

RELIGHTING FEDERAL CAVE, BUCHAN, VICTORIA, USING the SUN'S RAYS

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Background

In March 1915, the then superintendent of the Buchan Caves Reserve, F J Wilson, in company with an employee, W H Bonwick, discovered a 'new cave' by following the low level ongoing stream passage from Royal Cave and then climbing upwards from near where the stream passage drops into a tight and normally closed sump (later linked to Dukes Cave). Wilson, in a letter to the Secretary for Lands, dated 27/3/1915, described it as 'a nice open passage with a few grottoes', 'extending about 400 yards back into the hill' and noting that it had a 'very fine chamber of rich formation near the end'. Wilson further opined that 'if an entrance could be got at the northern end it (the cave) would be very easy to improve'.



*LED track lights mounted on existing wrought iron stanchions with LED feature light at base of left stanchion. Concrete steps illuminated by LED strip lights secured to guard wire below hand railing.
Photo: Daryl Carr*

During the following month, Wilson surveyed the interconnection to 'fix the position' of the northern end of the new discovery. In a further letter to the Secretary of Lands, 8 June, Wilson advises that work on opening the new tunnel had started and asked that the explosives already applied for be sent as soon as possible. A tunnel was driven by day labour and with funding constraints imposed by the Lands Department, took until May 1916 to break through to the northern end of the new cave. In Wilson's 2 May letter to the Secretary, he advised that the tunnel was 230 links (46 m) long and that 'it struck the cave exactly where I intended'.

Duly named 'Federal Cave', the new cave was soon added to the guided caves menu for visitors to the Buchan Caves Reserve. Fixed electric lighting was installed in Federal Cave, together with Fairy and Royal Caves, c1920. Electricity supply was from an internal combustion engine driven, DC generating plant. The underground wiring was lead sheathed, rubber insulated, cotton braided, two-core cable. Light fittings were simple reflectors, sometimes of the jeweller's shop silvered glass variety, with general service incandescent lamps in porcelain base Edison screw holders.



*Solar panels installed 2012 near cave entrance.
Photo: Daryl Carr*

Federal Cave lacked the extensive speleothem 'decoration' of the Fairy and Royal show caves, with its main attraction in that respect being the 'King Solomon's Temple' formation that marked the end of the electrically lit extent. It also required visitors to retrace their steps in order to leave the cave when both Fairy and Royal caves had one-way 'through tours' by virtue of separate entrance and exit tunnels. As a consequence, its use as a show cave declined. By the late 1960s when its sister show caves were rewired for operation from the SECV mains electricity supply – using enclosed transformers in the caves to supply 32 V light fittings – the lighting in Federal Cave was not upgraded and was then no longer operational.



*Control Box No. 10 with 12V sealed battery and supply from solar PV panel teed off from the 'bus' cable.
Photo: Daryl Carr*



*LED feature light and 'Techno' cable tee-off fitting.
Photo: Daryl Carr*

During the 1970s the then Caves Reserve manager encased the metal gate on the Federal Cave tunnel entrance with concrete to thwart occasional break-ins. This was removed in the late 1980s with a new steel door being fitted and the cave then used for occasional guided 'adventure tours' with participants fitted out with helmets and lights. These tours were commonly offered during the busy school holiday periods and gave a different experience of the 'standard' tours in the lit Fairy and Royal Caves.

By 1983 management of the Buchan Caves Reserve had passed from the Lands Dept to various newly formed departments and ultimately to Parks Victoria. Graham Parkes, as Parks Victoria's first Buchan Caves Ranger-in-Charge instigated the establishment in 1991 of the Friends of Buchan Caves (FOBC) as volunteer group to assist Parks Victoria in maintaining the caves and karst under its management at Buchan. This was one of the early Parks Victoria 'Friends Groups' and has over the succeeding years undertaken many useful projects ranging from surface track marking, tree planting and arranging interpretative signage to cleanup work in the show caves.

A proposed solar cell based lighting system

In 2001, FOBC member, Peter Robertson, proposed a project to relight Federal Cave based on distributed sealed secondary batteries maintained by a photovoltaic panel. It was contended that such a system would be well suited to the occasional guided tours conducted in the cave. After obtaining Parks Victoria's in-principle agreement, via Dale Calnin, the then Buchan Caves Ranger in Charge, the first part of the Federal Cave main passage was fitted with LED (light emitting diode) track lights powered from sealed 12 V lead-acid batteries placed at strategic intervals. The batteries were charged from a common 'bus' cable that was initially supplied from a 24 V DC transformer – rectifier located at the Caves Reserve administration offices. With the assistance of a grant successfully applied for by the FOBC, a 170 watt 24V DC photovoltaic panel was purchased in 2005 to takeover from the mains-operated transformer rectifier. The solar panel was mounted on a pole above the tunnel entrance to the cave and was commissioned in July 2005. Although the artificial lighting was then limited to only part of Federal Cave it is believed to have been the first solely solar cell powered cave lighting installation in Australia. Light emitting diodes (LEDs) – single and in small cluster assemblies – were also still evolving as commercial products and their use for cave lighting was novel.

The 'key' to the distributed battery system was in the associated control boxes where a printed-circuit-board, designed and built by Peter Robertson, regulated charging of its sealed cell battery, switched 'on' track lights, and subsequently also feature lights, in response to a signal from motion detection devices. These responded to the movement of persons heading either inwards or outwards in each passage section, and switched 'on' track lights and any feature lights set up in that section for a preset time interval. Persons remaining in or coming back in range of a motion sensor would reset the time delay so that the lights in the section remained 'on'. The moulded plastic control boxes included silicon rubber cover seals and all cable entries were made via cable glands.

LED track lights were mounted inside downward facing black finished plastic housings and typically mounted on short PVC conduit posts or secured to existing hand railing stanchions. Most initial feature lights were 20 or 50 watt, 12V tungsten-halogen 'dichroic' lamps mounted in 'sealed' outdoor garden light fittings. The initial cabling consisted of flat 'figure-eight' 0.75 or 1 mm² plastic insulated cable.

With the first several sections of the cave lighting having 'proven the concept', the installation was progressively extended further into the cave. Many members of the Friends of Buchan Caves volunteer group assisted with the installation of the lighting system over successive working bees.

As time progressed the lighting system served its intended purpose, however, cable faults increased in frequency along with failure of some of the early LED track light assemblies. The adverse high humidity environment likewise took its toll on the 12 V incandescent lamps in the enclosed 'garden' fittings. Many lengths of the single insulated 'figure-eight' cable succumbed to the cave atmosphere with internal corrosion of the stranded copper conductors, indicating that the plastic insulation was not impervious. Inferior copper quality in these cables may also have been a factor in their deterioration. In singular contrast, the domestic type movement sensors – commonly used to switch 'on' outside home security lights – continued to function reliably.

Upgrading the Installation

With the solar powered distributed secondary battery based lighting system having been successfully proven in-principle and found useful in practice for irregular cave tours, a further FOBC proposal was put to Parks Victoria via Dale Calnin to upgrade the installation. This included replacing most of the cabling and, where needed, light fittings and lamps, with more durable products. Investigations into cabling canvassed tinned copper conductor cables as used for mining and marine applications. Sources of suitably sized cables of this description were not located and instead an elastomer insulated and sheathed cable with plain copper conductors commonly employed for connection to submersible motors on deep well pumps was chosen, having a wide temperature tolerance and resistant to water penetration to depths of 100 m.

In 2012 another grant for materials purchase was successfully applied for by FOBC through Dale Calnin and orders placed for the new cable along with moulded plastic 'Techno' (Italian) waterproof (IP65) tee-off connection fittings. A 6 mm² conductor cross-section was chosen for the trunk or 'bus' cable to run from the external solar photovoltaic panel through the cave from which tee-offs would service each successive control box and its associated rechargeable sealed battery. Two-core 1.0 mm² cable was ordered for wiring to LED track lights and two-core 1.5 mm² for display lights and sub-trunk cables from which the track lights would tee-off.

Another series of working bees attended by FOBC members during 2012 stripped out the earlier figure-eight cables, placed and where practicable, concealed the new black sheathed trunk cabling and installed replacement light fittings, etc., under the



*Dale Calnin (Parks Victoria), Peter Robertson and Daryl Carr (Friends of Buchan Caves) marking the commissioning of the solar powered Federal Cave lighting system, July 2005. Post mounted PV panel behind.
Photo: Daryl Carr*

supervision of Peter Robertson. FOBC and VSA member, Rudy Frank, devised a rig for pre-assembling and terminating pre-measured branch cables in the comfort of the Guides Room, and thereby reduced work that had to be performed within the cave. Peter experimented with homemade enclosures for 3 and 5 watt LED replacements of former 'dichroic' incandescent feature lights based on PVC plumbing fittings, coming up with a superior sealed fitting to the previously employed cast alloy 'garden light' fittings.

As a part of the upgrade, a second 170 watt photovoltaic panel was mounted beside the original panel to increase the battery charging capacity. The upgraded installation was practically complete by early 2013. The experience since then has been

favourable with comparatively few lamp failures and almost no cable or cable termination faults.

Concluding Comments

Federal Cave continues to operate with its totally solar cell powered lighting system comprising LED track lights and limited, separately circuited, multi-LED feature lights extending from its tunnel entrance through to the impressive flowstone and stalactite / stalagmite 'King Solomon's Temple' speleothem – the 'rich formation near the end' first observed by F W Wilson in 1915. The lighting is deliberately 'low key' to sustain the 'being in a cave feel' and recognising that for the most part, in contrast to the Fairy and Royal Caves, speleothem 'decoration' is not a dominant factor. Instead, the distinctive former stream passage evolution, prominent display of the dipping limestone strata and cross-sectional exposure of sediment beds in what is a predominately a simple straight passage offers a different kind of cave experience and opportunity for interpretation.

Since 2012, various other Australian 'show caves' have utilised solar cells in conjunction with battery banks to support mains backed-up cave lighting systems or have plans to do so. The now extensive range of proven LED lights, including high output multiple LED assemblies and their low power demand has greatly facilitated potential for solar powered cave lighting systems with mains supply being available as backup.

The distributed sealed battery system described above and totally reliant on locally generated solar energy has shown itself to be viable for intermittent and 'special' cave tours, as applies for Federal Cave at Buchan.

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