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In this issue:
Parks & Wildlife Service, Tasmania Newdegate Cave Rehabilitation Plan 1994

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Editorial

In this issue, in accordance with *Southern Caver*'s objective of publishing significant material which might otherwise remain unpublished or inaccessible to the public, we present the full text of a rehabilitation plan for Newdegate Cave at Hastings in Southern Tasmania, prepared in 1994 by Ian Houshold, then Parks and Wildlife Service Karst Officer and Phil Bradley, then Ranger-in-Charge, Hastings Caves.

Shortly after its preparation, a summary of the plan appeared in the *ACKMA Journal* (No. 17, December 1994). The editor of that august journal, Kent Henderson, said the plan –

> *… must rate as one of the most comprehensive yet developed for a single Australasian cave, and it can clearly be recommended as a model for others to emulate.*

This reprint of the plan contains all the information in the original. There have been some minor text corrections and some pages have been combined to save space. The original page numbers have been retained – in some cases two appear on the same 'new' page. The format of some tables has been altered – again, in the interests of space-saving.

This publication of the plan has been approved by the Tasmanian Department of Tourism, Arts and the Environment. In granting approval the Acting Secretary of DTAE advised (24/1/07):

> *… the recommendations have all been implemented, which has proved an outstanding benefit to the Newdegate Cave environment.*

Suggested form of citation:

Houshold, I. & Bradley, P. 1994 *Hastings: Newdegate Cave rehabilitation plan.* Parks & Wildlife Service, Tasmania: Hobart. 59 pp. Reprinted in *Southern Caver,* 63 (2007).

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[These are *SC* page numbers; the original pagination of the plan has also been retained.]

Cover photo: Titanias Palace, Newdegate Cave, Hastings photo: Parks & Wildlife Service.

Celebrating >60 years of organised speleology in Australia - since 1946

STC was formed from the Tasmanian Caverneering Club, Southern Caving Society and Tasmanian Cave and Karst Research Group.
STC is the modern variant of the oldest caving club in Australia.

HASTINGS
NEWDEGATE CAVE
REHABILITATION PLAN

[Original had the cover photo, Titanias Palace, here]

Parks and Wildlife Service
July 1994

Hastings: Newdegate Cave Rehabilitation Plan

Parks and Wildlife Service, Tasmania, July 1994

Written by Ian Houshold and Phil Bradley

Photos and maps by Ian Houshold

NEWDEGATE CAVE REHABILITATION PROJECT PROPOSAL

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NEWDEGATE CAVE REHABILITATION PLAN

PART 1 SIGNIFICANCE OF NEWDEGATE CAVE AND EFFECTS OF VISITATION

1.1 Introduction

Newdegate Cave was developed for intensive tourism through a series of upgrades between the late 1930's and the early 1970's, and as a result there was little formal planning for the long term future of the cave. Natural features of the system have suffered as a result of staff having to work around a style of development which does not integrate environmental management with the development of walkways and electric lighting.

Many features are continuing to be degraded - dust and lint carried in by visitors accumulate on formations, and unsightly and destructive plant growth on both formations and sediments is continuing as a result of inappropriate lighting. Many parts of the cave were used as dumps for unsafe stairways, old cable, conduit and other refuse. This is affecting the habitat of cave fauna. Accumulations of mud and sawdust on formations are degrading the resource either through the coating being incorporated by subsequent calcite deposition or etching of the formation by humic acids leached from the sawdust.

Although selected areas have been cleaned it will be impossible to carry out a thorough cleaning program until adequate pathway drainage has been built and holding tanks for contaminated water installed. Cleaning without these will only spread the pollution further through the system - rather than dispersing it is likely that any mud or organic deposits will build up in ponded or sumped areas in the lower parts of the system, creating a malodorous mess.

In the past few years much research has been applied to the development of measures for the sustainable use of tourist caves, with a lot of original work carried out in Australian caves. Integration of cave cleaning systems with walkways, the development of low voltage lighting systems, and use of appropriate materials for track formation and surfacing are being tested in caves around the country, however the individual character of each particular cave means that certain practices will only be suitable for specific sites. Much room exists for further developments as knowledge of karst management practices increases and more appropriate lighting and cleaning technology becomes available.

These measures, as well as others particularly suited to Newdegate Cave are necessary if the environment of the cave is to be restored and maintained in an acceptable manner. Considerable effort has been expended in the development of a "clean" walkway from the carpark to the cave, and on an upgraded visitor information shelter at the cave entrance. Now that clean access to the cave has been guaranteed the time is right to begin a redevelopment which will allow ongoing use to occur without the environmental degradation which is inevitable given existing conditions.

The first part of this submission describes the natural history of the Hastings karst area and Newdegate Cave in particular, and how they fit in with proposed management of the significant karst resources of the Lune and D'Entrecasteaux valleys in southern Tasmania. A detailed description is given of the existing condition of Newdegate Cave and of present and ongoing visitor impacts. Predictions are made of the consequences for the cave system if the proposed developments are not carried out in the near future.

Part two consists of a detailed rehabilitation plan which addresses issues in the restoration of the cave, appropriate management responses, objectives and actions, costings and a timescale for implementation.

1.2 The Lune River Karst Areas

The headwaters of the Lune and D'Entrecasteaux Rivers contain a large, virtually continuous area where the dominant landforming agent is solution of the rock - a karst area. As a result much of the drainage is underground through cave systems. Blind and dry valleys, streamsinks and large springs where water disappears and reappears, and extensive sinkhole areas containing both solutional and collapse dolines are found throughout the area. Ordovician limestone and Precambrian dolomite form the main karst rocks, with their unconformable boundary located in the vicinity of Hot Springs Creek. Historically, the dolomite karst has been referred to as the Hastings karst, whilst the limestone karsts in the headwaters of the Lune and in the Marble Hill - D'Entrecasteaux area have been named the North Lune and Ida Bay karst areas respectively.

Numerous references describe the Ida Bay area, mostly following investigations surrounding the closure of the Lune River Limestone quarry (eg Eberhard 1990, Houshold & Spate 1990, Kiernan 1991). However, comparatively little work exists concerning Hastings. A broad description of the Hastings karst is given in Houshold & Davey (1987), whilst descriptions of individual caves are found in Kiernan (1971), Skinner & Skinner (n.d.), Skinner (1973) and Mathews (1985). Clarke (1990), Jackson (1990) and Sharples (1994) describe that part of the Hastings karst in State Forest surrounding the Hastings Caves State Reserve, whilst Houshold (1993) describes the karst hydrology of the area. An assessment of the carrying capacity of the State Reserve was made by Cutler (1991), and the resulting report contains a description of existing and potential tourist use of the reserve, including both the cave and the thermal pool.

The Hastings karst area is the only karst in Southern Tasmania with a cave developed for general tourist access. Newdegate Cave is one of only two tourist caves in Australia formed in dolomite as compared with limestone – the more common cave bearing rock. As the other, Tantanoola Cave in South Australia, is essentially an abandoned sea-cave, Newdegate Cave represents the only easily accessible dolomite cave in the country formed through solution of the rock as opposed to mechanical abrasion. Hence it forms a valuable educational resource for both local and interstate visitors.

Whilst partly a function of the location of suitable dolomite outcrops across the country, the location of Newdegate Cave is also a result of the excellent environment for cave development found in southern Tasmania. Cool-temperate climatic conditions with high rainfall and an abundance of soil humus from tall mixed forest overlying the dolomite give rise to high levels of carbonic acid in the abundant groundwater, necessary to dissolve sparingly soluble dolomite.

By coincidence the Precambrian dolomite adjoins a large deposit of Ordovician limestone, which stretches from the unconformable contact in the vicinity of Hot Springs Creek southwards around the headwaters of the Lune River and its tributaries to the Ida Bay karst area where Exit Cave and its many tributaries is found. The karst bearing limestone continues discontinuously from here into the Southwest wilderness area with limestone probably cropping out in the Catamaran and South Cape Rivulet valleys (Sharples 1994). Neither of these karst areas has yet been explored for caves and many are still to be found in the Ida Bay and North Lune areas.

The Hastings - Ida Bay area therefore represents an excellent collection of karst features on a variety of rock types, with a high potential for all styles of cave tourism. The highly developed Newdegate Cave is the most easily accessible cave, with tours operated by Parks & Wildlife Service guides leaving hourly throughout the day. This cave caters for most reasonably fit tour parties, although it is not suitable for wheelchair access. Mystery Creek Cave, part of the Exit system, has recently been established as a centre for adventure tours run mainly by local private operators (Parks & Wildlife Service 1994). The cave is not developed in any way, other than with rudimentary route markers. All lights and equipment are supplied by the client or the operator.

Other caves, both in the Hastings and Ida Bay areas are suitable for this form of activity. Numerous undeveloped caves are found in both areas, which may be visited by experienced speleologists. Two of these caves, Exit and King George V, require access permits from the Service. The area southwest of Exit Cave has a high potential for the discovery of further significant cave systems. Both areas also possess an excellent potential for the development of surface karst interpretative walks, where sinkholes, disappearing streams and large springs and cave entrances may be visited.

1.3 The Hastings Karst

The Hastings karst area is located in the valleys of Hot Springs Creek, a tributary of the Lune River, and Creekton Rivulet, part of the Esperance River system (Fig. 1). The dolomite is overlain by flat bedded Permo-Triassic sediments which form an impermeable cap rock on the karst rocks along the surface divide between the two drainage systems. Rain falling on the caprock collects into surface streams which generally disappear underground through streams inks and into cave systems when they reach the contact with the underlying dolomite. Steeply dipping cave passages have resulted, with Waterloo Swallet and Trafalgar Pot both contributing water to the Newdegate Cave system.

Newdegate Cave itself is a complex system with almost 2 km of documented passages. The cave has developed parallel to the surface course of Hot Springs Creek, along the predominant line of strike of the dolomite. Mystery Creek, an intermittent stream which flows through the lower levels of the cave when Hot Springs Creek is in flood, is thought to be a flood overflow channel of the surface creek. This has not as yet been proven through tracer tests. A more detailed description of the cave is found in the next section.

Although approximately 20 caves are known in the area, three other notable caves are found in the State Reserve: Beattie Cave, King George V Cave and Wolf Hole. Beattie Cave consists of a single chamber, easily accessible and reasonably well decorated, although showing signs of vandalism. King George V Cave is a complex, medium sized system which has in the past been shown to tourists. The cave, located approximately 800 m east of Newdegate, contains some very well decorated areas with long straw stalactites abundant. This cave may be suitable for guided ‘adventure tours’ where visitors are supplied with caving equipment and lights. Wolf Hole, 300 m east of King George V Cave, is notable for its large collapsed entrance. A circular hole, approximately 40 m deep and 15 m in diameter, leads downwards through Permian sediments to intersect the cave which has developed in the underlying dolomite. The cave contains one of Tasmania’s largest underground lakes, Lake Pluto, and many very fine straw stalactites. This cave is suitable only for experienced cavers. The hydrology of Wolf Hole is interesting in that the most likely source for the water in the cave is streams originating to the north of the surface divide in the Creekton catchment, with tributary streams passing to the south underneath the surface drainage divide.

The Hastings thermal springs are located approximately 4 km east of Newdegate Cave. These springs are thought to be the result of groundwater in the dolomite being forced downwards to a depth of approximately 600 m through a synclinal structure to re-appear in a major fault zone under hydrostatic pressure. The warmth of the springs is due entirely to the natural geothermal gradient. They occur over an area of about 0.25 ha with an average temperature of 28°C and a flow of approximately 30 l/sec. The warm water forms part of the karst system, as it contains high levels of dissolved calcium carbonate, however no warm springs have as yet been discovered in the caves of the area. Further large warm springs are located southwards on the Lune plains, however these springs

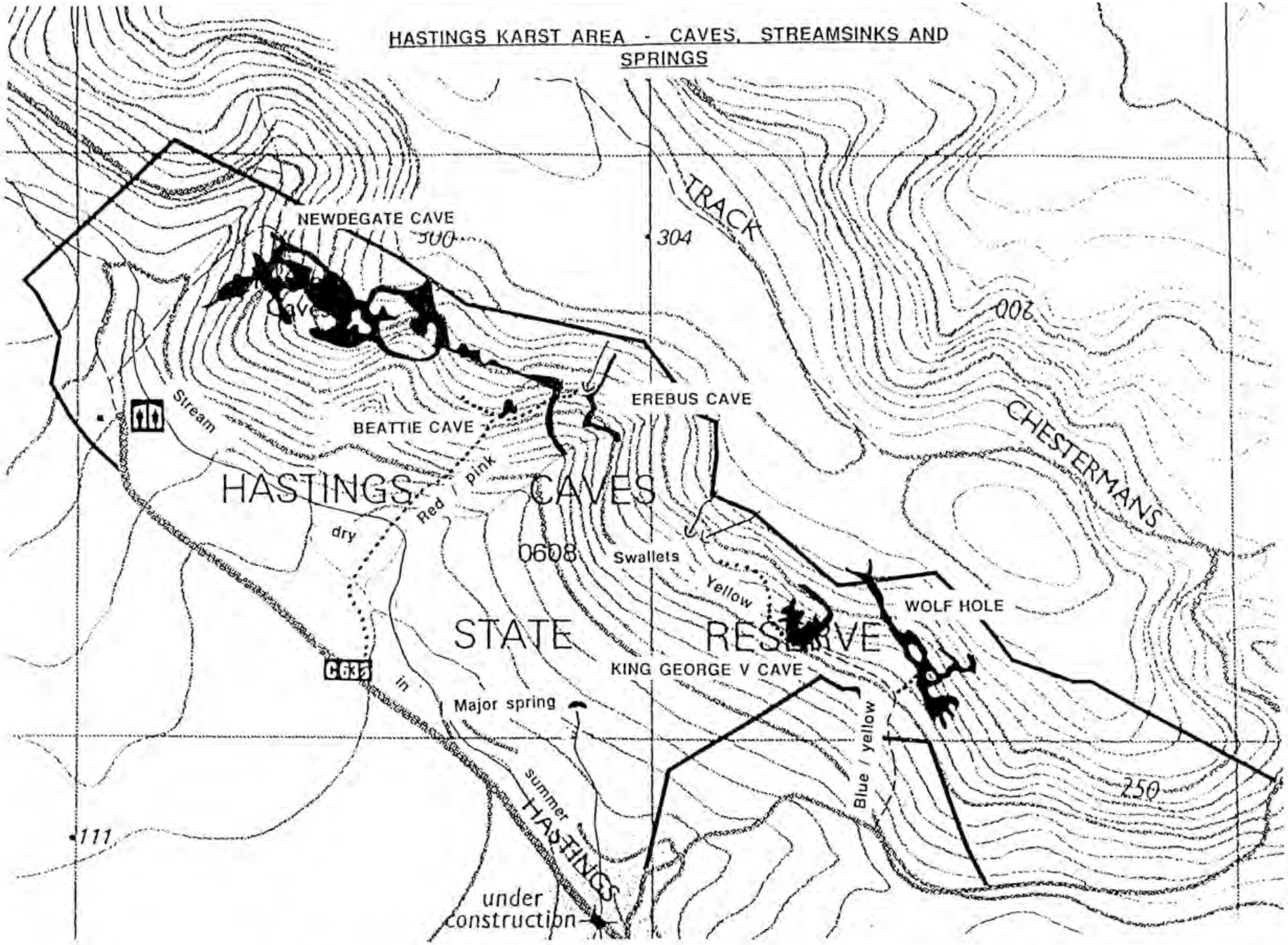

Fig. 1. The Hastings Caves area - caves and surface topography (After Tasmanian Caverneering Club survey TCC 130).

emanate from a limestone bedrock. This suggests that the Hastings dolomite karst and the limestone karsts further south are hydrologically linked.

A public pool has been constructed on one of the springs. This popular area lends itself to an integrated interpretative program with a focus on the warm and cool hydrology of the karst area.

The Hastings karst contains a diverse cave adapted fauna including cave beetles *(Idacarabus* sp.), harvestmen *(Monoxyomma, Lomanella* sp.), pseudoscorpions *(Pseudotyrannochthonius* sp.) and aquatic fauna such as the depigmented Tasmanian Mountain Shrimp *(Anaspides* sp.) Some of these species are thought to be endemic to the Hastings area, and maintenance of their habitats, especially those in Newdegate Cave, is very important. It is highly likely that present accumulations of mud, sawdust and other organic accumulations in the cave, and also lampenflora infestations (algae, mosses and ferns associated with artificial lighting) are adversely affecting the habitat for these creatures.

1.4 Newdegate Cave

1.4.1 Description of the cave - significance and vulnerability

Newdegate Cave (Fig. 2) and its surroundings have a high scientific significance, to both earth scientists and biologists. The cave consists of a maze of passages at various levels, although two major levels may be recognised - firstly that of the floors of the main Cathedral Chamber and the Binney Chamber, and secondly that of the present course of Mystery Creek, flowing at the base level of the system. The upper levels of the cave show evidence of having originally developed in the phreatic groundwater zone - the area permanently below the water table. Large chambers composed of smooth rounded forms dissolved along the major joint patterns in the rock, maze sections and very little evidence of the action of fast flowing water such as scalloping and fluting of the rock surface are evidence for formation under conditions of very slowly circulating groundwater. These original shapes have not been modified to any great extent by fast flowing water, but have been coated in most areas by magnificent speleothem displays.

In contrast, the lower levels of the system consist of a classical vadose canyon, incised as the water table dropped in response to incision of the surface valley of Hot Springs Creek. This canyon still floods from time to time, and deposits of fine clays on the surface of speleothems in the main upper chambers attest to large scale flooding of even the upper levels in the relatively recent past (‘000’s of years). This stream is still actively excavating the lower levels. Although it’s flow is only intermittent, underground flows beneath the present cave floor are still continuing solution of the rock. This, combined with destabilisation of large sediment banks within and above the vadose canyon is causing a slow natural subsidence in some areas, leading to cracking of speleothems. This is a completely natural process, unlikely to cause any major movement in the near future, and not a cause for concern.

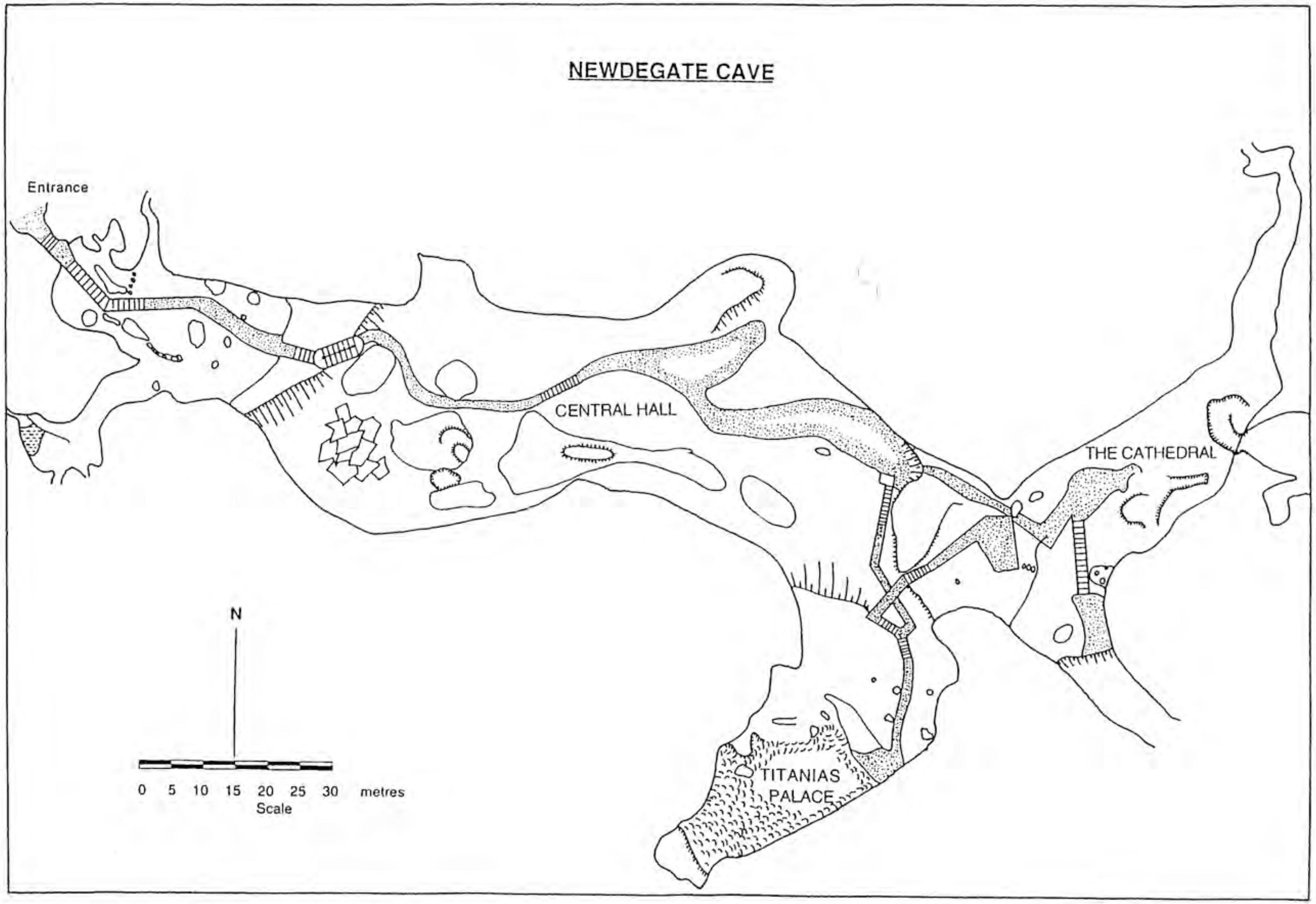

Fig. 2. Plan of the tourist routes within Newdegate Cave.

Newdegate Cave is likely to be the most richly decorated dolomite cave in Australia. Although many undeveloped dolomite caves are found in various parts of Tasmania, and far more rarely on the mainland, none so far discovered contains the masses of speleothems found in Newdegate. Speleothems found in Newdegate Cave include massed displays of what are most likely to be calcite speleothems: stalactites, stalagmites, shawls, straws, columns, shields, helictites, cave coral etc. No - one has studied the effect of the dolomite bedrock on the character of these speleothems, however the incorporation of dolomite in the crystal structure is likely to produce some interesting forms and mineralogy. Long, spiky crystal ‘flowers’ are likely to be composed of aragonite, however only sampling and analysis will confirm this. White, powdery coatings on the cave wall, resembling moonmilk but far drier, are found in many areas. These coatings have not yet been analysed.

Many of these formations are extremely delicate, and many aspects of the existing infrastructure of the cave are allowing ongoing deterioration to occur. These are discussed further in the next section.

The cave is the type locality for the first truly troglobitic species described in Australia - *ldacarabus cordicollis* - a small, totally blind cave beetle. A very closely related species - *ldacarabus troglodytes* - also totally cave adapted, is endemic to the nearby Ida Bay karst area. Morphological comparison of these two species will be an interesting exercise in explaining evolutionary divergence within a very restricted range.

Various other cave adapted invertebrates are found in Newdegate Cave, including the Tasmanian Cave Spider *(Hickmania troglodytes)* - a very large spider with a leg span of up to 12 cm and a large teardrop shaped egg sac which it suspends from the cave roof. Large huntsman like spiders are found in the cave also, however they have not yet been described. Cave Crickets - *Micropathus tasmaniensis* - are common near the cave entrance, making nightly trips into the outside bush to forage. Springtails - *Collembola* - are found on damp surfaces and pools throughout the cave, whilst harvestmen of the species *Monoxyomma cavaticum* and the relatively rare *Lomanella sp* inhabit drier areas. *Pseudotyrannochthonius tasmanicus* is an interesting, scorpion - like creature which inhabits plant debris washed into the stream during floods or fallen in through surface fissures. The Tasmanian Glow Worm - *Arachnocampa tasmaniensis* - is found in restricted sections of the cave. It was probably never very common in the system, as they generally require a permanently flowing stream to provide the habitat for they main prey - flying insects such as caddis flies and stoneflies. No specific studies of the cave fauna of Newdegate have been undertaken - these lists are from the studies of recreational speleologists and departmental officers. A complete faunal inventory for the cave would most likely reveal a great deal more.

Tasmanian caves, particularly those in rainforest areas such as Newdegate have the highest species diversity in temperate Australia (Eberhard 1991). Many of these creatures may be seen as part of a cave tour and, as well as their intrinsic interest, help the guides to draw relationships between the surface and underground environments. Unfortunately the habitat for these creatures has been severely degraded in the past, particularly near the surface trails, and most of the population of cave life now lives away from the disturbed areas. It is hoped that if this restoration plan can be implemented then many of the creatures displaced by pollution may return to areas near the tourist routes.

Being Australia's only tourist cave developed through solution of dolomite, as opposed to limestone, its major significance lies in opportunities for interpretation and education of visitors as to the nature of karst processes and biota in this rock type, which are not available anywhere else in the country. The specific environmental conditions surrounding the cave explain its development and character and make excellent interpretative resources. The cool mixed forest and rainforest above the cave, in conjunction with abundant rainfall, provide significant opportunities for interpretation of Tasmanian forest ecosystems. The addition of an underground trip, in which the surface environment may be linked to the solution and deposition of dolomite, and interactions between surface and cave adapted species integrate biological and geomorphic processes in a unique and spectacular way.

1.4.2 Present condition of the cave

Newdegate cave forms the focus for the great majority of tourists to southern Tasmanian cave areas, and has done for many decades. Catering for approximately 40 000 visitors per year it is one of the most popular tourist attractions in the south of the state. It is centred on one of the most diverse regions of karst in the country, and borders the extensive Western Tasmanian Wilderness World Heritage area. The cave is the most highly visited attraction in the state reserve system south of Hobart. Information related to the World Heritage area and surrounding state reserves is disseminated by information officers stationed at the cave.

The cave is electrically lit and concrete or earth pathways have been constructed with many steps giving easy access through the first 300 m of the system. Unfortunately the existing developments within the cave are having an adverse effect on the cave environment. In common with many cave developments of the 1930s - 1960s the infrastructure was very little concerned with the ongoing maintenance of natural environmental conditions.

Development of caves for tourism is now seen as an extremely complicated process. Caves possess no inherent carrying capacity for humans. Processes of geomorphic and biological evolution within cave systems occur generally over a far greater timespan than surface environments, environmental ranges are far more constrained and hence environmental tolerance of both landforms and species is far tighter than for almost any surface environment (Kiernan 1988). This is a relatively recent viewpoint however, stemming from an upsurge in scientific investigation into karst processes in the 1970s.

Throughout Australia cave managers have realised that in most cases existing lighting and walkways, and provisions to keep the caves clean are unsuitable, with many developments remaining relatively unchanged from the early part of the century. Newdegate Cave is certainly in this category at the moment, as the last major developments in the cave occurred in the late 1960's when wooden walkways were replaced with concrete structures, significant areas were rewired, and new switching stations were installed. Most of the developments did not however consider the sustainability of cave formations, sediments or biota, and the impacts which have occurred since the cave was first opened for intensive tourism in 1939 have continued to increase with visitor numbers.

These impacts fall into the following categories:

1. Introduction of foreign materials

Materials introduced during development

Over the last sixty years a great deal of foreign material has been introduced to the cave, both in the process of development and as a result of tourist traffic. Although the initial access to the cave has always been constructed from concrete, for the first thirty years of operation all internal steps and railings were built of wood. Eventually these became unsafe and were replaced with concrete, however a large amount of the original wood was merely dumped into holes remote from the sight of visitors. Although much of this wood has recently been removed through volunteer working bees supervised by Parks staff a great deal still remains. This material is rotting into the substrate forming an unnatural source of nutrients in the system, and a germination area for spores introduced to the cave on visitors clothes and shoes.

Refuse from previous lighting systems including discarded plastic conduit and copper wiring also remains in the cave. Whilst the plastic is probably inert it detracts from the aesthetic experience in the cave. Copper wiring on the other hand is oxidised in the damp environment and permanently stains the rock and any formations it contacts. Similar impacts are felt from steel wiring brackets. Again, working bees have helped remove much of this material, however a lot must remain until the cave is rewired.

In the past it was common practise to dispose of used light bulbs and fittings by throwing them into holes. As a result much broken glass is found throughout the cave.

As part of the development a great deal of crushed silica was introduced to the cave - mainly in the entrance area. Although reasonably inert and not likely to cause any major environmental problems, this material has now covered a significant area of floor formation which would be better restored to its original condition.

This material can all eventually be removed, leading to a more natural system. This will be reasonably easy to address, however what is a more difficult problem is the spores, seeds, dust, mud, lint, skin and hair that are continually transported into the cave by visitors and guides. Visitors also bring with them their own personal acid supply in the form of the carbon dioxide they exhale. Carbon dioxide dissolved in water droplets condensed onto cave formations forms a carbonic acid solution which, if concentrated enough, can dissolve the surface of the formation. Tests in the cave show that CO_2 concentrations in the cave air over the summer and Easter busy periods may have the potential to do this.

2. Materials brought in by visitors

Dust and organics

Before the development of the present raised walkway to the cave entrance the access track to the cave was first constructed from crushed silica, the dust from which was most likely transported into the cave by early visitors. In the early 1960s this was replaced by tree fern trunks and then a sawdust layer. People walking the track carried large amounts of this material into the cave on their feet. A great deal was swept from the paths onto nearby formations, discolouring them and building up a source of humic acid which subsequently began dissolving the surface layers of the formations. Some of this material has been removed by hand but a great deal remains in inaccessible locations.

To alleviate this problem a new raised walkway and entrance shelter were constructed from treated pine. This greatly reduced the amount of organic material transported into the cave on visitors feet. There is, however an ongoing problem with mud and silt carried in the cleats of shoes and released when the sole is wetted in the cave. This material presently runs off the uncurbed pathways and onto formations.

Only part of the tourist route through the cave has been surfaced. A large area of ‘natural’ floor remains in the central part of the cave. Material picked up on visitors shoes is then transported throughout the cave which again results in discolouration of formations by track runoff. In time this material will be incorporated into the speleothems as calcite builds up a film over the top. It will then be impossible to remove.

Many kilograms of fine materials such as dust, lint, hair and skin flakes have been transported into the cave by visitors. Most of this material is light enough to float in the air, and is often carried high into the cave on up draughts created by the heat given off by powerful spotlights. Large amounts of this material have accumulated on fine formations such as helictites and straws, particularly those near walkways and near powerful lights. Significant amounts have been deposited on cave spiders webs.

What material doesn’t adhere to formations eventually falls out onto horizontal surfaces where it remains to discolour formations and introduce nutrients to the system. As with the mud and sawdust deposits mentioned above much of this material will eventually be incorporated into the surface of speleothems as calcite builds up and become impossible to remove.

Seeds and spores

Many seeds and spores are introduced to the cave by visitors. Although it is not unknown for native animals such as Brush Possums, Wombats and Tasmanian Devils to enter caves they generally do not move far from the entrance and would not be a major source of spores for the interior of the cave. Similarly migratory cave crickets may bring in spores but they also generally do not move far from the cave entrance. As opposed to mainland caves bats only enter the cave accidentally and very rarely.

There is, however a great deal of fungus growing throughout the cave on most substrates, particularly on old wood and in high nutrient areas such as fall-out zones where hair, skin and fibres accumulate. Although small amounts of fungal growth in the cave is natural the greater input of spores, and locally increased nutrient levels means that a far greater than natural mass of fungus is found in the cave than would have naturally occurred.

Seeds are often seen to germinate in the cave but generally do not survive. The only instances where the spores of ferns and mosses survive is in the vicinity of artificial lights, and these plants can become a major problem (see below).

Touching formations

Another consequence of a poorly designed route is that certain large stalagmites and columns are sometimes used as leaning posts, again especially if parties are large. Transfer of oils from the skin onto formations essentially prevents the further build-up of calcite. Also, continued touching will smooth and discolour the formation.

Erosion

Because the route is poorly designed and track edges poorly defined many people walk off the track onto surrounding areas. This is especially so in peak periods when large parties are common and guides cannot see everyone's movements. These areas are often composed of soft cave sediments, stalagmites or flows tones which are easily damaged by trampling feet. The result is an ongoing gradual erosion of features in the vicinity of the walkways which cannot be rehabilitated.

3. Problems caused through inappropriate lighting

As well as disturbing the natural airflow patterns of the cave, aiding the build-up of lint in the vicinity of lights, the artificial light itself can cause major disruptions in what would naturally be a totally dark environment. As mentioned above the only plant life naturally found in caves is generally fungus.

Green plants such as ferns and mosses, as well as certain types of algae are quite common in Newdegate Cave however, and these are entirely due to transport of seed and spores by visitors, artificial light in quantities sufficient to allow growth, and in some instances sufficient added nutrients to promote growth.

Algae in particular appears to prefer the smooth surfaces of speleothems and in some cases deposits have become quite thick, forming an inky blue colour. Mosses and ferns appear to prefer more friable substrates such as decomposing rock and cave sediments.

These plants, as well as being unsightly, can have quite a destructive effect on cave formations as their roots can etch or even break down the substrate on which they grow (Aley & Aley 1985).

All of these effects in combination have led to the gradual degradation of Newdegate Cave since it was first developed sixty years ago. Many of the effects can be halted and in some cases rehabilitated. This is absolutely necessary if the quality of the experience for visitors is to be maintained and management of the cave is to be raised to the level of best practice in Australia. The Tasmanian Parks and Wildlife Service has developed a comprehensive rehabilitation and ongoing maintenance plan for the cave which is outlined in the second part of this document.

Major changes in both management and infrastructure are necessary in order for the cave to remain an attraction. We now have the knowledge and technology to correct many of the mistakes of the past, however a substantial financial commitment in the form of a diversion of part of the revenue gained from ticket sales, an internal allocation, or an outside grant, is necessary in order for works to commence.

1.4.3 Likely deterioration if no action is taken

In general terms, the sooner that these issues are addressed the easier the job of rectifying the damage will be, and the scale of impacts will be proportionally lessened. The following examples illustrate the necessity for swift action.

As deposition of calcite is an ongoing process the more time that is allowed to elapse between the introduction of sediments and/ organics etc onto active flowstone surfaces and its cleaning, the harder the surface will be to clean and in many cases it will be impossible to clean. In some cave areas weak acid has been used to dissolve the surface film from formations in order to remove incorporated sediments. This practice is not acceptable in caves in Tasmania's National Parks as the risk it poses to the cave ecosystem does not justify the gains which may be achieved.

Similarly, where sawdust has been introduced and is adhering to speleothems humic acid will continue to leach from the deposits and will continue to etch the surface until removed.

Where lampenflora exists speleothem surfaces will continue to be etched and in some cases algae will be further incorporated into the crystal structure, staining the speleothem green or blue.

Bulk debris such as disused wooden stairways etc will continue to decompose, providing an unnatural source of nutrients for the system, whilst oxidation of different metals present in disused electrical systems, light fittings and handrails will continue to stain the surfaces on which they rest.

In the absence of effective track definition natural cave sediments and speleothems will continue to be eroded by visitors.

In order to clean the cave without the risk of further damage it is imperative that cleaning takes place as soon after introduction of foreign materials as possible. As outlined below, the sooner a program of track definition, drainage modifications, cleaning and re-lighting is commenced the easier it will be to maintain original features in as natural a state as possible.

It would be unacceptable to begin cleaning much of the cave before drainage, water supply and storage, and sludge pumping facilities are constructed. The waste water would merely be flushed deeper into the system, affecting previously unaffected areas, and concentrating harmful materials in sumps and pools below the presently developed tourist section.

Removal of bulk materials has already begun, and should be continued. Identification of lampenflora is in progress, as are trials of methods used to kill existing infestations. Limited cleaning of sawdust, lint and silt deposits has been carried out in the recent past. However, only a small proportion of the total problem may be addressed prior to the establishment of appropriate infrastructure to cope with relatively large amounts of water necessary to effectively clean the majority of the cave, the runoff and dead plant material from treated lampenflora areas and the development of a more appropriate lighting system.

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PART 2 REHABILITATION AND ONGOING MAINTENANCE OF NEWDEGATE CAVE

2.1 Introduction

This rehabilitation plan has been devised in order to return Newdegate Cave, its contents and associated ecosystems to as natural a condition as possible, and to maintain the cave and its contents in this condition given the use of the system by approximately 40 000 visitors per year. It is difficult to predict to what extent the natural systems of the cave may be restored, as very little baseline information exists, and visitor impacts have been addressed in only a piecemeal fashion for the five decades that the cave has been open to tourists.

As noted in Part 1, the natural carrying capacity of most cave systems is effectively zero humans. In comparison with most surface ecosystems the cave environment has almost no capacity to restore itself after an impact has occurred. Cave managers must be aware of the rate of natural change within a cave system, the effects of accelerated change due to visitation, and the most up to date methods of addressing impacts on the system without unknowingly exacerbating the problem locally or spreading problems any further from the impact site.

The collection of adequate baseline data for the Newdegate Cave system will only be possible after many years monitoring of natural systems in order to account for the high natural variability of the local ecosystem. The present lack of baseline data does not however preclude taking steps to rehabilitate the system in the short term. The scale of visitor impacts to date deviate sufficiently from baseline conditions that a reasonable estimate may be made of measures necessary to return the system to an approximation of its natural state. The system may then be more finely tuned as useable amounts of baseline data become available.

Setting up such a monitoring system is beyond the scope of this report, and should be addressed as part of an ongoing management plan for the cave and reserve

This plan draws on personal experience gained from cave rehabilitation projects throughout Australia and on documentation of projects worldwide. It reflects, as far as is known, the state of the art in all areas of walkway and illumination design, cleaning techniques and maintenance procedures. Some of these areas have attracted far more interest and research than others. Electrical systems and lighting design for example are presently progressing rapidly with the introduction of low voltage lighting systems, the use of optical fibres and miniature and automated switching systems. On the other hand much research still needs to be undertaken in the areas of lampenflora control and ongoing cleaning procedures. Trials of different materials and procedures are proposed for these areas.

The plan is divided into ten sections, each concentrating on a specific, interrelated set of issues. Each section briefly describes these issues (and should therefore be interpreted in the light of Part 1 where a more holistic approach is taken) then describes the proposed management response. Individual objectives, related actions, costs and timescales are tabulated, then specific technical details are provided for each aspect of the program. In the final section a time line for completion of the project is presented, along with a proposed maintenance schedule, to be followed after the original redevelopment is completed.

It must be stressed that this is not a management plan for the cave or the reserve as a whole. Numerous issues such as the limits of acceptable change within the system, visitor numbers both per tour, per day and per year, interpretation of the karst, monitoring of both baseline and visitor induced variations to natural processes, and the protection and development of the reserve surrounding the cave are beyond the scope of this plan and must be addressed in an overall management document. This rehabilitation plan merely forms a part of an all - encompassing management plan which is sorely needed for such a significant and popular reserve.

2.2 Visitor Walkway Surface & Assembly Areas Upgrade

2:2:1 Issues

Several walkway and assembly areas are uneven, providing a degree of discomfort and hazard for visitors. These sites are constructed from introduced gravels and clays which are mobile thereby compounding the problem of soil distribution throughout the cave system.

2:2:2 Management Response

Problem walkway and assembly areas will be clearly defined, levelled and reconstructed as identified.

Installation of a shoe washing facility and all weather matting at strategic locations will minimise tracking of introduced material and cave sediments.

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Table 2:2:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIORITIES	ESTIMATED TIME	COM-MENTS
Eliminate distribution of foreign matter throughout the cave system	Seal visitor carpark	20000	C	2 Days	
	Install elevated boardwalk access track to cave entrance	38000	A	30 Days	Comp-leted
	Install visitor shoe wash facility and interpretation material	500	A	4 Days	Work-force - 2
	Clearly define appropriate visitor pathway and assembly areas by installing concrete curbing designed to meet other objectives in the rehabilitation plan	40000	A	30 Days	Work-force - 8
	Install all weather matting in strategic areas as identified	6000	A	4 Days	Work-force - 2
Provide safe uniform surfaces on walkway and assembly areas including stabilising mobile surfaces to prevent transfer of cave sediments	Level and reconstruct concrete surfaces as identified	4000	A	6 Days	Work-force - 4
	Level, stabilise and install all weather matting on identified surfaces	3000	A	4 Days	Work-force - 3

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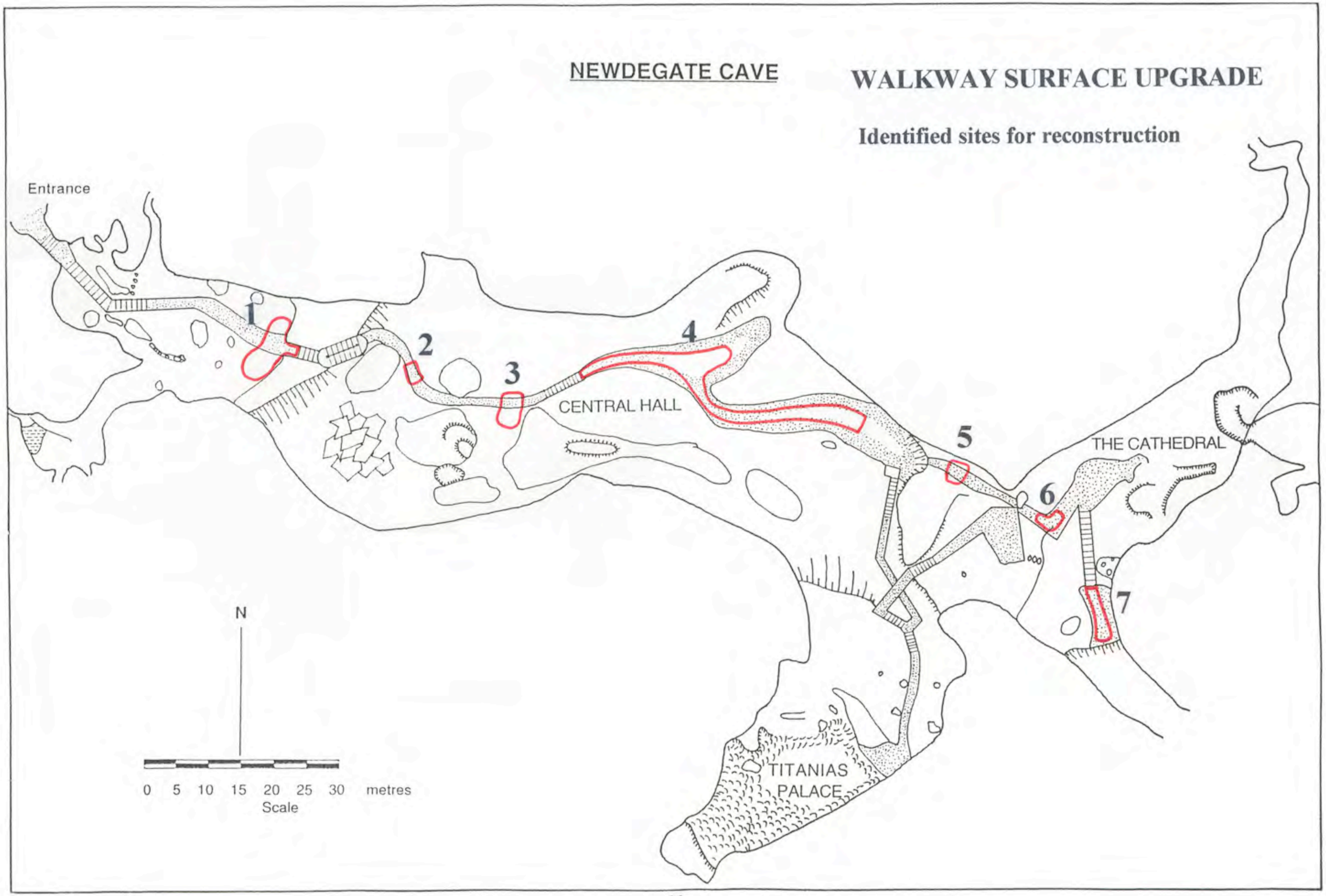
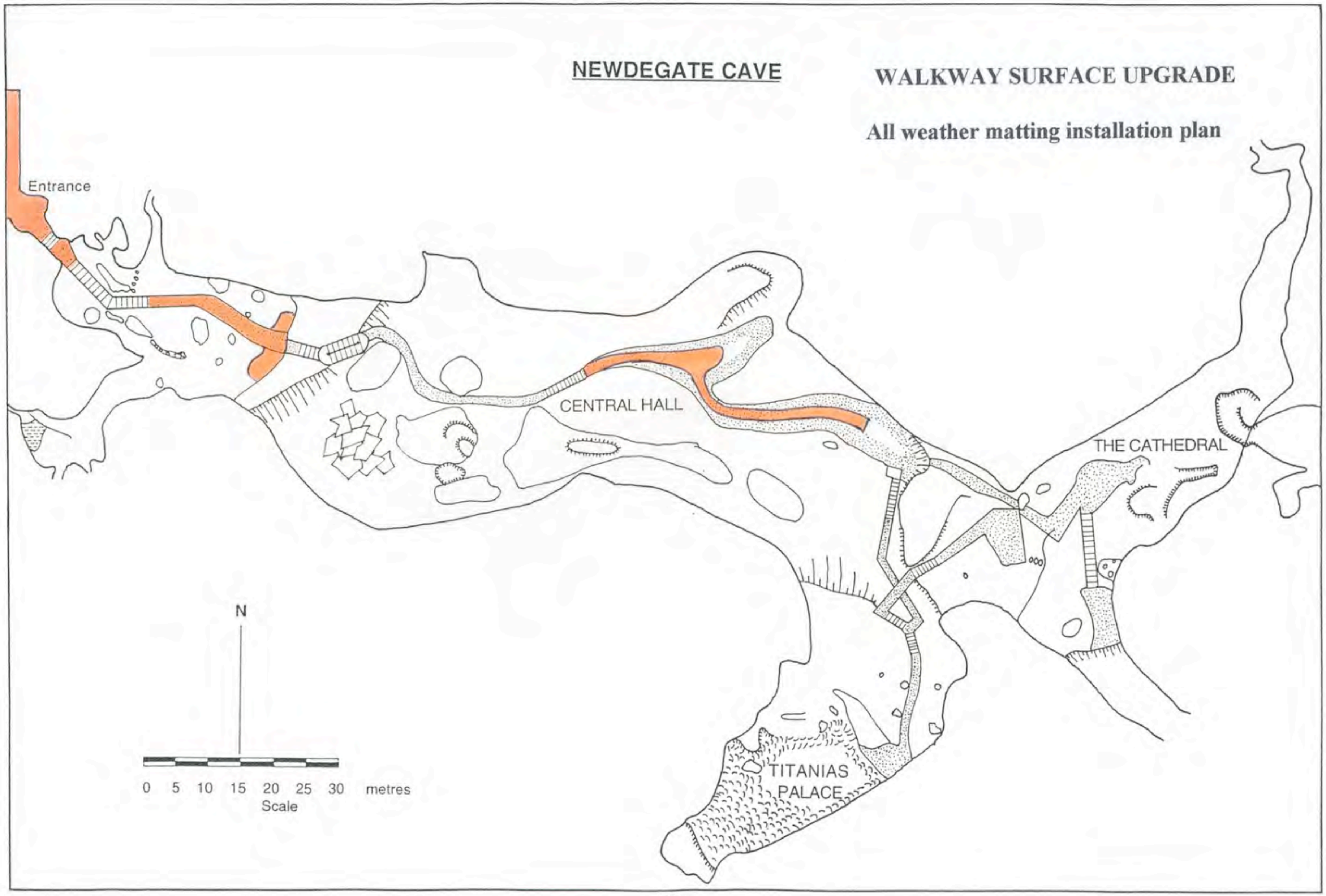
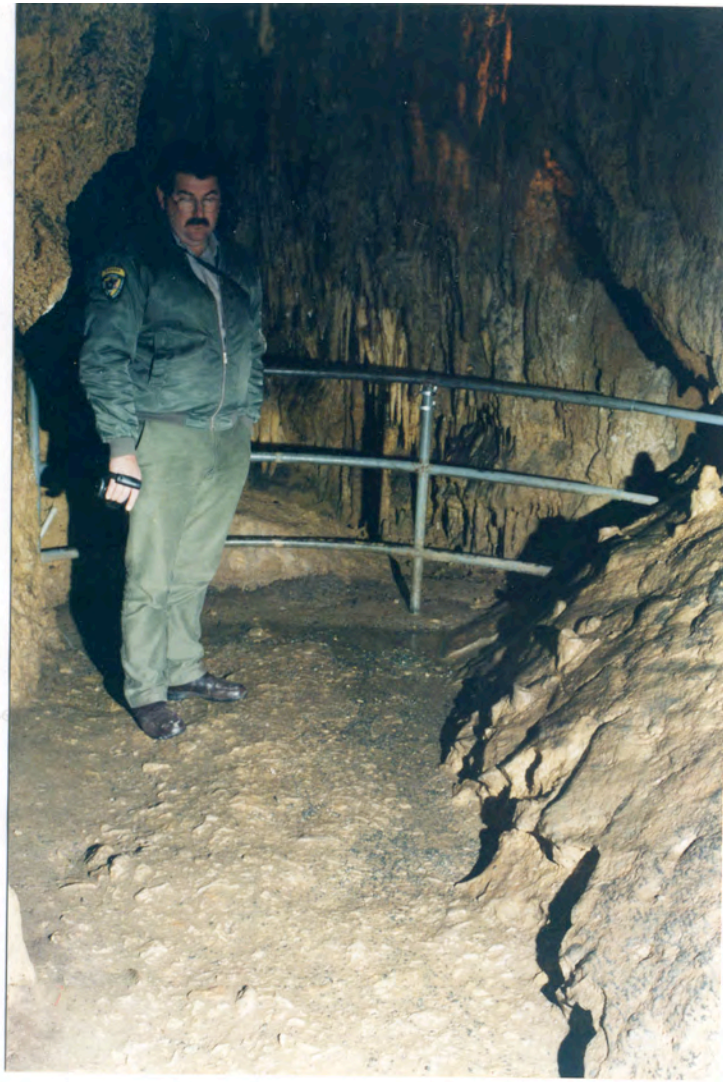

NEWDEGATE CAVE
WALKWAY SURFACE UPGRADE
Identified sites for reconstruction
Entrance
1
2
3
4
5
6
7
CENTRAL HALL
THE CATHEDRAL
TITANIAS PALACE
N
0 5 10 15 20 25 30 metres
Scale


NEWDEGATE CAVE
WALKWAY SURFACE UPGRADE
All weather matting installation plan
Entrance
CENTRAL HALL
THE CATHEDRAL
TITANIAS
PALACE
N
0 5 10 15 20 25 30 metres
Scale



Section 2.2. Unconsolidated material from unstable areas such as these is transferred on visitors shoes throughout the cave system, particularly when surface are wet. Rough surfaces are potential safety hazards for visitors.

2.3 Walkway Definition

2:3:1 Issues

Clear definition of public walkway and assembly sites within the cave is essential to the management and control of visitor impacts.

Absence of clearly defined access areas has lead to ongoing erosion, defacement and permanent destruction of natural cave features. Dirt deposition throughout the cave system is also compounded by visitors stepping outside established access sites onto naturally occurring silt and clay. Subsequently this extremely mobile material is added to the foreign soil distribution problem referred to in Section 1.

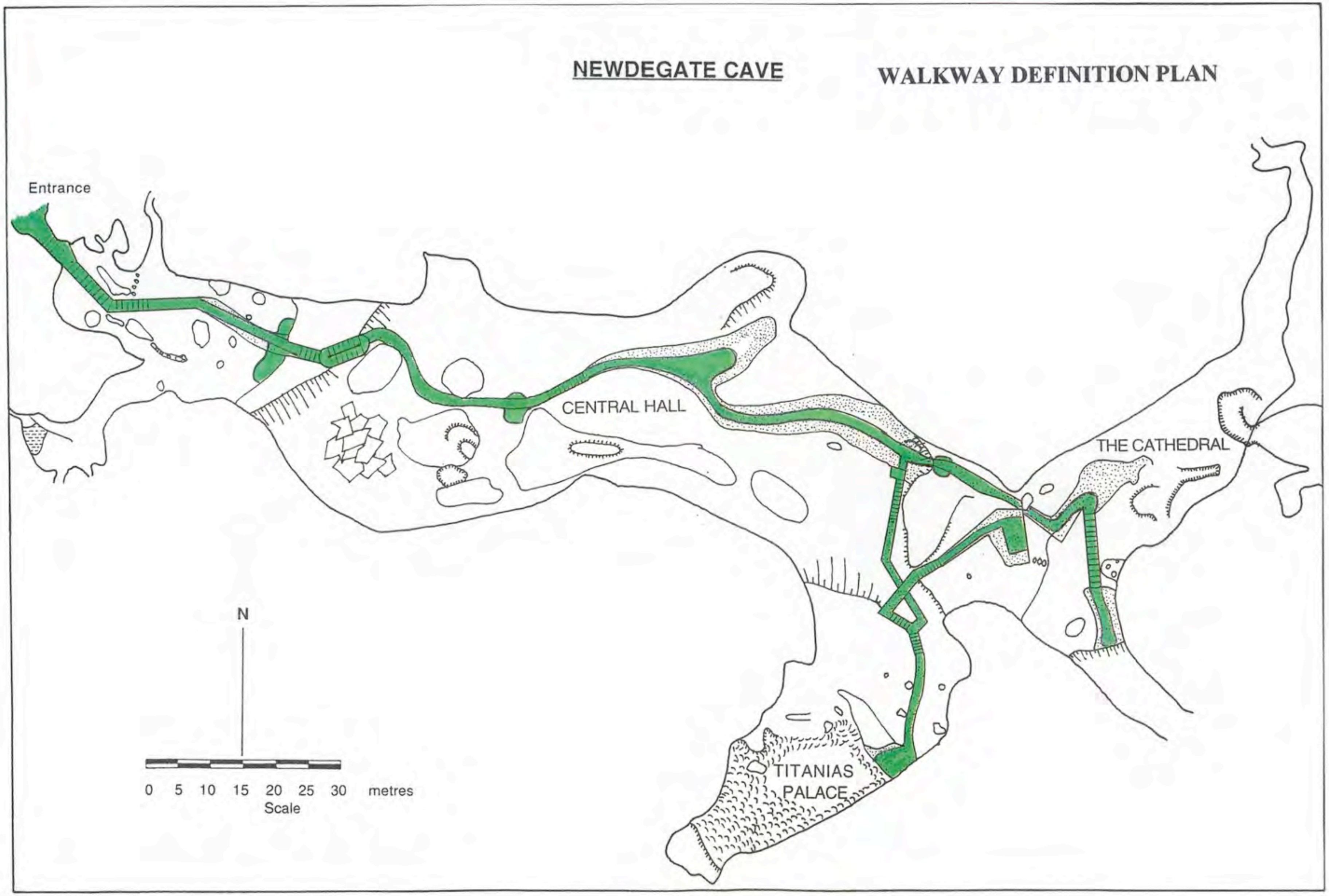
2:3:2 Management Response

Installation of concrete curbing to surround public access routes would clearly determine these sites and provide the required level of visitor control.

A multi-functional curbing design will provide pathway surface drainage, housing for plumbing and electrical services associated with refuse and washing systems and housing for electrical services associated with pathway lighting.

Table 2:3:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIOR-ITIES	ESTIMATED TIME
Define walkway and assembly areas in order to prevent tracking of cave sediments, erosion and irreparable damage to speleothems caused by visitors stepping outside acceptable access routes	Utilise concrete curbing to surround visitor access areas as identified		A	


NEWDEGATE CAVE
WALKWAY DEFINITION PLAN
Entrance
CENTRAL HALL
THE CATHEDRAL
TITANIAS PALACE
N
0 5 10 15 20 25 30 metres
Scale

24

Section 2.3 Poor walkway definition allows unacceptable degradation of speleothems and cave sediments by visitors venturing outside acceptable access areas

2.4 Pathway Drainage & Refuse

2:4:1 Issues

Naturally wet walkways and assembly areas within the cave mobilise material introduced on visitors shoes causing pathway slush to develop, accumulate and flow over natural areas.

2:4:2 Management Response

The pathway drainage and refuse system incorporates walkways being confined within concrete curbing as described in section 2. Effectively surface drainage is trapped within the curbing and channelled into drainage sumps strategically located throughout the cave system.

Each drainage sump will include a pump unit of sufficient capacity to completely remove the collected refuse from the cave system. Pump units will be connected to float switching devices to provide automatic operation 24 hours per day.

Plumbing and electrical services will be concealed within the concrete curbing and sump units will be located out of sight.

The system will also facilitate future washing and cleaning programs as the majority of regular maintenance operation will occur in the confined public areas.

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Table 2:4:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIOR-ITIES	ESTIMATED TIME	COMM-ENTS
Confine introduced foreign materials to visitor walkways	Utilise concrete curbing to surround visitor access areas as identified		A		
Channel Pathway slush and cleaning residue into drainage sumps	Utilise concrete curbing to drain all visitor access surface areas to sumps locations as identified		A		
Remove pathway slush and residue from cave system	Install sump and pumping units connected to a reticulated draining system as identified		A	8 Days	Work-force - 4
Conceal plumbing and electrical services associated with pathway drainage and refuse system	Install plumbing and electrical services in pathway curbing		A		

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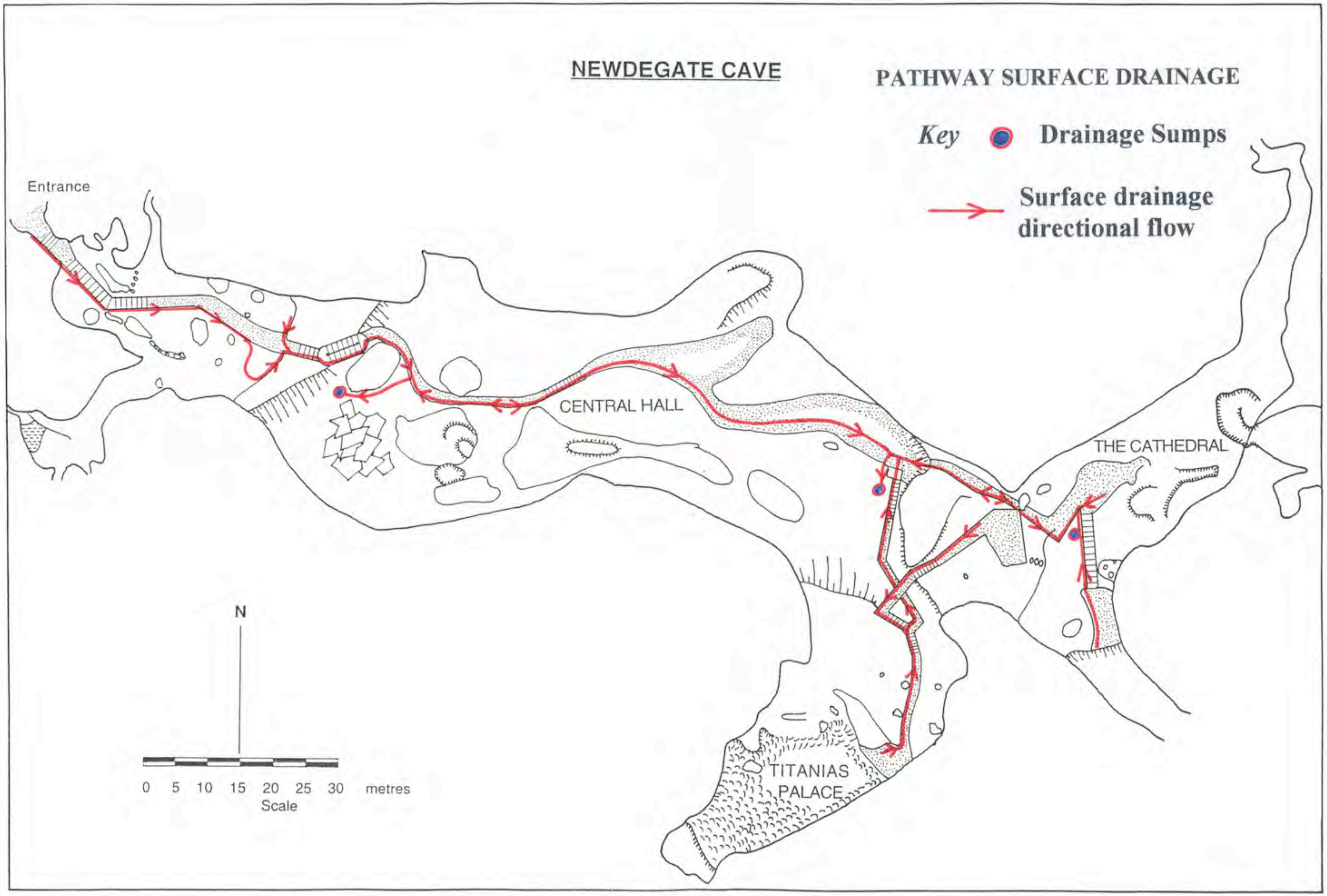
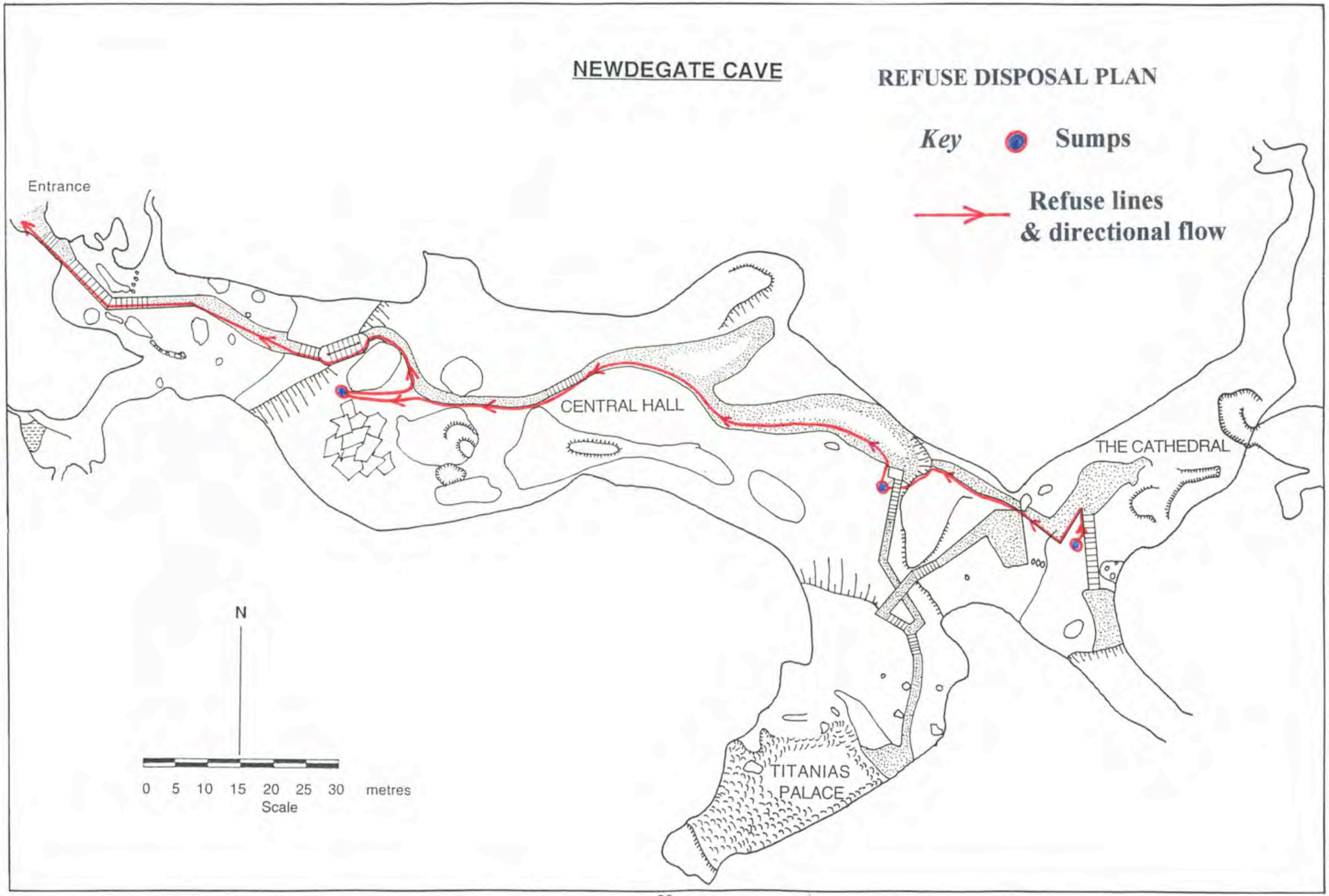

NEWDEGATE CAVE
PATHWAY SURFACE DRAINAGE
Key
Drainage Sumps
Surface drainage directional flow
Entrance
CENTRAL HALL
THE CATHEDRAL
TITANIAS PALACE
N
0 5 10 15 20 25 30 metres
Scale

28


NEWDEGATE CAVE
REFUSE DISPOSAL PLAN
Key
Sumps
Refuse lines
& directional flow
Entrance
CENTRAL HALL
THE CATHEDRAL
TITANIAS
PALACE
N
0 5 10 15 20 25 30 metres
Scale

Section 2.4 Material introduced on visitors shoes is mobilised on wet walkways causing pathway slush to develop, accumulate and flow over natural areas.

2.5 Reticulated Water System

2:5:1 Issues

On completion of the initial major restoration works a routine cleaning regime is planned to be implemented as detailed in Section 2:9:3.

The program will require a substantial water supply to adequately clean and flush formations and walkways.

2:5:2 Management Response

Reticulated water supply permanently installed in the cave is essential to implement the planned maintenance program.
Plumbing lines will be concealed within the concrete curbing with numerous outlets located at strategic locations throughout.

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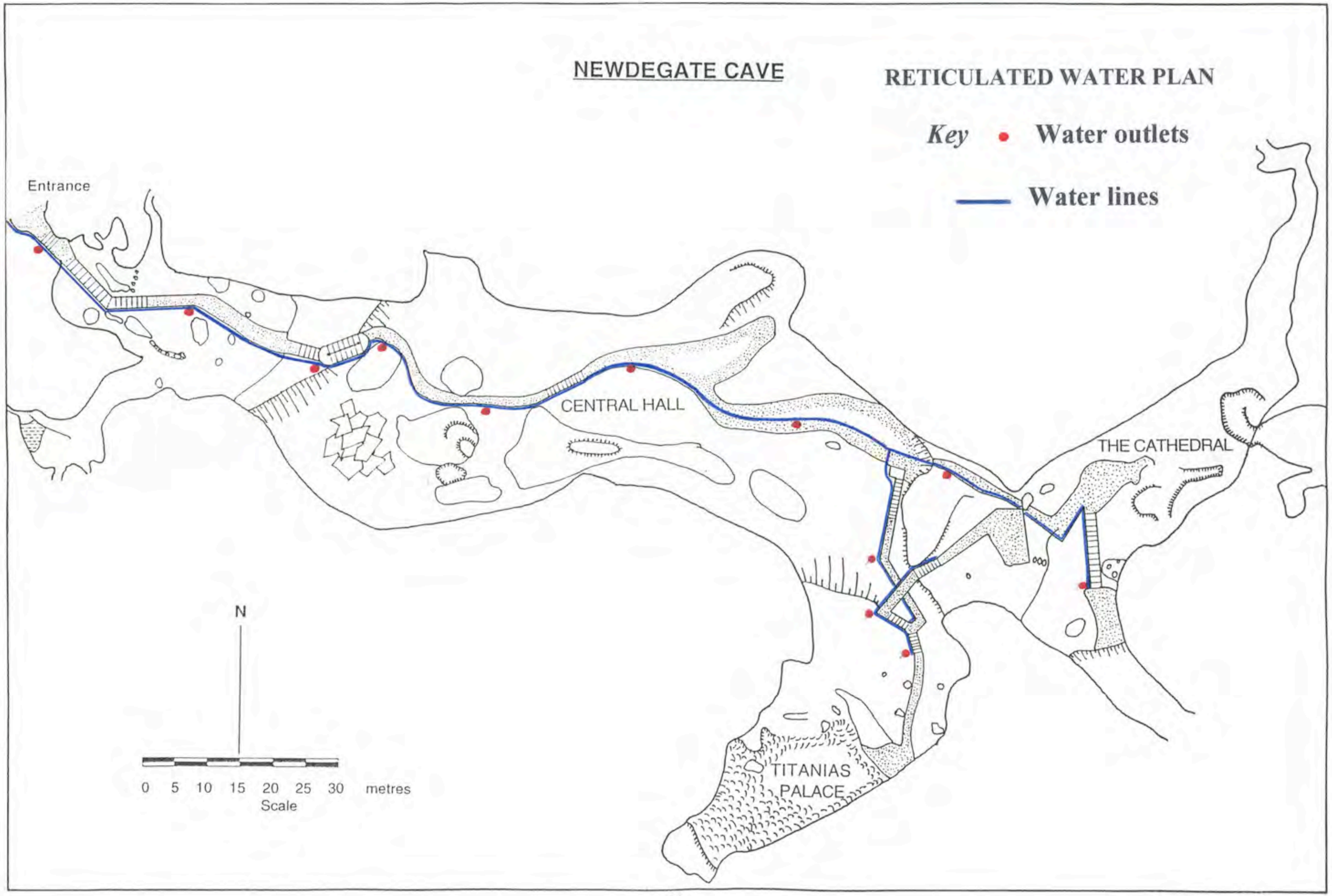
Table 2:5:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIOR ITIES	ESTIMATED TIME	COM-MENTS
Provide a substantial quality water supply to adequately clean and flush formations in accordance with established maintenance programs	Install plumbing lines and water outlets at strategic positions throughout the entire cave visitor section	3000	A	5 Days	Work–force - 4
	Install an adequate pumping system at Hot Springs Creek or rainwater tank and connect to reticulated system	5000	B	3 Days	Workforce - 2
Conceal plumbing equipment associated with reticulated water system	Install plumbing equipment in pathway curbing and beneath floor surface area		A		
Provide a water supply with acceptable environmental quality	Prepare and implement a water quality analysis program		A		
	Install neutralising units on delivery systems as required	1000	A	2 Days	Workforce - 2

32


NEWDEGATE CAVE
RETICULATED WATER PLAN
Key
Water outlets
Water lines
Entrance
CENTRAL HALL
THE CATHEDRAL
TITANIAS PALACE
N
0 5 10 15 20 25 30 metres
Scale

33

2.6 Pathway Lighting System

2:6:1 Issues

Pathway lighting at present is largely dependant on indirect illumination from the cave feature lighting system resulting in lint accumulation, lampenflora growth and obtrusive glare due to the placement of lights. Existing pathway lighting fixtures are also visually obtrusive.

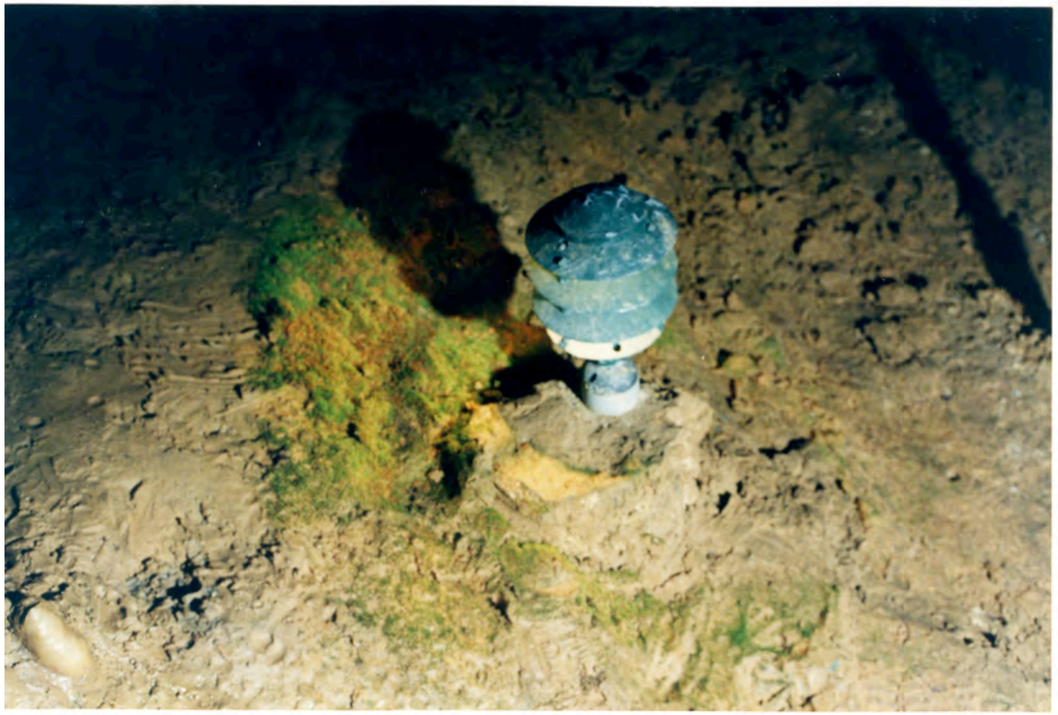
2:6:2 Management Response

Installing a specific circuit for pathway lighting and concealing fittings within the concrete curbing will alleviate the existing problems and provide scope for a emergency lighting system. Dual purpose and obtrusive light fittings can then be either removed or relocated .

Careful design of the proposed system can ensure a subtle and environmentally acceptable result will be achieved.

Table 2:6:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIOR-ITIES	ESTIMATED TIME	COM-MENTS
Provide unobtrusive, low intensity lighting specific to walkway and assembly areas in order to eliminate lampenflora growth and obtrusive glare	Research equipment/ design and install pathway lighting system to meet objective	4000	A	8 Days	Work-force 2
Provide emergency pathway lighting in the event of power failure	Research equipment and include emergency lighting system in pathway lighting circuitry	1500	C	3 Days	Work-force 2



Section 2.6 Inappropriate pathway lighting, not solely directed to the illumination of walkways, is visually obtrusive and promote lampenflora growth

2.7 Lampenflora Control

2:7:1 Issues

Lampenflora is evident at numerous locations throughout the cave system due to inappropriate placement of lights.

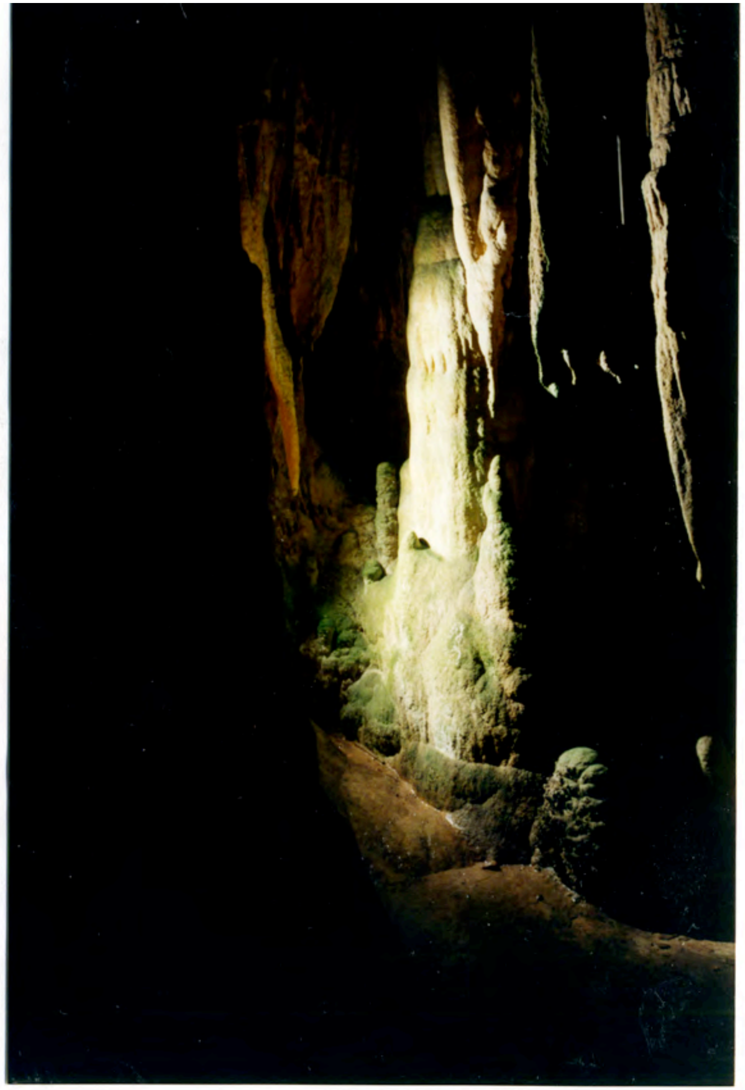
2:7:2 Management Response

Initial action will require the development of an eradication regime soundly based on environmental protection measures.

Essentially the cave lighting system requires extensive modification with a view to eradicate lampenflora infestation.

Table 2:7:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIORITIES	ESTIMAT-ED TIME	COMMENTS
Eliminate un-natural plant growths from within the cave system	Identify affected areas and modify lighting system where possible	1500	A	2 Days	Workforce - 2
	Research and trial alternate chemical dosing applications and establish an environmentally acceptable and effective procedure	500	A	5 Days	Workforce - 1
Establish an ongoing treatment regime in order to ensure permanent eradication of unnatural plant growths within the cave	Implement established eradication regime		A		



Section 2.7 Lampenflora; algae, mosses and sometimes ferns grow in artificially lit sections of the cave, degrading speleothems and sediments, and disrupting the cave ecology.

2.8 Lint Cleaning

2:8:1 Issues

Lint deposition is distributed at various locations and with abundance at confined visitor assembly areas.

The problem is compounded by some light placements which introduces heat convection to the area causing lint material to be drawn upwards and collect on speleothems.

2:8:2 Management Response

On completion of a carefully planned initial cleaning program, extensive lighting modifications will be undertaken, followed by the implementation of a routine maintenance/cleaning schedule.

Table 2:8:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	S	PRIOR-ITIES	ESTIMAT-ED TIME	COM-MENTS
Remove all accumulated lint material from the cave system and thoroughly clean affected areas	Prepare and implement an initial removal and cleaning program				
	Identify and record affected areas	100	B	1 Day	Workforce - 1
Regularly clean lint affected areas in accordance with an established maintenance regime	Prepare and implement a routine maintenance/ cleaning program	1500	A		
Provide measures to minimise lint mobilisation within the cave	Modify lighting systems in affected areas where possible	1500	B	2 Days	Workforce - 2

Section 2.8 Lint, hair, dust and other light particles introduced by visitors adhere to delicate formations throughout the cave. Convection currents from inappropriately sited lamps aid the concentration of these materials.

2.9 Bulk Debris & Rubbish Removal

2:9:1 Issues

Although the majority of bulk debris and rubbish deposits have been removed, large quantities estimated at 3 tonnes still remain at various locations. These sites are visually obtrusive and pose serious threats to the cave environment.

2:9:2 Management Response

A major operation will be undertaken to remove the material and rehabilitate affected sites.

Given the sensitive nature of the exercise it is recommended experienced personnel be involved and will be drawn from caving clubs and local friends groups as on previous occasions.

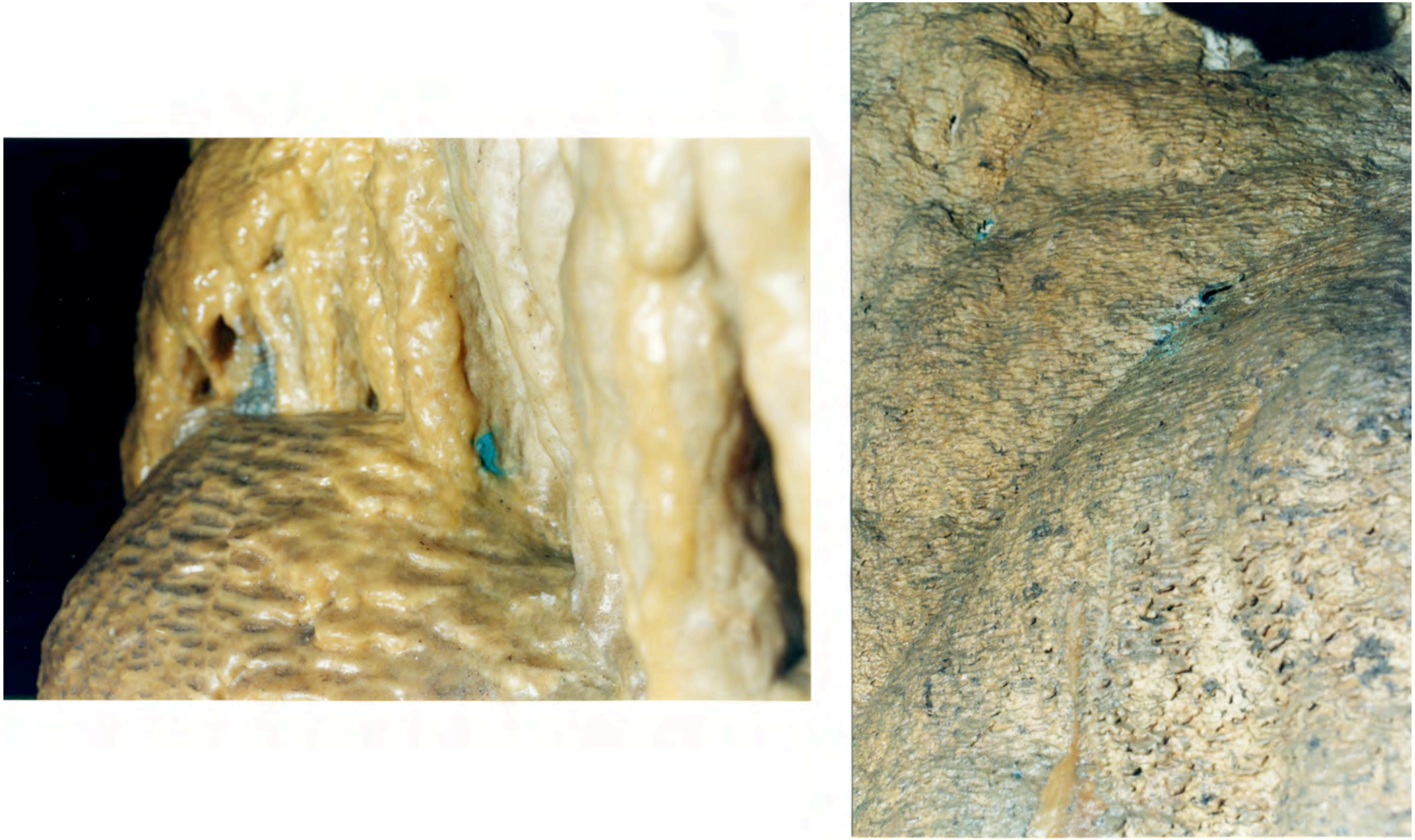
Table 2:9:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIORITIES	ESTIMATED TIME	COMMENTS
Remove all unused foreign materials deposited throughout the cave system	Identify and record affected areas	100	B	1 Day	Workforce -1
	Plan and organise logistics and operations		A	2 Days	Workforce -2
	Implement plan to meet objective	3500	A	4 Days	Workforce -8
Rehabilitate areas affected by foreign matter deposition	Plan and organise logistics and operations		A	1 Day	Workforce -2
	Implement plan to meet objective	2000	A	2 Days	Workforce -8

Section 2.9 Much bulk debris has been removed from the cave already. Many tons of rotting wood from disused stairways have been removed (above), whilst a large amount (right) still remains

Many parts of the cave have been used as dumping grounds, in this case for rubble following pathway development and disused light globes.

In some areas natural features have been "improved" on; in this case through the use of broken formations.



Copper and iron oxides from disused electrical systems and walkway fittings disfigure many flowstone areas.

2.10 Walkway & Formation Cleaning

2:10:1 Issues

Large quantities of accumulated introduced slush is deposited extensively throughout the cave system .
The material has invaded all pathways and adjacent natural cave features creating visual and environmental impacts.

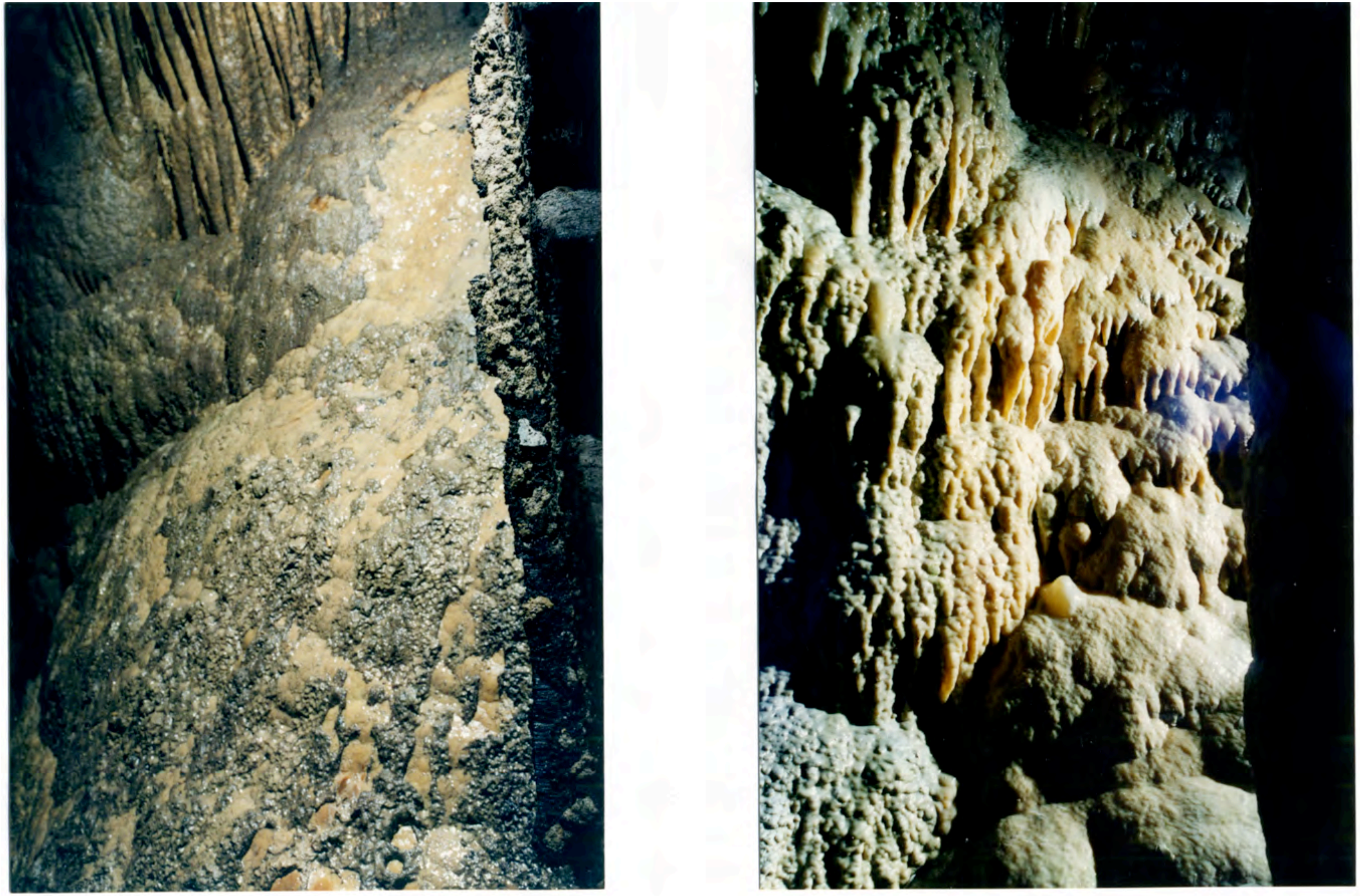
2:10:2 Management Response

Following the completion of a carefully planned extensive cleaning exercise, a regular maintenance/cleaning program will be prepared and implemented.

Table 2:10:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIOR-ITIES	ESTIMATED TIME	COMMENTS
Remove accumulated foreign materials from all natural surfaces and walkways	Identify and record affected areas	100	B	1 Day	Workforce - 1
	Plan and organise logistics and operations		A	2 Days	Workforce - 2
	Implement plan to meet objective	18000	A	30 Days	Workforce - 6
Regularly remove accumulated foreign materials from all natural surfaces and walkways in accordance to an established cleaning regime	Prepare an annual maintenance/ cleaning program		A	2 Days	Workforce - 2
	Implement established program to meet objective		A		Ongoing

Section 2.10 Sediment from walkways has built up on path edges and is being transferred to speleothems.



Much sediment and organic matter (sawdust) has built upon active speleothems (left). A clean flowstone for comparison (right).

2.11 Cave Lighting & Electrical Systems

2:11:1 Issues

Newdegate Cave's electrical services require vast improvements from many perspectives.

In many instances position of light fittings promote lampenflora and lint deposition, numerous magnificent features are obscured by inadequate lighting; many light fittings and switch stations are visually obtrusive and detrimental to cave aesthetics; the existing 110 volt power supply inhibits effective maintenance and development works and lack of emergency lighting poses problems with visitor control during power failure.

2:11:2 Management Response

Several caves throughout Australasia in recent years have undergone extensive electrical refits.

Techniques and systems employed at Yarrangobilly and Naracoorte Caves appear to be the most influential and accepted options.
Provision of a 240 volt main throughout a show cave is considered essential to enable the use of standard electrical equipment.
With the establishment of a 240 volt main, cave lighting trends are toward connecting low voltage dichroic systems to the primary power source.

Subsequently extensive research and trials are necessary to determine appropriate direction for the electrical systems upgrade to ensure a top quality result is achieved.

Table 2:11:2 MANAGEMENT RESPONSE

OBJECTIVES	ACTION	$	PRIOR-ITIES	ESTIM-ATED TIME	COM-MENTS
Upgrade existing lighting and electrical systems to achieve the following-					
Minimise lampenflora growth and lint mobilisation	Identify and record affected areas				
	Research alternate lighting systems				
	Revamp and upgrade existing lighting system to meet objective				
Improve illumination of spectacular cave features presently not highlighted	Identify and record affected areas				
	Research alternate lighting systems				
	Revamp and upgrade existing lighting system to meet objective				
Eliminate glare/ conceal aesthetically obtrusive cable and light fittings and remove fittings from natural features where possible	Identify and record affected areas				
	Research alternate lighting systems				
	Revamp and upgrade existing lighting system to meet objective				
Provide adequate power supply throughout the cave system to accommodate common electrical fittings and appliances	Research alternative methods and select option				

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	Upgrade existing system to meet objective				
Conceal existing visually obtrusive switch stations	Identify and record affected areas				
	Research alternate switching systems and select option				
	Upgrade existing system to met objective				
	TOTAL	$50 000		60 Days	Work-force -3

49

Section 2.11 Many outmoded, aesthetically obtrusive light fittings and switch stations are located throughout the cave. Environmental degradation through drilling, cable and conduit location and lampenflora growth is ongoing.

Many exposed conduits and cables are found throughout the cave.

PART 3 TIMELINE FOR IMPLEMENTATION

Calendar Start Date

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Start	Finish	Activity
1/01	31/01	Research equipment and design pathway lighting system
1/01	5/01	Carry out research and trials on chemical dosing applications. Establish acceptable and effective procedure.
1/02	5/02	Prepare and implement a water quality analysis program
1/02	31/12	Implement Lampenflora eradication regime
1/03	3/03	Seal visitor car park
1/03	31/03	Define visitor pathway & assembly areas by installing concrete curbing
1/03	31/03	Install pathway drainage & reticulated water plumbing & electrical services in curbing
1/03	31/03	Install pathway lighting system
14/03	17/03	Level & reconstruct concrete surfaces as identified
1/04	4/04	Level, stabilise & install weather matting on identified surfaces
1/04	8/04	Install sump and pumping units connected to reticulated draining system as identified
4/04	8/04	Install all weather matting in strategic areas
9/04	11/04	Install pumping system for reticulated washing system
9/04	11/04	Install neutralising units on delivery systems as required
12/04	16/04	Install visitor shoe wash facility & interps material
17/04	18/04	Identify and record bulk debris affected areas
19/04	20/04	Plan and organise logistics and operations for bulk debris removal
19/04	20/04	Plan and organise logistics and operations for rehabilitation of bulk debris affected areas

28/04	29/04	Identify and record all areas affected by pathway slush
30/04	1/05	Prepare logistics and operation plan for walkway and formation cleaning
1/05	2/05	Identify Lampenflora affected areas and modify lighting system
1/05	5/05	Implement bulk debris removal operation
1/05	5/05	Implement rehabilitation program for bulk debris affected areas
7/05	7/06	Implement walkway and formation cleaning operation
1/06	2/06	Identify and record lint affected areas
3/06	4/06	Develop on-going lint removal program
5/06	7/06	Modify lighting system in lint affected areas
8/06	9/06	Prepare a routine maintenance program for walkway and formation cleaning
10/06	31/12	Implement an established routine cleaning program for walkways and formations
11/06	11/08	Research and prepare extensive plans to upgrade existing lighting and electrical systems
12/06	27/06	Prepare and implement initial lint removal and cleaning program
1/09	30/09	Implement lighting and electrical systems upgrade in accordance with prepared plans
		Install board walk access track to cave entrance

PART 4 RECURRENT MAINTENANCE PROGRAM

1: VISITOR SHOE WASH FACILITY

OBJECTIVE	ACTIONS	PERIOD
Maintain the shoe wash facility to a clean and functional standard	Check flushing system operation	Daily
	Remove silt and wash matting	Daily

2: NEWDEGATE CAVE NATURE TRAIL

OBJECTIVE	ACTIONS	PERIOD
Maintain the walkway at a safe and functional condition	Clear windfalls and overgrown vegetation	As required
	Inspect boardwalk for structural defects	6 monthly
	Implement structural repairs - as required	

3: CAVE VISITOR SHELTER

OBJECTIVE	ACTIONS	PERIOD
Maintain the shelter at a safe functional condition	Inspect building for structural defects	6 monthly
	Implement structural repairs	As required
	Sweep assembly floor area	Twice weekly
	Clean poly carbonate roof	Twice annually
	Vacuum ticket office	Weekly
	Clean ticket office windows	Weekly
	Clean roof gutters	6 monthly

4: ALL WEATHER MATTING INSTALLATIONS

OBJECTIVE	ACTIONS	PERIOD
Maintain installations in a clean functional condition	Wash and vacuum matting installations	Weekly
	Monitor installations for wear	Monthly
	Replace worn sections	As required

5: HAND RAIL INSTALLATIONS

OBJECTIVE	ACTIONS	PERIOD
Maintain hand rails in a safe functional condition	Check for structural defect	6 monthly
	Arrange and implement repairs	As required

6: PATHWAY DRAINAGE REFUSE SYSTEM

OBJECTIVE	ACTIONS	PERIOD
Maintain system in a complete functional condition	Clean strainers and filters	Weekly
	Test pump operations	Weekly
	Check plumbing and draining installations	Monthly
	Check forest distribution system	Weekly

7: CAVE FEATURE LIGHTING SYSTEM

OBJECTIVE	ACTIONS	PERIOD
Maintain system in a safe and fully functional condition	Inspect system for faulty switches and lights	Weekly
	Replace lights and faulty switches	As required
	Inspect light installations and switch stations	Annually
	Replace light fittings and switch stations	As required

8: PATHWAY & EMERGENCY LIGHTING SYSTEM

OBJECTIVE	ACTIONS	PERIOD
Maintain system in a safe and fully functional condition	Inspect system for faulty switches and lights	Weekly
	Replace lights and faulty switches	As required
	Inspect light installations and switch stations	Annually
	Replace light fittings and switch stations	As required

9: RETICULATED WATER SYSTEM

OBJECTIVE	ACTIONS	PERIOD
Maintain system at a fully functional and environmentally acceptalbe level	Test pump operations	Weekly
	Test filtration and neutralising units	Weekly
	Check plumbing installations	6 monthly

10: CO_2 MONITORING

OBJECTIVE	ACTIONS	PERIOD
Monitor carbon dioxide levels at critical locations throughout the cave	Use drager tubes to measure CO_2.	Twice weekly
Document CO_2 fluctuations	Record levels in a record book at the cave entrance	Twice weekly

11: RADON MONITORING

OBJECTIVE	ACTIONS	PERIOD
Monitor radon concentrations at critical locations throughout the cave	Install radon monitors in line with the national cave radon monitoring programme	Seasonally

12: LAMPENFLORA CONTROL

OBJECTIVE	ACTIONS	PERIOD
Eliminate all un-natural plant growths within the cave system	(Dependant on outcomes of trials)	

13: LINT CONTROL

OBJECTIVE	ACTIONS	PERIOD
Maintain lint deposits at an acceptable maximum level	Check lint detector installations	Weekly
	Implement cleaning procedures	As required

14: PATHWAY & FORMATION WASHING

OBJECTIVE	ACTIONS	PERIOD
Maintain introduced material deposits at an acceptable maximum level	Monitor introduced material deposits	Weekly
	Clean walkways and formations	As required

15: LITTER COLLECTION

OBJECTIVE	ACTIONS	PERIOD
Keep all areas within Hastings Reserve free of all introduced litter	Collect and remove litter deposits as found	As required
	Undertake detailed litter collection exercises	Monthly

16: INTERPRETATION INSTALLATIONS

OBJECTIVES	ACTIONS	PERIOD
Maintain installations at a clean, presentable and functional level	Clean interpreation panel glass	Weekly - as required
	Clean signage installations	Monthly
	Check for installation deterioration	Monthly
	Replace or upgrade installations	As required
	Adjust tour schedule signage	26 Dec/1 Feb/Easter/ 1 April/1 October

17: TORCH MANAGEMENT

OBJECTIVES	ACTIONS	PERIOD
Maintain torch systems at fully functional condition	Replace rechargable batteries	Annually
	Maintain light bulb supplies	Annually
	Replace charging units	As required
	Replace torches	As required
	Charge batteries	As required