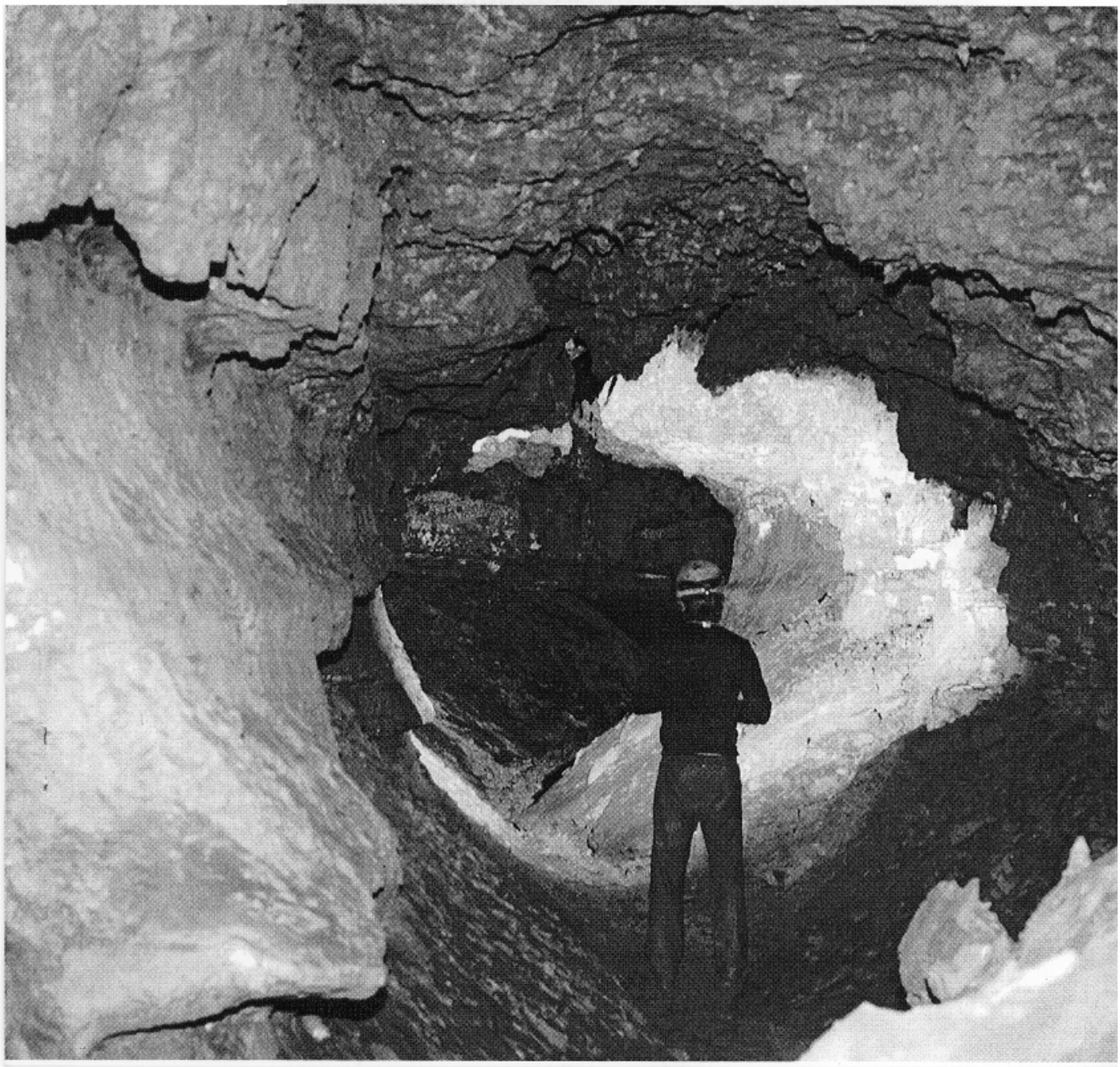
# The Capital Caver

Number Three
March, 1996



# The Capital Caver, No 3: March, 1996
# Edited by William H. Russell

The Capital Caver is published by the Texas Cave Management Association -Austin Committee, to keep TCMA members informed and enthusiastic. The TCMA Austin Committee was established to work with the City of Austin on cave related problems under the authority of an agreement ratified by the Austin City Council between the City of Austin and the TCMA. Barton Springs, endangered species, cave preserves, cave access, and development regulations are all interrelated. The City of Austin and other organizations need timely, scientifically accurate information in order to effectively manage the karst. TCMA Austin, in cooperation with other caving entities, is organized to provide this knowledge and to develop a constituency of informed cavers. Cavers are the karst police, keeping a loving watch on their hidden realm.

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Cover Photograph by Julie Jenkins: The Hovorka Highway section of The Dark Side of the Moon passage in Blowing Sink Cave, named after Dr. Susan Hovorka who contends that "conduit permeability" is best developed "in the deep parts of the confined aquifer and decrease towards the Edwards outcrop." The Dark Side of the Moon passage is a now mostly abandoned phreatic conduit beneath the Edwards Limestone outcrop.

Adventure Caving Photograph pg. 2 by Bev Shade: The Editor demonstrating Travis County exploration techniques in Flint Ridge Cave

Elder's Lair Drawing by Kathy Garrett

Photographs pgs. 12 & 26 by Julie Jenkins and Bill Russell

Logo and other small drawings by Justin Seligman

The elves of the RDDW GmbH (Reformiertes Deutsches Demokratisches Waldvolk) who produce the Capital Caver have written in past numbers of *The Capital Caver* about their problems with funds for preservation of the *Waldvolksinstitut für Unterirdishe Forschung* (Elf Institute) and the Max Planck Institute. The Capitol Caver thanks you for your outpouring of letters in support of the elves. The letters were sent with a commentary to our local representative in Congress, and an appropriation was obtained to help the elves and the Max Planck Institute. Unfortunately, Jessie Helms found out about the appropriation. He had the funds rescinded and denounced the elves as "blasphemous creatures of Communism, repugnant to all God-fearing Americans." We have replied that these particular elves are hard-working capitalist elves, and hope to get a prominent cleric to attest that elves are not mentioned in the Bible and thus are not in themselves blasphemous.

Adventure Caving

Many people apparently feel they live boring lives, they work, watch TV, and go to bed, but not much happens. They would like to have an adventure, sense that something has happened. Many go to Yellowstone, Las Vegas, or Disneyland, but still aren't satisfied. So when an advertisement goes out for an adventure, the mass of bored humanity is ready to respond. They generally have little interest in caves; they want entertainment and excitement. Most drop out when they find out you have to expend energy and get dirty, but the ones that stay are those that really wanted an adventure. This is not a conducive mindset for safe, responsible caving.

However, the same publicity, pitched only as "Explore Caves," will attract a group that might want entertainment, adventure, and exercise, but who think caves are the place where these things might happen for them. They are much more likely to enjoy caves for a long time, to care what other cavers think, and contribute to the caving community.

Caver training should start with "basic training," how to climb rope, what type of light to use, etc.; but at least as important, just as in preparation for life, is what kind-of-caver-will-you-be training. All through training, there should be references to exploration of new cave, mapping, digging, and inspirational stories of wonderful discoveries. Just "doing" a cave should be discouraged, not by saying that recreational caving is bad, but by talk of what needs to be done. When a caver returns from Golondrinas, the response should not be "Wow, you are wonderful," but "Did you check the bottom? There are holes that blow air, and no one knows where it comes from?" And maybe, a not-too-personal reference to tourist caving.

The goal should be to have cave trips be purposeful, not just to see cave. Most trips should be for discovery and mapping, but almost as many are needed for training, photography, and restoration. The goal of each trip should only be a guideline. In caving, as elsewhere, most discoveries are a fortuitous coincidence of opportunity and insight. Whatever the goal, do not neglect the small hole that blows air, the unusual bug, the casual observation that leads to discovery. People who like caves will respond to these initiatives. People who want adventure will go off to Golondrinas with parachutes.

# Environmental Evaluation of Blowing Sink Cave:

A report prepared for the
City of Austin Power and Light Department
by
William H. Russell
Texas Cave Management Association

**Introduction**

In August of 1995, City of Austin workers clearing a power line right-of-way west of Brodie Lane in south Austin encountered a brush and board-covered hole, eight feet deep in the center of the right-of-way. They painted a large red circle around the site, and contacted the TCMA for advice on any potential hazards that this feature might pose to construction and the environment. Upon investigation, the hole was found to be a new entrance to Blowing Sink Cave. The old entrance and most of the depression surrounding the old entrance appeared full of leaves and dirt, probably left by large floods in 1994. Reportedly, after the rescue of an ill-equipped climber from the cave, the owner attempted to block the entrance with a grate of welded pipes. This grate could have caught washed in detritus, blocking the entrance, and filling the bottom of the sink with sediment. Water entering the sink then flooded onto the power line right-of way and scoured out the new entrance.

A survey of the cave was made to determine if the cave presented any hazards to workers or construction along the right-of-way. The deepest surveyed point was 254 feet below the entrance, making Blowing Sink the deepest known cave in Travis County. 1655 feet of passage were surveyed, and several smaller passages were left unexplored due to time considerations. Much of the cave is probably too deep to directly affect safety or construction, although domes in the deeper part of the cave extend upward toward the right-of-way. However, a small room 15 feet east of the entrance is a definite hazard. This room is located directly under the centerline of the right-of-way, with a roof of wedged rocks only a few feet below the surface. Any construction at this locality would likely cause collapse.

Blowing Sink Cave is on private property, and it is requested that cavers not attempt to visit this cave until some type of access agreement can be arranged. Like many cave owners, the owners of Blowing Sink Cave are reluctant to agree to management proposals out of the probably realistic fears that management by others will lead to numerous visits to their property, and expose them to legal liability. The fewer problems cave owners have with cavers, the more likely they will be willing to cooperate as expansion of subdivisions forces them to do something. The cave floods frequently, and it requires vertical equipment to explore safely; the lower levels are, in places, wet and constricted.

**Description**

From the entrance, the cave trends east and then north, following fractures paralleling a north-south fault that crosses the west side of the depression surrounding the entrance. The first 150 feet of the cave is mostly a flood-scoured, irregular crawlway, one to four feet high and two to eight feet wide that descends over breakdown blocks and ledges to a depth of 30 feet before reaching a small room. From this room, a short squeeze extends to the top of a vertical pit 70 feet deep and 20 feet in diameter. One can climb down to a ledge where rope work is required to descend the 50 feet to the bottom of the pit. Another route from the small room before the pit is a squeeze through breakdown in the floor. This narrow squeeze, named the Breach Birth, is quite awkward. To pass the last boulder, it is necessary, while standing in a narrow slot, to slide into a low horizontal squeeze at floor level. Then the real fun: one's feet extrude from the squeeze and try to find footholds in the top of a fissure, while the body is bending through two right angles. The fissure is climbable, and from the bottom of the fissure, a crawlway connects to a ledge 15 feet above the bottom of the main pit.

At the bottom of the Main Pit, a short climbdown beside two large white boulders ends at a ledge overlooking a thirty-foot drop into a lower room, the Kirschberg Hall. This room is 40 feet long, 20 feet wide, 30 feet high, with a floor that slopes up to a balcony at the east end. A squeeze in the floor through water-scoured breakdown drops into a horizontal crawlway in breakdown that leads 15 feet to a small room between the solid wall and the breakdown. Once in the small room, it became evident that we were not the first visitors to this part of the cave. Boards had been wedged between breakdown blocks in an apparent attempt to stabilize a fifteen-foot climbdown through loose rubble and large limestone blocks. It is not clear exactly what supports some of these rocks. Floods are apparently removing sediment, causing collapse and rearrangement of the larger blocks. Just before the climbdown through the breakdown, there is a small hole in the floor that shortly opens into a north-trending passage that enlarges into a decorated room with several tall domes, named North Umberland after the red clay. This room drains into a horizontal tube with airflow that becomes too small to follow after about 100 feet.

From the bottom of the climbdown through the boards and breakdown, a squeeze through more potentially unstable breakdown ends in a low, scoured-clean crawlway over eroded flowstone and slabs of limestone. This passage extends to a sharp corner and an awkward squeeze into the top of Liverpool Pit, a 20-foot pit with burnished ledges of black chert in a smooth white limestone. At the bottom of the pit is a constricted-in-places passage named the Sandpaper Tube, after the gritty sediments packed into the walls and floor. These sediments are rapidly being removed by floodwater, and their absence will be a decided improvement. The "tube" lowers and widens just before the 15-foot Flowstone Climb drops down into a somewhat more spacious crawlway, the Twist of Fate. This cleanly-washed, rock-walled crawlway goes around a few sharp bends and then encounters a new aggravation, pools of water. The final pool of water originally filled more than half the passage, allowing only a small part of each explorer's back to remain dry as one crawled through. This pool was ponded behind breakdown in a small room, and by moving a few rocks; the water level was lowered until the passage was only half full. Ahead, the passage slopes down to a squeeze into the Egyptian Junction, where the passage from the surface the joins the relatively horizontal Eileen's River Passage.

Eileen's River is named for Eileen Conley, instrumental in the formation of the Barton Springs/Edwards Aquifer Conservation District. This perennial cave stream is by far the largest accessible body of groundwater related to the Barton Springs segment of the Edwards Aquifer, and is the only flowing stream. Eileen's River is thus unique, and a valuable hydrologic and biologic resource. Eileen's River flows through the Egyptian Junction, and then south, following a cleanly-scoured passage (three feet high and five feet wide) for 80 feet until it drops through the two foot in diameter Waterfall Hole. The entire flow pours through this hole into a lower passage, and beyond the hole, a dry floodwater overflow passage continues over packed red clay.

The passage below the Waterfall Hole is a jagged crawlway, five feet wide and two feet high, that extends in two directions, both of which soon become mostly water-filled and difficult to follow. The overflow passage leads 80 feet to a clay bank that slopes down into Lower Eileen's River, with over twice the flow that it had at Egyptian Junction. Upstream, the ceiling lowers, and the passage appears to connect back to the Waterfall Hole, while downstream, a very pleasant two- to three-foot-high and eight-foot-wide, sediment-free passage continues through numerous pools and over several travertine dams. After 150 feet, Eileen's River splashes over a six-foot-long flowstone cascade into a water-floored room, 20 feet long, 15 feet wide and five feet high. The water is up to five feet deep, and the only lead is an underwater passage extending to the south. The water in this room does not appear to represent the surface of the Edwards Aquifer. Eileen's River is flowing on impervious beds in the lower Edwards Limestone, and the water in this terminal room is essentially a pool in the river. Eileen's River quite likely continues for a considerable distance before joining the Aquifer proper.

Upstream from the Egyptian Junction, Eileen's River flows from a north-trending crawlway, two feet high and three feet wide, with a strong flow of air. The floodwater does not follow this passage, whose first section is partly filled with a fine sediment that turns into a muddy soup when crawled through. However, soon there is only a shallow stream between low clay banks. 120 feet upstream from the Egyptian Junction, a small infeeder almost blocked by a travertine dam leads to a short crawl to the bottom of a 15-foot chimney. Following the air flow up that chimney, one enters a large mud-floored passage, The Dark Side of the Moon.

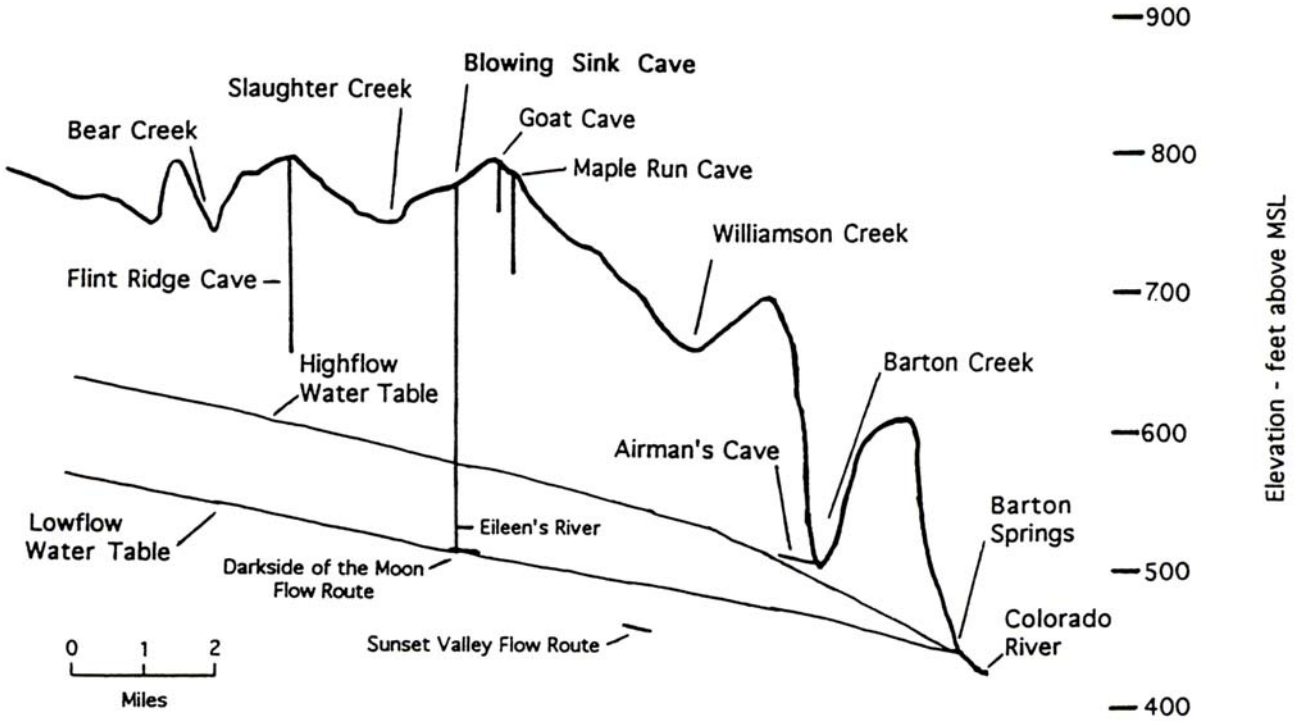



**Figure 1: Hydrologic Profile along the Edwards Aquifer**

Water levels modified from Slade, et al., 1986, and Hauwert and Vickers, 1994. Much of lower Blowing Sink Cave is flooded during high water level. Passages between high water level and low water level are occasionally flooded and provide some of the storage for the water that maintains spring flow between rains. The apparent steep slope of the water table is due to the vertical exaggeration of the profile (100X); its actual slope is very low. Note that the deepest possible cave in Travis County is along the Slaughter -Williamson Creek Divide, about 280 feet. Goat Cave or one of the other caves in the Austin Karst Preserve is potentially the deepest in the area.

The Dark Side of the Moon is a section of a mostly abandoned groundwater conduit, considerably modified by breakdown and sedimentation. The Dark Side of the Moon trends NNE-SSW, roughly parallel to the trend of the other major passages in the cave. To the south of the chimney, the passage extends for 160 feet, averaging eight feet high and ten feet wide, and ending in a large silt bank, although there is a likely continuation through breakdown with airflow along the left wall. To the north of the chimney, the main passage extends as a walkway for forty feet, to where an infeeder enters over two travertine dams, and then continues as a stoopway for 60 feet. Here the passage enlarges, to form the Hovorka Highway, fifteen feet wide and high for the next 150 feet, finally constricting to a comfortable walking passage for the next 100 feet, to an apparent blockage where the passage is filed with mud and breakdown. However, a somewhat constricted 40-foot crawlway leads through the blockage back into the main passage at the base of Oblivion Dome. This dome extends upward from a 20-foot-wide section of the main passage. The top of the dome is not visible, but it is at least 40 feet high, with an apparent passage about 20 feet above floor level. Beyond the dome, the ceiling lowers, but an opening on the right side leads down over mud-covered breakdown to a terminal siphon. Beneath the water level, a small passage can be seen to continue.

The Dark Side of the Moon passage is 20 feet above Eileen's River at the south end, but trends slowly downward to the northeast to the breakdown blockage, and then slopes more steeply down to the terminal siphon, 254 feet below the entrance -- the deepest point below the entrance reached in any Travis County cave, 8 feet lower than the water level in the downstream siphon in Eileen's River, and possibly connected directly to the Edwards Aquifer.

**Cartography**

The cave was mapped with a hand-held Suunto compass which gives directions accurate to within a degree, a Suunto inclinometer for inclination, and a fiberglass tape for distance. This type of survey, if done carefully, is accurate to about 1%, but due to the reconnaissance nature of this survey, the accuracy achieved is probably somewhat less. The deepest point in the cave is the terminal siphon at the north end of The Dark Side of the Moon passage, 254 feet below the surface. The water level in the downstream siphon in Eileen's River is 246 feet below the surface, and using the elevation of the entrance as 776 feet from City of Austin Topographic Map D-15 gives the elevation of the water surface in the lowest part of Eileen's River as 530 feet, with The Dark Side of the Moon terminal siphon as 522 feet.

The survey data from the cave was plotted on cross-section paper at ten feet to the inch, and then the passage detail was added. This data was then photographically reduced to twice the size of the printed map, and traced in ink. The names and the title block were added, and the map was then reduced for final printing.

The vertical profile is an extended profile: that is, the full length of each survey is shown. This method portrays the correct depth, length and slope of each section of passage, but does not indicate the true vertical relations between passages. Consult the plan to determine what features lie directly below any point. A small section of the profile through the top of the Main Pit and the Breach Birth is a projected profile.

**Biology**

Close attention was paid to the biology of Blowing Sink Cave because a study of the biology of Blowing Sink Cave while the surrounding area is still relatively undeveloped will provide a baseline to determine the effects of development. Blowing Sink Cave will be an ideal observation site because it receives runoff from a considerable area, including a section of the power line right-of-way. Surface runoff enters Blowing Sink Cave, and after traveling through large conduits, it enters the Edwards Aquifer, carrying any pollutants present directly into the groundwater.

Only a cursory survey was made of the terrestrial fauna, which appeared to be typical of southern Travis County caves. The frequently strong air flow and resulting low humidity would tend to force many cave animals away from the larger, easily-traversed passages. Careful collecting would likely find a large variety of terrestrial species inhabiting the cave.

Endangered species were not found in Blowing Sink Cave, and none are likely to inhabit the cave. Few of the species listed for Travis County are found south of the Colorado River, and none have been found south of Barton Creek (U.S. Fish and Wildlife Service, 1954). Blowing Sink Cave is in Veni's "Southern Travis County Karst Fauna Region" (Veni & Associates, 1992), and, as he speculated, the Barton Creek Valley appears to be a significant barrier to the southern extension of the listed endangered species.

Much of the limited time available was spent in careful examination of the aquatic fauna. Eileen's River, a permanent stream well supplied with nutrients, is exceptional and should provide a look at the biological composition of the Barton Springs segment of the Edwards Aquifer. Eileen's River is only a few feet above the elevation of the Edwards Aquifer and is flooded by rises in the aquifer level, and so any organisms common in the Barton Springs segment of the Edwards should be able to reach this environment.

Upper Eileen's River is separated by a three-foot waterfall from Lower Eileen's River. Downstream from Egyptian Junction, Eileen's River flows trough a gravel-floored, flood-scoured passage, but upstream from the junction, there is a backwater during floods, which has allowed considerable organic matter to collect (mostly, what appears to be leaf particles).

Perhaps the most important biological observation is the absence of salamanders in Eileen's River. This habitat would appear ideal for salamanders, it resembles areas inhabited by salamanders in other caves, such as Buttercup Creek Cave (now connected to Ilex Cave) in the Jollyville Plateau (Russell, 1993), and the numerous small streams in caves along Cibolo Creek and the Guadalupe River (Sweet, 1982; Reddell, 1984). The entire mapped length of the stream was carefully searched for salamanders, and none were seen. Salamander densities in other similar caves are several per hundred feet, though in some areas of Buttercup Creek Cave, there is only about one per hundred feet.

Not finding salamanders in Eileen's River could be due to several causes. They could be scarce and just not noticed especially if, unlike most cave salamanders, they have functional eyes and could hide upon seeing the cavers' lights. This does not appear possible, since in much of upper Eileen's River there is no place to hide, and when a light sweeps across a pool, any movement is easily noticed.

It is also possible that salamanders are not found in Eileen's River due to pollution of the cave stream. One source of pollution would have been the Circle C Oil Spill about two miles west of the cave, where an oil pipeline was broken in 1986. This does not appear likely, either, since there is no evidence of oil, and it is unlikely that the oil from the Circle C Oil Spill would have ever reached Eileen's River. Large quantities of mountain cedar "needles" are carried into the cave by floods, and these might be toxic enough to drive salamanders from the area. Another source of toxic material that must be considered is the imported fire ant. When flat areas on the surface are flooded, the fire ants from each mound form into a large a mass that floats free and is carried downstream by the floodwaters and into caves and sinkholes. It is not uncommon after a heavy rain to find several cubic feet of fire ants and leaves jammed into constrictions far into a cave. The fire ants survive in the cave for several days, and, if present in Eileen's River, they might be eaten by salamanders as they float on the surface. It is not known what the lethal dose of fire ants would be (because of formic acid), or even if fire ants would be harmful, but as they are washed into the cave in enormous numbers, their effect must be considered.

Another problem, obviously related to the absence of salamanders, is the lack of any visible organism living either in Eileen's River, Lower Eileen's River, or the pool at the end of The Dark Side of the Moon passage. Under close observation with a strong light, no aquatic animals are visible. Most shallow pools and streams in the Edwards Limestone have a considerable fauna, easily visible, though sometimes hard to collect. It does not appear likely that any of the pollutants mentioned could have caused the lack of organisms in such widely-dispersed areas as Eileen's River and the end of The Dark Side of the Moon passage. The most likely cause would appear to be the extreme changes in the habitat due to fluctuations in the water table. Shallow water species apparently have difficulty when the area is deeply flooded during high water levels. The limiting factor is thus likely to be oxygen availability. The shallow pools that crustacea normally inhabit are well-aerated, but, after the aquifer has risen, sources of oxygen are far distant, and water movement in the cave is almost nonexistent.

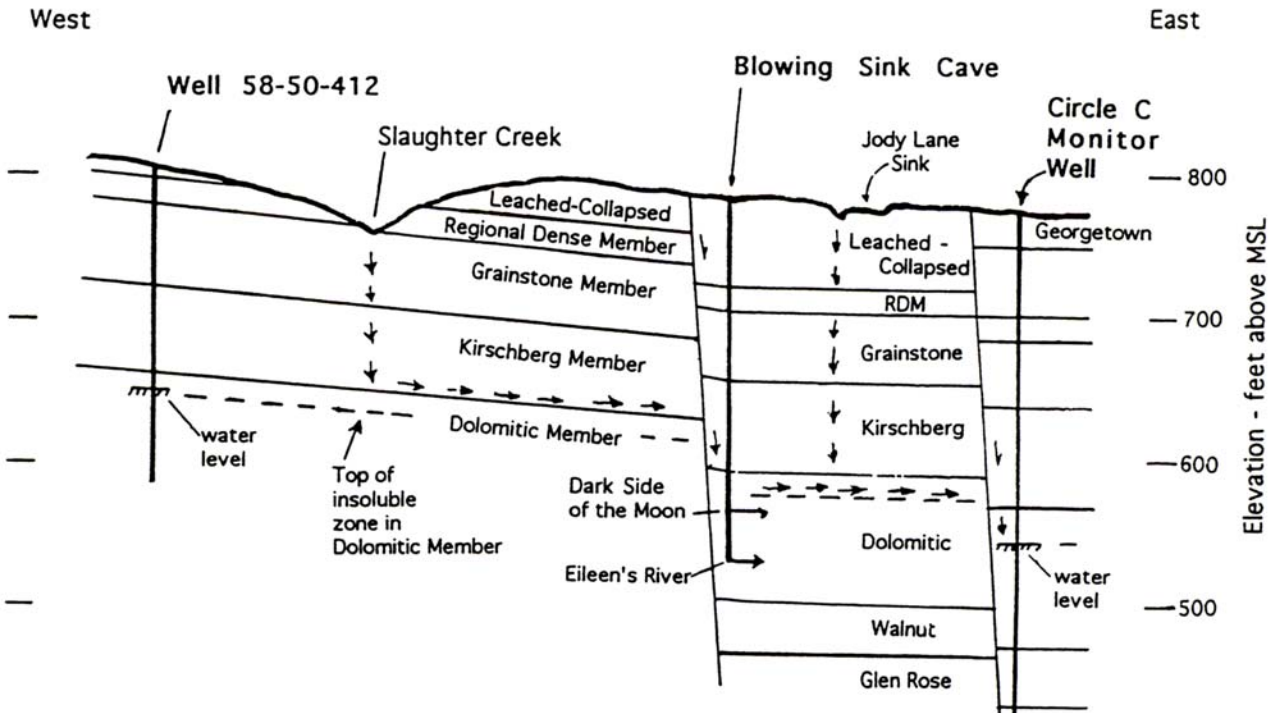



**Figure 2: Geologic Cross Section through the Blowing Sink Area**

Well Geology provided by the Barton Springs/ Edwards Aquifer Conservation District. Even though Blowing Sink Cave is north of a line from the Circle C Monitor Well to well 58-50-412, the formation contacts in the main pit fit well into the profile. The geology may be more complicated than shown; there are possibly other faults in the section. The Dark Side of the Moon passage follows relatively steep dips to the northeast to reach what is likely the surface of the Edwards Aquifer. Arrows indicate hypothetical flow paths that may produce the flood pulses in the Circle C Monitor Well.

Decay of the abundant organic matter could therefore create oxygen-deficient areas in the flooded cave passages. The difference between the seemingly ideal salamander habitat in Eileen's River and that in other caves inhabited by salamanders is that Eileen's River is deeply flooded for long periods. If water level changes limit crustacea habitat, the resulting lack of accessible food would tend to confine *Eurycea sosorum* to the vicinity of Barton Springs.

The absence of salamanders in the seemingly ideal habitat in Blowing Sink Cave is also a strong indication that salamanders are not generally present in the Barton Springs Segment of the Edwards Aquifer, and that *Eurycea sosorum,* the Barton Springs Salamander, is confined to the vicinity of Barton Springs. The Barton Springs Salamander is only slightly adapted to the cave environment, and apparently cannot inhabit, the food-poor areas far from the springs (Chippendale, et al., 1993)

**Recharge**

The quality of water entering the Edwards Aquifer is important to many organisms, including humans. While water quality is not the chief responsibility of the City of Austin Power and Light Department, the city does have a special responsibility in the Edwards Aquifer Recharge Zone to employ conservative siting, construction, and operating strategies, and to be aware of the unique biological hazards associated with the Barton Springs Aquifer. Transformers and substations should be sited away from recharge features, construction and operating techniques that minimize surface disturbance should be used, and the use of toxic chemicals should be minimized.

Blowing Sink Cave is one of the most important point recharge sites in the county. After major rain events, the cave receives drainage from approximately 50 acres. Water from Deer Lane, 2500 feet to the north flows south, first filling South Pipeline Sink, then Flat Sink, and then (following a wide, shallow drainage south for 1000 feet) flowing into Blowing Sink Cave. The area draining into Blowing Sink has low relief and gentle slopes of about 1%. At present, there is virtually no development and no impervious cover within the Blowing Sink drainage area. As a result, only the major rain events produce runoff that reaches Blowing Sink Cave. However, after several days of rain, a stream a foot deep and 100 feet wide has been observed flowing into the cave entrance. Water entering the cave has a relatively low sediment load due to the low slope and relatively vegetated drainage channels. The area is somewhat overgrazed, and some fine black clay sediment is transported into the cave by the floodwater, along with considerable quantities of leaves and fine organic debris.

**Hydrology**

Blowing Sink Cave is an excellent example of how surface sinkholes funnel surface water directly into the Edwards Aquifer. Floodwater entering the cave reaches a depth of over 200 feet below the surface within a few minutes, flowing though a series of steeply-sloping, rock-lined conduits, with no filtration or removal of contaminants. These flood pulses carry large amounts of recharge into the aquifer, and, if they carry any appreciable amount of sediment, the sediment will, over time, fill voids in the limestone and reduce storage in the aquifer. Flood pulses similar to those in Blowing Sink Cave have also been recorded in the Circle C Monitor Well.

There are three significant hydrologic regimes in Blowing Sink Cave: the sink hole drain regime, the vadose stream regime, and the phreatic conduit regime. The sinkhole drain regime extends from the entrance down to Eileen's River. This section of the cave is characterized by extensive flood scour, greatly accelerated in the last few years due to the relatively recent integration of the cave. Prior to human exploration, the flood pulses were relatively minor, the entrance was mostly blocked, and throughout the cave, there were constrictions that blocked and filtered the flood pulses. Considerable erosion has taken place slowly over the many years prior to integration, as evidenced by a flowstone canopy in the small room before the Main Pit that has gravel and chert nodules stuck to the bottom. Much of fine material removed from the upper reaches of the cave has collected at the bottom of the Kirschberg Hall. Below this point there was much less erosion: clay banks had been present in the lower part of Liverpool Pit, and the Sand Paper Crawl. With the opening of the entrance and the enlargement of openings in the bottom of the Kirschberg Hall, however, waterflow has become

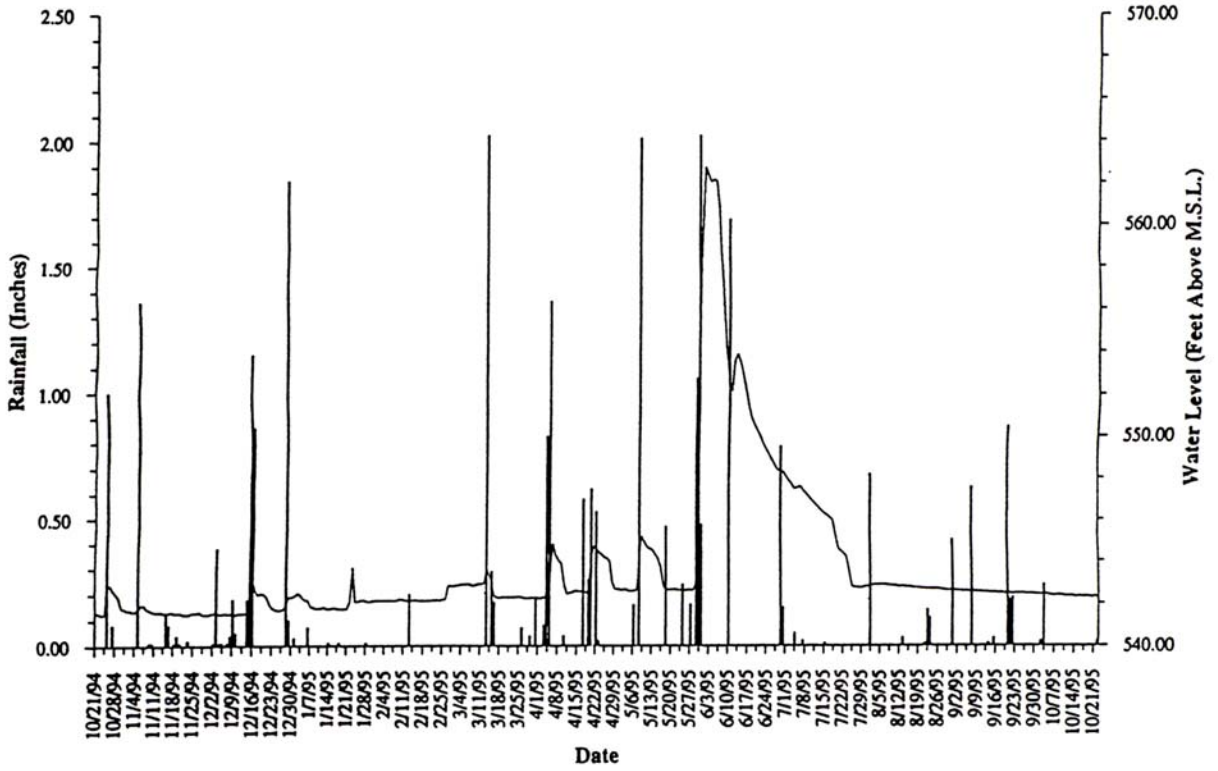



**Figure 3: Rainfall and Water Levels in the Circle C Monitor Well**

Data provided by the Barton Springs/Edwards Aquifer Conservation District (BS/EACD) Rainfall is measured at the BS/EACD weather station at Frate Barker and Manchaca, 2.5 miles south of the Circle C Monitor Well (State Well Number 58-40-411). Local rainfall produces an almost immediate rise in water level followed by a rapid decline. The rapid response time indicated local recharge through nearby fractures and sinkholes. The rapid decline indicates the well is drilled into a pool of water perched on an impervious bed above the level of the main aquifer just to the east, and that the passages to the aquifer are not constricted. There is little local storage, and so recharge quickly drains into the aquifer just to the east. This rapid rise and fall is quite similar to small surface streams. In this area, sinkhole drains act much like storm drains for a city, rapidly delivering unfiltered water to the aquifer.

much more rapid, and this sediment and clay are rapidly being removed and carried into the aquifer by major foods. With in a few years, the entire cave will be scoured clean of loose sediment, with the exception of the large accumulation at the bottom of the Kirschberg Hall protected by shoring and trapped behind boulders. The total amount of sediment eroded from the entire cave is not great, a total of several cubic yards.

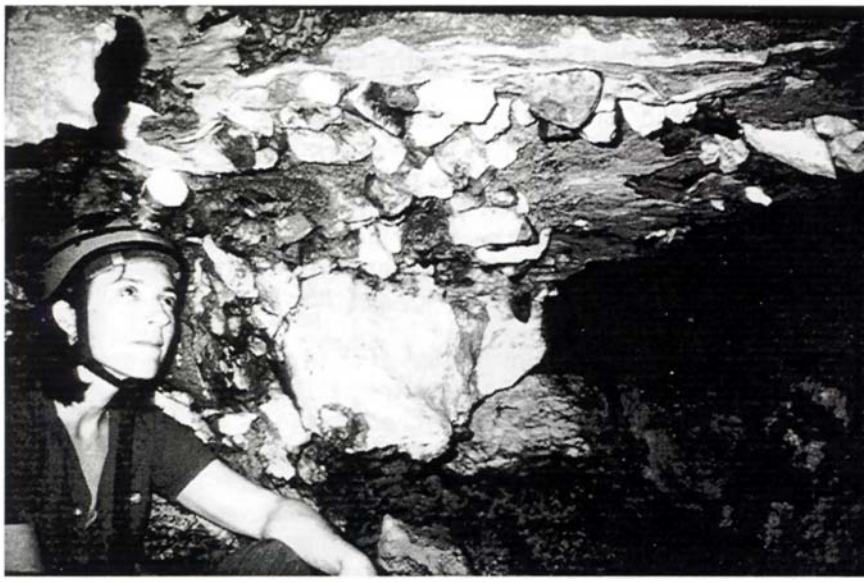
At present, the sediment load in the water entering the cave appears low. Surface slopes are very low, and after major rain events, the flow into the cave follows shallow, grass-lined channels, acquiring little sediment. However, if the surface were disturbed by construction, this situation could change drastically, and even a minor flood could introduce more sediment into the cave than all the previous floods combined.

The second and perhaps most interesting hydrologic regime is the vadose stream development in the lower levels of Blowing Sink Cave. The most significant aspect of this regime is the unexpected magnitude of the vadose stream development. Extensive vadose flow on impervious beds in the upper part of the dolomitic member is not predicted by most models of the Edwards Aquifer. Conventional representations of the Edwards Aquifer portray the entire Edwards as permeated with fractures and cavernous porosity. (See, for example the "conceptual cross section", Fig.13, in Slade et al., 1986). Caves should extend down to the surface of the aquifer, and there should not be extensive horizontal flow above the aquifer level. And if this conventional model is applicable anywhere, it should apply in the highly faulted, fractured, and cavernous area along Brodie Lane in south Austin. However, the existence of extensive vadose flow in the upper dolomitic member indicates the lower one hundred feet or so of the Edwards Limestone is, at least locally, not permeable and has little storage capacity.

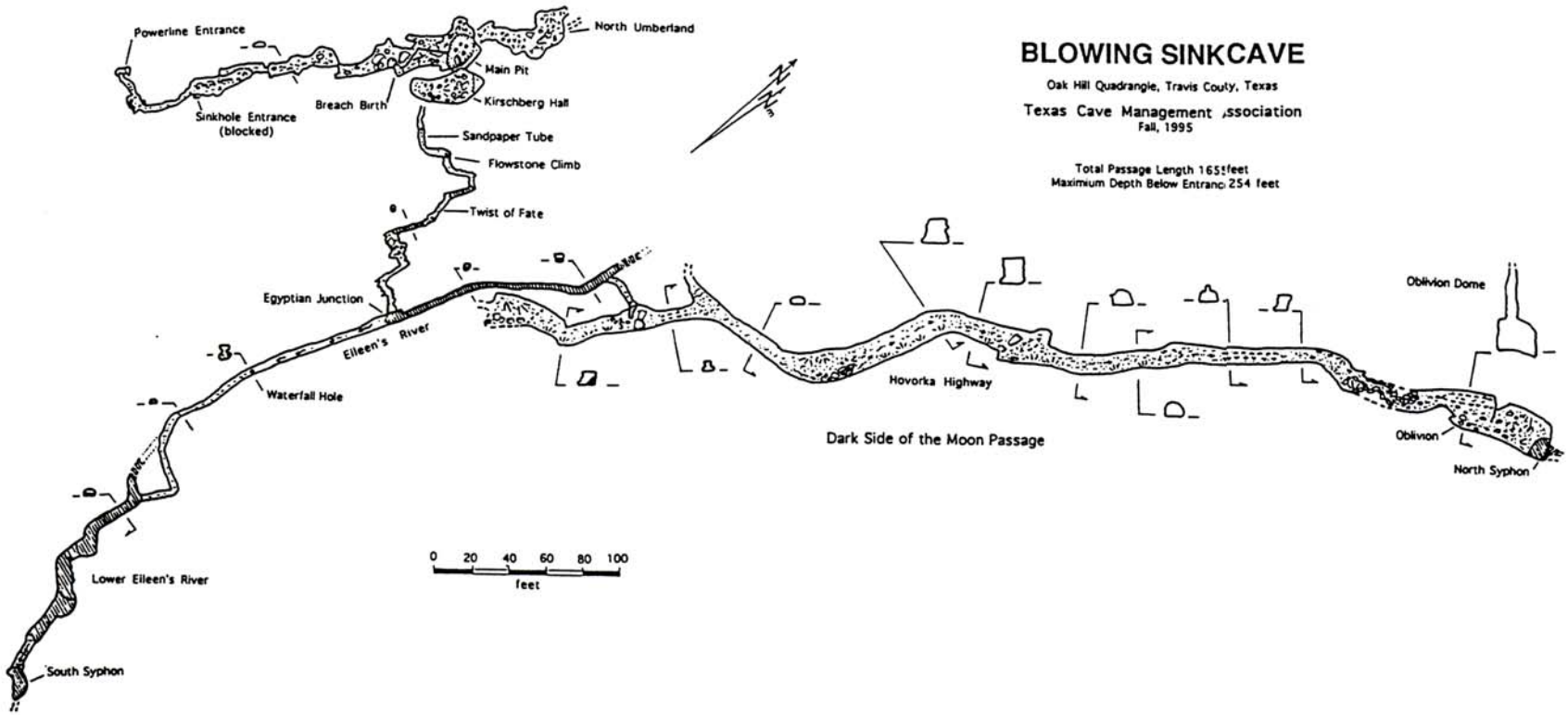
This impervious zone explains the behavior of wells like well 58-50-412 across Slaughter Creek, about a mile west of Blowing Sink Cave in the western Edwards outcrop (Fig. 2). The water level in this well tends to remain relatively constant and does not rise and fall in conjunction with the level of the Edwards Aquifer to the east (E.T. Baker, Jr., 1986). The Circle C Monitor well, just southeast of Blowing Sink Cave, also has a relatively constant water level just above 541 feet, isolated from and slightly above the water levels in the Edwards Aquifer to the east (Fig. 2) (Nico M. Hauwert, and Shawn Vickers, 1994).

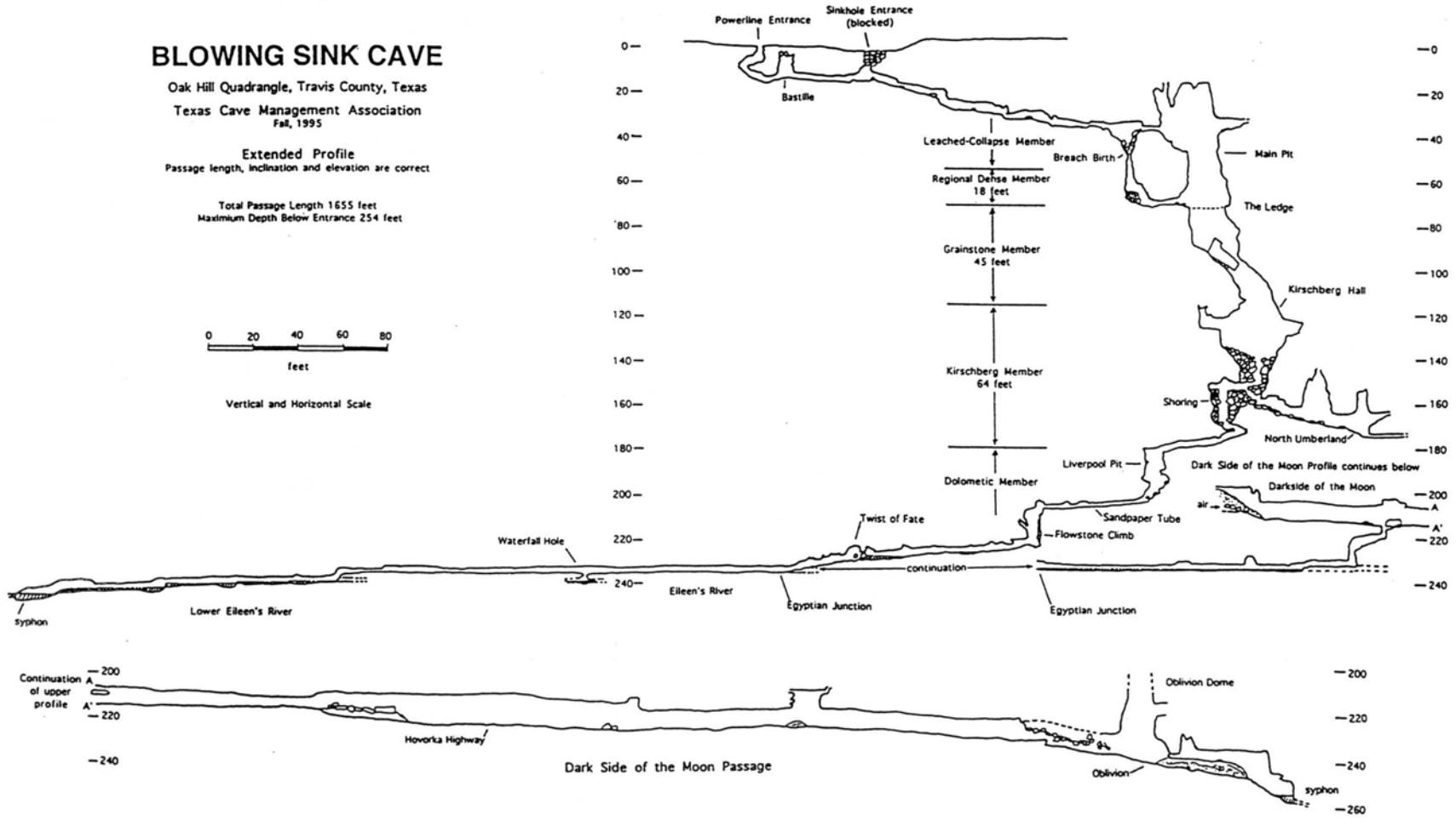
This isolation indicates that wells drilled in the western portion of the Edwards Limestone outcrop might be less reliable than previously thought since they do not produce from a large integrated aquifer, but only from a thin zone perched on the underlying dolomite. Wells drilled completely through the Edwards Limestone may produce from a thin solution zone at the base of the Edwards, just above the Walnut (Basal Nodular Member). Along the western edge of the Edwards outcrop, this lower solution zone may be the only reliable source of groundwater, and wells which do not encounter high permeability in this zone may produce only small amounts of water. Recharge along much of the western edge of the outcrop descends to the top of the Dolomitic Member and then flows laterally to the east through a few conduits, to reach the main aquifer to the east. In these areas, only small amounts of water are stored in the Edwards. Wells just to the east of this zone, which produce ample water from the Edwards Aquifer, but tap the thin but very permeable zone at the top of the Dolomitic Member, might be subject to failure during drought, when the aquifer level drops below the top of the impervious zone.

The water level in the downstream end of Eileen's River was 11 feet below the water level in the Circle C Monitor Well, located about a thousand feet to the southeast, in the direction of flow in Eileen's River. It appears that the well-developed flood pulses observed in the Circle C Monitor well do not originate from Eileen's River, but from another independent source. It is likely that flood pulses in the well originate from local recharge, possibly water from Jody Lane Sink, a large shallow depression 600 feet north of the observation well. The water level in the Circle C well is perched on the upper Dolomitic Member, probably very near to where this water spills over into Eileen's River and the main Edwards Aquifer.



Top left-Erosion removed a clay bank to form a flowstone canopy
Top right- Looking up the fissure below the Breach Birth
Left- Lower Eileen's River before South Siphon
Lower left- Flowstone in Lower Eileen's River
Lower right- Eileen's River at Egyptian Junction


BLOWING SINKCAVE
Oak Hill Quadrangle, Travis Couty, Texas
Texas Cave Management ssociation
Fall, 1995
Total Passage Length 165±feet
Maximium Depth Below Entranc 254 feet
Powerline Entrance
Sinkhole Entrance (blocked)
Breach Birth
Main Pit
North Umberland
Kirschberg Hall
Sandpaper Tube
Flowstone Climb
Twist of Fate
Egyptian Junction
Eileen's River
Waterfall Hole
Lower Eileen's River
South Syphon
Hovorka Highway
Dark Side of the Moon Passage
Oblivion Dome
Oblivion
North Syphon
0 20 40 60 80 100
feet


BLOWING SINK CAVE
Oak Hill Quadrangle, Travis County, Texas
Texas Cave Management Association
Fall, 1995
Extended Profile
Passage length, inclination and elevation are correct
Total Passage Length 1655 feet
Maximum Depth Below Entrance 254 feet
0 20 40 60 80
feet
Vertical and Horizontal Scale
Powerline Entrance
Sinkhole Entrance (blocked)
Bastille
Leached-Collapse Member
Regional Dense Member 18 feet
Grainstone Member 45 feet
Kirschberg Member 64 feet
Dolometic Member
Breach Birth
Main Pit
The Ledge
Kirschberg Hall
Shoring
North Umberland
Liverpool Pit
Dark Side of the Moon Profile continues below
Darkside of the Moon
air
A
A'
Sandpaper Tube
Flowstone Climb
Twist of Fate
Waterfall Hole
continuation
Eileen's River
Egyptian Junction
Egyptian Junction
Lower Eileen's River
syphon
0
20
40
60
80
100
120
140
160
180
200
220
240
Continuation of upper profile
Hovorka Highway
Dark Side of the Moon Passage
Oblivion Dome
Oblivion
syphon
200
220
240
260

The base flow of Eileen's River, 10 gpm at the Egyptian Junction where it was measured, and over twice that in Lower Eileen's River, indicates a large upstream source area. The base flow in this stream derives from water stored in fractures, debris-filled fissures, and solution cavities, as well as the probably considerable seepage from intergranular porosity. It is possible that recharge from Slaughter Creek just downstream from the Mt. Bonnell Fault contributes to the flow of Eileen's River. This appears unlikely, but could be tested with a dye trace. Most likely the ultimate source area for Eileen's River is surface recharge from several square miles along the Williamson-Slaughter Creek divide.

The phreatic conduit regime comprises the Dark Side of the Moon passage, a now mostly abandoned conduit that carries water only after major rain events and during high levels of the aquifer. This passage receives considerable floodwater input through breakdown at the south end of the passage. This water flows northeast along the passage and into the terminal siphon, with some flow down into Eileen's River. It is likely that some of the water entering North Umberland reappears in The Dark Side of the Moon, and that, for brief periods, the passage functions as a vadose drain, but mud deposits and ceiling debris indicate the passage is completely flooded at times. During these periods, The Dark Side of the Moon again functions as a phreatic conduit helping to carrying the general flow of the aquifer north to Barton Springs.

The existence of Eileen's River Passage and the even larger Dark Side of the Moon passage indicate that base level flow has been channeled through this segment of the Aquifer for a considerable time. Large abandoned conduits like The Dark Side of the Moon passage give evidence of hydrologic integration of the Edwards Aquifer in the geologic past. A similar conduit currently in use probably causes the elongate trough in the surface of the Edwards Aquifer near Sunset Valley (Hauwert, 1995).

Conduit development in the Barton Springs segment of the Edwards Aquifer is probably concentrated in the section near Barton Springs. Away from Barton Springs, much of the groundwater flow appears to be through low, wide solution zones. The bedrock in these favorable zones is so much more soluble than the rock above and below that tubular conduits do not develop. Models of groundwater flow and cave passage development derived from the dense, uniform limestones in eastern United States do not apply to the Edwards Group, where adjacent beds frequently have radically different solubilities. Rather than a dendritic network of passages extending from sinkholes to a few master conduits, many sinkholes drains terminate in low wide zones of solutional rubble.

**Speleogenesis**

Blowing Sink Cave, like many others in the Austin Area, is developed in a disturbed zone along a relatively minor fault. This fault is likely the southern end of the Goat Cave Fault that forms the edge of the Edwards Limestone outcrop just east of Goat Cave, north of Deer Lane. The Goat Cave Fault dies out to the south and forms a structurally complex area where the displacement from the fault is transferred to other systems. The minor fault that controls the development of Blowing Sink Cave is exposed in the new entrance to the cave, and parallels much of the known cave. Along the downthrown side of the fault, drag has produced dips steeply to the east, about 10 to 15 degrees near the fault and declining away from the fault. Only the lower Eileen's River and The Dark Side of the Moon passages are far enough to the east of the fault to escape the effect of the fault drag.

Permeability is commonly enhanced near faults and other linear geologic elements (De La Garza and Slade, 1986). The groundwater flow that formed Blowing Sink Cave is probably typical of southern Travis County, with the unusual aspect of Blowing Sink Cave being that the entire system is humanly passable. Initially, northward water flow followed fractures adjacent to a local fault, where fracturing and crumpling due to fault drag provided an easily enlarged flowpath. Just north of the present entrance, fracturing penetrated the Regional Dense Member, forming a "drain" for the surrounding area. Over time, these initial fractures were enlarged to form the Main Pit. Below the Regional Dense Member, the waterflow enlarged voids in the Kirschberg Member to form the rubble-floored Kirschberg Hall. It appears likely that the original flow then continued north through North Umberland and followed a now-blocked passage connecting to The Dark Side of the Moon passage. As the watertable declined, vadose water entered the cave and scoured fill from the upper levels, enlarging additional fractures to form the Breach Birth fissure and forming the crawlway to the ledge, a short-cut to the Kirschberg Hall. This vadose water also formed the drain that connects the Kirschberg Hall to Eileen's River, making possible the extensive vadose modification of the system.

Eileen's River Passage developed where the downward flow from surface infiltration and sinkholes were blocked by impervious beds in the lower Edwards Limestone. The considerable vadose flow through this passage indicates a sizable drainage area, and little storage and no solutional enlargement of fractures in much of the Lower Edwards Limestone.

The Dark Side of the Moon passage is an older phreatic passage, considerably modified by sediment and breakdown. This passage developed as a major waterflow conduit above the lower impervious beds, following fractures parallel to local faulting.

The waterflow that formed in The Dark Side of the Moon appears to have been to the north, as would be expected, though flow scallops are not well developed. The vertical position of The Dark Side of the Moon passage is stratigraphically determined, formed along especially soluble beds in the upper Dolomitic Member, above the impermeable lower beds. The same bed forms the ceiling of the passage for several hundred feet. Both the Circle C Monitor Well and Well 58-50-412 share a perched water level 30 feet below the top of the dolomitic member (Fig. 2), the same stratigraphic location as The Dark Side of the Moon. Quite likely, this bed is lower limit of solution in much of the area; only intense local fracturing has allowed the Eileen's River Passage to 'develop below this level for a short section. Extensive large voids must be immediately accessible through Eileen's River, as flood waters have scoured this section, with no sign of blockage.

Hydrologically efficient conduits, like the Dark Side of the Moon are responsible for the configuration of Blowing Sink Cave and other caves in southern Travis County. Once a large conduit develops in a favorable geologic zone such as the upper Dolomitic Member, the slope of the water table is greatly reduced, and the pizeometric surface falls below the Regional Dense Member. Recharge from the surface reaches this generally impermeable unit and is unable to descend farther, forming a perched groundwater pool above the Regional Dense Member. In a few areas, fracturing has provided a pathway through the Regional Dense Member. These fractures act as drains for a large area, forming complex vertical cave systems like Blowing Sink Cave.

**Conclusions**

1. Blowing Sink and Blowing Sink Cave comprise a significant recharge feature that quickly channels large quantities of surface runoff into the Edwards Aquifer.
2. The presence of extensive vadose groundwater flow above the level of the Edwards Aquifer indicate that, at least locally, the lower 50 to 75 feet of the Edwards Limestone are impervious and do not contribute to storage in the Edwards Aquifer.
3. The absence of aquatic salamanders in Blowing Sink Cave indicates *Eurycea sosorum,* the Barton Springs Salamander, is likely confined to the vicinity of Barton Springs, and does not inhabit the distant reaches of the Aquifer.
4. Waterflow routes in the past were strongly influenced by both structure and lithology, and sizable conduits can develop along favorable routes.

**Recommendations**

1. During and after development, the area around Blowing Sink and some distance upslope should be protected by setbacks.
2. To maintain the quantity of good-quality water entering the aquifer, consideration should be given to connecting Blowing Sink to the drainage channel leading from the area to the north of Blowing Sink. Topography indicates a major drainage channel will be somewhere near Blowing Sink. After development, even small rains will produce more runoff than can flow through Blowing Sink Cave, and much of this water will be of poor quality. A gate on the connecting channel could allow poor-quality water to by-pass the sink and good-quality water to be channeled into the Aquifer.
3. Provisions should be made for continued biologic studies in Blowing Sink Cave. Studies in Blowing Sink Cave (and other caves) may well confirm that *Eurycea sosorum* is limited to the vicinity of Barton Springs. If few salamanders are present in the aquifer, disruptions to Barton Springs may well effect the entire population.
4. Provisions should be made for continued hydrologic studies in Blowing Sink Cave. Eileen's River originates from a large recharge area and would be an ideal place to monitor the effects of urbanization on water quality.

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For many cavers, caves are almost a drug, a refuge from the trials and tribulations of outside reality, a place of their own. But did you ever consider you might have a bad trip, a really bad trip, and find more in the underground than you ever dreamed of?

The following was adapted for cavers by Bill Russell from H. P. Lovecroft's "The Elder's Lair."

When evening cools the zephyr's stream
And shadow stalks the hillside ways,
There is one house with lights ablaze
For a caver brave who fears to dream.

For he alone of all mankind
Found the cave that serpents shun,
While struggling toward the setting sun,
He found the cave that lies behind.

No other eyes had ventured there
Since eyes were lent for human sight,
But in their caverns dark as night
He found the Elder's secret lair

Caver went where no sun will shine
Past leagues where life can have no home
Through passages past pit and dome
By amorphous hoards of things malign.

Inhuman shapes, half seen, half guessed,
Half solid and half ether-spawned
Seethed up from starless voids that yawned
The Elders mocked his foolish quest.

Sweating with fright the caver crept
Back through the cave that serpents shun
So that he lay by rise of sun
Safe in the place where oft he slept.

None saw him leave or come at dawn
Nor does his flesh bear any mark
Of what he met in that curst dark
Yet from his sleep all peace is gone.

When evening cools the zephyr's stream
And shadow stalks the hillside ways,
There is one house with lights ablaze
For a caver brave who fears to dream.

# Wyoka:

## Beyond the Slime Tube and through the Iron Maiden

From the first, Bianca was strangely attracted to the Slime Tube. Following a strong air flow, we had just climbed down about 12 feet through a narrow fissure to a breakdown floor. From this level, one could look into a horizontal slot in the wall a little over a foot high, but entry was blocked by jagged, spiky nubbins. The air appeared to be coming from this opening, so I began to pound on the nubbins while Bianca checked the other leads. None of the other leads were exciting, and Bianca soon became restless, and finally squeezed in over the still-sharp projections. The projections were tougher than they looked, and as I pounded away Bianca's voice faded into the distance.

How we got this far in Wyoka is an interesting story in its self. There had been several years of work with assorted setbacks, but thanks to the EMS, no one died. Sufficient to say: nothing comes easy in Wyoka.

Bianca finally returned, backing slowly out, completely covered with gooey clay. She reported the passage finally became too low after about 100 feet, but at this point there was a bypass passage that looked like it could be enlarged. The airflow was strong, and the constriction water scoured so we returned with digging equipment. The passage, named with good reason the Slime Tube, was uniformly about 18 inches high, and three feet wide with a flat ceiling and slopping slimy walls, and a clay floor. We slid along until we reached a small opening in the left wall that lead to the parallel passage, and started digging. Every effort was a struggle. All the equipment, people, packs, and tools soon became mired in a gooey muck. Gobs of clay were scraped out of the floor and walls and pushed into the low continuation. Chemical persuasion was needed for the rocks, since only a limited blow could be struck with a hammer in the constricted space. We would both back up to the end of the wire, and then detonate the charge, one that, in such a confined space, produced a strong shock wave like a kick in the stomach. Then we would slide forward to view the progress, generally covered by toothpaste-like extrusions of clay produced by the blast.

After several trips and a fortuitous flood that removed much of the tailings, we finally had created a space big enough to turn around in. This was real progress. The more space we had, the better we could dig, and so progress was more rapid. Finally, Bianca was able to squeeze through to find the passage blocked just ahead by a two-foot-high wall of jagged projections rising out of the floor like shark's teeth. But beyond this, the passage looked passable and scoured clean. No clay. We thought anything would be better than the clay, so on Sunday, the twelfth of November, we returned with high hopes. First, we removed a few rocks from the bypass passage, and then Bianca squeezed through and dug large clay balls out of the floor and rolled them through to me. Finally the passage was large enough, and I slid through and attacked the Shark's Teeth. Soon there was passable space, and open passage.

The passage continued much like before, but without the clay. However, our enthusiasm was tempered by a new development: numerous sharp bedrock projections, only one or two every few feet, and for the most part easily eliminated. But as the passage continued, the sharp edges became a problem, and the body began to suffer. When the protrusions were broken, knife-sharp edges were left. It was impossible to entirely avoid these projections, due to the small size of the passage. One edge caught on the welder's shirt I wear for small digs and shredded the fabric. One edge cut Bianca's knee through her knee pad. On the way out, we named this section the Iron Maiden, being quite similar in size and construction to the medieval torture device.

After about 100 feet, a side passage entered from the night, and the main passage was much improved. Still not quite high enough to crawl, but large enough to pass another person and turn around in — always desirable features in a long passage. After 50 more feet, we reached a blockage, but not one that appeared serious. The passage appeared to make an abrupt right turn, sediment and a few rocks had collected along the left wall, and a small cutoff trench had developed on the right. Ahead looked promising with at least a lowering of the floor. But it was time to return to the surface while we still had energy and clothing. The trip back was uneventful, except for muffled cries of pain and much energy expended rolling the pack back through the Slime Tube, as it became a bigger and bigger clay ball, finally exceeding the diameter of the passage.

After two weeks, memory had faded enough for a return trip, and we returned to scoop the booty: explore the big cave that lay just ahead —the reward for all our effort. Arriving at the entrance, a large rattlesnake laughingly flicked its tongue at us and slithered sedately into a small hole. An omen? We pushed quickly (relatively) through the Slime Tube, the Shark's Teeth, and finally to the end of the Iron Maiden, and started to dig along the left side. No problem until almost through. Two small fist-sized, sharp projections would not break despite the best blows we could give them. Bianca squeezed in and tried to create some space by digging away clay on the left wall, and finally got her head through, but could squeeze no further. We then tried to enlarge the sharp, spiky, narrow channel along the right wall. With effort we created a body-sized slot by breaking off the jagged honeycomb, until we could see into a deeper slot extending ahead. Exploring to this point had shredded Bianca's clothing, and I left bloody smears on the walls, but couldn't find the cut due to the muddy goo covering my body. The dig along the left wall appears to be the best way to go. The passage widens ahead and slopes down to the right, leading to a pit of some sort along the right wall, an apparently larger opening than the narrow slot. The floodwaters waters have found a shortcut into this pit, cutting the narrow slot along the right wall. The pit appears passable, and as soon as our wounds heal, we will be back.

Reported by Bill Russell... To be continued.

If you cannot bear the silence and darkness, do not go there; if you dislike black night and yawning chasms, never make them your profession. If you fear the sound of water hurrying through crevices toward unknown and mysterious destinations, do not consider it. Seek out the sunshine. It is a simple prescription. Avoid the darkness.

It is a simple prescription, but you will not follow it. You will turn immediately to the darkness. You will be drawn to it by cords of fear and longing. You will imagine that you are tired of sunlight; the waters that unnerve you will tug in the ancient recesses, of your mind; the midnight will seem restful -- you will end by going down.

"The Places Below"
The Night Country
Loren Eiseley

Quoted in The Almost Complete Eclectic Caver by Thom Engel

# Standards for Cave Modification for Exploration

*William H. Russell*

Many people, and even some cavers, regard caves as a delicate, sensitive, natural resource, best left in a natural state. The official NSS conservation guidelines state that all contents of a cave are important and should be left undisturbed. Cavers who wish to modify the cave to make exploration possible should respect these beliefs and make any necessary modifications as unobtrusive and natural appearing as possible. Much of the opposition to digging in caves arises from digs that have turned a once-attractive area into an ugly pile of rubble. Diggers should remember that, in many caves, they are digging for the ages. Long after the World Trade Center, the Eiffel Tower, the local mall and the interstate highway system have crumbled into dust; your ugly dig will still be an ugly dig.

Most damage to caves is from two sources: cave-impacting land use and unorganized individuals who leave broken formations, trash and graffiti. Land use problems arise from overgrazing that fills caves and sinkholes with mud, subdivisions where urban runoff pollutes the cave stream, and shopping centers that pave over the karst, obliterating caves along with the rest of nature. The damage that cavers do to caves through exploration and digging is many times offset by the reduction in damage to caves from other sources due to policies promoted by cavers. Strong caving organizations are necessary to prevent damage to caves through education, conservation, and regulation. Digging provides the activities and discoveries that are essential for strong caving organizations.

The standards given below are based on the assumption that cave modification necessary for exploration is a desirable activity. Digging, enlarging passages, and draining pools and siphons are appropriate when the obstacles to be eliminated are impediments to the exploration of new cave not currently accessible. Modifications addressed under these guidelines are to find more cave, and not to make trips less strenuous. For example, the digging of a shaft into Honey Creek Cave in Central Texas, eliminating a mile-long swim, is justified in that it opened new areas for exploration, and all involved in the cave project were in favor of the new entrance. These guidelines do not address modifications undertaken to enable more people to enjoy the caving experience, for safety, or for commercial development.

The following standards are primarily aesthetic in nature, and are not intended to cover engineering, ventilation, air quality, blasting, timbering, or other technical problems. Even an introduction to engineering and construction practice would require a large volume. These standards assume familiarity with the necessary procedures to safely and efficiently accomplish the dig. It is also assumed that proper permission and clearance from the landowner and any affected agency have been obtained. These standards address the digger's obligation to other cavers.

These digging standards should be referred to as the **TCMA 1995 Standards**

1) **Pre-Project Assessments:** An adequate assessment of the project is to be done before any modification. This assessment must consider the following:

a) Is the effort worthwhile; is the potential for discovery of new cave likely enough to justify the effort and damage to the cave?

b) Are there other approaches, places or methods to reach the same goal, and, if so, is the method, locality, or route selected the best choice?

c) Is the necessary labor available to complete the project within a reasonable amount of time? (Digs in progress are usually ugly and 'frequently dangerous.)

d) Have satisfactory arrangements been made for the disposal of the tailings?

e) Can the dig area be restored to a natural-appearing condition?

These might seem like burdensome constraints on activity. However, this is not the case. These requirements are intended only to spur an internal dialogue that should aid the digger in anticipating problems and making certain the project is ready to proceed. In many cases, the evaluation will take only a few seconds. As an example, consider a typical minor dig where a rock blocking the passage is to be pushed to one side. Worthwhile cave is visible, other approaches do not appear feasible, and the manpower is at the job site. The rock pushed to one side will appear quite natural. Move the rock.

2) **Additional Special Assessments:** Some modifications have special problems that will require additional evaluation.

a) Will stalactites, flowstone or other speleothems be damaged by the dig? Damage to attractive speleothems should be considered a serious negative. If they are outstanding or unusual for the area, the dig should be reconsidered. If not outstanding and similar to others in the cave and area, special consideration should nonetheless still be given to minimize damage. All broken calcite should be carefully buried.

b) Will the project change the nature of a recognized locality? The size, shape, and appearance of recognized localities should not be altered without near unanimous agreement during discussions, and perhaps even a formal agreement with affected caving groups. Cavers may **not** be happy that "Fat Man's Misery" is no more.

c) Will archeological, paleontological, or other material of scientific interest be damaged? Only a small number of caves contain material of significant scientific interest. An occasional bone in the debris pile below an entrance is not usually of paleontological importance. If there are large amounts of bone material or numerous artifacts, the site should be reviewed by a specialist. Many land owners and especially state and federal agencies, require review of the dig by a specialist if **any** paleontological or archeological material is found, even after initial clearance.

d) Is the area to be modified obviously stable? Digging through breakdown or beneath loose fill will require **considerable** thought to ensure that the dig can be safely undertaken. Vertical walls of unconsolidated material should be avoided. Clay slopes frequently will not even support their own weight when wet.

e) If this is a major project, will air or water flow through the cave be adversely affected (which can affect biota)? Airflow can usually be controlled with a door. Limiting water flow is more difficult.

f) Modifications to make travel to the end of present exploration less difficult so that more caves can be discovered should have widespread support from persons and groups who visit the cave. To arbitrarily change the nature of a cave visited by others without their prior consent is unacceptable. At the very least, discussions should be held with all easily identified users of the cave several months in advance of any modification. In newly discovered caves, necessary modifications should be undertaken immediately after discovery, when the discoverers are the only group involved. Otherwise, the discoverers might have to live with the cave as discovered. If no agreement can be reached with other users of the cave, political methods (voting in the grotto, etc.) should be used to resolve the issue. Appeals to non-caver landowners should be avoided.

3) **Construction Phase**

a) Preparation of the tailings area: If a sufficient material similar to the surrounding surface is not available to cover the tailings removed from the dig, the surface material from tailings area should be removed before the dig starts, piled nearby, and then used to cover the tailings.

a) The ceiling, walls, and (less importantly) the floor should be dug back to natural breaks. After blasting, all the broken rock should be carefully removed and carried to the tailings pile. The one exception to digging back to a natural wall is when trenching in a wide, low passage. In this case, it is not usually necessary or practical to dig back to natural walls.

b) All wires, boxes, used batteries, and other obvious trash should be removed from the dig site and cave as they are produced and disposed of elsewhere. Small, left-over pieces of boards and timbers can be left at the site for future use, but broken boards, bent nails, and other trash should not be left until the end of the dig.

c) Do not bring more material, supplies or tools to the dig site than can be used within a reasonable time.

d) The most efficient dig size for extensive digs is about two feet wide by three feet high. This dig size is small enough to minimize the material broken up and moved, but large enough to minimize the effort required to move material through the dig.

e) If blasting is required anywhere near calcite deposits or other speleothems, the charges should be packed with pure clay (no rocks or pebbles) to minimize chipping of the walls and formations.

4) **Post Project***

a) All broken rock and other tailings should be compacted and arranged as unobtrusively as possible and covered with material similar to the surrounding surface.

b) In surface digs, all tailings should be deposited in a low, soil-covered mound, less than one foot high for every three feet of width, and the entrance should be stabilized and made safe. When involved in surface digs through trash-filled entrances, diggers should suitably dispose of all trash removed.

c) All tools and construction materials should be removed from the area.

d) Walls of freshly broken rock are a special problem. If a surface similar to adjacent walls can not be obtained by digging back to a natural break, the freshly exposed rock surface should be treated to naturalize the surface. A slurry of clay and water can be worked into the surface with a wire brush to produce a more natural appearance.

e) All damaged formations, pieces of flowstone, and crystalline calcite should be buried in the tailings pile, leaving a clean break between undamaged areas and open tunnel.

**Project sites should be restored to a natural appearance.*

## Caver's Dream

The caver is a foreigner both where she lives and where she caves. She creates suspicion both at home and in the karst. At home she is only half feminine, and in the karst she is only half masculine. Hidden in the karst, high in the mountains is a deep and wonderful cave where she is to make her greatest discovery. At the top of the forest she looks for this cave; finding it is her greatest test. Then, finally reaching the end of a long path, she meets two men and asks them her way. They gaze at her, holding their machetes and remaining silent, although they know where the cave is. Then one of them points with his finger and says: "Go that way and at the first crossing turn left, and then left again, and it will bring you right to the cave." The caver thanks them, thinking it was a good thing they had not asked her why she wanted to find the cave because they would certainly be suspicious of her as a foreigner and would wonder what her real purpose was. She continues down the path, takes the first left turn, and then left again; it is not at all difficult to follow the directions, but the second left leads not to the cave but to a large field. And in front of the field stand two smiling men with machetes whom she already knows. They apologize through their smile and say: "We gave you the wrong directions: you should have turned right at the first crossing and then right again, and there is the cave. But we had to find out whether you really did not know the way or were just pretending. However, it's late now and you can't reach the cave today. And that means not ever. Because the cave will no longer exist as of tomorrow. You have missed your entire life's destination because of this small test, but you must realize we had to take this precaution to protect ourselves and the cave from any evil intent on the part of travelers looking for treasure. But don't blame yourself either. Had you taken the opposite direction and gone right instead of left, it wouldn't have changed anything, because then we would have known you were deceiving us and that you did know the way to the cave, even though you were inquiring about directions, and we would have had to check up on you: your purpose would have been clearly suspect, since you were concealing it from us. So really you can't get to the cave either way. But you haven't sacrificed your life in vain: it has been used to verify something in the world, and that is no small matter.

The men talked and the caver had one consolation—she had not been asked her purpose, and the men by the field had no idea what it was. But at the same time, she had thus deceived them and hindered their investigation, which meant that her life had actually been sacrificed in vain after all. Of course it was in vain from their point of view, in one way, and, from her point of view, in another. What did she care about their checking?

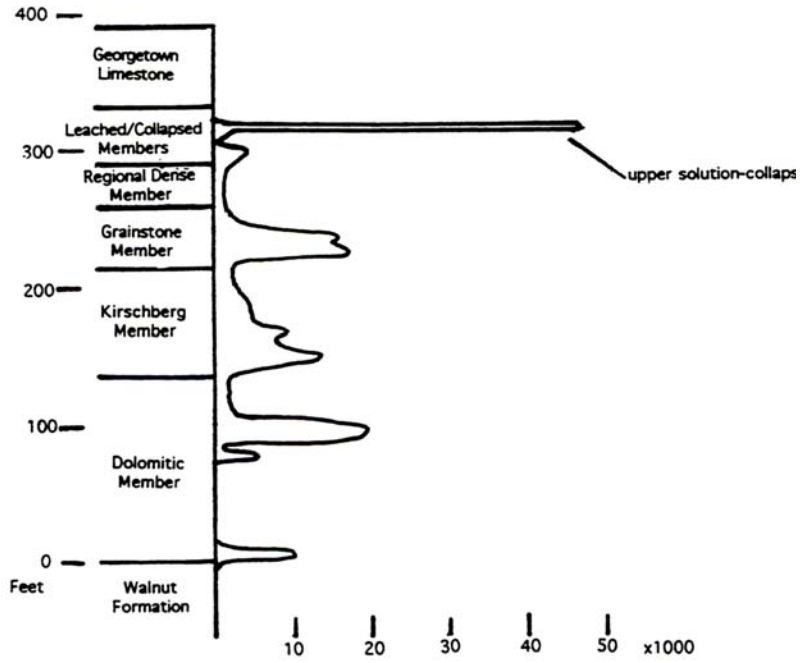
It all comes out the same anyway. And so the purpose of her being no longer awaited her. Now she starts thinking the purpose was not in the cave itself, but somewhere along the way to the cave, as vain as the actual search was. Suddenly, her memory of the search becomes more and more beautiful; looking back, she begins to see the many beauties of the trip, and she concludes the crucial thing happened not at the end of the trail by the field, but somewhere much earlier on, during the first half of the journey, which she never would have thought of, had the trip not been in vain. In the rearrangement of her memories, she begins to pay attention to new details, barely registered in her mind. She looks for the most important details, constantly narrowing down their numbers, until by ruthless reduction and increasingly strict selection; she arrives at a single scene from her memory:

Camped by a small spring on the edge of the karst where the water of life flows from darkness through a sunlit pool and back into the unknowable dark. Drinking a small glass of wine, special for the occasion, as the last light of the sun glints through the trees and off the water. Thinking of her friends here and back home as she sips the last of the wine, and the water flows on into the night.

As told to Bill Russell (The Kafka of the karst), with apologies to Milorad Pavić.

**Stratigraphic Distribution of Southern Caves in the Edwards Group, Travis County, Texas**

The distribution of solutional voids in the Edwards Limestone is of both practical and theoretical importance in understanding the Edwards Aquifer. Until recently, most estimates of the distribution of solution voids came from cavities and porosity encountered in wells. With the detailed mapping of the Edwards Limestone by the USGS and the Barton Springs/Edwards Aquifer Conservation District, it is now possible to compile a stratigraphic distribution of cave passage. Using the larger caves in the Oak Hill and Signal Hill Quadrangles gives a composite picture of cave distribution throughout the Edwards Group. The results of compiling the stratigraphic distribution of the five largest caves, Airman's Cave, Blowing Sink Cave, Flint Ridge Cave, Ireland's Cave, and Whirlpool Cave, are presented below.




Distribution of cave passage in southern Travis County. Cubic feet/stratigraphic foot.

The actual distribution of observed cavernous solutional openings is somewhat different than expected from the "porosity" reported from wells. The "upper solution collapse zone" appears more prominent than reported from wells, but this is due both to the considerable energy spent exploring Airman's Cave and the chance of missing this thin zone in many well records. The base of the Leached-Collapsed Member does not appear to be an important cave former, as might be expected from groundwater flow perched above the Regional Dense Member, but the lack of cave passage might be due to extensive collapse of the low wide areas formed by solution. The relatively thick, permeable Kirschberg Member is prominent in well records, but it is a relatively poor cave-former, due to solutional rubble and insoluble residues. The upper part of the Dolomitic Member is a much better cave-former than is indicated from well records, likely as a result of limited porosity, but it has a tendency to form large conduits.

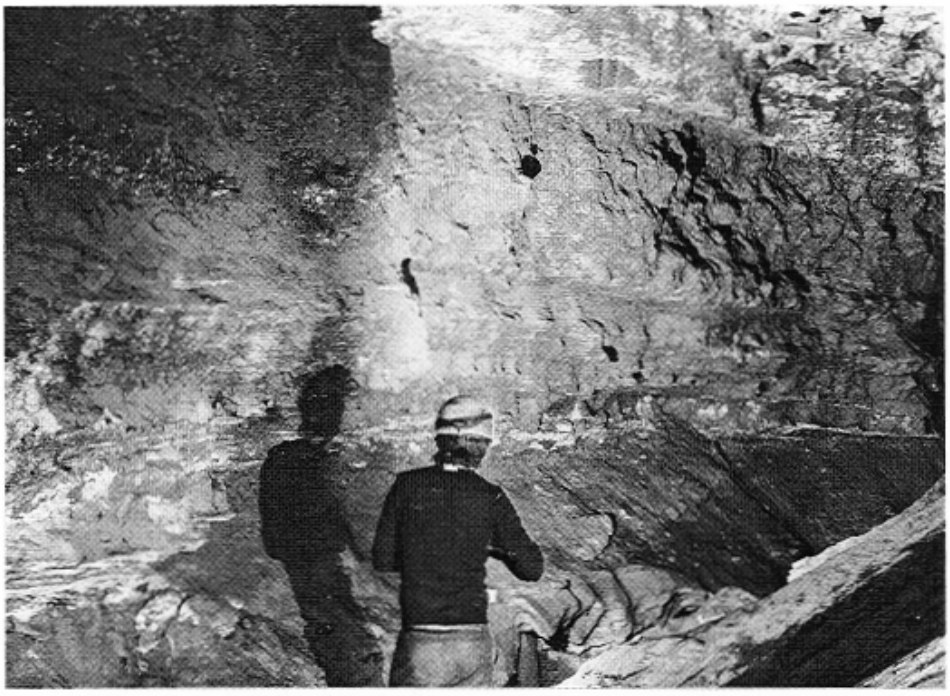
**“Conduits” in the Deep Edwards Limestone-Observations**

by

Bill Russell

When Dr. Sue Hovorka reported that “conduit permeability” was developed in the deep Edwards, I and at least a few others thought she certainly must be referring to small voids and interconnections, more like “honeycomb porosity” than actual conduits. To most cavers, a conduit is a relatively large linear opening, generally with dimensions of feet, formed by a concentrated flow of groundwater. However, when I called Dr. Hovorka, she insisted that her “conduits” appeared to be real conduits, even by caver standards. They would likely qualify as caves, and apparently have dimensions of feet. The evidence for actual conduits appears somewhat indirect. Caliper logs went off scale at six inches, and pumping tests indicated that these “conduits” supported pumpage rates several orders of magnitude greater than the normal porosity. Pumpage rates from the deep Edwards were greater than from the shallow Edwards.

It is difficult to see how actual conduits could form at great depth, where there is little likelihood of much ground water velocity. The source of the increased solution in the deep Edwards appears to be chemical reactions with the heavily mineralized water to the east of the Bad Water line. Perhaps what appear to be conduits are Carlsbad/Lechuguilla type “bone yard” solution voids. These could have dimensions of feet and produce large volumes of water, and their development would not require much movement of water. Considerable quantities of water flows great distances through the Edwards Limestone but, there still appears to be no general description of the type and location of conduits used by this flow. This is where cavers, geologists and hydrologists need to get together.



The Dark Side of the Moon passage in Blowing Sink Cave, a caver sized conduit

# Travis County Top Ten - Length and Depth

| | Length in feet | |
|---|---|---|
| 1. | Airman's Cave | 11300 |
| 2. | Blowing Sink Cave | 1655 |
| 3. | Whirlpool Cave | 1440 |
| 4. | Cave X | 1070 |
| 5. | Flint Ridge Cave | 928 |
| 6. | Grassy Cove Cave | 658 |
| 7. | Austin Caverns | 550 |
| 8. | Ireland's Cave | 489 |
| 9. | Bandit Cave | 440 |
| 10. | Lost Gold Cave | 400 |

| | Depth in feet | |
|---|---|---|
| 1. | Blowing Sink Cave | 254 |
| 2. | Flint Ridge Cave | 152 |
| 3. | Cave X | 119 |
| 4. | Dead Dog Cave | 91 |
| 5. | Brodie Sink Cave | 86 |
| 6. | Maple Run Cave | 76 |
| 7. | William's Well | 75 |
| 8. | Midnight Cave | 57 |
| 9. | Whirlpool Cave | 52 |
| 10. | Grassy Cove Cave | 44 |

Compiled by Bill Russell, March 1996

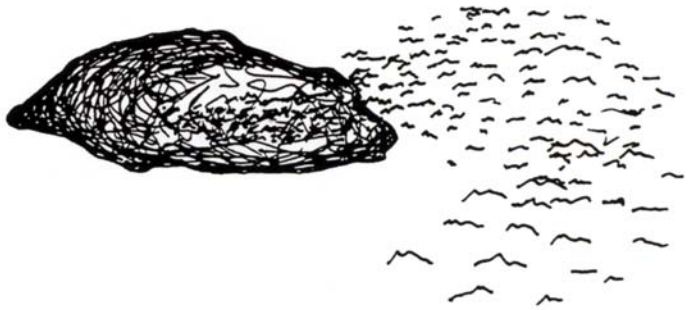
## Caving in Texas

With Kinepak and Detagel
We'll dig and dig straight through to hell

With Prima Cord and Emulex
Digging is more fun than sex

Most cavers stop when things get tight
We just use some dynamite

If smoke and rocks are what you crave
Texas is the place to cave



Kinepak©, Detagel©, Emulex©, and Prima Cord© are brand names of explosives. Dynamite is a popular word for all explosives, but actual dynamite, a nitro-glycerin based explosive, is no longer manufactured, and the toxic fumes it produced made it unsuitable for in-cave use.

** ** ** ** *** ** ** * * ** *** ** * * * * *

A quote from Will White that accurately describes the situation in Blowing Sink Cave and the Edwards Aquifer in general: "In effect, the position of the surface base level or of the conduit determines the position of the water table, rather than the water table determining the position of conduit development" (William B. White, Geomorphology and Hydrology of Karst Terrains [Oxford: Oxford UP, 1988]: pp. 294-295).

### Interstitial Thought

Is the karst water table, a "potentiometric surface" or a "pizeometric surface"? In other words, is it a surface of equal potential or equal pressure? It is obviously both, but what word should one use? Will White and Bill Russell like pizeometric, but our local speleolexicographer, George Veni, likes potentiometric surface. Just read the Project Cheve report, and found that Jim Smith also likes potentiometric. Must be a generational thing. I grew up during the pizeometric period, and George and Jim are from the potentiometric period.

**Will the Cenozoic End with the Kantun?**

From *Breaking the Maya Code,* by Michael D. Coe (pp. 275-76):

> "But who knows? Perhaps we are all headed for destruction. The Maya wise men all across Yucatan predict that the world will end in the year 2000 *y pico* — "and a little." How many years will that "a little" be? The Great Cycle of the Maya calendar, which began in darkness on 13 August 3114 B.C., will come to an end after almost five millennia on 23 December A.D. 2012, when many of you who read this will still be alive. On that day, the ancient Maya scribes would say, it will be 13 cycles, 0 katuns, 0 tuns, 0 unials, and 0 kins since the beginning of the Great Cycle. The day will be 4 Ahau, 3 Kankin, and it will be ruled by the Sun God, the ninth Lord of the Night. The moon will be eight days old, and it will be the third lunation in a cycle of six. And what is to happen? A katun prophecy in the Book of Chilam Balam of Tizimin reads:
>
> Then the sky is divided
> Then the land is raised,
> And then there begins
> The Book of the 13 Gods.
> Then occurs
> The great flooding of the Earth
> Then arises
> The great ltzam Cab Am
> The ending of the word
> The fold of the Katun:
> That is a flood
> Which will be the ending of the word of the Katun."

** There are many large (several kilometers in diameter) objects wandering through the solar system, and "the sky was divided" sounds like the earth will encounter such an object on the 23 of December 2012. The Quaternary may end like the Cretaceous.

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