

PART TWO: DETAILED INFORMATION

PROTECTION HISTORY AND SETTING

The Cardinal Creek karst site was first identified to MNR District staff in 1991 (or earlier) as a “geologic site of interest” by a high school teacher and a university professor from the Ottawa area (names not recorded). At that time, the site was treated as a candidate (i.e. unconfirmed), regionally- to provincially- significant (yet to be determined) earth science ANSI. It resurfaced as a provincially significant candidate earth science ANSI in a consultant’s report in 2001 (see earth science checksheet: Gorrell 2001). Although identified as a provincially significant ANSI, it was noted that the nature and extent of the karst system was largely unknown to the scientific community at that time, and required more study to determine its core values.

The creek flowing through the karst area here is sometimes called Leonard Creek, whereas the Cardinal Creek karst site is also known locally as Cumberland Cave (Quebec) and Orleans Cave (Ontario). This should not to be confused with Cumberland Caves #1 and #2 which occur further downstream along the Ottawa River.

The Cardinal Creek valley formed within the relatively flat-lying Chaplain Sea basin after its retreat from the region, and formed a drainage-way to the proto-Ottawa River. The valley is characterised by a meandering course, very steep banks, deep ravines, and a largely bedrock substrate. The karst area can be roughly divided into two main areas, separated by the major gravel road works along Watters Road. A southern portion includes that main cave system, whereas the northern portion includes the main valley and springs system of the karst. Most of the interest and descriptions on the site has focussed on the cave system.

DETAILED EARTH SCIENCE FEATURES

Introduction:

Two sketches of the main features of the karst system are attached (Figures 1, 2). These are representational in nature, and are not to scale (Marcus Buck, caver and karst expert, pers.com. 2008). The surficial and subterranean features of the karst system are described in some detail by Beaupre and Schroeder (1991), based on extensive observations and measurements during field work. Some of their results are referenced and summarized here.

The Cardinal Creek Karst represents a karst tunnel valley system by which groundwater disappears beneath the surface into an entrance cave, and re-appears at several waterfalls along Cardinal Creek as springs, until it re-emerges at the foot of the system. Groundwater is partially controlled with a storm sewer, which directs runoff into the karst cave entrance. A natural dry channel (part of a man-made berm?) may also feed this system during periods of high run-off. Water run-off in the system may be fed by an artificial pond held up by a small dam upstream of this entrance cave.

The following descriptions are based on a review of the existing literature specific to the Cardinal Creek karst system, speaking with karst and groundwater (hydrogeologists) experts, and two reconnaissance field visits in early spring and midsummer 2008 by the present author (Kor 2008).

The Cardinal Creek Karst site incorporates features which are probably Holocene in age (they were formed in the last 10 000 years), and which are covered by the "Postglacial and Holocene Events Environment" and, more significantly, the "Karst Landforms Processes and Environments" as outlined and described in the *Earth Science Framework* (Davidson 1981). There is some discussion that the karst may have been inherited during the Holocene, suggesting that the system was formed during an earlier time.

Bedrock Geology:

The bedrock exposed at the site consists of the Middle Ordovician Bobcaygeon Formation of the Ottawa Group (Johnson et al. 1992). It is made up of pure, fossiliferous, coarse-grained, massive to thick-bedded limestone, with thin shale partings (Photo 3). The Bobcaygeon Formation was laid down in a shallow, marine, inland sea environment. Important joint sets, roughly east-west in orientation, occur within the bedrock that are utilized by underground water in the development of the karst system. The bedrock is generally buried beneath up to 20 metres of insoluble, glaciomarine silt and clay.

Surficial Geology:

Till and shallow to deepwater marine sediments are overlain by deltaic sand and gravel formed along the western shores of the Champlain Sea. Following glacial retreat, the valley of Cardinal Creek entrenched itself into the clay plain of the Champlain Sea. The eroding banks of the valley expose these sediments and their history.

Glacial striae on the area's bedrock surface indicate a roughly south-southeast ice movement direction. Striae and features related to water erosion are present on some of the exposed bedrock surfaces in the creek valley (Figure 3). They are best exposed on the bedrock surface at the base of the clay bluff just north of the Watters Road bridge. Here it is overlain by glacial till.

The oldest sedimentary deposit in the valley is a thin- to discontinuous, stony, silty clay diamict (till) with erratic boulders of Paleozoic and Precambrian origins. It can be seen lying directly on top of the bedrock surface in the valley. It was likely modified once the Champlain Sea inundated the Ottawa River valley. In some places it is absent; in others, it can be seen to overly directly on bedrock. Its presence suggests that it was deposited at the base of the glacial ice at a time when the karst was still forming, which in turn suggests that the karst may have been inherited; i.e., that it may be older than postglacial (i.e., preglacial or interglacial). After the last glaciation, once Cardinal Creek cut through the surficial sediments down to bedrock, it opened up the cave entrances to the karst system.

The banks of the creek are dominated by treed and exposed sections of glaciomarine, silty clay representing deposition in deep water conditions in the Champlain Sea, which inundated the Ottawa River valley once the glacial ice cover was removed. The clays are grey, thinly laminated, non-fossiliferous, and non-calcareous. The clays are susceptible to slumping, most of which likely occurs during heavy runoff conditions (like spring melting and severe storm events).

The upper surface of the creek valley exposes a discontinuous layer of sand and gravel material which are thought to have been deposited as a delta along the western shores of

the sea. All the described sediments are likely exposed in the unvegetated walls of the Cardinal Creek valley.

Karst Features:

The main karst features which occur in the system at Cardinal Creek include karren (surface etching and pooling by waters), dry stream beds, sinks (all of which are impenetrable due to clayey plugs of sediment), springs (mainly impenetrable artesian types, some of which have been buried or otherwise impacted by slumping from upslope materials), and sinkholes (also known as dolines). These features occur mainly in the clay plain south of Watters Road.

In addition, Buck (pers.com. 2008) noted the presence of a “breakdown collapse” structure which is not known to be present in other karst systems of the province. These occur in the main cave section of the system south of Watters Road. He indicates that this feature consists of a large suffosion doline above the central portion of the cave system on the surface. Inside the cave, the breakdown is largely sealed by clay that has settled in from above creating an effective hydraulic constriction. There are a number of examples of large collapse dolines over collapsed cave roofs (e.g., Bonnechere Cave, Ottawa River Caves, Dewdney’s Caves, Puzzle Lake Cave, possibly Warsaw Caves, etc), but this may be the only such site where the surface expression is entirely within overburden, with no bedrock exposed. The closest example of such a feature is Tyendinaga Cave, which is a straight passage terminating in breakdown at either end.

The caves are transitory in shape and scale. The upstream caves consist of a group of short, straight small galleries with walls of collapsed limestone blocks and debris. The central portion of the caves consists of two, sub-parallel, horizontal galleries. Finally, the southern portion of the cave consists of a vadose maze, in which intersecting cavities form a grid pattern of limestone cavities. These caves probably focus groundwater into springs which exit, among other places, along the banks of Cardinal Creek north of Watters Road.

None of the other core features in themselves are notably representative, as they commonly occur frequently in other karst systems, including in protected areas of the province (e.g., the Eramosa Karst site and many Bruce Peninsula sites). The karst features of the site are well-described by Beaupre and Schroeder 1991). A sketch diagram is presented showing the character of the main cave system south of Watters Road. This map (Figure 2) is not to scale.

DETAILED SIGNIFICANCE

The evaluation of significance of the Cardinal Caves Karst site is partially based on discussions with experts in this very specialized field of study (i.e., karst). In this case, the input by consultants Marcus Buck and Daryl Cowell is here credited. (any errors in the presentation of this checksheet are mine).

The evaluation of significance is also based on a comparison of similar features elsewhere. Karst terranes have recently been studied in more detail (notably by the Ontario Geological Survey) because of (among other criteria) their impacts on land use planning. As such, the Cardinal Creek karst features were compared in quality, condition, complexity and special features with other known sites in Ontario.

Despite the noted impacts (see Detailed Sensitivity section), there is one feature that is not known to be represented elsewhere in the province that may still be intact (not confirmed; Buck pers.com. 2008). There is a large “breakdown collapse” in the centre of the main cave with a large suffosion doline above it on the surface. Inside the cave, the breakdown is largely sealed by clay that has settled in from above, creating an effective hydraulic constriction. There are a number of examples of large collapse dolines over collapsed cave roofs (e.g., Bonnechere Cave, Ottawa River Caves, Dewdney’s Caves, Puzzle Lake Cave, etc) but there may not be any other site where the surface expression is entirely within overburden with no bedrock exposed. The closest example may be Tyendinaga Cave which is a straight passage terminating in breakdown collapse structures at either end. However, it is a fossil cave that may be pre-glacial in origin.

Furthermore, there are some complexities in the cave geometry upstream from the breakdown collapse structures that strongly suggest maze-development in response to the breakdown constriction. These phenomena are well-described in the literature. A constriction, in this case created by collapse of the cave roof and plugging by infilling overburden, causes a localized area of steep hydraulic gradients that leads to rapid enlargement of completing flow routes. This leads to development of new passages around the constriction. There is no indication that the downstream impacts at the presumed original springs have had an impact to the hydraulics in the upstream portion of the cave. Therefore, the form and function of this feature are still intact. This is considered to be a valid argument for assessing this site as provincially significant (Buck pers.com. 2008).

The small valley created by Cardinal Creek in post-Champlain Sea time has value as an indicator of the hydraulic function of the downstream end of the karst system. This area may be significantly impacted, both physically and functionally, by the construction along Watters Road. Despite its high scenic qualities, the geological valleys of the valley system north of Watters Road is considered to be locally significant. Studies of groundwater patterns in the area (if undertaken in the future) may enhance the significance of the northern portion of the site.

The bedrock exposures in the area of the site, being primarily limestone of the Bobcaygeon Formation, are not well-exposed along the creek, and are better represented in other protected sites in the region. Similarly, the surficial deposits encompassed by the site, including the till and glaciomarine clay and silt, are well represented in other protected areas in the region. However, these features do contribute to the “story” of the karst development in the Cardinal Creek valley.

Besides the presence of provincially significant karst features and systems, the Cardinal Creek Karst site is located in an urban area, and as such has excellent educational and recreational potential. It is a scenic, interesting landscape that is well worth preserving for public enjoyment and education. It is also a relatively large and complex cave (being roughly the 12th longest cave in the province), with an estimated length of some 340 metres. There is still much to learn from the hydrology, geology and geomorphology of this cave, so the potential for scientific study is also emphasized here. The valley and springs portion of the site (north of Watters Road) is of high scenic value.

The site is of great interest to the caving community as it is considered to be an excellent caving site. The main cave is reputed to be about the 12th longest in Ontario. Although sketch maps exist for the site, there has been recent interest by the caving community to

properly map the system. It may be one of the most-visited caves by cave specialists in the Ottawa area (Buck, pers.com. 2008).

DETAILED SENSITIVITY

The site is not pristine. It has been impacted by human activities in the form of a culvert, an artificial berm, an abandoned water well, collapsed roof materials, and the burial of a spring have all been reported or noted in the past, in and around the cave system (undocumented). The construction of Watters Road and its corridor cut a wide swatch through the middle portion of the site, and are responsible for most of the observed impacts. In addition, steep banks of clay and silt have been eroded by foot traffic throughout the site. Natural slumping of the unstable clays and silts are also ongoing, and may be enhanced by foot traffic.

Buck (pers.com. 2008) indicates that there have been at least three key impacts to the karst. First, the sinkpoint (and upstream entrance) has been landscaped so its geomorphology has been impacted. Also, Watters Road has likely buried one of the original springs, which has implications regarding the hydraulics and hydrology of the cave system. Finally, the nature of recharge to the cave may have been altered as a result of the landscaping at the sinkpoint, although it is not clear exactly how this may have occurred. Beaupre and Schroeder (1991) suggest that these disturbances generally have not impacted the form and function of the karst along Cardinal Creek.

DETAILED RECOMMENDATIONS

It is recommended that the Cardinal Creek Karst site be confirmed as a **Provincially Significant** earth science ANSI. The recommended boundary of the ANSI site consists of that portion of the main (core) cave and karst system south of Watters Road. It includes lands entirely owned by the City of Ottawa, and excludes most of the impacts made by Watters Road and the existing housing lot near the caves. It also does not encompass the Cardinal Creek valley north of Watters Road at this time. The recommended boundary is presented in Figure 4.

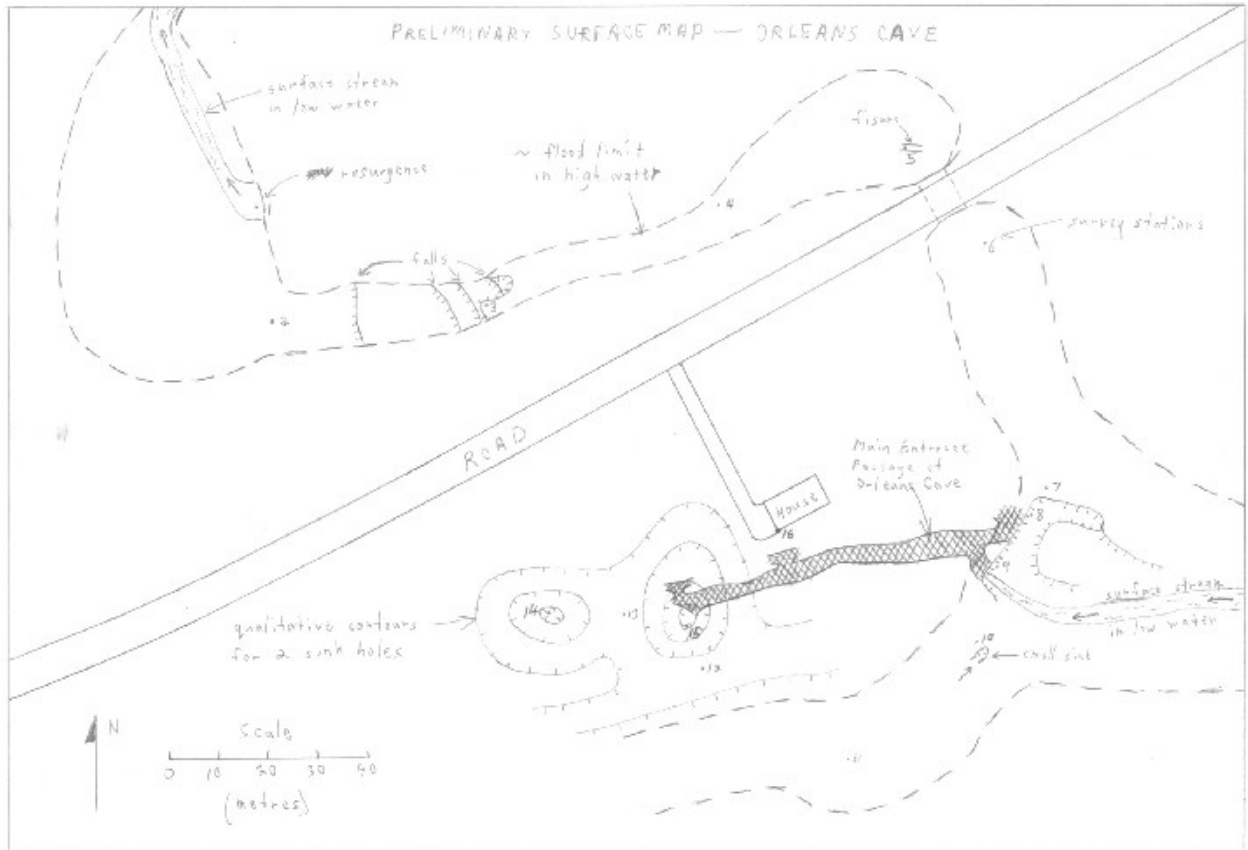
REFERENCES

Beaupre, M. and Schroeder, J. (Speltech Inc.) 1991. The Cumberland Cave and Karst System. A Geological and Geomorphological Study; consultant's report for Tamarack Developments Corporation; 46p. + photos and diagrams.

Buck, M.J. and Cowell, D.W. 2008. Evaluation and Revision of the Karst Process Theme for Ontario's Earth Science Framework; consultant's report for Ontario Parks, Planning and Research, Peterborough, Ontario; Open File Earth Science Report 0802, 16p. + tables and diagrams.

Johnson, M.D., Armstrong, D.K., Sanford, B.V., Telford, P.G. and Rutka, M.A. 1992. Paleozoic and Mesozoic Geology of Ontario; Chapter 20 in: Geology of Ontario, Special Volume 4, Part 2; pp.907-1008.

Williams, D.A., Rae, A.M. and Wolf, R.R. 1984. Paleozoic geology of the Ottawa area, southern Ontario; Ontario Geological Survey, Map 2716, scale 1:50 000.



Mapped by Marcus and Harvey Duck (1980)

Figure 1. General setting of Cardinal Creek cave system and karst features. The long polygon with dark hashed lines represents the main ("core") karst cave system.

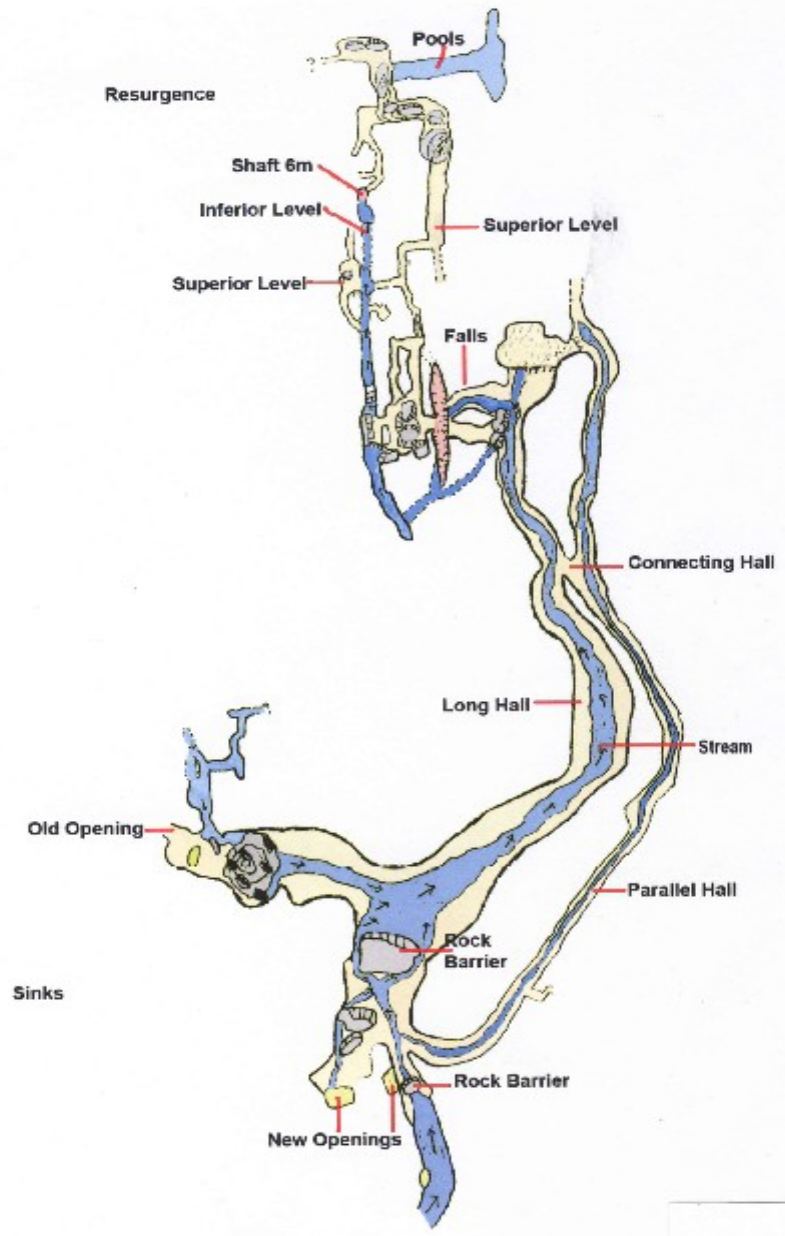


Figure 2. Sketch map of main cave system. North to the right.



Figure 3. Water-carved surface of the Paleozoic limestone bedrock, above the first falls near the Watters Road bridge, within the City of Ottawa right-of-way lands.



Figure 4. Cardinal Creek Karst ANSI boundary consists of the property line enclosing the City of Ottawa lands designated as PIN 145260100 (central portion of map).