Palaeontological impact assessment report for the proposed building of the Bhatha Road (upgrade to type 7A) between the D799 and P263, Kleinfontein village, Ladysmith, KwaZulu-Natal

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Geology

The geology in the vicinity of the site is dominated by late Permian argillaceous deposits of the Ecca and Beaufort Groups (Figure 1). The Ecca shales are representative of the Volksrust Formation and are blue-grey to dark-grey in colour. This rock type was observed within all three of the drainage lines (Fig. 2 & 3, 1-3), although some of this material may represent transitional deposits representing early aspects of the conformably overlying Beaufort. The Beaufort is represented by the Adelaide Subgroup and comprises of dark-grey shales which are carbonaceous in places, as well as grey mudstones, siltstone and sandstone. There are also several outcrops of dolerite in the region, representing Jurassic lava intrusions which gave rise to the dolerite dykes in the landscape. Considerably younger alluvial deposits occur alongside many of the drainage lines within the valleys and are Quaternary in age (Figure 1).

At the point marked "Watercourse" on the original map (number 1 below) pockets of grey-green mudstones of the Beaufort were observed which were fossiliferous, the results of which are discussed below. Large dolerite boulders were also observed at this point, sitting below the Quaternary alluvial deposits. Slightly upstream of point 2 (drainage line 1) a thin band of sandstone was observed within the stratigraphy indicating that this section also represents the Beaufort, although no fossils were observed in this search area. Point 3 (drainage line 2) where the culvert will be built contained eroded, reworked bedrock and the crossing will have minimal impact to the underlying geology.

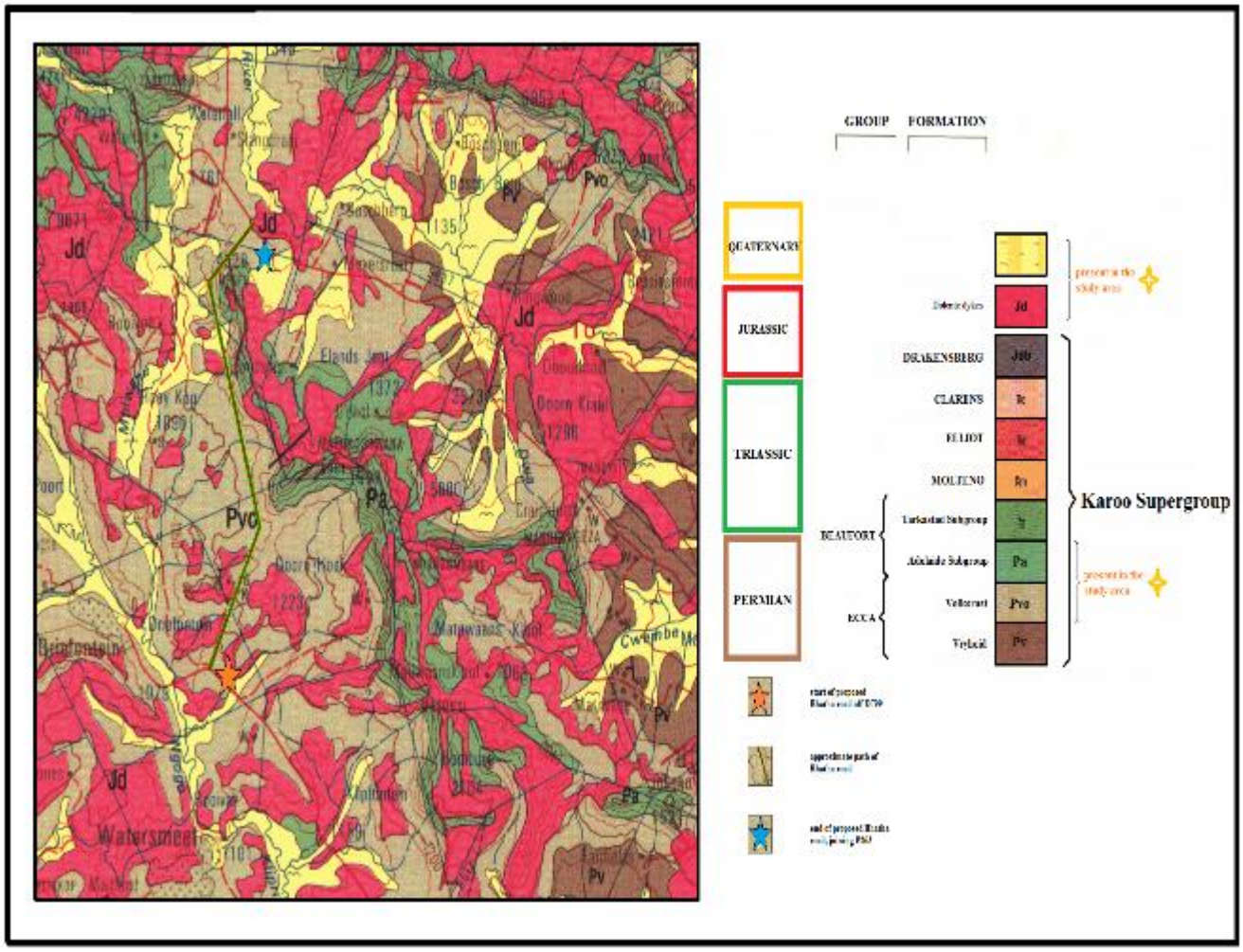

Figure 1: Geological map showing the lithology of the region where the proposed development will take place. Stratigraphic layers of palaeontological interest include Late Permian Ecca deposits comprising of blue-grey to dark-grey shale of the Volksrust Formation (**Pvo, light brown**) & predominantly argillaceous sediments (grey mudstone, dark-grey shale & siltstone) representing the Adelaide Subgroup of the Beaufort (**Pa, green**). Other common geological occurrences observed in the landscape include Jurassic intrusions giving rise to dolerite dykes (**Jd, pink**), as well as much younger Quaternary alluvial deposits (**yellow**). (Modified from 1:250 000 Geological Series 2828 Harrismith, Council for Geoscience 1998)

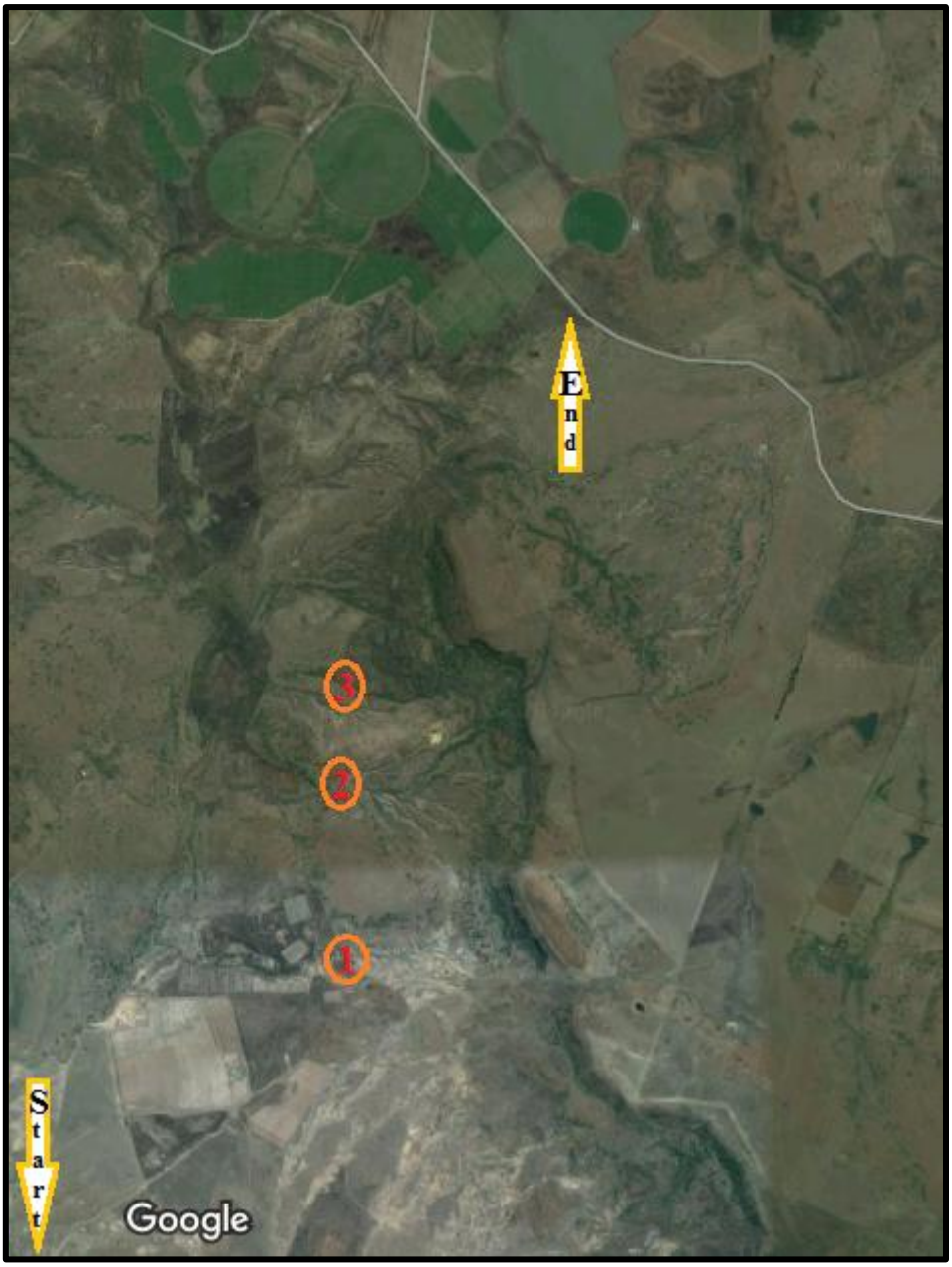

Figure 2: Satellite image of valley where Bhatha road development will take place. The **S**tart arrow (S28º 17' 59.1", E29º 42' 51.1") indicates where it branches off the D799 and the End arrow (S28º 14' 58", E29º 44' 52") indicates where it joins the P263. Number 1 (S28º 17' 01.5", E29º 43' 52.4") indicates the watercourse where the fossils were observed, number 2 (S28º 16' 27.4", E29º 43' 35.6") is referred to as "Drainage Line 1" on the map of the original proposal and number 3 (S28º 16' 09.7", E29º 43' 33.6") is referred to as "Drainage Line 2". North is at the top of the page. Image courtesy of Google Earth, DigitalGlobe (2016).

Figure 3: Satellite image of the valley where Bhatha road development will take place. The Start arrow (S28º 17' 59.1", E29º 42' 51.1") indicates where the road branches off the D799, the End arrow (S28º 14' 58", E29º 44' 52") indicates where it joins the P263. At points 1, 2 & 3 the Ecca bedrock (Volksrust Formation) was visible, but at the watercourse (1) a mudstone containing fossils was also noted, possibly representing some pockets of Beaufort lower down in the stratigraphy. The elevation of the landscape is exaggerated to emphasize the topography, North is at the top of the page. Image courtesy of Google Earth, DigitalGlobe (2016).

Figure 4: Photo indicating the start of the Bhatha road, off the D799, heading in an easterly direction (S 28º 17' 59.1", E 29º 42' 51.1")

Figure 5: Adjacent to mielie field mud road splits in two. The original map indicates that the road will follow the route to the left on the way to the "Watercourse" (point 1)

Palaeontology

The Karoo Basin is one of the richest fossil sites in the world, representing a phenomenal geological succession which preserves the evolution and development of several tetrapod lineages, including Synapsids (the ancestors of mammals), diapsids (the ancestors of dinosaurs and reptiles) and Anapsids (the ancestors of tortoises and turtles). For this precise reason, SAHRA has given this area a palaeontological sensitivity rating of high to very high (see www.sahra.org.za/sahris/map/palaeo) for the (predominantly) argillaceous sediments of the Beaufort Group represent thriving palaeo-ecosystems that occurred along the banks of the rivers of that time.

Fossils were only observed at one location, at the site known at "Watercourse" on the original map or as point 1 in Figure 2 and 3 above. The fossils all seem to be plant in origin and are very fragmentary in nature. Fossil stems were recorded, as well as a possible fruiting body (Figure 6 and 7). Some recorded observations were likely geological and chemical in nature, such as several possible nodules, as well as flat disc-like observations which were likely chemical in nature (Figure 8).

Palaeontological impact of Bhatha Road

Although the geological map indicates that the majority of the pathway of the road will sit on Ecca bedrock, there is place where the road will cross fossiliferous Beaufort. An observed buffer varying in height and comprising of top soil, alluvium and colluvial debris (e.g. dolerite boulders) may serve to protect (to a degree) potential fossils located in underlying bedrock from roadway construction above. An exception would be at point 1 ("Watercourse") where erosional activity of the stream has removed all overlying clays and soils and the bridge will lie directly on top of fossiliferous mudstones. The quality and quanitities of these fossils does not warrant any action in terms of a temporary halt of

building activities to rescue specimens or a recommendation for a follow-up site inspection during construction. The fossils are very fragmentary in nature and their incompleteness restricts scientific identification, making the knowledge they can contribute to science negligible. This mudstone outcrop extends over several metres in the area of the bridge (causeway), but even careful inspection of the length of this unit not directly affected by construction failed to yield any vertebrate or invertebrate fossils, trace fossils or any visible fossil communities or relationships. Therefore the construction of this road will not pose any significant threat to observed and recorded palaeontological resources in the landscape.

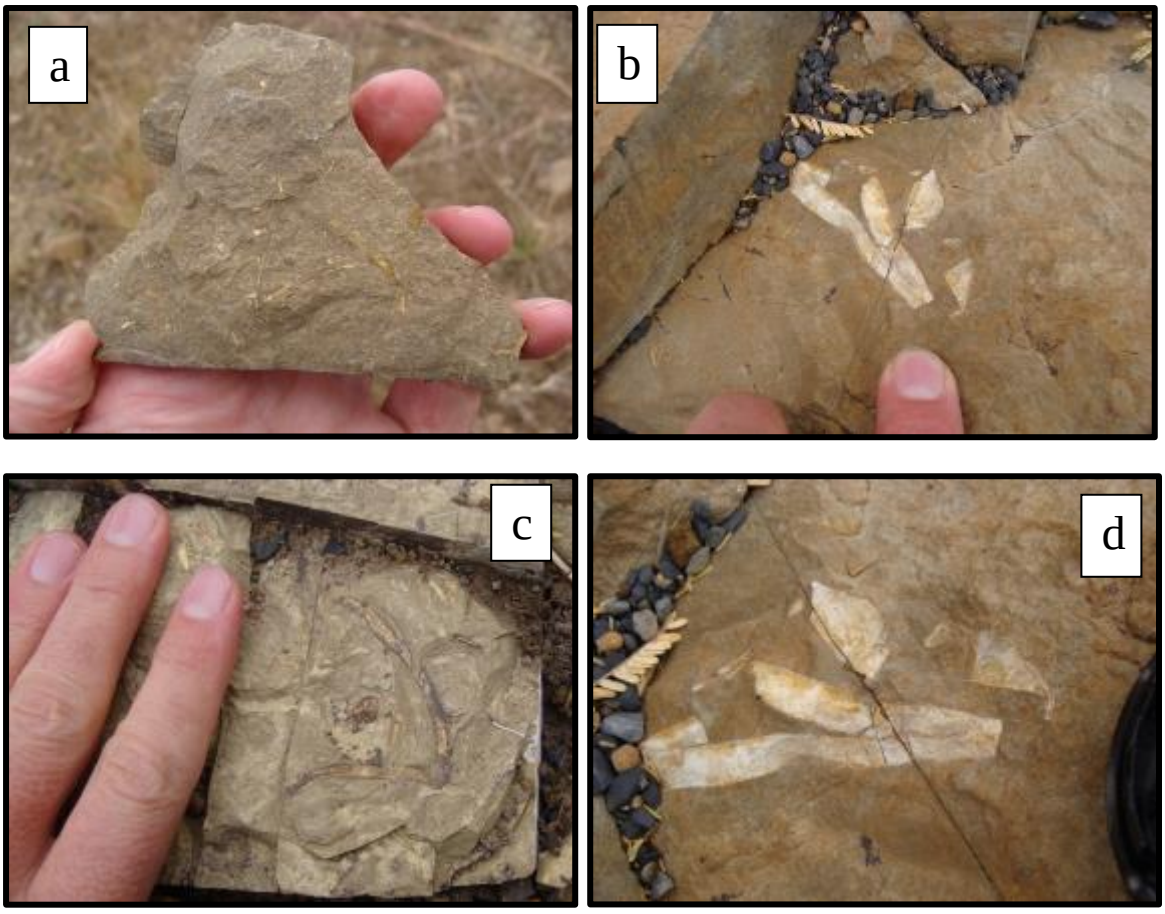

Figure 6a,b,c,d: Plant fossils observed at "Watercourse" (point 1), located in a Beaufort grey-green mudstone. 6a possibly represents thin stems or branches, and could have been herbaceous in structure. 6b-d represents plant stems which appear to have been woodier in nature. 6d is the same fossil as 6b, taken from above and with the tip of a shoe for further scale

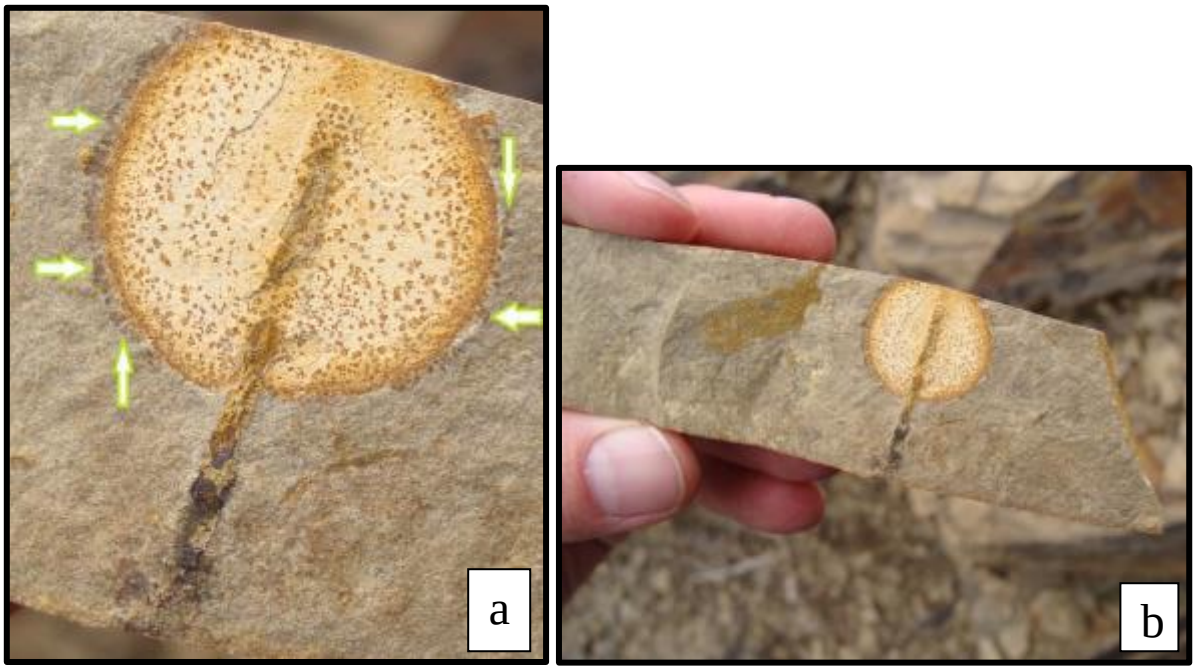

Figure 7a,b,c: Figure 7a is the zoomed in version of Figure 7b. Although this may be a chemical structure, the image may also be that of a reproductive or fruiting body of a plant, with the green arrows pointing to possible outgrowths on the edge of the structure. 7c bears some resemblance to 7a and b but is most probably a biochemical signature, e.g. some form of decay

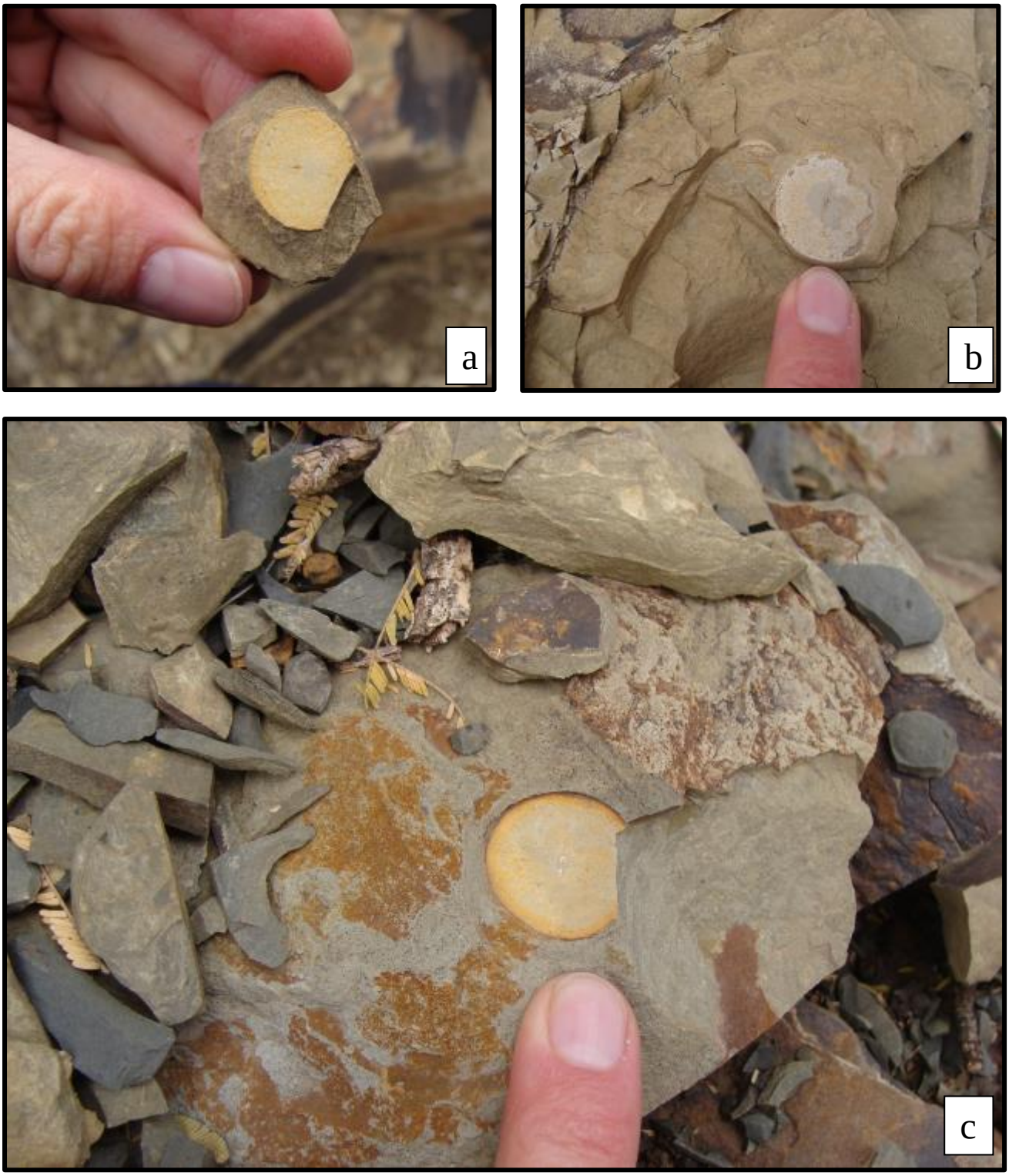

Figure 8a,b,c: Structures recorded at point 1 ("Watercourse") that are likely geological and chemical in nature include several possible nodules, as well as flat disc-like formations which are probably chemical in origin. All three examples observed at the site had nuclei at the centre, and the centre of 8c appears to contain a bone fragment

Figure 9: Point 1, ("Watercourse") depicting the existing road running over bedrock in the form of fossiliferous Beaufort mudstone. This is the approximate place where the causeway will be positioned. Looking up the valley in a northerly direction

Figure 10: Beaufort mudstone and dark grey Ecca shale. The few recorded fossil fragments were observed within the mudstones of this site. Younger deposits in the form of large dolerite boulders, alluvial clays and topsoil are seen lying above the shale (top left, below bright green tree).

Figure 11: Looking east at point 1 (“Watercourse”). On the right is dark grey shale, on the left grey-green mudstone. The bridge or causeway will be built in this position, resting on bedrock.

Figure 12: Point 2 (“Drainage 1”), looking east towards the mountain. This is the position of the probable culvert as the crossing is narrower and free of rocks and bedrock.

Figure 13: Within the stream channel of "Drainage 1", looking east. There were patches of bedrock within the stream bed, but the majority of the shale was transported and redeposited. Higher up in the stream bed carbonaceous shales, as well as a thin band of sandstone, was visible within the stratigraphy, indicating typical elements of the Beaufort deposits. In spite of intensive searching in the general area, no fossils were recorded in the area of the proposed culvert of "Drainage 1".

Figure 14: Looking west along drainage 1, point 2. There were two roads crossing the stream in close proximity, the one further downstream was narrower whereas this one had more boulders and bedrock which prevented effective vehicular access. No archaeological or palaeontological material was recorded during the survey of drainage 1

Figure 15: Looking north up the valley and standing next to the stream of drainage 1. This is the crossing further upstream and I was uncertain which of these two points would be chosen for the culvert so both were surveyed but neither contained any archaeological or palaeontological material

Figure 16: The rest of the survey was done on foot as the grass was getting too high and the road was beginning to fade out. Furthermore, just a hundred metres from Drainage 1 on route to Drainage 2, the road had been blocked off by a newly erected fence. A gentleman was working on the fence and had created a gate further down in a corner of a camp he had fenced in.

Figure 17: The position of “Drainage 2” (point 3), indicated by the trees growing in the streambed. Behind the trees is the path that the road will follow as it curves right, goes around the mountain and joins with the P263

Figure 18: The view from where the road crosses the stream of Drainage 2 (point 3) and where the second culvert will be positioned. The road disappeared soon afterwards and the rest of the survey was done by following the GPS to the junction with the P263

Figure 19: Close to Drainage 2 (point 3) but further upstream, approximately 2.2 km from the junction with P263. Heading towards the corner where the road will round the mountain and meet the existing road

Conclusion

Although this palaeontological survey did locate some fossils, they were fragmentary in nature and of poor quality. Karoo rocks were exposed at several points within the survey area but only one drainage line (point 1) provided fossil evidence within these rocks.

Development should exist in balance with conservation, but this site doesn't have the criteria to warrant conservation status. Inferior fossil examples will have little bearing on the building of the causeway that will cover this minor site and may cause some damage to the fossils. The benefits to the community living in this region outweigh the loss of a few fragmentary

fossil plant remains and the road will have ultimately have a positive impact on the lives of many families.