Chapter 10: Palaeontological Impact Assessment

Scoping and Environmental Impact Assessment:
Sontule Citrus – Agricultural Expansion on Remainder of Farm 632, Sunland, Sundays River Valley Municipality

Draft EIA Report

September 2022

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Public Process Consultants
Environmental Impact Assessment and Public Participation Management

PALAEONTOLOGICAL SPECIALIST STUDY: COMBINED DESKTOP & FIELD-BASED ASSESSMENT

Proposed Sontule Citrus agricultural expansion on the Remainder of Farm 632 near Addo, Sundays River Valley Municipality, Eastern Cape

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March 2022

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EXECUTIVE SUMMARY

Sun Orange Farms (Pty) Ltd. is proposing the Sontule Citrus agricultural development on the Remainder of Farm 632, situated between Kirkwood and Addo in the Sundays River Valley Municipality, Eastern Cape Province. The project involves the establishment of new citrus orchards and associated infrastructure, including a new farm dam, irrigation infrastructure and internal roads on an existing citrus farm.

The Sontule Citrus agricultural project area is underlain at depth by fossiliferous marine sediments of the Sundays River Formation (Uitenhage Group) of Early Cretaceous age. Shelly invertebrate fossils have been previously recorded from the Cretaceous beds here in the scientific literature (e.g. McLachlan & McMillan 1976). During a recent one-day site visit several rich fossil sites yielding well-preserved bivalve molluscs as well as storm-generated coquinas (shell beds) of broken shelly remains and a few blocks of well-preserved petrified wood were recorded from small exposures of marine siltstones and calcareous sandstones along the low escarpment on the northern borders of the project area. However, none of these fossil sites lie within the project footprint and therefore no mitigation measures are recommended in their regard.

The proposed agricultural expansion will be situated in an undulating, gently sloping plateau area which has already been partly disturbed by agriculture, farm tracks and quarrying and is largely vegetated by dense subtropical thicket. The Cretaceous bedrocks here are entirely mantled by deep (several meters) alluvial deposits of the Late Caenozoic Kudus Kloof Formation. These sandy to gravelly sediments of inferred Pliocene age are often calcretised in the subsurface and are generally unfossiliferous. No fossil remains, apart from possible calcretised plant root traces of low scientific interest, were recorded within them.

Given (1) the small (partially disturbed) footprint of the proposed agricultural expansion, (2) the likely deeply weathered condition of the underlying Mesozoic bedrocks near-surface, as well as (3) the low palaeontological sensitivity of the overlying superficial sediments, the palaeontological heritage impact significance of all components of the proposed agricultural expansion (i.e. new blocks of citrus plantation, new dam, internal roads, irrigation pipeline etc) is assessed as LOW (negative) without mitigation. Current impacts on palaeontological heritage within the wider project area involve on-going destruction of newly exposed fossils by natural weathering and erosion processes (Impacts due to farming activities or illegal fossil collection here are likely to be negligible). This assessment applies to the individual project components as well as their anticipated cumulative impact.

There are no objections on palaeontological heritage grounds to authorisation of the proposed Sontule Citrus agricultural development. No further palaeontological heritage studies or specialist mitigation are required for the proposed developments, pending the potential discovery or exposure of any significant fossil remains (e.g. vertebrate bones and teeth, large blocks of petrified wood, shelly fossil horizons) during the construction phase. The ECO responsible for these developments should be alerted to the possibility of important fossil remains being found either on the surface or exposed by fresh excavations during construction.

Should fossil remains such as bones, shells or petrified wood be discovered during construction, these should be safeguarded (preferably in situ) and the ECO should alert the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (e.g. recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this report). The specialist involved would require a collection permit from ECPHRA. Fossil material must be curated in an approved repository (e.g. museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013).

1. INTRODUCTION

The project applicant, Sun Orange Farms (Pty) Ltd., is proposing the Sontule Citrus agricultural development on parts of the Remainder of Farm 632 (c. 459 ha in total area), situated near Dunbrody on the southern side of the Sundays River and the R336 tar road, c. 13 km southeast of Kirkwood and c. 15 km NW of Addo in the Sundays River Valley Municipality, Eastern Cape Province (Figs. 1 & 2). The project involves the establishment of new citrus orchards and associated infrastructure (144 ha) including a new farm dam (~3ha), irrigation infrastructure and internal roads on an existing citrus farm.

The following project details have been provided by Public Process Consultants:

- **Proposed New Dam**

The Sontule citrus development will require the construction of a new dam on site which will be supplied with water from the LSRWUA canal system via an existing dam on the property.

- The existing dam has a capacity of 20 000m³
- The proposed new dam will be supplied with water from the existing dam via a 315mm uPVC pipe
- New dam specs:
    - Dam wall height 5 meters
    - Total proposed dam footprint ~31 800 m²
    - Estimated dam capacity ~49 000 m³
- New pumphouse (electrical consumption for pumps ~75kw)
- Relay water to orchards via pipes of varying sizes of either 250mm or 315mm uPVC pipe

- **Internal Irrigation Infrastructure**

Irrigation water will be supplied to the orchards via uPVC pipes varying in diameter from 250mm to 315mm. Irrigation water will be reticulated within the orchards via a network of underground pvc irrigation pipes and valves, with varying internal diameters (60mm to 160mm). The applicant proposes to utilise drip/ micro irrigation as the preferred method of water delivery to the trees within the orchards.

- **Electrical Infrastructure**

Pumping requirements will be 75kW for the existing dam and 30kW for the new (top) dam. A step-up transformer to be placed at the existing Eskom point with a cable to be placed in the same trench as the pipeline. A step-down transformer will be required at the proposed new dam. Electricity capacity is yet to be confirmed and will require written confirmation from Eskom.

- **Access**

Access to the site and proposed orchards will be from the existing gravel roads on the farm. The internal roads will be ~9m in width, but lengths will be confirmed in the Civil Engineering Services Report. A Traffic Impact Assessment has been undertaken by a traffic specialist to determine the suitability of the existing farm access to accommodate the additional generated traffic and the potential impact of the proposed development on the R336.

- **Footprint**

The footprint for the new dam will be 3.18 ha and the area proposed for clearing is approximately 144 ha and thus, dependent on the outcome of the various specialist assessments, a total clearance area of 147 ha is proposed. Approximately 321ha of natural area is remaining on the farm. However, portions thereof are anticipated to be unsuitable for development due to biophysical constraints such as unsuitable soils, steep slopes, drainage lines and the requirement to conserve a representative portion of the vegetation types identified on site in order to meet conservation targets.

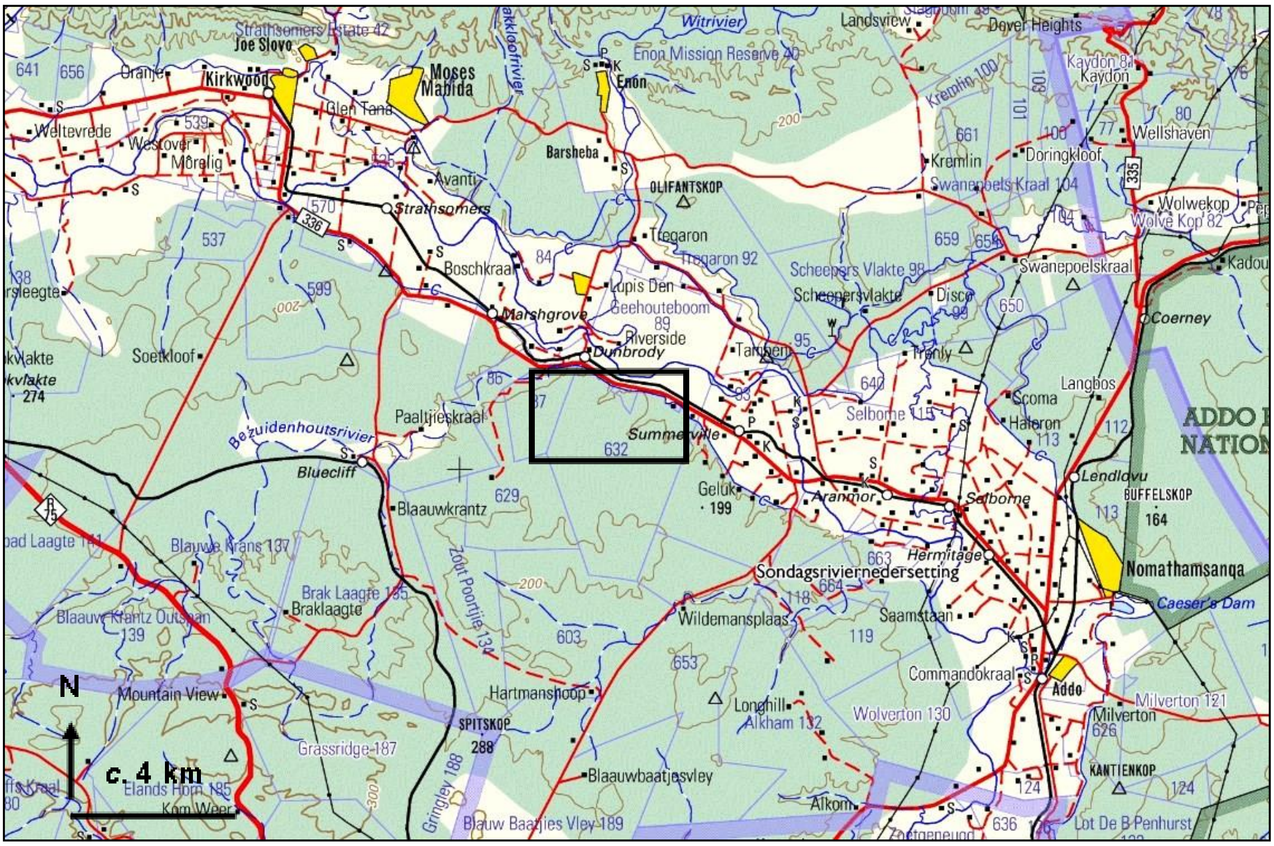

Figure 1: Approximate location of the Sontule Citrus agricultural project study area (black rectangle) on the Remainder of Farm 632, situated near Dunbrody on the southern side of the Sundays River and the R336 tar road, c. 13 km southeast of Kirkwood and c. 15 km NW of Addo in the Sundays River Valley Municipality, Eastern Cape (Extract from 1: 250 000 topographical sheet 3324 Port Elizabeth, courtesy of The Chief Directorate: National Geo-spatial information, Mowbray).

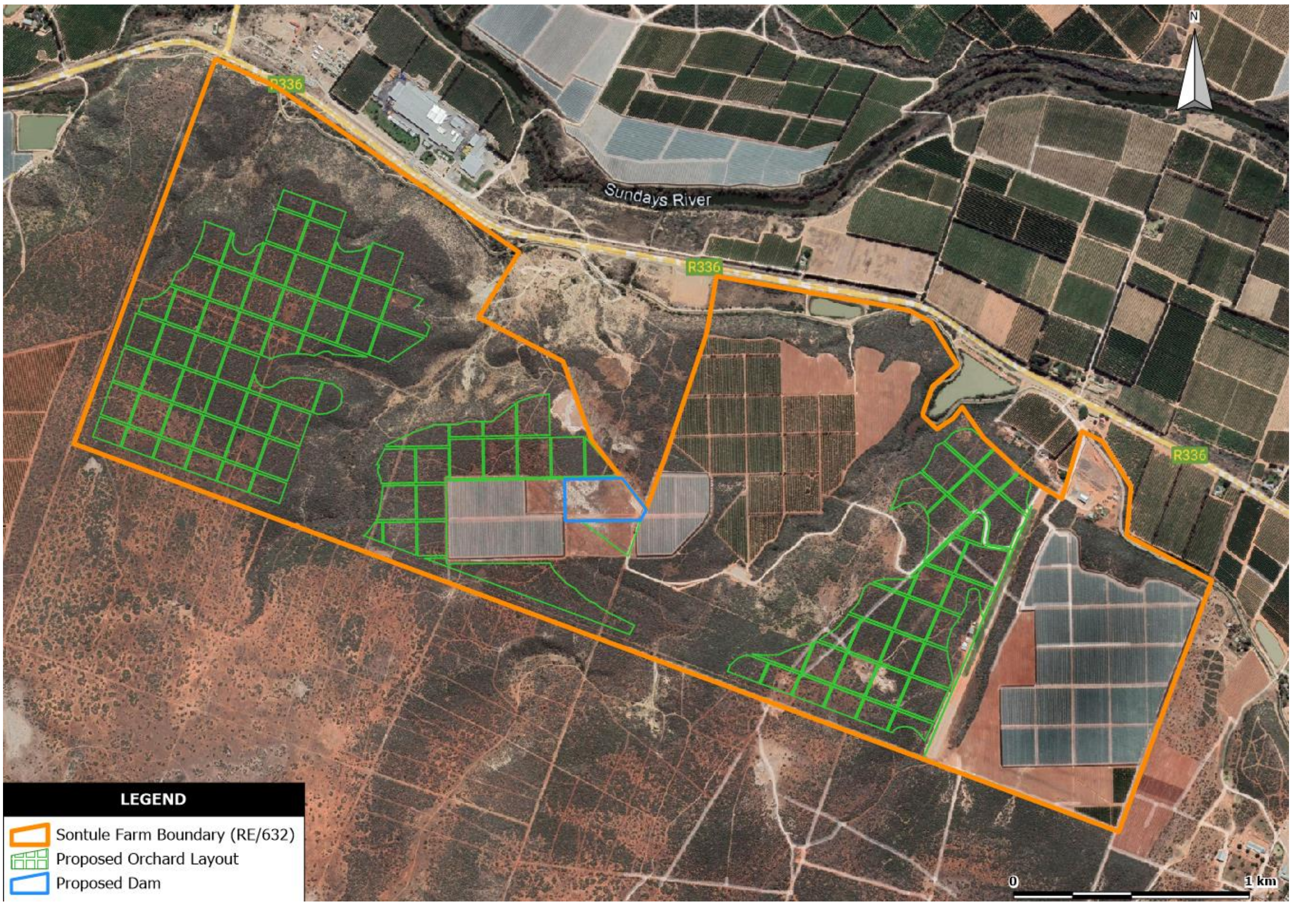

Figure 2: Google Earth© satellite image of the Sontule Citrus project area on the Remainder of Farm 632 (orange polygon).

The Sontule Citrus project area is underlain at depth by potentially fossiliferous sediments of the Sundays River Formation (Uitenhage Group) of Early Cretaceous age. In accordance with the National Heritage Resources Act, 1999, a palaeontological heritage assessment is required as part of a Heritage Impact Assessment for such projects, since important fossil material of scientific and conservation value has previously been recorded from the Kirkwood – Addo region area within this formation (e.g. McLachlan & McMillan 1976).

The present PIA (Palaeontological Impact Assessment) report has accordingly been commissioned as part of the EA Process on behalf of the applicant by the Independent Environmental Assessment Practitioners Public Process Consultants (Contact details: Ms Sandra Wren, Public Process Consultants, 120 Diaz Road, Adcockvale, Port Elizabeth 6001. Phone: 041 374 8426. Cell: 082 4909 828. E-mail: sandy@publicprocess.co.za).

1.1. Legislative context of this palaeontological study

The various categories of heritage resources recognised as part of the National Estate in Section 3 of the National Heritage Resources Act (1999) include, among others:

- geological sites of scientific or cultural importance;
- palaeontological sites;
- 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 have been developed by SAHRA (2013).

2. APPROACH TO THE PALAEONTOLOGICAL HERITAGE ASSESSMENT

This combined desktop and field-based PIA study was based on the following information sources:

1. A short project outline, kmz files and maps provided by Public Process Consultants;

2. A review of the relevant scientific literature, including published topographical maps (1: 50 000 scale map 3325BC Bersheba, 1: 250 000 scale map 3324 Port Elizabeth), geological maps (sheet 3324 Port Elizabeth, Council for Geoscience, Pretoria and the associated short sheet explanation by Toerien & Hill 1989), Google Earth© satellite images, and several previous palaeontological heritage assessments in the region (See Almond in References);

3. A one-day site visit by the author and an experienced assistant on 27 January 2022.

4. The author's database on the formations concerned and their palaeontological heritage (cf Almond et al. 2008).

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. The potential impact of the proposed development on local fossil heritage is 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 assessment study by a professional palaeontologist is usually warranted to identify any palaeontological hotspots and make specific recommendations for any mitigation required before or during the construction phase of the development.

On the basis of the desktop and Phase 1 field assessment studies, the likely impact of the proposed development on local fossil heritage and any need for specialist mitigation are then determined. Adverse palaeontological impacts normally occur during the construction rather than the operational or decommissioning phase. Phase 2 mitigation by a professional palaeontologist – normally involving the recording and sampling of fossil material and associated geological information (e.g. sedimentological data) may be required (a) in the pre-construction phase where important fossils are already exposed at or near the land surface and / or (b) during the construction phase when fresh fossiliferous bedrock has been exposed by excavations. To carry out mitigation, the palaeontologist involved will need to apply for a palaeontological collection permit from the relevant heritage management authority, i.e. the Eastern Cape Provincial Heritage Resources Authority, ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). It should be emphasized that, providing appropriate mitigation is carried out, the majority of developments involving bedrock excavation can make a positive contribution to our understanding of local palaeontological heritage.

2.1. Assumptions & limitations

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 proposed Sontule Citrus agricultural project the major limitation for fossil heritage assessment is the low level of Mesozoic bedrock exposure due to extensive cover by largely unfossiliferous superficial sediments as well as the limited access to many parts of the study area because of the dense thicket vegetation. However, sufficient sedimentary rock exposures were examined during the course of the one-day site visit, supported by several previous field-based palaeontological heritage studies in the wider region, to allow an adequate assessment of the potential impacts of the proposed development.

2.2. Legislative context

The present combined desktop and field-based palaeontological heritage report falls under Sections 35 and 38 (Heritage Resources Management) of the South African Heritage Resources Act (Act No. 25 of 1999), and it will also inform the EMPr for this 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:

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   (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 SAHRA (2013) and by Heritage Western Cape (2021).

3. GEOLOGICAL BACKGROUND

The Sontule Citrus agricultural project area on the Remainder of Farm 632 is situated on the southern side of the Sundays River near Dunbrody, midway between Kirkwood and Addo and just east of the tributary valley of the Bezuidenhoutsrivier (Figs. 1 & 2). It largely comprises gently undulating terrain on a broadly north-sloping pediment surface at elevations of c. 100-150 m amsl. (Figs. 3 to 6). This upland area is partly disturbed by farm tracks, existing citrus plantations and a few small quarries; most of the remainder – where the new citrus orchards will be established - is clothed in dense subtropical thicket vegetation with narrow pathways and small clearings. Bedrock exposure in this upland area is almost non-existent. A gently sloping, N-facing escarpment between c. 70 and 100 m amsl. incised by small stream valleys runs along the margins of the pediment plateau. Most of the escarpment slopes are clothed in thicket vegetation and mantled by gravelly soils and scree. Uitenhage Group bedrocks – the main target for the present palaeontological study - are exposed here and there in small footslope quarries and lower-lying areas incised by gully erosion.

The geology of the Kirkwood – Addo region of the Sundays River Valley is shown on 1: 250 000 geological map 3324 Port Elizabeth (Council for Geoscience, Pretoria; Toerien & Hill 1989) (Fig. 7). The present study area lies towards the northern edge of the extensive Algoa Basin which is infilled with a 3.5 km-thick succession of alluvial fan, fluvial and estuarine to marine shelf sediments of Late Jurassic to Early Cretaceous age (c. 150-125 Ma) that are referred to as the Uitenhage Group (McLachlan & Anderson 1976, Shone 2006). The Remainder of Farm 632 is entirely underlain at depth by marine sediments of the Sundays River Formation (Ks, red in map Fig. 7). These marine beds interfinger along the basin margin to the north, west and south, outside the project area, with continental facies of the Kirkwood Formation (J-Kk, orange in Fig. 7). Sandy to gravelly alluvial terrace deposits ("High Level Gravels") of Late Caenozoic (Miocene to Recent) age that are assigned to the Kudus Kloof Formation mantle the Mesozoic Uitenhage Group bedrocks across the higher lying parts of the project area. The type area for this formation is located on the farm Kudus Kloof 117 which lies some 5 km to the SE of the present study area (Hattingh 1994) (Fig. 8).

Figure 3: View northwards across the western sector of the Remainder of Farm 632 showing the flat, very gently N-sloping pediment surface on the skyline, gravelly hillslopes in the foreground and valley slopes clothed in dense subtropical thicket vegetation.

Figure 4: Most of the outcrop area of the Sundays River Formation along the escarpment slopes is mantled by colluvial gravels – Sundays River Formation sandstones and concretionary material, quartzite cobbles and pebbles from the Kuduskloof Formation – as well as thicket and soils.

Figure 5: Typical low-relief terrain on the upland plateau where the new citrus groves will be established with pervasive quartzitic eluvial surface gravels and sandy soils exposed in paths and clearings among dense thicket vegetation.

Figure 6: One of a few areas on the upland plateau that have been disturbed by quarrying for subsurface calcrete.

3.1. Sundays River Formation

The Sundays River Formation is of Early Cretaceous (Valanginian-Hauterivian) age, i.e around 140-130 Ma (million years old). It comprises a thick (up to 2 km) succession of thin-bedded, grey-green sandstones, siltstones and finer-grained mudrocks that are often highly fossiliferous (Shone 2006). Depositional settings range from estuarine through littoral (shoreline) to marine outer shelf (McMillan 2003). These beds are differentiated from the older to contemporaneous Kirkwood Formation of the Uitenhage Group by (a) the absence of reddish-hued mudrocks, (b) the presence of prominent-weathering calcareous sandstones, and (c) the frequent occurrence of fossil marine shells. These last are commonly, but not invariably, associated with the thin, calcareous sandstone beds, many of which are tempestites (i.e. storm deposits). Various members within the Sundays River succession have been identified from borehole data (Cooper 2018). Key geological accounts of the Sundays River Formation include those by Du Toit (1954), Rigassi & Dixon (1972), Winter (1973), McLachlan & McMillan (1976), Tankard et al. (1982), Dingle et al., (1983), McMillan (2003) and Shone (1976, 2006). For the study area the geological sheet explanations by Haughton (1928), Engelbrecht et al. (1962), Toerien and Hill (1989) and Le Roux (2000) are most relevant.

Uitenhage Group bedrocks are only exposed in small quarry and gullied areas in the escarpment zone while stream valley floor outcrops elsewhere are completely covered by gravelly colluvium, soil and vegetation. The best exposures are seen just west of a small cluster of houses towards the northern edge of the study area (Figs. 9 & 10). Here gently dipping, tabular bedded, gullied purple grey, grey-green to khaki massive siltstones with horizons of blocky-weathering, coffee-brown ferruginous diagenetic concretions (some septarian) pass upwards into a zone with thin (up to a few dm), pale brownish-weathering, thinly and flat-laminated sandstone interbeds. The reddish to purplish hues seen lower down in the succession suggest a nearby continental influence and are more typical of the Kirkwood Formation which crops out just to the west, while abundant shelly fossils (Section 4) are mainly associated with more typical Sundays River grey-green beds above. In the same sector of the farm can be seen thick (several m), medium-bedded, well-sorted, pale brown sandstone packages associated with dark brown-patinated ferruginous carbonate concretions, overlain by interbedded siltstones and thin sandstones with banks of shelly coquina ("shell beds") (Fig. 11) as well as well-jointed benches of tough, dark brown calcareous sandstone containing comminuted shelly debris and thin shelly coquinas (Fig. 12).

3.2. Caenozoic sediments

Sandy to gravelly alluvial deposits of the Kudus Kloof Formation have been described by Hattingh (1994) and mapped in detail along the Sundays River Valley by Hattingh (2001) (Fig. 8). Representatives of Terrace 5 (dark green in Fig. 8), Terrace 6 (purple), Terrace 7 (mid blue), Terrace 8 (orange) and Terrace 9 (grey) are mapped within the Sontule Citrus study area. These terrace gravels are of inferred Middle to Late Pliocene age. The various gravel subunits are not readily distinguished on the ground, however, and they have often been modified by erosional downwasting. Occasional relict banks of coarse, clast-supported Kudus Kloof alluvial conglomerates are visible on hillslopes (Fig. 15). Some of the denser gravel layers may be eluvial / remanié deposits that have been condensed by downwasting from thicker gravel-containing sand bodies. The gravels are generally poorly sorted, subrounded to well-rounded and oligomict; they are predominantly composed of grey to brownish Cape Supergroup quartzite with occasional darker brown Sundays River sandstone clasts.

A well-developed horizon of heavily calcretised, non-shelly, poorly-sorted breccio-conglomerates of the Kudus Kloof Formation occurs at c.115 m amsl along the northern edge of the project area where it directly overlies a package of tabular-bedded, olive-green Sundays River Formation sandstone and blocky-weathering, grey green siltstones (Figs. 13 & 14). The conglomerate clasts are mainly subrounded to well-rounded quartzite pebbles, cobbles and boulders but locally blocks of reworked olive green sandstone are incorporated within the calcretised sandstone matrix. Calcrete veins penetrate downwards between the bedrock layers. Based on its elevation, this horizon may correspond to the Early Pliocene T4 terrace (115-125 m amsl) of Hattingh (2001). The extensive calcrete quarry at a similar to slightly higher elevation (c. 120 m amsl) (Fig. 6) may be related to the same alluvial terrace. Calcretised aeolianites and not just alluvium might also be represented here. The several meter thick, dense calcrete zone shows a greenish speckling, floating gritty grains and fine veins (Fig. 37); it is probably a composite unit and is capped by brown soils packed with calcrete rubble (Fig. 16).

Some test pits on the upland plateau expose sandy to bouldery alluvial sediments with interstitial calcrete derived from modified Kudus Kloof alluvium. Elsewhere deep, only sparsely gravelly orange-brown sandy soils might, at least in part, represent modified aeolian sands (cf Pliocene aeolianites and calcarenites of the Nanga Formation, Algoa Group, which are often secondarily rubified) (Fig. 20). They are best exposed in test pits where a well-developed subsurface calcrete hard pan at a depth of c.30-50 cm may sometimes be seen (Figs. 18 & 19). Flaked quartzite artefacts are common among the overlying surface gravels. Reworked colluvial gravels of quartzite, Sundays River sandstone and concretionary debris, calcrete blocks and saprolitic sandy to silty soils mantle the escarpment slopes which are underlain by Uitenhage Group bedrocks (Fig. 4).

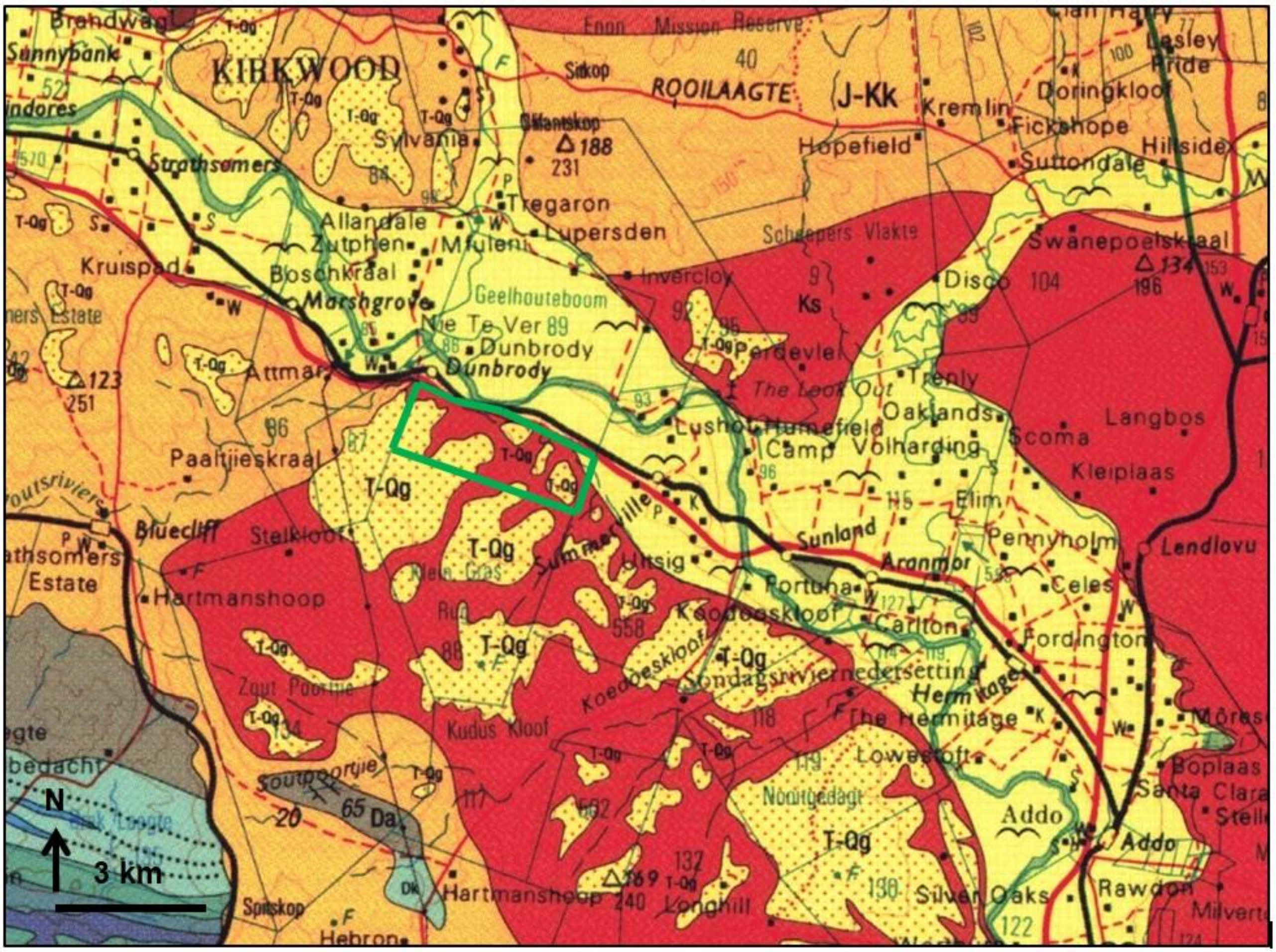

Figure 7: Extract from 1: 250 000 geological map 3324 Port Elizabeth (Council for Geoscience, Pretoria). The study area for the proposed Sontule Citrus agricultural project between Kirkwood and Addo in the Sundays River Valley, Eastern Cape (approximately indicated by the green rectangle) is underlain by Early Cretaceous marine sediments of the Sundays River Formation (Uitenhage Group) (Ks, red). A series of fluvial terrace gravel units of the Kudus Kloof Formation ("High Level Gravels") of Late Tertiary / Neogene age are also mapped here (T-Qg, yellow with red stipple) capping a stepped pediment surface incised into the Uitenhage Group bedrocks on the southern flanks of the Sundays River Valley.

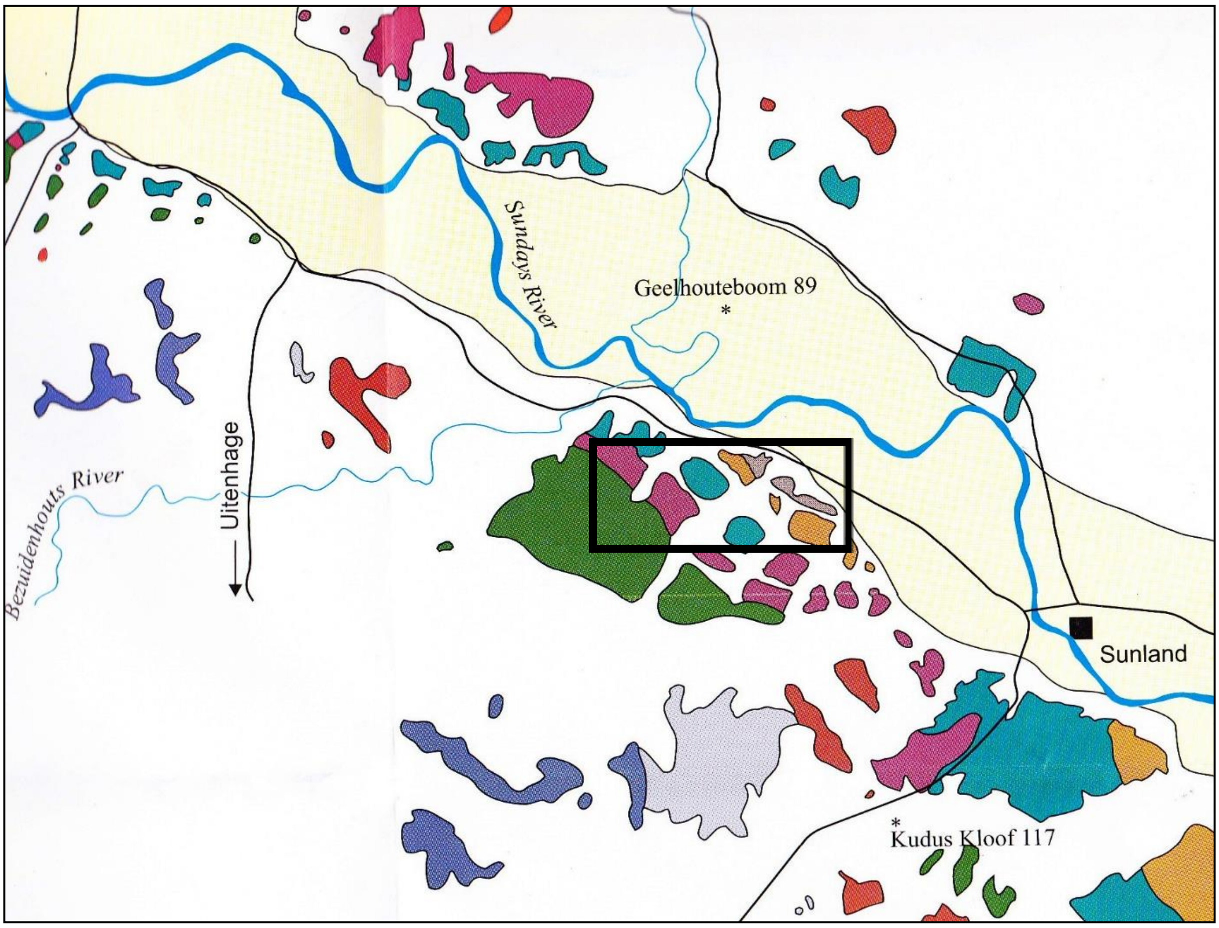

Figure 8: Extract from map of High Level Terrace Gravels of the Sundays River published by Hattingh (2001, Appendix 2) showing the representatives of Terrace 5 (dark green), Terrace 6 (purple), Terrace 7 (mid blue), Terrace 8 (orange) and Terrace 9 (grey) alluvial gravels within the Sontule Citrus study area (black rectangle). These terrace gravels of inferred Middle to Late Pliocene age are now grouped within the Kudus Kloof Formation whose type area on Kudus Kloof 117 lies some 5 km further to the SE (Hattingh 1994).

Figure 9: Small quarry excavated into gently dipping, purplish-brown and khaki sediments of the Sundays River Formation in the NW sector of the project area. The reddish to purplish hues seen here suggest a nearby continental influence and are more typical of the Kirkwood Formation which crops out just to the west; the two formations may inter-finger here.

Figure 10: The grey-green to khaki siltstones and thin sandstones within the upper part of the Sundays River Formation succession illustrated above are highly fossiliferous and contain many large-scale ferruginous concretions (hammer = 30 cm) (Locs. 924 to 929).

Figure 11: Thick unit of pale brown, well-sorted sandstone with darker, brownish, ferruginous carbonate concretions overlain by a several dm-thick shelly coquina (arrowed), Sundays River Formation (hammer = 30 cm) (Loc. 935) (See also Fig. 33).

Figure 12: Hillslope exposure of in situ and slightly displaced blocks of brownish calcareous sandstone of the Sundays River Formation that contain abundant fossil mollusc assemblages and coquinas (Loc. 946) (See also Figures 31 & 32).

Figure 13: Well-calcretized, poorly-sorted, quartzitic alluvial gravels capping a pediment surface incised into Uitenhage Group bedrocks at c. 115 m amsl – possibly Terrace 4 of the alluvial Kuduskloof Formation of inferred Early Pliocene age.

Figure 14: Extension of the same calcretised unit of the Kuduskloof Formation shown in the previous figure, here showing a calcrete hardpan directly overlying thin, tabular sandstones of the Sundays River Formation (hammer = 30 cm).

Figure 15: Coarse, poorly-sorted, quartzitic terrace gravels of the Kuduskloof Formation at c. 100 m amsl – possibly Terrace 5 of inferred Middle Pliocene age (hammer = 30 cm).

Figure 16: Thick sandy calcrete hardpan exposed on the margins of a shallow quarry in the central sector of the Remainder of Farm 632 and capped by dark brown soils with abundant calcrete rubble (hammer = 30 cm).

Figure 17: Well-developed calcrete hardpan beneath gravelly brown soils exposed in a shallow quarry area in the south-eastern sector of the project area (hammer = 30 cm).

Figure 18: Test pits within the proposed citrus plantation project areas often expose a clacrete hard pan 30 to 50 cm beneath the surface, capped by sparsely gravelly, orange-brown sandy soils (hammer = 30 cm).

Figure 19: Test pit into coarse alluvial gravels and sands that mantle large portions of the citrus plantation project areas, here at c. 126 m amsl and possibly derived from Terrace 4 of the Kuduskloof Formation.

Figure 20: Bright orange-brown, only sparsely gravelly sandy soils which cover parts of the plateau area might, at least in part, be derived from modified aeolianites such as the Nanaga Formation which is typically rubified in the coastal interior.

Figure 21: Readily gullied, khaki to grey-green silty soils on lower hillslopes are derived from the underlying Sundays River Formation mudrocks and grade downwards into saprolite.

4. PALAEONTOLOGICAL HERITAGE

The fossil record of the main sedimentary rock units represented within the study area on the Remainder of Farm 632 is outlined here, together with any new palaeontological data based on the recent site visit. GPS locality details of numbered fossil sites mentioned in the test and figure legends are tabulated in Appendix 1 of this chapter.

4.1. Fossils in the Sundays River Formation

In palaeontological terms the Sundays River Formation (Uitenhage Group) contains one of the most prolific and scientifically important marine biotas of Mesozoic age in southern Africa (See brief review by Almond 2010, from which the following section is largely abstracted). Fossils have been recorded from the Sundays River beds in the Algoa Basin since the early nineteenth century (1837). Cooper (1981) provides a good review of the earlier literature. Important collections were made, for example, by the famous Eastern Cape geologists W.G. Atherstone and A.G. Bain (see Sharpe 1856) and there has been a long history of palaeontological publications dealing with the Sundays River fauna since then. Among the key papers are those by Sharpe (1856), Kitchin (1908), Spath (1930), Du Toit (1954), Engelbrecht et al. (1962), Haughton (1969), McLachlan & McMillan (1976, 1979), Klinger & Kennedy (1979), Cooper (1981, 1991), Dingle et al. (1983), McMillan (2003) and Shone (1986, 2006). Well-illustrated accounts of Sundays River fossils have been given by MacRae (1999) and Cooper (2018). The ammonites and microfossils are of particular biostratigraphic (rock dating) importance, while the foraminiferans (a group of protozoans) are useful for palaeoenvironmental analysis (See extensive discussion in McMillan 2003). Despite the long history of palaeontological work on Sundays River fossils, there has been little systematic collection of fossils – especially macrofossils - from these beds in recent decades and most taxa remain poorly studied (e.g. most invertebrate groups, apart from the ammonites, trigoniid bivalves and foraminiferans). Much further research remains to be done here, however, and a lot of palaeontologically valuable material is undoubtedly being destroyed in the currently active brick pits in the Algoa Basin region.

The main invertebrate macrofossils recorded from the Sundays River Formation are a rich variety of molluscs. These include several cephalopod subgroups - mainly ammonites, plus much rarer nautiloids and belemnites. The cephalopod fauna has been revised recently by Cooper (1981, 1983) and is dominated by a series (14 spp.) of strongly ribbed, coiled ammonites of the Genus Olcostephanus, also well-known from Early Cretaceous marine faunas elsewhere in the world. Interestingly, clear examples of well-developed sexual dimorphism (male and female shells of different size and form) are shown in this genus. Much rarer partially coiled ammonites (Distoloceras) and straight-shelled, obliquely ribbed forms (Bochianites) also occur.

The Sundays River molluscs include a number of mainly small-bodied gastropods (c. 6 genera, including limpets), and over forty genera of bivalves (mussels, clams etc). In terms of abundance as well as biodiversity the bivalve molluscs are also the dominant group. The commonest form is the thick-shelled “Devil’s toenail” oyster Aetostreon (previously known as Exogyra or Gryphaea) which is often preserved in dense coquinas (shell beds) at the base of storm sandstones. Some of the other bivalves, such as the strongly–ribbed or knobbed trigoniids (eleven species in seven genera, recently revised by Cooper 1979, 1991) and the elongate-shelled Gervillella – all shallow infaunal forms - are also quite substantial (20-30 cm long or more) with robust shells. Encrusting oysters cemented onto shells, rocks or hardgrounds are common (e.g. Amphidonte). Dense storm-transported accumulations of scaphopod molluscs (tusk shells) were discovered during a recent field study by Almond (2011). Most of these South African fossils are badly in need of taxonomic and palaeobiological revision along the lines of recent work on similar-aged South America molluscs by Lazo (2007 and earlier papers).

More minor invertebrates – including stenohaline as well as euryhaline taxa - from the Sundays River Formation are solitary and branching colonial corals, tube-dwelling serpulid polychaetes, bryozoans, echinoderms (usually fragmentary crinoids or sea lilies, ophiuroids or brittle stars, sea cucumbers, regular echinoids) and shrimp-like crustaceans. However, more intensive collecting from these beds is likely to reveal further invertebrate taxa. This is suggested by the recent discovery of two new crustaceans (including several specimens of strongly tuberculate crabs) within Sundays River concretions (Dr Billy de Klerk, pers. comm., 2010), the scaphopods or tusk shells mentioned earlier, and recent new records of beetle remains south of Addo (Mostovski & Muller 2010). Sundays River trace fossils are poorly studied, but are locally abundant. They range from dense banks of cylindrical intrasediment burrows to a range of borings into wood, shells and hardgrounds (i.e. cemented substrata on the sea floor including, for example, exhumed early diagenetic concretions). A spectrum of microfossils from this stratigraphic unit include foraminiferans, ostracods, dinoflagellates and land-derived pollens and spores (Dingle et al. 1983, McMillan 2003). Among the rarer microfossil groups recorded are radiolarians, seed shrimps, and fragments of echinoderms (ossicles of crinoids, ophiuroids, holothurians and echinoids).

The Sundays River beds contain sparse, often unidentifiable plant fossils such as fragments of driftwood (sometimes insect- or perhaps mollusc-bored), leaf and twig debris, amber (fossil resin), lignite, charcoal and the reproductive structures of charophyte algae (stoneworts). Fossil vertebrates from the Sundays River Formation are very rare indeed. The best-known example is the partial skeleton of a 3 m-long plesiosaur (an extinct group of large marine reptiles), Leptocleidus capensis. This comes from the famous, but poorly-localized, site of Picnic Bush on the Swartkops River near Port Elizabeth (Andrews 1910; see MacRae 1999 and Cooper 2018 for good illustrations). Isolated dinosaur bones and teeth have also been mentioned (e.g. a dinosaur vertebra from Barkly Bridge south of Addo; Engelbrecht et al. 1962), though several earlier records probably stem from the older Kirkwood Formation. Gess (undated report) recently reported small vertebrate remains associated with marine molluscs and drift-wood from a site in the Sundays River Valley.

Early records of Cretaceous fossil remains from the Sundays River Formation of the Algoa Basin near Addo – including several reports of fossil molluscs (ammonites, bivalves, gastropods) as well as tubiculous serpulid worms - have been collated by McLachlan and Anderson (1976) (Fig. 32). They include records of various molluscan taxa along the low, north-facing riverine escarpment near Dunbrody, close to or within the present study area. Cretaceous fossils recorded during a recent field survey on Vissers Vale 96 some three kilometres to the east by Almond (2019) included a range of molluscan taxa associated with thin (20 cm or less thick), lenticular shelly coquinas within cliff and riverbank exposures of both siltstone and sandstone facies of the Sundays River Formation. The coquinas are made up of disarticulated and broken shells and are dominated by various oysters such as the encrusting Amphidonte / Ceratostreon, the toenail-shaped, free-living Aetostreon as well as rarer strongly-ornamented trigoniid bivalves.

Locally abundant, mollusc-dominated marine shelly fossil assemblages are recorded from a few small exposures of sandstone and mudrock facies along the Sundays River Formation escarpment in the north-central portion of the Sontule Citrus project area on the Remainder of Farm 632 (See fossil sites mapped in Figure A1 in Appendix 1). It is likely that fossils occur widely in this escarpment zone. Shelly coquinas in the higher portions of the Sundays River Formation succession here are commonly associated with thin, medium to coarse-grained, calcareous sandstone units, comprising comminuted shell debris, especially of various bivalve molluscs, as well as intact but usually disarticulated valves (Figs. 28, 31 & 32). Original shell material is usually preserved, but mouldic preservation within calcareous sandstone is also seen. Thin shell pavements are made of closely-packed, similarly orientated valves. Thin pebbly conglomeratic lenses contain shelly material as well as occasional fragments of ferruginized woody stem axes and subcylindrical rusty-brown bodies that possibly represent reworked, secondarily mineralized burrow casts (0.5 cm wide) (Figs. 29 & 30). Silty mudrock packages contain locally common, thick-shelled trigoniid bivalves (some specimens articulated and possibly in life position, others preserved within disgenetic nodules) and thin-shelled, irregularly shaped oysters (Amphidonte) (Figs. 23 & 26). The latter are variously preserved freely within the silty matrix, in compact clumps or stacks encrusting oyster or other shells, or affixed to hard substrates such as calcareous sandstones and carbonate concretions, some of which were exposed as hardgrounds on the sea floor. Impressive shelly coquinas up to a decimeter or so thick within siltstone packages contain myriads of loose to mutually consolidated mollusc valves (Amphidonte, trigoniids, Pinna, possible Mytiloperna, Isognomon etc) (Figs. 11, 33 to 35).

Local concentrations of angular blocks of pale greyish petrified wood preserving fibrous wood fabric (Fig. 36) are more typical of the Kirkwood Formation ("Wood Beds"). These fossils, as well as the purplish and reddy hues of some of the nearby siltstone exposures suggest that inter-tonguing of continental Kirkwood and marine Sundays River facies occurs in this area; the contact between these rock units is mapped just to the west of the Remainder of Farm 632 (Fig. 7).

5.2. Fossils in Late Caenozoic alluvial deposits

Neogene to Recent colluvial, alluvial and lag gravel, sand and clay deposits may also contain fossil remains of various types. In coarser sediments like river conglomerates these tend to be robust, highly disarticulated and abraded (e.g. rolled bones, teeth of vertebrates) but well-preserved skeletal remains of plants (e.g. wood, roots) and invertebrate animals (e.g. freshwater molluscs and crustaceans) as well as various trace fossils may be found within fine-grained alluvium. Embedded human artefacts such as stone tools that can be assigned to a specific interval of the archaeological time scale (e.g. Middle Stone Age) can be of value for constraining the age of Pleistocene to Recent drift deposits like alluvial terraces. Ancient to modern "High Level Gravels" tend to be coarse and to have suffered extensive reworking (e.g. winnowing and erosional downwasting), so they are generally unlikely to contain useful fossils. No fossils are reported from the Kudus Kloof Formation by Hattingh (1994, 2001); these fluvial terraces are dated by reference to correlated fossiliferous marine terraces along the coast. Fine-grained carbonaceous muds associated with vlei areas may contain peats, palynomorphs (pollens, spores) and other microfossils as well as the bones and teeth of mammals and other fauna that died in the area.

No gastropod shells or other body fossils were observed within the well-developed calcretes observed in elevated plateau areas on the Remainder of Farm 632. Narrow vermiform structures within dense calcrete might represent root traces (rhizoliths) (Fig. 37) while possible indications of possible meniscate back-filled burrows were also seen. Incipient calcretisation focused around subfossil plant roots is seen in road cuttings through older sandy soils (Fig. 38) while soils elsewhere occasionally contain subfossil shells of the large land snail Cochlitoma ("Achatina"), sometimes retaining faint colour markings.

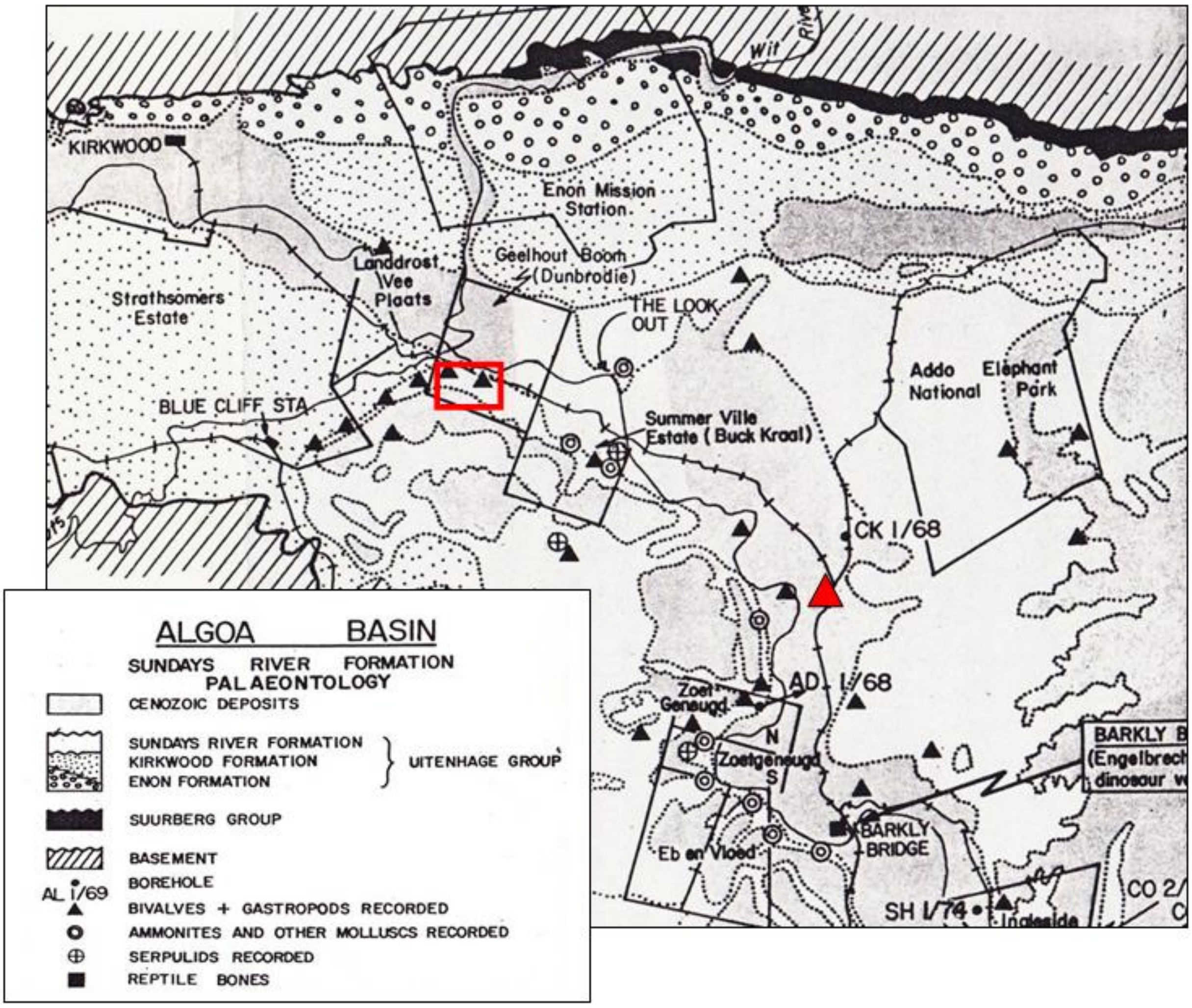

Figure 22: Fossil localities in the Sundays River Formation of the Algoa Basin near Addo (town marked by red triangle), with the present study area on the Remainder of Farm 632 near Dunbrody approximately indicated by a red rectangle. Several groups of marine invertebrates (molluscs, including bivalves, gastropods and ammonites, as well as serpulid worm tubes) are reported from Sundays River Formation beds on the flanks of the Sundays River Valley between Kirkwood and Addo, including the present study area, while various dinosaur and other vertebrate remains are recorded from Barclay Bridge to the south of Addo (Figure modified from McLachlan & Anderson 1976, their Fig. 8).

Figure 23: Concentration of thick-shelled, strongly ornamented, articulated and disarticulated trigoniid bivalves enclosed within a concretionary zone within siltstone facies of the Sundays River Formation (Loc. 928) (scale in cm and mm).

Figure 24: Articulated specimen of large, trigoniid bivalve apparently preserved in life position within siltstone facies (Loc. 929) (scale in cm).

Figure 25: Well-preserved valves of the small, thin-shelled oyster *Amphidonte* weathering out of siltstone facies of the Sundays River Formation. The largest shell seen here is 3.5 cm across (Loc. 929).

Figure 26: Stacks of superimposed *Amphidonte* oyster shells (scale in cm) (Loc. 929).

Figure 27: Dense cluster (c. 9 cm across) of *Amphidonte* oyster shells encrusting one another (Loc. 929).

Figure 28: Slab of brownish, gritty to pebbly calcareous sandstone containing comminuted shelly debris as well as probable reworked invertebrate burrow casts (see following figure for detail) (scale = 15 cm) (Loc. 926).

Figure 29: Close-up of rusty-brown, subcylindrical casts (0.5 cm wide, arrowed) of invertebrate burrows within the pebbly calcareous sandstone illustrated above (Loc. 926).

Figure 30: Small ferruginised woody stem axes preserved within pebbly calcareous sandstone facies (scale in cm and mm) (Loc. 925).

Figure 31: Thin pavement of wave-sorted, well-sorted, disarticulated bivalve shells preserved within brown-weathering calcareous sandstone (scale in cm and mm) (Loc. 947).

Figure 32: Comminuted shelly debris (largely bivalves) forming a shelly hash preserved within a brownish calcareous sandstone (scale in cm) (Loc. 946).

Figure 33: Thin, prominent weathering shelly bed within siltstone succession, with underlying apron of downwasted shells extending downslope (hammer = 30 cm) (Loc. 935).

Figure 34: Close-up of weathered-out bivalves from the shell bed illustrated above – mainly the thin-shelled oyster *Amphidonte* but also possible *Isognomon*, among other taxa (largest shell is c. 6 cm wide) (Loc. 935).

Figure 35a, b: Well-cemented cluster of intact and broken bivalve shells with detail of several shells seen in lower figure (scale in cm and mm) (Loc. 935).

Figure 36: Angular blocks of pale grey petrified log preserving fibrous woody fabric (scale in cm) (Loc. 930) (scale in cm and mm). These fossils suggest proximity to land and possible inter-tonguing of Kirkwood and Sundays River Formations in the study area.

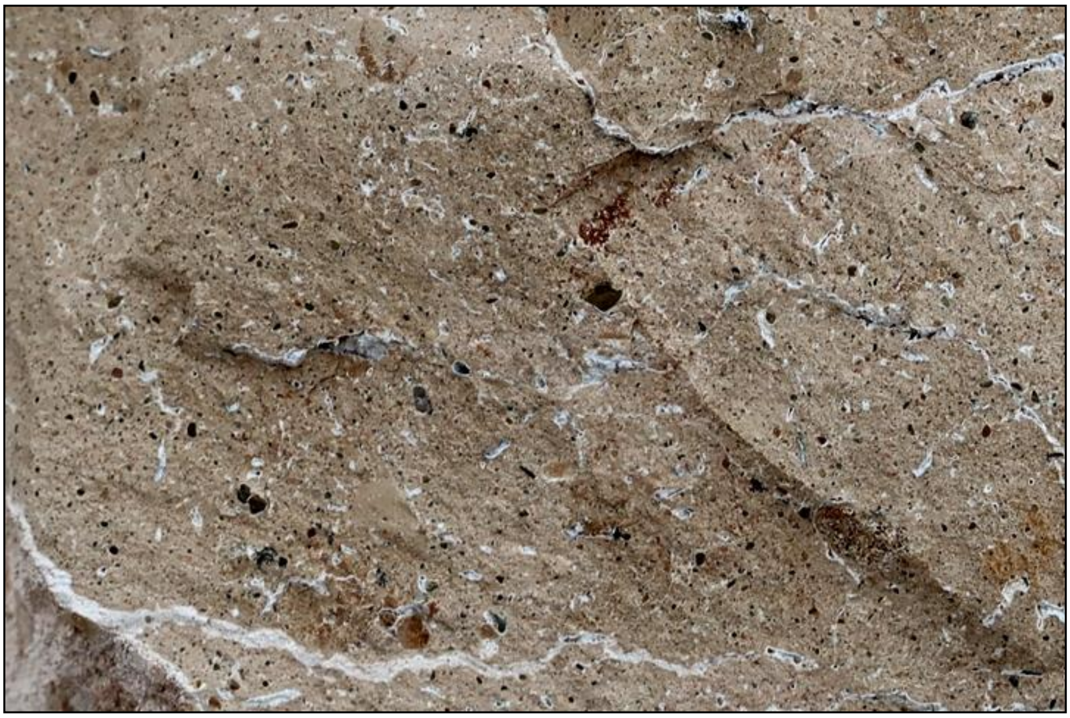

Figure 37: Close-up of dense, dark-speckled Late Caenozoic calcrete hardpan from quarry area showing pale vermiform structures that *might* be fine root traces, or perhaps abiogenic (field of view c. 6 cm across) (Loc. 951).

Figure 38: Road cutting through well-consolidated, orange-brown sandy sediment showing incipient pale calcretisation around subfossil plant roots (hammer = 30 cm) (Loc 957).

5. CONCLUSIONS & RECOMMENDATIONS

The Sontule Citrus agricultural project area on Remainder of Farm 632, situated between Kirkwood and Addo in the Sundays River Valley, Eastern Cape Province, is underlain at depth by fossiliferous marine sediments of the Sundays River Formation (Uitenhage Group) of Early Cretaceous age. Shelly invertebrate fossils have been previously recorded from the Cretaceous beds here in the scientific literature (e.g. McLachlan & McMillan 1976). During a recent one-day site visit several rich fossil sites yielding well-preserved bivalve molluscs as well as storm-generated coquinas (shell beds) of broken shelly remains and a few blocks of well-preserved petrified wood were recorded from small exposures of marine siltstones and calcareous sandstones along the low escarpment on the northern borders of the project area (See satellite locality map in Appendix 1 of this chapter). However, none of these fossil sites lies within the project footprint and therefore no mitigation measures are recommended in their regard.

The proposed agricultural development will be situated in an undulating, gently sloping plateau area which has already been partly disturbed by agriculture, farm tracks and quarrying and is largely vegetated by dense subtropical thicket. The Cretaceous bedrocks here are entirely mantled by deep (several meters) alluvial deposits of the Late Caenozoic Kudus Kloof Formation whose type area lies a few kilometres to the east. These sandy to gravelly sediments of inferred Pliocene age are often calcretised in the subsurface and have experienced erosional concentration through downwasting. They are generally unfossiliferous and no fossil remains, apart from possible calcretised plant root traces of low scientific interest, were recorded within them.

Given (1) the small (partially disturbed) footprint of the proposed agricultural developments, (2) the likely deeply weathered condition of the underlying Mesozoic bedrocks near-surface, as well as (3) the low palaeontological sensitivity of the overlying superficial sediments, the palaeontological heritage impact significance of all components of the proposed agricultural projects (i.e. new blocks of citrus plantation, new dam, internal roads, irrigation pipeline etc) is assessed as LOW (negative) without mitigation. Current impacts on palaeontological heritage within the wider project area involve on-going destruction of newly exposed fossils by natural weathering and erosion processes (Impacts due to farming activities or illegal fossil collection here are likely to be negligible). This assessment applies to the individual project components as well as their anticipated cumulative impact. In the absence of full data regarding potential impacts of comparable proposed or authorised agricultural developments in the Addo – Kirkwood region, cumulative impacts on local fossil heritage cannot be realistically assessed. However, given the large outcrop areas of the sedimentary formations concerned, they are likely to fall within acceptable limits.

There are no objections on palaeontological heritage grounds to authorisation of the proposed Sontule Citrus agricultural development. No further palaeontological heritage studies or specialist mitigation are required for the proposed developments, pending the potential discovery or exposure of any significant fossil remains (e.g. vertebrate bones and teeth, large blocks of petrified wood, shelly fossil horizons) during the construction phase. The ECO responsible for these developments should be alerted to the possibility of important fossil remains being found either on the surface or exposed by fresh excavations during construction.

Should fossil remains such as bones, shells or petrified wood be discovered during construction, these should be safeguarded (preferably in situ) and the ECO should alert the Eastern Cape Provincial Heritage Resources Authority (ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za). This is so that appropriate mitigation (e.g. recording, sampling or collection) can be taken by a professional palaeontologist (See tabulated Chance Fossil Finds Procedure in Appendix 2 to this chapter). The specialist involved would require a collection permit from ECPHRA. Fossil material must be curated in an approved repository (e.g. museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013).

6. ACKNOWLEDGEMENTS

Ms Sandra Wren of Public Process Consultants, Port Elizabeth, is thanked for commissioning this palaeontological study and for providing the necessary background information. I am very grateful to Ms Madelon Tusenius for logistical back-up, palaeontological input as well as companionship in the field.

Table 1: Assessment of anticipated impacts of the proposed Sontule Citrus agricultural project on scientifically valuable palaeontological heritage on the Remainder of Farm 632 (construction phase)

Nature of the Impact	Potential disturbance, damage or destruction of scientifically valuable and legally protected fossil heritage resources due to surface clearance and excavations during the construction phase (*e.g.* for farm dam, citrus orchards, internal roads, underground pipelines).
Extent	Site Specific - The impact will be limited to the proposed development footprint.
Duration	Permanent
Consequence/ Intensity	Low
Probability	Improbable - The proposed development area will be restricted to areas which are covered by thick unfossiliferous superficial sediments (alluvium, topsoils).
Degree of Confidence	Medium
Reversibility	Irreversible – Once the palaeontological material has been removed or destroyed this impact cannot be reversed.
Irreplaceable Loss of Resources	Unlikely. Similar fossils to those recorded here are known elsewhere from the extensive Sundays River Formation outcrop area.
Status and Significance (without mitigation)	Low Negative (-)
Mitigation	• The construction phase of the projects should be monitored by an Environmental Control Officer (ECO), who should monitor for potential fossil material on an ongoing basis. • Should substantial fossil remains be exposed during construction, however, the ECO should safeguard these, preferably *in situ*, and alert ECPHRA as soon as possible so that appropriate action (*e.g.* recording, sampling or collection) can be taken by a professional palaeontologist. • In the event that fossilised material is uncovered, construction on the affected excavation should cease until a palaeontologist has assessed the material. • Fossilised material encountered at the site may only be removed or destroyed upon authorisation from the relevant Heritage Resources Authority (*i.e.* ECPHRA. Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za) by the issuing of an appropriate permit. • A Chance Fossil Finds Protocol is to be appended to the Construction EMPr and implemented should any substantial fossil remains be uncovered. • Fossil material must be curated in an approved repository (*e.g.* museum or university collection) and all fieldwork and reports should meet the minimum standards for palaeontological impact studies developed by SAHRA (2013).
Status and Significance (after mitigation)	Low Positive (+) - Providing appropriate palaeontological mitigation is carried out, the majority of developments involving bedrock excavation can make a positive contribution to our understanding of local palaeontological heritage.

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8. 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, Northwest, Gauteng, KwaZulu-Natal, Mpumalanga and the Free State under the aegis of his Cape Town-based company Natura Viva cc. He has served as 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 development 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

APPENDIX 1: FOSSIL SITE DATA – JANUARY 2022

All GPS readings were taken in the field using a hand-held Garmin GPSmap 64s instrument. The datum used is WGS 84. Please note that:

- Locality data for South African fossil sites is not for public release, due to conservation concerns.
- The table does *not* represent all potential fossil sites within the project area but only those sites recorded during the 1-day field survey. The absence of recorded fossil sites in any area therefore does not mean that no fossils are present there.

Loc	GPS data	Comments
924	S33° 28' 40.6" E25° 32' 55.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Shelly coquinas (molluscan debris, occasional intact bivalve valves) within calcareous sandstone concretions. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
925	S33° 28' 40.7" E25° 32' 54.6"	Remainder of Farm 632 near Addo. Sundays River Fm. Shelly coquinas (molluscan debris) associated with small rusty-brown woody stem axes, possible ferruginised subcylindrical burrow casts (0.5 cm diam.) within calcareous pebbly sandstone. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
926	S33° 28' 40.2" E25° 32' 55.3"	Remainder of Farm 632 near Addo. Sundays River Fm. Ferruginous gritty sandstone with pebbly conglomerates, reworked cyclindrical burrow casts, shelly debris. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
927	S33° 28' 39.9" E25° 32' 55.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Thin-shelled oysters (*cf Amphidonte*) encrusting ferruginous sandstone of possible hardground origin. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
928	S33° 28' 39.4" E25° 32' 54.7"	Remainder of Farm 632 near Addo. Sundays River Fm. Ferruginous diagenetic concretions containing thick-shelled trigoniid bivalves. Clusters of thin-shelled encrusting oysters (*cf Amphidonte*). Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
929	S33° 28' 39.3" E25° 32' 54.5"	Remainder of Farm 632 near Addo. Sundays River Fm. Upper siltstone portion of exposed succession (beneath thin-bedded sandstones) containing abundant trigoniid bivalves, thin-shelled oysters. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
930	S33° 28' 41.4" E25° 32' 54.2"	Remainder of Farm 632 near Addo. Sundays River Fm. Several angular float blocks of pale grey petrified logs up to 20 cm long with clear woody fabric. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
931	S33° 28' 42.8" E25° 32' 53.8"	Remainder of Farm 632 near Addo. Possible subfossil *Cochlitoma* (“*Achatina*”) in soils overlying saprolitic Sundays River formation siltstones. Proposed Field Rating IIIC Local Resource. Site lies outside project footprint so no mitigation required.
935	S33° 28' 53.8" E25° 32' 54.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Dense shelly coquinas up to dm or so thick associated with siltstone and thin sandstones overlying thick sandstone package. Range of shelly taxa dominated by oysters (*Amphidonte*), possible trigoniids, pectinoids, *Isognomon*. Shells mainly disarticulated, intact or broken, locally bound within concretionary lenses. Proposed Field Rating IIIB Local Resource. Proposed Field Rating

		IIIB Local Resource. Site lies outside project footprint so no mitigation required.
945	S33° 28' 49.8" E25° 33' 03.0"	Remainder of Farm 632 near Addo. Sundays River Fm. Downwasted blocks of pale brownish shelly calcareous sandstone (oysters *inter alia*) in shallow stream valley. Proposed Field Rating IIIB Local Resource. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
946	S33° 28' 49.9" E25° 33' 03.6"	Remainder of Farm 632 near Addo. Sundays River Fm. Downwasted blocks of pale brownish shelly calcareous sandstone (intact and broken shells of bivalves) in shallow stream valley. Proposed Field Rating IIIB Local Resource. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
947	S33° 28' 49.9" E25° 33' 03.7"	Remainder of Farm 632 near Addo. Sundays River Fm. Downwasted to nearly *in situ* blocks of pale brownish shelly calcareous sandstone (intact and broken shells of bivalves, locally forming thin pavements) in shallow stream valley. Proposed Field Rating IIIB Local Resource. Proposed Field Rating IIIB Local Resource. Site lies outside project footprint so no mitigation required.
951	S33° 28' 52.4" E25° 33' 09.0"	Remainder of Farm 632 near Addo. Extensive shallow quarry into dense calcrete showing narrow, vermiform plant root traces (rhizoliths and / or possible occasional invertebrate burrows (equivocal). Proposed Field Rating IIIC Local Resource. Site lies outside project footprint so no mitigation required.
957	S33° 29' 13.2" E25° 33' 23.4"	Remainder of Farm 632 near Addo. Farm road cutting into partially calcretised orange-brown, non-pebbly sandy sediments (alluvial / aeolian) with calcrete haloes around subfossil plant roots. Proposed Field Rating IIIC Local Resource. Site lies outside project footprint so no mitigation required.

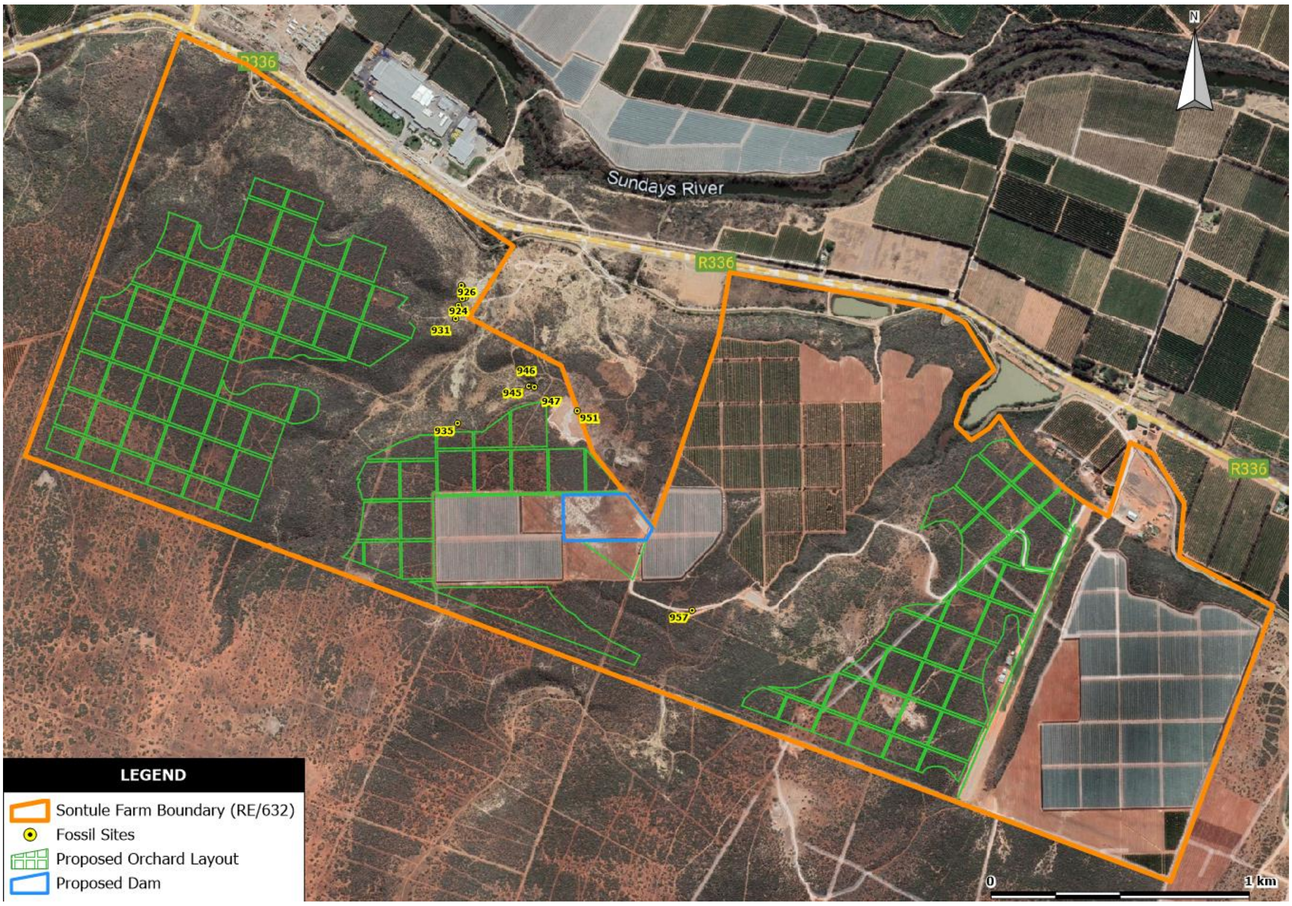

Figure A1.1: Google Earth© satellite image of the Sontule Citrus project area on the Remainder of Farm 632 near Addo showing location of recently recorded fossil and subfossil sites. None of the fossil sites lies within the footprint of the proposed agricultural development and no mitigation is required in their regard.

<table>
<tr><td colspan="3">APPENDIX 2: CHANCE FOSSIL FINDS PROCEDURE: Remainder of Farm 632 near Addo</td></tr>
<tr><td>Province & region:</td><td colspan="2">Eastern Cape, Sundays River Valley Municipality</td></tr>
<tr><td>Responsible Heritage Management Authority</td><td colspan="2">ECPHRA (Contact details: Mr Sello Mokhanya, 74 Alexander Road, King Williams Town 5600; Email: smokhanya@ecphra.org.za).</td></tr>
<tr><td>Rock unit(s)</td><td colspan="2">Early Cretaceous Sundays River Formation Uitenhage Group), Late Caenozoic Kudus Kloof Formation</td></tr>
<tr><td>Potential fossils</td><td colspan="2">Shelly invertebrates, petrified wood, rare dinosaur bones and teeth, trace fossils in Sundays River beds.
Freshwater molluscs, calcretised trace fossils, possible bones and teeth of mammals in Caenozoic alluvium.</td></tr>
<tr><td rowspan="5">ECO protocol</td><td colspan="2">1. Once alerted to fossil occurrence(s): alert site foreman, stop work in area immediately (N.B. safety first!), safeguard site with security tape / fence / sand bags if necessary.</td></tr>
<tr><td colspan="2">2. Record key data while fossil remains are still in situ:
Accurate geographic location – describe and mark on site map / 1: 50 000 map / satellite image / aerial photo
Context – describe position of fossils within stratigraphy (rock layering), depth below surface
Photograph fossil(s) in situ with scale, from different angles, including images showing context (e.g. rock layering)</td></tr>
<tr><td>3. If feasible to leave fossils in situ:
Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation
Ensure fossil site remains safeguarded until clearance is given by the Heritage Resources Authority for work to resume</td><td>3. If not feasible to leave fossils in situ (emergency procedure only):

Carefully remove fossils, as far as possible still enclosed within the original sedimentary matrix (e.g. entire block of fossiliferous rock)
Photograph fossils against a plain, level background, with scale
Carefully wrap fossils in several layers of newspaper / tissue paper / plastic bags
Safeguard fossils together with locality and collection data (including collector and date) in a box in a safe place for examination by a palaeontologist
Alert Heritage Resources Authority and project palaeontologist (if any) who will advise on any necessary mitigation</td></tr>
<tr><td colspan="2">4. If required by Heritage Resources Authority, ensure that a suitably-qualified specialist palaeontologist is appointed as soon as possible by the developer.</td></tr>
<tr><td colspan="2">5. Implement any further mitigation measures proposed by the palaeontologist and Heritage Resources Authority</td></tr>
<tr><td>Specialist palaeontologist</td><td colspan="2">Record, describe and judiciously sample fossil remains together with relevant contextual data (stratigraphy / sedimentology / taphonomy). Ensure that fossils are curated in an approved repository (e.g. museum / university / Council for Geoscience collection) together with full collection data. Submit Palaeontological Mitigation report to Heritage Resources Authority. Adhere to best international practice for palaeontological fieldwork and Heritage Resources Authority minimum standards.</td></tr>
</table>