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Geological Heritage Subcommittee
NSW Division

Response to
2015 EIS Hornsby Quarry Road Construction Spoil Management project,
prepared by AECOM Australia for RMS

The Geological Heritage Subcommittee of the NSW Division, Geological Society of Australia, is pleased to make a submission to the NSW Department of Planning & Environment concerning one important aspect of the above report which does not appear to been investigated to the same level of thoroughness as is evident throughout the remainder of the EIS. We are concerned that the Geological Society of Australia, despite having commissioned the initial report into the Geological Heritage of New South Wales (Percival 1979) in which the geoheritage aspects of the Hornsby Diatreme at the Hornsby Quarry site were first documented, was not regarded as a stakeholder during the preparation of the EIS and therefore was not previously consulted. As a result, the significance of the geological phenomenon uniquely exposed in the quarry wall at the eastern end of the site has been overlooked and disregarded, leading to formulation of a plan for infilling the quarry which will largely obliterate this feature of State, National and arguably Global significance.

We are not opposed to the overall concept of the plan to infill the abandoned quarry, recognizing that without some sort of remediation involving removal of the water and filling of the void, the site remains dangerous and off-limits. Where we believe the concept needs to be substantially modified involves retaining access to the eastern face of the quarry where the cross section through the diatreme is exposed, down to the 40m level, and removal of any excess spillage of spoil that would cover this face. Compared to the current plan as outlined in the EIS, this would involve filling the majority of the void as presently proposed, but with a batter on the eastern side sloping down to the 40m level. This sloping face could readily be integrated with the proposed recreational use of the infilled quarry void by providing a site for a mountain bike track. If the spoil is to be conveyed into the quarry void from the eastern side, all waste rock must be removed from (or preferably, never allowed to accumulate on) the distinctive dish bedding on the eastern wall. The benches cut into the eastern wall must be retained clear of loose rock and spoil for ease of future access for researchers, students and the general public.

We consider that the EIS has failed to fully appreciate the geological significance of the Hornsby Diatreme Geological Site, located in the Hornsby Quarry, because of the entirely unsatisfactory approach of the authors of **Appendix I** (Technical working paper: non-Aboriginal heritage assessment) to assessing the geological features of the site. Our opinion is based on the following misinterpretations and factual errors in this Appendix.

1. Location and scale of the feature

The authors appear to believe that the diatreme consists only of a rectangular section of the eastern wall of the quarry, as shown in their Figure 2. This interpretation is wrong, and displays a basic lack of understanding of geology. The quarry is in fact located within the diatreme (or in parts of two diatremes), and so the eastern face of the quarry represents a cross-section through a much larger structure. The Hornsby Diatreme in fact occupies a large area of land in and near Old Man Valley as shown in orange and marked JV17 in Figure 1 below, extracted from the *Sydney 1:100,000 Geological Sheet* (Herbert & West, 1983).

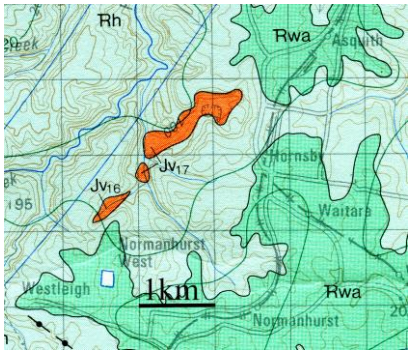

Figure 1: Geological map of the Hornsby region (from Herbert & West 1983: Sydney 1:100,000 Geological Sheet)

Figure 2 (page 10 of Appendix I) shows the part of the significant exposure of the diatreme in relationship to the proposed level of fill in the quarry, not in relationship to the present partly water-filled state of the quarry. There is no justification or source given for the boundaries indicated in Figure 2 of Appendix I.

2. Significance of the exposure of the diatreme in the quarry, in particular the eastern wall

The major failing of Appendix I is to be found in Table 6 on page 28 in the findings regarding *Importance to the course of NSW's cultural or natural history, Associate significance, Research Potential, Rarity, Representativeness and the statement of significance*.

2.1 Importance to the course of NSW's cultural or natural history (Criterion a)

Incredibly, the compilers of Table 6 in Appendix I only consider the historical significance of the site and make no reference to its natural history, which is the main reason for the site's original recognition of significance by the Geological Society of Australia (Percival; 1979, 1985) and its later listing in the Register of the National Estate. Following are the facts of its geological significance:

A. Hornsby Quarry is the largest diatreme known in the Sydney Basin and provides the last remaining artificial section through a diatreme in this State. Diatremes are the remains of maar volcanoes, "produced by explosive eruptions that cut deeply into the country rock. A maar is the crater cut into the ground and surrounded by an ejecta ring, while the diatreme structure continues downward and encloses diatreme and root zone deposits" (White & Ross, 2011 p.1). Maars typically form as a result of the explosive interaction between molten volcanic material and groundwater. They are quite rare geological features and the Hornsby Diatreme is the best example in NSW, if not Australia.
B. Studies of pollen, coal and wood fragments included in the diatreme at Hornsby Quarry (Joplin, 1968; Taylor, 1976; Morgan, 1976, 1977, 1978; Helby & Morgan, 1979) shows that it, and most likely the other 95 known and sixty inferred diatremes in the Sydney Basin (used here in its geological sense) are of Jurassic age (200-146 million years ago), suggesting that at that time the Sydney Basin was a region with high groundwater levels peppered with exploding volcanoes with crater lakes. The discovery of Jurassic pollen at

Hornsby Quarry by Helby & Morgan (1979) marks the first and only finding of fossil material of this age in the Sydney Basin. Unfortunately, the distinction between the Triassic sedimentary rocks of the Sydney Basin and the Jurassic age of the diatremes that intruded them was overlooked or misunderstood in the EIS, as shown in Figure 6.5 in Volume 1 where both rock types are mistakenly attributed to the Triassic Period (and the widespread Hawkesbury Sandstone of the Sydney Basin, clearly indicated by the symbol Rh on the geological map, is not identified as such).

C. The Hornsby Diatreme provides us with a rare window into the petrology of the rocks forming the Earth's crust through which the molten material passed through on its way to the surface. This is due to the inclusion of xenoliths (from the Greek for "strange rock": Whitten & Brooks, 1972) in the diatreme material which provide evidence about the physical and chemical conditions of the lower crust below the Sydney area (Wilshire & Binns 1961; Joplin 1968; Griffin & O'Reilly 1986). An example is shown in Figure 2.

Figure 2: Small dark xenolith, in front of boot, embedded in larger rock fragment on access track.

2.2 **Associate significance (Criterion b)**

Far from being associated only with the working life of the quarry as Apendix I suggests, the Hornsby diatreme was identified in the early twentieth century (Pittman, 1903) and has been a site for geological research since then. The diatreme is associated with the work of a number of historically significant NSW geologists including: E.F. Pittman (1903), M. Morrison (1904), W.N. Benson (1911), E.C. Andrews (1924) and G.D. Osborne (1920). Through its inclusion in field guides by Nashar (1967) and Branagan & Packham (2000), and its illustration in a coffee-table book on volcanoes by Sutherland (1995), the diatreme has been recognized as being important for geological research and education of the general public.

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▲ *Basin-like layers of tuffs and breccias filling the Hornsby diatreme pipe, northeast Sydney, New South Wales, March 1979.*

Figure 3: Published illustration of eastern face of quarry (March 1979) showing dish bedding, from Sutherland (1995, p. 119).

2.3 Research Potential (Criterion e)

Appendix I incorrectly failed to identify any research potential for the Hornsby Diatreme. But the most recent studies of the site have produced a new interpretation of the saucer bedding as being a result of original deposition, not due to slumping or subsidence as previously thought (Barron & Barron 2001), and contributed to recognition of a geological feature, muddy breccia, not previously described (PSM 2007b). The lack of more recent work has not been due to a lack of interest, but rather results from an inability to gain access to the site since Hornsby Council has managed it after closure of the working quarry.

Hornsby Quarry has also previously been used as a field site for training both geology and civil engineering students in Engineering Geology. The increasing interest in diatremes and related features as hosts not only for diamonds but also for other mineral deposits, such as gold, may increase the significance of the site as a research and educational resource for students of economic geology.

2.4 Rarity (Criterion f)

While diatremes are relatively abundant in the Sydney Basin, Hornsby Quarry is now the only site in the Sydney Basin where an artificial section through a diatreme is preserved, where associated geological structures can be examined, and where researchers can examine and collect unweathered rock.

Dish Beds

The most important features seen in the eastern face of the quarry are dish beds, as shown in the image below (from Herbert 1983). A literature review has revealed no other sites in NSW or Australia where dish beds in a diatreme are exposed, making the site unique at a national level. Furthermore, an international image and literature search also found no sites with an exposure of dish bedding comparable with that in the eastern face of Hornsby Quarry, suggesting that this exposure is likely to be a geoheritage feature of International Significance.

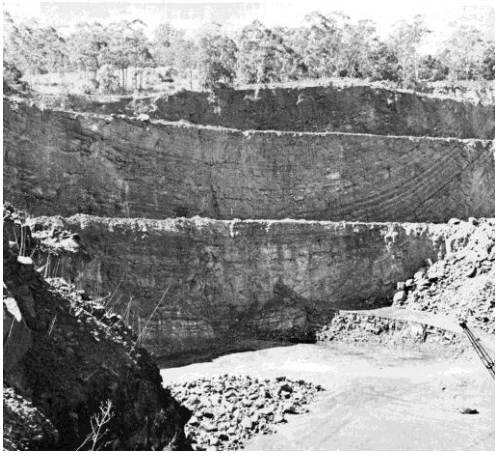


Figure 4: Eastern face of Hornsby Quarry from Herbert (1983)

Dish beds, or "centroclinal (saucer-shaped) bedding" of White & Ross (2011), are attributed to subsidence of the diatreme fill during the eruption. Although White & Ross, in their recent global review of maars and related volcanic features, depict dish beds and bedding in diatremes, none are comparable with the exposure in Hornsby Quarry.

Exposed Unweathered Diatreme Structures and Rock

As the last unfilled excavated diatreme in the Sydney Basin, Hornsby Quarry is now the only

locality in the Sydney Basin where it is possible for scientists and students to examine and access internal features towards the top of a diatreme and investigate the unweathered rock forming this feature.

2.5 Representativeness (Criterion g)

Diatreme Structure

The site is representative of the features of a diatreme in general and specifically representative of the upper parts of a diatreme as per the model of Lorenz (1973, Fig 6, p 198). Taken together with the naturally exposed Bondi Diatreme, the whole exposure in the walls of Hornsby Quarry make a pair of exposures showing both the lower and upper parts of diatremes as per the model of Lorenz (1973, Fig. 6, p 198) (see also Crawford et al., 1980; Rickwood, 1985.).

Breccia

The Hornsby Diatreme is composed of volcanic breccia containing large fragments of basalt and smaller fragments of a range of igneous rocks including granite, gabbro and peridotite. There are also fragments of shale, sandstone, conglomerate and coal, with veins of secondary calcite veins cutting through the breccia. This assemblage of rock types is representative of all those occurring in Sydney Basin diatremes and is likely to include fragments of rock brought up from within the Earth's crust, combined with material falling into the crater from above.

Lapilli

This term refers to pebble sized (4-32mm) ejecta (material thrown out by a volcanic eruptions) found in blocks of rock in various parts of the quarry. These provide evidence of explosive eruptions (Hamilton, 1970; Byrnes, 1982) and are therefore important features representative of a maar volcano. An example from Hornsby diatreme is illustrated in Figure 5.

Figure 5: Lapilli in a fallen block on the 40m bench.

3. Statement of Significance

The statement of significance on page 26 of Appendix I demonstrates in our opinion a complete ignorance on the part of the authors concerning the significance of the exposure of the diatreme on the eastern face. This should be re-written with the advice of a geoheritage specialist who is knowledgeable about the geology of the Sydney Basin.

4. Likely Impact of the Development on the Eastern Face

Since the authors of Appendix I give no indication of how they arrived at the boundaries shown in Figure 2, or how they decided (on page 35) that filling to a level of 64m would have minor impact on the heritage value of the diatreme, it is difficult to assess the validity of their claim. Looking at the eastern face of the quarry from a distance, the image below (Figure 6)

shows that filling to 64 m would only preserve the bare minimum representative sample of the most significant features of the diatreme structure.

Figure 6: East face showing approximate position of 64m level

On the other hand, restricting filling to the level of the 40m bench would result in preservation of the area of high significance as shown in the green box in Figure 7 (below), and would retain access by scientists and students to examine the unusual and rare unweathered rocks forming the diatreme.

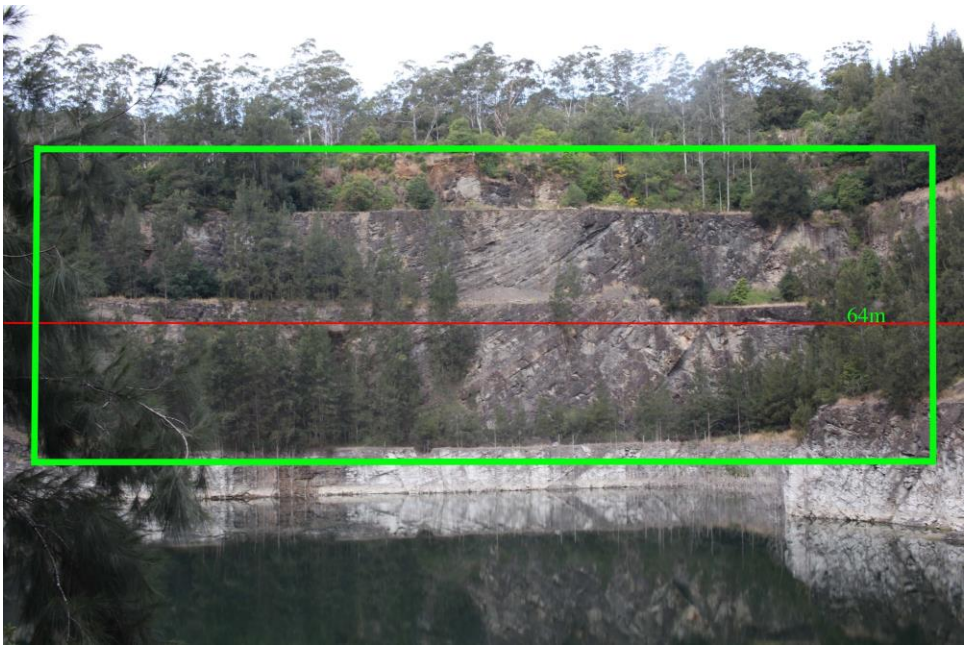


Figure 7: Looking towards the eastern face showing the 64m level (red), and the most significant area of the diatreme cross section (outlined in green)

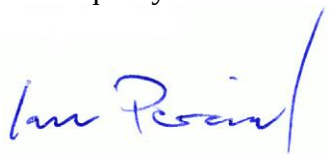
In their assessment of the impact on the geological site, the authors of Appendix I appear to have ignored Figure 4.1 on page 45 (71 of the pdf) of Volume 1 of the EIS, which indicates spoil piled up against the eastern wall of the quarry well above the 64m level. Figure 4.4 on page 55 (81) of

Volume 1 of the EIS, shows that the spoil will be dumped in a pile onto the southern end of the eastern wall. This is not the way to conserve an internationally significant geoheritage site.

Conclusions & Recommendations

As demonstrated by the above analysis of Appendix I, the current assessment and recommendations for the conservation of the geoheritage site in the eastern wall of Hornsby Quarry are seriously flawed. The existing report is inadequate, incorrect and appears to have been undertaken by consultants with limited (or perhaps no) geological knowledge. Furthermore, information readily available in the scientific literature has been ignored or misinterpreted. Given that the primary reason behind the scientific significance of the Hornsby Quarry site is the rare geological phenomenon it exposes, this oversight is inexcusable.

The Geoheritage Subcommittee of the Geological Society of Australia Inc (NSW Division) strongly recommends that this particular aspect of the EIS should be revised with the assistance of a geoheritage specialist, with this reinvestigation to be undertaken using standards and guidance from the Australian Natural Heritage Charter, Second Edition (2002). It is essential that the geoheritage specialist be given physical access to the whole of the site in the eastern end of the quarry.



Dr Ian G. Percival
Convenor

For and on behalf of the
Geological Heritage Subcommitttee,
NSW Division, Geological Society of Australia Inc.

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