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Terrestrial Animal (Invertebrate) Species Impact Assessment – Proposed Dana Bay Emergency Access Road, Mossel Bay

Compiled for: Sharples Environmental Services cc (SES)

Project name: The Proposed Dana Bay Emergency Access Road on Remainder of Portion 7 of Farm 225, Mossel Bay

Applicant: Mossel Bay Municipality

19 October 2022

DECLARATION OF INDEPENDENCE

In terms of Chapter 5 of the National Environmental Management Act of 1998 (Act No. 107 of 1998), as amended, and the Environmental Impact Assessment Regulations, 2014, specialists involved in Environment Assessment Processes must declare their independence and provide their contact details, relevant experience, and a curriculum vitae.

I, Jonathan F. Colville, as the appointed independent specialists, do hereby declare that I am financially and otherwise independent of the client and their EAP, and that all opinions expressed in this document are my own and based on my scientific and professional knowledge, and available information.

Jonathan F. Colville

ABRIDGED CURRICULUM VITAE

Jonathan Colville
Qualifications: **PhD (Zoology):** University of Cape Town, 2009; **Postdoctoral Research Fellowship:** South African National Biodiversity Institute, 2009-2013.

SACNASP Registration No: 134759 (Ecological Science (Professional Natural Scientist)).

Experience: I have over fourteen years post-PhD experience in the fields of terrestrial ecology, including investigating the spatial patterns of South Africa's animal and plant diversity, with a particular focus on invertebrates. Between 2009 and 2019, I was involved with the South African National Biodiversity Institute's (SANBI) Biodiversity, Research, Assessment and Monitoring Division (BRAM) undertaking ecological research on South Africa's insect and plant diversity. Since 2020 I have been working as a specialist faunal consultant for EIAs and conservation projects. *See copy of my CV attached as Appendix-1 to this report.

CONDITIONS PERTAINING TO THIS REPORT

The content of this report is based on my best scientific and professional knowledge, and available information. I reserve the right to modify the report in any way deemed fit should new, relevant, or previously unavailable or undisclosed information become known to me from on-going research or further work in this field, or pertaining to this investigation, and will inform SES accordingly. This report must not be altered or added to without the prior written consent of myself. This also refers to electronic copies of the report, which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must refer to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

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1. INTRODUCTION

Sharples Environmental Services has been engaged by Mossel Bay Municipality to undertake an Environmental Impact Assessment for an emergency access road on the remainder of portion 7 of Farm 225 (Mossel Bay). Part of this assessment includes a specialist impact assessment for four invertebrate species that were identified by the screening tool as of Medium Sensitivity. An initial faunal site sensitivity and assessment report (chepri (Pty) Ltd, 2022) observed two of the four invertebrate species at the project site and concluded a high likelihood of the other two invertebrate species occurring there.

As detailed in the Government Gazette No. 43855 (Published in Government Notice No. 1150; 30 October 2020) the Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species, when a SCC is confirmed or likely to occur on the project site, a Terrestrial Animal Species Specialist Assessment must then be undertaken.

The following four invertebrate species were considered in this impact assessment:

- **Orthoptera**:
    - Medium Sensitivity: *Aneuryphymus montanus* (Yellow-winged Agile Grasshopper)
- **Lepidoptera**:
    - Medium Sensitivity: *Sensitive species 13* (Butterfly)
    - Medium Sensitivity: *Aloeides thyra orientis* (Eastern Red Russet)
    - Medium Sensitivity: *Lepidochrysops littoralis* (Coastal Giant Cupid)

2. TERMS OF REFERENCE

I was appointed by SES on 01 September 2022 to conduct an impact assessment, including a desktop study and site visit to assess the possibility of the occurrence of the four invertebrate SCC and the availability of suitable habitat for these at the project site. Based on the information obtained from these two phases, an assessment of the nature and the extent of the potential impacts of the proposed development on the populations of the SCC located within the project area would be undertaken as stipulated in the Government Gazette, No. 43855 (Published in Government Notice No. 1150) of 30 October 2020: '*Protocol for the Specialist Assessment and Minimum Report Content Requirements for Environmental Impacts on Terrestrial Animal Species*' and following SANBI's (2020) '*Guidelines for the Implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for Environmental Impact Assessments In South Africa*'.

1. Carry out a desktop study to determine if any of the invertebrate SCC have been recorded at or near the project area and to ascertain their habitat requirements.
2. Conduct a site visit of the project area to assess the physical and biological characteristics of the site with regards to habitat suitability and sensitivity for the four invertebrate SCC.
3. Estimate of the nature and the extent of the potential impacts of the proposed development on the populations of the invertebrate SCC located within the project area, including project (preferred) alternative (as defined in Figure 1) and a 'No-go' option.
4. Provide potential mitigation measures to reduce the impacts of the development on the invertebrate SCC.
5. Provide a terrestrial animal (invertebrate) species impact assessment report detailing the findings of the desktop study and site inspection and including a reasoned opinion, based on the findings

of the specialist assessment process, regarding the acceptability or not of the development and if the development should receive approval or not.

3. METHODOLOGY

3.1 DESKTOP STUDY

- Distributional records for the four invertebrate SCC were extracted from digitized databases of several South African museums (e.g., Iziko Museum of South Africa, Ditsong National Museum of Natural History, South African National Collections of Insects). Online resources, such as the IUCN Red List of Threatened Species (https://www.iucnredlist.org/), the Orthoptera Species File Online (http://orthoptera.speciesfile.org/HomePage/Orthoptera/HomePage.aspx), LepiMAP (https://vmus.adu.org.za/), and iNaturalist (https://www.inaturalist.org/) were also consulted for information on SCC's geographic distributions and habitat requirements.
- Published information on the four invertebrate SCC was also investigated to further assess their distribution range, ecology, habitat, and any life history requirements.
- Methodology used to assess possible impacts from the proposed development activities follows Appendix-1, as given to by SES.
- No modelling was required.

3.2 FIELD SITE VISIT

- The project area (Figure 1) was surveyed on the 28 September 2022 to assess habitat quality, in terms of the type and amount of natural vegetation remaining. The extent of disturbance that the project area has experienced, in terms of changes to its vegetation and physical properties (e.g. soil) was also considered.
- Andrew Morton (Chairman of the Lepidopterists Society of the Western Cape) participated in the site inspection and in searching for the three butterfly SCC.
- Season: Spring.
- Duration: ~ 6 hrs.
- Areas at and around selected points were investigated across the project area and photographed (Figures 4 - 14).
- At, or near each photograph site the surrounding habitat was characterised, photographs were taken of the surrounding area, and the likelihood of any of the SCC being present was assessed.
- In additional to visual searching, sweep netting (SANBI, 2020) using an insect net was undertaken at selected points for the Orthoptera SCC.
- Seasonal Relevance:
    - For the four invertebrate SCC spring to summer is an ideal time for detection of these species (Mecenero *et al.*, 2013; SANBI, 2020).

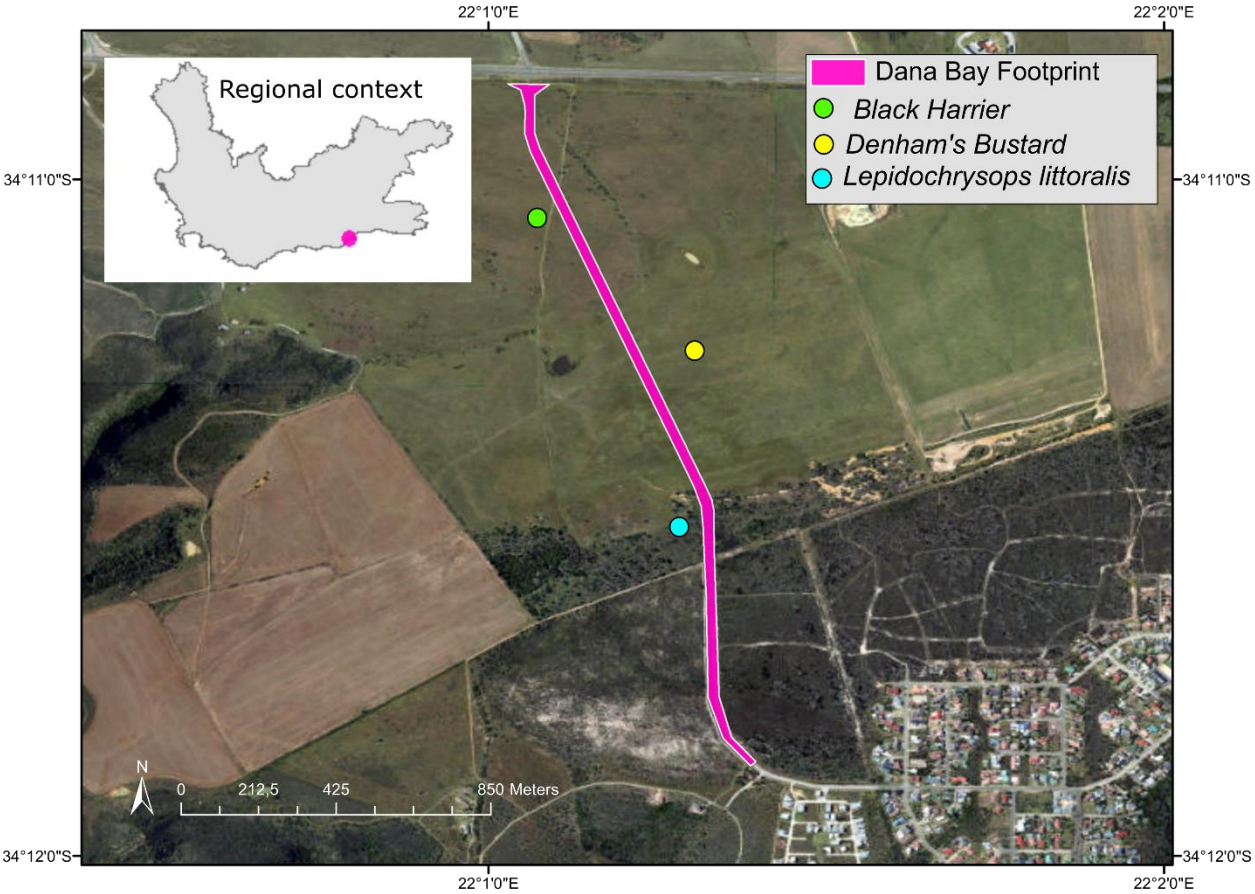

Figure 1. The proposed project development area on the remainder of portion 7 of the Farm 225, Mossel Bay, Western Cape Province. Three animal species of conservation concern, including one of the butterfly SCC flagged by the screening tool for this project, were recorded during the field site visit.

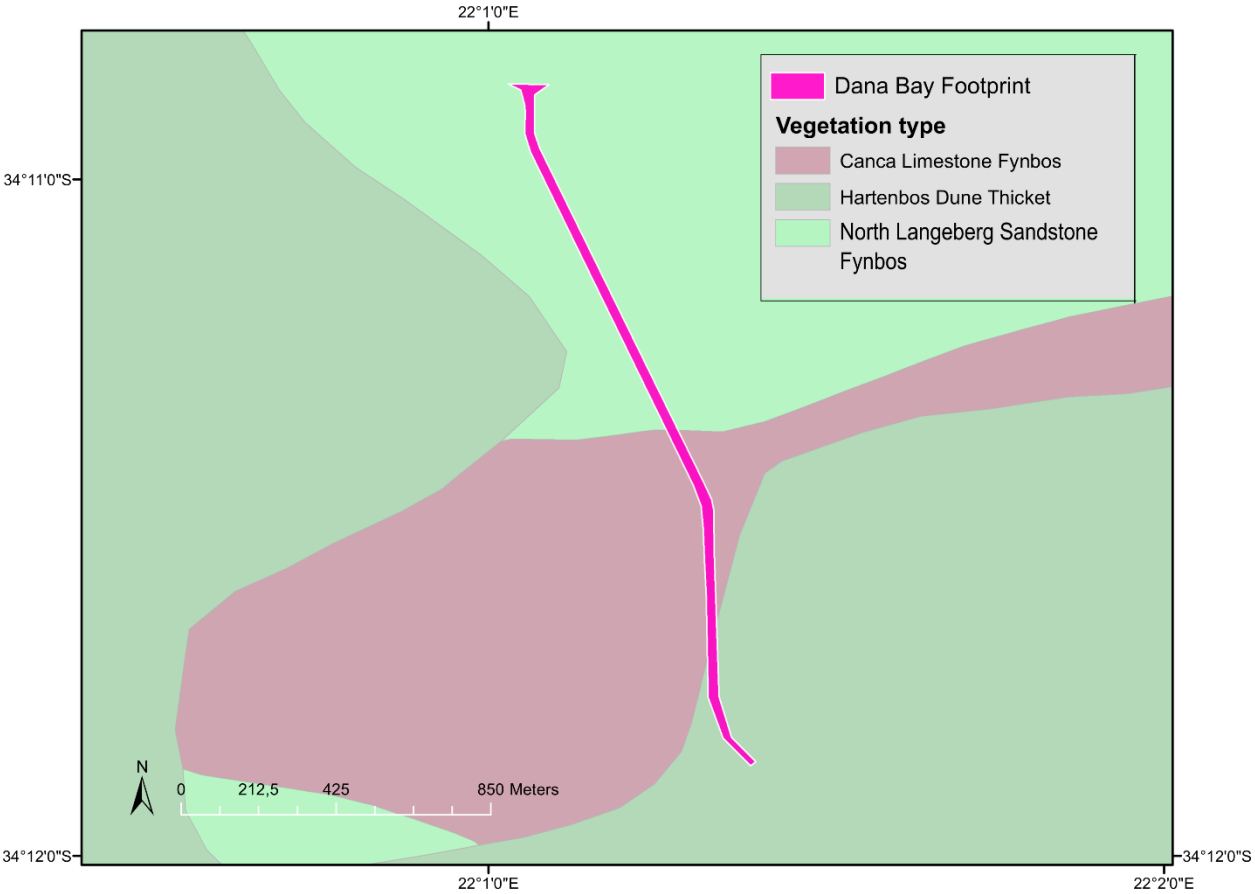

Figure 2. The proposed access road crosses three different vegetation types (SANBI, 2018; Skowno *et al.*, 2019). The north of the project area has been heavily disturbed by agriculture, whereas the southern area of the project crosses high-quality fynbos vegetation.

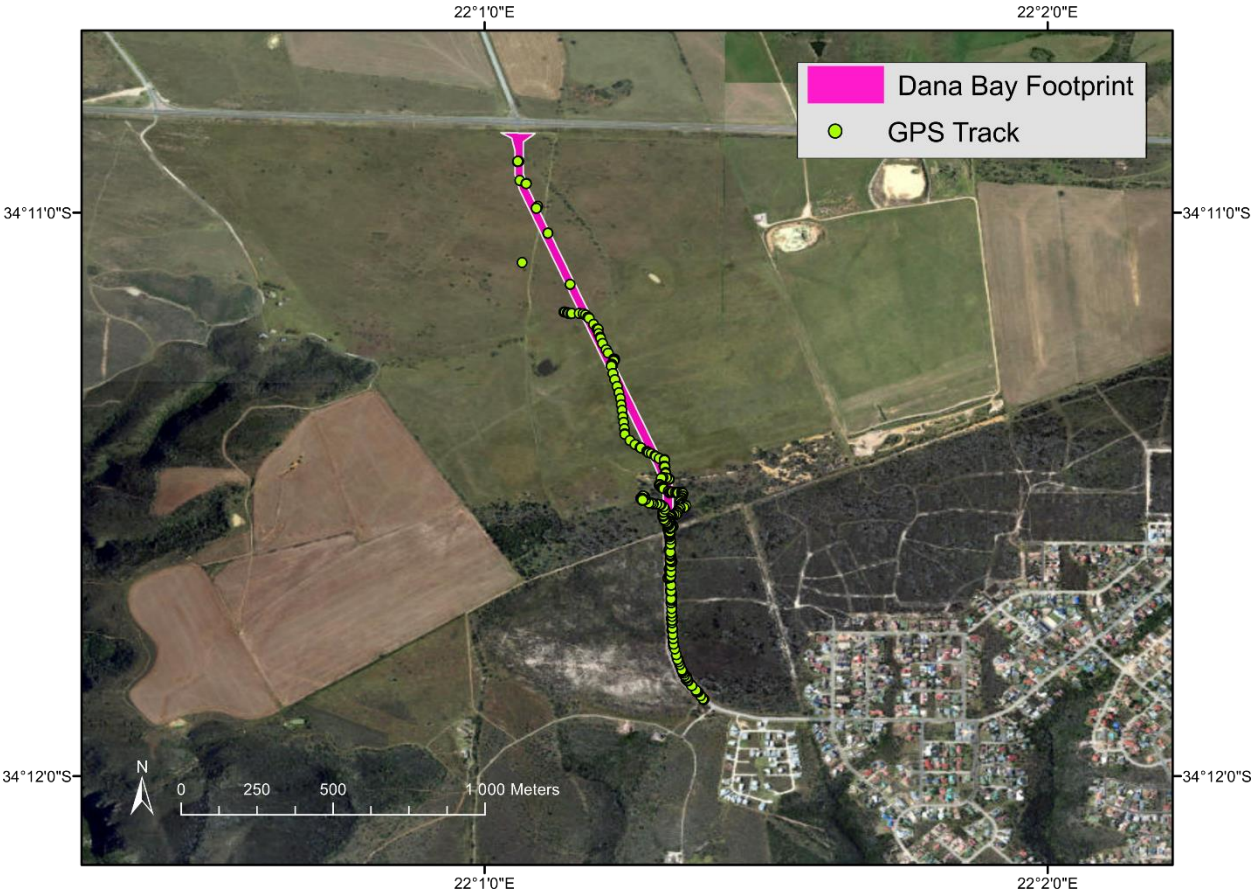

Figure 3. The GPS track walked by specialists on 28 September 2022.

4. RESULTS

4.1 ASSUMPTIONS AND LIMITATIONS

- It is assumed that all third-party information used (e.g. GIS data and species historical records) was correct at the time of generating this report.
- A site visit was undertaken during spring (late September) on a warm and sunny day, ideal for most invertebrate SCC activity. Undertaking a site visit in spring is an ideal time to detect most of the listed invertebrate SCC at the project site.

4.2. DESKTOP STUDY

The main vegetation type of the project area following SANBI (2018) and Skowno *et al.* (2019) is:

- North Langeberg Sandstone Fynbos (Least Concern)
- Canca Limestone Fynbos (Least Concern)
- Hartenbos Dune Thicket (Least Concern)

4.2.1 INVERTEBRATE SPECIES OF CONSERVATION CONCERN (SCC)

Orthoptera:

Aneuryphymus montanus (Brown 1960) Yellow-winged Agile Grasshopper

- This species of grasshopper is endemic to South Africa and has an IUCN Red List Category and Criteria of **Vulnerable** B2ab (iii,v) (Hochkirch *et al.*, 2018).
- Within South Africa, the species has a broad distribution occurring across mountainous habitats of the "Cape Region" from the north-western winter-rainfall areas near Clanwilliam, eastwards until just before East London (Brown, 1960). The species appears to be associated with several fynbos vegetation types (e.g., Leipoldtville Sand Fynbos, Kogelberg Sandstone Fynbos) and "south-facing cool slopes" (Kinvig, 2005).
- It has a large estimated extent of occurrence of 172463km^2 and its estimated geographic range overlaps the project area (Bazelet and Naskrecki, 2014).
- The species has not been historically recorded from near the project area; the closest known historical record is approximately 94km northwards, with the closest known coastal record 215km eastwards in Tsitsikamma Sandstone Fynbos.
- Two individuals were, however, possibly located near the southern portion of the project site during the first faunal assessment by chepri (Pty) Ltd (2022; Fig. 18). Species identification awaits confirmation and photographs of the individuals found are still to be uploaded to an online repository, such as iNaturalist.

Lepidoptera:

Sensitive species 13

- This species of butterfly is a endemic to South Africa and has an IUCN Red List Category and Criteria of **Endangered** B1ab(ii,iii,iv,v). [**Please Note: Citations for published literature related to this sensitive species have been withheld to protect its identity and can be requested from the author of this report if needed].
- Within South Africa, the species is known only from a single restricted area along the south coast of the Western Cape Province.
- Associated ant: *Crematogaster peringueyi*.
- It has an estimated extent of occurrence of 20km^2 and the closet record to the project area is ~110km away.

Aloeides thyra orientis Pringle 1994 (Eastern Red Russet)

- This species of butterfly is endemic to South Africa and has an IUCN Red List Category and Criteria of **Endangered** B1ab(ii,iii,iv,v) (Mecenero *et al.*, 2013, 2020).
- The species has a known distribution from around ten localities within south coastal areas (Witsand and Mossel Bay to Knysna) (Mecenero *et al.*, 2013).
- The species appears to be associated with several fynbos vegetation types, including Canca Limestone Fynbos, which is found at the project site.
- No published information is known for larval food plants or ant associations.
- It has an estimated extent of occurrence of >500km^2 across several highly fragmented populations (Mecenero *et al.*, 2013).
- The species has not been historically recorded from the project area; the closest known record is approximately 22km away.

- An individuals was, however, located near the southern portion of the project site during the first faunal assessment by chepri (Pty) Ltd (2022; Fig. 18). Species identification awaits confirmation and a photograph of the individual found is still to be uploaded to an online repository, such as iNaturalist or LepiMAP.

Lepidochrysops littoralis Swanepoel & Vári, 1983 (Coastal Giant Cupid)

- This species of butterfly is endemic to South Africa and has an IUCN Red List Category and Criteria of **Endangered** B1ab(ii,iii,iv,v)+2ab(ii,iii,iv,v) (Edge, 2018; Mecenero *et al.*, 2020).
- Within South Africa, the species has a narrow distribution range along the south coast of the Western Cape Province occurring from De Hoop Nature Reserve to Mossel Bay.
- The species appears to be associated with several coastal vegetation types, including Hartenbos Dune Thicket, which is found at the project site.
- Little is known about the lifecycle of this butterfly, but it is likely associated with *Camponotus* ants and its foodplant is likely a species of *Selago*, *Pseudoselago* or *Aspalathus*.
- It has an estimated extent of occurrence of 2488km^2, with several highly fragmented populations found across this area (Edge, 2018; Mecenero *et al.*, 2013).
- The species has not been historically recorded from the project area; the closest known record is approximately 20km eastwards from Hartenbos Dune Thicket.

4.3 FIELD SITE VISIT

- The weather was warm and sunny, conducive to insect activity.
- All areas across the project development were investigated, and several sites were sampled for invertebrate SCC and chosen to provide representative photographs (Figures 4 -14).
- Habitat characteristics and likelihood of any of the invertebrate SCC being found around each picture site is provided below.
- Overview of locations of these photographs. Note that photos towards the edge of the project area are taken looking into the project area, and thus the areas represented are far more than simply the footprint of the photographer.

Figure 4. The northern section of the proposed access road looking towards the N2. This area is highly disturbed and consists of old fallow lands currently grazed by cattle, as evidenced by the large amount of dung.

Figure 5. Past mechanical clearing of vegetation is evident. The area consists of grass pastures and low growing shrubs. [GPS: S34.18183 E32.01766].

Figure 6. Exposed TMS in the fallow fields. Looking south across the homogenous habitat of the northern parts of the road project. A family of bat-eared foxes were (*Otocyon megalotis*) were spotted near here. [GPS: 34.18395 E22.01855].

Figure 7. Specialist walking along a dirt road approximately a third of the way down the proposed access road heading south. Looking back over the northern section of the project area towards the PetroSA refinery.

Figure 8. Transitional zone between fallow fields and degraded senescent fynbos, with evidence of encroachment of alien invasive plant species (*Acacia cyclops* (rooikrans)). The vegetation is dense here and considered as less favourable habitat for any of the invertebrate SCC. [GPS: 34.19086 E22.02200].

Figure 9. *Crematogaster peringueyi* arboreal ant nest seen in the Canca Limestone Fynbos habitat of the project area. Several of these ant nests were seen and potentially could be translocated outside of the project footprint through search-and-rescue as a mitigation measure. Specialist standing near ant nest to show general vegetation hight. [GPS: S34.191490 E22.021980].

Figure 10. Current fences in place in the southern parts of the access road. The vegetation in this area is the start of high-quality fynbos habitat for the four invertebrate SCC. [GPS: S34.19299 E22.02217].

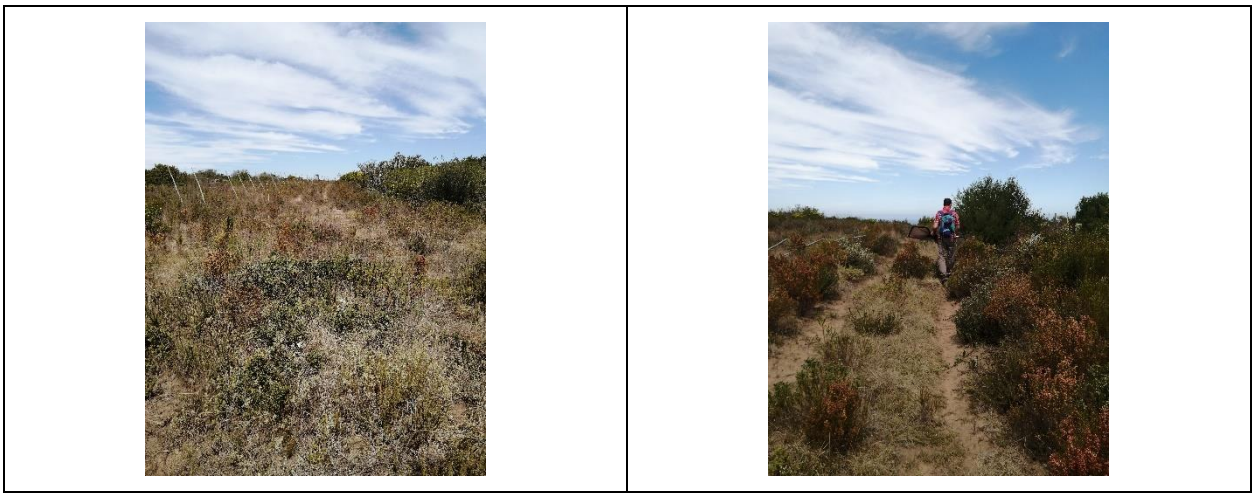

Figure 11. Looking southwards down the existing dirt road. Specialist walking down existing dirt road southwards. The evidence of large alien plant trees in this habitat is of high concern for the invertebrate SCC. [GPS: 34.19276 E22.02213].

Figure 12. Looking south down the existing sand road. Specialist looking for a specimen of Protea Scarlet butterfly (*Capys alphaeus alphaeus*) seen flying near a large *Leucospermum praecox* bush; this species can be confused with the SCC butterfly *Aloeides thyra orientis* flagged for this project. [GPS: S34.19384 E22.02217].

Figure 13. High-quality fynbos is found in the southern areas of the project area either side of the existing dirt road and fence. Two parallel dirt roads run from this area to the southern end of the proposed access road. [GPS: S34.19570 E.22.02223].

Figure 14. The southern area of the road ends along a grass-covered road and locked access gate near the Dana Bay residential area.

4.3.1 SCC Located at the Project Area

- The only invertebrate SCC listed by the screen tool for this project located during the site visit was the butterfly SCC *Lepidochrysops littoralis*; a female was collected approximately 50m from the proposed road (Figure 1). [Record submitted to LepiMAp: VM-Upload No.: 836939]. This record confirms that potentially two of the butterfly SCC flagged by the screening tool for this project occur within the project area (see faunal assessment report by chepri (Pty) Ltd (2022)).
- Several other butterfly species were also observed at the project area:
    - *Zizeeria knysna knysna* (African Grass Blue)
    - *Capys alphaeus alphaeus* (Protea Scarlet)
    - *Vanessa cardui* (Painted Lady)
    - *Pseudonympha magus* (Silver-bottom Brown)

    - *Cassionympha detecta* (Cape Dull Brown)
    - *Colias electo electo* (African Clouded Yellow)
- Denham's Bustard (*Neotis denhami*), a bird SCC flagged by the screening tool for this project, was also recorded in the fallow fields close to the northern parts of the project area, with two individuals flushed (Figure 1). [SABAP2 Observational record submitted and accepted: Card Number: 3410_2200a022118a20220928].
- A Black Harrier (*Circus maurus*), another bird species of high conservation concern, although not flagged by the screening tool for this project, was also recorded near the northern section of the project area (Figure 1). [SABAP2 Observational record submitted and accepted: Card Number: 3410_2200a022118a20220928].

4.4 Assessment of Impacts

The access road will fall mainly (~70% of its length) over degraded old fallow land. The remaining ~30% falling along the southern areas of the project will fall over high-quality fynbos habitat. From a faunal (invertebrate) perspective, the overall impact of the proposed development along the degraded section is considered of low significance. The impact along the fynbos habitat is considered medium, but of low significance once mitigation is considered. Of higher concern for the invertebrate SCC is the presence of alien plant encroachment into the good quality fynbos habitat. The overall footprint of the access road is relatively small in relation to the potential high negative impact of continued alien plant encroachment across the high-quality fynbos habitat. Removal of these plants from the development area would have a positive impact on local invertebrate SCC populations.

4.4.1 Construction Phase Impacts

Relatively small areas of invertebrate SCC habitat (natural vegetation) will be negatively affected during the construction phase. The 'No-Go' or 'leave as is' option would potentially see the high-quality fynbos habitat of the project area becoming overgrown with invasive alien trees if no alien plant management plan is earmarked for future implementation. The encroachment of alien plants would have significant long-term negative impacts and implications for the invertebrate SCC. The mitigation measure of removal and future monitoring of these alien plants would solve this issue.

Construction Phase		
Potential impacts on the local habitat and fauna:	**Alternative 1 (Preferred Alternative)**	**Alternative 2 (No-Go)**
Nature of impact:	Disturbance and habitat destruction associated with removal of natural vegetation, soil compaction and disturbance	Disturbance and habitat loss associated with continued alien plant encroachment of fynbos habitat
Consequence of impact or risk:	Loss of important sub-populations of butterfly SCC; Further fragmentation of sub-populations of butterfly SCC across habitats of the south coast	Loss of important sub-populations of butterfly SCC; Further fragmentation of sub-populations of butterfly SCC across habitats of the south coast
Determination of Extent (Scale):	Site specific	Local to possibly Regional
Determination of Duration:	Medium term	Long term
Determination of Probability:	Highly probable	Highly probable
Determination of Significance (without mitigation):	Low	Medium-High
Determination of Significance (with mitigation):	Low	Low
Determination of Reversibility:	Completely Reversible	Completely Reversible

Determination of Degree to which an Impact can be Mitigated:	Can be mitigated	Can be mitigated
Determination of Loss of Resources:	Marginal loss of resource	Significant loss of resources
Determination of Cumulative Impact:	Low	High
Determination of Consequence significance:	Low	High
Mitigation Measures:	• Clearing of natural vegetation should be prevented or to be kept to a minimum where necessary. • The smallest possible working corridor, particularly along the southern fynbos habitats, must be used. • No off-road driving should be allowed by construction vehicles. • All temporary/permanent fences to be erected will need to be of sufficient low height and mesh size to allow fauna (small rodents, antelope, etc.) to move freely through and to not act as a barrier to dispersal. The southern parts of the access road will bisect an area of fynbos and must not impede migration of the local fauna from and across the project area. • Any drainage/water run-off trenches required to be built alongside the road should be shallow and broad with low-angle sides (<30 degrees) so as not to trap fossorial invertebrates (e.g. dung beetles) and small vertebrates (e.g. snakes, tortoises). • Several arboreal ant nests of *Crematogaster peringueyi* were found at along the proposed road (Figure 9). Considering the importance of these ant nests for the larvae of certain butterflies, the nests could potentially be translocated through search-and-rescue to the immediate vicinity outside the road footprint. Some success has been achieved with this strategy in other parts of the Western Cape. A specialist (such as the author of this report) would need to be contracted for this. • Any alien vegetation found on the project area, particularly in the southern fynbos areas, should be removed by an alien plant clearing team during the construction phase; invasive alien plants are seen as a significant threat to the habitat of the invertebrate SCC (Hochkirch *et al.*, 2018; Mecenero *et al.*, 2013).	• Removal and future monitoring of alien plants, particularly from southern fynbos habitats.

4.4.2 Operation Phase Impacts

Considering that the access road will only be used in an emergency and that access will be controlled through locked gates, the impact significance during the operational phase of the proposed access road development is considered low. It should only have a very small and localised impact on populations of invertebrate SCCs and not affect their long-term viability and persistence in the area.

Continued monitoring and removal of alien plants would, however, be a key mitigation measure to be implemented after the construction phase.

Operational Phase		
Potential impacts on the local habitat and fauna:	**Alternative 1 (Preferred Alternative)**	**Alternative 2 (No-Go)**
Nature of impact:	Disturbance and possible road deaths associated with vehicle movements	Habitat loss associated with continued alien plant encroachment
Consequence of impact or risk:	General disturbance to faunal SCC; Loss of individuals of grasshopper SCC.	Loss of important sub-populations of butterfly SCC; Further fragmentation of sub-populations of butterfly SCC across habitats of the south coast
Determination of Extent (Scale):	Site specific	Local to possibly Regional
Determination of Duration:	Short term	Long term
Determination of Probability:	Improbable	Highly probable
Determination of Significance (without mitigation):	No significance	Medium-High
Determination of Significance (with mitigation):	No significance	Low
Determination of Reversibility:	Completely Reversible	Completely Reversible
Determination of Degree to which an Impact can be Mitigated:	Can be mitigated	Can be mitigated
Determination of Loss of Resources:	No loss of resource	Significant loss of resources
Determination of Cumulative Impact:	Negligible	High
Determination of Consequence significance:	Negligible	High
Mitigation Measures:	• Removal and future monitoring of alien plants, particularly from southern fynbos habitats.	• Removal and future monitoring of alien plants, particularly from southern fynbos habitats.

4.4.3 Cumulative Impacts

Although the development is considered of low significance for the four invertebrate SCC, it may become more significant if added to existing or future impacts from other activities in the area. Habitat loss in the south coastal areas of the Western Cape Province is considered the main threat faced by the three butterfly SCC flagged for this project. The proposed development will occur in a broader area within a mosaic of vegetation and habitat that is highly fragmented and disturbed through coastal development and agriculture, and alien plant infestations.

Currently, it seems unlikely that the addition of the proposed access road will contribute to a cumulative negative impact on the long-term viability of any of the populations of the SCC and their persistence. Mitigation measures would help to further reduced any cumulative negative impacts, particularly in terms of alien plant removal and monitoring. In this regard, removal and monitoring of alien plants would potentially have a larger long-term positive impact offsetting any smaller short-term negative impacts from the access road development.

5. Impact Statement

The proposed access road development is unlikely to generate significant negative impacts on any of the invertebrate SCC flagged for this project once mitigation is followed. It is the specialist's opinion that the proposed development will have an overall low significance on the four invertebrate SCC and

therefore the proposed development can be approved in terms of the specific theme of this terrestrial animal species assessment.

6. ACKNOWLEDGMENTS

Andrew Morton (Chairman of the Western Cape Lepidopterist Society) assisted with site surveying and provided valuable input concerning butterfly taxa of conservation importance associated with the project area. CapeNature is thanked for research collection permits: CN44-87-20545 and CN44-59-13497.

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APPENDIX – 1

3. Methodology to determine the significance ratings of the potential environmental impacts and risks associated with the alternatives.

Describe the methodology to be used in determining and ranking the nature, significance, consequences, extent, duration of the potential environmental impacts and risks associated with the proposed activity or development and alternatives, the degree to which the impact or risk can be reversed and the degree to which the impact and risk may cause irreplaceable loss of resources.
The assessment criteria utilised in this environmental impact assessment is based on, and adapted from, the *Guideline on Impact Significance, Integrated Environmental Management Information Series 5* (Department of Environmental Affairs and Tourism (DEAT), 2002) and the *Guideline 5: Assessment of Alternatives and Impacts in Support of the Environmental Impact Assessment Regulations* (DEAT, 2006).

Determination of Extent (Scale):

Site specific	On site or within 100 m of the site boundary, but not beyond the property boundaries.
Local	The impacted area includes the whole or a measurable portion of the site and property, but could affect the area surrounding the development, including the neighbouring properties and wider municipal area.
Regional	The impact would affect the broader region (e.g. neighbouring towns) beyond the boundaries of the adjacent properties.
National	The impact would affect the whole country (if applicable).

Determination of Duration:

Temporary	The impact will be limited to the construction phase.
Short term	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than 8 months after the completion of the construction phase.
Medium term	The impact will last up to the end of the construction phase, where after it will be entirely negated in a period shorter than 3 years after the completion of construction activities.
Long term	The impact will continue for the entire operational lifetime of the development but will be mitigated by direct human action or by natural processes thereafter.
Permanent	This is the only class of impact that will be non-transitory. Such impacts are regarded to be irreversible, irrespective of what mitigation is applied.

Determination of Duration:

Temporary	The impact will be limited to the construction phase.
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Long term	The impact will continue for the entire operational lifetime of the development but will be mitigated by direct human action or by natural processes thereafter.
Permanent	This is the only class of impact that will be non-transitory. Such impacts are regarded to be irreversible, irrespective of what mitigation is applied.

Determination of Probability:

Improbable	The possibility of the impact occurring is very low, due either to the circumstances, design or experience.
Probable	There is a possibility that the impact will occur to the extent that provisions must therefore be made.
Highly probable	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up to mitigate the activity before the activity commences.
Definite	The impact will take place regardless of any prevention plans.

Determination of Significance (without mitigation):

No significance	The impact is not substantial and does not require any mitigation action.
Low	The impact is of little importance, but may require limited mitigation.
Medium	The impact is of sufficient importance and is therefore considered to have a negative impact. Mitigation is required to reduce the negative impacts to acceptable levels.
Medium-High	The impact is of high importance and is therefore considered to have a negative impact. Mitigation is required to manage the negative impacts to acceptable levels.
High	The impact is of great importance. Failure to mitigate, with the objective of reducing the impact to acceptable levels, could render the entire development option or entire project proposal unacceptable. Mitigation is therefore essential.

Very High	The impact is critical. Mitigation measures cannot reduce the impact to acceptable levels. As such the impact renders the proposal unacceptable.

Determination of Significance (with mitigation):

No significance	The impact will be mitigated to the point where it is regarded to be insubstantial.
Low	The impact will be mitigated to the point where it is of limited importance.
Medium	Notwithstanding the successful implementation of the mitigation measures, the impact will remain of significance. However, taken within the overall context of the project, such a persistent impact does not constitute a fatal flaw.
High	Mitigation of the impact is not possible on a cost-effective basis. The impact continues to be of great importance, and, taken within the overall context of the project, is considered to be a fatal flaw in the project proposal.

Determination of Reversibility:

Completely Reversible	The impact is reversible with implementation of minor mitigation measures
Partly Reversible	The impact is partly reversible but more intense mitigation measures
Barely Reversible	The impact is unlikely to be reversed even with intense mitigation measures
Irreversible	The impact is irreversible and no mitigation measures exist

Determination of Degree to which an Impact can be Mitigated:

Can be mitigated	The impact is reversible with implementation of minor mitigation measures
Can be partly mitigated	The impact is partly reversible but more intense mitigation measures
Can be barely mitigated	The impact is unlikely to be reversed even with intense mitigation measures
Not able to mitigate	The impact is irreversible, and no mitigation measures exist

Determination of Loss of Resources:

No loss of resource	The impact will not result in the loss of any resources
Marginal loss of resource	The impact will result in marginal loss of resources
Significant loss of resources	The impact will result in significant loss of resources
Complete loss of resources	The impact will result in a complete loss of all resources

Determination of Cumulative Impact:

Negligible	The impact would result in negligible to no cumulative effects

Determination of Cumulative Impact:

Negligible	The impact would result in negligible to no cumulative effects

Low	The impact would result in insignificant cumulative effects
Medium	The impact would result in minor cumulative effects
High	The impact would result in significant cumulative effects

Determination of Consequence significance:

Negligible	The impact would result in negligible to no consequences
Low	The impact would result in insignificant consequences
Medium	The impact would result in minor consequences
High	The impact would result in significant consequences

APPENDIX – 2
CURRICULUM VITAE – JONATHAN F. COLVILLE

EDUCATION

PhD (Zoology): University of Cape Town, 2009. Thesis title: "*Understanding the evolutionary radiation of the megadiverse monkey beetle fauna (Scarabaeidae: Hopliini) of South Africa*".

Postdoctoral research fellowship: South African National Biodiversity Institute, 2009-2010.

PRIOR EMPLOYMENT

National Research Foundation Research Career Advancement Fellow: South African National Biodiversity Institute (2014-2019).

Researcher, South African National Biodiversity Institute, GEF/UNEP/FAO Global Pollination Project – South Africa (2010-2014).

PUBLICATIONS

Books edited:

- Allsopp, N., **Colville, J.F.**, Verboom, G.T. (2014). *Fynbos: Ecology, Evolution, and Conservation of a Megadiverse Region* (16 chapters; pp 1-377). Oxford University Press.

Book chapters:

- Forest F., **Colville J.F.**, Cowling R.M. (2018). Evolutionary diversity patterns in the Cape Flora of South Africa. In: *Phylogenetic Diversity: Applications and challenges in biodiversity science*. R. Scherson, D. Faith (Eds), Springer International Publishing.
- Lebuhn, G., Connor, E.F., Brand, M., **Colville, J.F.**, Keday, D., Resham, B.T., Muo, K., Ravindra, K.J. (2015). Monitoring pollinators around the world. In: *Pollination services to agriculture*. B. Gemmill-Herren (Ed), Routledge.
- **Colville, J.F.**, Potts, A.J., Bradshaw, P.L., Measey, G.J., Snijman, D., Picker, M.D., Procheș, Ș., Bowie, R.C.K., Manning, J.C. (2014). Floristic and faunal Cape biochoria: do they exist? In: *Fynbos: Ecology, Evolution, and Conservation of a Megadiverse Region*. N. Allsopp, J.F. Colville, G.A. Verboom (Eds), Oxford University Press.
- Lach, L., Picker, M.D., **Colville, J.F.**, Allsopp, M.H., and Griffiths, C.L. (2002). Alien invertebrate animals in South Africa. In: *Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species*. D. Pimentel (Ed), CRC Press, London.

Journal articles:

- Barraclough, D.A., and **Colville, J.F**. (2022). The first species of Nemestrinidae (Diptera) endemic to Madagascar: A remarkable new species of *Atriadops* Wandolleck, 1897. *Zootaxa*. 5196 (1): 145–150.
- Dombrow, H., **Colville, J.F**., Bowie, R.C.K. (2022). Review of the genus *Amblymelanoplia* Dombrow, 2002 (Coleoptera: Scarabaeidae: Melolonthinae: Hopliini) with the description of ninety-three new species from South Africa and observations on its biogeography and phylogeny. *Zootaxa*. 5163 (1): 1-278.
- Melin, A., and **Colville, J.F**. (2022). Description of the male of *Rediviva steineri* Kuhlmann 2012 (Hymenoptera: Melittidae), an endemic oil-collecting bee species from South Africa. *African Entomology*. 30: e11178.

- Allen-Perkins, A., Magrach, A., Dainese, M., Garibaldi, L., … **Colville, J.F**., et al. (2022). CropPol: A dynamic, open, and global database on crop pollination. *Ecology*. 103, 3, e3614.
- Dorchin, N.; van Munster, S.; Klak, C.; Bowie, R.C.K.; **Colville, J.F**. (2022). Hidden diversity – A new speciose gall midge genus (Diptera: Cecidomyiidae) associated with succulent Aizoaceae in South Africa. *Insects*. 13, 75. https://doi.org/10.3390/insects13010075
- Cohen, C., Liltved, W.R., **Colville, J.F**., Shuttleworth, A., Weissflog, J., Svatos, A., Bytebier, B., Johnson, S.D. (2021). Sexual deception of a beetle pollinator through floral mimicry. *Current Biology*. 31: 1–8.
- Krenn, H.W., Karolyi, F., Lampert, P., Melin, A., **Colville, J.F**. (2021). Nectar uptake of a long-proboscid *Prosoeca* fly (Nemestrinidae) – Proboscis morphology and flower shape. *Insects*. 12(371): 1–13.
- McLeod, L., and **Colville, J.F.** (2021). Observations on unusual feeding and mating behaviour of a monkey beetle genus *Amblymelanoplia* Dombrow (Coleoptera: Scarabaeidae: Hopliini). *African Entomology*. 29(1): 301–306.
- **Colville, J.F**., Beale, C.M., Forest, F., Altwegg, R., Huntley, B., Cowling, R.M. (2020). Plant species richness, turnover and evolutionary diversity track gradients of stability and ecological opportunity in a megadiversity centre. *Proceedings of the National Academy of Sciences* (*PNAS)*. 117 (33): 20027–20037.
- Dombrow, H. & **Colville, J.F.** (2020). Review of the genus *Beckhoplia* Dombrow with the description of fifteen new species from South Africa and observations on its biogeography (Coleoptera: Scarabaeidae: Melolonthinae: Hopliini). *Zootaxa*. 4823(1): 1-64.
- Melin, A., Altwegg, R., Manning, J.C., and **Colville, J.F.** (2020). Allometric relationships shape foreleg evolution of long-legged oil bees (Melittidae: *Rediviva*). *Evolution*. https://doi.org/10.1111/evo.14144.
- Melin, A. & **Colville, J.F**. (2020). A nesting aggregation of *Rediviva intermixta* (Melittinae: Melittidae) with males sleeping together in nests (Namaqualand, South Africa). *The Journal of the Kansas Entomological Society*. 92 (3): 561–568.
- Melin, A., **Colville, J.F**., Duckworth, G.D.; Altwegg, R.; Slabbert, R.; Midgley, J.J.; Rouget, M.; Donaldson, J.S. (2020). Diversity of pollen sources used by managed honeybees in variegated landscapes. *Journal of Apicultural Research*. Doi10.1080\00218839.2020.1750757.
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- Melin, A. & **Colville, J.F.** (2019). A review of 250 years of Southern African bee taxonomy and exploration (Hymenoptera: Apoidea: Anthophila). *Transactions of the Royal Society of South Africa*. 74:1, 86-96. [**Featured on Cover Page**]
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- Barraclough, D., **Colville, J.F.**, Karolyi, F., Krenn, H.W. (2018). A striking new species of *Prosoeca* Schiner, 1867 (Diptera: Nemestrinidae): An important pollinator from the Bokkeveld Plateau, Northern Cape Province, South Africa. *Zootaxa* 4497: 411–421.
- **Colville, J.F.**, Picker, M.D., Cowling, R.M. (2018). Feeding ecology and sexual dimorphism in a speciose flower beetle clade (Hopliini: Scarabaeidae). *PeerJ*: 6:e4632.
- Melin, A., Mathieu, R., **Colville, J.F**., Midgley, J.J., Donaldson, J.S. (2018). Quantifying and evaluating distributed floral resources for managed honeybee pollination using an expanded concept of supporting ecosystem services. *PeerJ*: e5654.
- Cowling, R.M, Bradshaw, P.L., **Colville, J.F.**, Forest, F. (2017). Levyns' Law: Explaining the evolution of a remarkable longitudinal gradient in Cape plant diversity. *Transactions of the Royal Society of South Africa*. 72: 184-201.
- Treurnicht M., **Colville J.F.**, Joppa L.N., Huyser O., Manning J.C. (2017) Counting complete? Finalising the plant inventory of a global biodiversity hotspot. *PeerJ:* 5:e2984.
- Janion-Scheepers, C., Measey, G.J., Braschler, B., Chown, S.L., Coetzee, L., **Colville, J.F.**, Dames, J., Davies, A.B., *et al*. (2016). Soil biota in a megadiverse country: Current knowledge and future research directions in South Africa. *Pedobiologia*. 59: 129-174.
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- Forest, F., Goldblatt, P., Manning, J.C., Baker, D., **Colville, J.F.**, Devey, D.S., Jose, S., Kaye, M., Buerki, S. (2014). Pollinator shifts as trigger of speciation in painted petal irises (*Lapeirousia*: Iridaceae). *Annals of Botany*. 113: 357-71.
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- **Colville, J.F.**, Picker, M.D., Cowling, R.M. (2002). Species turnover of monkey-beetles (Scarabaeidae: Hopliini) along environmental and disturbance gradients in the Namaqualand region of the Succulent Karoo, South Africa. *Biodiversity and Conservation*. 11: 243–264.
- Picker, M.D., **Colville, J.F.**, van Noort, S. (2002). Mantophasmatodea now in South Africa. *Science*. 297: 1475.

Technical reports:

- **Colville, J.F.**, and Cohen, C. (2022). Terrestrial Biodiversity Specialist Assessment. Duyker Eiland Prospecting Rights. Prepared for Elemental Sustainability (Pty) Ltd.
- **Colville, J.F.**, and Cohen, C. (2022). Terrestrial Animal Species Specialist Assessment. Proposed mixed use housing development. Prepared for EcoSense CC.

- **Colville, J.F.**, and Cohen, C. (2022). Terrestrial Animal Species Specialist Assessment. Proposed agricultural development. Prepared for McGregor Environmental Services.
- **Colville, J.F.**, and Cohen, C. (2022). Terrestrial Animal Species Specialist Assessment. Blue Sky's Project Prepared for Doug Jeffery – Environmental Consultants.
- **Colville, J.F.**, and Cohen, C. (2022). Terrestrial Animal Species Specialist Assessment. Proposed Expansion of Nature's View Dam near Citrusdal. Prepared for Earth Grace Environmental Consultancy.
- **Colville, J.F.** (2021). Terrestrial Animal Species Specialist Assessment. Proposed enlargement of existing Kleigat Dam. Prepared for Earth Grace Environmental Consultancy.
- **Colville, J.F.** (2021). Terrestrial Animal Species Specialist Assessment. Moorreesburg Wastewater Treatment Works Upgrade Project. Prepared for Zutari (Pty) Ltd.
- **Colville, J.F.** (2021). Terrestrial Animal Species Specialist Assessment. Maxnau Citrus Development. Prepared for Charl de Villiers Environmental Consulting.
- **Colville, J.F.** (2021). Terrestrial Animal Species Specialist Assessment. Gletwyn Estate Mixed Use Development. Prepared for Johan Neethling Environmental Services cc.
- **Colville, J.F.** (2021). Terrestrial Animal Species Specialist Assessment. Moorreesburg Wastewater Treatment Works Upgrade Project. Prepared for Zutari (Pty) Ltd.
- **Colville, J.F.** (2021). Terrestrial Animal Species Specialist Assessment. Proposed Development of Solar Photo-Voltaic Renewable Energy Power Station. Prepared for Resource Management Services (RMS).
- **Colville, J.F.** & Picker, M.D. (2009-2010). *Invertebrate impact assessment – Oudekraal, Table Mountain*. Prepared for Doug Jeffery Environmental Consultants.
- Picker, M.D. & **Colville, J.F.** (2007). *Invertebrate impact assessment: Worcester Island Development*. SRK Environmental impact report for Consulting Engineers and Scientists, Cape Town.
- Picker, M.D. & **Colville, J.F.** (2006). *Baseline faunal investigation for proposed development at Altona, Worcester, Western Cape Province*. Environmental impact report for SRK Consulting Engineers and Scientists, Cape Town.
- **Colville, J.F.** & Picker, M.D. (2005). *Scoping Phase II: The impact of development of Worcester on the insect and scorpion fauna*. Environmental impact report for Chand Environmental Consultants, Cape Town.
- **Colville, J.F.** (2001) *Scoping and faunal assessment for proposed housing development, Skapenberg, Somerset West*. Prepared for Design consultants CNdV Africa

MEMBERSHIPS/RESEARCH ASSOCIATE

- Membership of Entomological Society of Southern Africa (2007-current).
- Membership of Lepidopterists Society of Southern Africa (2014-current).
- Honorary Research Associate (HRA), Statistics in Ecology, Environment and Conservation (SEEC), Department of Statistical Sciences, UCT (2014-current).
- SACNASP registration for Ecological Science (Professional Natural Scientist) (member#: 134759).

PROFESSIONAL SERVICES

- Editorial board *African Entomology* (2010-current).
- Editorial board *Metamorphosis* (2017-current).
- Editorial board *PeerJ* (2019-current).
- CAPE Invasive Alien Animal (IAA) Working Group (2016-2018).