RECOMMENDED EXEMPTION FROM FURTHER PALAEONTOLOGICAL STUDIES & MITIGATION:

PROPOSED MOUNT ROPER ROMA SOLAR PLANT, FARM MOUNT ROPER 321 NEAR KURUMAN, GA-SEGONYANA LOCAL MUNICIPALITY, NORTHERN CAPE

John E. Almond PhD (Cantab.)
***Natura Viva* cc,**
PO Box 12410 Mill Street,
Cape Town 8010, RSA
naturaviva@universe.co.za

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EXECUTIVE SUMMARY

The study area for the proposed 50 MW Mount Roper Solar Plant located on Farm 321 Mount Roper near Kuruman is underlain by basinal banded ironstone of the Daniëlskuil Formation that are of Precambrian age and only known to contain microfossils. These ancient bedrocks are overlain by rubbly colluvial deposits and wind-blown sands of Pleistocene or younger age that are not palaeontologically sensitive. The overall palaeontological impact significance of the proposed solar plant development is considered to be LOW because:

- The study area is underlain by Precambrian banded iron formations of low palaeontological sensitivity (microfossils only);
- The Precambrian rocks are deeply buried beneath unfossiliferous rock rubble and wind-blown sands;
- Extensive, deep bedrock excavations are unlikely to be involved in this sort of solar park project.

It is therefore recommended that, pending the exposure of significant new fossils during development, exemption from further specialist palaeontological studies and mitigation be granted for this solar plant development.

There are no objections on palaeontological heritage grounds to authorisation of the proposed power plant. Should any substantial fossil remains (*e.g.* vertebrate bones and teeth, shells, calcretised burrows) be encountered during excavation, however, these should be reported to SAHRA for possible mitigation by a professional palaeontologist (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za).

The anticipated impact significance on local fossil heritage of developments proposed in the Kuruman - Hotazel study region is rated as low to very low. The bedrocks and superficial sediments here are all of low palaeontological sensitivity and have large outcrop areas, so impacts on unique fossil heritage are considered unlikely. The additional palaeontological impact due to the proposed solar plant is negligible compared with anticipated impacts from extensive mining projects in the region. It is concluded that the cumulative impact on the sparse local fossil assemblages posed by the Mount Roper solar plant and other developments in the Kuruman – Hotazel region is low.

1. OUTLINE OF DEVELOPMENT

Roma Energy Mount Roper (Pty) Ltd is proposing to construct a 5 MW Photovoltaic (PV) Energy Generation Facility, the Mount Roper Roma Solar Plant, on Farm 321 Mount Roper situated on the south side of the R31 and 13.2 km WNW of Kuruman, Ga-segonyana Local Municipality, Northern Cape (Fig. 2). The land is currently zoned for agriculture and is owned by Poper Moore CC.

The proposed activity entails the construction of about 18540 solar modules with a footprint of up to 20 ha. The PV panels will be mounted on pedestals drilled and set into the ground. Extensive bedrock excavations are not envisaged, but some vegetation will need to be cleared from the site. Associated infrastructure includes a perimeter access road, single track internal access roads, trenches for underground cables, 2 to 4 transformer pads, a switching station, a maintenance shed, and a temporary construction camp. Connection with the grid will be *via* the Riries 66/11kV substation 0.75 km to the northwest on the far side of the R31.

The present palaeontological heritage comment has been commissioned by EnviroAfrica cc, Somerset West as part of a comprehensive Heritage Impact Assessment of the proposed development (Contact details: Mr Bernard de Witt, EnviroAfrica cc, P. O. Box 5367, Helderberg, 7135; 29 St James St, Somerset West; mobile: +27 82 4489991; tel: +27 21 851 1616; fax: 086203308).

1.1. Legislative Framework

The present palaeontological heritage assessment report contributes to the consolidated Heritage Impact Assessment for the proposed solar plant and falls under the South African Heritage Resources Act (Act No. 25 of 1999). It will also inform the Environmental Management Programme (EMPr) for this alternative energy project.

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites; and
- palaeontological objects and material, meteorites and rare geological specimens.

According to Section 35 of the National Heritage Resources Act, dealing with archaeology, palaeontology and meteorites:

(1) The protection of archaeological and palaeontological sites and material and meteorites is the responsibility of a provincial heritage resources authority.
(2) All archaeological objects, palaeontological material and meteorites are the property of the State.
(3) Any person who discovers archaeological or palaeontological objects or material or a meteorite in the course of development or agricultural activity must immediately report the find to the responsible heritage resources authority, or to the nearest local authority offices or museum, which must immediately notify such heritage resources authority.
(4) No person may, without a permit issued by the responsible heritage resources authority—
    (a) destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site or any meteorite;
    (b) destroy, damage, excavate, remove from its original position, collect or own any archaeological or palaeontological material or object or any meteorite;
    (c) trade in, sell for private gain, export or attempt to export from the Republic any category of archaeological or palaeontological material or object, or any meteorite; or
    (d) bring onto or use at an archaeological or palaeontological site any excavation equipment or any equipment which assist in the detection or recovery of metals or

archaeological and palaeontological material or objects, or use such equipment for the recovery of meteorites.

(5) When the responsible heritage resources authority has reasonable cause to believe that any activity or development which will destroy, damage or alter any archaeological or palaeontological site is under way, and where no application for a permit has been submitted and no heritage resources management procedure in terms of section 38 has been followed, it may—

(a) serve on the owner or occupier of the site or on the person undertaking such development an order for the development to cease immediately for such period as is specified in the order;

(b) carry out an investigation for the purpose of obtaining information on whether or not an archaeological or palaeontological site exists and whether mitigation is necessary;

(c) if mitigation is deemed by the heritage resources authority to be necessary, assist the person on whom the order has been served under paragraph *(a)* to apply for a permit as required in subsection (4); and

(d) recover the costs of such investigation from the owner or occupier of the land on which it is believed an archaeological or palaeontological site is located or from the person proposing to undertake the development if no application for a permit is received within two weeks of the order being served.

Minimum standards for the palaeontological component of heritage impact assessment reports (PIAs) have been published by Heritage Western Cape, HWC (2016) and the South African Heritage Resources Agency, SAHRA (2013).

1.1. Study approach and methodology

Due to (1) the small footprint of the proposed solar plant development as well as (2) the inferred very low palaeontological sensitivity of the study area - based on previous desktop and field-based assessments of comparable bedrocks by the author and others in the broader region (*e.g.* Almond 2010, 2012, 2015a), only a desktop palaeontological impact assessment is submitted here.

In preparing a palaeontological desktop study the potentially fossiliferous rock units (groups, formations *etc.*) represented within the study area are determined from geological maps and satellite images. The known fossil heritage within each rock unit is inventoried from the published scientific literature, previous palaeontological impact studies in the same region, and the author's field experience (Consultation with professional colleagues as well as examination of institutional fossil collections may play a role here, or later following field assessment during the compilation of the final report). This data is then used to assess the palaeontological sensitivity of each rock unit to development (provisional tabulations of palaeontological sensitivity of all formations in the Northern Cape have already been compiled by Almond & Pether (2008); see also the palaeosensitivity maps provided on the SAHRIS website). The likely impacts of the proposed development on local fossil heritage are then determined on the basis of (1) the palaeontological sensitivity of the rock units concerned and (2) the nature and scale of the development itself, most significantly the extent of fresh bedrock excavation envisaged. When rock units of moderate to high palaeontological sensitivity are present within the development footprint, a Phase 1 field-based assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation or monitoring required before or during the construction phase of the development.

1.3. Limitations of this study

The accuracy and reliability of palaeontological specialist studies as components of heritage impact assessments are generally limited by the following constraints:

1. Inadequate database for fossil heritage for much of the RSA, given the large size of the country and the small number of professional palaeontologists carrying out fieldwork here. Most development study areas have never been surveyed by a palaeontologist.

2. Variable accuracy of geological maps which underpin these desktop studies. For large areas of terrain these maps are largely based on aerial photographs alone, without ground-truthing. The maps generally depict only significant ("mappable") bedrock units as well as major areas of superficial "drift" deposits (alluvium, colluvium) but for most regions give little or no idea of the level of bedrock outcrop, depth of superficial cover (soil *etc*), degree of bedrock weathering or levels of small-scale tectonic deformation, such as cleavage. All of these factors may have a major influence on the impact significance of a given development on fossil heritage and can only be reliably assessed in the field.

3. Inadequate sheet explanations for geological maps, with little or no attention paid to palaeontological issues in many cases, including poor locality information.

4. The extensive relevant palaeontological "grey literature" - in the form of unpublished university theses, impact studies and other reports (*e.g*. of commercial mining companies) - that is not readily available for desktop studies.

5. Absence of a comprehensive computerized database of fossil collections in major RSA institutions which can be consulted for impact studies. A Karoo fossil vertebrate database is now accessible for impact study work.

In the case of palaeontological desktop studies without supporting Phase 1 field assessments these limitations may variously lead to either:

a) *underestimation* of the palaeontological significance of a given study area due to ignorance of significant recorded or unrecorded fossils preserved there, or

b) *overestimation* of the palaeontological sensitivity of a study area, for example when originally rich fossil assemblages inferred from geological maps have in fact been destroyed by tectonism or weathering, or are buried beneath a thick mantle of unfossiliferous "drift" (soil, alluvium *etc*).

Since most areas of the RSA have not been studied palaeontologically, a palaeontological desktop study usually entails *inferring* the presence of buried fossil heritage within the study area from relevant fossil data collected from similar or the same rock units elsewhere, sometimes at localities far away. Where substantial exposures of bedrocks or potentially fossiliferous superficial sediments are present in the study area, the reliability of a palaeontological impact assessment may be significantly enhanced through field assessment by a professional palaeontologist.

In the case of the present study area near Kuruman in the Northern Cape, preservation of potentially fossiliferous bedrocks is favoured by the semi-arid climate and sparse vegetation. However, bedrock exposure is constrained by extensive superficial deposits, such as surface gravels and soils, and there has been little formal palaeontological fieldwork in this area. Confidence levels for this impact assessment are nevertheless rated as *medium to high.*

2. GEOLOGICAL BACKGROUND

The proposed solar plant study area (*c.* 27˚ 20' 50" S, 23˚ 11' 17" E) is situated in on flat terrain at an elevation of *c*. 1200 m amsl on the floor of a shallow, N-S trending valley within the northern portion of the Kurumanheuwels between Kuruman and Hotazel, Northern Cape. The site lies on the south side of R31 road connecting these two settlements.

The geology of the study area near Kuruman is shown on the 1: 250 000 geology map 2722 Kuruman (Council for Geoscience, Pretoria; Fig. 1 herein). A very short sheet explanation is printed on the map. The proposed Mount Roper Solar Plant is underlain at depth by ancient Precambrian sediments of the **Asbestos Hills Subgroup** (also referred to in the older literature as the Asbesheuwels Subgroup). This succession forms the upper part of the Late Archaean to Early Proterozoic **Ghaap Group** (**Transvaal Supergroup**) of the Griqualand West Basin (Ghaap Plateau Sub-basin). Useful reviews of the stratigraphy and sedimentology of these Transvaal Supergroup rocks have been given by Moore *et al.* (2001) and Eriksson *et al.* (2006). The Ghaap Group represents some 200 Ma of chemical sedimentation - notably iron and manganese ores, cherts and carbonates - within the Griqualand West Basin that was situated towards the western edge of the Kaapvaal Craton.

The Precambrian sediments present at depth beneath the Mount Roper study site belong to the iron–rich succession of the **Daniëlskuil Formation** (**Vad** in Fig. 1). This unit is up to 200 m-thick and is interpreted as a current- or wave-reworked banded iron formation (BIF), as suggested by the abundance of BIF intraclasts and sedimentary structures (Beukes 1983, Klein & Beukes 1989, Beukes & Klein 1990). The base of the Danielskuil Formation has been radiometrically dated to 2.43-2.49 Ga, *i.e.* Early Proterozoic (Eriksson *et al.* 2006). BIF rocks generally consist of rhythmically bedded, thinly composition- and colour-banded cycles of fine-grained mudrock, chert and iron minerals (siderite, magnetite, haematite) that were deposited in an offshore, intermittently anoxic basin. BIF deposition characterizes the Late Archaean – Early Proterozoic interval (2600-2400 Ma) before the onset of well-oxygenated atmosphere and seas. There are a number of asbestos mines in the region, including one 1.4 km southeast of the study site and another 2.2 km to the north.

The Precambrian basement rocks within the study area are mantled with various **superficial deposits** that are mapped as rubble (triangular symbols in Fig. 1), probably consisting of an admixture of colluvium, downwasted surface gravels and coarse alluvium of intermittently flowing streams, as well as **wind-blown sand** (**Qs**). These deposits are mainly of local origin and are generally young (Quaternary to Recent).

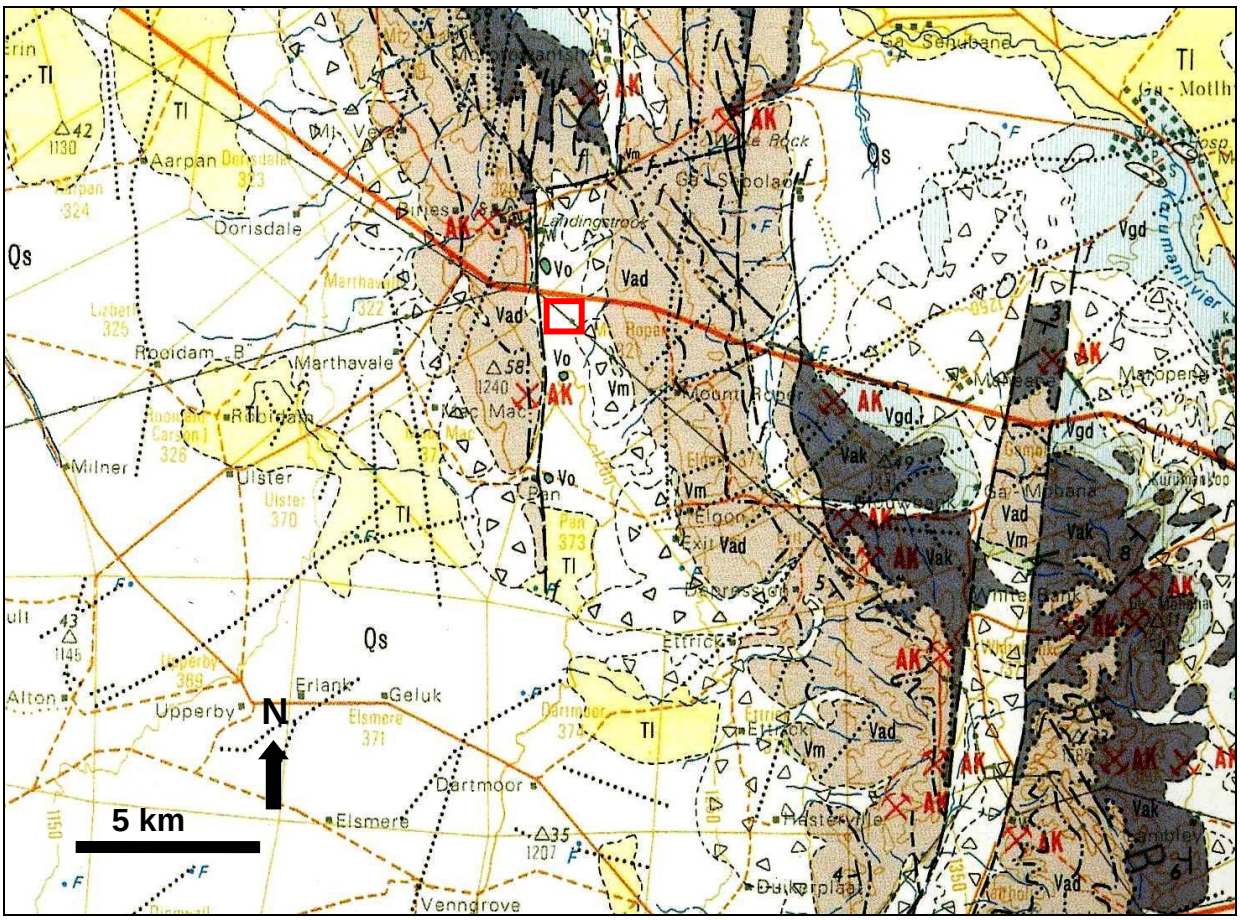

Fig. 1. Extract from 1: 250 000 geological map 2722 Kuruman (Council for Geoscience, Pretoria) showing approximate location of proposed Mount Roper Roma Solar Plant study area within a valley eroded into the northern Kurumanheuwels 27.5 km WNW of Kuruman, Northern Cape Province (small red rectangle). The study area is underlain at depth by Precambrian (Early Proterozoic) sedimentary rocks of the Daniëlskuil Formation (Asbestos Hills Subgroup, Ghaap Group, Transvaal Supergroup) (Vad). The Precambrian bedrocks of the floor of the valley are blanketed with colluvial and alluvial rock rubble (triangular symbols) as well as wind-blown sand (Qs, white). The mining symbol marked AK refers to crocidolite (asbestos) mines in the region.

3. PALAEONTOLOGICAL HERITAGE

The deep water BIF facies of the Asbestos Hills Subgroup (Kuruman and Daniëlskuil Formations) are not known to contain macroscopic fossils. They have not yielded stromatolites which are normally restricted to the shallow water photic zone since they are constructed primarily by photosynthetic microbes. However, there are several reports of microfossils from cherty sediments within the Kuruman Formation, just below the Daniëlskuil Formation, according to MacRae (1999) and Tankard *et al.* (1982 – see refs. therein by Fockema 1967, Cloud & Licari 1968, La Berge 1973. *N.B*. The stratigraphic position of these older records may require confirmation). It is likely that cherts within the Daniëlskuil Formation also contain scientifically interesting Early Proterozoic microfossil assemblages.

The superficial rock rubble and wind-blown sands mantling the Precambrian bedrocks are unlikely to be fossiliferous.

The palaeontological sensitivity of the Mount Roper Solar Plant study area is accordingly assessed as LOW.

3.1. Cumulative impacts on palaeontological heritage

In order to assess cumulative impacts on palaeontological heritage, previous palaeontological impact assessment reports (PIAs) for alternative energy and other developments in the Kuruman – Hotazel region were accessed using the SAHRIS website as well as the author's own database. It is noted that for the great majority of development proposals in the region a PIA report has not been submitted, reflecting its low palaeontological sensitivity. Most of the proposals documented are for mineral prospecting (no PIAs available) but there are also solar power projects near Hotazel, *c*. 20 km NW of the Mount Roper solar plant study area (Almond 2015b), in the Asbesheuwels *c*. 15 km west of Kuruman (Almond 2012b) and various solar and housing developments near Kathu, some 45 km to the SW (Almond 2014, 2015c, 2015d). In practice, the only strictly relevant studies are those that deal with comparable fossil heritage assemblages from the same sedimentary rock units that are represented in the Mount Roper solar plant study area itself, in particular BIF sediments of the Ghaap Group and superficial sediments broadly associated with the Kalahari Group (*i.e.* calcretes, alluvium, surface gravels rock rubble).

In general, the anticipated impact significance on local fossil heritage of developments proposed in the Kuruman - Hotazel study region is rated as low to very low. The bedrocks and superficial sediments here are all of low palaeontological sensitivity and have large outcrop areas, so impacts on unique fossil heritage are considered unlikely. The additional palaeontological impact due to the proposed solar plant is negligible compared with anticipated impacts from extensive mining projects in the region. It is concluded that the cumulative impact on the sparse local fossil assemblages posed by the Mount Roper solar plant and other developments in the Kuruman – Hotazel region is low.

4. CONCLUSIONS & RECOMMENDATIONS

The overall fossil heritage impact significance of the proposed Mount Roper Roma Solar Plant development is considered to be LOW because:

- The study area is underlain by Precambrian banded iron formations of low palaeontological sensitivity (microfossils only);
- The Precambrian rocks are deeply buried beneath unfossiliferous rock rubble and wind-blown sands;
- Extensive, deep bedrock excavations are unlikely to be involved in this sort of solar park project.

It is therefore recommended that, pending the exposure of significant new fossils during development, exemption from further specialist palaeontological studies and mitigation be granted for this solar plant development.

There are no objections on palaeontological heritage grounds to authorisation of the proposed power plant. Should any substantial fossil remains (*e.g.* vertebrate bones and teeth, shells, calcretised burrows) be encountered during excavation, however, these should be reported to SAHRA for possible mitigation by a professional palaeontologist (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za).

The Environmental Control Officer (ECO) responsible for the solar plant development should be made aware of the potential occurrence of scientifically-important fossil remains such as stromatolites within the development footprint. During the construction phase all major clearance operations (*e.g.* for new access roads) and deeper (> 1 m) excavations (*e.g.* for solar panel footings) should be monitored for fossil remains on an on-going basis by the ECO. Should substantial fossil remains - such as stromatolites, vertebrate bones and teeth - be encountered at

surface or exposed during construction, the ECO should safeguard these, preferably *in situ*. They should then alert the relevant provincial heritage management authority as soon as possible - *i.e.* SAHRA for the Northern Cape (Contact details: Dr Ragna Redelstorff, SAHRA, P.O. Box 4637, Cape Town 8000. Tel: 021 202 8651. Email: rredelstorff@sahra.org.za). This is to ensure that appropriate action - *i.e.* recording, sampling or collection of fossils, recording of relevant geological data - can be taken by a professional palaeontologist at the developer's expense.

These mitigation recommendations should be incorporated into the Environmental Management Programme (EMPr) for the solar plant project.

Please note that:

- All South African fossil heritage is protected by law (South African Heritage Resources Act, 1999) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency (in this case Heritage Western Cape);

- The palaeontologist concerned with potential mitigation work will need a valid fossil collection permit from SAHRA (N. Cape) and any material collected would have to be curated in an approved depository (*e.g.* museum or university collection);

- All palaeontological specialist work should conform to international best practice for palaeontological fieldwork and the study (*e.g.* data recording fossil collection and curation, final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies developed by HWC (2016) and SAHRA (2013).

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Fig. 2. Google earth© satellite image showing the study area for the Roma Energy Mount Roper Solar Plant situated on Farm 321 Mount Roper 13.2 km WNW of Kuruman, Northern Cape (yellow polygon).

6. QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Dr John Almond has an Honours Degree in Natural Sciences (Zoology) as well as a PhD in Palaeontology from the University of Cambridge, UK. He has been awarded post-doctoral research fellowships at Cambridge University and in Germany, and has carried out palaeontological research in Europe, North America, the Middle East as well as North and South Africa. For eight years he was a scientific officer (palaeontologist) for the Geological Survey / Council for Geoscience in the RSA. His current palaeontological research focuses on fossil record of the Precambrian - Cambrian boundary and the Cape Supergroup of South Africa. He has recently written palaeontological reviews for several 1: 250 000 geological maps published by the Council for Geoscience and has contributed educational material on fossils and evolution for new school textbooks in the RSA.

Since 2002 Dr Almond has also carried out palaeontological impact assessments for developments and conservation areas in the Western, Eastern and Northern Cape, Limpopo, Gauteng, KwaZulu-Natal, Mpumalanga, Northwest and Free State under the aegis of his Cape Town-based company *Natura Viva* cc. He has been a long-standing member of the Archaeology, Palaeontology and Meteorites Committee for Heritage Western Cape (HWC) and an advisor on palaeontological conservation and management issues for the Palaeontological Society of South Africa (PSSA), HWC and SAHRA. He is currently compiling technical reports on the provincial palaeontological heritage of Western, Northern and Eastern Cape for SAHRA and HWC. Dr Almond is an accredited member of PSSA and APHP (Association of Professional Heritage Practitioners – Western Cape).

Declaration of Independence

I, John E. Almond, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed project, application or appeal in respect of which I was appointed other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Dr John E. Almond
Palaeontologist
***Natura Viva* cc**