonder Cave qualifies for national heritage status because of its:*

- Importance in the pattern of South Africa's history.** Wonder Cave provides an analogue model for interpretation of the complex history of fossiliferous deposits in the Cradle of Humankind.*
- Possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage.** Wonder Cave retains rare examples of limestone formations in the Cradle of*

Humankind. Speleothems in most other caves in this area were removed by limestone miners in the twentieth century.

- (c) **Potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage.** The on-going formation of fossiliferous breccia in Wonder Cave is valuable for public education because it demonstrates the process by which early hominin bones were deposited in solution cavities and became fossilised.
- (d) **Importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects.** Wonder Cave demonstrates the characteristics of natural speleothem formations and of consolidated and unconsolidated talus cones beneath avens.
- (e) **Importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.** The aesthetic qualities of Wonder Cave are partly intact although some limestone formations have been damaged.
- (f) **Importance in demonstrating a high degree of creative or technical achievement at a particular period.** No stone or bone tools have been found at Wonder Cave.
- (g) **Strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.** Wonder Cave is important to all South Africans who are interested in the history of our species and the way in which fossil deposits are formed.
- (h) **Strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa.** No special association has yet been established.
- (i) **Significance relating to the history of slavery in South Africa.** The age of the deposits at Wonder Cave places it well before the time period of slavery in South Africa. (J Deacon 2002)

### 3 SITE ANALYSIS: STATUS QUO, RISKS AND THREATS, JULY 2008

In order to provide a basis against which change can be assessed, a status quo report is necessary. Ideally, change is assessed by means of comparison of 'fixed point photography' and such fixed points are in the process of being selected and installed. For scientific excavations, the datum point has been used where possible.

In order to assess the management strategies that may be necessary in order to preserve site values, threats and risks to site values have been analysed as part of the status quo, and the next section (Section 4) describes desired states and management outcomes.

#### 3.1 Physical Environment: Surface

This section addresses the status quo of seven elements of the physical environment, namely physical and legal access to the property, rangeland or veld condition, erosion, fire management, rare plants and animals, alien invasive species and visual aesthetics.

##### 3.1.1 Access, legal and physical

Status quo:

Compliance with TPA ROD –

Team, I need guidance as to how much of the access problem has been solved – this applies to adjacent Dimolen as well – I am not up to date here and need help. This is the kind of info that just does not come my way. Also I have no idea what kind of follow-through the MA does between site inspections – i.e. who in the MA sees that the recommendations are implemented? (This is all very pertinent to whether or not SAHRA will sign the management plan and I am leaving the query until comment from the MA is received)

Risks and Threats:

- Access to this 'landlocked' property is difficult as it is via the Rhino and Lion park. Relations between landowners and road users has been strained in the past and the issue remains unresolved.
- The alternative access via the "Dolomite Road" is likewise unresolved

### **3.1.2 Rangeland**

Status quo:

- There is no rangeland as such within the Wonder Cave precinct because the entire enclosure is informally landscaped and there are gardens with roses, etc.

Risks and threats:

- The entire area has already been transformed, and there are no further threats at present

### **3.1.3 Erosion**

Status quo:

- Erosion could become an issue in the car park area, because it is sloping and not graveled everywhere. Parts that are grassed are becoming worn in patches. Once eroded, bare soil is difficult and expensive to rehabilitate and revegetate.

Risks and threats

- Erosion has affected the car park area (Fig 3) as well as the entrance pathway and its steps (Figs. 4 and 5). This will continue to deteriorate unless anti-erosion interventions are put in place.

### **3.1.4 Fire management**

Status quo:

- Management of fire is highly significant in the adjacent reserve and it is supposed that the landowner has his own or a communal fire management policy in place.
- The thatched roof restaurant burned to the ground some months ago (although in this case, the cause was uncontrolled domestic fire)
- Because of the danger of drawing smoke and ash into the cave, firebreaks should be slashed or mown, and not burnt. Ash and smoke settled on rock formations and discolours them

Risks and Threats:

- The thatched restaurant burnt down, highlighting the risk of domestically started fires and the need for fire-fighting equipment and staff training in such situations
- Grass fires in the vicinity can cause smoke and soot to be drawn into the cave where it would discolour speleothems

### **3.1.5 Red Data Species, rare plants and animals**

Status quo:

- Not an issue at Wonder Cave.

- A significant bat population succumbed to disturbance many years ago. This has had a serious impact on the nutrient status of the cave and probably accounts for the low micro-biota levels reported for the cave (Batchelor, 1980)

**Risks and Threats:**

- In the transformed landscape, there are no immediate risks or threats

### **3.1.6 Alien vegetation**

**Status quo:**

- There is some alien vegetation but it is inaccessible, difficult and dangerous to clear. It does not cause the usual problems associated with alien vegetation (blocking access, dense impenetrable stands, etc.).

**Risks and threats:**

- Not an issue at present

### **3.1.7 Visual aesthetics, site context**

**Status quo:**

- The view from the property is excellent and inappropriate land uses and building should be prevented. This task falls to the COH WHS MA, which monitors all incoming development plans.

**Risks and Threats:**

- The location of the site makes it particularly vulnerable to visual impact of any development. The site is on the steep side of a hillock near the top of a deep valley, and is almost totally enclosed by higher landforms all round. This location of the fossil site increases sensitivity of the contextual area to visual impact of development, especially as local landowners have the penchant for building on the tops of hills or on ridgelines.

## **3.2 Physical Environment: Subterranean**

**Status quo:**

- The absence of cave biota is a reason for concern and requires attention. The major source of nutrients in the nutrient-poor cave environment is bat guano, which supports a variety of microbiota. The displacement of the bat colony has meant a diminished level of nutrients.
- The remaining bird life associated with the sinkhole entrances to this cave constitutes an important source of cavern entrance zone nutrients, and steps should be taken to ensure their continued presence.
- A further problem is "substrate death" caused by its compaction due to pedestrian traffic. International Best practice requires that walkways be raised, and compacted surfaces gently loosened to allow aeration and the resumed movement of micro-organisms through the substrate. This should be done in such a way as to minimize dust, using wet screens.
- It also recommends that walkways be constructed of stainless steel. The use of galvanized steel is not recommended in high relative humidity conditions or raised CO<sub>2</sub> levels. The chemical corrosion of mild steel impacts on the cave atmosphere. Welding must not be done inside the cave.

- The wooden railway sleepers are gradually rotting away, giving off CO<sub>2</sub> in the process. This contributes to a raised CO<sub>2</sub> level in the cave atmosphere. All wooden structures should be removed and replaced with stainless or galvanized steel, without concrete castings on the support structures. On no account should cement bags be opened within or even near the cave – fine dust is a devastating problem.
- The rehabilitation of the speleothems needs to be addressed. These can be washed using low power pressure cleaners, preferably using cavern derived water. The green and orange-brown algal growth that is apparent on some of the formations is caused by the electric lighting, which should be changed and monitored. Special 'cold' Eco-Lights should be installed. These processes will provide the tourist with a much-improved experience. This process will take time and money.
- The accumulated grease at the foot of the lift girders is causing pollution. The un-oiled lift clutch emits both a drone and a high-pitched squeak which discourages birds from entering the upper reaches of the cave. The lift needs regular maintenance and inspection according to the legislation governing machinery.
- The existing electrical wiring is aesthetically displeasing and should be unobtrusively installed with distribution boxes out of the public view. The installations as they stand do not comply with cave wiring codes. Wiring codes are available by contacting Prof Elery on e-mail at [elery@alphalink.com.au](mailto:elery@alphalink.com.au) and explaining the problem – he will indicate the best practice code for addressing the issue.
- A disaster management plan and action policy needs to be drawn up to deal with emergency evacuation of personnel and tourists trapped in the cave.
- Information concerning the risks of histoplasmosis to AIDS-sufferers and other medically "at risk" visitors needs to be kept visible, pertinent and in the public eye.
- The cement pathway with the low bricked parapet has a diversion which diverts the normal flow of run-off away from the cave entrance. Abstraction of groundwater combined with redirected rainwater which would normally enter the cave is contributing to the desiccation of the cave.

Risks and Threats:

- Risks and threats are still poorly understood, particularly with regard to cave atmosphere, substrate and biota
- The report of a professional site safety inspector is required in order that threats and risks be properly formulated

### **3.3 Infrastructure**

#### **3.3.1 Access roads, culverts, bridges, etc.**

Status quo:

- The management of these items falls to the management of the Rhino and Lion Park. They fall outside of the Wonder cave precinct

Risks and threats;

- The entrance driveway is steeply sloping and erosion is already an issue here, and so is erosion of the entrance pathway – see Erosion above

#### **3.3.2 Fencing and gates**

Status quo:

- Fencing and gates are adequate to control unauthorized entrance of both pedestrians and vehicles and is the management concern of the Landowners.



Threats and risks:

- None at present

### **3.3.3 Parking**

Status quo:

The parking area is not ideal in that the ground is sloping and constant vehicular movement is causing erosion. Only part of the park is graveled and even here, signs of erosion are developing. The grassed area is becoming threadbare and the situation requires monitoring

Risks and threats;

- The entrance driveway is steeply sloping and erosion is already an issue here, and so is erosion of the entrance pathway – see Erosion and access road (3.3.1) above

### **3.3.4 Built environment**

Status quo:

Service infrastructure (such as sheds, water tanks, storage areas) is not screened and since the fire, is unsightly.

#### ***Pathways, walkways and viewing platforms***

- There is a cement pathway leading to the caves. This could channel water but a diversion directs water away from the entrance. (diversion of water is exacerbation of cave desiccation)
- There is a steep but good stairway (in terms of step depth) and there is a useful handrail.
- The handrail is of galvanized metal and the undersurface, where drips form, is already progressively corroding at deeper depths into the cave where humidity and CO<sub>2</sub> concentrations are higher.
- The stairway ends at the door to an electric elevator
- At the bottom of the lift shaft, passengers step out onto a cement platform which has a low wall around it. The wall is surmounted with a metal railing which is becoming dangerous as it progressively corrodes
- The lift has to make several up and down trips until the entire party is assembled below.
- From the lift base, a path leads off around the cave. For most of the route the pathway substrate is compacted cave floor, which has a knobby dimpled surface texture characteristic of severely compacted floors.
- In places there is a raised metal walkway, also in places replaced with new galvanized material
- In places there are wooden sleepers which are rotting gradually in the damp environment, and giving off CO<sub>2</sub>.
- The route through the cave is generally well designed and shows off most of the site values. The archaeological area is avoided and it is recommended that a decision as to what should become of the abandoned excavations be undertaken – are they to be backfilled, or could they be incorporated into a meaningful educational experience, with a little extra site interpretation? (where will suitable backfill material be found?)
- The tour ends with a steep climb up out of the aven. Most tourists make for the restaurant

#### ***Tourist-related, including signage***

- There is a restaurant with a veranda which has an excellent view.

- The small 'museum' type display was an excellent idea because it interested visitors and supplemented what the guides would have told them. It is recommended that a similar feature be implemented when the building is rebuilt.
- There is little in the way of published literature concerning the caves and a brochure would be useful
- There is no site interpretation boards outside the cave the lime-burning kiln could be interpreted quite easily

#### ***Ablutions and storage***

- There are good toilets but no holding tank was visible: It would appear that environmentally hazardous septic tanks and 'soakaways' may have been constructed. These could pose a problem for groundwater contamination, and cannot be considered as acceptable in a dolomitic environment.

#### **Risks and threats:**

- Since the fire, the quality of the visitor infrastructure available is not of a standard concomitant with a World Heritage Site, and 'visitor recoil' could result

### **3.3.5 Waste Management**

#### ***Sewage***

- See above

#### ***Litter***

- The landowner manages waste disposal and litter. For a public area, the site was not unduly littered.

#### **Risks and threats:**

- Site and groundwater pollution. The interim abluion and toilet facilities are not up to World Heritage Site standards

### **3.3.6 Energy**

#### **Status quo:**

- The site is on ESKOM power

#### **Risks and threats:**

- None at present

### **3.3.7 Water**

#### **Status quo:**

- Borehole water supplies the enterprise. Here used to be two large plastic storage tanks mounted on high stands

#### **Risks and Threats:**

- The unscreened tanks impact on visual aesthetics

### **3.3.8 Telecommunications**

Status quo:

- Cellphone and landline are available

Risks and threats:

- None

### **3.4 Research Environment**

Status quo:

There is no permit open at the site at present. The last person the work here was Dr F. Durand. All fossils and archaeological residues are protected and may not be disturbed by Wonder Cave staff without a permit from SAHRA

#### **3.4.1 Previous and ongoing research and excavations**

- Lime miners in the early twentieth century removed calcite flowstone but left most of the speleothems intact.
- In the 1990s, a team led by Frans Roodt and Professor Maryna Steyn of the University of Pretoria and assisted by members of the South African Society of Amateur Palaeontologists, sampled the youngest talus cone. Dr Ina Plug identified the fossilized and partially fossilized bones of rodents, frogs, lizards and birds and established the relatively recent age of this formation. There is no evidence that people occupied the cave in pre-colonial times.
- Wonder Cave was opened to the public by the previous owner, Mr van Wyk, in 1991 as a "show" cave and it is still being used for tourism by the current owner as an additional attraction to the adjacent Rhino and Lion Nature Reserve.
- Professor Steyn's excavation permit for Wonder Cave expired on 01.10.97. The fossils recovered are curated at the Department of Anatomy, University of Pretoria Medical School.
- Dr. Francois Durand (RAU) in conjunction with persons from the University of Pretoria carried out research at the cave.
- At the moment, there is no ongoing active research. The site does, however, retain research potential.

#### **3.4.2 Excavation edges**

Status quo:

- These appear to be friable but stable. They are completely out of reach and there is no pedestrian traffic around the edge.

Risks and threats:

- None at present, but monitoring required

#### **3.4.3 Excavation walls**

Status quo:

- These are well cut and vertical and appear to be stable. The depth labels from the old Durand excavation are still in place

Risks and Threats:

- None at present, but monitoring is required

### **3.4.4 Access to excavations: steps, ladders, lifts etc.**

**Status quo:**

- The excavation is reached from the underground tourist route by means of steps created from well-stuffed sand bags. These make for an easy access but they will burst and deteriorate in time. A decision needs to be reached regarding the excavation – is it to be lined and backfilled, or just left? Should the sand bags be removed? Where will backfill material be sourced?

**Risks and threats:**

- Indecision could lead to eventual collapse of the excavation walls and disintegration of the sand bags

### **3.4.5 Erosion in excavation site**

**Status quo:**

- Erosion is a natural ongoing process. The lack of disturbance and the fact that the aven above the debris cone into which the excavation has been cut is closed, means that it is stable and not subject to active water erosion. There are drips from the roof that will cause erosion over time

**Risks and Threats**

- None at present

### **3.4.6 Compliance with conditions of excavation permit**

This was assessed when the excavation was active and is no longer relevant

### **3.4.7 Witness sections**

**Status quo:**

The three intact walls of the excavation as they are, are a good reference section and provide insights into stratigraphy

**Threats and risks:**

- Stratigraphy will not be visible if excavation is backfilled
- Stratigraphic conclusions reached should be independently verifiable. If no witness sections are preserved, this would not be possible
- Dating results need to be independently verifiable. If witness sample sections are not preserved, this will not be possible
- New techniques and analytical procedures are perpetually coming to light. These need to be applied to sites from which earlier conclusions were obtained, in order to verify and expand understanding. If there are no witness sections, this cannot be accomplished.

### **3.4.8 Dumps**

**Status quo:**

- It is not known where spoil material from the excavation was dumped, and whether or not this was inside or outside of the cave.

Risks and threats;

- In future, serious consideration will need to be given with regard to creating dumps within, or sourcing sandbags material from, subterranean caves – there is a perpetual risk of creating dust which will adhere to damp speleothems. There is also the potential for altering or interfering with cave stratigraphy and sedimentation.

### **3.4.9 Repository**

Status quo:

- There are apparently two repositories; The University of Pretoria and the Rand Afrikaans University, now the University of Johannesburg

Risks and threats:

- Loss of, or deterioration of artefacts
  - Loss of information concerning artefacts
  - Lack of publicized information about artefacts
- These threats are not an issue at present.

### **3.5 Site safety and security**

Site Safety and security needs to be considered from a number of perspectives: Firstly, the physical stability of the valuable site fabric itself, and then from the perspective that site stability (or instability) impacts on the safety of researchers and those visiting the site. The safety of surface features, infrastructure and the special safety risks of subterranean environments all need special consideration.

Site Stability is affected by two different threat sources: Firstly, by natural causes which include the ongoing weathering and decalcifying processes, and secondly from man-made influences such as the alteration of surface drainage and poor excavation techniques, or by mining activities which create unstable voids, and blasting, which shatters rock and created fractures. However, it is only by the inherently destructive twin processes of mining and excavation that site significance was or can be realised.

Site security refers to man-made threats to personal and property safety, such as crime.

#### **3.5.1 Physical safety**

Entrance is tightly controlled and it is assumed that personal safety is not a problem

#### **3.5.2 Safety of surface and built environment**

Status quo:

- The built environment is not unduly unsafe but will have to await the report of a site safety officer.
- There is a notice board which indicates appropriate visitor behavior.
- There is a notice about histoplasmosis - it should draw attention to the fact that people whose health is compromised by HIV positive status or AIDS are at high risk concerning Histoplasmosis infection. There should be another board giving a similar warning in the restaurant area

### **3.5.3 Safety of excavation area**

Status quo:

- The excavation area is no longer active and as it was abandoned and stabilized, it appears to be safe at this time.

### **3.5.4 Subterranean safety**

Status quo:

There has not been a site safety inspection by the COH WHS MA since the original safety report was written and therefore the main points have been extracted and re-iterated for the sake of continuity. It is not known how many of these recommendations have been taken up and the report of the next site safety inspection is awaited:

- Access to the cave is by means of an extremely steep metal stairway (beginning portion comprises a flight of cement steps) with handrails. The treads are roughened, and where the width of the access aven allows, the staircase has been doubled, with a central dividing handrail. This allows up-coming and down-going parties to pass one another. The guide usually precedes the tourists and is there to control unruly and dangerous behaviour.
- The stairway terminates at a platform that provides access to a small electric lift (capacity 10 persons, including operator). This lowers tourists into the cave, being supported by four vertical metal lift guides, concreted into the floor. The sides of the lift are meshed, allowing tourists to see cave formations as they descend. The lift opens onto a much-compacted landing platform on a 'mezzanine level' above the cave floor. Visitors are left while the lift ascends to collect additional tourists. This is repeated until the whole party is assembled. There is a risk of unattended persons wandering off or tampering with nearby speleothems.
- The landing platform, being many meters above the true cave floor, has a protective railing of metal. This, however, has corroded to the point where it is possible to flake and peel concentric layers of metal off the bars. It is a safety risk, as tourists are apt to sit on them and lean against them while waiting for the party to assemble.
- The tourist route through the cave presents a variety of substrates. Mostly, it consists of highly compacted residual cave earth. Compaction is caused by pedestrian traffic. In other places, wooden railway sleepers have been used as treads or stairs, and in still others, cement paths and steps have been installed. In many places the walkway is uneven and floor level lighting is inadequate. The need to watch one's footing all the time means that one cannot look at what the guide is pointing out. The walkway would be termed unsafe by international standards, and as many nations adopt an "if you stumble, you sue" attitude, public liability insurance is a must.
- There is no alternative exit route apart from the lift, except by means of mechanical climbing and caving aids. The status of their emergency cave evacuation procedure is unknown.
- Around the cave entrance are a number of avens that provide openings into the underground cavern system. These ought to be fenced, not only to prevent people falling into them, but to prevent stones and other objects from being thrown into them, which would cause a risk to the tourists on the underground route. Naturally loose and falling rubble is a safety risk almost throughout the length of the metal stairway, and unobtrusive safety catch nets could be considered.
- The overhanging brow of uncalcified loose material is an area of concern as rocks and rubble could cascade into the cave entrance. Although no signs of failure of the sidewall were observed, the brow needs to be chamfered off and dangerous loose material

removed. Due to the high amount of traffic, the entrance area should be monitored on a daily basis and professionally monitored on a six-monthly basis. The monitoring can be conducted by means of visual examinations by tour guides as loose material on the footwall will indicate instability. Event-driven inspections are also required - e.g. after heavy rainstorms and at the end of the rainy season, as saturated rock becomes heavy and unstable. Visual examinations should suffice provided the brow area is made safe. This should be done prior to any rehabilitation of the interior of the cave as a considerable amount of dust could be generated.

- The bi-annual inspections should be done against a data-base which forms a frame of reference, e.g. baseline photographs and detailed descriptions of the area, to ensure that deterioration is adequately monitored. If further deterioration is noted, then additional action could be taken by using shotcrete, rock bolts or both.
- In-cave lighting, especially at floor level, could improve portions of the tourist route as some areas are poorly lit and present a risk of slipping and falling. Handrails should be checked regularly: in some areas near the lift, the handrails need to be replaced with immediate effect as they are at an advanced stage of corrosion. People leaning against the rails are at risk of falling through, and the vertical drop is considerable.
- The hanging wall is domed over much of its extent being typical of a solution cavern. Some stepped fractures were noted where blocks of roof rock have become detached and parted along natural bedding planes. These have fallen to the floor of the cave. The footwall should be monitored on a daily basis by the tour guides for signs of fallen rock and visual inspection with a high powered light should be done routinely.
- The electric hoisting equipment is subject to its own set of safety rules and regulations.
- No cave is ever entirely safe.

Threats and risks: surface, subterranean and infrastructure

- Personal safety might become a risk – holdups in the area are on the increase
- Equipment and vehicles may become at risk
- Lack of site safety inspections increases the risk of unintentional safety risks going unattended
- Unprotected drops create safety hazard, especially for elderly visitors
- Lack of emergency recovery equipment and first aid poses a threat to responsible tourism and to on-site excavators
- The report on site safety of surface features, infrastructure and the subterranean environment is awaited – all three areas carry safety risks at present

### **3.6 Presentation of site values**

#### **3.6.1 Site interpretation**

Status quo:

- The site values are adequately presented by the site guides who have a basic training as site guides
- There used to be a small annotated museum which supported the interpretation that the tourist guides presented
- There are few publications pertaining to the caves
- The site values are not well presented off-site

Threats and risks:

- Lack of site interpretation diminishes tourist experience – tourism is limited to special groups at present

- Lack of site interpretation restricts dissemination of knowledge concerning the site and inhibits its presentation to a wider audience as required in terms of the WHC
- Lack of presentation of site values to a wider audience prevents information concerning site significance from reaching public psyche
- Potential funders might not know about site significance
- Public not educated about full range of COH WHS values

### **3.6.2 Visitor numbers**

Status quo:

The landowner in all probability has a good idea of how many visitors the cave receives on an annual basis but there is not yet a mechanism for collating visitor numbers to sites throughout the Cradle of Humankind.

Risks and Threats:

- Visitor numbers are required for management purposes

## **4 MANAGEMENT OBJECTIVES, DESIRED OUTCOMES**

This section notes desired states and management outcomes, and the section and Table that follow (Section 5) describe the management strategies required to achieve such outcomes. The management objectives have the preservation all site values as a goal.

Having experienced both the quality of the amenities and the quality of the tourist experience AT Wonder Cave an issue that immediately comes to mind is the problem of exercising quality control over private tourist initiatives to ensure that they conform to acceptable international and environmental standards.

The structures to perform and enforce such quality control (referred to by SAHRA as "the management and monitoring of the tourist experience") do not yet exist. The terms of the heritage agreement ought to include such issues. As this type of tourism monitoring goes beyond the brief of SAHRA, some other structure will have to handle it. Tourism in the Cradle of Humankind has the potential to showcase the country and should be of the highest quality possible. – comment please.

### **4.1 Physical environment, surface**

Desired outcomes include the following:

*Rangeland:*

- To ensure that contextual veld conditions and rangeland in immediate vicinity of fossil site is maintained in as good a condition as possible.

*Erosion:*

- To ensure that the fossil site and its environs are free from active erosional problems and that existing areas of erosion are analysed, remedied, rehabilitated and monitored for follow-up action if necessary

*Fire management:*

- To ensure that a proper fire regime appropriate to Bankenveld is maintained on the fossil site.



- To ensure that fossil site users (when the site is active) are aware of fire hazards and can control on-site fires.
- To ensure that the fossil site does not constitute a fire hazard and that activities taking place there do not create fire hazards
- To ensure that the basic data necessary to assess the long-term impact of frequent fires is available, which information is necessary to feed back into appropriate fire management

*Biodiversity, rare plants and animals:*

- To ensure that a database of plant and animal species present on site is available, because biological values are as yet poorly understood
- To assess which of these are target species for use as food, medicines, economic reasons, etc., and to what extent they are being collected
- To identify, record and map special species in order to ensure their protection
- Landscaping should attempt to make use of the wonderful array of indigenous plants which would beautify any garden, besides being of interest to visitors as well as being suited to the growing conditions

*Alien vegetation:*

- Desired outcome is a fossil site which is free from alien invasive species, and, as far as possible, from weeds

*Visual aesthetics:*

- Desired outcome is protection of viewshed and contextual environment

## **4.2 Physical environment, subterranean**

The subterranean environment is the *raison d'être* for Wonder Cave. The entire site significance rests on this environment. The cave has considerable educational and tourism value and is a useful comparative cave in the scientific sense, even if its fossil potential is not great. Therefore, it is worth conserving and rehabilitating, as far as this is possible.

- Desired outcome is a subterranean environment in which the cave atmosphere, substrate, biota and appearance is kept in as undisturbed and natural a condition as possible
- A further desired outcome is a subterranean environment which, if it is being visited or excavated, is safe for all site users.

## **4.3 Infrastructure, built environment**

Desired outcomes include:

- Tourist facilities which are aligned to standards expected of a World Heritage Site
- Unsightly service infrastructure should be screened as far as possible from public view

## **4.4 Research environment**

Desired outcomes include the following:

- To ensure that lack of funding does not inhibit research opportunities and prevent site potential from being realised

- To ensure that the Management Authority has in-house heritage expertise which allows for the follow-up of fossil site inspection observations and recommendations
- To ensure that all dumps, old and new, are committed to plan, with appropriate annotations – there are problems with dumping excavated soil inside a cave
- To ensure that new dumps are appropriately sited and properly constructed
- To ensure that excavations are safely executed and compliant with permit terms and conditions
- To ensure that appropriate witness sections are left and stabilized
- To ensure that sample sites are properly recorded and that results are independently verifiable
- To ensure safe excavation edges, walls and bases, and that these are stabilized when work ceases.
- To ensure that dump management becomes part of the permit application; such as indications as to dump site selected, construction method, long-term future of dump.
- To ensure that fossils are carefully and properly prepared, catalogued, curated and housed in a safe repository
- To ensure that regular site safety inspections take place
- Finalisation of the need for a mutually agreed decision as to the future of the excavation

#### **4.5 Site safety and security**

Desired outcomes are often not within areas of management open to the Management Authority because the caves are a privately owned and operated commercial operation. Some desirable outcomes include:

- The full report of a professional site safety inspector is awaited in order that interventions required to ensure site safety can be planned for and installed
- Warning notices regarding histoplasmosis need to make sure that immune-compromised individuals fully understand the risks
- Friable edge to entrance aven should be chamfered off without creating dust
- Safety nets might be considered to catch smaller pieces of debris falling in to the cave
- Other shaft-like aven openings ought to be fenced to prevent objects from being thrown in to the cave.
- Loose rock embedded in unsupported wall should be barred down – check daily
- Lighting in cave needs attention, especially at foot level (Torches move and cause disturbing shadows)
- Uneven pathway appears to be a safety hazard, particularly if wet and slippery
- Wooden infrastructure impacts on cave atmosphere as it gives off CO<sub>2</sub>.
- Tourists impact on cave atmosphere as they give off CO<sub>2</sub>.
- The hanging wall is peeling off along bedding planes. Huge chunks of the roof could fall. Daily inspection of footwall for signs of instability should be undertaken, particularly after heavy rains when the rock is saturated and clay layers act as a lubricant for unstable rock
- The metal rail at the base of the lift needs replacing, as does railing elsewhere
- Visually, the cave wiring and concealment of distribution boxes needs further attention
- Grease at lift bottom will pollute cave substrate
- Noise from lift disturbs birds in entrance. Birds now the major agent for adding nutrients to the cave system
- The elevator needs its own regular safety inspections

#### **4.6 Presentation of site values**

- This is adequately done by the site guides
- A few publications and brochures explaining the site values would be a bonus

### **5 MANAGEMENT AND MONITORING TASKS**

The following are operational management tasks and issues that need to be addressed now or in the future as part of on-going management actions. Their funding is still problematic.

The development of research at the fossil sites has been limited by the unfortunate perceptions that the State may not fund development on privately owned property and that the scientists are 'site-users'. This needs to change as it must be seen as the responsibility of the authorities to foster research and necessary associated development on these sites. It is recommended that in future, scientists be viewed rather as 'value adders' and thus eligible for some easement for the funding of heritage site management interventions which they are currently expected to fund, for example, fencing. In effect, the state has been expecting others to finance the protection of the COH WHS fossil sites.

Sites which have no active scientist are generally neglected – this is an indication of the positive influence which scientists have on fossil sites.

The following table has been drawn up with the specific aim of clarifying who should do what, and when, on the heritage site. The Table also provides some indication of priority ratings. It has been constructed in such a way as to incorporate all the key management issues, strategies and monitoring criteria so that it may be used independently of the text.

The relative priority of the management measures has been identified based on ICCROM definitions as follows:

- Immediate - to be attended to urgently as it constitutes a danger to the public or a resource;
- Urgent - to be attended to urgently to protect the resource;
- Necessary - to be attended to, to protect the resource;
- Desirable - to be attended to from a development perspective;
- Keep watch – to be monitored to see if the problem is serious.

An integrated monitoring programme is vital to the successful management of public access. This programme should identify where visitor pressure is compromising the quality of the environment or visitor experience.

Therefore it is recommended that the principle of Limits of Acceptable Change (LAC) be used to monitor tourism impacts on the environment. LAC should define management actions that would be triggered in response to defined signs of visitor pressure. Areas that should be monitored in order to manage visitor impacts include:

Any signs of visitor pressure on footpaths and/or roads such as excessive erosion, destruction of surrounding ecology, aesthetic value, etc, that may indicate that the conservation value of the area is being threatened should be considered. If the area is being adversely affected then mitigating measures need to be put in place such as limiting the number of visitors to the site/area, improving the quality of the road/footpath to accommodate more visitors, increasing the number of roads/footpaths to spread the visitor pressure, etc;

**TABLE 1 FOLLOWS:**

**TABLE 1 MANAGEMENT AND MONITORING TASKS FOR WONDER CAVE**

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
<b>Surface environment</b>						
Access - legal access to property	<ul style="list-style-type: none"> <li>Adjacent landowners are particular about access – both pedestrian and vehicular</li> </ul>	<ul style="list-style-type: none"> <li><i>Maintenance of cordial relations with landowners regarding access (*)</i></li> <li>Ensure that any scientist who works on site has a properly negotiated preferably written letter of permission.</li> </ul>	Future concern	landowner	<ul style="list-style-type: none"> <li>Check if access issue has been addressed in MOU's between landowner and research scientists</li> </ul>	Annual
Rangeland condition	<ul style="list-style-type: none"> <li>No rangeland within Wonder cave precinct</li> </ul>	<ul style="list-style-type: none"> <li><i>Rangeland in optimum condition (*)</i></li> </ul>		Landowner	<ul style="list-style-type: none"> <li>Check for trampled bare areas</li> <li>Check for loss of palatable grasses and forbs</li> </ul>	Ongoing
Landscape gardening	<ul style="list-style-type: none"> <li>Inappropriate exotics</li> </ul>	<ul style="list-style-type: none"> <li><i>Site gardens showcase indigenous vegetation (*)</i></li> <li>Plantings of attractive indigenous species</li> </ul>	Desirable	landowner	<ul style="list-style-type: none"> <li>None, recommendation only</li> </ul>	Ongoing
Retention of topsoil, surface drainage, surface erosion	<ul style="list-style-type: none"> <li>Loss and dispersal of topsoil makes re-vegetation difficult</li> <li>Dust, especially in cave atmosphere</li> <li>Degraded vegetation cover</li> </ul>	<ul style="list-style-type: none"> <li><i>Fossil site free of erosion (*)</i></li> <li>Check all tracks and car park</li> <li>Check for surface drainage and distribution of rainwater runoff over surface</li> <li>Check for signs of surface erosion</li> <li>Create drainage to spread water flows</li> <li>Rehabilitate eroded areas</li> </ul>	Necessary	landowner	<ul style="list-style-type: none"> <li>Check for worn patches of vegetation where cars habitually park</li> <li>Check for erosion gulleys in tracks</li> <li>Check for patches of exposed soil</li> <li>Monitor drainage arrangements</li> </ul>	Ongoing

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Car park	<ul style="list-style-type: none"> <li>• See above</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Fossil site free of erosion (*)</b></li> <li>• Pave with appropriate paving, paying attention to drainage and correct distribution of rainwater run-off</li> <li>• Provide circular through route if possible</li> <li>• Plant indigenous shade trees</li> </ul>			<ul style="list-style-type: none"> <li>•</li> </ul>	
Erosion	<ul style="list-style-type: none"> <li>• Storm water erosion especially on slopes</li> <li>• Erosion caused by wear and tear of motor vehicle movement</li> <li>• Erosion caused by re-directed water, storm water concentrated by road and pathways</li> <li>• Loss of topsoil</li> <li>• Unightly bare patches of soil</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Fossil site free of erosion (*)</b></li> <li>• Rehabilitate by creating mitre drains, and keeping these open</li> <li>• Restore by packing surface ruts with rock and brushwood to break flow of water (see Coetzee 2005)</li> <li>• Implement fixed point photography monitoring</li> </ul>	necessary	Landowner, GDACE to advise	<ul style="list-style-type: none"> <li>• Check for deepening of ruts or curbing of further erosion</li> <li>• Check mitre drains for blockage and keep clear of washed debris and sediment</li> <li>• Monitor all rehabilitation efforts</li> <li>• Change strategy if necessary</li> <li>• Photographic monitoring of rehabilitation efforts</li> </ul>	Ongoing

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Fire Management	<ul style="list-style-type: none"> <li>• Too frequent fires have a negative effect on vegetation.</li> <li>• Fire is a threat to fixed and moveable property</li> <li>• Ash and smoke is a threat to the subterranean environment because they are 'drawn into the cave by normal air-flow circulation</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Site safe from uncontrolled veld and domestic fire (*)</b></li> <li>• Implement a fire management programme</li> <li>• A firebreak and inspection route around the property is recommended</li> <li>• Cut and slash firebreaks rather than burn to prevent fly ash and smoke entering cave</li> <li>• Record fire frequency and intensity</li> <li>• Take precautionary measures to contain domestic fires started on site</li> <li>• Brief residents on what to do in such a situation</li> <li>• Provide fire extinguishers, training in their use and annual checks of equipment</li> <li>• Provide suitable beaters for staff on site</li> </ul>	necessary	Landowner	<ul style="list-style-type: none"> <li>• Set up rangeland study for base data against which fire impact can be assessed</li> <li>• Set up a fire frequency recording programme</li> <li>• Cut and slash firebreaks rather than burn</li> <li>• Check location and functionality of fire extinguishers</li> <li>• Ensure that annual check of equipment takes place</li> <li>• Ensure that residents and staff know how to use equipment</li> <li>• Ensure that beaters are always on hand</li> </ul>	Ongoing
Red data species, rare and economically significant plants	<ul style="list-style-type: none"> <li>• Loss of edible and medicinal plants through over-collection</li> <li>• Many important plant species are not on RED DATA list.</li> <li>• Inadvertent destruction be development and activities on site</li> <li>• Oss through lack of fire control</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Preservation of biodiversity (*)</b></li> <li>• Surveillance of indigenous plant use</li> <li>• Draw up a species list of medicinal, poisonous, edible and economically significant species</li> <li>• Map occurrence and preferred microhabitats</li> <li>• Monitor collection and utilization</li> <li>• Identify and mitigate observed threats</li> <li>• Alert staff to problems of unauthorized collection</li> </ul>	Necessary	Landowner, GDACE	<ul style="list-style-type: none"> <li>• Check for signs of digging geophytes out by the roots</li> <li>• Check local roadside vendors for plants on sale</li> <li>• Monitor continued presence of mapped occurrences</li> </ul>	Ongoing

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Invasive alien plant species.	<ul style="list-style-type: none"> <li>• Invasion of avens and other habitats by alien species</li> <li>• Loss of biodiversity</li> <li>• Unattractive landscape</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Fossil site free of invasive aliens(*)</b></li> <li>• Make a list of all invasive plant species</li> <li>• Map and prioritise infestations</li> <li>• Determine best eradication or control programme. GDACE available for assistance</li> <li>• Assess costs and find budget</li> <li>• Begin control according to guideline provided in generic management plan</li> <li>• Enlist expertise of GDACE</li> <li>• Implement control and clearance programme</li> <li>• Monitor and follow up as required</li> <li>• Photographic baseline for monitoring purposes</li> </ul>	necessary	Landowner, GDACE	<ul style="list-style-type: none"> <li>• Visual checks for infestations and incidence density</li> <li>• Check efficacy of control measures implemented</li> <li>• Monitor with fixed point photography</li> </ul>	Ongoing
Weeds & shrub growth	<ul style="list-style-type: none"> <li>• Roots destabilize breccias in time</li> <li>• Plants reduce visibility of noteworthy sections</li> <li>• Weeds give a negative visual experience and project an air of dereliction</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Weed-free fossil site (*)</b></li> <li>• Pull weeds by hand, or 'skoffel'</li> <li>• Destroy in a manner that does not spread seed further</li> </ul>	Necessary	Landowner,	<ul style="list-style-type: none"> <li>• Visual checks for weed infestations</li> <li>• Fixed point photography for controls</li> </ul>	Ongoing
Development in 'viewshed'	<ul style="list-style-type: none"> <li>• Negative visual impact</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Preservation of sense of place and natural qualities of viewshed (*)</b></li> <li>• COH WHS to monitor all new development plans</li> </ul>	Necessary	COH WHS MA	<ul style="list-style-type: none"> <li>• Check plans for visual impact on viewshed of site</li> </ul>	Ongoing



Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Habitat protection: Removal of stromatolites.	<ul style="list-style-type: none"> <li>Loss of Heritage material and site significance.</li> <li>Loss of micro-habitats (mosaic of sunny and shady areas).</li> </ul>	<ul style="list-style-type: none"> <li><b>Preservation of Peindaba Stone and fossil stromatolites and associated microhabitats (*)</b></li> <li>Landowner and field staff to maintain surveillance</li> <li>Heritage Monitors to be alerted</li> </ul>	Necessary	Landowner, Heritage Inspectors	<ul style="list-style-type: none"> <li>Check for signs of disturbed soil, exposed patches of soil, overturned and disturbed rock</li> </ul>	Ongoing
Sinkhole area, open aven near tourist cave	<ul style="list-style-type: none"> <li>Unprotected open holes with large vertical drops                             <ul style="list-style-type: none"> <li>safety of visitors</li> <li>safety of tourists below from thrown objects</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li><b>Underground environment safe from falling or thrown objects (*)</b></li> <li>Erect signage indicating appropriate behaviour</li> </ul>		landowner	<ul style="list-style-type: none"> <li>check fence for stability, soundness</li> <li>check notices for legibility</li> </ul>	annually
Entrance aven to tourist cave	<ul style="list-style-type: none"> <li>weathering, unconsolidated material in overhanging brow</li> <li>cascade and sloughing into access stairwell</li> <li>Loose falling rocks</li> </ul>	<ul style="list-style-type: none"> <li><b>Safe entrance area for site visitors (*)</b></li> <li>take baseline photographs for monitoring</li> <li>level off brow area,</li> <li>shotcrete if further deterioration noticed.</li> </ul>		Landowner	<ul style="list-style-type: none"> <li>monitor regularly against baseline photo's</li> <li>footwall below aven and stairwell to be monitored for fallen debris</li> </ul>	daily
Pathway to tourist cave	<ul style="list-style-type: none"> <li>altered surface drainage pattern, diverts rainwater away from cave</li> <li>desiccation of subterranean environment</li> </ul>	<ul style="list-style-type: none"> <li><b>Prevention of cave desiccation</b></li> <li>Ensure normal amount of rainwater can enter cave via an alternative route</li> </ul>		Landowner	<ul style="list-style-type: none"> <li>check channel remains open</li> </ul>	annually, plus after heavy rainfall events
Visitor walkway	<ul style="list-style-type: none"> <li>compaction</li> <li>loss of cave biota</li> </ul>	<ul style="list-style-type: none"> <li><b>Substrate rehabilitation (*)</b></li> <li>gently loosen, after seeking professional advice on method</li> </ul>		Landowner	<ul style="list-style-type: none"> <li>walkway will have to be installed first</li> </ul>	quarterly
<b>SUBTERRANEAN ENVIRONMENT</b>						

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Interpretation of subterranean environment	<ul style="list-style-type: none"> <li>Lack of information regarding the significance of caves to science of palaeontology</li> <li>Lack of appreciation of the significance and sensitivities of the subterranean environment</li> </ul>	<ul style="list-style-type: none"> <li><b>Appropriate interpretation of subterranean environment to visitors (*)</b></li> <li>Incorporate caves and ecology of subterranean environment into site interpretation</li> <li>Liaise with caving groups and request assistance with education</li> </ul>	necessary	Landowner, tourist guides	<ul style="list-style-type: none"> <li>Check that subterranean environments are suitably interpreted</li> </ul>	Ongoing
Cavern chamber: dirty speleothems	<ul style="list-style-type: none"> <li>Inappropriate lighting is causing algal growth and ruining speleothems</li> <li>Loss of site appeal, site significance</li> <li>Loss of tourist enjoyment of site</li> </ul>	<ul style="list-style-type: none"> <li><b>Speleothem rehabilitation (*)</b></li> <li>Reduce time of lights on</li> <li>Replace lights with 'cold light' implement a professional cleaning job of the speleothems after obtaining advice available from managers of international 'show caves'</li> <li>Clean with pressure hose AFTER all surface rehabilitation work has been done, using cavern water if possible</li> </ul>	desirable	landowner	<ul style="list-style-type: none"> <li>Check condition of speleothems</li> <li>Check duration and quality of lighting</li> <li>Monitor against 'before' and after' photographs</li> </ul>	ongoing
Lower lift platform area	<ul style="list-style-type: none"> <li>Safety of metal handrail surrounding parapet wall – corrosion has rendered unsafe</li> </ul>	<ul style="list-style-type: none"> <li><b>Site safety (*)</b></li> <li>Check regularly until replaced with stainless steel</li> <li>Request tourist guide to warn visitors against leaning against rails</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>Check handrail for further evidence of corrosion</li> </ul>	ongoing
Lower lift platform area	<ul style="list-style-type: none"> <li>Accumulation of greas drips will pollute cave floor substrate</li> <li>Grease can become slippery if dispersed</li> </ul>	<ul style="list-style-type: none"> <li><b>Prevention of site pollution (*)</b></li> <li>Provide a grease drip tray .</li> <li>Check and replace when filled</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>Check condition of lower lift platform for drips of grease and interventions installed to mitigate</li> </ul>	

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Visitor walkway	<ul style="list-style-type: none"> <li>• Poor lighting at foot level in places</li> <li>• Safety risk</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Best practice visitor route (*)</b></li> <li>• Install eco-friendly lighting at foot level cables preferably concealed under raised boardwalk</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>• Monitor for defunct light bulbs and replace regularly</li> </ul>	
Visitor walkway	<ul style="list-style-type: none"> <li>• Compaction of substrate</li> <li>• Loss of cave biota</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Best practice visitor route, rehabilitation of substrate (*)</b></li> <li>• Gently loosen after consulting experts</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>• Walkway will need to be installed so that re-compaction does not occur</li> </ul>	Future concern
Visitor walkway	<ul style="list-style-type: none"> <li>• Use of wooden railway sleepers causes increased CO<sub>2</sub> levels as they rot</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Best practice visitor route, rehabilitation of substrate (*)</b></li> <li>• Remove all wood from cave</li> </ul>	necessary	Landowner	<ul style="list-style-type: none"> <li>• Check that wooden infrastructure has been replaced with inert plastic wood or stainless steel</li> </ul>	Ongoing
Unsanitly wiring and distribution boxes	<ul style="list-style-type: none"> <li>• Distribution boxes and wiring to be concealed or disguised, cables buried (control dust with wet screen)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Best practice visitor route (*)</b></li> <li>• Refer to best practice for show caves</li> <li>• Conceal electrical installations</li> <li>• Control dust</li> </ul>	Future concern, necessary	landowner	<ul style="list-style-type: none"> <li>• Check visual aesthetics of cave routs</li> </ul>	onging
Lighting	<ul style="list-style-type: none"> <li>• Bad lighting can cause algal growth and bacterial colonies on speleothems</li> <li>• Wrong lighting raises ambient temperature</li> <li>• Permanent lighting disturbs biota, exacerbates algal growth</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Best practice visitor route (*)</b></li> <li>• Install correct lighting</li> <li>• Limit times of lighting</li> <li>• Turn off lights when tourists have passed a section of the route</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>• Check speleothems for algal and bacterial growth</li> <li>• Measure ambient temperature regularly</li> </ul>	Ongoing

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Visitor numbers	<ul style="list-style-type: none"> <li>Increased CO<sub>2</sub> levels</li> <li>Speleothems degenerate</li> </ul>	<ul style="list-style-type: none"> <li><b>Maintenance of correct carbon dioxide levels (*)</b></li> <li>Regularly monitor carbon dioxide concentrations, humidity and temperature and report to authorities as required in terms of the permit</li> <li>Reduce tourist numbers is necessary</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>Apply NOSSA criteria</li> </ul>	
Lift maintenance	<ul style="list-style-type: none"> <li>Malfunction</li> <li>Noisy clutch a deterrent to birds</li> </ul>	<ul style="list-style-type: none"> <li><b>Site safety, environmental best practice (*)</b></li> <li>check regularly according to existing legislation</li> <li>silence clutch</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>Apply NOSSA criteria</li> </ul>	
Presence or absence of breeding colonies of bats	<ul style="list-style-type: none"> <li>Loss of colony – sensitive to human interference</li> <li>Species involved (Miniopterus natalensis) is declining in numbers</li> <li>Loss of bats causes loss of nutrients in cave</li> </ul>	<ul style="list-style-type: none"> <li><b>Conservation of rare bat species (*)</b></li> <li>The entire colony appears to have departed – only one or two bats observed</li> <li>Ensure that bats have free access into and out of cave</li> <li>GDACE can offer advice</li> </ul>	Necessary	GDACE to monitor	<ul style="list-style-type: none"> <li>GDACE to establish monitoring criteria for bats</li> <li>Check for presence and numbers of bats</li> </ul>	Ongoing, breeding season
Porcupine lairs and owl roosts	<ul style="list-style-type: none"> <li>Disturbance and displacement of animals</li> <li>Porcupine lairs are important as modern analogues for taphonomic processes of the past</li> </ul>	<ul style="list-style-type: none"> <li><b>Conservation of porcupine lairs and owl roosts (*)</b></li> <li>Protect any porcupine lairs on site</li> <li>Encourage that their behavior and lair contents are studied without disturbing animals</li> </ul>	necessary	All site users	<ul style="list-style-type: none"> <li>Check that porcupine lairs remain active – note presence of quills, droppings, gnawed bones</li> </ul>	Ongoing
<b>INFRASTRUCTURE</b>						
Access road	<ul style="list-style-type: none"> <li>See erosion above</li> </ul>	<ul style="list-style-type: none"> <li>See above</li> </ul>			<ul style="list-style-type: none"> <li></li> </ul>	

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Culverts, bridges, drainage line crossings	<ul style="list-style-type: none"> <li>None at Wonder cave</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>	N/A	N/A	<ul style="list-style-type: none"> <li>N/A</li> </ul>	N/A
Perimeter fence	<ul style="list-style-type: none"> <li>The Wonder Cave precinct is fenced</li> <li>Perimeter fences curb unauthorized access, tampering with equipment, vandalism and theft</li> </ul>	<ul style="list-style-type: none"> <li>N/A. perimeter fence exists</li> </ul>	N/A	N/A	<ul style="list-style-type: none"> <li>N/A</li> </ul>	N/A
Car park – erosion of surface	<ul style="list-style-type: none"> <li>Frequent parking can cause erosion of surface</li> <li>See above for further risks, e.g. dust</li> </ul>	<ul style="list-style-type: none"> <li><b>Rehabilitation of existing erosion (*) and prevention of further erosion (*)</b></li> <li>Monitor and spread crushed stone gravel when necessary</li> </ul>	Keep watch	landowner	<ul style="list-style-type: none"> <li>Check surface and surrounds of car park for signs of erosion</li> </ul>	Ongoing
Toilets, ablution	<ul style="list-style-type: none"> <li>Inadequate or improper sewage disposal could pollute groundwater</li> <li>Poor toilet facilities create a poor tourist impression</li> </ul>	<ul style="list-style-type: none"> <li><b>Environmental best practice on dolomitic substrates, prevention of groundwater pollution (*)</b></li> <li>Septic tanks and soak -aways are not recommended in an dolomitic area honeycombed with subterranean caves</li> <li>Closed system preferable</li> </ul>	Necessary	Landowner	<ul style="list-style-type: none"> <li>Check type of toilet</li> <li>Check efficacy, odours, flies</li> </ul>	Ongoing
Services (waste) and storage tanks	<ul style="list-style-type: none"> <li>Visual impact</li> </ul>	<ul style="list-style-type: none"> <li><b>Maintain visual integrity and aesthetics (*)</b></li> <li>Screen, or use screening plants</li> </ul>	desirable	landowner	<ul style="list-style-type: none"> <li>Check visual aesthetics of environment</li> </ul>	Ongoing

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Waste management and disposal	<ul style="list-style-type: none"> <li>Litter</li> <li>Wild animals die from ingesting wind-blown plastic bags</li> <li>Water pollution</li> </ul>	<ul style="list-style-type: none"> <li><b>Litter free fossil site (*)</b></li> <li>Provide litter bins, more when extra people are expected</li> <li>Collect and remove all litter regularly</li> <li>Best practice would require sorting and recycling litter</li> </ul>	necessary	Landowner	<ul style="list-style-type: none"> <li>Check for left litter</li> <li>Check that sufficient litter bins have been installed and appropriately located</li> <li>Check removal schedule</li> <li>Check that litter stored on site cannot be wind distributed</li> <li>Encourage recycling</li> </ul>	Ongoing
Pathways for site users and visitors	<ul style="list-style-type: none"> <li>Visitors/children falling into excavations, avens or miners' excavations</li> <li>Pathways can cause erosion</li> </ul>	<ul style="list-style-type: none"> <li><b>Environmentally acceptable and safe route for site visitors (*)</b></li> <li>Capping with thin layer of cement</li> <li>Psychological barriers at dangerous or no-go areas</li> <li>Use safe retaining area for visitors</li> <li>Provide anti-erosion measures at sensitive areas</li> </ul>	Done	landowner	<ul style="list-style-type: none"> <li>Check visitor pathways, boardwalks, viewing platforms for safety - of visitors and of site fabric</li> <li>Check pathways for wear and tear and channeling/erosion</li> </ul>	Ongoing
Site plaque recognizing World Heritage Site status and National Heritage Site Status	<ul style="list-style-type: none"> <li>Part of WHS but not yet declared as NHS</li> </ul>	<ul style="list-style-type: none"> <li><b>Site plaque commemorating site status erected (*)</b></li> <li><b>If SAHRA decides to complete the process of registration as a NHS:</b> <ul style="list-style-type: none"> <li>Select appropriate position, agreed by researchers and landowner (Done)</li> <li>Ensure wording appropriate and agreed, checked by SAHRA</li> <li>Ensure that both SAHRA and WHS logos appear</li> <li>Acquire budget</li> <li>SAHRA to install</li> </ul> </li> </ul>	Future concern	SAHRA	<ul style="list-style-type: none"> <li>Check plaque condition and safety (brass plaques liable to theft)</li> </ul>	Ongoing

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Signage: adequacy	<ul style="list-style-type: none"> <li>Poor tourist experience if site not adequately interpreted</li> </ul>	<ul style="list-style-type: none"> <li><b>Appropriate site interpretation for visitors (*)</b></li> <li>Site is open to general public, tourist guide provides site interpretation</li> <li>Re-install small site museum when building rebuilt</li> <li>Include interpretive signage and brochures</li> <li>Signage needs to be approved by SAHRA</li> </ul>	necessary	Landowner	<ul style="list-style-type: none"> <li>Check quality of signage</li> <li>Check quality of site interpretation</li> </ul>	Ongoing
museum	<ul style="list-style-type: none"> <li>Insufficient information concerning site values</li> <li>Excellent support for underground visitor experience</li> </ul>	<ul style="list-style-type: none"> <li><b>Appropriate site interpretation for visitors (*)</b></li> <li>Re-install museum exhibit by providing space to display main site values effectively</li> <li>Can be used to advertise adjacent sites</li> </ul>	necessary	landowner	<ul style="list-style-type: none"> <li>Check adequacy of museum display</li> </ul>	ongoing
Visitor impacts	<ul style="list-style-type: none"> <li>Littering</li> <li>Pollution</li> <li>Erosion of pathways</li> <li>Disturbance of excavations</li> <li>Theft of rock formations, bones and fossils</li> <li>Graffiti</li> </ul>	<ul style="list-style-type: none"> <li><b>Visitor impacts eliminated or minimized (*)</b></li> <li>These potential impacts all adequately attended at Wonder Cave, with the exception of those which are as yet not ascertained, such as CO<sub>2</sub> concentration levels</li> </ul>	Attended	landowner	<ul style="list-style-type: none"> <li>Check for littering</li> <li>Check for pollution of site</li> <li>Check all walkways for wear and tear</li> <li>Check for visitor disturbance of excavations or equipment</li> <li>Check for tampering with rock formations</li> <li>Check for graffiti!</li> </ul>	Ongoing
Infrastructure: water	<ul style="list-style-type: none"> <li>Related infrastructure can be unsightly</li> </ul>	<ul style="list-style-type: none"> <li><b>Unsightly infrastructure camouflaged or screened (*)</b></li> <li>Concealed or screen storage tank for pumped water</li> <li>Bury pipelines</li> </ul>	desirable	landowner	<ul style="list-style-type: none"> <li>Buried pipeline</li> <li>Concealed/screened storage tank</li> </ul>	

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Infrastructure: Energy	<ul style="list-style-type: none"> <li>Visual impact of power lines</li> </ul>	<ul style="list-style-type: none"> <li><b>Unightly infrastructure camouflaged or screened (*)</b></li> <li>Bury cable underground</li> <li>Cave lighting to be concealed</li> <li>Conceal or disguise distribution boxes in cave</li> <li>Comply with international cave wiring code for cave electrical installations</li> </ul>	Necessary	Landowner	<ul style="list-style-type: none"> <li>Check cave for method of installation of wiring system</li> <li>Check distribution boxes</li> </ul>	ongoing
Telecommunications	<ul style="list-style-type: none"> <li>None. Landline and cellphone reception available</li> </ul>	<ul style="list-style-type: none"> <li></li> </ul>			<ul style="list-style-type: none"> <li>None</li> </ul>	
<p><b>RESEARCH ENVIRONMENT: There is no active research or excavation at Wonder Cave and management issues therefore omitted from table.</b></p>						
<p><b>SITE SAFETY, SECURITY AND STABILITY</b></p>						
Domestic cooking fires	<ul style="list-style-type: none"> <li>Gas cylinders can explode</li> <li>Boiling oil can catch fire</li> <li>Domestic cooking fires are a potential source of uncontrolled fire</li> </ul>	<ul style="list-style-type: none"> <li><b>Fire hazard on site minimized (*)</b></li> <li>Provide fire extinguishers</li> <li>Train staff in their use - suppliers often provide free training</li> <li>Ensure extinguishers checked annually</li> <li>Brief residents on what to do in the event of fire</li> <li>Provide appropriate beaters in the event of a grass fire</li> <li>Burn suitable firebreaks around fossil site and infrastructure</li> </ul>	Necessary	Landowner	<ul style="list-style-type: none"> <li>Check that extinguishers are installed and appropriately mounted</li> <li>Check that staff understand their use</li> <li>Ensure that equipment is inspected annually</li> <li>Check that there are sufficient beaters on site</li> </ul>	At each fossil site inspection



Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Signage, site safety and warnings	<ul style="list-style-type: none"> <li>Lack of appropriate signage can expose visitors to unexpected hazards, e.g. that there is a bees' nest</li> </ul>	<ul style="list-style-type: none"> <li><b>Site safety compliant with existing Public health and Safety regulations (*)</b></li> <li>Install appropriate behavior modifiers and site safety signage as and when this becomes necessary</li> <li>Appropriate safety signage is a requirement of Public (Occupational) Health and Safety Act</li> <li>Maropeng even warns against possible presence of snakes</li> </ul>	Necessary	Landowner	<ul style="list-style-type: none"> <li>Check for installation and appropriate wording</li> <li>Check for appropriate location of signs, design and durability</li> </ul>	Ongoing
Safety signage	<ul style="list-style-type: none"> <li>Inadequate warning of risks of histoplasmosis to AIDS sufferers and others</li> </ul>	<ul style="list-style-type: none"> <li><b>Site safety compliant with existing Public health and Safety regulations (*)</b></li> <li>Install signboard at cave entrance and in serving area and print warning on tickets</li> </ul>	Necessary	Landowner	<ul style="list-style-type: none"> <li></li> </ul>	

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Subterranean environments	<ul style="list-style-type: none"> <li>• Instability due to roof parting along bedding planes</li> <li>• Natural instability</li> <li>• Metal handrails are corroding</li> <li>• Footpath is uneven in places</li> <li>• Footpath poorly lit in places</li> <li>• Footpath slippery in places</li> <li>• Entrance area aven has unstable and friable brow edge</li> <li>• Open sinkholes are unsafe because of vertical drops</li> <li>• Thrown objects can injure tourists below</li> <li>• Disaster management and rapid evacuation procedure necessary</li> <li>• Cave to surface communication recommended</li> </ul>	<ul style="list-style-type: none"> <li>• <i>Site safe as possible for site users</i> (*)</li> <li>• Implement recommendations of previous and forthcoming site safety officer's report</li> </ul>	Necessary	Landowner	<ul style="list-style-type: none"> <li>• Check that site safety recommendations and instruction are being complied with</li> </ul>	Ongoing

Issues	Threats or Risks	Desired outcomes (*) and Management Measures	Priority	Responsibility	Monitoring Criteria	Monitoring frequency
Bees, "Kransbye", Wasps	<ul style="list-style-type: none"> <li>The numerous cavities and hollows are home to several bee hives and wasps' nests. Many people are allergic to bee stings in particular.</li> </ul>	<ul style="list-style-type: none"> <li><b>Site safe as possible for site users (*)</b></li> <li>Ensure that the necessary antihistamines are on hand.</li> <li>Destroy or have hives removed if these are where people frequently work.</li> <li>Post warning signage</li> <li>Provide first aid post</li> </ul>	Necessary	Tour Operator	<ul style="list-style-type: none"> <li>Monitoring should include checking the route for insect problems.</li> <li>Monitor speed at which an emergency case could reach appropriate medical help</li> </ul>	Ongoing
Accidental falls	<ul style="list-style-type: none"> <li>Tourists suing the operator</li> </ul>	<ul style="list-style-type: none"> <li><b>Site safe as possible for site users (*)</b></li> <li>Ensure that walkways are as even as possible. Provide handrails and steps at vertical drops and changes of level.</li> <li>Keep group sizes small enough to control at all times</li> </ul>	Necessary if tourism is taking place on site	Tourist operator,	<ul style="list-style-type: none"> <li>Monitor route by walking it regularly to check for flaws in routing, infrastructure</li> </ul>	Ongoing
Theft, crime	<ul style="list-style-type: none"> <li>The isolated situation makes the site particularly prone to petty theft of excavation and other equipment.</li> </ul>	<ul style="list-style-type: none"> <li><b>Site safe and secure as possible for site users (*)</b></li> <li>Provide secure lock-up facilities on -site for researchers equipment – lock-up garage required</li> <li>Control on all persons entering the area</li> <li>Patrolling site monitors (including the Game Park) might be considered.</li> <li>Consider security fence around research-related infrastructure and storage</li> </ul>	Necessary	Landowner, site residents	<ul style="list-style-type: none"> <li>Security checks</li> </ul>	Ongoing
<b>GENERIC ISSUES RELATING TO FOSSIL SITE EXCAVATIONS: There are no excavation on site at present and this section has therefore been omitted</b>						

TABLE 2 FOLLOWS

**TABLE 2: TOURIST INFRASTRUCTURE AND VISITOR EXPERIENCE MANAGEMENT AND MONITORING**  
**Do we omit this? It is important but what control can the COH WHS MA possibly exert over a poor visitor experience – SAHRA must be informed by MA in annual report**

TOURIST-RELATED INFRASTRUCTURE AND VISITOR EXPERIENCE MANAGEMENT						
ISSUES	THREATS OR RISKS	MANAGEMENT MEASURES	PRIORITY	RESPONSIBILITY	MONITORING CRITERIA	FREQUENCY
Reception area	<ul style="list-style-type: none"> <li>if there is poor quality service or installations, visitor recoil factor may become manifest</li> </ul>	<ul style="list-style-type: none"> <li>Inspections and recommendations</li> <li>visitor questionnaires</li> </ul>	Future concern	<ul style="list-style-type: none"> <li>? COH WHS MA, SAHRA (presentation of WHS values is important)</li> </ul>	<ul style="list-style-type: none"> <li>reception area                             <ul style="list-style-type: none"> <li>tidy</li> <li>clean</li> <li>attractive</li> </ul> </li> <li>reception staff                             <ul style="list-style-type: none"> <li>attentive</li> <li>prompt</li> <li>polite</li> <li>knowledgeable</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>monthly?</li> </ul>
Abolition and toilet facilities	<ul style="list-style-type: none"> <li>poor quality</li> <li>visitor recoil factor</li> </ul>	<ul style="list-style-type: none"> <li>inspections</li> <li>visitor questionnaires (like at service stations on national roads)</li> </ul>	Future concern	<ul style="list-style-type: none"> <li>landowner</li> </ul>	<ul style="list-style-type: none"> <li>cleanliness and functioning</li> <li>appearance</li> <li>ambiance</li> </ul>	<ul style="list-style-type: none"> <li>daily</li> </ul>
Quality of tourism-related infrastructure	<ul style="list-style-type: none"> <li>sub-standard</li> <li>visitor recoil</li> <li>not safe</li> <li>poorly site and installed</li> <li>not present (for example, sun-shelter at entrance to cave; site interpretation sign boards</li> </ul>	<ul style="list-style-type: none"> <li>inspections</li> <li>visitor questionnaires</li> </ul>	Future concern	<ul style="list-style-type: none"> <li>landowner</li> </ul>	<ul style="list-style-type: none"> <li>appropriateness and quality of design in relation to function</li> </ul>	<ul style="list-style-type: none"> <li>annual</li> </ul>

<p><b>Quality of site interpretation - verbal</b></p>	<ul style="list-style-type: none"> <li>poor site interpretation by tour guide cannot communicate site significance</li> <li>tourist recoil</li> </ul>	<ul style="list-style-type: none"> <li>inspection by tourist guide accrediting body</li> <li>upgrade communication skills</li> <li>improve content of tourist information</li> </ul>		<ul style="list-style-type: none"> <li>?                     <ul style="list-style-type: none"> <li>landowner</li> <li>tourist guide training facility</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>does the tour guide cover the field?</li> <li>are the facts correct?</li> <li>are the key concepts presented?</li> <li>does he/she interpret what the visitor sees?</li> <li>can he/she field questions?</li> <li>can he/she adapt intellectual accessibility to be appropriate to the group?</li> </ul>	<ul style="list-style-type: none"> <li>quarterly</li> </ul>
<p><b>Quality of field museum – visual presentation</b></p>	<ul style="list-style-type: none"> <li>uninspiring display</li> <li>insufficient material</li> <li>poor quality of information</li> <li>visitor recoil, disappointment</li> </ul>	<ul style="list-style-type: none"> <li>inspections (?)</li> </ul>		<ul style="list-style-type: none"> <li>?                     <ul style="list-style-type: none"> <li>?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>does tour guide cover the field?</li> <li>are the facts correct?</li> <li>are the key concepts presented?</li> <li>does he/she interpret what the visitor sees?</li> <li>can he/she field questions?</li> <li>can he/she adapt intellectual accessibility to be appropriate to the group?</li> </ul>	<ul style="list-style-type: none"> <li>quarterly</li> </ul>
<p><b>Quality of support brochures and field guides – printed presentation</b></p>	<ul style="list-style-type: none"> <li>uninspiring layout</li> <li>insufficient material</li> <li>poor quality of information</li> <li>visitor recoil, disappointment</li> </ul>	<ul style="list-style-type: none"> <li>inspections (?)</li> </ul>		<ul style="list-style-type: none"> <li>?                     <ul style="list-style-type: none"> <li>?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>does the tour guide cover the field?</li> <li>are the facts correct?</li> <li>are the key concepts presented?</li> <li>does he/she interpret what the visitor sees?</li> <li>can he/she field questions?</li> <li>can he/she adapt intellectual accessibility to be appropriate to the group?</li> </ul>	<ul style="list-style-type: none"> <li>quarterly</li> </ul>
<p><b>Tourist numbers, crowding, long queues</b></p>	<ul style="list-style-type: none"> <li>tourist recoil</li> <li>long queues</li> <li>loss of quality of tourist experience</li> </ul>	<ul style="list-style-type: none"> <li>provide alternative activities nearby</li> <li>tourism inspections</li> </ul>		<ul style="list-style-type: none"> <li>?                     <ul style="list-style-type: none"> <li>?</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>tourism</li> </ul>	<ul style="list-style-type: none"> <li>quarterly</li> </ul>

<b>Disaster management plan</b>	<ul style="list-style-type: none"> <li>• Legal problems if accident plan not in place</li> <li>• Problem if lift or electricity fails</li> </ul>	<ul style="list-style-type: none"> <li>• Develop disaster management plan</li> <li>• Develop linkages with District Municipality Disaster Centre</li> </ul>			<ul style="list-style-type: none"> <li>• Presence of emergency equipment inspected</li> <li>• Testing of equipment</li> <li>• Training of staff</li> </ul>	Weekly quarterly
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## **6 BIBLIOGRAPHY**

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