

5th August 2021
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Reference: 2021ISJ12-F02-20210805

Preliminary Assessment of subterranean fauna habitat for the Gnarabup Tourism Development, Leeuwin – Naturaliste region, Western Australia.

Attention Jason Hick
Director
Emerge Associates Pty Ltd

Dear Jason

Invertebrate Solutions Pty Ltd (Invertebrate Solutions) was requested by Emerge Associates Pty Ltd (Emerge) to provide a preliminary assessment for the presence of conservation significant subterranean invertebrates and communities, as well as the likelihood of suitable habitat for subterranean fauna for the Gnarabup Tourism Development Project, located on the western edge of the Gnarabup settlement in the southwest region of Western Australia.

This technical memorandum is not intended to replace or act in the place of a complete desktop assessment for subterranean fauna but serves as a preliminary assessment of publically available records in literature and those held by the Department of Biodiversity Conservation and Attractions (DBCA).

Project Description

The proponent proposes to construct a resort and village development within two sites respectively. The main resort building will be located central to Lot 783, and the proposed villas will be nestled throughout Lots 501, 502, 503 and 504.

The resort site is proposed to include:

- A 'U' shaped resort building with an envelope of approximately 8,700 m² in size. The proposed building will include three levels overall, with the building proposed to be excavated into the existing natural depression on the back side of the north-south dune to the west of Lot 783 for part of the lowest level.
- Landscaping between the proposed resort building and Ocean View Road/ Mitchel Drive/ Wallcliffe Road public road reserves.
- Private driveways, parking bays and footpaths.

- An outdoor bar, adult and children's pool captured within the centre of the 'U' shaped building.
- Tree planting along the southern, northern and eastern boundaries.
- Rock walls, turfed areas, fire pit, seating and alfresco.
- Drainage swale.
- Retention of native vegetation, footpaths and a turfed area within the Mitchell Drive road reserve immediately north of Lot 783.
- A footpath and lookout within the northern 'Parks and Recreation' portion of Lot 783.

The village site is proposed to include:

- 25 apartments, 4 townhouses, 51 villas (80 dwellings) self-contained villa apartments.
- Tree planting and gardens throughout.
- Reef Drive/Seagrass Place intersection redesign.

The sites that will be subject to excavation as part of earthworks will be the village hub commercial and retail Lot 504 apartment site and resort site (the northern area) that will be excavated between 3 m to 5 m below existing the ground levels to enable the building to be less prominent in the landscape. Invertebrate Solutions has made the following assumptions in the writing of this report and its subsequent conclusions:

- No abstraction of groundwater or dewatering for construction purposes will be undertaken, resulting in no impacts to regional or local groundwater levels.
- Ground excavations will be limited to 5 m from existing ground surface.

Geological and Geomorphological Setting

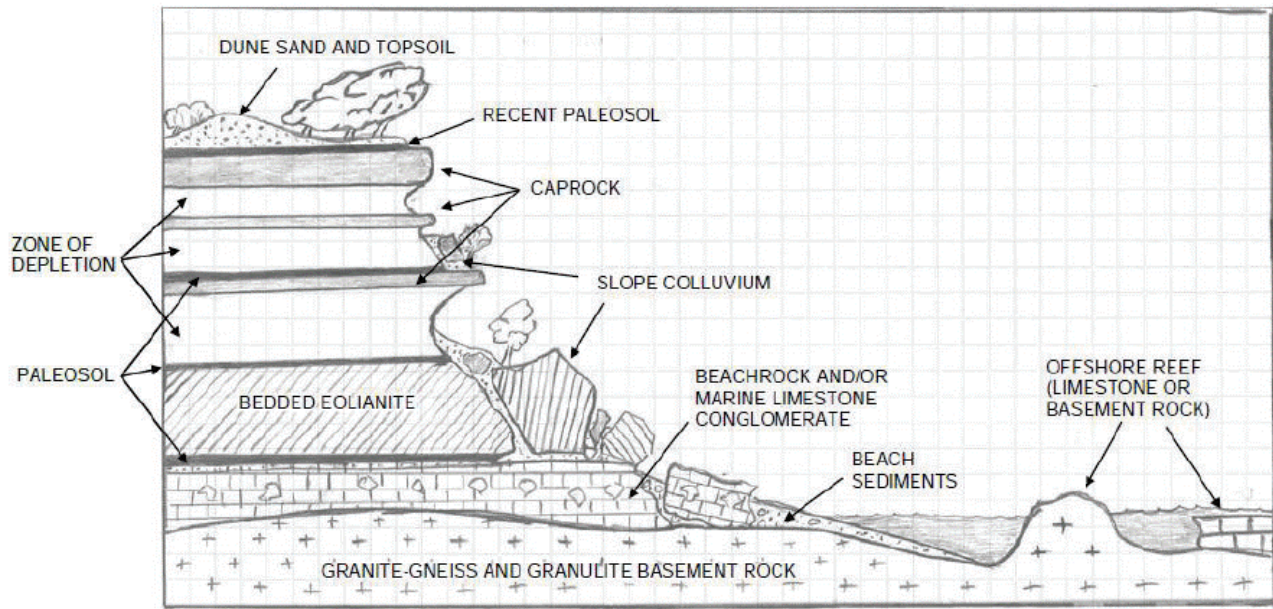
The Leeuwin-Naturaliste Ridge is a linear strip of karstic dune limestone up to 6 km wide and contains numerous caves (Bastian, 1962, 1964, Williamson, 1980, Williamson & Bell, 1980, Eberhard, 2003, 2004). The ridge is part of the Tamala Limestone that extends north of Perth (Playford *et al.* 1976) and was formed in several stages over the past 600,000 years with youngest parts adjacent to the Indian Ocean on the western side. The soft Tamala Limestone overlies a hard granitic gneiss basement that is largely impermeable to water. On the western edge of the ridge is the largely unconsolidated Quindalup Dune system that is present along much the coastal strip. This is largely not karstic and composed of unconsolidated calcareous sands that contains limited interconnected voids (Moulds and Thomas 2017).

The Leeuwin Naturaliste Ridge contains syngenetic karst that unique in that speleogenesis and lithogenesis occur concurrently i.e. caves and karst features form at the same time as the loose sediment is being cemented into rock that is generally soft and porous (Grimes 2006). Syngenetic karst is distinctive in that cave systems are shallow and horizontal with a general lack of directed conduits (low irregular chambers occur instead) (Grimes 2006). Caves are often clustered at the margins of topographic highs or along the coast and contain paleosol horizons and have vertical solution pipes which locally form dense fields (Grimes 2006). Syngenetic caves also contain extensive breakdown and subsidence in the form of collapse-dominated cave systems, along with a variety of surface and subsurface breccias and locally large collapse dolines and cenotes and with limited surface

sculpturing such as karren (Grimes 2006). These features are best developed in host sediments that have well developed primary matrix permeability and limited secondary cementation (and hence limited mechanical strength), for example dune calcarenites. Certain hydrological environments also assist: invading swamp waters or mixing at a well-developed watertable; or, near the coast, mixing at the top and bottom of a freshwater lens floating on salt water. Where these factors are absent the karst forms tend to be more akin to those of classical hard-rock or telogenetic karst. (Grimes 2006)



Plate 1 Surface Geology of the Gnarabup area (after Figure 2.2 MP Rogers and Associates 2020). Approximate project area shown in red.



Note: Not all possible contacts and relationships are shown.

Plate 2 Generalised geological profile for the Gnarabup coastal area (after Golder 2017)

In the Margaret River region the caves are best developed in the older more-cemented dunes of the Tamala Limestone located in the centre and topographic high of the ridge and are of three types: linear caves formed by cave streams above an impermeable basement; the inclined fissure type, which also includes other breakdown forms; and the horizontal maze caves of the Augusta area (Eberhard, 2003) which are relatively rare in Western Australia.

The Gnarabup Project is located within the Tamala Limestone unit (Plate 1) that contains multiple hardcap zones in the vertical profile (Plate 2) that form when calcium carbonate has been leached from zones of depletion and then deposited when the water becomes saturated. The caprock is substantially harder than the zones of depletion.

Conservation Significant Subterranean Fauna and Habitats

A list of conservation significant fauna subterranean invertebrate fauna for Leeuwin Naturaliste Ridge was compiled from the DBCA Wildlife Conservation (Specially Protected Fauna – *Biodiversity Conservation Act 2016*) Notice 2019 (DBCA 2019) and the DAWE’s Protected Matters Search Tool (PMST) within 30 km of the Project area. No subterranean species that are listed under the BC Act and/or the EPBC Act and are likely to occur or have known habitat within the region (Leeuwin – Naturaliste Ridge).

The PMST results listed three (3) Threatened Ecological Communities (TEC) associated with subterranean fauna within 30 km of the Project (Table 1). All three of these TECs are located in caves that occur between five and 13 km to the south of the Project area and will not be impacted in any way by the proposed development. The

occurrence of these root mat communities is well known throughout the Leeuwin Naturaliste Ridge from the continued exploration of caves by various speleological groups over the previous 60 years and it is highly unlikely that any similar root mat community occurs within or the local vicinity of the Project area.

Table 1 Conservation significant subterranean communities potentially within the region.

Community Name	Description	Conservation listing (BC Act)	Conservation listing (EPBC)	Distance from Gnarabup Project
Aquatic Root Mat Community 2	Root mat communities based upon the rootlets and their associated microflora providing the primary food source for aquatic cavernicoles (cave animals) in these communities include crustaceans, mites, rotifers, microscopic worms, tardigrades, and insects and crustaceans. Some of the species appear to be endemic to these cave systems, and some to be confined to a single cave.	Critically Endangered	Endangered	13.7 km Strongs Cave
Aquatic Root Mat Community 3		Critically Endangered	Endangered	12.7 km Kudjal Yolgah and Budjur Mar Caves
Aquatic Root Mat Community 4		Critically Endangered	Endangered	6.3 km Calgardup Cave

Subterranean fauna habitat availability in the Gnarabup Project Area

The Project area is located on the western extremity of the Leeuwin Naturaliste Ridge, approximately 150 m from the Indian Ocean. Whilst the ground surface is largely covered in calcareous sand that provides little interconnected void space the underlying caprock horizons (Plate 2) may contain minor karstic features, depending upon the vertical extent of the caprock. The zones of depletion will contain extensive interconnected void spaces, however, due to the leaching of calcium carbonate from these zones they are extremely friable and subject to internal collapse resulting in some void space being filled with fine grained sand and other material near the base of these horizons.

The likelihood of stygofauna and troglifauna being present within the Project area is considered to be Moderate to Low based upon the presence of Tamala Limestone, however, due to a very shallow vertical profile of limestone within the Project area, habitat is limited and extends well beyond the Project boundary. The amount of stygofauna habitat is also limited by sea water incursions into the regional water table due to the proximity (150 m) to the coast, however, further hydrogeological information for the site is required to confirm this.

Conclusions

Although subterranean fauna may be present within the limited footprint of the Project area, there is potentially a Low likelihood of impact to stygofauna and troglifauna from virtually all aspects of the project due to no groundwater abstraction or dewatering, and only four metres of excavation in one part of the Project is proposed. The absence of dewatering and groundwater abstraction removes any possibility of groundwater drawdown and associated loss of subterranean fauna habitat. Contamination of groundwater during Project construction and operations may potentially impact upon subterranean fauna habitat, but risks of unexpected spills or contamination, altered surface hydrology and altered subsurface water infiltration can be minimised by management plans and mitigation measures through the construction and operation of the project.

Limitations and Exclusions

This preliminary assessment was limited to the extent of information made available to Invertebrate Solutions at the time of undertaking the work. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein. This technical memorandum is not intended to replace or act in the place of a complete desktop assessment for subterranean fauna but serves as a preliminary assessment only and further investigation or data may change the conclusions therein.

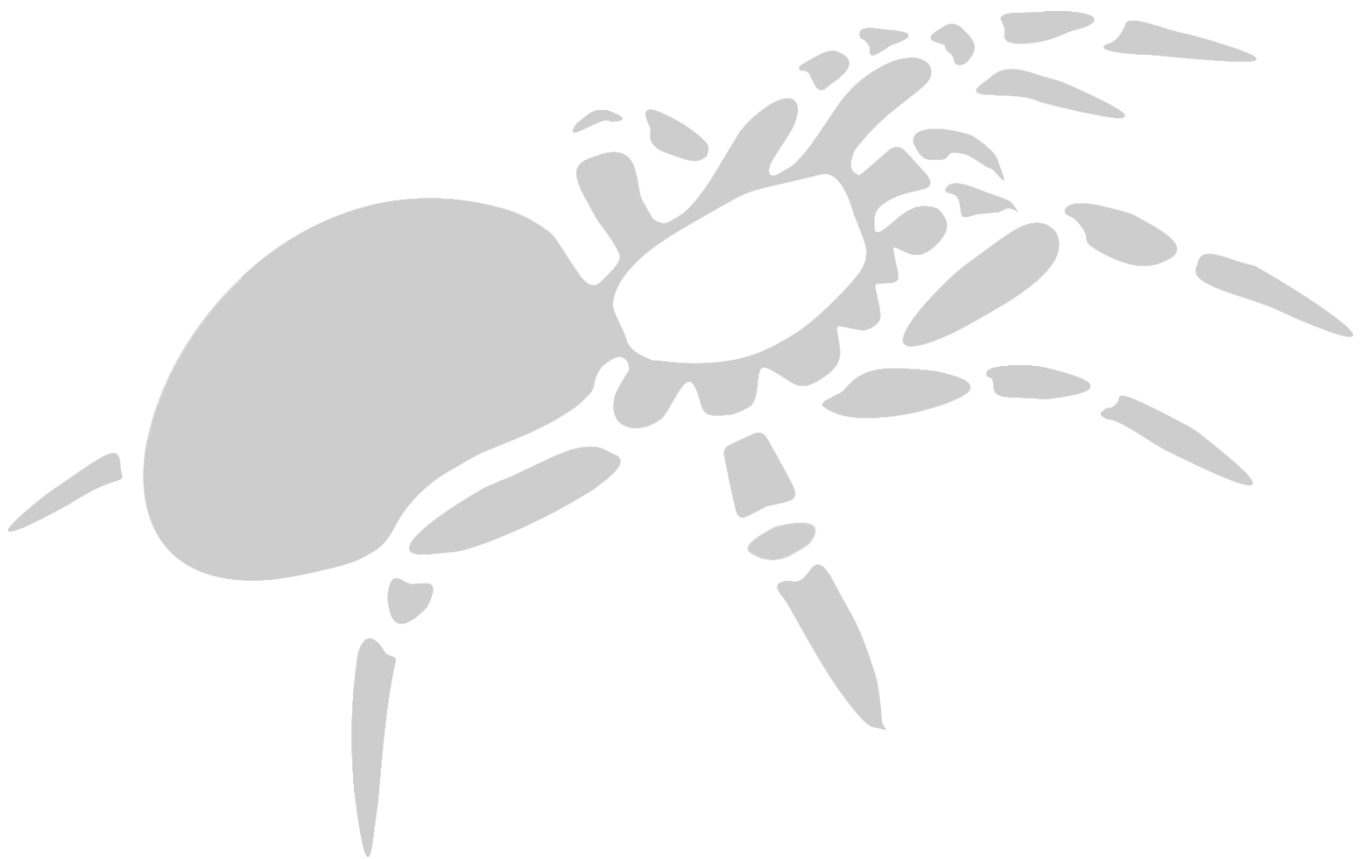
The opinions, conclusions and any recommendations in this report are based on information available, including published species distribution records and reviewed at the date of preparation of the report. Invertebrate Solutions has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by Invertebrate Solutions described in this report (this section and throughout this report). Invertebrate Solutions disclaims liability arising from any of the assumptions being incorrect.

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