2019
Strategic Environmental Assessment for Marine and Freshwater Aquaculture Development in South Africa

APPENDIX A-3

Archaeology, Palaeontology and Cultural Heritage Specialist Assessment

Archaeology, Palaeontology and Cultural Heritage Specialist Assessment

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1 SUMMARY

This chapter aims to provide, at a high level, a measure of scoping and assessment of heritage sensitivity across the seventeen study areas identified as possible locations for accelerated aquaculture development across the country. While the scope of this project is large, several useful outcomes in terms of heritage have resulted from this work, and these are listed below.

This report has relied on, and made extensive use of, several important tools – the South African Heritage Resources Agency's (SAHRA) South African Heritage Resources Information System (SAHRIS) (SAHRA 2017), the SAHRIS Palaeosensitivity Map (SAHRA 2014) and the international wreck database (Wrecksite 2017). These resources are available to heritage practitioners, developers and the general public and provide valuable information about the likely impacts to heritage resources. They are, further, able to provide location information on declared and formally protected heritage sites, such as Grade I and II sites, such that these can be avoided. Thus, if employed at the earliest conceptual phase of a development, as is required in terms of Section 38(1) of the National Heritage Resources Act, 1999 (Act No. 25 of 1999) (NHRA), these tools can be used proactively to plan developments responsibly.

While these resources do not fulfil the requirements of the heritage legislation in terms of assessing heritage resources in a given area, nor of determining the specific impacts to those resources likely to result from a given development, they do characterise the variable heritage sensitivities across the country, and provide the opportunity to implement no-go and buffer areas at the planning stage.

A range of heritage studies, from site specific desktop assessments to full scale Heritage Impact Assessments (HIA) will likely need to be conducted for each development application prior to development. Heritage resources are particularly poorly suited to large scale, high level assessments such as this one, and to blanket exemptions from due consideration. Rather they require site specific assessment, at a point in the development process where the project-specific impacts can be analysed and assessed. To facilitate this, a heritage consultant should be an initial member of an aquaculture/mariculture project design team to ensure that heritage issues are addressed before committing to construction. The appropriate type of specific heritage report that will be required for each development application will have to be determined by the relevant Heritage Authority (HA) based on the project information and location on a case by case basis. If an Environmental Impact Assessment (EIA) is required, then an area specific HIA may be necessary in terms of Section 38(8) of the NHRA. If no EIA is required, then an area specific HIA may be required by the relevant HA in terms of Section 38(1). **See Section 6.3. Limits of Acceptable Change.**

SAHRA should be the commenting authority for all aquaculture developments arising from this process and located within the identified study areas. It is proposed that, wherever possible, SAHRA enter into specific Memoranda of Understanding with each of the affected Provincial Heritage Resources Authorities (PHRAs) to allow SAHRA to be the commenting body in each instance, with relevant PHRA input. In practice, such an arrangement will see PHRAs submit their comments to SAHRA for collation into an integrated comment. The existence of the NHRA and the compliance procedures legislated therein mean that blanket exemptions from process are not possible for heritage resources under an SEA based on the National Environmental Management Act, 2009 (Act No. 14 of 2009) (NEMA), however, this arrangement will reduce red tape and turnaround times in processing these applications. **See Section 7.1. Planning phase.**

Impacts of aquaculture developments are likely to be severe and permanent on affected archaeological and palaeontological resources. While impacts will be variable on all types of heritage resources, and dependent on the type of aquaculture system being implemented, it is likely that they will be most profound on archaeological and palaeontological heritage resources. As these resources are finite and irreplaceable, these impacts will be permanent and irreversible. Further to this, mitigation, in any form other than preservation *in situ*, will still result in impacts to these resources. Useful mapping resources are freely available online that enable applicants to determine the likelihood of their proposed development impacting known heritage sites and features. SAHRIS can be used to determine the location of all known heritage sites, while the SAHRIS Palaeosensitivity map (SAHRA 2014) can be used to establish the

palaeontological sensitivity of the receiving environment. **See Sections 6.3.1 Palaeontology and 6.3.2 Archaeology.**

The degree of impacts from offshore and nearshore developments on shipwrecks cannot be determined with any accuracy at this level of study. It is recommended that any off- and nearshore developments are subject to desktop studies with specific input from a maritime archaeologist to determine the likelihood of the proposed development impacting maritime and underwater heritage resources and proposing the appropriate mitigation measures. These deskbased assessments should include the review of available geophysical and/or geotechnical data. **See Section 5 Key potential impacts and their mitigation.**

Graves and graveyards, which are likely to be common occurrences throughout the study areas, should be considered of high local significance in all cases, and preserved *in situ* in all instances. Whether graves are known, or located within marked graveyards, or are unknown and identified during field surveys, every effort should be made to preserve these *in situ*, and not disturb, damage, or move them. Instances where this is unavoidable should be identified during the HIA process, and in these instances, or where graves are accidentally encountered during development activities, the appropriate measures should be followed in accordance with Section 38 of the NHRA. **See Section 6.3.4 Graves.**

Built environment and cultural landscapes will require specific assessment prior to development proceeding in each instance, as these aspects could not be adequately assessed in this study. Site specific assessments, which may include detailed landscape character analysis, will need to be conducted of built environment features and cultural landscapes. These assessments will form part of the HIA conducted for each proposed development. **See Sections 6.3.5 Built heritage and 6.3.6 Cultural landscapes.**

This study characterises the heritage landscape for each study area in terms of the above resources, and provides sensitivity maps that account for the known instances of these heritage resources. In this way, it provides a means, at a broad level, to identify the locations, and types of heritage resources that should be taken into consideration at the planning phase of aquaculture development in order to ensure that projects are not subject to costly and time consuming delays.

2 INTRODUCTION

Heritage is a non-renewable and irreplaceable resource, and, as such, the loss of any evidence for the human past is an irretrievable loss, the extent of which, though in some way linked to the sphere and degree of significance of that resource, is nonetheless variable and hard to quantify. For this reason, mitigation, in the form of complete or partial preservation of the resource *in situ,* at one end of the scale, to partial or complete preservation of the resource in record only - through excavation, photographing, describing and recording, is always preferable to destruction without mitigation. Indeed, protection of cultural heritage is mandated by law, with permits required before alteration to, or damage of, these resources is allowed (Section 48(2) of the NHRA, and punitive measures can be implemented against those guilty of breaking this law (Section 51(1) of the NHRA).

South African heritage, as defined in Sections 2 and 3 of the NHRA, forms an integral, part of our identity as South Africans living in this country and, further, as people on this planet, and the South African archaeological and palaeontological record is one of the richest and most scientifically valuable on earth (Deacon and Deacon 1999; Mitchell 2002). Therefore, beyond a simple legal obligation to identify, preserve and conserve this heritage, is a moral and ethical obligation.

Any development poses a possible risk to heritage resources that may exist there, particularly in rural areas that have not been subject to intensive, recent human activity. Areas suitable for aquaculture, particularly, are likely to contain archaeological, historical and further cultural heritage resources. This is due to the fact that the very feature that is central to inland fish farming, namely access to freshwater, has been a deciding factor in the preferential exploitation and settlement of the landscape throughout time (Mitchell 2002). Similarly, the successful farming of marine resources depends on areas where wild marine populations thrive, and these too would have been preferentially sought out by all people throughout time as food sources (Parkington 2006; Bailey and Parkington 2009). As such, one can expect palaeo-anthroplogical and archaeological heritage resources to occur both at coastal and inland sites earmarked for aquaculture. More recently, in historic times, coastal areas with abundant fish and shellfish have been settled by fishing communities, while inland areas with abundant freshwater were often preferentially settled for farming, meaning that historic towns, farms and associated structures can be expected as well.

At coastal sites, further heritage resources are to be expected in the form of shipwrecks, many of which relate to the earliest European navigation round the Cape and settlement there. These sites have international significance as markers of global trade systems and imperial expansion, but also speak to the development of local maritime trade. All shipwrecks are part of the national estate and are recognised as Grade I resources, in terms of Section 7 of the NHRA, and protected and managed by SAHRA. SAHRA maintains a lists of known wrecks around the coast, as well as their geographic co-ordinates, where these are known. Some of these are mapped on SAHRIS (SAHRA 2017), while other site location can be obtained from the international shipwreck database (Wrecksite 2017). Wrecks include numerous types of vessels, at varying depths and distances off shore, and in varying states of preservation.

The final layer of significant heritage that could be affected by these developments comprises the layered cultural landscape that reflects the tapestry of interplay between people and the landscape through time. The effect of people on their landscape, and the restrictions and possibilities the landscape exerts on people results in a unique combination of tangible and intangible characteristics that give each location its particular visual heritage character and sense of place. New, potentially visually intrusive developments in such landscapes can cause irrevocable shifts and rifts in this sense of place that has developed gradually, through more appropriate landscape interventions, through time.

Given a long historic relationship with a surrounding landscape, communities imbue sites and routes associated with use of natural resources - such as hunting, fishing, wood collection, water collection (rivers and springs), herb collection, medicinal plant collection (which would be inextricably linked to the indigenous knowledge of herbal medicine) and similar activities - with intense cultural significance (E. Bailey, Hearth Heritage, pers.comm. 20 October 2017). The relationship of these people with their environment is part of their identity, understanding of the world, their religion, their lifeways, while the way they use their landscape is inextricably linked to their culture, history, beliefs. It is important, when operating at such vast scale, not only to consider individual sites but the linkages and routes between them are also very significant. Built heritage may be considered a component of 'cultural landscape', especially where building complexes are set within particular contexts or have particular relationships to associated landscapes.

When considering impacts to cultural landscapes and built environment, local level, municipal planning, particularly by means of land use and zoning regulations, have a crucial role to play in guiding the responsible placement of future developments in the landscape. Areas that are prescreened, and have been demarcated for industrial development, such Industrial Development Zones (IDZ), or demarcated as ports, could prove preferential for aquaculture development, as concerns that sensitive cultural landscapes or built heritage might be adversely affected are reduced in these areas.

In those places internationally where robust environmental planning legislation is in place, the development of aquaculture infrastructure is subject to those laws which serve also to protect heritage. As such, countries with active aquaculture industries, such as Mauritius, Scotland and the United States, have recognised the expansion of aquaculture as a potential threat to cultural and heritage resources (Corner *et al.* 2013; Historic Environment Scotland 1999; Mauritius Department of Environment 2009; United States Department of Commerce, 2009).

In Scotland, for instance, the Environmental Impact Assessment Practical Guidelines Toolkit for Marine Fish Farming (Carse and Pogorzelec, 2007) identified possible threats of aquaculture development to cultural heritage as:

- Physical, chemical and/or biological impacts on terrestrial and submerged sites of
- archaeological interest or potential;
- Increased visual intrusion;
- Increased noise and disturbance;
- Changes in original landscapes and settings; and
- Loss of amenity.

The document further notes that the heritage assessments for aquaculture EIAs will require a scoping exercise, at a minimum, to "identify known historic assets including the relevant heritage designations in the study area and to make a qualitative assessment of the likely impact of the proposal on the importance and integrity of the resource" (Carse and Pogorzelec, 2007). At the time the document was released, Historic Scotland, the heritage authority responsible for the management of that country's heritage resources, was only "beginning to investigate the significance of the effects of aquaculture on marine cultural heritage resources and may issue its own guidance in due course" (ibid), although such aquaculture-specific guidelines have not as yet been compiled.

In South Africa, SAHRA and the nine Provincial Heritage Resource Agencies (PHRAs) are responsible for managing the impacts to heritage resources posed by all kinds of developments, aquaculture included, through adherence to the processes for heritage resource management proscribed in the NHRA.

To date (August 2017) SAHRIS (SAHRA 2017) lists eight aquaculture projects, two of which are for abalone, three for Reticulated Aquaculture System (RAS) fish farms (sturgeon, Nile tilapia and rainbow trout) and a further three for the establishment of Aquaculture Development Zones (ADZs), two of which are proposed offshore of Saldanha, and one which is land-based at Coega. The ADZs cover a range of proposed technologies, from raft and longline to cage culture in Saldanha Bay and flow through and RAS systems at Coega, as well as a variety of proposed species, from marine and freshwater finfish, to mussels, local scallops and abalone.

Of these eight projects, three have been assessed and approved by the relevant heritage authorities, three have been submitted and are awaiting assessment, while two are still in draft stage. A further two Heritage Impact Assessments exist on the SAHRIS system, but these have not yet been linked to specific development applications (SAHRA 2017). Each of these reports is site specific, and speaks to the heritage resources found at each location, rather than exploring the specific impacts of each kind of proposed development. As such, these reports are not particularly useful in this study for establishing likely sensitivities relative to proposed aquaculture technologies. The exception to this is the HIA for two offshore developments in Saldanha Bay (Sharfman 2016), which provides insight into the types of impacts offshore mariculture technologies can have on submerged heritage resources. Sharfman (2016) notes, "[o]bservations of the impact of mooring blocks on the seabed were made in Ilha de Mozambique, where comparable environmental conditions exist. While water currents resulted in some scouring of the seabed around mooring blocks, scour was shallow and negligible." Sharfman (2016) further provides a useful model for the assessment of impacts to shipwrecks, noting the location, significance and condition of each wreck, and tabulating these features to determine the likely risks to each, allowing for a variable, responsive approach to impacts to wrecks.

Given the link between the availability of fresh water on land, and edible marine resources at the coast, and human exploitation of these resources throughout history, it is clear that areas desirable for the development of aquaculture are likely to be areas that have been inhabited by humans and our hominid ancestors for thousands, and, even, millions of years. In many cases, people continue to live in these areas and make use of these same resources, lending these areas traditions and practices that are steeped in history. South Africa has an abundant, and internationally significant palaeontological record, and our coastline is littered with sailing vessels from the times of earliest trade between the western and eastern worlds, to more recent times. That aquaculture development will impact heritage resources, therefore, is evident, but an analysis of the location, type and significance of resources, and the degree of impact posed by each type of farming method, will enable us to determine preferential sites for the location of developments, in terms of heritage.

3 SCOPE OF THIS STRATEGIC ISSUE

This chapter seeks to summarise and document the heritage character of each of the 17 areas under assessment in this project. Due to the dispersed locations of these 17 areas, the heritage character of the study areas cannot be established as a single unit, nor as a contiguous entity. Rather, this heritage character is variable across the landscape, and reflects the interconnectedness of culture and nature (climate, topography, vegetation, minerals) across a country as large and mutable as South Africa.

Due to the macro-focus necessary in a high level study of this kind, there is not the scope to provide detailed assessment of all known heritage resources in each of the study areas, nor, given the range of technologies under review, to assess the impacts specific to each system exhaustively. Due to the dispersed nature of palaeontological resources across the country, and the link between human and hominid activity and fresh water and marine food resources, palaeontological and archaeological resources are the most likely to be impacted by aquaculture development. For this reason, the chapter is weighted in favour of assessment of archaeological and palaeontological resources, at the expense of assessment of built environment, cultural landscape and intangible heritage resources. These provisos should be kept in mind, although they are somewhat mitigated by the treatment of visual impacts on significant and sensitive landscapes in the Visual Assessment chapter, and of intangible and living heritage in the Socio-Economic Assessment chapter.

Section 38 of the NHRA prescribes the process to be followed in the event of developments that potentially impact heritage resources. In terms of Section 38(1), i.e. those instances where the application does not trigger other legislation such as the NEMA, the applicant must notify the relevant heritage authority of the proposed development at the earliest stages of the process. The relevant heritage authority is then required to respond within 14 days indicating whether or not heritage resources are likely to be impacted by the development, and if they are, indicating that a Heritage Impact Assessment in terms of Section 38(3) of the NHRA is required. Section 38(3) of the NHRA details the kind of information that must be submitted as part of a Heritage Impact Assessment (HIA).

In terms of Section 38(8) of the NHRA, for any proposed development that requires an Environmental Impact Assessment (EIA) in terms of NEMA, the consenting authority must ensure that the evaluation of impacts to heritage completed as part of the impact assessment fulfils the requirements of the relevant heritage resources authority in terms of Section 38(3) of the NHRA and any comments and recommendations of the relevant heritage resources authority with regard to such development have been taken into account prior to the granting of the consent. As this assessment seeks to contribute to a knowledge-base towards a potential relaxation of NEMA compliance requirements, it is foreseeable that Section 38(8) would not apply to this project, but rather the provisions of Section 38(1), (2), (3) and (4). As such, the assessment would be submitted to SAHRA and the relevant PHRAs in order to satisfy the requirements of Section 38(1) of the NHRA.

All specialist work that forms part of the requirements stipulated in Section 38(3) of the NHRA should conform to international best practice, while archaeological and palaeontological studies should also comply with SAHRA minimum standards for the archaeological and palaeontological components of impact assessment reports (SAHRA 2007) and the minimum standards for mitigatory/rescue palaeontological studies recently developed by SAHRA (SAHRA 2013).

As described in the SAHRA minimum standards, the process of assessment for the archaeological (AIA) or palaeontological (PIA) specialist components of heritage impact assessments usually involves:

1. Initial pre-assessment (scoping) phase, where the specialist establishes the scope of the project and terms of reference for the developer.
2. Impact Assessment/Specialist Report:
   a) Identifies heritage resources;
   b) Assesses their significance;
   c) Comments on the impact of the development
   d) Makes recommendations for their mitigation or conservation, OR
   e) A Letter of Recommendation for Exemption (if there is no likelihood that any sites will be impacted).
3. Mitigation/Rescue, which involves planning the protection of significant heritage resources via excavation/collection at sites that may be lost.
4. Heritage Site Management Plan (for heritage conservation), may be required in rare cases where the site is so important that development will not be allowed. Developers may also choose to, or be encouraged to, enhance the value of the sites retained on their properties with appropriate interpretive material or displays.

3.1 Heritage Resources

Heritage can broadly be considered the tangible places and objects that have been passed down from previous generations, as well as the intangible cultural practices and traditions that shape our daily lives. The heritage character of an area, therefore, is delineated by the interplay of materials, forms, location, spatial configurations, uses and cultural associations or meanings attributed to that area, that contribute to its heritage value and that must be retained to preserve that value (Canada's Historic Places, n.d.).

Heritage resources are defined in Section 2 of the NHRA as “any place or object of cultural significance”, where cultural significance can be understood as meaning “aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance”. Heritage resources together constitute the National Estate, as defined in Section 3 of the NHRA, and each constituent resource enjoys recognition and protection under the Act.

A variety of heritage resources contribute to the heritage character of each of the areas, and these are briefly dealt with below. Each category of heritage resource was subjected to largely similar assessment processes to derive the heritage character of each area. These processes consisted of consulting SAHRIS to identify the known, graded and declared heritage sites and resources, as well as mapped sites derived from surveys, for each resource type across the country. These data were supplemented by consultation of heritage reports captured into SAHRIS as well as academic reports and the specialist knowledge of the contributing authors.

Additional information was obtained from the international shipwreck database (Wrecksite 2017) for shipwrecks, and the 1:1 000 000 geological maps for the palaeontology as well as the SAHRIS Palaeo-sensitivity map (SAHRA 2014). This work is by no means exhaustive, but does provide an idea of the categories and distribution of heritage resources in each area sufficient to determine the known heritage character of each study area and flag the known sites that will need to be avoided and/or buffered.

These abovementioned tools are all important resources that can be used by a project developer to try to avoid sensitive known heritage features from the outset. They are not without limitations and gaps, but they do provide a starting point for responsible planning.

See Appendix for further information.

3.2 Gradings

Section 7(1) of the NHRA provides for heritage resources to be assigned Grades I, II or III, while Section 7(2) provides for subcategories of the latter two. Grading of sites is necessary for heritage management as it informs the conservation of generally protected sites and it is a legal requirement for the formal protection of sites. Grading can only be approved by heritage resources authorities, although it is requested that practitioners provide suggested gradings (or field ratings) in HIA reports. Where available, the grading level recommended by the relevant heritage practitioner was captured on SAHRIS, although many of the sites uploaded to SAHRIS do not yet have formal or provisional gradings (field ratings), either because they have been sourced from research surveys or simply because they had no provisional grades suggested as part of the impact assessments.

The grading of heritage sites which form part of the National Estate[1] is done according to Section 7 of the NHRA as follows:

a) Grade I: Heritage resources with qualities so exceptional that they are of special national significance;
b) Grade II: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and
c) Grade III: Other heritage resources worthy of conservation.

SAHRA is the national authority and manages Grade I sites; PHRAs manage Grade II sites. Grade II sites can be declared as Provincial Heritage Sites under Section 27 of the NHRA after the competent PHRA has established their significance. Many of the current Provincial Heritage Sites were declared as National Monuments under the National Monuments Act, No 28 of 1969. These sites automatically became Provincial Heritage Sites when the NHRA came into effect in 1999. In all provinces aside from the Western Cape, Eastern Cape and KwaZulu-Natal, SAHRA has not devolved the management of archaeology and palaeontology to provincial level, and only Grade II and Grade III built environment sites are managed by the PHRAs in those six provinces, while SAHRA manages applications in terms of Sections 35, 36 and 38 of the NHRA. The NHRA also makes provision for the devolution of powers to manage Grade III sites down to local municipal level but only one municipality, the City of Cape Town Metropolitan Municipality, has thus far obtained limited powers to manage Grade III heritage resources from Heritage Western Cape (HWC).

This report follows the Heritage Western Cape Short Guide to and Policy Statement on Grading issued in 2016, as the most comprehensive guidelines to gradings (HWC 2016), and offers categories of grading for Grade III heritage resources. Gradings are not legislated, but provide useful measures of relative significance for Grade III resources.

Grade IIIa sites are of such high local significance that they should be protected and retained. These sites should be included in the heritage register of each municipality according to Section 30 of the NHRA, and

1 See Appendix for definition of National Estate as defined in Section 3 of the NHRA

any alterations must be regulated through a permit process with the relevant heritage authority. Human remains are treated with high significance and graves generally fall within this category. While relocation of graves takes place from time to time, relocation should always be considered as the last resort. Rock art sites, caves with archaeological deposits and fossil localities are commonly ascribed a Grade IIIa rating.

Grade IIIb sites are heritage resources rated to have medium local significance. They should preferably be retained where possible, but, where developments cannot be realigned or moved, mitigation is normally appropriate. Archaeological and palaeontological sites falling into this category include sites which cannot be sufficiently recorded or understood during an initial survey alone or which require dating, excavation and/or other techniques to analyse the sites.

Grade IIIc sites are of low local significance. These resources must be recorded satisfactorily before destruction is allowed. In many instances the recording and description of the site undertaken during a HIA is sufficient and further recording or mitigation is not normally required. Grade IIIc structures can normally be demolished under a permit from the relevant heritage authority.
Sites with little or no heritage value are deemed NCW (Not Conservation-Worthy). Although this categorisation of sites is not currently recognised by SAHRA, it is useful in a high level study with as broad a scope as this assessment.

3.3 Limitations and Assumptions

The broad level of assessment in this study did not include any field assessments or ground-truthing, nor any public participation. As such, the research has been focused on known heritage resources, largely as captured and mapped on SAHRIS. While this is a powerful and useful tool, not all information is captured to it, and not all information on its system is accurate. Information at the local and provincial level, in the form of heritage registers and inventories, is often not retained, or, where these exist, are not available on the system, and many heritage resources appear to be inaccurately mapped or graded. In addition, the research is hampered by the absence in some areas of previous commercial or research heritage work, such that our knowledge of the heritage resources in that area can only be based on an educated reading of the known landscape, climate, vegetation and water supply. Shipwreck data on SAHRIS, particularly, is limited, with few sites mapped, and little information available about each wreck.

The large size of the study areas precludes fine-grained characterisation of landscape qualities, and the scale is generally too large to accurately determine the presence of built heritage elements where these exist outside of towns. A limitation that is specific to the palaeontological assessment is the lack of access to the 1:250 000 scale geological maps of the study areas. While the 1.:1 000 000 maps are available and have been used for this assessment, the scale and resolution of geological layers represented on these maps is not fine-grained enough to make accurate assessments of the geology of each area, the distribution of potentially fossiliferous layers, or the likelihood of exposures of fossil-bearing strata at the surface. Further to this, most information pertaining to palaeontological sites is captured in academic literature, rather than Palaeontological Impact Assessments (PIAs), and is, therefore, not readily available on SAHRIS.

Due to the impacts from aquaculture developments likely being greatest to archaeological and palaeontological resources, these have been given precedence in this study over other resources that are likely to be more resilient in the face of development, such as intangible heritage and cultural landscapes, or less likely to be affected, such as built environment. It should be noted, however, that this model of impacts holds true at the macro-scale of this study, but not necessarily at the site specific scale of individual developments. This approach is partly mitigated by the treatment of sensitive and significant cultural landscapes in the Visual Assessment chapter, and of living and intangible heritage in the Socio-Economic chapter of this study.

Key assumptions of a study such as this one include the assumption that the general knowledge of the heritage practitioners involved is representative of the range of heritage resources that might be encountered and that the study has thus covered all possibilities. Further, it is assumed that the known heritage sites in a given area do not account for all the heritage resources to be found in that area, even where these regions have been extensively surveyed, as changing environmental conditions, such as erosion, can lead to the discovery of additional, previously buried heritage resources. It is assumed that the distribution of heritage resources is fairly similar in similar contexts, such that if site X has not been surveyed, it is assumed that site Y would yield similar resources in similar densities if X and Y are otherwise similar. Following from this, it is assumed that the known heritage resources in a given area can serve to illustrate the broad heritage character of the area, and serve as a representative sample of the types and grades of sites in that region. In terms of palaeontology, specifically, it is assumed that where fossils have been located in geological units in one areas, fossils are likely to occur in other areas where the same geological units are prevalent.

4 KEY HERITAGE ATTRIBUTES AND SENSITIVITIES OF THE STUDY AREAS

For this section, in those instances where the degree of geographical overlap allowed, some freshwater and marine aquaculture study areas have been combined, and dealt with as a single, contiguous area. In order to retain the greatest resolution, the heritage resources maps, and sensitivities maps for these areas have been retained separately. These areas are the Richards Bay freshwater study area and the Durban-Richards Bay marine study area, as well as the Eastern Cape freshwater study area and the East London-Kei marine study area.

Derivation of Combined Heritage Sensitivities

The sensitivity maps for the study areas represent elements relating to known heritage resources including physical sites (places), as well as palaeontological significance, as determined by fossil sensitivity. These two layers (heritage sites and palaeo-sensitivity layers) were combined to create a composite heritage sensitivity map, and given a 4-tier "Sensitivity Class" hierarchy of Very High sensitivity, High sensitivity, Medium sensitivity and Low sensitivity, based on the sensitivity hierarchies discussed below. The 4-tier grading conforms with sensitivity gradings of other resource types in this SEA.

The known heritage resources located within each study area, as reflected on SAHRIS (SAHRA 2017), were combined from the following elements: Archaeological sites, including archaeological, battlefield, geological, meteorological, palaeontological and underwater sites; Built Environment, including structures, monuments and memorials; Burial Grounds and Graves, including burial grounds and graves, living heritage/sacred sites and natural sites and places; and Cultural, including conservation areas and cultural landscapes.

The sites were divided further into Grade I & II, which were afforded a buffer of 1 km, Grade IIIa, with a buffer of 100 m, Grade IIIb, with a buffer of 50 m, and Grade IIIc and ungraded, with a buffer of 25 m. The absolute sizes of these buffers were arbitrarily ascribed as exclusion zones that were reflective of the resource significance and also visible on the large scale maps, while their relative size reflects the differing sphere of significance of differently graded sites. Grade I & II sites comprise the Very High sensitivity group, Grade IIIa the High sensitivity group, Grade IIIb the Medium sensitivity group, and Grade IIIc and Ungraded constitute the Low sensitivity group in the final *combined heritage sensitivity layer.*

The palaeontological layers, as depicted on the SAHRIS Palaeosensitivity Map (SAHRA 2014), reflect the relative likelihood of the underlying geological layers containing fossil remains. These layers were selected and clipped to the boundary of each freshwater and marine area, and were combined to form Very High, High, Medium and Low fossil sensitivity within the area. This terminology, adapted to conform to the study specifications, was derived from the original designations of Very High; High and Moderate; Low and Unknown; and Insignificant/zero, respectively.

Any declared palaeontological sites which have been captured on SAHRIS are included in the combined sensitivity maps. However, as indicated previously, most palaeontological sites are not identified through impact assessment, but rather through academic research, and are not, therefore, captured on SAHRIS. The key palaeontological sites identified in each study area have been mapped separately in order to flag their locations, where possible at this scale, and are represented in Figures 2, 12, 29, 35 and 48 below. Where these key sites represent likely outcrops of certain formations for which the location cannot be derived at this scale, they have been noted but not mapped.

4.1 Freshwater Aquaculture Study Areas

4.1.1 Study Area 1 – Limpopo

4.1.1.1 Landscape character

This study area extends from the Limpopo River, south-westwards up to the Makapan-Strydpoortberge highlands to the south of Polokwane, spanning the Tropic of Capricorn, and is located between Musina in the north and Polokwane in the south. The region's vegetation comprises the Central Bushveld Bioregion, and small parts of Mopane Bioregion and Lowveld Bioregion (Mucina & Rutherford 2006). Important landmarks in the area include the Wolkberge in the south-eastern portion of the study area, the Soutpansberg Mountain range in the north and the Limpopo River, which forms the northern boundary of the study area. The area is rural in character with several nature reserves and various informal settlements.

4.1.1.2 Palaeontology

Most of the Limpopo study area is of insignificant to low palaeontological sensitivity due to the preponderance of unfossiliferous Precambrian basement rocks (Figure 1). See Appendix for further details.

Key sites: Kalkbank (Figure 2).

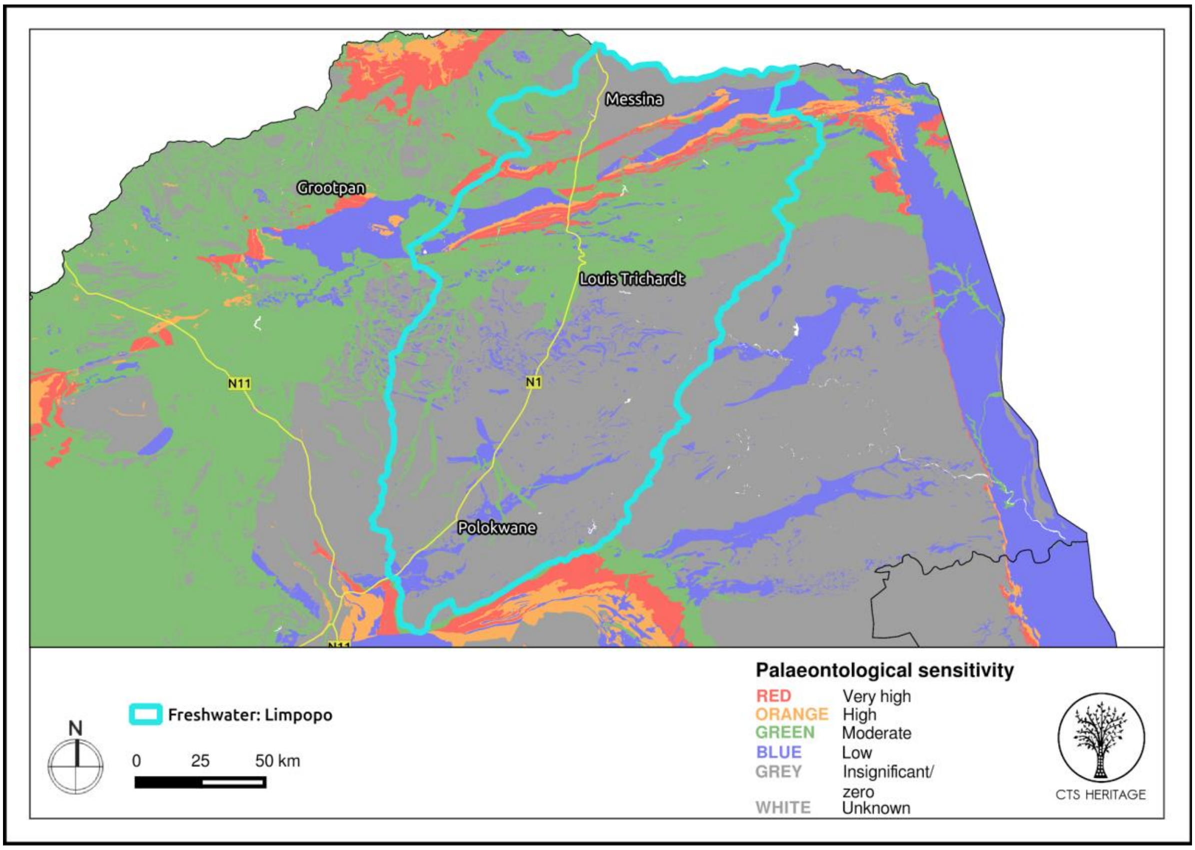

Figure 1. Limpopo Fossil Sensitivity Map (SAHRA 2014).

4.1.1.3 Archaeology

Limpopo Province has a rich archaeological heritage (Figure 3). Two World Heritage sites occur outside but on the periphery of the study area and are worth mentioning namely Makapansgat to the south with its fossil record (McNabb & Binyon 2004; Phillipson 2005) and Mapungubwe to the north, considered to be the first state in South Africa (Huffman 2000 & 2007). Within the study area, sites dating to the Stone Age, Iron Age and historical period are known to occur throughout the area.

Isolated Early Stone Age (ESA) artefacts have been recorded for the area with only a few sites subjected to academic research such as the site at Kudu Kopje (Sumner & Kuman 2014). Another significant site, also outside of the study area, is at Bushman Rock Shelter (Mason 1969, Wadley 1987), a well-known site in the Ohrigstad district.

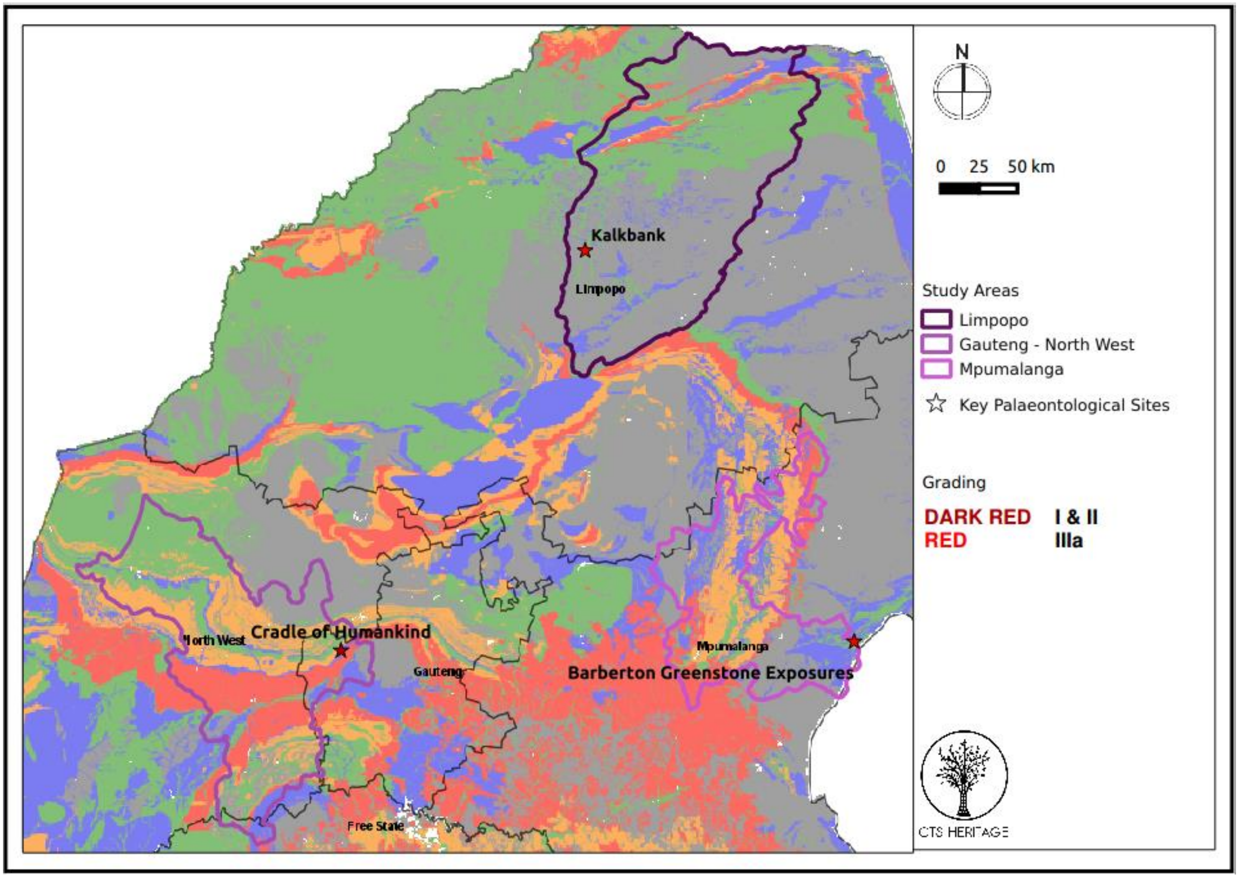

Figure 2. Combined site location map for key palaeontological sites in Limpopo, Mpumalanga and Gauteng-North West study areas.

This cave was excavated twice in the 1960s by Louw and later by Eloff. The Middle Stone Age (MSA) layers show that the cave was repeatedly frequented over a long period. Lower layers have been dated to over 40 000 Before Present (BP), while the top layers date to approximately 27 000 BP (Esterhuysen and Smith in Delius, 2007). MSA open-air sites are found throughout the region. The MSA Pietersburg lithic industry is characteristic of this period and is epitomized by large elongated products, including long points that are usually unifacial and manufactured on blades from hornfels (Mason 1962; Sampson 1974). Other rocks that occur in large pieces, such as quartzite, were also used, suggesting that the appearance of Pietersburg assemblages may, to a degree, be influenced by available rocks.

When Iron Age farmers arrived in the area they encountered stone tool using Later Stone Age (LSA) hunter gatherers (Bradfield *et al*. 2009). This contact period and the debate whether hunter gatherers survived it has been the subject of deliberation (Schoeman 2006, Wadley 1996). A wealth of rock art sites is found in the area (Bergh 1999) which includes fine lined hunter gatherer art, geometrics that could be associated with herders and more recent white finger paintings of the Northern Sotho (Eastwood and Smith 2005; Eastwood and Eastwood 2006).

Several Iron Age sites dating to the Early, Middle and Late Iron age are found in the study area and ceramic facies represented date from between AD 280 and AD 1840 (Evers 1980; Moore 1981; Collett 1982; Loubser 1991; Klapwijk and Huffman 1996; Whitelaw 1996; Huffman 2007).

Extensive stone-walled settlements are found around Polokwane, associated with the Ndebele groups who resided here (Loubser 1991). The area was also affected by various conflicts in the South African War, evidenced by blockhouses, the concentration camp at Polokwane, the Wolkberg Battlefield as well as memorials such as the one for Chief Makgoba in Magoebaskloof (Changuion 2008) to name a few.

4.1.1.4 Graves

Graves and informal cemeteries can be expected anywhere on the landscape and several graves are known in the study area (Figure 3). Family cemeteries can be expected close to farmsteads, with informal cemeteries widespread in informal settlements. Unmarked graves are often found where Iron Age settlements occur.

4.1.1.5 Built heritage

The Voortrekker town of Schoemansdal was proclaimed in 1848 and was the northernmost village established by European settlers (Plug *et al*. 2000). In terms of built heritage, several historical, vernacular buildings occur, and the study area includes graded buildings such as the Irish House in Polokwane. There are no National Heritage Sites (NHSes) in the study area, although one site is graded as Grade 1 and 10 sites are graded as Grade 2 resources (Figure 3). These include natural features like the Baobab trees at Musina and the Eersteling Monument, that marks the site of the South Africa's first gold rush close to Polokwane.

4.1.1.6 Cultural landscape

Small-scale or fine grained agriculture characterises much of the area, with dispersed rural settlements, in which the agricultural patterns are subtle and have low impact on the 'wilderness' character of much of the study area (D. Gibbs, David Gibbs Landscape Architect, pers.comm. 24 October 2017). Archaeological sites are widely distributed across the area, and, specifically, the Iron Age landscape is considered to be of high value.

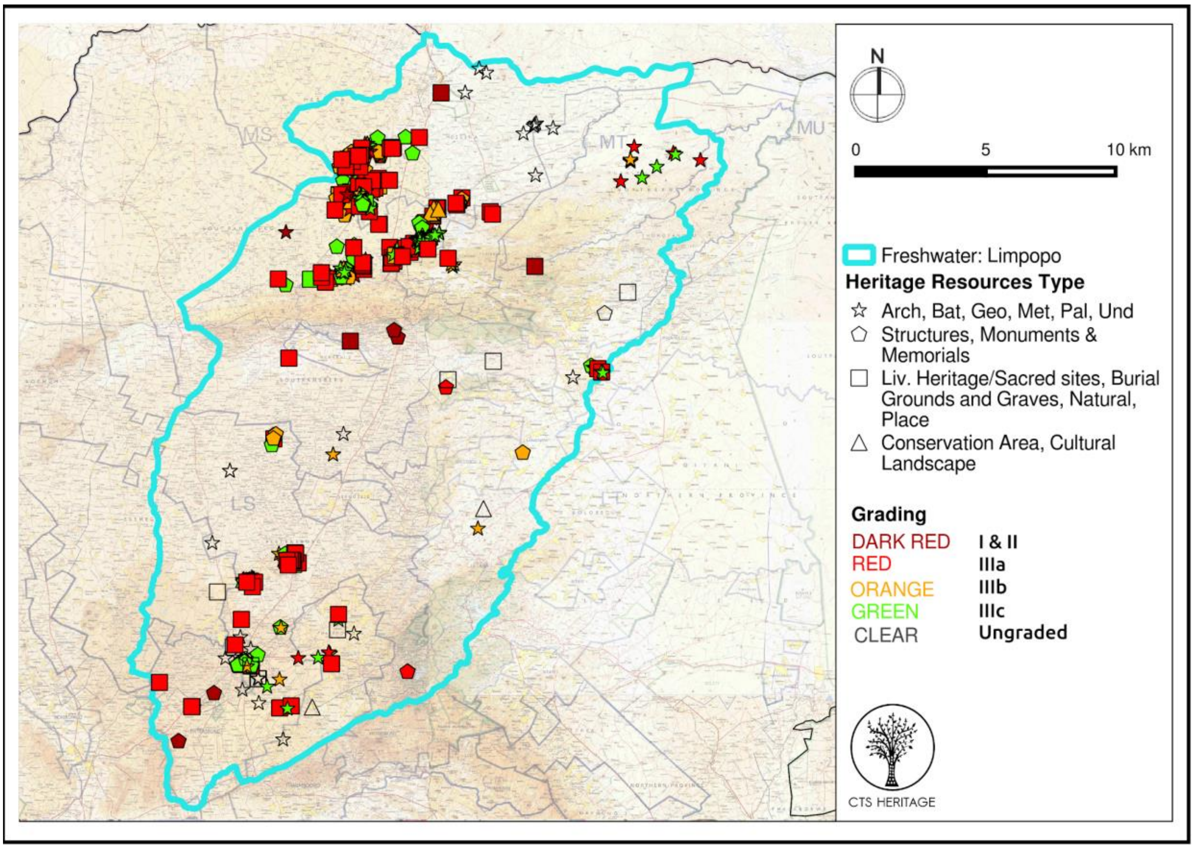

Figure 3. Limpopo heritage resource map.

4.1.1.7 Development guidelines

Archaeological sites may be found virtually anywhere within the study area (Figure 4), especially around floodplains, however it is anticipated that most sites can be mitigated either through preservation *in situ* or through mitigation.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh Karoo Supergroup bedrocks (Tshipise Basin), consolidated alluvial deposits as well as lacustrine, pan or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 4).

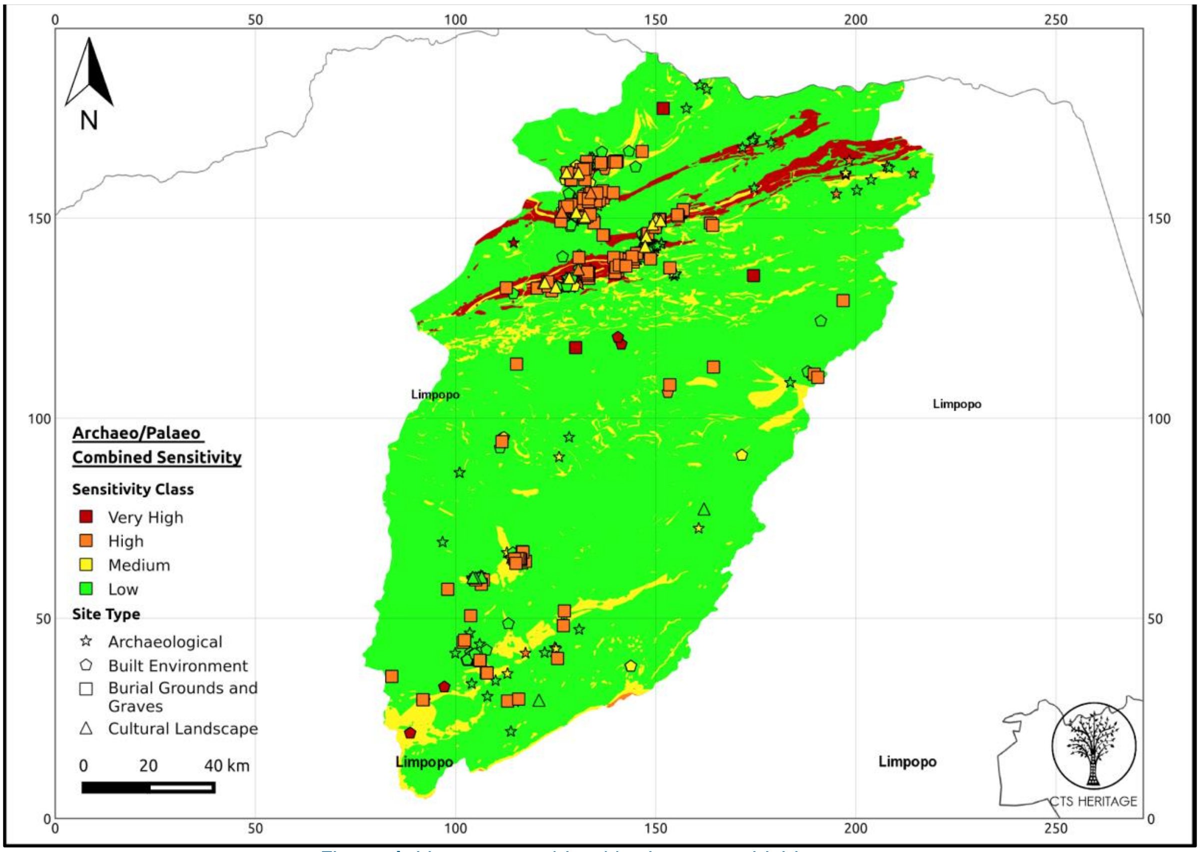

Figure 4. Limpopo combined heritage sensitivities map.

4.1.2 Freshwater Study Area 2 – Mpumalanga

4.1.2.1 Landscape character

The study area consists of two Bioregions, namely the Mesic Highveld Grassland Bioregion and the Lowveld Bioregion (Mucina & Rutherford 2006). The area is characterised by mountains, panoramic passes, valleys, rivers, waterfalls and forests. Several small towns occur in the area such as Lydenburg and surrounds, characterised by mining activities as well as historic towns such as Waterval-Boven and Pilgrims Rest. The area hosts a strong tourism industry and is home to nature reserves and scenic drives.

4.1.2.2 Palaeontology

A substantial number of Precambrian sedimentary rock units of the Transvaal Supergroup in the central portion of the study area are known to contain fossils in their outcrop areas elsewhere (Figure 5), notably stromatolites or microbial mounds. However, it is unclear if comparable fossils occurrences are to be found in outcrops falling within the present study area.

Drainage lines are of special palaeontological impact significance because many of the best fresh bedrock exposures occur here (river cliffs, banks and beds of streams), as well as due to the possible occurrence of fossiliferous ancient alluvial sediments (e.g. terrace gravels) as well as lake, pan or vlei deposits. See Appendix for further details.

Key sites: the exceptional geo-heritage of this region contains the best evidence for the formation of the earth's crust, in the form of excellently preserved 3 200 million to 3 600 million year-old rock sequences (Bmmlworldheritage.org, 2017). As such, the Barberton Greenstone Belt exposures of the Barberton/Mahkonjwa Mountain area have been proposed as a World Heritage Site (Figure 2).

4.1.2.3 Archaeology

Very few ESA sites are on record for Mpumalanga. An example where ESA tools have been discovered located outside of the study area is at Maleoskop (Bergh 1999) on the farm Rietkloof, which is one of only a handful of such sites in Mpumalanga. MSA material is found widely across South Africa and some MSA manifestations can be expected in the study area.

Sites dating to the LSA are found in numerous rock shelters throughout Eastern Mpumalanga, where some of the rock art is still visible. A number of these shelters have been documented throughout the Province (Schoonraad in Barnard 1975; Bornman 1979 and Delius 2007). These include areas such as Witbank, Ermelo, Barberton, Nelspruit, White River, Lydenburg and Ohrigstad (Figure 6).

Two LSA rock shelters with four panels of rock art have been excavated at Honingklip near Badplaas in the Carolina District. These sites were occupied between 4870 BP and as recently as 200 BP. Stone walling at both sites dates to the last 250 years of hunter-gatherer occupation, and may have served as protection against intruders and predators. Pieces of ceramic and iron beads found at the site indicate that there was early social interaction between the hunter-gatherer (San) communities and the first farmers who moved into this area at around 500 AD. The Lydenburg area is archaeologically well known for its rock engraving sites, most notably Boomplaats (Pijper 1918; Van Hoepen 1939; Maggs and Ward 1995; Mbewe 2005; Delius 2007).

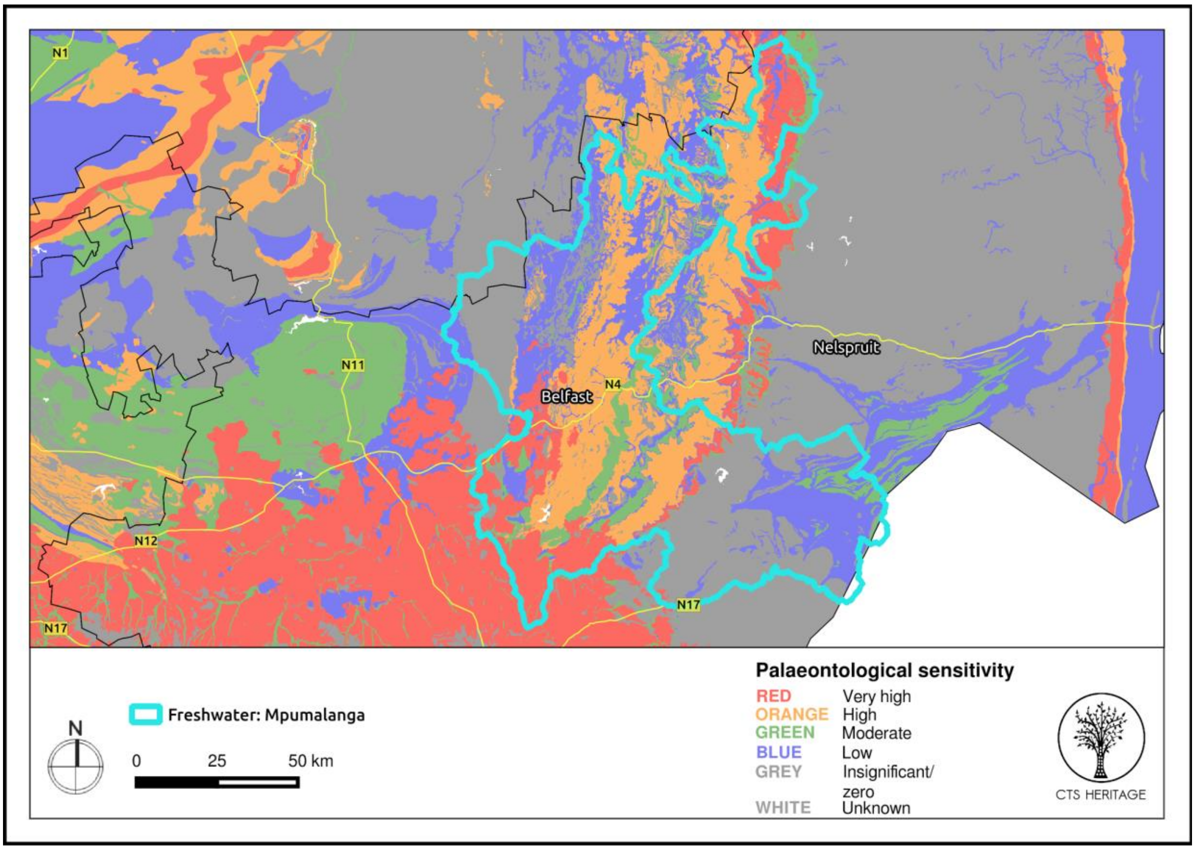

Figure 5. Mpumalanga Fossil Sensitivity Map (SAHRA 2014).

Several Iron Age sites dating to the Early, Middle and Late Iron Age are found in the study area and the ceramic facies represented date between AD 750 and 1840, with a hiatus between AD 1000 and AD 1650 (Evers 1980; Collett 1982; Whitelaw 1996; Huffman 2007).

Of interest for the study area are the famous ceramic sculptures referred to as the Lydenburg Heads, seven hollow ceramic heads that were found broken in one storage pit at the Sterkspruit site near Lydenburg, dating to the Early Iron Age (IA) (Evers 1982; Inskeep & Maggs 1975; Whitelaw 1996). The study area is also well known for the extensive Late Iron Age stone-walled settlements that are found along the Mpumalanga escarpment (Collett 1982; Marker & Evers 1976). Rock engravings in the same area also depict this settlement pattern (Maggs and Ward 1995; Van Hoepen 1939).

Numerous pre-*Difaqane* and *Difaqane* wars[2] also took place in the study area during the last quarter of the 18th century and during the first three decades of the 19th century (Bergh 1999).

Sites dating to the historic period occur sporadically in the study area. These are mostly farming related, although some mining sites occur as well (e.g. the old Albion Colliery, dating to the 1940s). Sites relating to the early railway history of South Africa are present in the Waterval-Boven and Waterval-Onder areas (De Jong *et al.* 1988), with the Five Arch Bridge close to Waterval-Boven being the best known.

During the Anglo-Boer War, a number of battles took place in the region, such as on the farm Wilmansrust, in June 1901. During this clash, more than 50 British troops were killed. The Witkloof Memorial also attests to the conflict that took place in the area, while the Machadodorp area, specifically, played an important role during the Anglo Boer War until 1902 (Jooste 2008).

The area contains no NHSes, and 19 PHSes (Figure 6), encompassing natural sites (such as Horseshoe Waterfall at Pilgrims Rest), historical buildings and structures, predominantly located within towns, but also including road and rail bridges, and one archaeological site, Mapoch's Caves.

4.1.2.4 Graves

Graves and cemeteries are widely distributed across the landscape and can be expected anywhere (Figure 6). Family cemeteries can be expected close to farmsteads, with informal cemeteries widespread in informal settlements. Unmarked graves are found in association with Iron Age settlements.

4.1.2.5 Built heritage

The south-eastern Highveld is characterised by vernacular architecture in which sand stone and ferricrete was used to build farmsteads and dwellings in urban as well as in rural areas (Pistorius 2006). Of particular significance is the historic town of Pilgrim's Rest, which developed during the early days of the South African gold rush. Many of the town's Victorian era buildings are made of corrugated iron, which lends a distinctive character to the built fabric of the settlement (D. Gibbs, David Gibbs Landscape Architect, pers.comm. 24 October 2017). Further built heritage sites relate to historic railway infrastructure.

4.1.2.6 Cultural landscape

The cultural landscape should be considered significant in this region, and comprises the layers of human occupation of the region from the Early through to Later Stone Ages, the extensive settlement of the area during the Iron Age, and then several layers of historical cultural landscape. These include the battlefields, the railway infrastructure, historic mining remnants and historic settlements, farmsteads, forestry plantations and towns.

2 The *difaqane/mfecane* period was a time of enormous social upheaval amongst the Zulu tribes of KwaZulu-Natal, partly in response to the incursion of European traders into the Maputo area (Huffman 2007). These factors coincided with severe drought, and changing political structures amongst the Zulu tribes that ultimately led to the rise of Shaka Zulu and his army that expanded the territory of the Zulu nation violently and aggressively across the region. Many people across south eastern southern Africa were killed, many tribes disbanded, and many fled west to escape the threat of war.

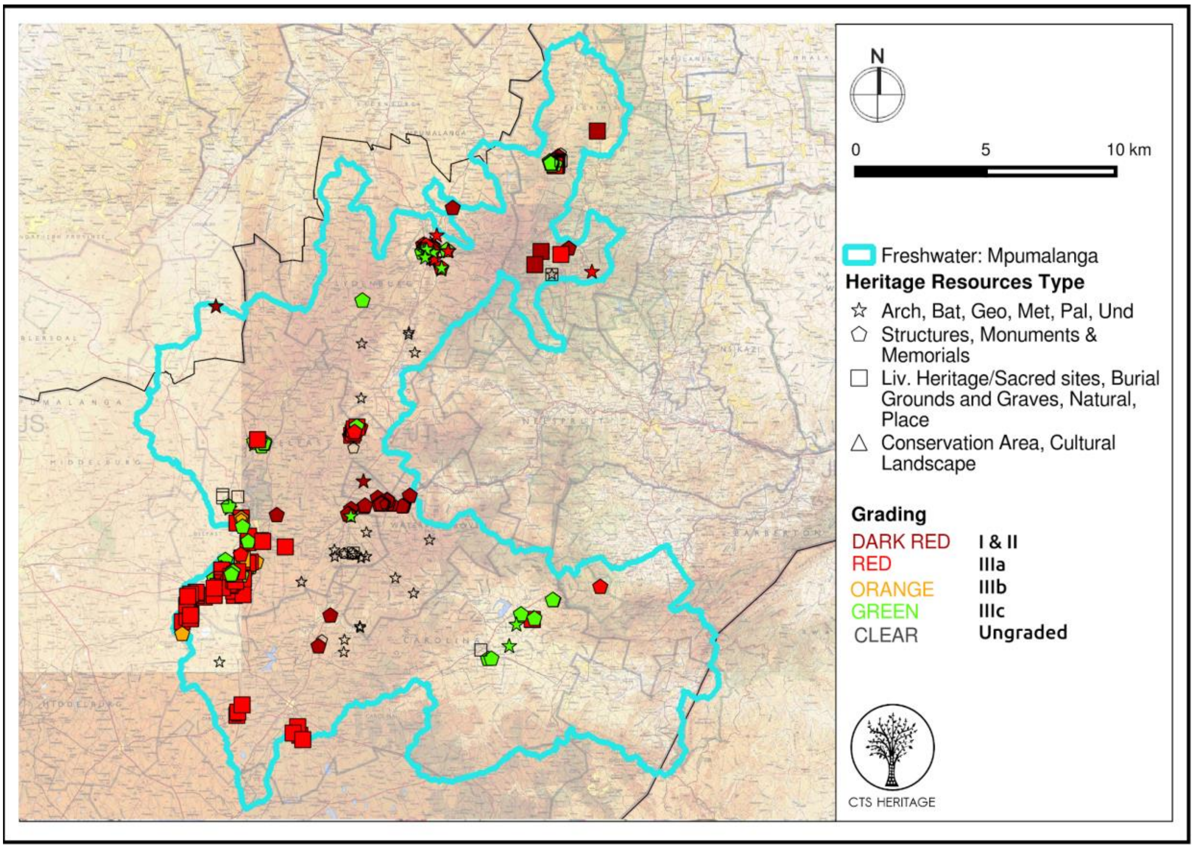

Figure 6. Mpumalanga heritage resource map.

4.1.2.7 Development guidelines

Iron Age sites can be expected throughout the study area, especially on hilly areas where stone is readily available for constructing stone-walled settlements, and on floodplains close to rivers (Figure 7). It is anticipated that most of these sites can be mitigated either through preservation *in situ* or through mitigation. Formal and informal cemeteries as well as pre-colonial graves occur widely across Southern Africa. It is generally recommended that these sites are preserved *in situ* when they occur within a development area. These sites can be relocated if conservation is not possible, but this option must be seen as a last resort and is not advisable.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh Transvaal Supergroup bedrocks or consolidated alluvial or colluvial deposits should be subject to a field-based palaeontological assessment, and none should occur within the proposed Barberton/Makhonjwa Mountain WHS or its buffer zone (Figure 7). Fossiliferous breccias might be associated with karstified limestone / dolomite outcrop areas such as the Malmani Subgroup along the escarpment edge.

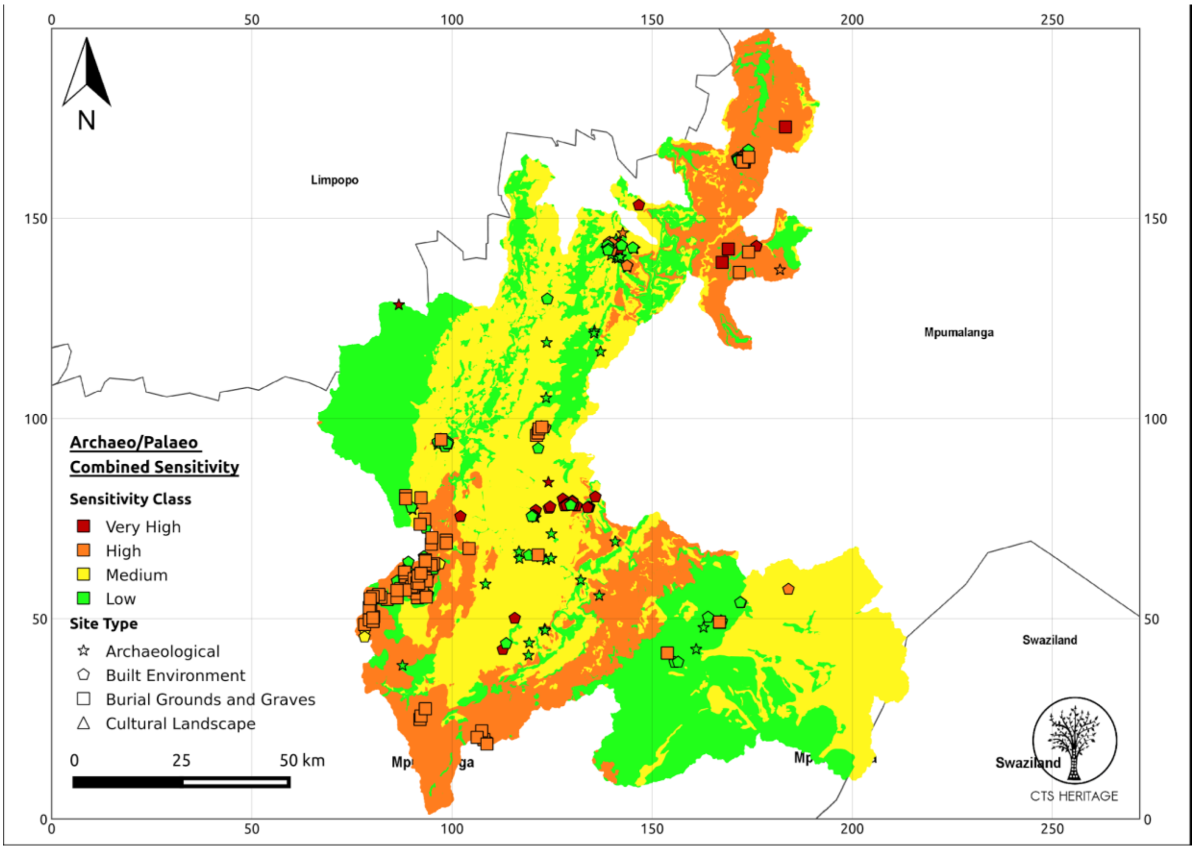

Figure 7. Mpumalanga combined heritage sensitivities map.

4.1.3 Freshwater Study Area 3 – Gauteng-North West

4.1.3.1 Landscape character

This study area encompasses an extensive portion of the interior plateau of Southern Africa, stretching from the Gauteng-Free State border near Parys in the south, north-eastwards towards Rustenburg and north-westwards to the Marico region due west of the Pilanesberg. The area consists of two Bioregions, namely the Central Bushveld Bioregion and the Dry Highveld Grassland Bioregion (Mucina & Rutherford 2006). The eastern portion consists of highly developed urban areas, with mining activities in the southern section, while the rest is largely rural in character and characterised by farming activities, with a few small towns such as Potchefstroom and Koster.

4.1.3.2 Palaeontology

This study area is of considerable geo-heritage interest (e.g. Vredefort impact structure, Witwatersrand gold-bearing sediments), and also features several palaeontological hotspots (Figure 8). These concern, firstly, the rich Archaean to Proterozoic record of shallow marine to intertidal stromatolites (microbial mounds) within the Chuniespoort and Pretoria Groups (Transvaal Supergroup). Secondly, diverse Plio-Pleistocene mammals, including a range of early fossil hominins, have been recovered from numerous cave deposits in the Cradle of Humankind north of Krugersdorp. See Appendix for further details.

Key sites: Cradle of Humankind (numerous sites) (Figure 2).

4.1.3.3 Archaeology

The area is rich in heritage sites and can be classified according to different regions within the study area. In the eastern portion of the study area are the fossil Hominid sites of Sterkfontein, Swartkrans, Kromdraai, and environs that were declared a UNESCO (United Nations Organization for Education, Science and

Culture) World Heritage site in 1999, more commonly known as the Cradle of Humankind (COH) (Figure 9). The area is a geological outcropping of the Malmani Dolomites (see Herries *et al*. 2009; Dirks & Berger 2013) that preserve the fossil remains of distant human ancestors, as well as those of a prolific array of fauna. The cave sites in the area range in age from as early as 4.5 million years old (Bolts Farm), (Gommery *et al*. 2008) to as recent as 70 000 years old (e.g. Plovers Lake; Thackeray and Watson 1994; Herries *et al*, 2009). Further, there are a number of modern archaeological sites that overlay the dolomites due to the high occurrence of raw materials such as chert, quartzite, and quartz in the area (Mason 1951). The area is of Outstanding Universal Value due to its abundance of hominin fossil (human ancestors) remains from three genera: *Australopithecus*, *Homo* and *Paranthropus*. Alongside the human ancestors we find stone tools ranging from the Oldowan through to the Later Stone Age, as well as bone tools.

Also in the eastern portion of the study area on the northern side of the Magaliesberg is a site known as the Jubilee Shelter. This shelter has been excavated and provides a record from the Late Pleistocene to the 7th Century AD (Turner, 1986), comprising an extended cultural sequence for the area, with assemblages characteristic of the Middle Stone Age and Later Stone Age, including assemblages from the Oakhurst and Wilton industries (Wadley, 1986). The Jubilee Shelter provides evidence of hunter–gatherer occupation during three phases of agro-pastoralist contact, beginning in 225 AD and characterised by cooperative contact, prior to the hunter-gatherers being either assimilated or dispersed to other areas (Wadley, 1996). Several other shelters with archaeological deposits are also on record for this area.

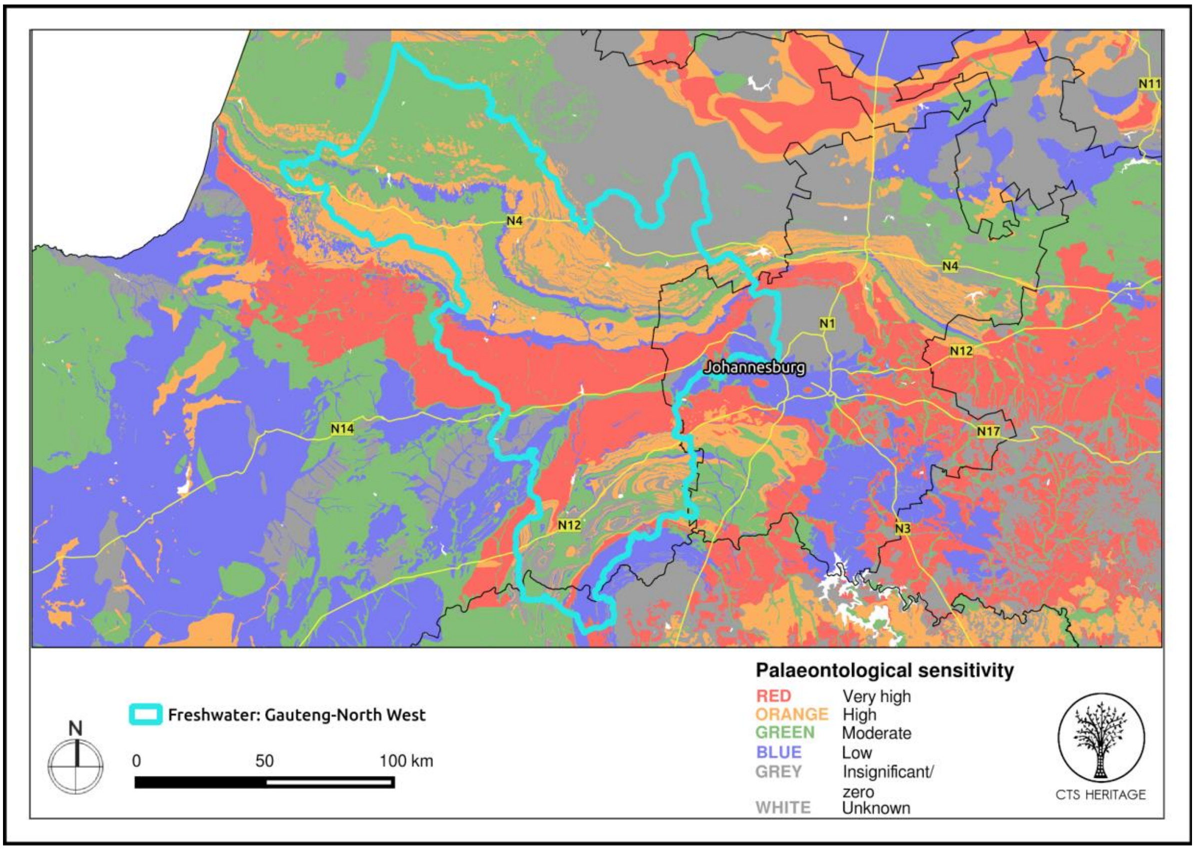

Figure 8. Gauteng-North West Fossil Sensitivity Map (SAHRA 2014).

In addition to these Stone Age sites, the eastern and southern portions contain several sites dating to the Iron Age and the ceramic facies represented date from between AD 450 and AD 1840, with a hiatus between AD 750 and AD 1460 (Mason 1969; Taylor 1979; Mason 1986; Huffman 2007). The eastern portion also contains several Later Iron Age stone-walled sites categorised as Type N and Klipriviersberg walling (Taylor 1979) that date to between 1500 and 1700 AD. Molokwane settlements that date from the late 18th century to the beginning of the Historic Period (Huffman 2007), stretch across the hilly areas of Gauteng west to Zeerust (Boeyens 2000; Huffman 1986; Mason 1986; Pistorius 1992; Taylor 1979).

The area contains 15 NHSes and 34 PHSes (Figure 9). These range from buildings, natural features, burial grounds to archaeological and palaeontological sites.

4.1.3.4 Graves

Graves and cemeteries are widely distributed across the landscape and can be expected anywhere. A number of historical graveyards are known from the area, some of which has been declared National and Provincial Heritage Sites (e.g. Ventersdorp and Potchefstroom cemeteries) (Figure 9). Family cemeteries can be expected close to farmsteads, with informal cemeteries widespread in informal settlements. Unmarked graves are found where Iron Age Settlements occur.

4.1.3.5 Built heritage

In terms of the built environment, historic farmsteads associated with the settlement of Voortrekkers and structures older than 60 years can be expected. A historic mining landscape associated with the discovery of gold on the Witwatersrand and the establishment of mining towns e.g., Krugersdorp (1887) and Randfontein (1890) also occurs in the eastern portions of the study area.

4.1.3.6 Cultural landscapes

The cultural landscape is broadly similar to parts of Mpumalanga, with the notable difference being the extensively developed areas that are widespread across the Gauteng Province. Mining overburden (tailings), slag dams and infrastructure associated with historic mining activity has contributed to a cultural landscape shaped by technology and industry (D. Biggs, David Biggs Landscape Architect, pers. comm. 24 October 2017).

4.1.3.7 Development guidelines

Iron Age sites can be expected in undisturbed areas throughout the study area, especially on hilly areas and on floodplains close to rivers (Figure 10). It is anticipated that most of these sites can be mitigated either through preservation *in situ* or through mitigation. Formal and informal cemeteries as well as pre-colonial graves occur widely across Southern Africa. It is generally recommended that these sites are preserved *in situ* when they occur within a development area. These sites can be relocated if conservation is not possible, but this option must be seen as a last resort and is not advisable.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh bedrocks of the Transvaal Supergroup, consolidated or gravelly alluvial deposits (including terrace gravels) or vlei sediments along water courses, as well as cave and calc-tufa deposits in limestone / dolomite bedrock areas should be subject to a field-based palaeontological assessment (Figure 10).

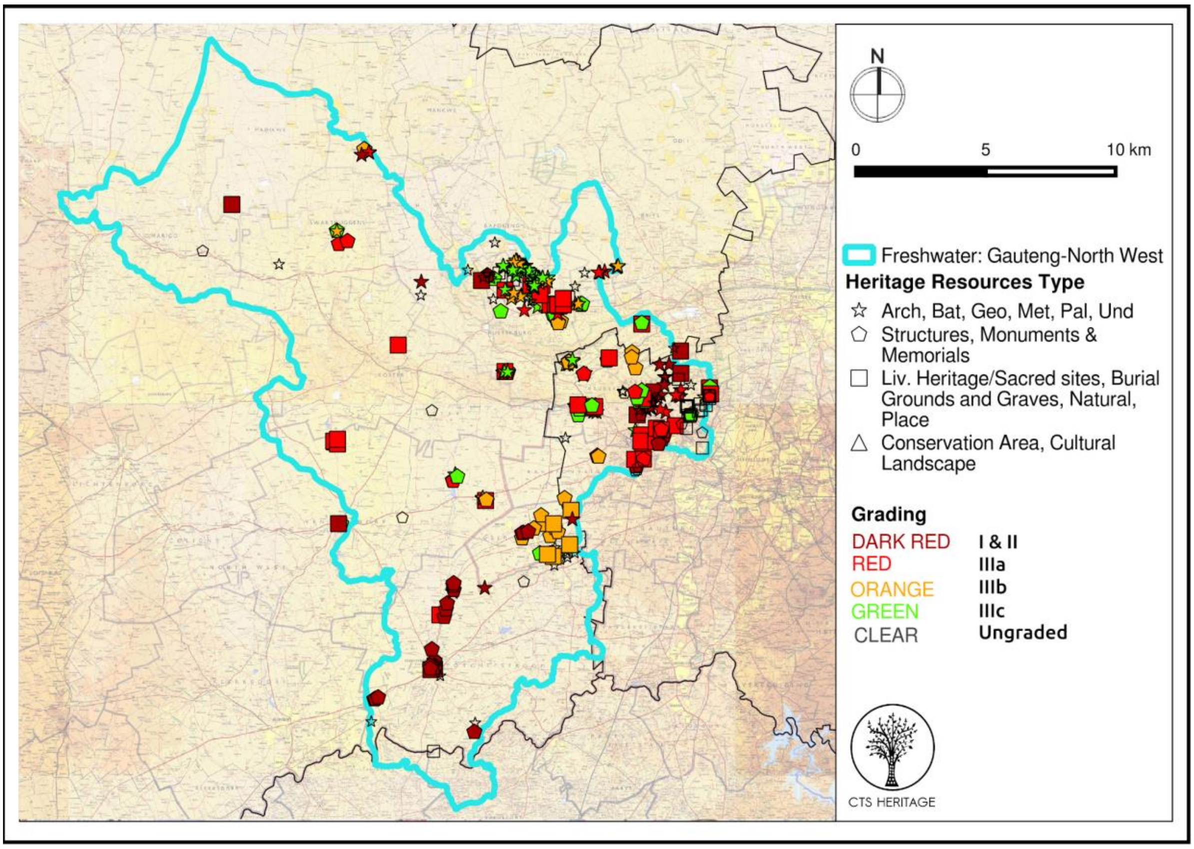

Figure 9. Gauteng-North West heritage resource map.

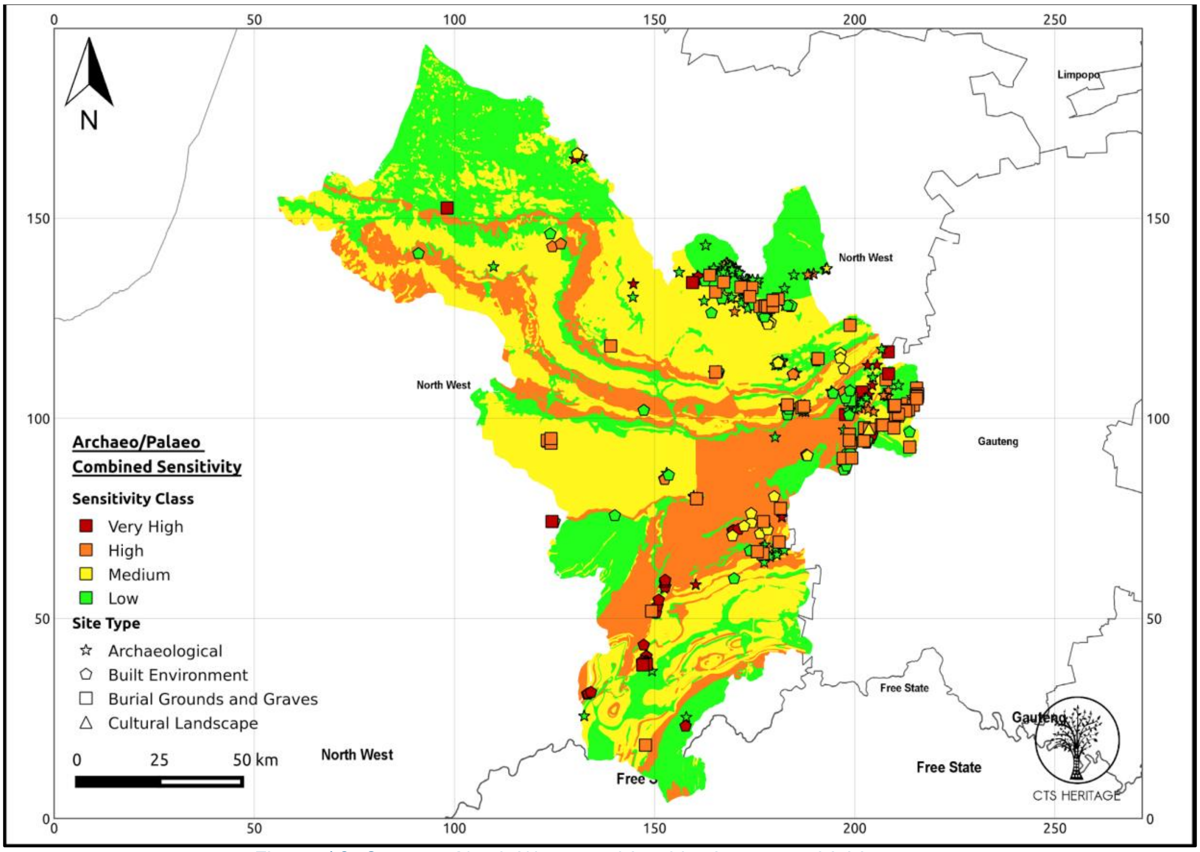

Figure 10. Gauteng-North West combined heritage sensitivities map.

4.1.4 Freshwater Study Area 4 – Vaalharts

4.1.4.1 Landscape character

The Vaalharts freshwater study area covers a large expanse of semi-arid, hilly to flat terrain centred on the Vaal River and its tributaries in the Vryburg-Kimberley-Douglas area and spanning parts of the Northern Cape, Northwest Province and Free State. It is relatively flat, although the Ghaap Escarpment runs along its north-western edge and low, sometimes steep-sided, hills occur in places where dolerite intrusions occur. It includes the major drainage line of the Vaal River which is joined in the southern part of the study area by the Harts River. It is a strongly agricultural region. The affected Bioregions include the Eastern Kalahari Bushveld, the Upper Karoo and the Dry Highveld Grassland Bioregions (Mucina & Rutherford 2006).

4.1.4.2 Palaeontology

The Vaalharts study area contains a wide range of fossil material of Archaean to Holocene age (Figure 11). Lacustrine sediments within the Archaean Ventersdorp Supergroup might contain stromatolitic horizons, while a rich record of varied stromatolites and associated microfossils is recorded from shallow marine to intertidal carbonates of the Late Archaean Ghaap Group. On the northern margins of the Main Karoo Basin glacial-related sediments of the Mbizane Formation (Dwyka Group) and post-glacial mudrocks of the Prince Albert and Whitehill Formations (Ecca Group) are known for their varied biotas of shelly invertebrates, fish, mesosaurid reptiles and plant material (e.g. fossil wood). Characteristic Permian Glossopteris floras may be associated with coal in the Vryheid Formation and perhaps also in the overlying Volksrust Formation. Important Miocene / Pliocene to Holocene mammal faunas have been collected from ancient alluvial gravels along the Vaal River as well as from calc-tufa deposits on the Ghaap Plateau edge near Taung, including the famous “Taung Child” juvenile australopithecine skull. See Appendix for further details.

Key sites: Boetsap (stromatolites), Douglas (Prince Albert marine fossils) Taung (Taung child and Plio-Pleistocene mammals), Canteen Kopje near Barkly West and Windsorton (Plio-Pleistocene mammals) (Figure 12).

4.1.4.3 Archaeology

A number of rock shelters occur along the Ghaap Escarpment and host mostly LSA materials (Humphreys & Thackeray 1983). Elsewhere, the archaeology tends to be out in the open. A number of very important sites occur in the study area including: the fossil hominid site of Taung, a NHS (Štrkalj & Kaszycka 2012); the rock engraving sites of Wildebeeskuil and Driekopseiland, a PHS, in the southern part of the area (Beaumont & Vogel 1989; Morris 1988); and the ESA, MSA and LSA site of Canteen Koppie, a PHS at Barkly West (Beaumont & McNabb 2000; Forssman *et al*. 2010) (Figure 13). The Vaal River gravels are well-known for the many ESA artefacts, including abundant hand axes, that they contain (Goodwin 1928; Leader 2009; Power 1955). In the southern part of the study area the so-called ‘Type-R’ stone-walled settlements line the Riet River (Maggs 1971). Many other less-known Stone Age archaeological sites occur in the area, with some such as an engraving site near Warrenton (Rossouw 2008) and an ESA site near Taung (Kuman 2001) being important. Historical archaeology is also present and often connected to old mining activities along the Vaal River (e.g. Morris 2009; Rossouw 2008). A number of battles were fought in the southern part of the study area during the Second Anglo-Boer War (a.k.a. the South African War) (Von der Heyde 2013).

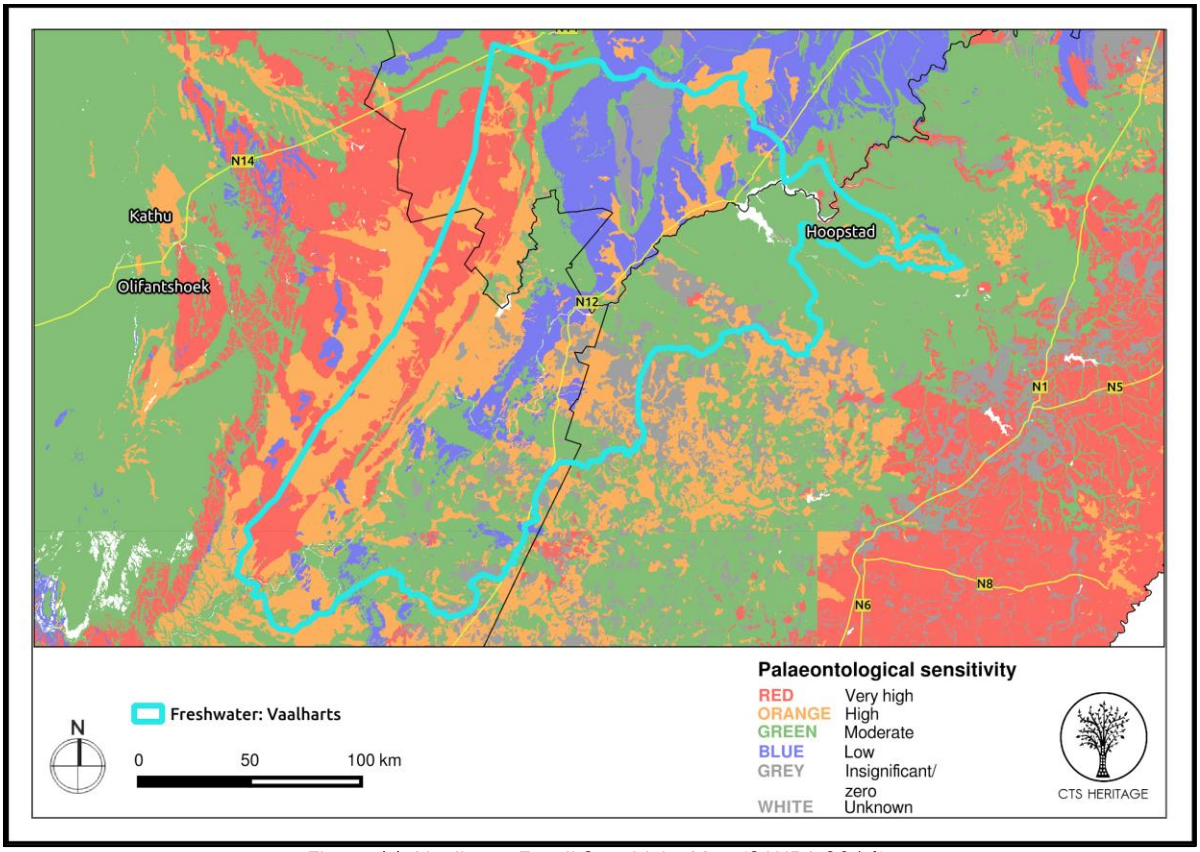

Figure 11. Vaalharts Fossil Sensitivity Map (SAHRA 2014).

4.1.4.4 Graves

Morris (1992) records many Stone Age graves from the study area, with most being along rivers. Graveyards both abandoned and still in use, also occur widely (e.g. Rossouw 2008).

4.1.4.5 Built heritage

Because the inland parts of South Africa were occupied by colonists relatively late in the country's history, there are fewer older built heritage sites than is the case further south. Nevertheless, many historical structures do occur, especially in the older towns. Kimberley is particularly important as the town sprang up over a very short period in response to the discovery of diamonds. This led to an entire section of the modern city being developed in the Victorian style and a very high density of heritage buildings therefore occurs there. Kimberley was the first city in the southern hemisphere to install electrical street lights – with 16 lights officially illuminated on 2nd September 1882 (D. Biggs pers. Comm.).

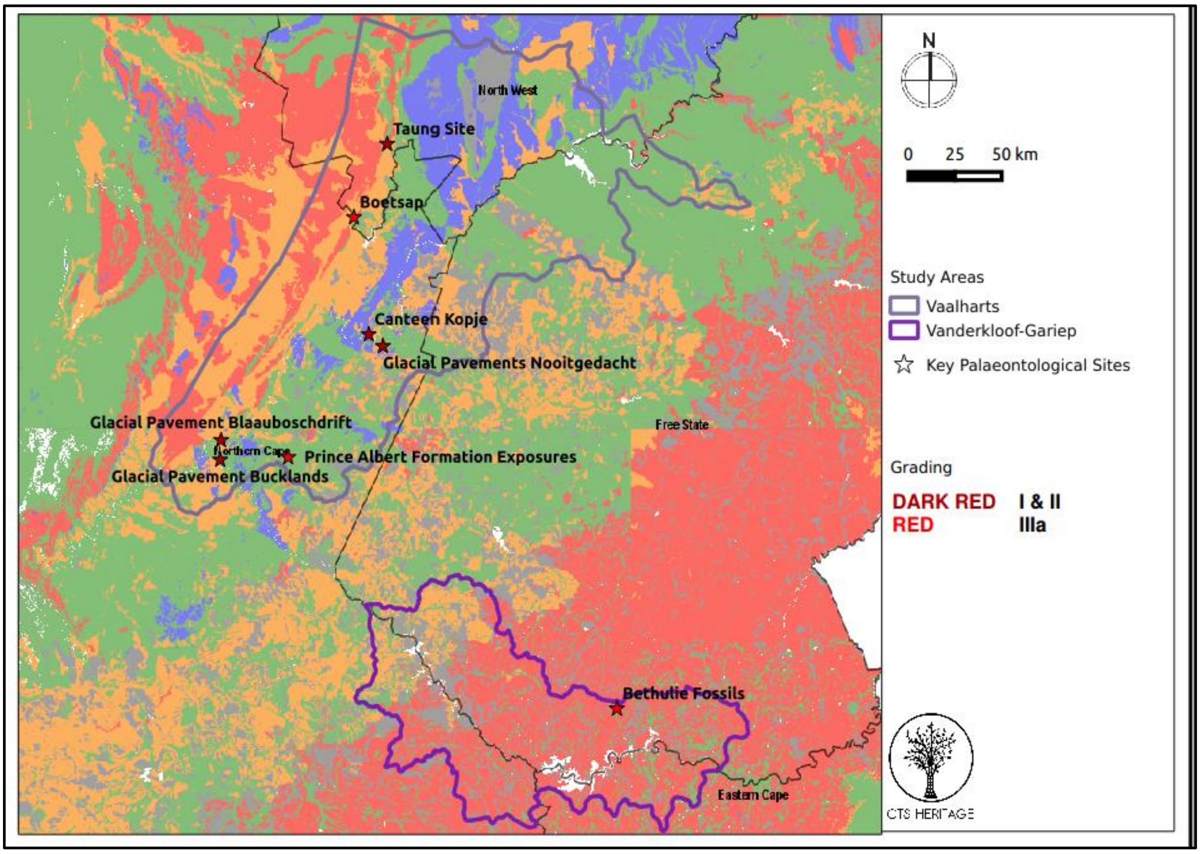

Figure 12. Combined site location map for key palaeontological sites in Vaalharts and Vanderkloof-Gariep study areas.

4.1.4.6 Cultural landscape

The agricultural landscape is broadly structured according to a grid pattern, further divided into linear strips. These strips are currently irrigated from central pivots, which create large circular patterns, especially distinctive when viewed from above. Comparing recent aerial photographs (2016) to earlier aerial surveys (1984) indicates a striking change in landscape pattern – reflecting technological changes in farming practices - from a much finer-grain rectilinear mosaic pattern (within the broader grid structure) to the larger circular patterns. Whereas the broad grid pattern has endured as a means of spatial organization, the 'surface' texture and 'grain' of the landscape is vastly changed. The landscape of historic mining is also important as it was a crucial economic driver during the early parts of the last century.

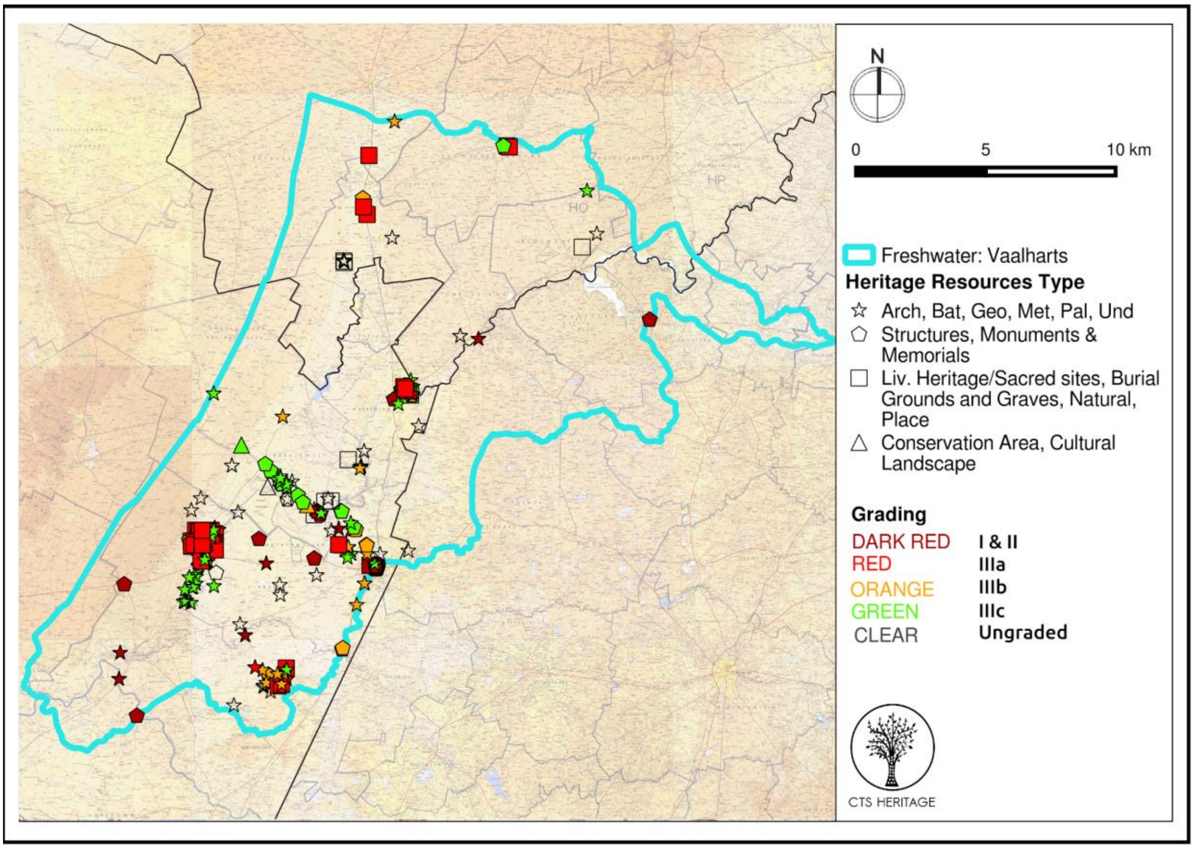

Figure 13. Vaalharts heritage resource map.

4.1.4.7 Development guidelines

Many areas are likely to be suitable for development but great care will need to be taken along any of the river margins in the area, since artefact occurrences and rock art are strongly tied to the riparian zone (Figure 14).

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh bedrocks of the Transvaal Supergroup, Prince Albert, Whitehill, Vryheid Formation and Volksrust Formations, consolidated or gravelly alluvial deposits (including terrace gravels) or vlei sediments along water courses, as well as cave and calc-tufa deposits in limestone / dolomite bedrock areas should be subject to a field-based palaeontological assessment (Figure 12).

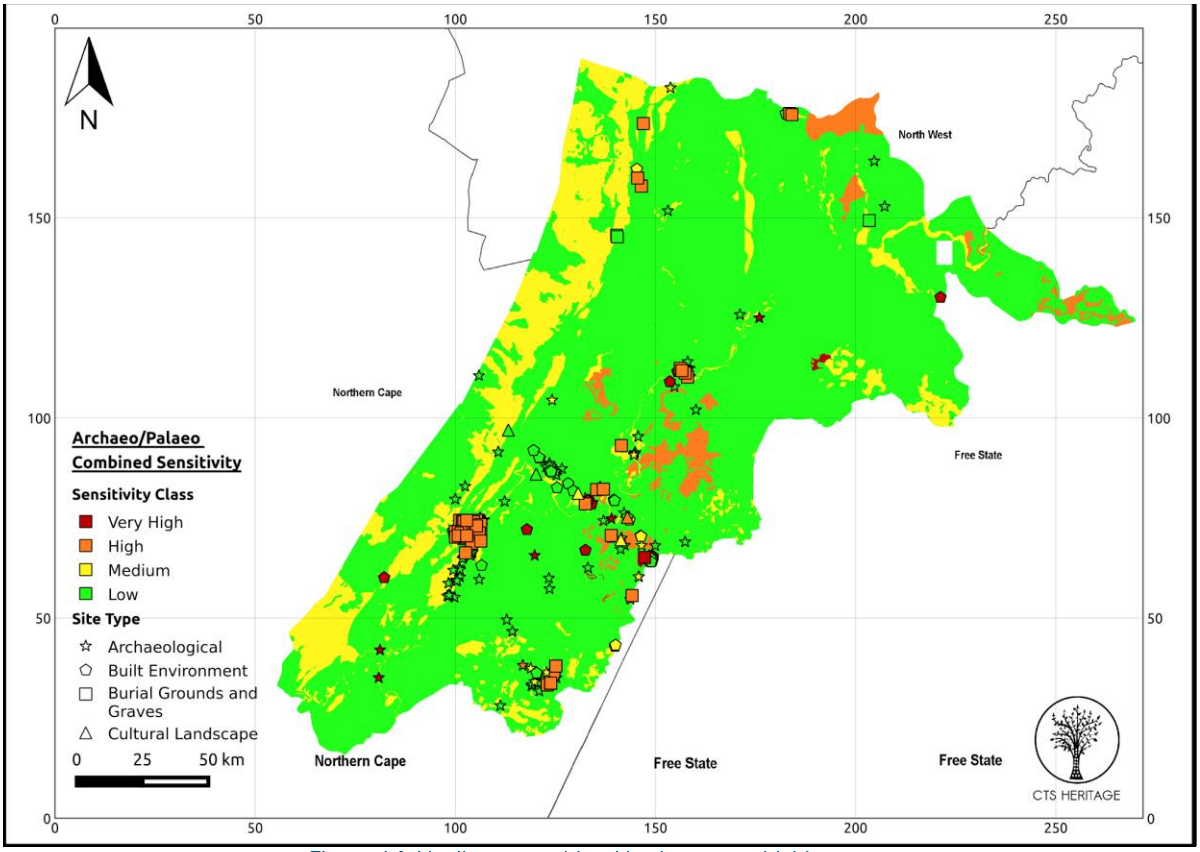

Figure 14. Vaalharts combined heritage sensitivities map.

4.1.5 Freshwater Study Area 5 – Free State-KZN Highlands

4.1.5.1 Landscape character

The study area consists of two Bioregions, namely the Mesic Highveld Grassland Bioregion and the Sub-Escarpment Grassland Bioregion (Mucina & Rutherford 2006). The area is characterised by mountains, valleys, rivers, waterfalls and forests. The area is mostly rural in character with scenic landscapes contributing to tourism in the region. Several historic towns occur in the area, such as Bergville, Winterton and Harrismith, while agricultural activities dominate the low-lying areas.

4.1.5.2 Palaeontology

The Free State-KwaZulu Natal (KZN) Highlands study area is of high palaeontological sensitivity overall due to the richly-fossiliferous Karoo Supergroup bedrocks with numerous good exposures in regions of high relief (Figure 15). There are several important plant, invertebrate and vertebrate fossil records from several Karoo rock units represented here. These rocks and fossils span the key Permian to Jurassic time interval which featured key events in the evolution of continental ecosystems such as the end-Permian and Early Jurassic mass extinctions, the evolution of early mammals and dinosaurs and associated vegetation changes. Drainage lines are of special palaeontological impact significance because many of the best fresh bedrock exposures occur here (river cliffs, banks and beds of streams), and due to the possible occurrence of fossiliferous ancient alluvial sediments (e.g. terrace gravels) as well as lake or vlei deposits. See Appendix for further details.

Key sites: numerous Karoo vertebrate sites (Sites have not been mapped at this scale).

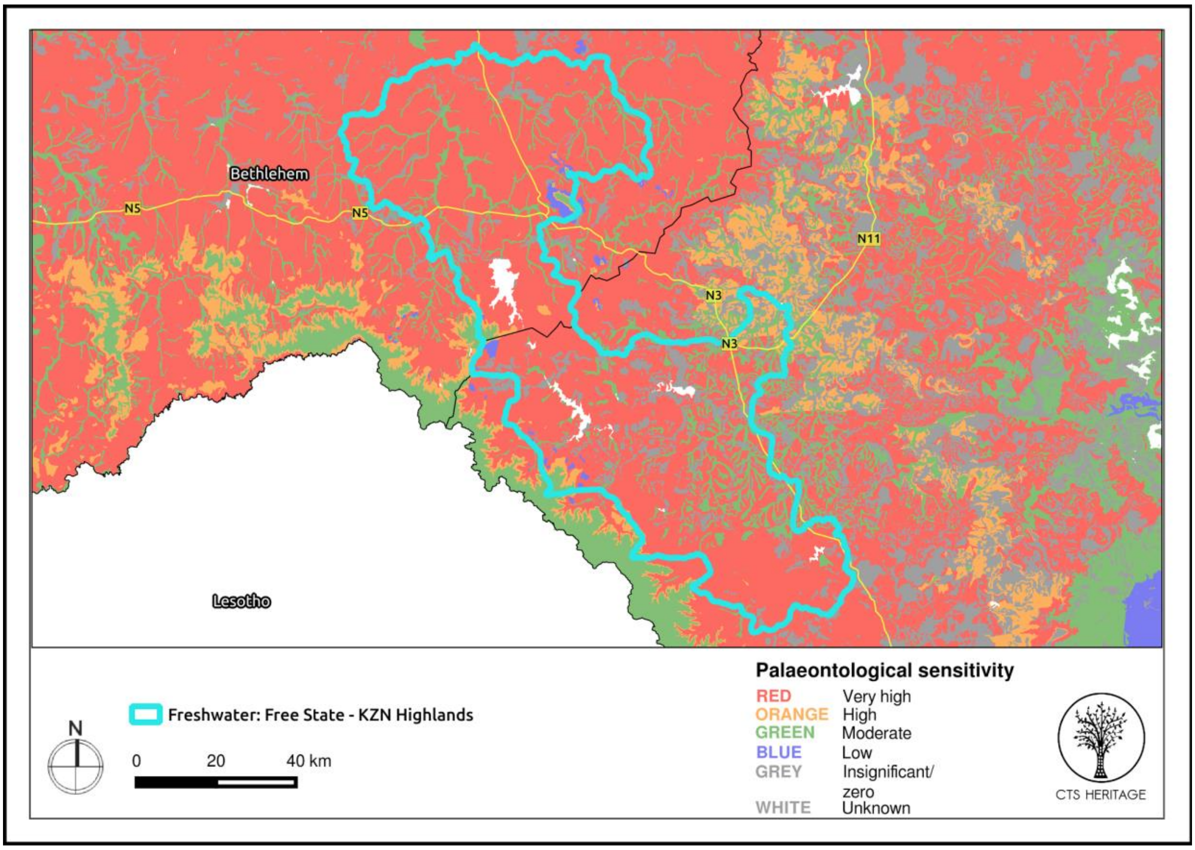

Figure 15. Free State-KZN Highlands Fossil Sensitivity Map (SAHRA 2014).

4.1.5.3 Archaeology

In terms of the Stone Age archaeology of the area, the LSA is the most prominent with an abundance of rock art, such as the rock paintings at Giant's Castle and Kamberg in the Drakensberg Mountains (Vinnicombe, 1976). Rock art sites have also been documented in the areas around Estcourt and Mooi River (Figure 16). In terms of the Iron Age the earliest known stonewalling in the region, characteristic of the Central Cattle Pattern (CCP) settlement layout, is known as Moor Park, which dates from the 14th to 16th Centuries AD (Huffman 2007). This type of stonewalling can be found in defensive positions on hilltops in the Midlands of KwaZulu-Natal (Huffman 2007). In addition to these stone walled settlements, several Iron Age sites dating to the Early and Late Iron Age are found in the study area and the ceramic facies represented date from AD 450 – AD 1820 (Beater and Maud 1963; Maggs 1976; Whitelaw 1994; Huffman 2007).

A large number of Boer War battlefields and related sites occur in this area including the sites of the Battles of Spioenkop and Colenso (Von der Heyde 2013). Heritage sites attesting to this include blockhouses, military cemeteries, memorials, museums and forts. The Voortrekkers passed through this region, and their passage is marked in place names, such as Retief's Pass, and historic farm buildings. 18 Provincial heritage sites are located in the study area consisting mostly of historic structures, but including three Iron Age rock engravings (Figure 16).

4.1.5.4 Graves

Graves and cemeteries are widely distributed across the landscape and can be expected anywhere. The area contains numerous battlefield sites and military cemeteries. Family cemeteries can be expected close to farmsteads with informal cemeteries widespread in informal settlements. Unmarked graves are associated with the areas where Iron Age Settlements occur.

4.1.5.5 Built heritage

As indicated above, historic buildings occur in this region, some in rural settings on farms, but most clustered within towns and villages. In addition to these structures, there are blockhouses and memorials related to the Boer War.

4.1.5.6 Cultural landscapes

The cultural landscape of this area is of high significance. In addition to the traces of the San presence in the region, as depicted in the rock paintings, parts of the landscape are substantially transformed by the stonewalled settlements of the Iron Age agro-pastoralists. More recently, the first Voortrekkers to reach KZN passed through this area, lending it additional layers of cultural significance that are further augmented by the battles that took place here during the Boer War, and are attested to not only by the structures and battlefields, but also the numerous war cemeteries.

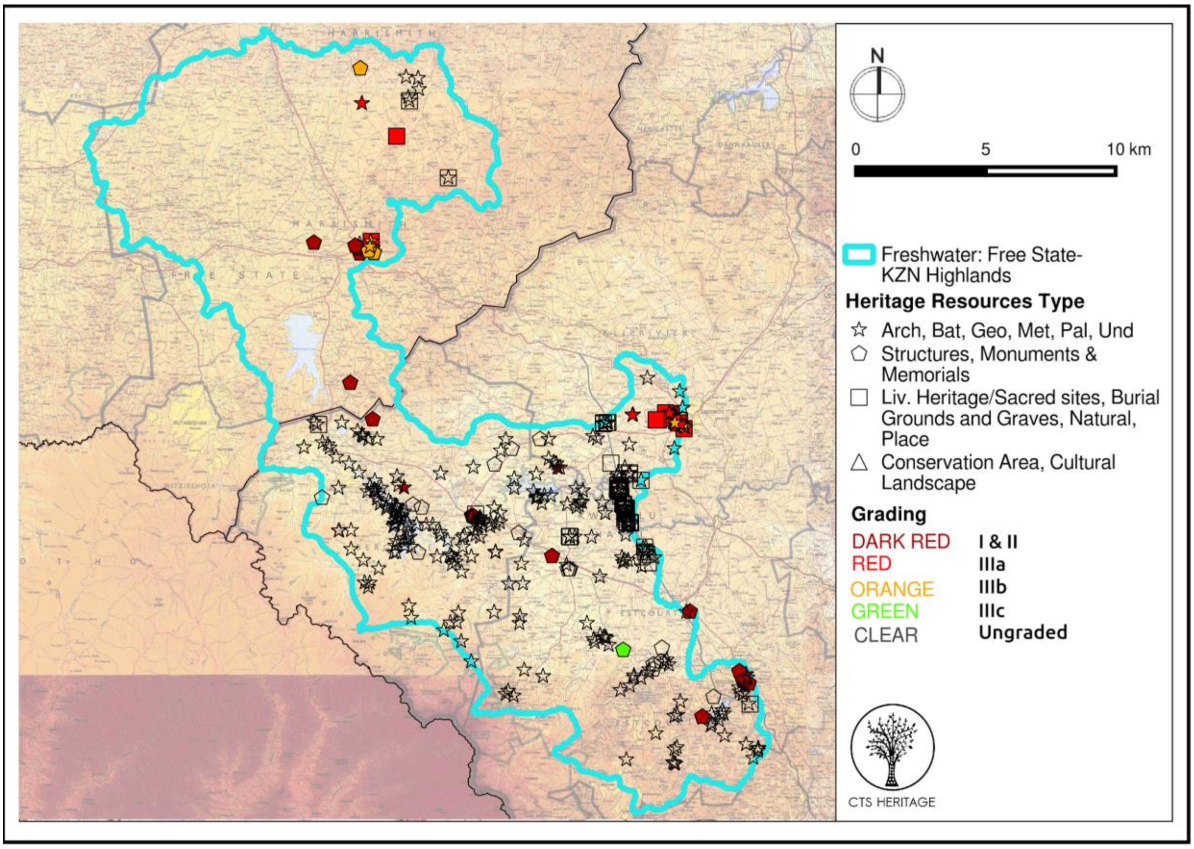

Figure 16. Free State-KZN Highlands heritage resource map.

4.1.5.7 Development guidelines

Rock Art occurs throughout the area and, in many areas, is an important tourist attraction. Iron Age sites can be expected throughout the study area, especially in hilly areas where stone is readily available for constructing stone walling, and on floodplains close to rivers (Figure 17). Battlefield sites and historical farmsteads occur widely across the study area. It is anticipated that most of these sites can be mitigated either through preservation *in situ* or through mitigation. Formal and informal cemeteries as well as pre-colonial graves occur widely across Southern Africa. It is generally recommended that these sites be preserved *in situ* when they occur within a development area. These sites can be relocated if conservation is not possible, but this option must be seen as a last resort and is not advisable.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh Karoo Supergroup bedrocks or consolidated alluvial or colluvial deposits should be subject to a field-based palaeontological assessment (Figure 17).

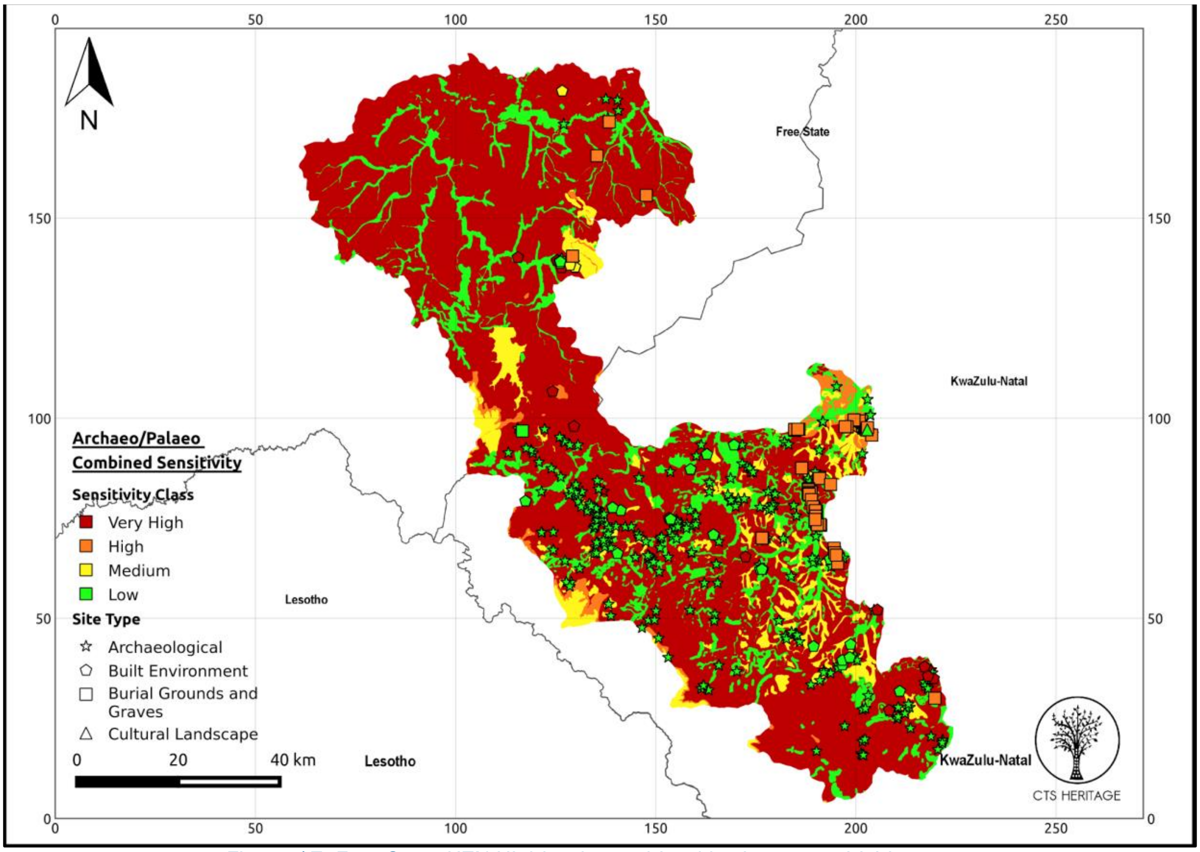

Figure 17. Free State-KZN Highlands combined heritage sensitivities map.

4.1.6 Freshwater Study Area 6 - Richards Bay and Marine Study Area 1 – Durban-Richards Bay

4.1.6.1 Landscape character

This study area is located in KwaZulu-Natal Province on the eastern seaboard of the country, between the Tugela and Mfolozi Rivers, and comprises three Bioregions, namely the Lowveld Bioregion, the Indian Ocean Coastal Belt Bioregion and the Maputaland Coastal Belt (Mucina & Rutherford 2006). The 185 km-long coastal area comprises the fairly linear KwaZulu-Natal coastline with only two major embayments, located towards either end: one at Durban, with its harbour, and the other at Richards Bay, where the dune system is extensively mined by Richards Bay Minerals. The Richards Bay Nature Reserve is a formally protected landscape located on the northern banks of the Mhlathuze River Estuary. The inland section is rural in character with several informal settlements with rolling hills and panoramic viewscapes.

4.1.6.2 Palaeontology

Most of the Richards Bay study area is of insignificant to low palaeontological sensitivity due to the extensive outcrop area of unfossiliferous Precambrian basement rocks, while there are, so far, no fossil records for the Ordovician Natal Group (Figure 18 and Figure 19). The Permo-Carboniferous to Early Jurassic Karoo Supergroup successions within the Main Karoo Basin and Durban-Lebombo Belt to the east are known to contain important fossil floras (e.g. Permian Emakwezini Formation) but are comparatively unexplored in palaeontological terms, with no major fossil vertebrate occurrences having been identified to

date. High levels of bedrock weathering may well have compromised fossil preservation in surface exposures here (e.g. through leaching of fossil bone, shell material, plant remains but not petrified wood).
Cretaceous to Paleogene marine sediments recording the early evolution of the Indian Ocean coast of South Africa and perhaps the end-Cretaceous extinction event (66 Ma) are poorly exposed on this southern portion of the KZN coastal plain but the small outcrops are highly fossiliferous and these beds extend widely in the subsurface. Fossil-rich units may have small surface outcrops but may be encountered much more widely in the shallow subsurface. Most of the inland portion of the study area is of medium to high palaeontological sensitivity, mainly due to Permian Ecca Group successions. The small Vryheid Formation outcrop areas are rated as highly sensitive, despite the presence of few of the fossil-bearing coal deposits characteristic of this Formation here.

Coastal rocky outcrops of the Ecca Group may be of special geological and palaeontological value due to rare exposures of fresh (i.e. unweathered) bedrock; in contrast, high levels of bedrock weathering are encountered in the hinterland. There are no sizeable outcrops of Cretaceous Zululand Group rocks, although these are present in the subsurface offshore.

The Late Caenozoic Maputaland Group cropping out along the KZN coast as well as in the shallow offshore region is mostly of moderate to low sensitivity (e.g. aeolian dune sands). However it may contain pockets of very high sensitivity where horizons or lenses of Pleistocene shelly marine sediments and organic-rich estuarine, lagoonal or lacustrine deposits occur at surface or in the shallow subsurface (e.g. Port Durnford and Isipingo Formations).

Drainage lines in the coastal interior are of special palaeontological impact significance because many of the best fresh bedrock exposures occur here (river cliffs, banks and beds of streams), and due to the possible occurrence of fossiliferous ancient alluvial sediments (e.g. terrace gravels) as well as lake, lagoon or vlei deposits. See Appendix for further details.

Key sites: small outcrop areas of Cretaceous St Lucia Formation (Mfolozi Flats, Richards Bay cores), Pleistocene Port Durnford and Isipingo ("Bluff") Formations along the coast (Sites not mapped at this scale.).

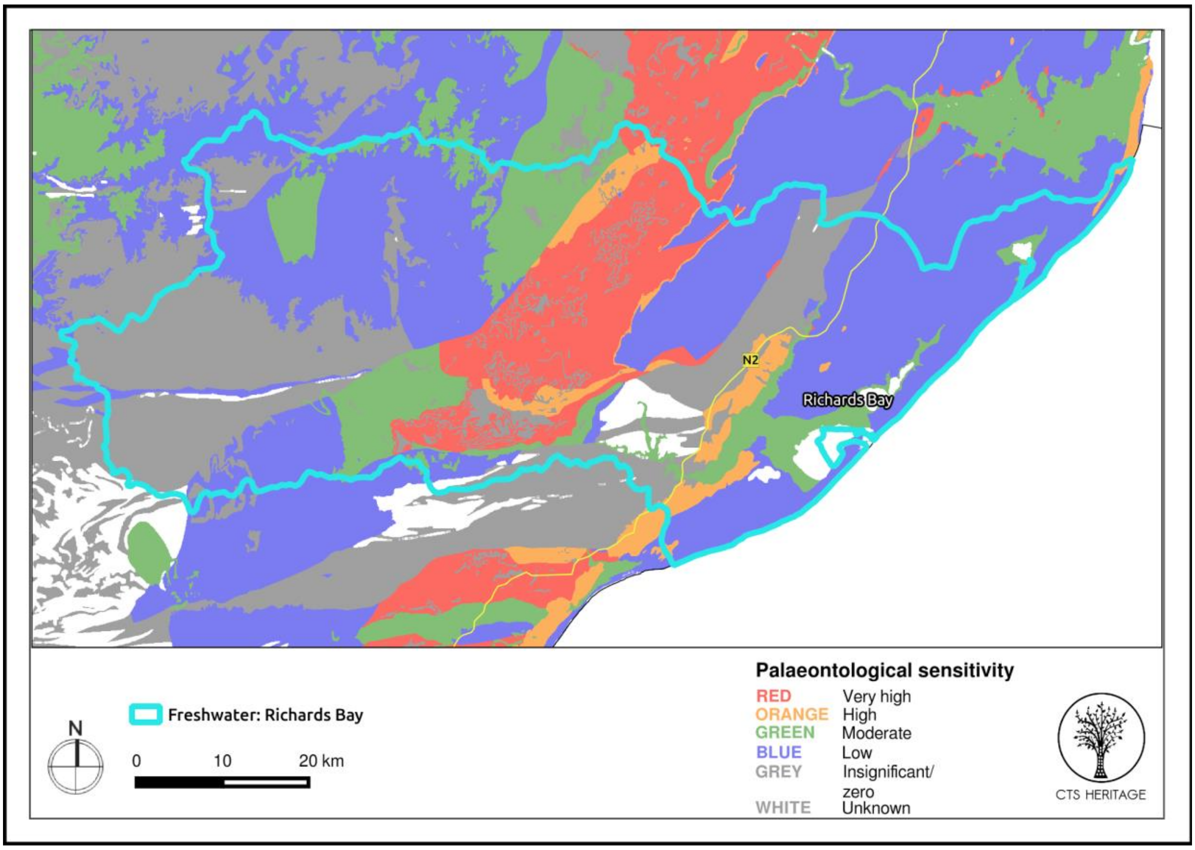

Figure 18. Richards Bay Freshwater Study Area Fossil Sensitivity Map (SAHRA 2014).

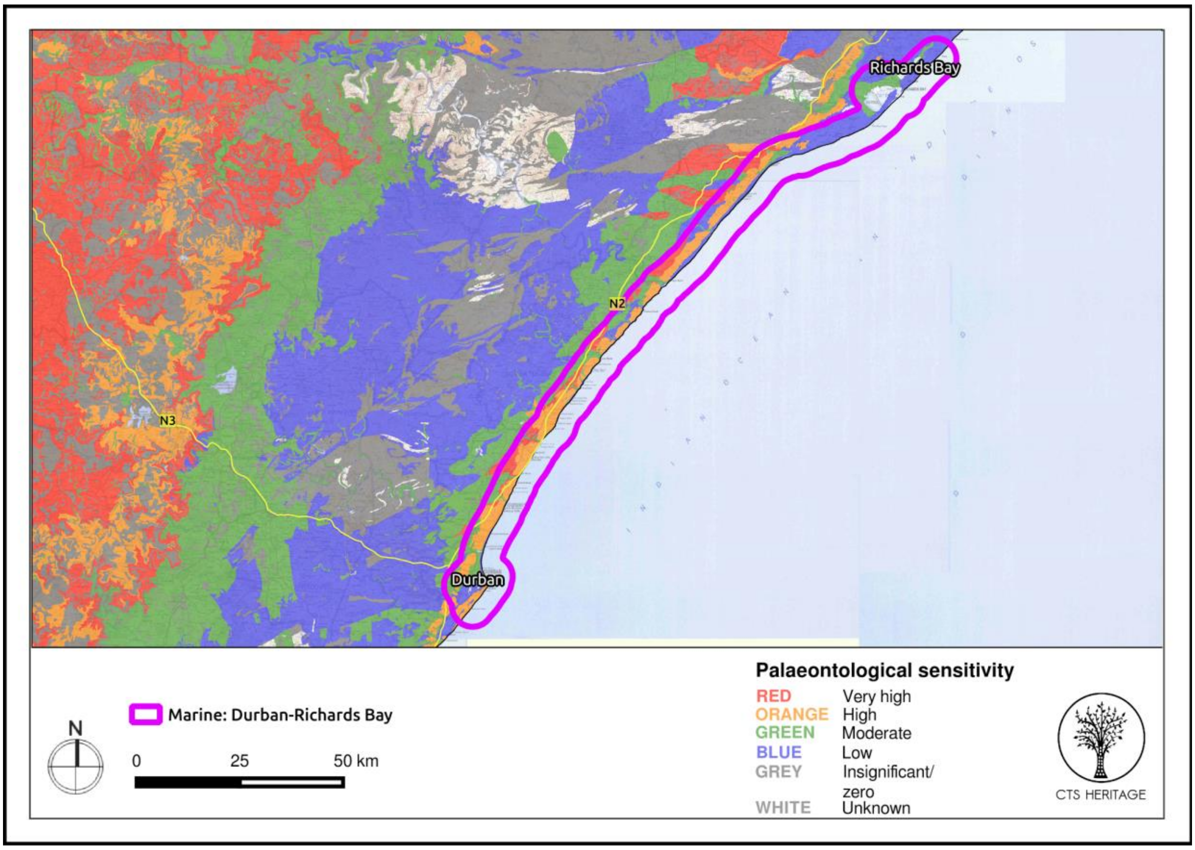

Figure 19. Durban-Richards Bay Marine Study Area Fossil Sensitivity Map (SAHRA 2014).

4.1.6.3 Archaeology

Several caves in KZN contain significant archaeological deposits (Figure 20 and Figure 21) like the well-known MSA site of Sibudu Cave to the south of the study area, which shows evidence for early forms of cognitive human behavioural patterns (Wadley, 2003). Another well-known cave, Border Cave, is situated to the north of the study area at the Ingodini Border Cave Museum Complex. Early excavations here, in the 1930s, exposed a thick deposit of archaeological material dating from the Iron Age overlaying MSA artefacts, while later work, in the 1970s, revealed a complete MSA sequence succeeded by Early and Later Iron Age deposits (Klein 1977). Although outside of the study area it provides evidence for the types of sites expected within the study area.

Early Nguni speaking people created Blackburn pottery that has been recorded along the north and south coast of KZN (Huffman 2007) and is often found in Shell Middens (Beater and Maud 1963). Mzonjani, 15 km from Durban, is the oldest known Iron Age site in KwaZulu-Natal, dating to the 3rd Millennium AD (Huffman 2007). Archaeologically, the Natal area was occupied by the Zulu people by AD 1050 (Huffman 2007) and Bulawayo the site of Shaka's Kraal is located in the study area. The wider study area is known to contain ceramic facies from industries dating between AD 450 and AD 1500 (Beater and Maud 1963; Whitelaw 1994; Huffman 2007).

Towards the coastal strip, heritage surveys showed that the area is of heritage significance especially the dune systems close to the sea (Anderson & Anderson 2008 and Anderson 2007, 2013) (Figure 20 and Figure 21). Shell middens and numerous graves are on record. Sites dating to the Early, Middle and Later Stone Age, and the Early and Later Iron Age have been recorded in the area north of Empangeni (Van der Walt 2016). However, the area north of Empangeni is considered generally “disturbed” by later human activities, especially sugarcane farming. If any sites have survived they would be confined to the edges of rivers and streams that run through the area, and hilltops.

4.1.6.4 Shipwrecks

More than 180 shipwrecks, dating from the 17th century to the present, are recorded in the SAHRA Shipwreck Database for the area between Durban and Richards Bay. The bulk of the wrecks are in the vicinity of Durban but sites are also spread along the rest of this piece of coast (J. Gribble, ACO-Associates, pers.comm. 5 October 2017) It is not anticipated that freshwater aquaculture operations will have any impact on coastal shipwrecks, although impacts to shipwrecks from offshore developments is possible.

4.1.6.5 Graves

Graves and cemeteries are widely distributed across the landscape and can be expected anywhere. Family cemeteries can be expected close to farmsteads with informal cemeteries widespread in informal settlements. Unmarked graves are associated where Iron Age Settlements occur and in shell middens in the dune systems.

4.1.6.6 Built heritage

Built heritage in this region consists of historic farm buildings – both formal and vernacular – in rural areas, as well as significant historical infrastructure such as bridges. Further historic buildings can be found within towns and settlements in the region, with some particularly fine examples of historic, largely Victorian, architecture in Pietermaritzburg and Durban, where several PHSes have been declared (Figure 20 and Figure 21).

4.1.6.7 Cultural landscapes

This region’s cultural landscape is composed of three elements. The first is the rural landscape which is determined by human occupation from pre-colonial times, in the form of Stone Age and Iron Age indicators, as well as a much later colonial (farmer/plantation) component. The second component is the urban landscape dating to the colonial period, which is further linked to the rural colonial landscape. The final component can be considered an industrial/mining landscape, centred on the dune fields.

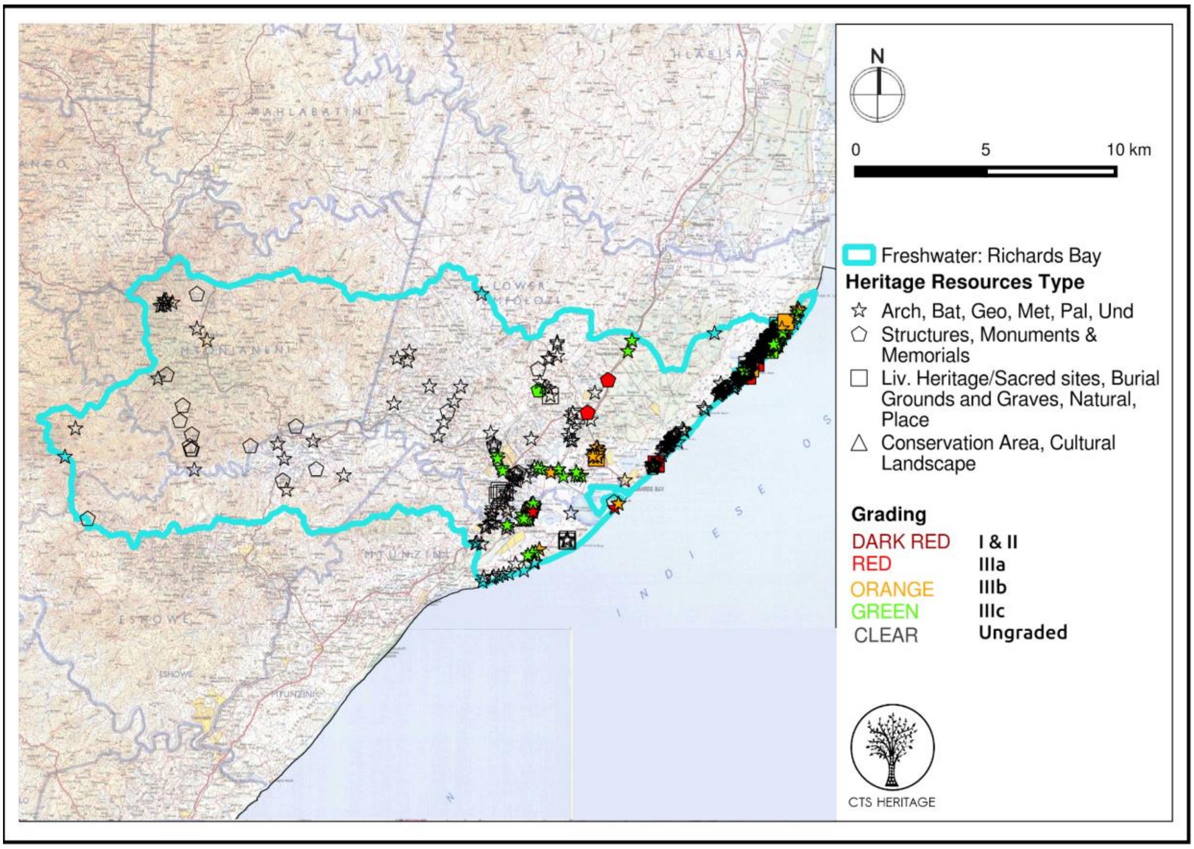

Figure 20. Richards Bay Freshwater Study Area heritage resource map.

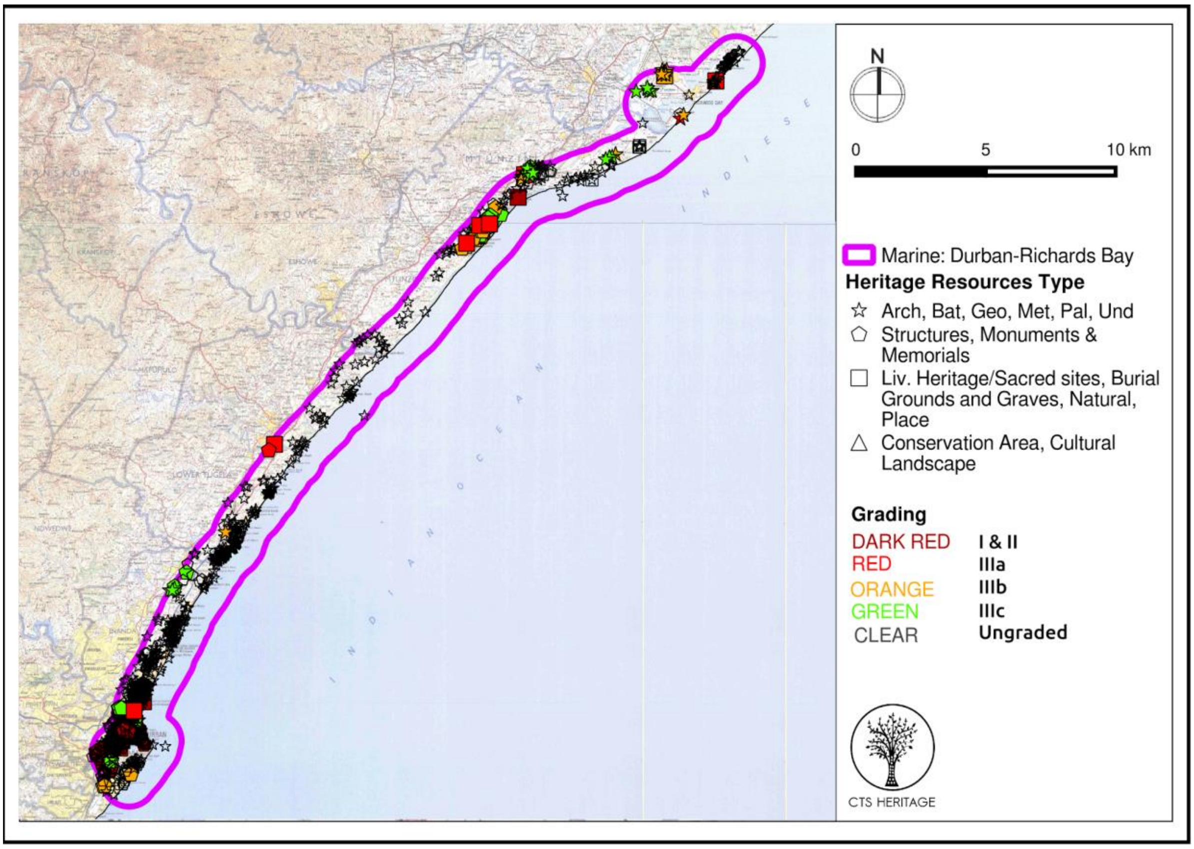

Figure 21. Durban-Richards Bay Marine Study Area heritage resource map.

4.1.6.8 Development guidelines

Large sections of the inland study area are characterised by sugarcane farming and if any sites have survived they would be confined to the edges of rivers and streams that run through the area, and hilltops. These areas are not deemed to be highly significant (Figure 22 and Figure 23).

Coastal environments are sensitive and it is possible that archaeological sites would be affected by developments. Shell middens can be expected on the coastline that is characterised by unmarked graves. It is anticipated that most of these sites can be mitigated either through preservation *in situ*, the recommended and preferred alternative, or through mitigation. Archaeological consultants for Richards Bay Minerals have developed a model procedure for traditional burials with known descendents, whereby through agreement with local communities, graves uncovered during development activities are studied and then reburied in the same place (Huffman 2007). Coastal environments are sensitive and it is possible that archaeological sites would be affected by development. It is unlikely that any underwater shipwrecks will be affected by freshwater aquaculture development, although impacts to shipwrecks from offshore developments are possible.

Formal and informal cemeteries as well as pre-colonial graves occur widely across Southern Africa. It is generally recommended that these sites be preserved *in situ* and within a development. These sites can however be relocated if conservation is not possible, but this option must be seen as a last resort and is not advisable.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh Ecca Group, Karoo Supergroup and Maputaland Group bedrocks or consolidated alluvial or colluvial deposits should be subject to a field-based palaeontological assessment (Figure 22 and Figure 23).

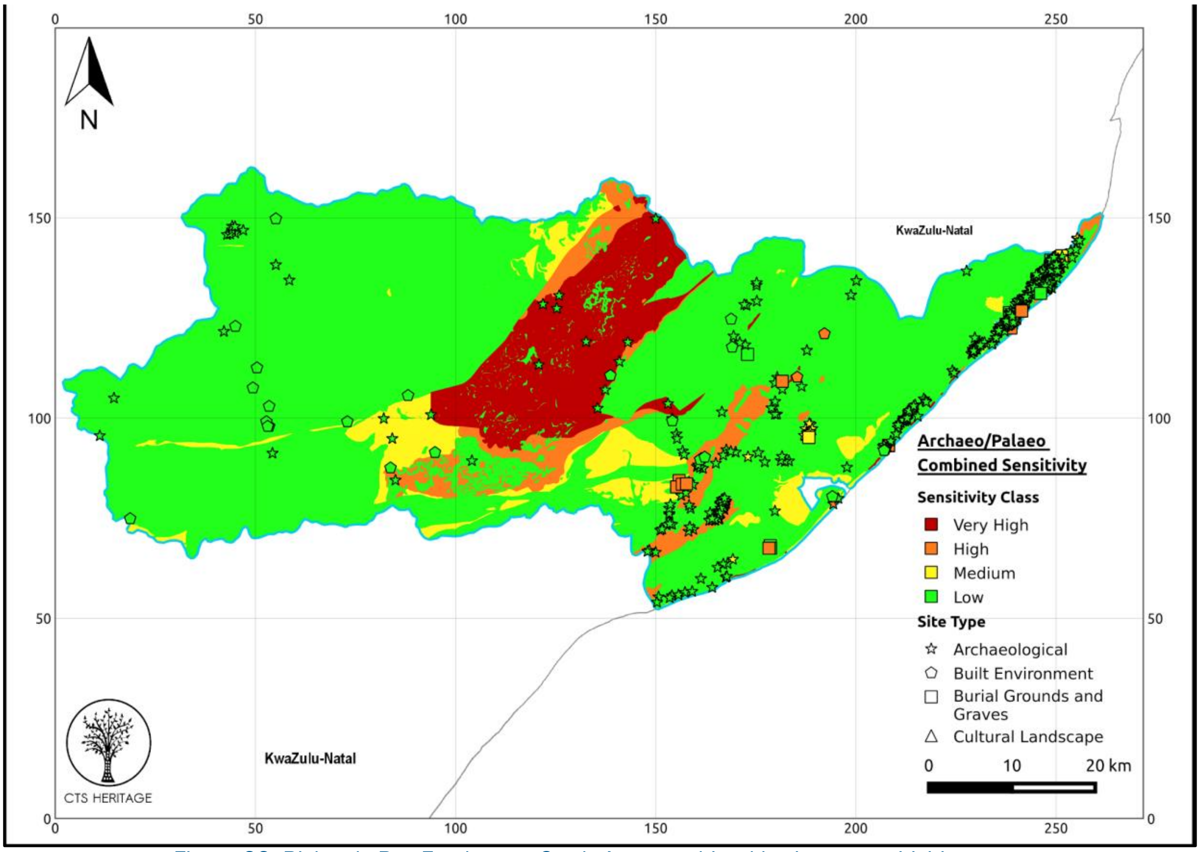

Figure 22. Richards Bay Freshwater Study Area combined heritage sensitivities map.

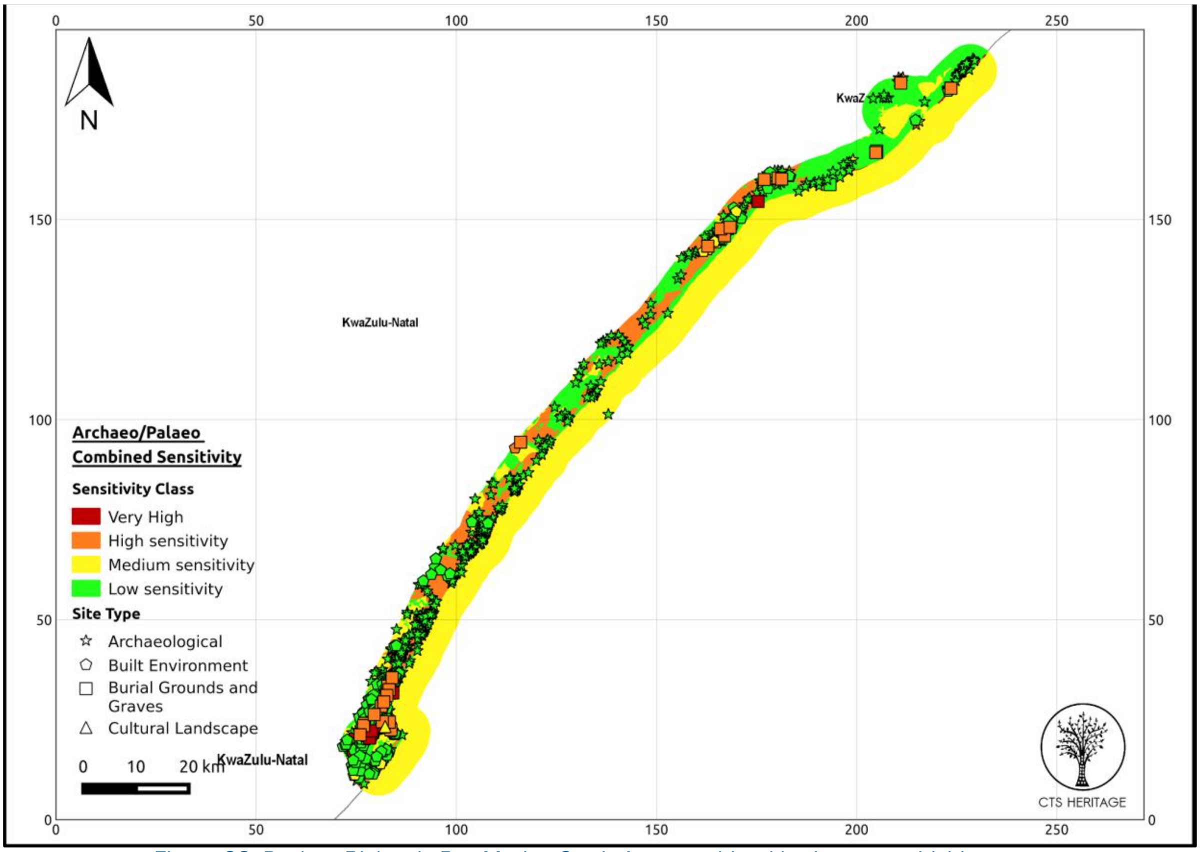

Figure 23. Durban-Richards Bay Marine Study Area combined heritage sensitivities map.

4.1.7 Freshwater Study Area 7 – Vanderkloof-Gariep

4.1.7.1 Landscape character

The Vanderkloof-Gariep study area encompasses a large region of semi-arid Karoo centred on the course of the Orange River (Gariep) between Orania and Aliwal North and spanning the Northern Cape, Eastern Cape and Free State borders. The affected Bioregions are the Upper Karoo and Dry Highland Grassveld Bioregions (Mucina & Rutherford 2006). This area is dominated by low hills, many of them underlain by dolerite. The Orange River flows from southeast to northwest through the study area and two large in-stream dams, the Gariep and Vanderkloof Dams are present along the river. The course of the river is strongly dictated by the dolerite dykes which are resistant to erosion. The land is mostly used for livestock grazing, but along the river downstream of each of the dams crops are grown under centre-pivot irrigation.

4.1.7.2 Palaeontology

The Vanderkloof-Gariep freshwater study area is of high geological as well as palaeontological interest related to key sections across the Ecca-Beaufort Group boundary as well as good bedrock exposures spanning the end-Permian mass extinction event (e.g. near Bethulie) (Figure 24). While the Ecca Group mudrocks and sandstones contain a fairly sparse fossil biota (e.g petrified wood, trace fossils), the Middle Permian to Early Triassic Beaufort Group is especially well-known for its rich record of fossil vertebrates (reptile, therapsids, amphibians and fish), as well as trace fossils (e.g. vertebrate burrows, trackways). Occasional Pleistocene mammal remains (bones, teeth) occur within older alluvial deposits. See Appendix for further details.

Key sites: Bethulie area (Permo-Triassic boundary sites) (Figure 12).

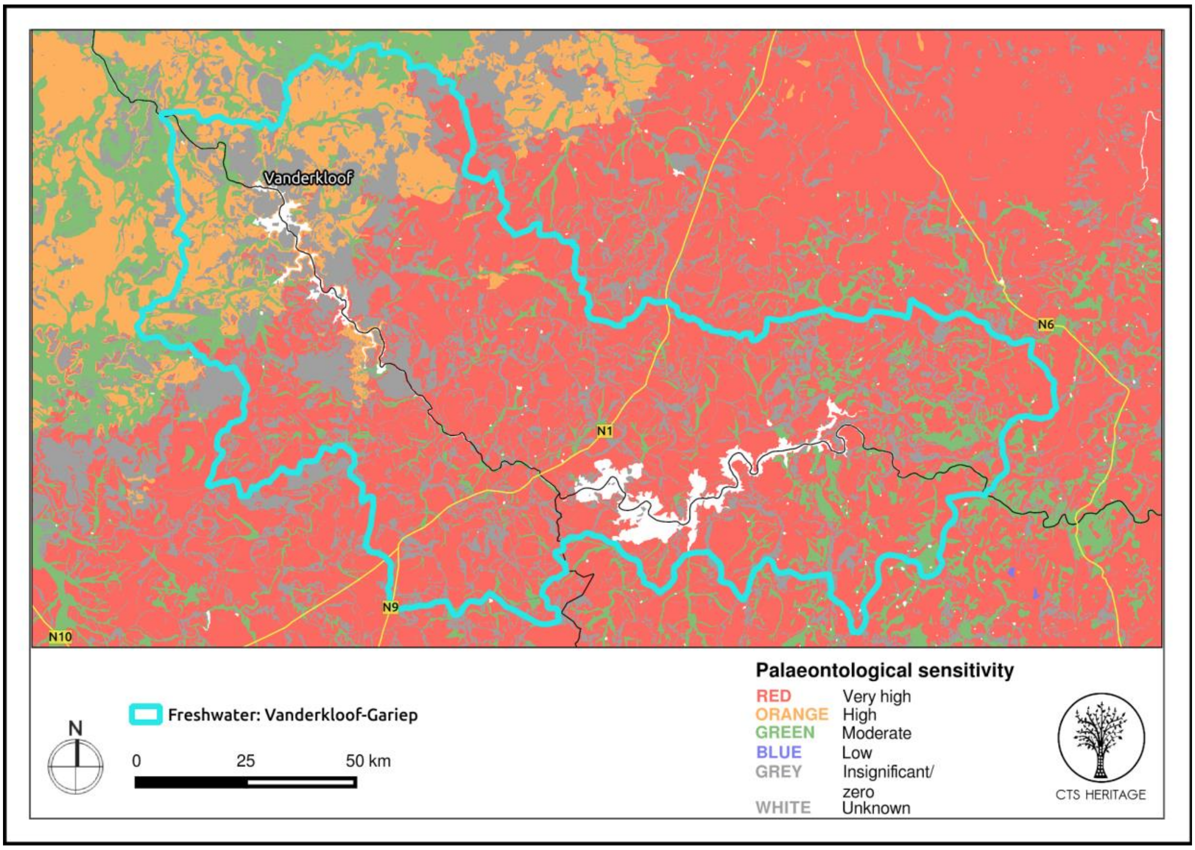

Figure 24. Vanderkloof-Gariep Fossil Sensitivity Map (SAHRA 2014).

4.1.7.3 Archaeology

Much of what we know about the archaeology of this region is the result of a single large research project carried out to rescue archaeological data and artefacts prior to flooding of the Gariep Dam (Figure 25). Sampson (1972, 1974, 1985), as part of one of the most comprehensive archaeological surveys undertaken in the country, recorded Stone Age sites from the ESA, MSA and LSA. Similar findings were made by Van Ryneveld (2013) who worked around the Vanderkloof Dam, who also reported a rock shelter with geometric rock art of the type associated with the Khoekhoen and a single site, now flooded by the dam, thought to be from the Late Iron Age. Van Ryneveld’s survey (2013) was only aimed at visiting known sites and she inferred that many more sites must be present in the surrounding landscape. The vast majority of recorded sites are open artefact scatters made on hornfels but rock shelters are known with a few having been studied by Sampson (1972). The strong presence of dolerite is important in this area because hornfels is found along the margins of these dykes. This latter rock type was used almost exclusively throughout the Stone Age of the area (Sampson 1972). Historical sites are also known to occur, often in association with older structures that are still in use today. Two Second Anglo-Boer (South African) War battles were fought in the area around Colesburg (Von der Heyde 2013).

4.1.7.4 Graves

Morris (1992) reports many graves from the north-western half of the study area but virtually none from the south-eastern half. This does not mean they are absent from the latter area, but rather that for various reasons, they have not been located yet. Graveyards are common in rural areas where they are likely to be found associated with historical farmsteads.

4.1.7.5 Built heritage

Historical structures are most common within the towns of the area, but many farmsteads are known to have historical structures on them. Colesberg, situated at the southern edge of the study area, has a high concentration of historical structures.

4.1.7.6 Cultural landscape

Outside of the towns, the landscape is largely natural because of the land use that predominates (i.e. grazing). The most important cultural landscapes are the agricultural ones that are closely associated with the Orange River and other smaller rivers in the area. The many centre pivot irrigation systems are a relatively recent addition, but they do continue the tradition of agriculture in these areas.

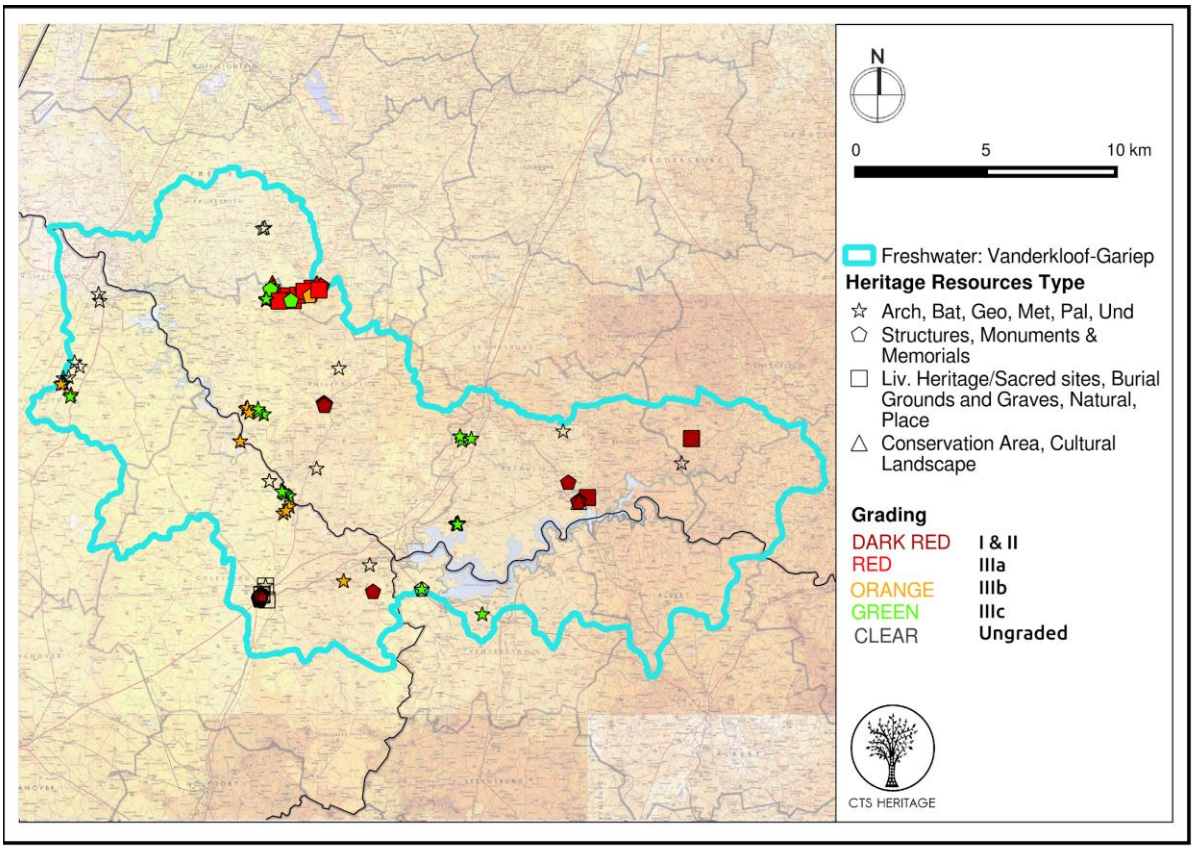

Figure 25. Vanderkloof-Gariep heritage resource map.

4.1.7.7 Development guidelines

It is likely that archaeological sites will be found widely in the region, but areas close to dolerite outcrops are likely to be most sensitive (Figure 26). However, the nature and context of the vast majority of sites does suggest that mitigation could be easily accomplished should this be necessary.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh bedrocks of the Beaufort Group as well as consolidated or gravelly alluvial deposits (including terrace gravels) along water courses should be subject to a field-based palaeontological assessment (Figure 26).

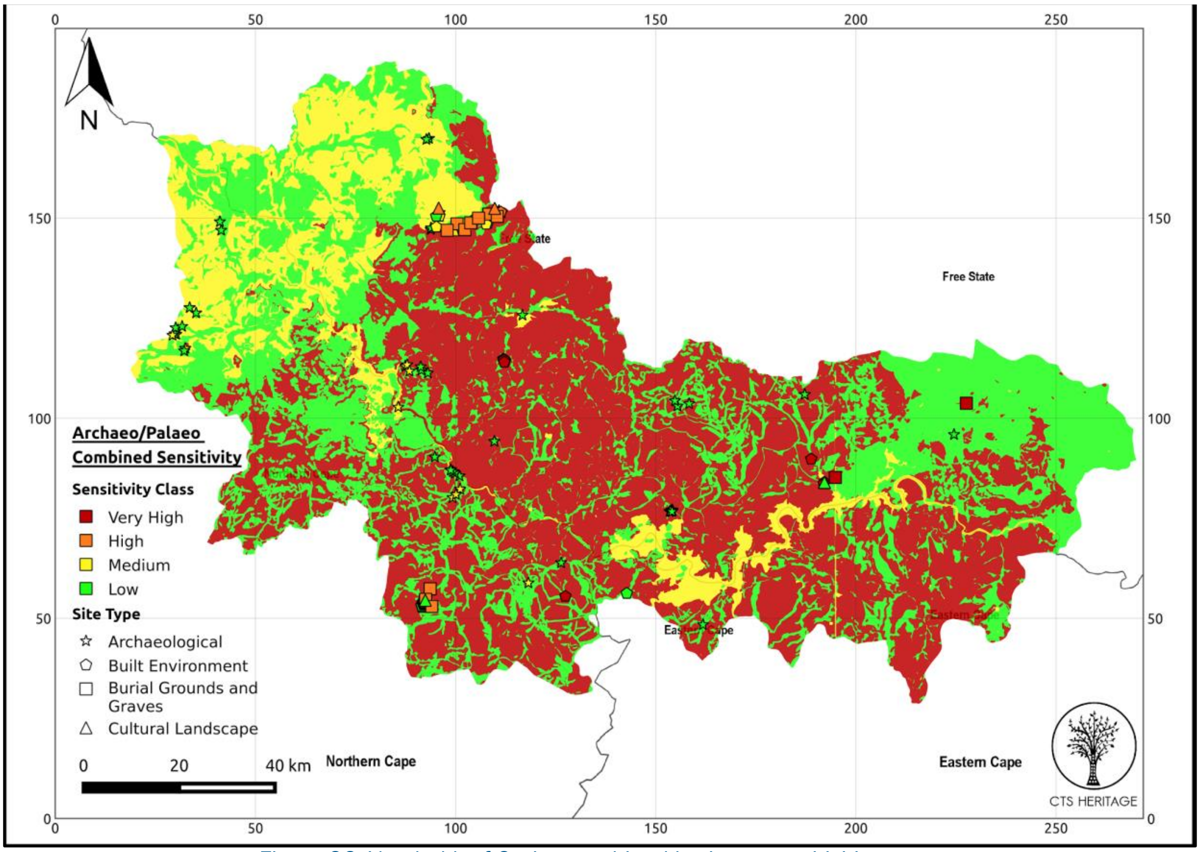

Figure 26. Vanderkloof-Gariep combined heritage sensitivities map.

4.1.8 Freshwater Study Area 8 – Eastern Cape and Marine Study Area 2 – East London-Kei

4.1.8.1 Landscape character

The combined Eastern Cape study areas extend from the predominantly rocky coast between East London, on the Buffalo River to the south, and the small town of Kei Mouth that lies on the Kei River in the north, north-westwards towards the foothills of the Drakensberg and lies entirely seawards of the Great Escarpment (South-eastern Coastal Hinterland of Partridge *et al*. 2010). This area, according to Mucina & Rutherford (2006), consists of the Sub-Escarpment Grassland Bioregion, Sub-Escarpment Savanna Bioregion and Albany Thicket. The area is rural in character with several communal settlements, with some settlements adhering to formal layouts. Where planning was not implemented or adhered to, a more scattered settlement pattern occurs. These rural settlements are generally surrounded by areas of arable and communal grazing lands (Van Schalkwyk 2008). The 84 km-coastal strip forms part of the "Wild Coast" region of the Eastern Cape, a region known for its long, stretches of white sandy beaches, and is mostly undeveloped with a few small towns and several private commercial farms.

4.1.8.2 Palaeontology

While most of the Eastern Cape study area is designated as of very high palaeontological sensitivity (Figure 27 and Figure 28), in practice records of well-preserved *in situ* fossils are scarce, perhaps due to high levels of bedrock weathering and poor exposure levels. However fresher bedrocks exposed along the modern coastline have yielded occasional important vertebrate fossils. Pockets of high palaeontological sensitivity may be associated with drainage lines on the coastal platform because many of the best fresh bedrock exposures occur here (river cliffs, banks and beds of streams), and due to the possible occurrence of fossiliferous ancient alluvial deposits (e.g. terrace gravels, lake or vlei deposits). At or close to sea level along the coast important fossil remains may be associated with small outcrop areas of ancient (Plio-Pleistocene) consolidated marine deposits and dune sands of the Algoa Group that are mistakenly indicated as of low palaeo-sensitivity on current maps. See Appendix for further details.

Key sites: Fort Grey silcretes, Lower and Upper Needs Camps, Igoda beds, Haga Haga WEF petrified woods, Nahoon Point hominid footprints (Figure 29).

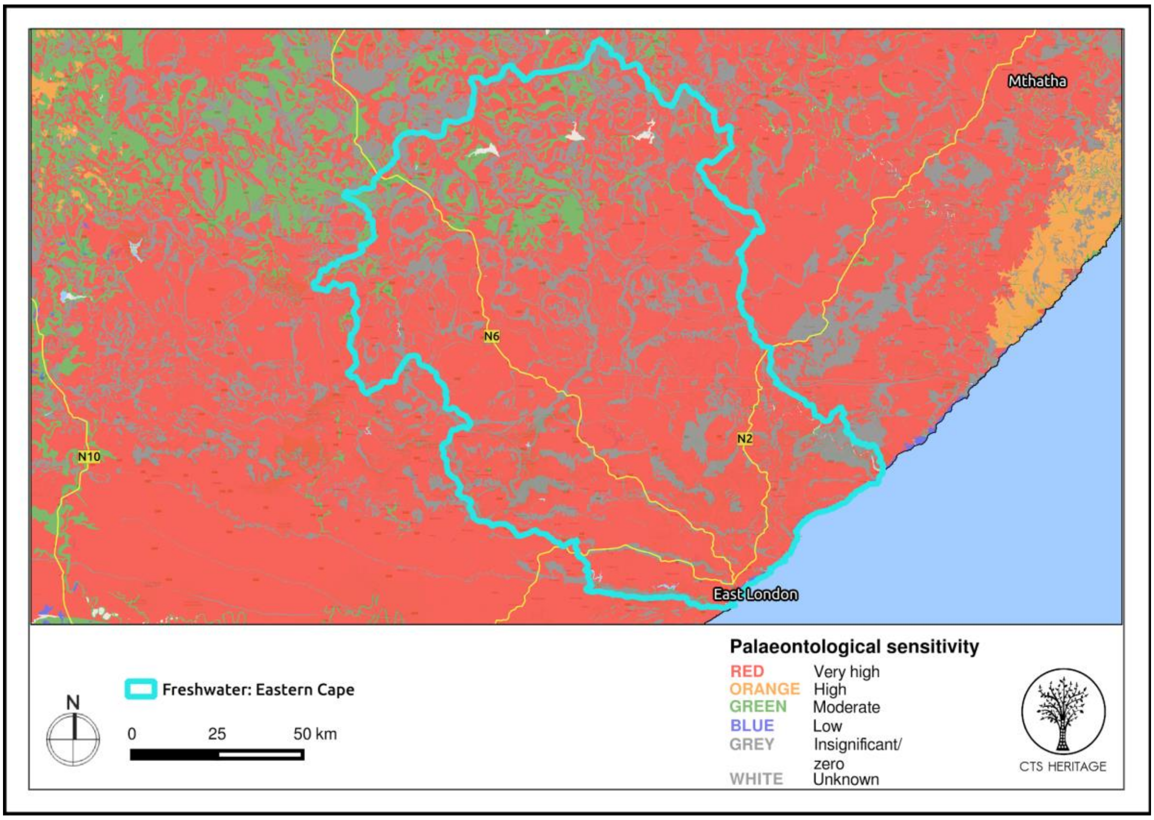

Figure 27. Eastern Cape Freshwater Study Area Fossil Sensitivity Map (SAHRA 2014).

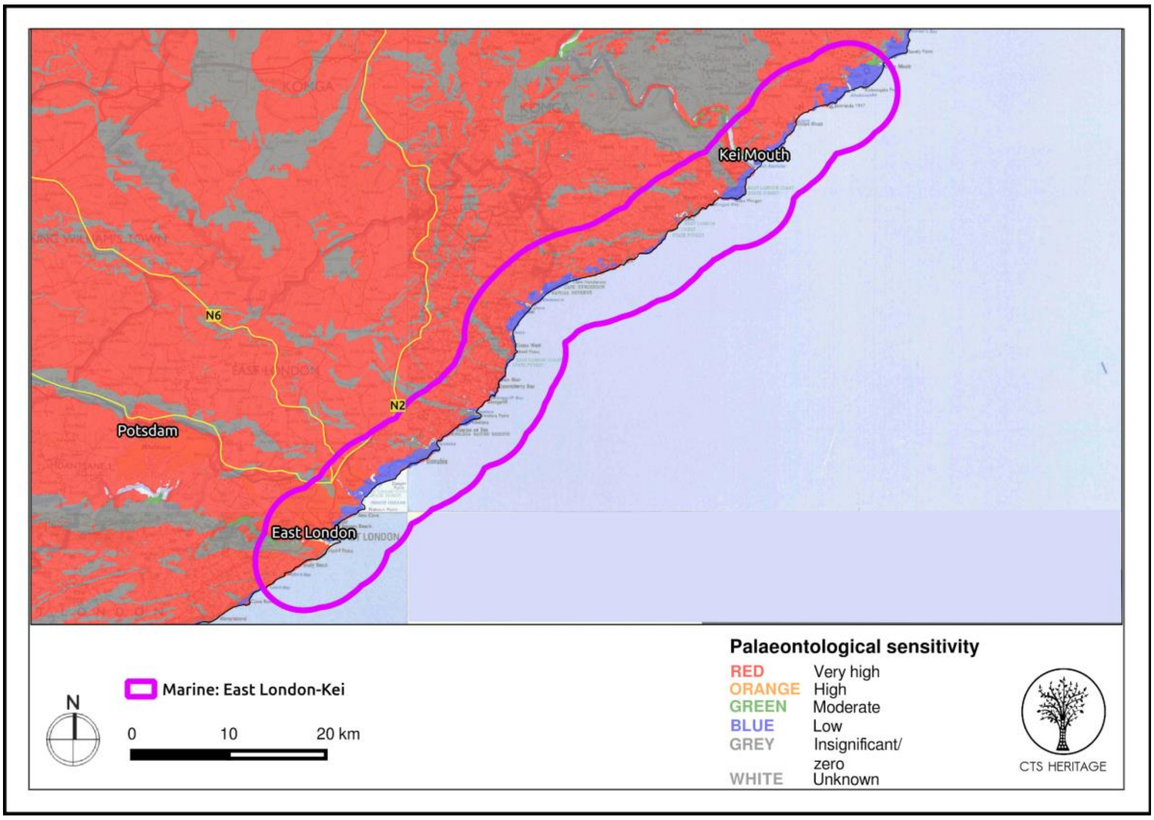

Figure 28. East London-Kei Marine Study Area Fossil Sensitivity Map (SAHRA 2014).

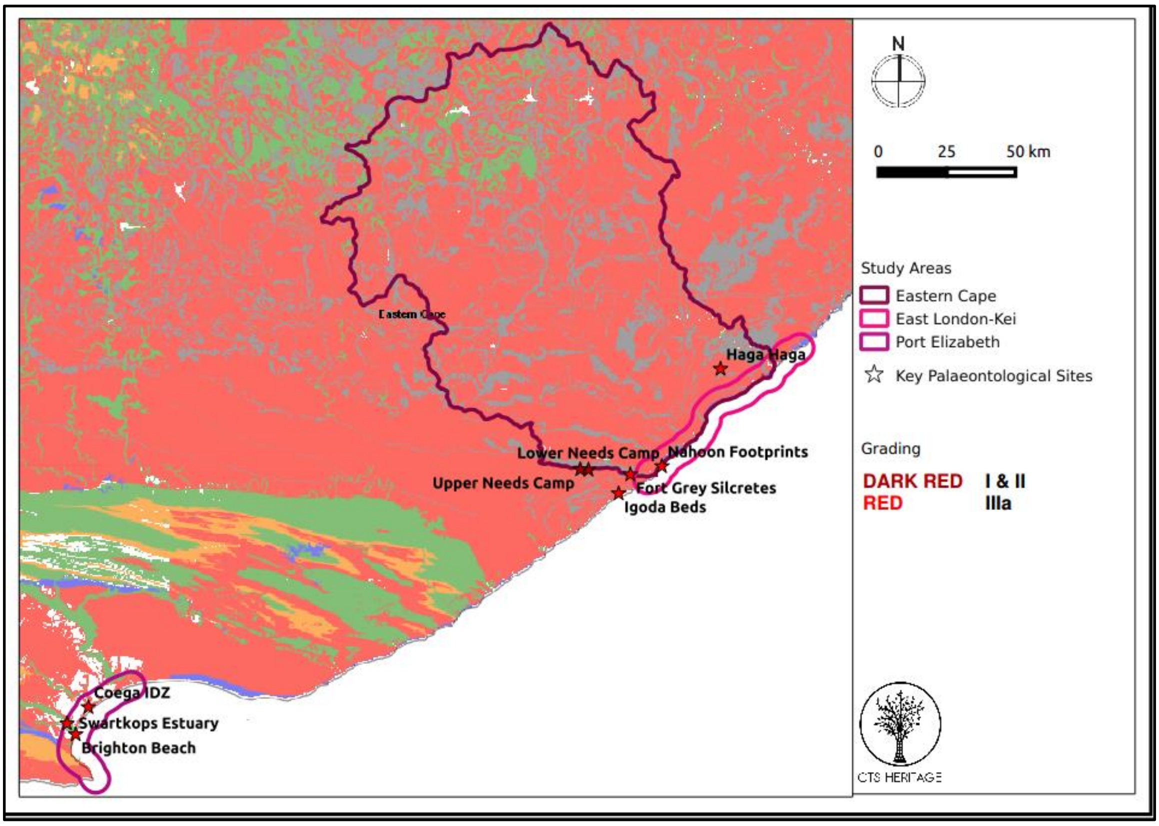

Figure 29. Combined site location map for key palaeontological sites in East London-Kei, Eastern Cape and Port Elizabeth study areas.

4.1.8.3 Archaeology

In terms of archaeological research, very few sites have been subjected to intensive academic investigations and most of the archaeological information from the area is a result of heritage surveys (Figure 30). The ESA has not been well documented in the area although some isolated ESA material was recorded (Van Ryneveld 2010a, 2016) together with MSA artefacts from the Needs Camp / Potsdam area (Van Ryneveld 2014d). MSA and, to a lesser extent, LSA, deposits seem to dominate (Van Ryneveld 2011a, 2011b, 2012, 2014a; Dreyer & Loock 2014), and are characteristic of the inner portions of the study area. Moving eastwards towards the coast, Webley (2008) commented on the presence of ESA, MSA and LSA lithic scatters identified by amateur and professional archaeologists across the greater Ann Shaw and Middledrift areas. In addition, LSA pastoralist presence in the landscape is well represented, confirming a Gonaqua-Khoekhoen settlement dating to before the 18th Century in the Ann Shaw area (Van Ryneveld 2016).

Closer to the coast are two important sites, the first is the Nahoon footprints site, some 10 km east northeast of Gonubie, where hominin / human footprints dating to 200,000BP have been discovered (Deacon 1966) (Figure 29, Figure 30 and Figure 31). The second site is the Klasies River Site (Singer and Wymer, 1982; Deacon, 1989, 1995) where the earliest modern human remains, dating to 125,000 BP, have been recorded (Figure 30 and Figure 31).

Deflated LSA coastal shell middens were reported on by Binneman & Webley (1996), while Anderson (2009) identified seven LSA shell midden sites at the East London IDZ. In addition, an ephemeral shell scatter situated approximately 2.5-3 km inland, on the banks of the Buffalo River, has been reported (Van Ryneveld 2010a). The 5-km strip from the coast inland is considered a 'sensitive' zone where shell middens may be expected to occur, as well as a sensitive environment where the prehistoric presence and use of freshwater resources is evident. Several Iron Age sites occur in the area and ceramic facies present have been dated to between 650 AD and 950 AD (Binneman *et al.* 1992, Binneman 1996; Huffman 2007). Canasta Place, an Iron Age Site, situated approximately 15-20 km west of East London constitutes the southernmost known Early IA site in South Africa (Nongwasa 1994). Within the study area another Early IA site, Kulubele (Binneman 1996) dating to AD 800 is located along the Great Kei River. Ceramics related to stone-walled settlements belonging to the Moor Park cluster have been recorded along the Transkei coast (Huffman 2007) where it was called Umgazana ware (Derricourt 1977). Radiocarbon dating places Moor Park between about AD 1350 and 1700. From the late 1500s / early 1600s increasing numbers of Later IA Nguni people moved south, into the Eastern Cape, as a result of Zulu tribal warfare and the resultant D*ifaqane*. These people largely displaced resident KhoiSan groups (Mitchell 2002).

Another important site worth mentioning is the Cove Rock Late Iron Age site, situated south of the Buffalo River (Coetzee 2008, Van Ryneveld 2008a, 2008b). The site is closely tied with the history of Nongqawuse, the young Xhosa prophetess who in 1856 prophesied the 'Cattle Killing' (1856-1857) to ensure expulsion of white settlers from Xhosa territory.

Numerous known Colonial Period sites, dating back to the 1840's occur in the study area mostly in the vicinity of the East London harbour [Van Ryneveld (2007, 2010b, 2012, 2014b, 2014c) and Webley & Vernon (2008)].

Forty two (42) Provincial Heritage Sites are on record for the study area and are all related to the built environment.

4.1.8.4 Shipwrecks

The study area is known for the many shipwrecks along the East London coastline, roughly from the Kei River mouth in the north to Kaysers' Beach in the south (Van Ryneveld 2015). The SAHRA Shipwreck Database lists more than 200 shipwrecks along this stretch of coastline, ranging in date from the 17th century to the present (J. Gribble, ACO-Associates, pers.comm. 5 October 2017). It is not anticipated that freshwater aquaculture operations will have any impact on coastal shipwrecks, although impacts to shipwrecks from offshore developments are possible.

4.1.8.5 Graves

Graves and cemeteries are widely distributed across the landscape and can be expected anywhere. Unmarked graves are expected in shell middens close to the coast. Both formal and informal graves have been reported in the area (Anderson 2011; Van Ryneveld 2007).

4.1.8.6 Built heritage

The most significant components of the built heritage are located within towns, with the architecture in East London showing the strong links with England, as well as traces of German influence, and several well-preserved examples of 19th-century architecture can be seen in the city. East of Gonubie, settlements are small, and their development is closely linked to tourism in more recent years. Further built heritage items are to be found on settler farms in the area.

4.1.8.7 Cultural landscapes

The cultural landscape reflects the occupation of the area from the Stone Age onwards, with particularly sensitive landscapes linked to the Xhosa settlement of the area, and recorded historic events, such as the Cattle Killing. Much of the area's sense of place is derived from the juxtaposition of the rural lands, which tend to have a pastoral quality, and the stretches of pristine beaches. The linkages between communities and landscape elements, such as forests, hills, rivers that people use as part of their cultural life are as significant as the places themselves, with these routes and links holding intrinsic cultural value for the people of the Eastern Cape (E. Bailey, Hearth Heritage, pers.comm. 20 October 2017).

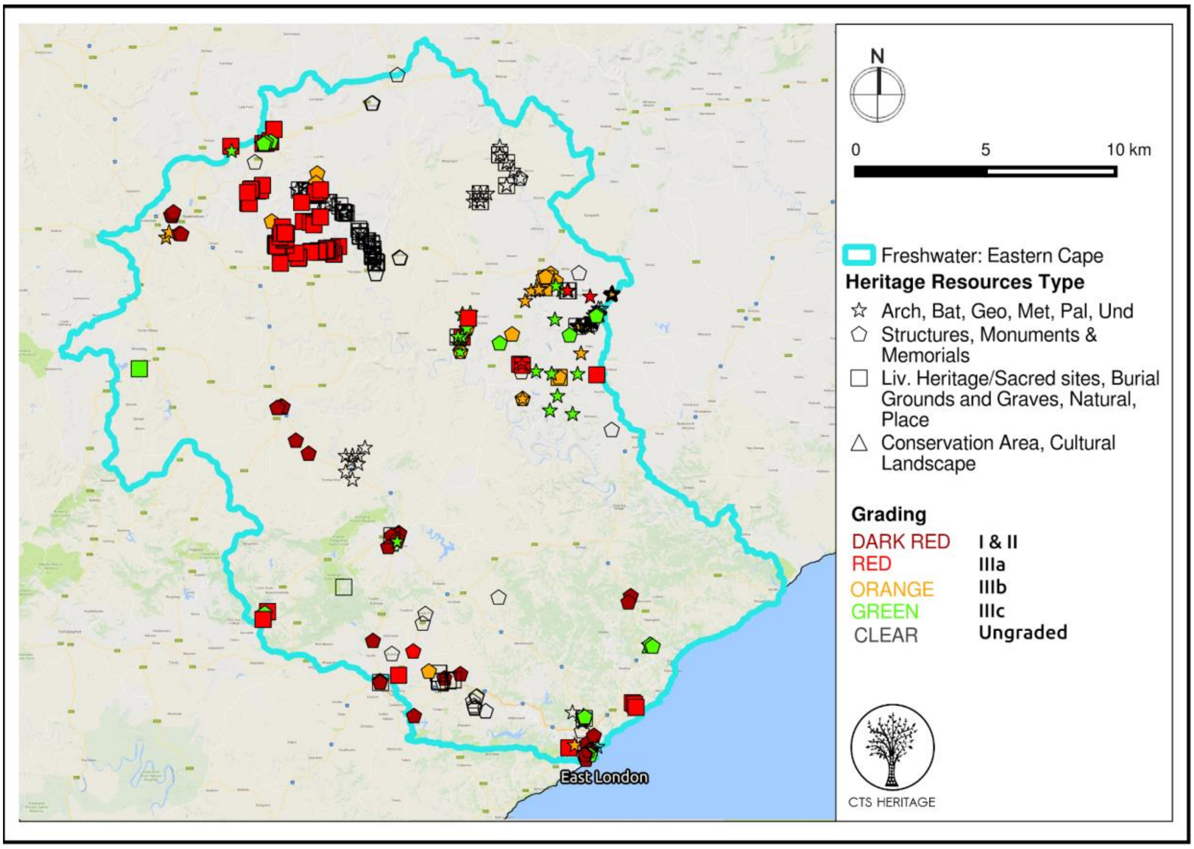

Figure 30. Eastern Cape Freshwater Study Area heritage resource map.

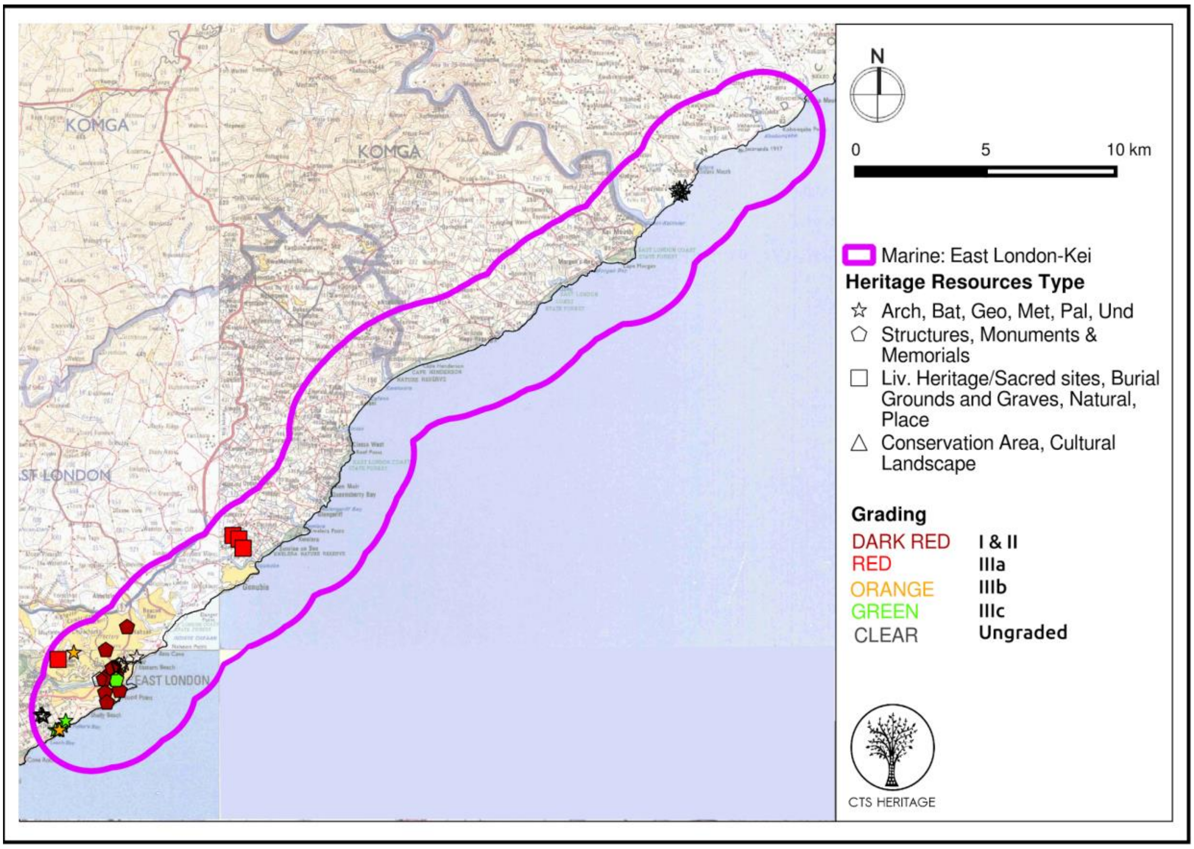

Figure 31. East London-Kei Marine Study Area heritage resource map.

4.1.8.8 Development guidelines

Coastal environments are sensitive to development and it is possible that coastal archaeological sites would be affected (Figure 32 and Figure 33). Shell middens can be expected as far as 5 km from the coast, and these are known to contain unmarked graves. It is anticipated that most of these sites can be mitigated either through preservation *in situ*, the recommended and preferred alternative, or through mitigation. Inland MSA and LSA artefacts are known to occur in contexts that can contribute to palaeo-environmental reconstructions (Van Ryneveld 2016).

Formal and informal cemeteries as well as pre-colonial graves occur widely throughout Southern Africa. It is generally recommended that these sites are preserved *in situ* and within a development. While these sites can be relocated if conservation is not possible, this option must be seen as a last resort and is not advisable. Public participation would be critical to identify and ensure the recognition and maintenance of the cultural landscapes in this area. The impact on underwater shipwrecks is unknown at this point but could potentially be significant.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh Karoo Supergroup bedrocks or consolidated alluvial or colluvial deposits (e.g. shelly sands, gravels, aeolianites) as well as estuarine, lagoon or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 29).

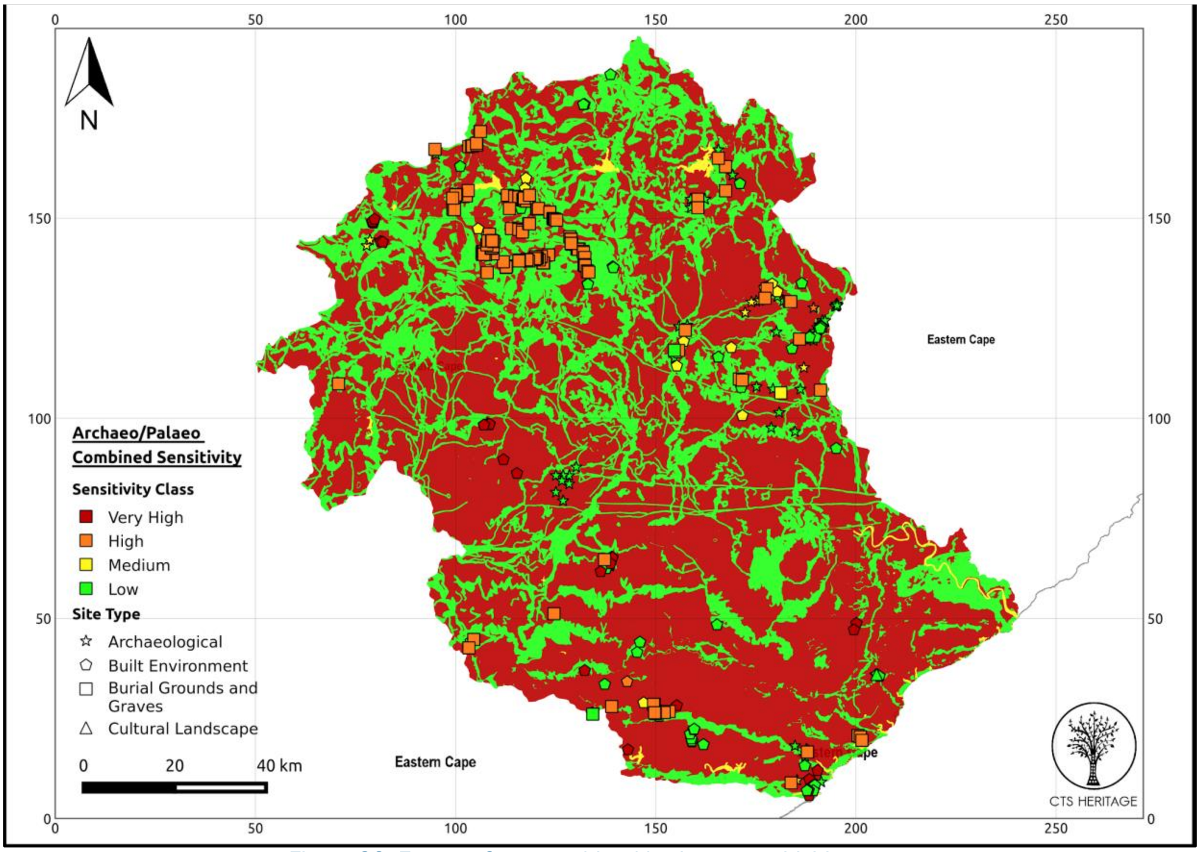

Figure 32. Eastern Cape combined heritage sensitivities map.

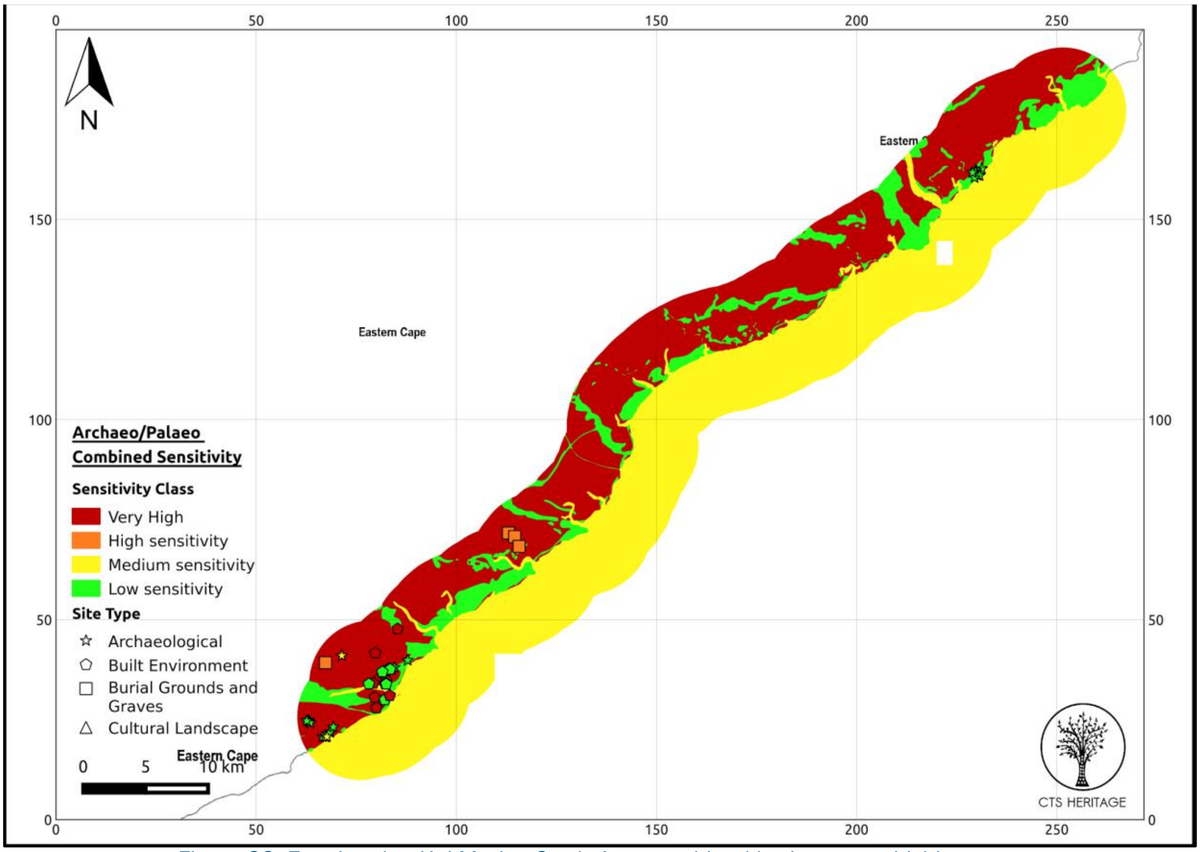

Figure 33. East London-Kei Marine Study Area combined heritage sensitivities map.

4.1.9 Freshwater Study Area 9 – Western Cape

4.1.9.1 Landscape character

This region is strongly variable in character and comprises the Southwest Fynbos, West Strandveld and West Coast Renosterveld Bioregions (Mucina & Rutherford 2006). The coastline is extensively developed and includes the easternmost suburbs of Cape Town, as well as the Stellenbosch, Franschhoek, Paarl and Wellington areas which form the core of the Cape Winelands. North of this is the gently rolling topography of the southern Swartland. The south-western extent of the Cape Fold Mountains separates the coast and Swartland from the Breede River Valley which includes a wide floodplain and many smaller hills. The Langeberg Mountains lie within the north-eastern edge of the study area.

4.1.9.2 Palaeontology

Away from the unfossiliferous basement granites and Precambrian metasediments of the Swartland, fossils occur in a wide range of stratigraphic contexts in the Western Cape freshwater study area (Figure 34). Key fossiliferous horizons within the Palaeozoic Cape Supergroup rocks comprising the Cape Fold Belt here include post-glacial mudrocks of the Cedarberg Formation (Table Mountain Group) that mainly crop out in the mountains as well as several mudrock-dominated formations of the Devonian to Early Carboniferous Bokkeveld and Witteberg Groups that tend to build low-lying hilly terrain. However, the Palaeozoic mudrocks in these units have often been extensively weathered and cleaved, seriously compromising their fossil content. The Dwyka tillites are unfossiliferous, while the overlying Ecca Group succession is famous for its well-preserved mesosaurid reptiles, fish and crustaceans, as recorded from the Karoo Supergroup outlier near Worcester. The Late Jurassic to Early Cretaceous beds of the Uitenhage Group in the Worcester-Robertson Karoo appear to be sparsely fossiliferous. Late Caenozoic (Miocene to Recent) shallow marine to coastal and fluvial sediments of the Sandveld Group along the False Bay coast and on the Cape Flats contain local concentrations of fossils including peat horizons, subsurface shelly beds and rich mammalian faunas associated with carnivore dens, as for example at Swartklip. See Appendix for further details.

Key sites: Swartklip (Langebaan Formation), Scherpenheuwel Quarry near Worcester (Whitehill Formation) (Figure 35).

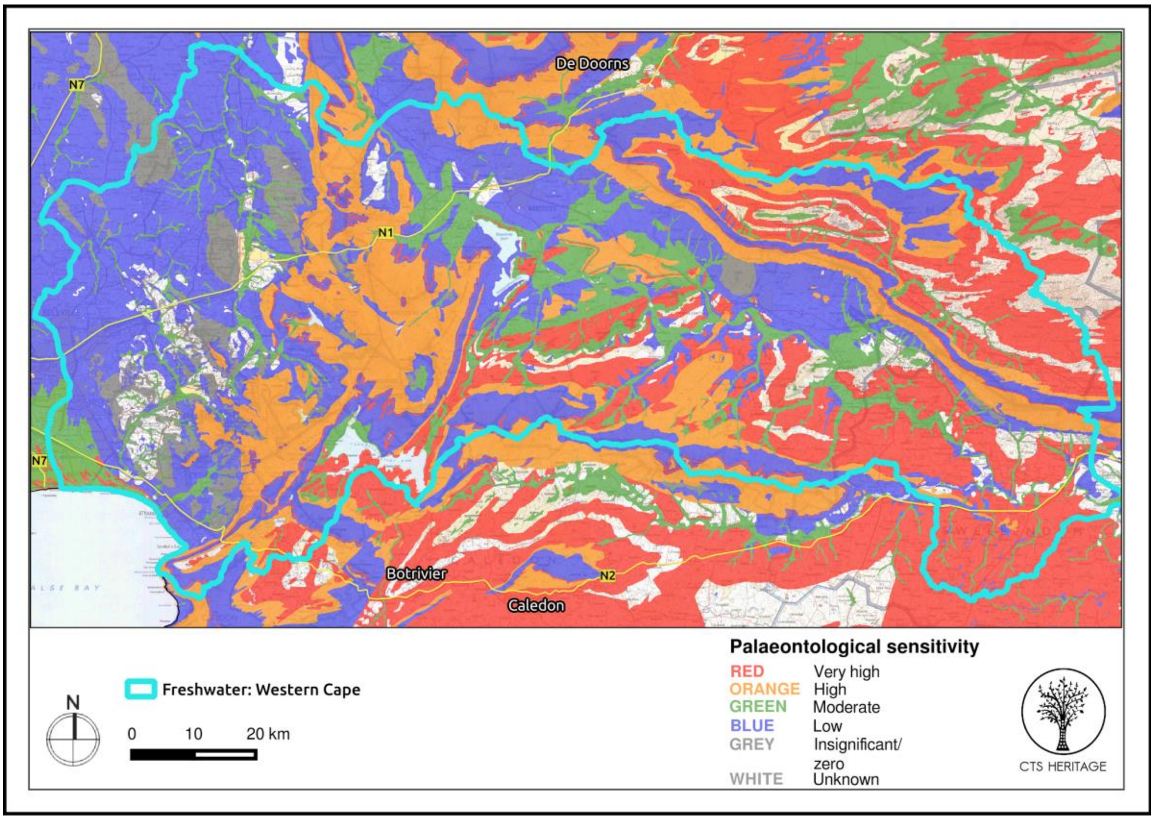

Figure 34. Western Cape Fossil Sensitivity Map (SAHRA 2014).

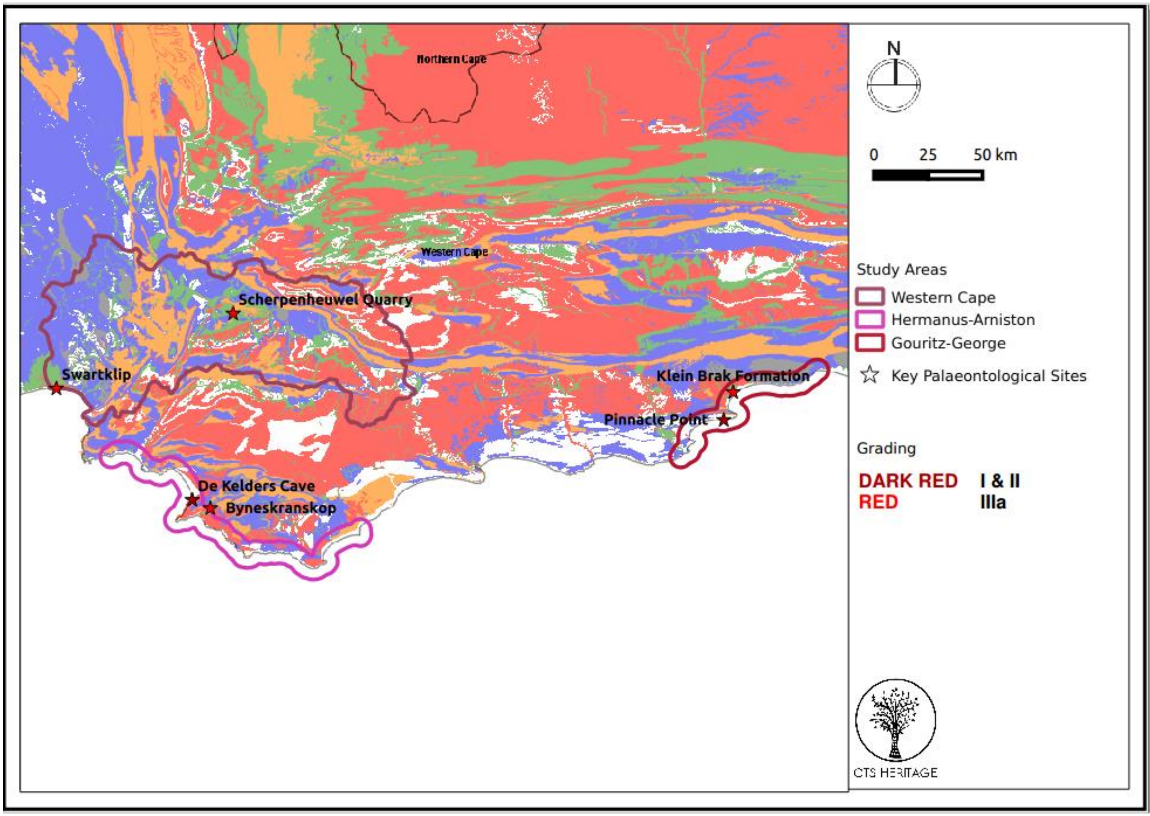

Figure 35. Combined site location map for key palaeontological sites in Western Cape, Hermanus-Arniston and Gouritz-George study areas.

4.1.9.3 Archaeology

The coastal area has been heavily developed, leaving little room for the preservation of archaeological resources (Figure 36). However, middens occur at the Lourens River mouth (Halkett & Hart 1996b) and a large midden is preserved in Gordon's Bay (Van Noten 1974). Rudner (1968) reported that many more middens existed in the area. The area at the western foot of the Cape Fold Mountains stretching northwards from Gordon's Bay beyond the study area is well-known for the extensive ESA materials found there. The Bosman's Crossing site in Stellenbosch is important from a historical point of view as it was from there that the so-called 'Stellenbosch Industry' was first described (Peringuey 1911; Seddon 1966), and the site is a PHS. Stone Age resources other than ESA artefacts are generally rare to the west of the mountains but LSA artefacts have been seen in Kuils River and a significant LSA site was excavated in the Franschhoek Valley (Orton, personal observation). Several rock art sites are known from the Cape Fold Mountains (Manhire & Yates 1994; Orton, personal observation) and the Langeberg Mountains further to the east (Orton, personal observation; Rust & Van der Poll 2011). Surveys in the Breede Valley generally yield only isolated artefacts or very low density scatters with important sites not known. Historical archaeology is commonly encountered in the Cape Winelands in the western part of the study area (e.g. Patrick & Clift 2005; Smuts 2012) and can be expected throughout that area (Figure 36). In the Breede Valley less work has been carried out but there is no doubt that historical remains will be present in many areas. In the far eastern part of the study area, the vicinity of Swellendam will be especially sensitive in this regard. The archaeological remains of historical mountain passes occur in this study area including the Gantouw Pass, a PHS above Gordon's Bay (Orton 2009c) (Figure 36) and the Cogmanskloof Pass between Ashton and Montagu (Orton 2011).

4.1.9.4 Shipwrecks

In comparison with other areas of False Bay, the study area has relatively few shipwrecks. The SAHRA database records fewer than 20 wrecks in this area, a good proportion of which are relatively modern. There are nevertheless a handful of historical wrecks recorded as being present in coastal zone of the study area, including the *Sarpine* (1691) and the *Drietal Handelaars* (1789). The important wreck of the *Colebrooke* (1778) lies just outside the study area near Kogel Bay, while an Avro Anson aircraft is recorded as having been lost in False Bay in 1943.

4.1.9.5 Graves

Morris (1992) has a few records of unmarked pre-colonial burials from this study area, but the vast majority of these come from the coast. Historical graveyards, both formal and informal, abound throughout the area.

4.1.9.6 Built heritage

Built heritage resources, many of them culturally significant, occur in large numbers throughout the study area. The towns are especially densely populated with numerous PHSes being present in most. Stellenbosch and Swellendam are the second and third oldest towns in South Africa, but Worcester and Montagu are also notable for the high density of preserved historic buildings (Fransen 2004). The outlying rural areas also have very many old structures because farming in this part of South Africa goes back to the early days of the Cape Colony, especially in the Winelands area and around Swellendam.

4.1.9.7 Cultural landscape

The Cape Winelands area is an internationally renowned cultural landscape, and graded as Grade I, while many other rural areas within the study area are important for the relationship between man and the land that they describe at scales varying between the individual farmstead and whole valleys. The cultural landscape is characterized by the juxtaposition of urban townscapes, intensively cultivated rural farmsteads, and mountain 'wilderness' beyond. A number of scenically important mountain passes are located in this study area, while many other roads are high quality scenic routes (Winter & Oberholzer 2013).

A further important cultural landscape is the Macassar area, including the Sheik Jusuf Kramat, as well as the Sheikh Sulaiman Abduragman Kramat in Bainskloof (E. Bailey, Hearth Heritage, pers.comm, 20 October

2017). These kramats both form part of the 'Circle of Tombs' which is culturally very significant to the Muslim community at the Cape. Further consideration should also be given to the largely undocumented or unrecorded history of the working classes in this area, which would include small communities, largely of farmworkers, in Pniel, Franschhoek, and other areas, as well as along the old wagon/ travel routes and old railroad routes (E. Bailey, Hearth Heritage, pers.comm. 20 October 2017).

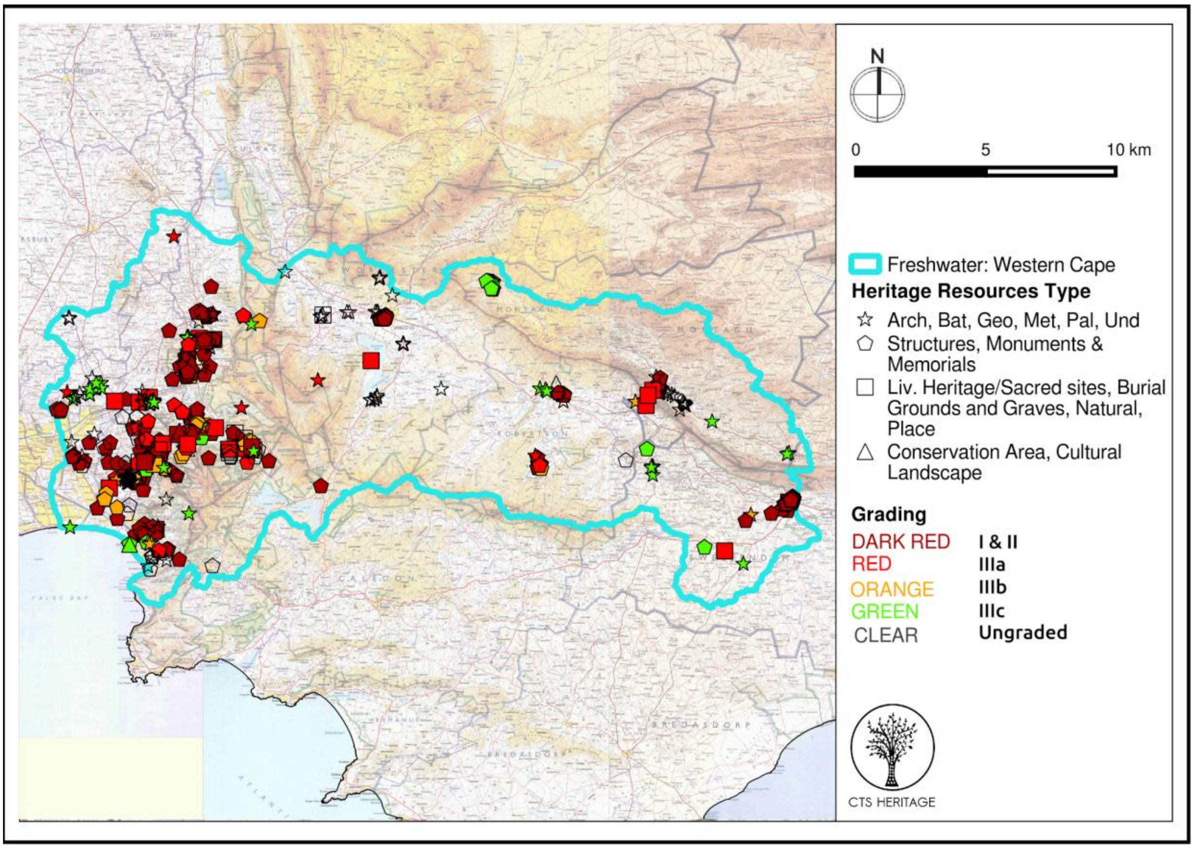

Figure 36. Western Cape heritage resource map.

4.1.9.8 Development guidelines

Careful placement of aquaculture facilities within rural landscapes should be feasible, although narrower valleys should be avoided because the visual prominence of new developments is likely to be greater and visual mitigation less easy (Figure 37). It is noted that the existing aquaculture facilities in the Du Toits Kloof area occur in the absence of other prominent cultural landscapes and thus are appropriately located. Disruption of significant cultural landscapes is likely to be the most important consideration in the placement of new facilities, and public participation with local communities would be essential to determine routes, sites or linkages which are significant and shouldn't be disrupted by development.

Large-scale aquaculture developments involving substantial excavation or disturbance of fresh bedrocks of the Cedarberg Formation, Bokkeveld Group, Witteberg Group, Whitehill Formation, consolidated alluvial or coastal deposits (*e.g.* shelly sands, gravels, aeolianites) as well as estuarine, lagoon or *vlei* sediments along river courses should be subject to a field-based palaeontological assessment (Figure 37).

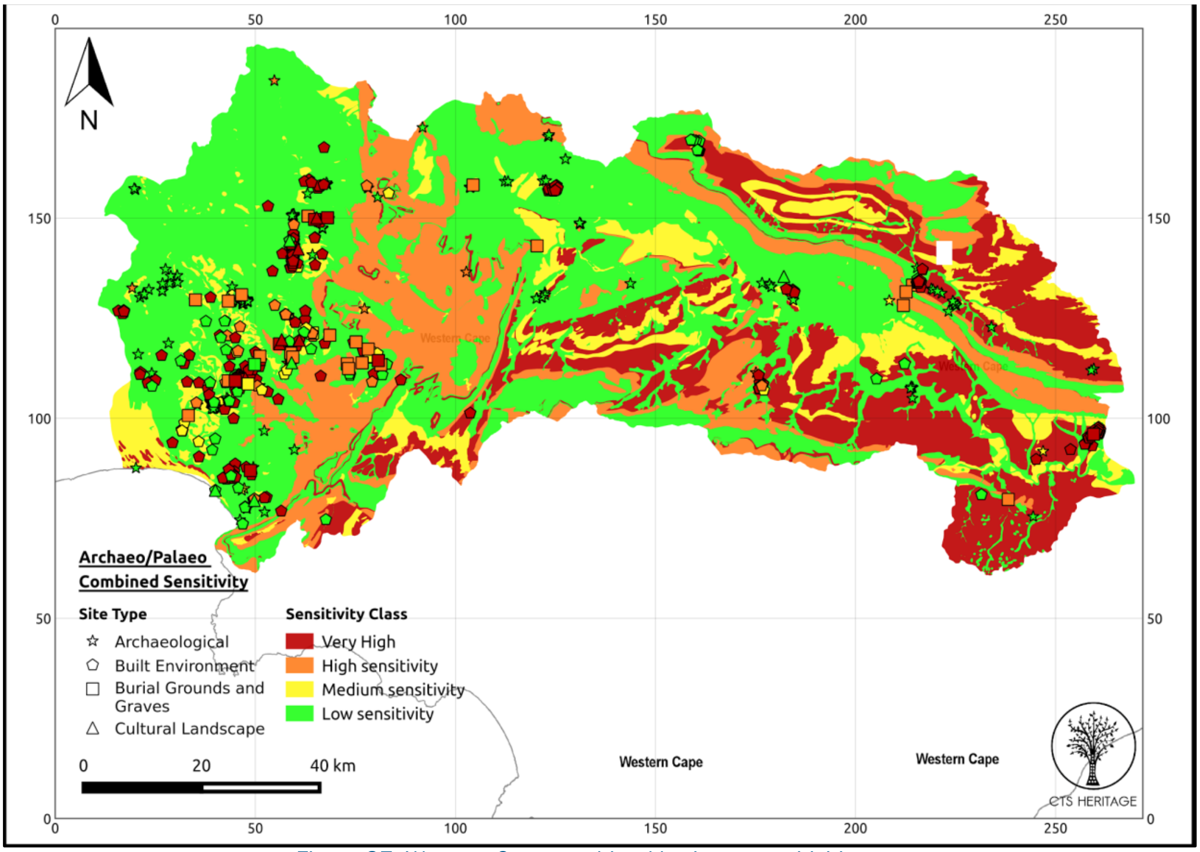

Figure 37. Western Cape combined heritage sensitivities map.

4.2 Marine Aquaculture Study Areas

4.2.1 Marine Study Area 3 – Port Elizabeth

4.2.1.1 Landscape character

This study area encompasses 55 km of predominantly sandy coastline with a few short rocky intervals (e.g. Cape Recife), in the western part of Algoa Bay, Eastern Cape; Port Elizabeth lies in the south-western part of the area. The area falls within the Albany Thicket Bioregion (Mucina and Rutherford 2006). Much the coast is developed, with most of the undeveloped part lying to the east, where it is backed by the western end of the well-known Alexandria Dunefield. The extensive development in this area is likely to have already affected heritage resources.

4.2.1.2 Palaeontology

The study area is entirely underlain by sedimentary rocks, and fossils of some sort are recorded from most of the rock units represented (Figure 38). In practice only a few units are of high palaeontological sensitivity, however, including limited exposures of Kirkwood and Sundays River beds along major river valleys (Cretaceous Uitenhage Group) as well as thin horizons of shelly coastal sands and gravels of the Alexandria and Salnova Formations (Miocene to Recent Algoa Group). See Appendix for further details.

Key sites: Brighton Beach, Coega and Swartkops Estuaries (See also sites tabulated by Almond 2010 for the Coega IDZ) (Figure 29).

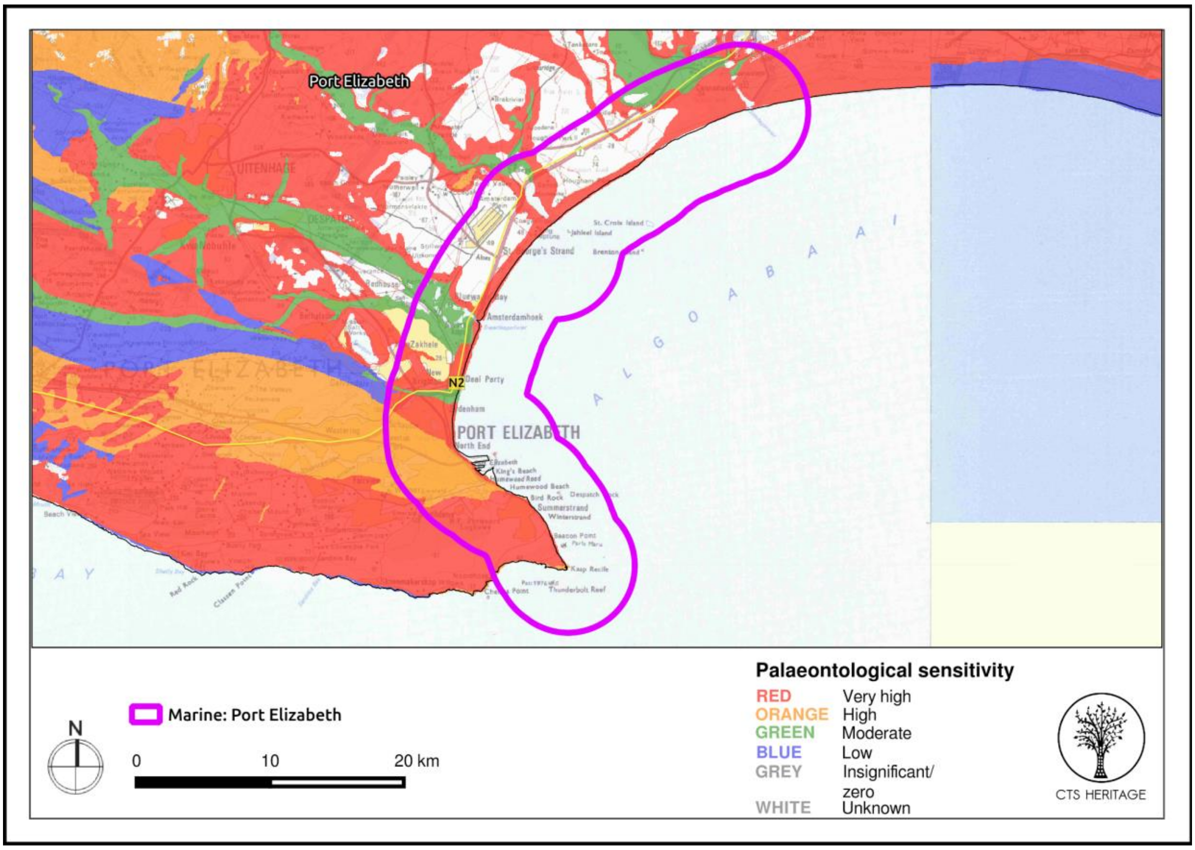

Figure 38. Port Elizabeth Fossil Sensitivity Map (SAHRA 2014).

4.2.1.3 Archaeology

Far fewer archaeological sites have been recorded in this area relative to most of the other coastal study areas (Figure 39). The vast majority of work in the area has been related to the Coega Harbour, and many archaeological sites have been recorded here. Binneman (2010) provides a review of these sites and also presents many new ones. These include middens of the white sand mussel (*Donax serra*) and artefact scatters dating predominantly to the ESA and MSA. The latter seemed to be largely in secondary contexts but nevertheless point to the possibility that buried materials may be present in the area. Stone artefacts of all ages have been found associated with river gravels along the Coega River (Binneman & Webley 1997), while ESA hand axes have been noted at Coega Kop just outside the inland edge of the study area (Kaplan 1993, cited in Kaplan 2008). Artefacts of varying age have also been located on the plains to the northeast of Coega (Kaplan 2008). Rudner (1968) describes a small white mussel midden at Cape Recife and notes that extensive shell middens once occurred in the area where Port Elizabeth now stands, with the area south of the harbour especially dense. He also described middens at the Swartkops River mouth, and between the Coega and Sundays Rivers. It is quite likely that historical archaeological remains will be present in places, especially associated with some of the older farms in the area like Hougham Park at Coega.

4.2.1.4 Shipwrecks

Many ships are known to have been wrecked in the waters of the study area (Wrecksite 2017). The SAHRA Shipwreck Database contains records for more than 360 wrecks in the southern half of Algoa Bay and around Cape Recife (J. Gribble, ACO-Associates, pers.comm. 5 October 2017). One site, the wreck of the *County of Pembroke* was removed after discovery during the construction of Coega Harbour (Maitland 2009).

4.2.1.5 Graves

Morris (1992) recorded no burials from the study area, but Binneman (2010) notes that human remains have been found in the dunes east of Coega and Bennie (2010) notes many Later Stone Age (LSA) graves have been found in the vicinity of the Swartkops River mouth in the central part of the study area. It is likely that further unmarked burials are present within the sand dunes, especially in areas close to shell middens. A number of historical graveyards are also known from the area around Coega (Bennie 2010).

4.2.1.6 Built heritage

Built heritage resources occur throughout the study area in variable density but with an obvious concentration within Port Elizabeth (Figure 39), many of which are declared Provincial Heritage Sites (PHSes). A number of structures, in town and in rural areas, relate to the arrival of British settlers in the area in the 1820s, including fortified farmhouses, a local vernacular that arose in response to the Frontier Wars that occurred in the region between the British and the Xhosa between 1779 and 1879. Several significant buildings have been documented in the eastern part of the Coega Industrial Development Zone (IDZ) and largely form part of the complex known as Hougham Park (Bennie 2010). These structures have not been maintained and are now in poor condition. The Cape Recife lighthouse is an important heritage resource dating back to 1851 (Williams 1993).

4.2.1.7 Cultural landscape

Being such a heavily developed area, there are unlikely to be many, if any, intact cultural landscapes of significance. In the east, the many Stone Age midden sites may be regarded collectively as a pre-colonial cultural landscape.

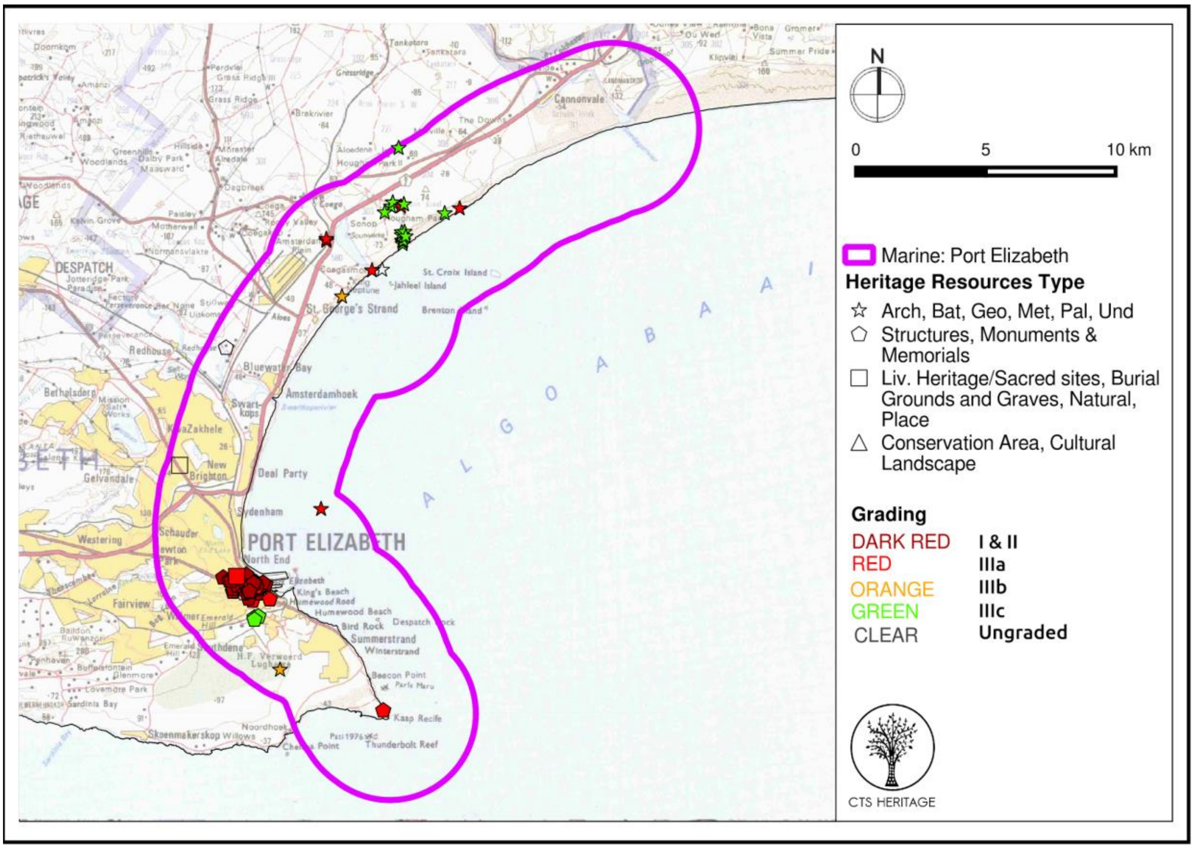

Figure 39. Port Elizabeth heritage resource map.

4.2.1.8 Development guidelines

Much of the study area is unsuitable for aquaculture development because of its built-up nature, but development behind sandy areas could be feasible despite the known presence of shell middens (Figure 40). This is because middens can be relatively easily mitigated and, unlike some other types of heritage resources, often do not merit *in situ* conservation.

Large-scale aquaculture developments involving substantial excavation or disturbance of Uitenhage Group bedrocks, or consolidated alluvial or coastal deposits (e.g. shelly sands, gravels, aeolianites) as well as estuarine, lagoon or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 40).

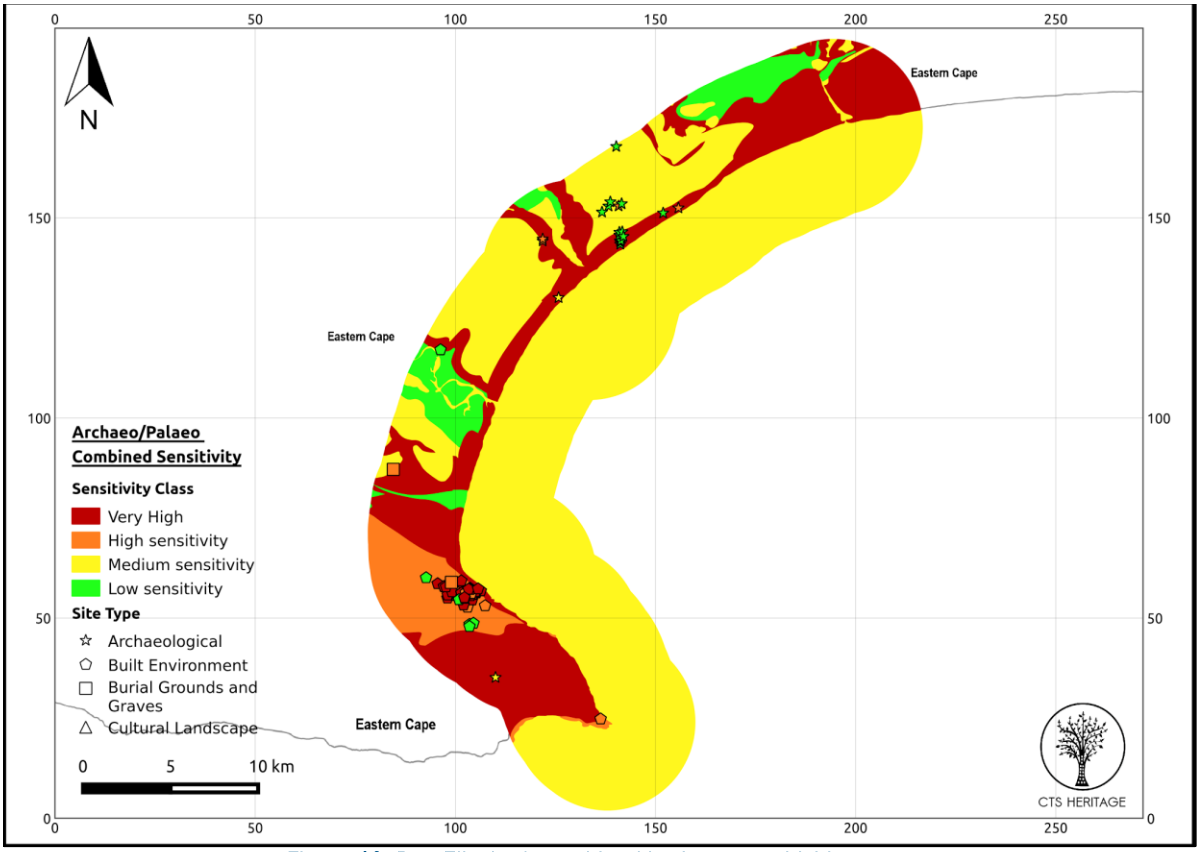

Figure 40. Port Elizabeth combined heritage sensitivities map.

4.2.2 Marine Study Area 4 – Gouritz to George

4.2.2.1 Landscape character

This study area involves approximately 120 km of Western Cape coastline, from immediately west of the mouth of the Gouritz River to Wilderness in the east. The area encompasses the South Coast Fynbos, South Coast Strandveld and Eastern Fynbos-Renosterveld Bioregions (Mucina & Rutherford 2006). Although united by the relatively flat coastal plain that lies just inland of the coast throughout the study area, the immediate coastline is strongly variable in character with sandy and rocky shores, dune fields, cliffs and river estuaries all being present. Numerous towns of varying size as well as many housing developments, including some golf estates, lie along a large proportion of the coastline and have irreversibly transformed the natural landscape.

4.2.2.2 Palaeontology

Most of the older bedrocks in the study area (Kaaimans Group, Cape Supergroup) are too deformed or deeply-weathered to contain useful fossils, while the Maalgaten Granite near George is completely unfossiliferous (Figure 41). The Cretaceous fluvial beds of the Uitenhage Group (Kirkwood, Buffelskloof and

Hartenbos Formations) contain important fossil plants and wood locally plus very rare dinosaur remains. Rich shelly estuarine to marine faunas of the Miocene to Pleistocene De Hoop Vlei and Klein Brak Formations (Bredasdorp Group) along the coast are of considerable palaeontological interest. See Appendix for further details.

Key sites: Hartenbos Formation type outcrop area near Hartenbos, lower reaches of Klein-Brakrivier, caves at Pinnacle Point (Figure 35).

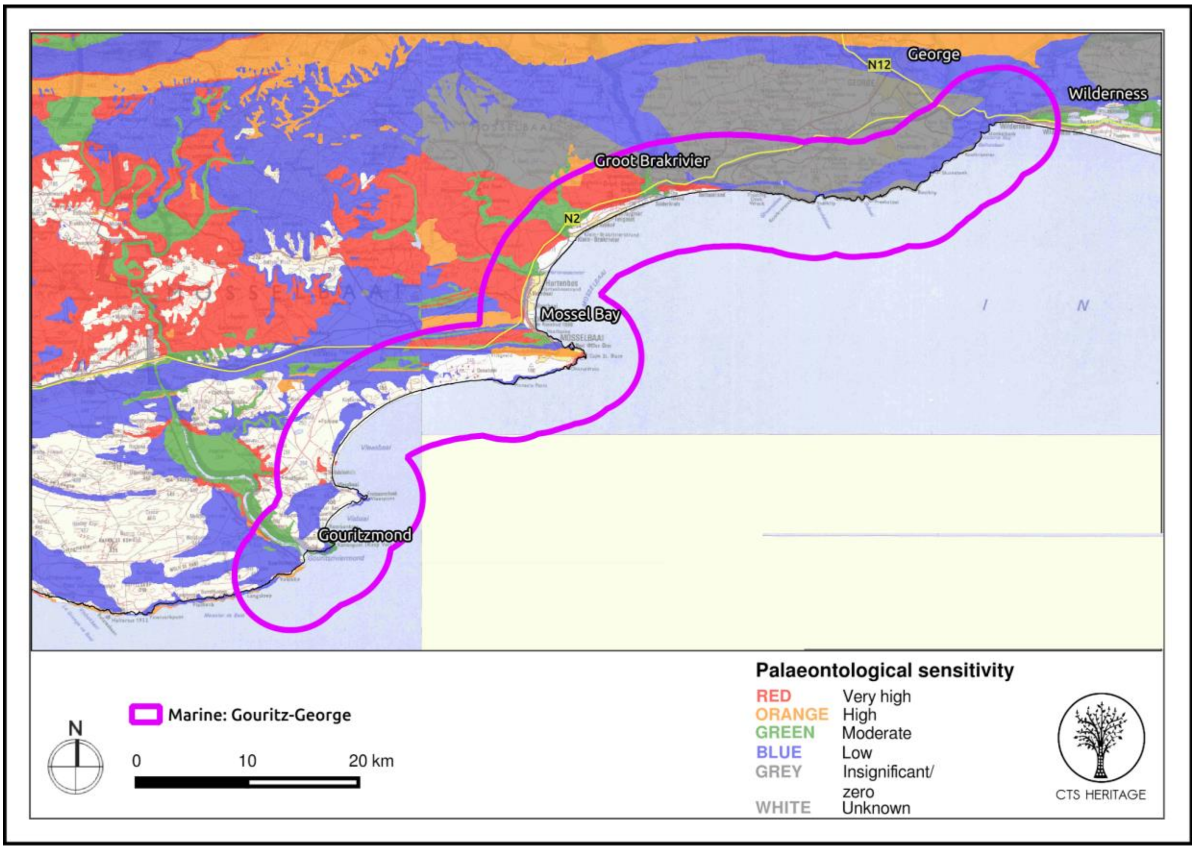

Figure 41. Gouritz-George Fossil Sensitivity Map (SAHRA 2014).

4.2.2.3 Archaeology

This area is most famed for the MSA archaeological sites that it hosts in coastal caves close to Mossel Bay (Figure 42). While Cape St Blaize Cave on the point at Mossel Bay has long been known and was first excavated in the late 19th century (Thompson & Marean 2008), it is the series of caves at Pinnacle Point, just southwest of Mossel Bay, that have attracted much scientific attention in recent years (e.g. Marean *et al*. 2004; Thompson *et al*. 2010). This part of the south coast of South Africa is well known for the ESA and to a slightly lesser degree MSA, resources it contains. ESA and MSA sites and occurrences have been found throughout the area including, for example, at the Gouritz River Mouth (Halkett & Hart 1996a), Dana Bay (Kaplan 2003), at Pinnacle Point (Nilssen 2005), around Mossel Bay (Kaplan 2014), inland of Hartenbos (Kaplan 2007a, 2009a) and near George (Dreyer 2006; Kaplan 2001). Open LSA shell middens have been found in many areas including the Gouritz River mouth area (Halkett & Hart 1996a), Vleesbaai and Boggomsbaai (Orton & Hart 2009), around Dana Bay (Kaplan 2005, 2007b), the area above the cliffs at Pinnacle point (Manhire & Nilssen 2008), in Mossel Bay (Orton & Hart 2009) and east of Herold's Bay (Kaplan 2001). Rock shelters and caves are abundant in the cliffs along the coast of this study area and it is likely that many contain archaeological material. Aside from the Pinnacle Point and Cape St Blaize examples, research has also been carried out at a coastal cave at Herold's Bay (Brink & Deacon 1982) and at two inland caves (Glentyre and Oakhurst) marginally outside the study area at Wilderness (Fagan 1960; Goodwin 1938). A small rock art site is also known from inland of Boggomsbaai (Kaplan 2014). Because there are many historical sites and farms in the area, although not much researched, there will certainly be many historical archaeological sites present. Historical ruins and related historical archaeological features and artefacts have been recorded at Mossel Bay (Webley 2009), Oubaai near Herold's Bay (Kaplan 2001) and near George (Orton & Hart 2011). Stone walled fish traps are also known from the area around Kanon (Perreira *et al*. 2008; Rudner 1968).

4.2.2.4 Shipwrecks

More than 60 shipwrecks have been recorded along this coastline, with the majority having occurred at, or near, Mossel Bay. Kaplan (2001) mentions the wreck of a trawler near Herold's Bay and other wrecks in the area are recorded in the SAHRA Shipwreck Database (J. Gribble, ACO-Associates, pers.comm. 5 October 2017).

4.2.2.5 Graves

Large numbers of Stone Age human burials have been reported from the study area, with many having been excavated from caves and rock shelters (Morris 1992). Undoubtedly many more lie undiscovered in the coastal dunes with the western part of the study area perhaps more sensitive.

4.2.2.6 Built heritage

Many historical structures occur in the study area, both within towns and in rural areas. The town of Mossel Bay is very well known for its many old stone buildings and historical lighthouse, but George also has a number of important heritage buildings (Fransen 2004).

4.2.2.7 Cultural landscape

The overwhelming cultural landscape character in the rural parts of the study areas is one of pastoralism where grazing lands dominate. However, there is extensive urban development throughout most of the study area with ribbon development having compromised the character of the coastline in most areas. The maritime cultural heritage of this region, and its links to Diaz and the Portuguese seafarers of the sixteenth and seventeenth centuries further adds to the layering of cultural landscapes in this region. The old Outeniqua Choo Tjoe railway line between Mossel Bay and Knysna can be considered a cultural landscape feature since it includes many man-made alterations of the landscape along its route.

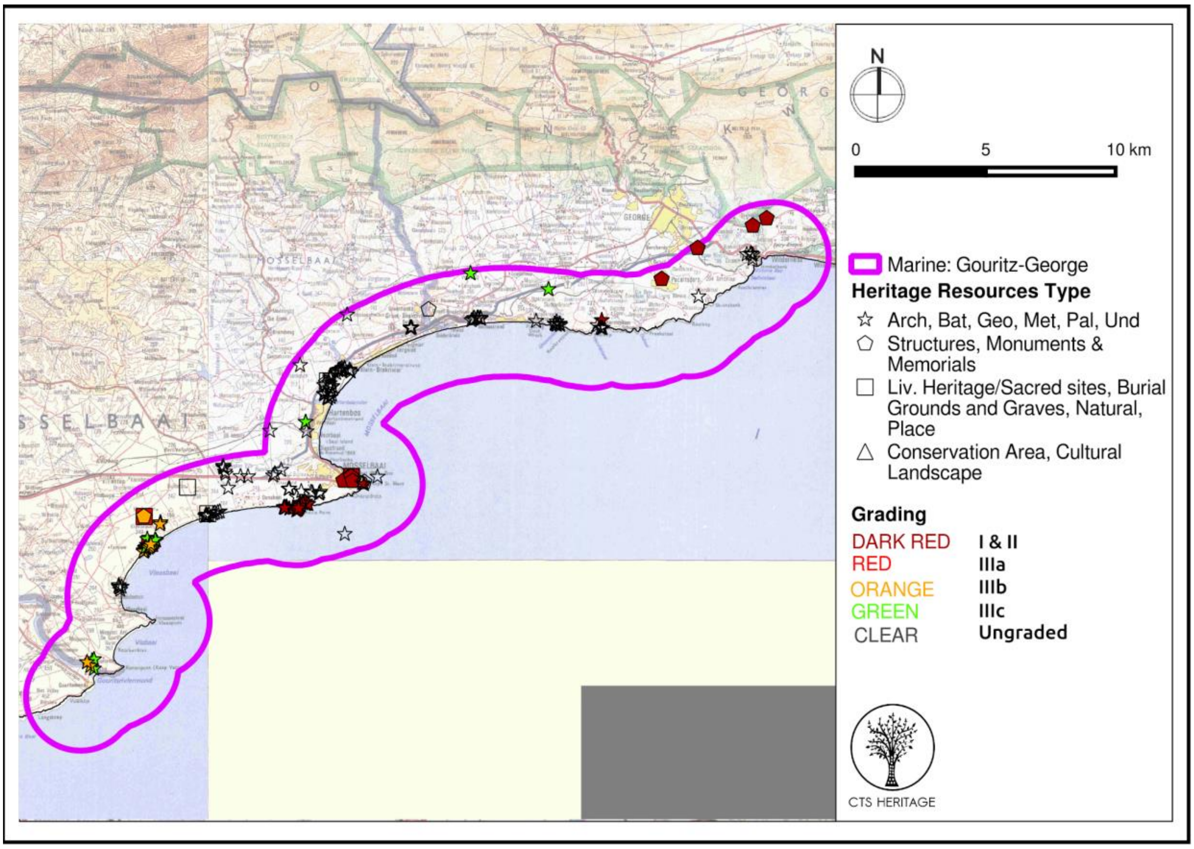

Figure 42. Gouritz-George heritage resource map.

4.2.2.8 Development guidelines

Topography may be a limitation on development in the eastern area where considerable landscape scarring may result from efforts to construct facilities above cliffs. The cliffs are also often archaeologically sensitive (Figure 43). However, the western part of the study area is likely to be more suitable with areas adjacent to the long sandy beaches likely the least sensitive in terms of archaeology and perhaps also visually.

Large-scale aquaculture developments involving substantial excavation or disturbance of Uitenhage Group bedrocks, or consolidated alluvial or coastal deposits (e.g. shelly sands, gravels, aeolianites) as well as estuarine, lagoon or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 43).

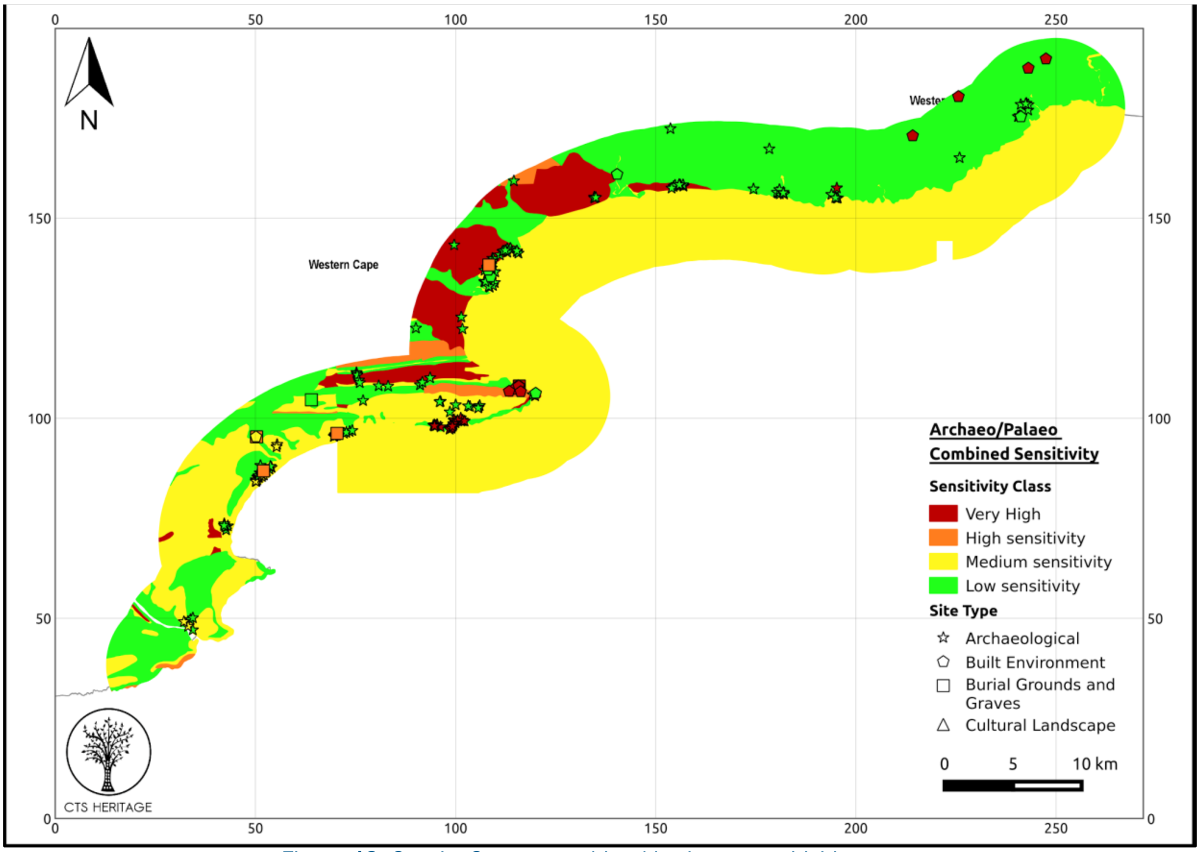

Figure 43. Gouritz-George combined heritage sensitivities map.

4.2.3 Marine Study Area 5 – Hermanus to Arniston

4.2.3.1 Landscape Character

The study area encompasses approximately 200 km of both rocky and sandy coast between Betty's Bay and Arniston in the Western Cape. The area lies within the Southwest and Southern Fynbos Bioregions (Mucina & Rutherford 2006). This coastal stretch is characterised by a narrow coastal belt bordered by rugged mountains, opening out, as one travels east, to rolling plains. The coastline itself is characterised by rocky shorelines interspersed with sandy beaches and several large, perennial rivers many with lagoons and estuaries. The area has become increasingly densely populated and early fishing villages have expanded into large towns.

4.2.3.2 Palaeontology

The study area is generally of low palaeontological sensitivity, despite the range of potentially fossiliferous sedimentary rocks here (Figure 44). This is in part due to high levels of tectonic deformation and weathering of the older bedrocks (e.g. Cape Supergroup), while only small outcrop areas of fossil-rich Pleistocene beds of the Bredasdorp Group are represented along the coast here. See Appendix for further details.

Key sites: Die Kelders, Byneskranskop near Gansbaai (Figure 35).

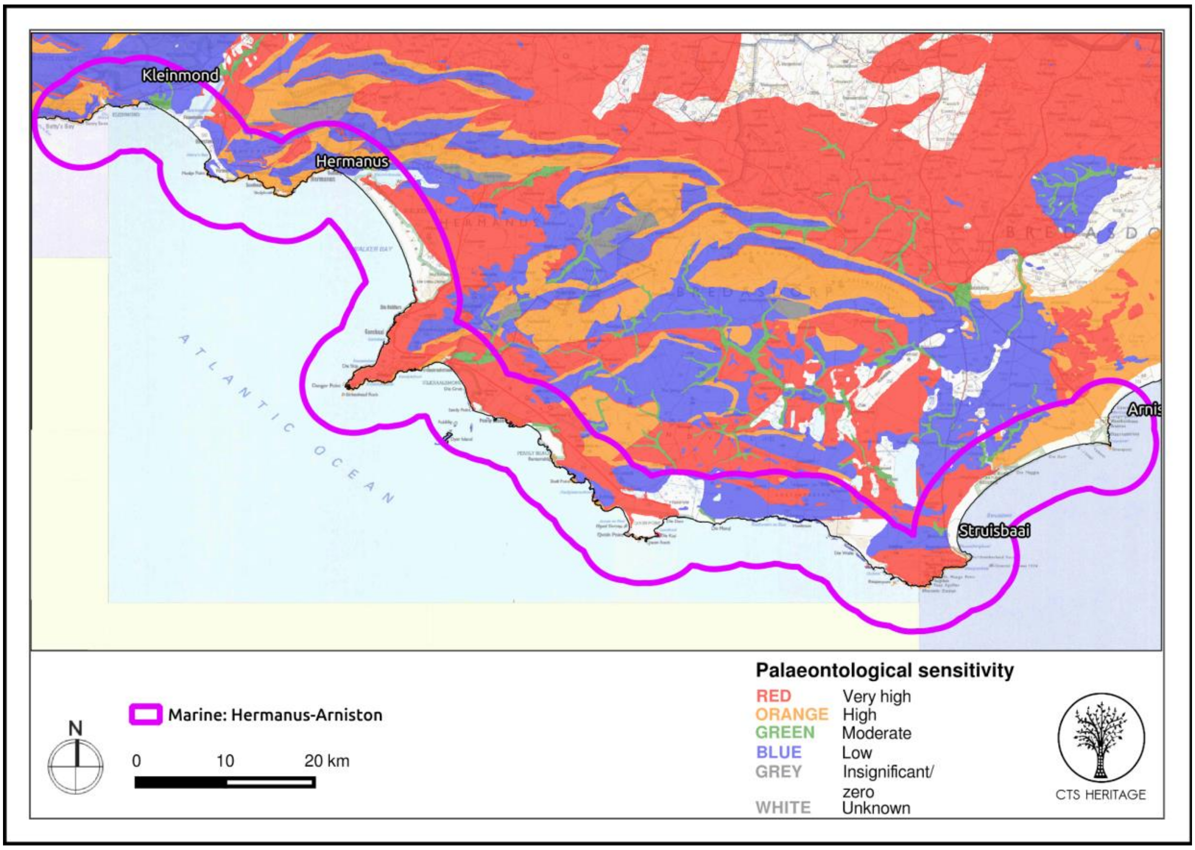

Figure 44. Hermanus-Arniston Fossil Sensitivity Map (SAHRA 2014).

4.2.3.3 Archaeology

The area is known to contain occasional ESA artefacts (Kaplan 2009b); significant MSA sequences in cave sites; extensive shell middens along the rocky shorelines and extending into the coastal dune belts, with associated burials; stone tool scatters, and stone-built fish traps in the intertidal zone (Avery 1974, Hart and Halkett 2010) (Figure 45). These resources, together, reveal extensive use of the area since at least 80 000 years ago, when pre-modern humans were frequenting the coastal caves. More recently, in the Later Stone Age, hunter gatherers and, later, herders camped in deflation hollows in the dune belts, and made use of the seasonally available marine shell fish, fresh water, and for the pastoral Khoekhoen, grazing in the relatively well-watered region. Archival and archaeological examination of the fish traps indicates that they appear to date from the colonial era (Hine 2007), and were maintained into the 20th century by the Elim communities (Avery 1975), although the possibility remains that the tradition originated locally in pre-colonial times (Hart & Halkett 2010); elsewhere in the country, these resources have been declared PHSes.

The area contains no NHSes, and 11 PHSes (Figure 45). These PHSes include historic structures, of which the most noteworthy are the historic fishermen's cottages at Hotagterklip and Kassiesbaai, and the Stillbay fishtraps, which have been graded as a Grade I resource by SAHRA, as well as maritime infrastructure including the old harbour at Hermanus and the lighthouse at Cape Agulhas. A further significant PHS is Die Kelders Cave 1, which is an internationally renowned archaeological site of high scientific value, located within the Walker Bay Nature Reserve. This site contains well preserved evidence for occupation in the MSA, as well as early anatomically modern human remains, while the LSA deposits have produced some of the earliest evidence for domesticated livestock known in the Western Cape (Frey *et al.* 2005; Marean *et al.* 2000).

4.2.3.4 Shipwrecks

Shipwrecks represent important heritage resources in this area, and the offshore area is known to contain more than 220 wrecks (J. Gribble, ACO-Associates, pers.comm. 5 October 2017). Notable wrecks off this stretch of coast include HMS *Birkenhead* (wrecked in 1852), origin of the custom of seeing women and children off sinking vessels first, the *Arniston* (1815), the wreck that lent its name to the village, as well as the *Meermin* (1766), the *Brederode* (1785), and the *Nossa Senhora dos Milagros* (1686).

4.2.3.5 Graves

In addition to the possibility of Stone Age graves, and historic and farm graves occurring throughout the area, there are documented cases of the discovery of the graves of shipwreck victims along this stretch of coast. Human remains apparently from the *Birkenhead* were encountered during the construction of an abalone farm near Danger Point in the 1990s (Kaplan 1997) and it is likely that other such burials are present along this stretch of coast.

4.2.3.6 Built heritage

Within towns, significant built heritage exists in the form of the historic fishermen's cottages, several of which, as stated, have been declared PHSes (Figure 45), and many villages have several historic homes that are conservation worthy at the local level. Further to these structures, lighthouses and historic farmsteads located outside of towns and villages constitute important resources within the landscape.

4.2.3.7 Cultural landscape

The cultural landscape of this region is inextricably linked to its proximity to the sea, and has been since pre-colonial times. Settlement of the area was originally in the form of small fishing villages from in the second half of the 19th century (Baumann *et al.* 2009). Increasingly since the Second World War, these towns have developed as recreational destinations. This tourism-driven boom has increasingly changed the character of the towns along the Overberg coastline. Active harbours and the presence of several abalone farms in the region retain and perpetuate the original economic links with the sea. Collectively, historic cottages and fishing settlements (e.g. Hotagterslip and Kassiesbaai) ,within their landform contexts, can be considered as vernacular cultural landscapes, while the historic fish traps could be considered marine cultural landscape features (D. Gibbs, David Gibbs Landscape Architect, pers.comm. 24 October 2017).

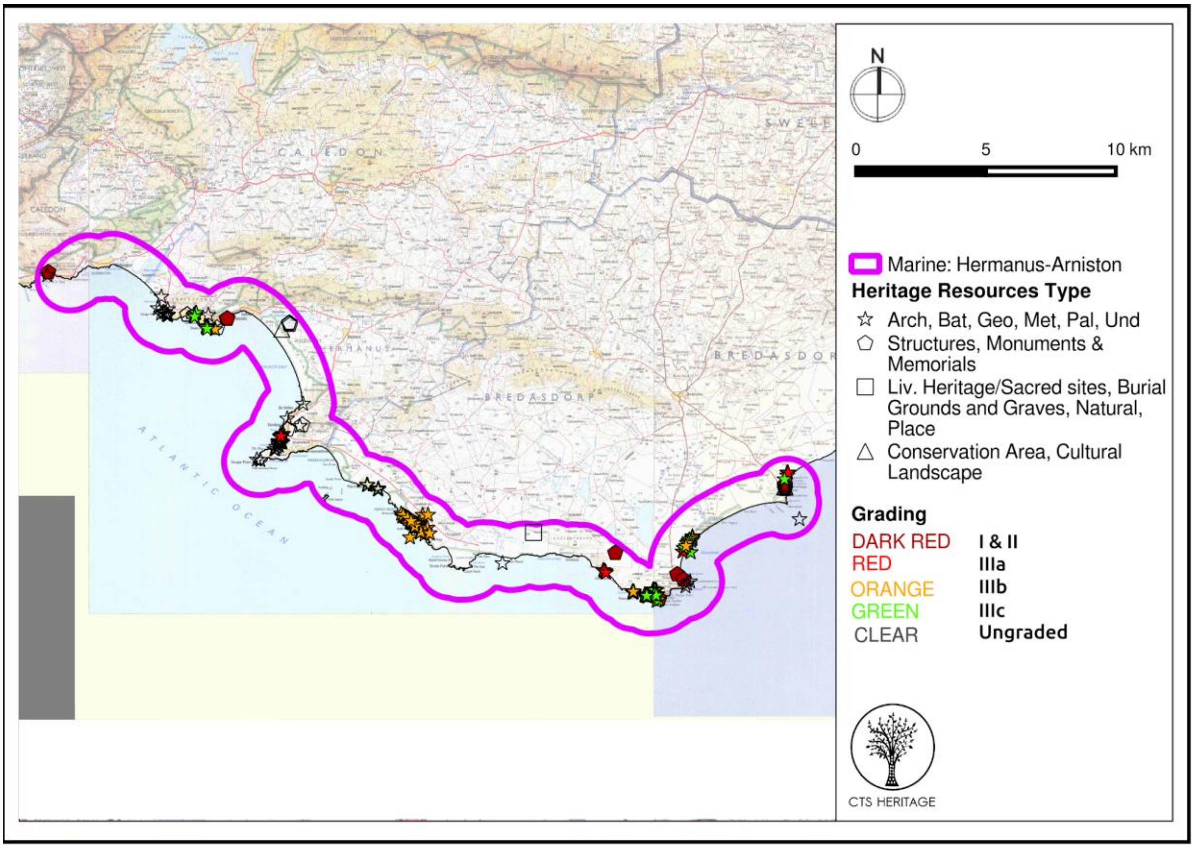

Figure 45. Hermanus-Arniston heritage resource map.

4.2.3.8 Development Guidelines

Any proposed development needs to take into account not only the formally protected fishing cottages and the intact elements of the early fishing and holidaying villages, but also, more broadly, the area's sense of place and connectedness to the sea, which has been a key feature of the region since at least the MSA, and is expressed in the spatial distribution of sites across the intertidal zones, beaches, rocky shorelines, limestone headlands and dune ranges (Figure 46). These sites represent a wealth of, often as yet undiscovered, prehistoric sites, including unexplored cave sites, and possible human burials, that are vulnerable to development of the dune cordon and beachfront. All developments on clifftops and rocky shores need to take cognisance of the existence of caves or sites below, as any archaeological deposit present is vulnerable to pollutants that can compromise the accurate dating of these sites by scientific means (Kaplan 2007c). The fish traps, though often visually prominent, are particularly vulnerable to developments on the coastline, or with outflows into the sea.

Large-scale aquaculture developments involving substantial excavation or disturbance of Bredasdorp Group layers, or consolidated alluvial or coastal deposits (e.g. shelly sands, gravels, aeolianites) as well as estuarine, lagoon or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 46).

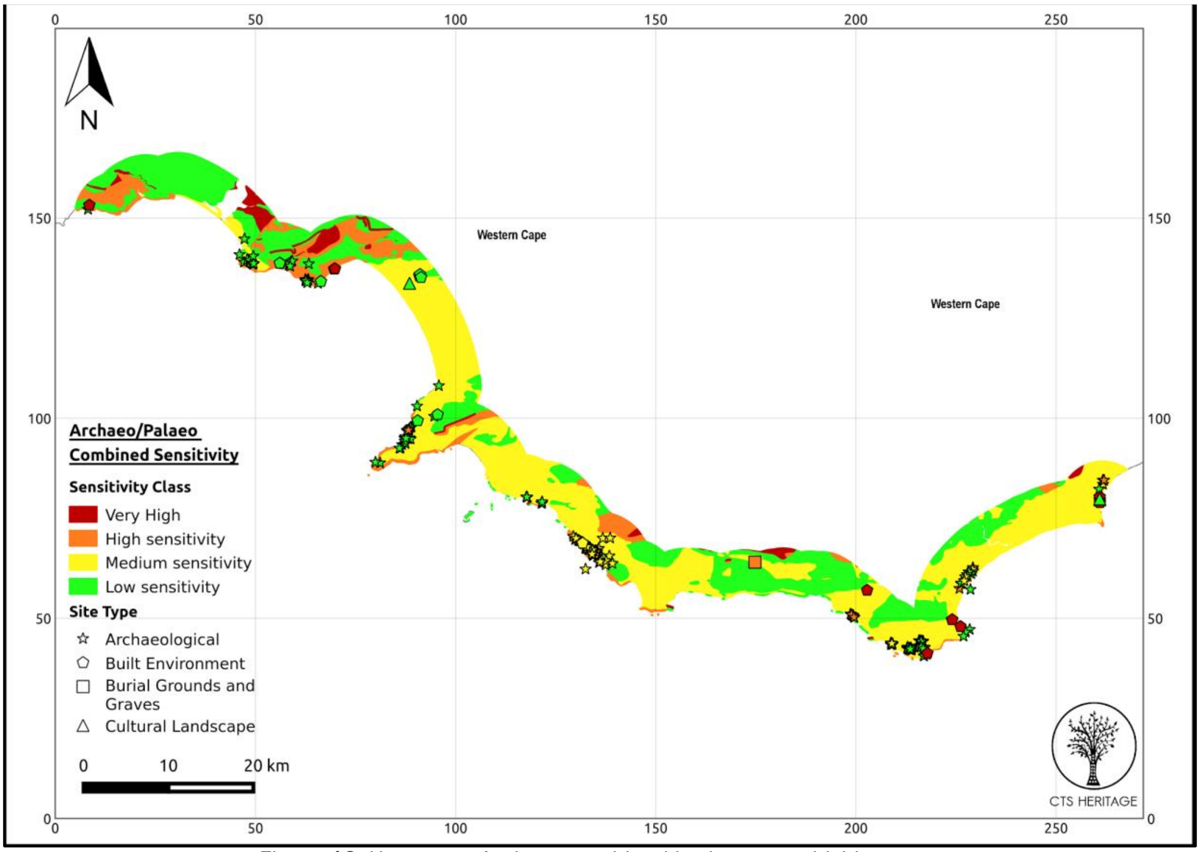

Figure 46. Hermanus-Arniston combined heritage sensitivities map.

4.2.4 Marine Study Area 6 – Velddrif to Saldanha Bay

4.2.4.1 Landscape character

This study area is an approximately 130 km-long stretch of the Western Cape coast centred on the Vredenburg Peninsula, a major granitic promontory which is situated some 100 km northwest of Cape Town. The Vredenburg Peninsula falls within the West Strandveld Bioregion (Mucina & Rutherford 2006). Its southern shore faces into Saldanha Bay which has a number of small islands in it and also hosts a small craft harbour in the west and an iron ore loading and crude oil discharge terminal for very large ships in the east. The southern edge of the study area abuts the West Coast National Park. The granite soil on the peninsula has been extensively cultivated over the last few centuries and very little undisturbed land remains. Much of the coastline has been developed for residential purposes but some areas of natural habitat remain in a strip along the western coast of the peninsula. The only dune fields in the study area occur within this western strip. The area to the east of Saldanha Bay town has been set aside for industrial development.

4.2.4.2 Palaeontology

Late Caenozoic sediments cropping out close to modern sea level (e.g. the Pleistocene Velddrif Formation) are vulnerable to impacts, but many older fossiliferous units in the Sandveld Group are buried beneath thick aeolianites and / or elevated well above the modern coast (Figure 47). See Appendix for further details.

Key sites: Prospect Hill Quarry, Bomgat, Sea Harvest, Hoedjiespunt and Spreeuwal sites in Saldanha Bay, Velddrif Formation type area north of Berg River mouth (Figure 48).

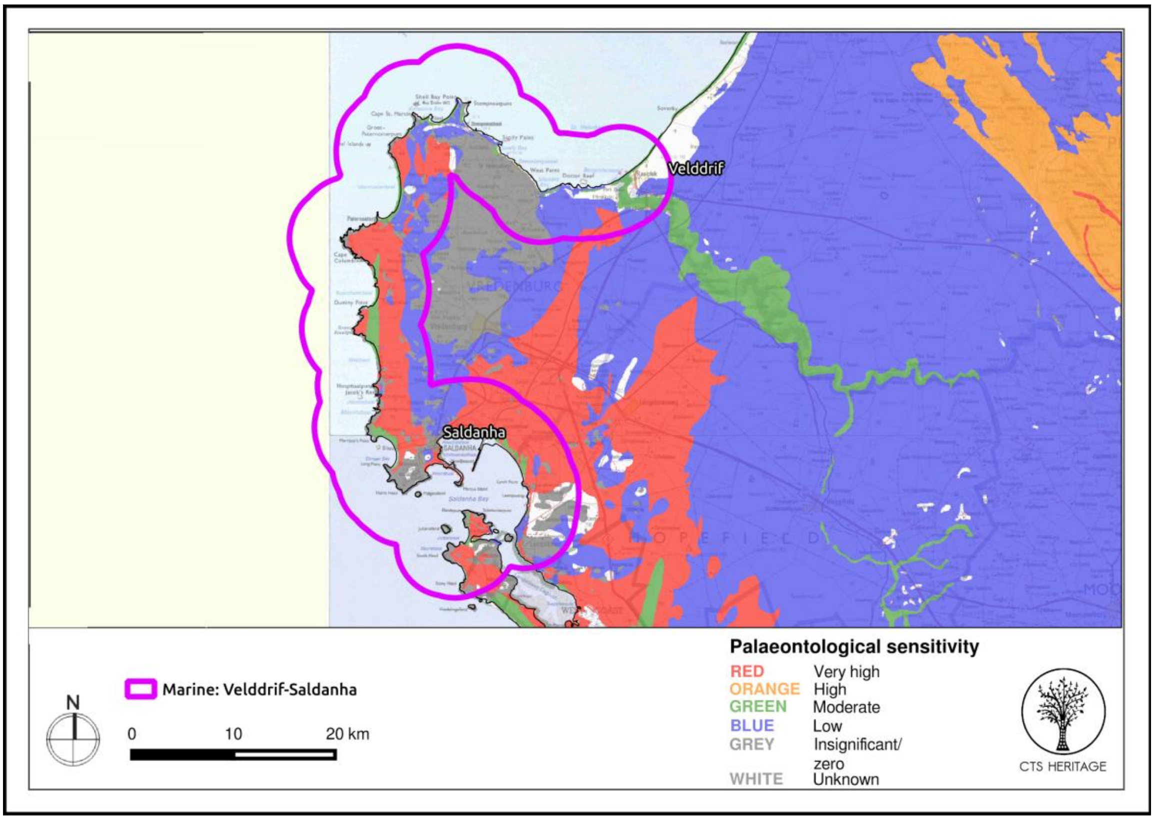

Figure 47. Velddrif-Saldanha Fossil Sensitivity Map (SAHRA 2014).

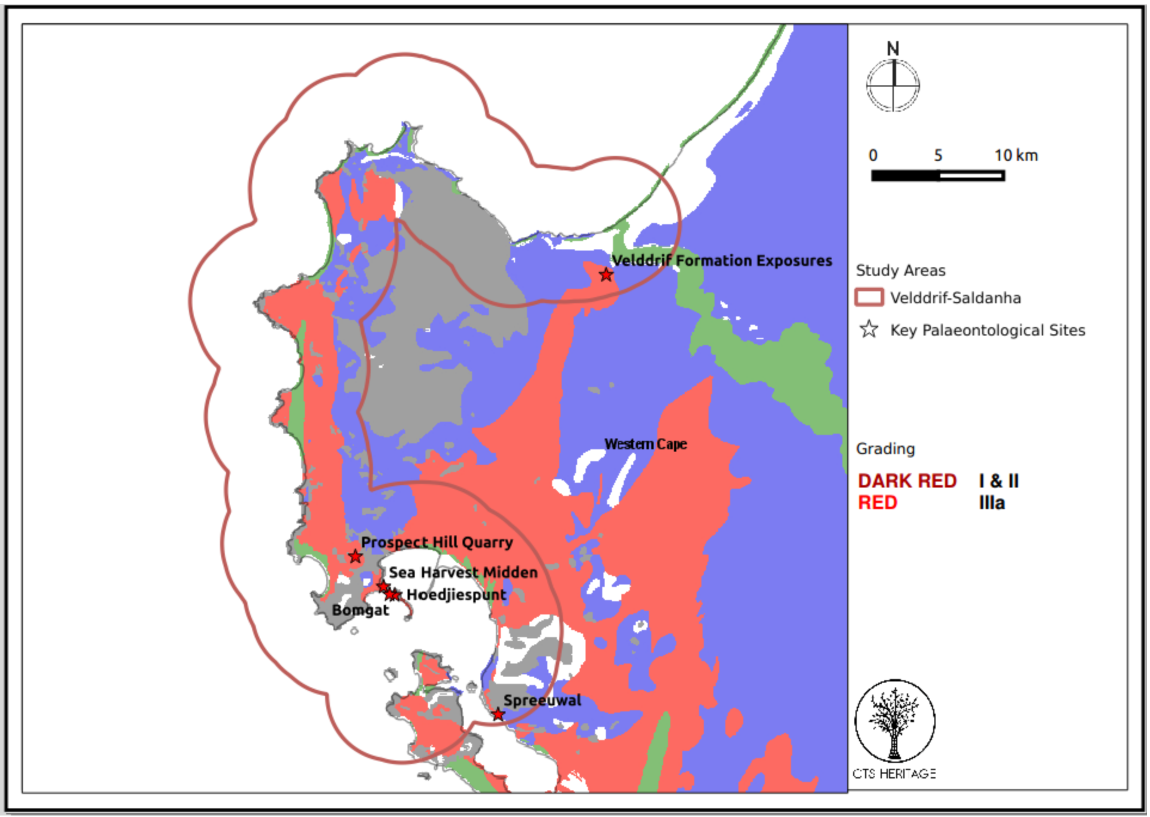

Figure 48. Combined site location map for key palaeontological sites in the Velddrif-Saldanha study area

4.2.4.3 Archaeology

Archaeological sites are super abundant on the Vredenburg Peninsula (Figure 49). As a result, much research has been carried out in the area. It is perhaps best known for the sites of Witklip, in the centre of the peninsula, and Kasteelberg, inside the study area and a proposed PHS, which have been central to a debate regarding the origins of precolonial herding in South Africa (Smith 2006; Smith *et al*. 1991). Both sites are located on large granite outcrops. Many important LSA shell midden sites have been found around the coastline. These include some very deep middens at Paternoster, one of which contains abundant faunal remains (Yates 2004) and has now been declared a PHS. Another important site was found at the Saldanha Bay Police Station and completely destroyed. With a basal date of about 6000 years, it is the oldest dated midden in the study area. It also yielded several human burials dating to about 2000 years ago (Dewar 2010; Orton 2009a). The less developed western edge of the peninsula hosts dune fields that have many sites in them as at Holbaai (Hine 2004) and Trekoskraal (Hart 2010; Kaplan 2017). The Vredenburg Peninsula is known from historical records to have been used quite heavily by the Khoekhoen for grazing their livestock. Despite the ploughing, archaeological sites are still found in agricultural lands. Although the archaeological context can be poor, these sites can still yield important finds as was the case at KFS5 just inside the study area where it is thought that a Khoekhoen kraal was present at some point in the past (Fauvelle-Aymar *et al*. 2006).

The southern part of this study area, around Saldanha Bay, is very important in terms of MSA archaeology. A number of MSA shell middens are known with one of them, at Hoedjiespunt, including fossilised human remains (Berger & Parkington 1995). The MSA sites are generally associated with calcrete formations. Bifacial points commonly associated with the MSA period known as “Still Bay” have also been found on the Vredenburg Peninsula (Bateman 1946; Smith 2006). Some historical archaeological sites are also known from the area. These include a farmstead with associated dumps to the northeast of Saldanha Bay (Kruger 2016) and a number of tidal fish traps along the coast of St Helena Bay (Hart & Halkett 1992). Historic remnants of a marine-based economy might still lie undiscovered on the seabed in Saldanha Bay, bearing testimony to the longstanding practice of fishing, whaling and similar exploitation of marine resources there (Sharfman 2016). An area in the south-western corner of the Vredenburg Peninsula is significant because of a now largely ruined World War II post consisting of many structures (or the remains thereof), a runway and various other features (Orton 2012a).

4.2.4.4 Shipwrecks

The SAHRA Shipwreck Database lists more than 160 shipwrecks known to exist in the study area with Saldanha Bay being potentially the most sensitive (J. Gribble, ACO-Associates, pers.comm. 5 October 2017; Turner 1988). Four well-known wrecks include the Dutch East Indiamen *Meerestein* wrecked in 1702 at Jutten Island (Turner 2009), *Middelburg,* fired and scuttled during the 1781 Battle of Saldanha, *Gouden Buys*, lost near the Berg River mouth in 1692 (Burman & Levin 1974; Gribble 2009a) and the galiot, *Nagel*, accidentally burned in 1709 (Gribble 2009b). However, it should be noted that a portion of the north-eastern part of the bay has been dredged to increase the depth for large ships. There are no on shore wrecks known to the author in this area.

4.2.4.5 Graves

Unmarked pre-colonial graves are known from this area and could occur anywhere, especially along the coastline. Most of those on record have come from the Saldanha Bay area (Morris 1992). The finding of up to six burials in a single archaeological site at Diaz Street Midden is extremely unusual (Dewar 2010).

4.2.4.6 Built heritage

This area has many heritage structures located in both rural and urban contexts, although very few were recorded as significant by Fransen (2004). The farms of the Vredenburg Peninsula host excellent examples of 19th century vernacular architecture, while along the coast one finds traditional fisherman’s cottages at Paternoster and Saldanha Bay, including a group of three that have been declared a PHS.

4.2.4.7 Cultural landscape

The Vredenburg Peninsula has been heavily developed in recent decades such that significant cultural landscapes are rare. There are, however, still some natural landscapes that remain as unspoilt reminders of the past beauty of the Peninsula. These occur along the western coast. Some sections of these natural landscapes contain high frequencies of LSA sites and can be considered as Stone Age cultural landscapes. A recent additional layer to this landscape comes in the form of several Wind Energy Farms, whose large, stark turbines form focal points in the visual landscape, while the salt pans at Velddrift Saltworks and the Saldanha Steelworks complex may be considered 'industrial' cultural landscapes (D. Gibbs, David Gibbs Landscape Architect, pers.comm. 24 October 2017).

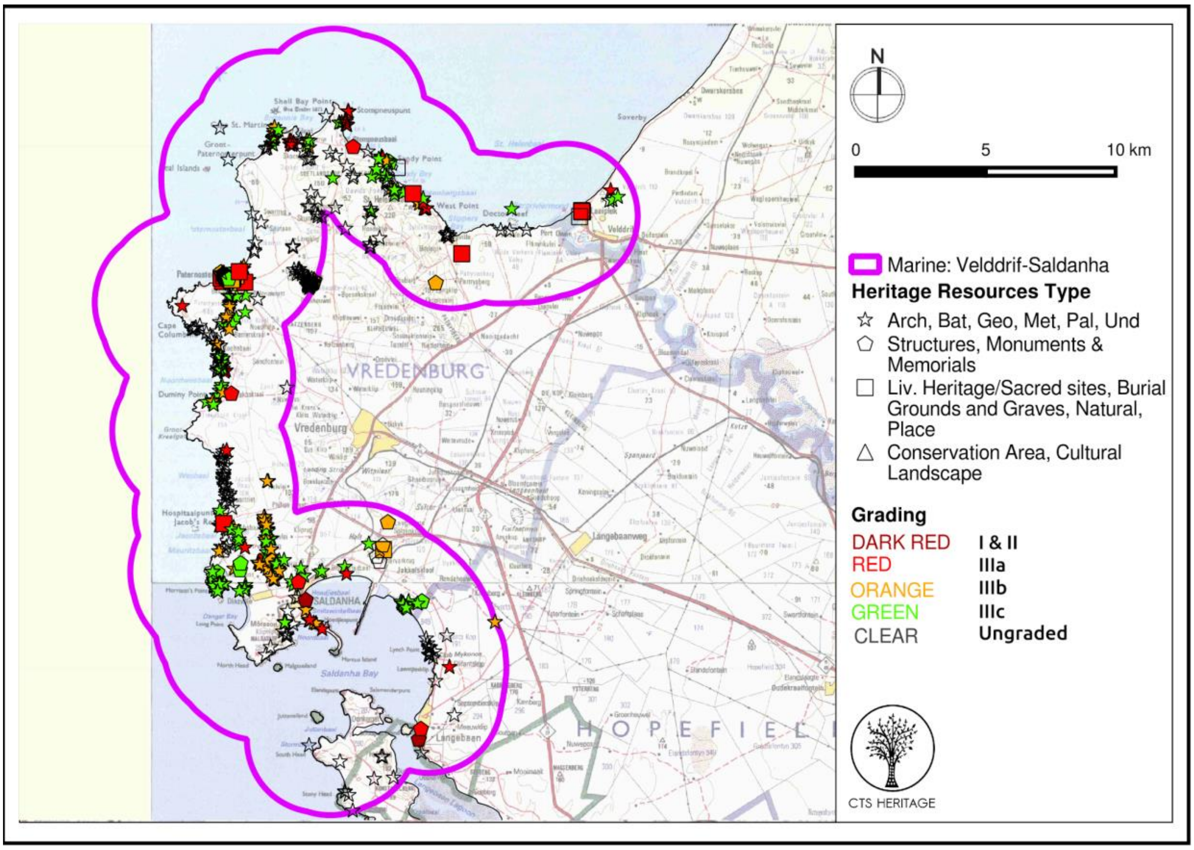

Figure 49. Velddrif-Saldanha heritage resource map.

4.2.4.8 Development guidelines

Most parts of the coastline are likely to be sensitive but, although archaeological sites may be found virtually anywhere within the study area, inland archaeological sites (more than about 500 m from the shore) are generally likely to be of lesser significance and easier to mitigate (Figure 50).

Large-scale aquaculture developments involving substantial excavation or disturbance of consolidated alluvial or coastal deposits (e.g. shelly sands, gravels, aeolianites) as well as estuarine, lagoon or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 50).

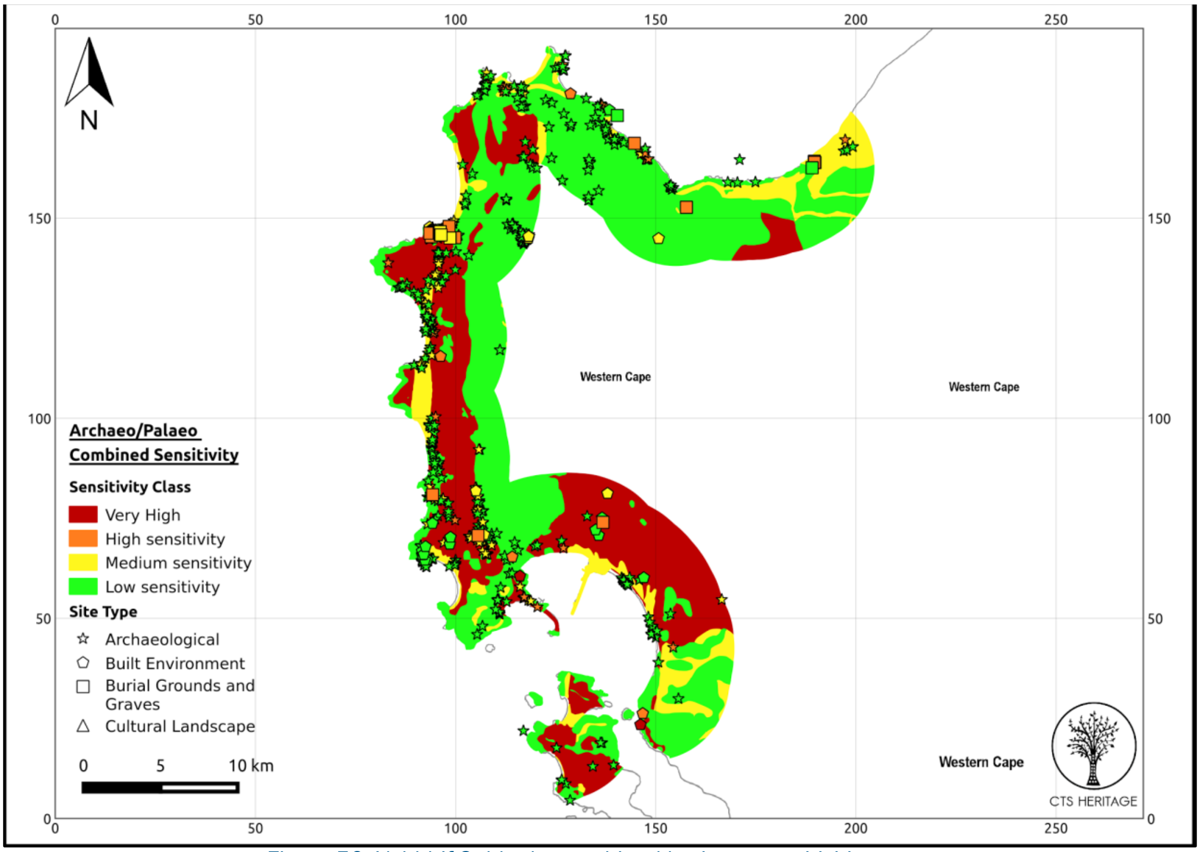

Figure 50. Velddrif-Saldanha combined heritage sensitivities map.

4.2.5 Marine Study Area 7 – Strandfontein to Lambert's Bay

4.2.5.1 Landscape character

This 50 km-long strip of coastline is variable in character and lies in the Namaqualand Sandveld Bioregion (Mucina & Rutherford 2006). The northern end is marked by the Olifants River with its large tidal estuary. South of this the beach is sandy but is backed by low cliffs. South of Strandfontein the shore is rocky and the cliffs higher but the latter become lower towards the south and from Doringbaai southwards the coast reverts to a sandy shore with intermittent rocky outcrops. A coastal dune cordon backs this southern section of the coast. The study area lacks aeolian dune fields. Away from the coast, rock outcrops are very rare but a few do occur, notably the hill known as Soutpansklipheuwel. The study area is relatively undisturbed away from the towns and in the south a number of farms have been turned into private nature reserves with very low density holiday houses.

4.2.5.2 Palaeontology

Ordovician trace fossil assemblages within Table Mountain Group bedrocks exposed along the coast are of palaeontological interest (Figure 51). Diverse fossil heritage material occurs within numerous terrestrial to shallow marine subunits of the Caenozoic West Coast Group. Fossiliferous Pleistocene to Holocene sediments cropping out close to modern sea level are especially vulnerable to impacts, but many older fossiliferous units in the West Coast Group are buried beneath thick aeolianites and / or elevated well above the modern coast. See Appendix for further details.

Key sites: [unclear from geology sheet explanations]

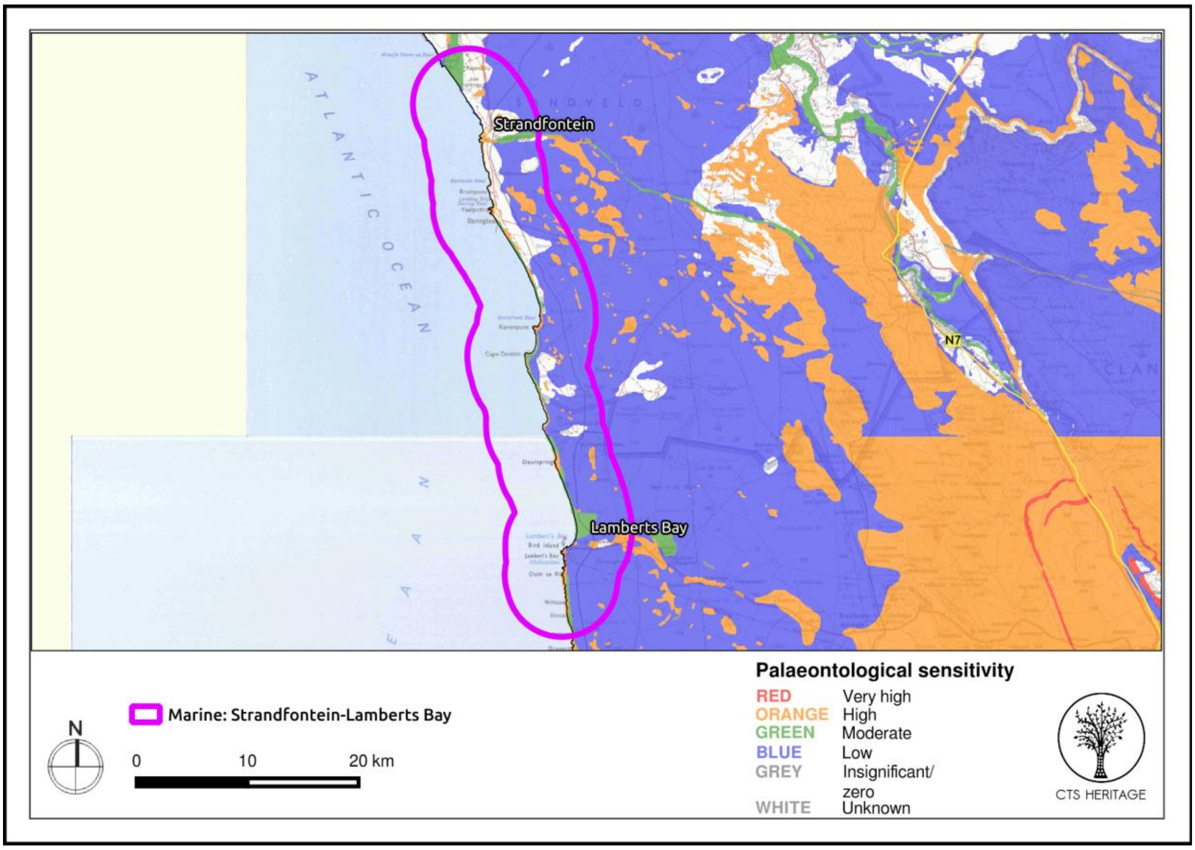

Figure 51. Strandfontein-Lamberts Bay Fossil Sensitivity Map (SAHRA 2014).

4.2.5.3 Archaeology

Shell middens and shell scatters are expected to occur along the coastline, with higher densities behind the rocky shores where shellfish would have been gathered (Figure 52). While little research has been conducted in the northern part of the study area, a few observations show that the expected pattern holds true. A low rocky hill northeast of Strandfontein attracted occupation and hosts a number of shell scatters and one shallow midden, while a few other shell sites were recorded just south of Doringbaai (Halkett & Hart 1995). In the south the rocky headlands host many sites dating to the mid- to late Holocene (Kaplan 2016; Orton 2013). Because of the limited rocky shore, there is much overprinting and some of the sites are very deep. One of the sites in this area is considered to be a shell midden of the type referred to as a ‘megamidden’ (Buchanan 1988). These are very large middens that generally contain a relatively low frequency of cultural materials and have only been identified between the area just north of Lambert’s Bay and St Helena Bay. Also in the southern part of the study area, the outcrop Soutpansklipheuwel is an important locality because it contains a large number of archaeological sites, including shell middens and scatters, and some rock paintings (Jerardino *et al*. 2014). Middens have also been recorded in the small section of the study area to the south of Lambert’s Bay (Orton 2007a).

4.2.5.4 Shipwrecks

Only a handful of shipwrecks are known to have occurred off this portion of coastline (Turner 1988; Wrecksite 2017), and most are in the vicinity of Lamberts Bay (J. Gribble, ACO-Associates, pers.comm. 5 October 2017). There are no on-shore wrecks known to the author in this area.

4.2.5.5 Graves

Very few unmarked graves have been reported from this region (Morris 1992), probably because of the small area that has been developed. However, there are certain to be many present, marked and unmarked, especially close to the coast in sandy contexts.

4.2.5.6 Built heritage

There are likely to be some structures in the area greater than 60 years of age, especially in the towns. Rural structures are quite widely dispersed and largely located away from the coastline.

4.2.5.7 Cultural landscape

The landscape in this study area is largely natural but the stretch immediately north of Doringbaai has been damaged by diamond prospectors and is quite heavily scarred. Some agricultural lands occur in the south with a number of centre pivot irrigation systems present south of Lambert's Bay.

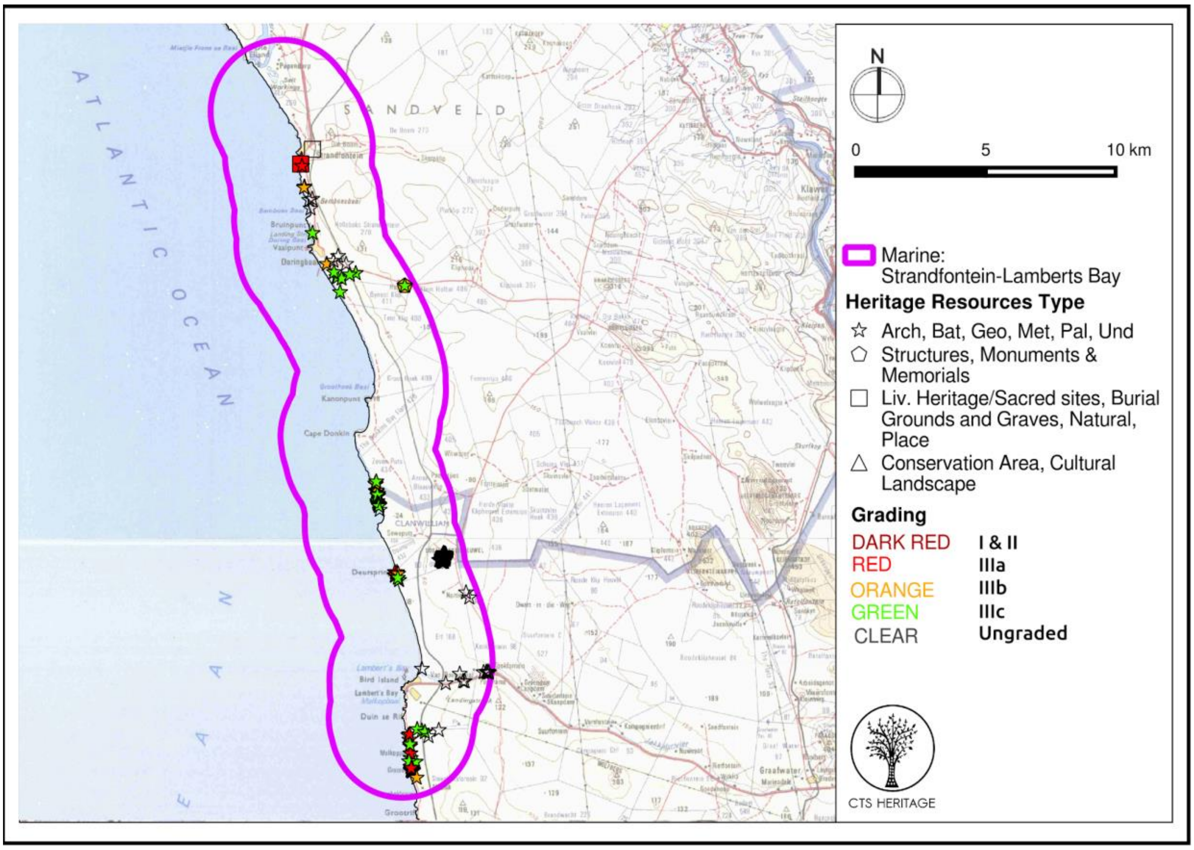

Figure 52. Strandfontein-Lamberts Bay heritage resource map.

4.2.5.8 Development guidelines

Coastal environments are generally sensitive and it is likely that archaeological sites would be intersected by onshore development almost anywhere (Figure 53). However, it is considered less risky to develop behind sandy shores than rocky shores because the latter are likely to have substantially more sites associated with them.

Large-scale aquaculture developments involving substantial excavation or disturbance of consolidated alluvial or coastal deposits (e.g. shelly sands, gravels, aeolianites) as well as estuarine, lagoon or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 53).

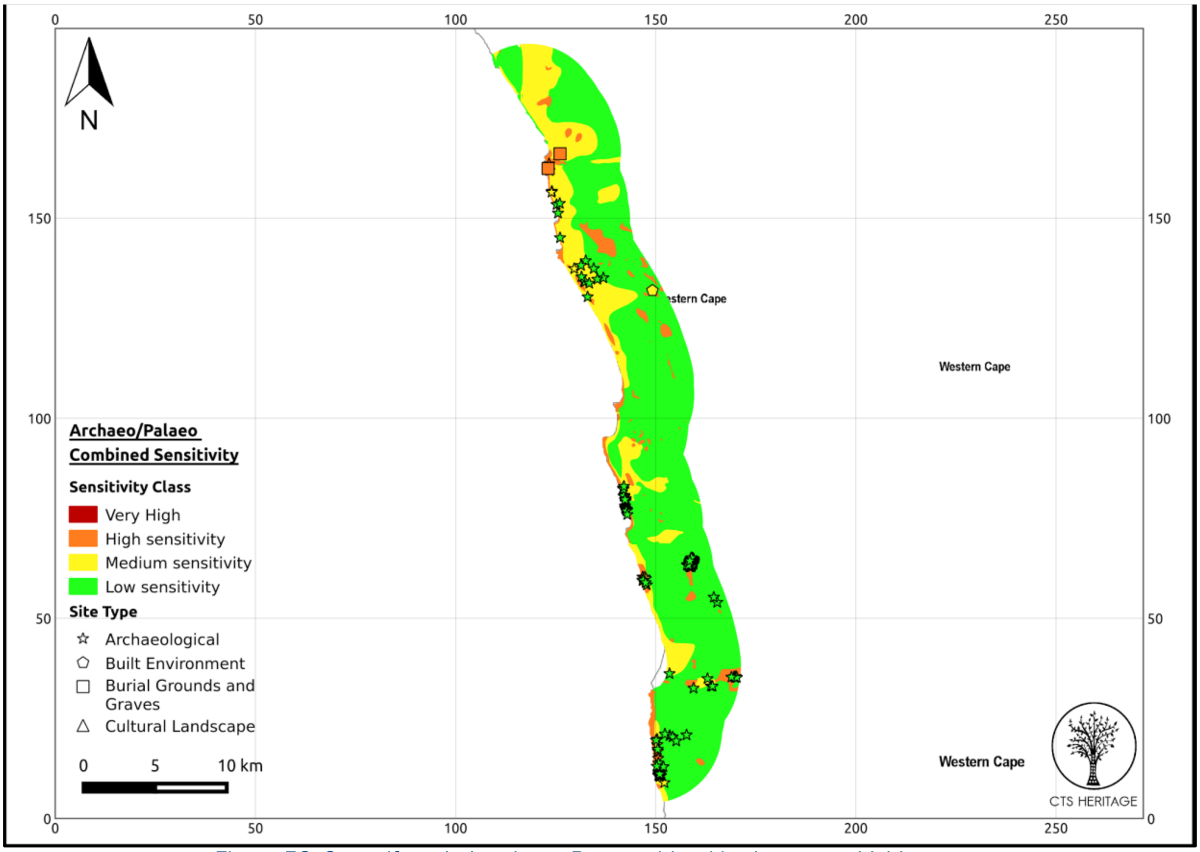

Figure 53. Strandfontein-Lamberts Bay combined heritage sensitivities map.

4.2.6 Marine Study Area 8 – Orange River to Hondeklip Bay

4.2.6.1 Landscape character

This area extends for over 230 km down the Namaqualand coast of the Northern Cape, from the mouth of the Orange River down to Hondeklip Bay. It falls within the Namaqualand Sandveld Bioregion, and encompasses the southern extent of the Southern Namib Desert Bioregion (Mucina & Rutherford 2006). It is typically a very remote area with very few towns. It is dominated along the coast by activities related to diamond mining. Although the coast is almost exclusively rocky, there are many sandy pocket beaches located where buried palaeo-river channels intersect the coast. Under the force of the dominant southerly wind these give rise to northwards-trending dune fields of white Holocene sand. For the rest, the substrate is older red sand which is generally vegetated with low (knee- to waist-high) and fairly sparsely distributed vegetation. Despite the rocky shore, inland rock outcrops are very rare within the study area and rock shelters are thus almost entirely absent. Several rivers reach the sea in this area but, aside from the perennial Orange River in the north, the flow is seasonal.

4.2.6.2 Palaeontology

Basement igneous, metamorphic and metasedimentary bedrocks cropping out along the Namaqualand coast are either unfossiliferous or are likely to contain, at most, microfossils and perhaps poorly-preserved stromatolites (Gariep Supergroup) (Figure 54). Diverse fossil heritage occurs within numerous terrestrial to shallow marine subunits of the Caenozoic West Coast Group. Fossiliferous Pleistocene to Holocene sediments cropping out close to modern sea level are especially vulnerable to impacts, but many older fossiliferous units in the West Coast Group are buried beneath thick aeolianites and / or elevated well above the modern coast. See Appendix for further details.

Key sites: [unclear from geology sheet explanations]

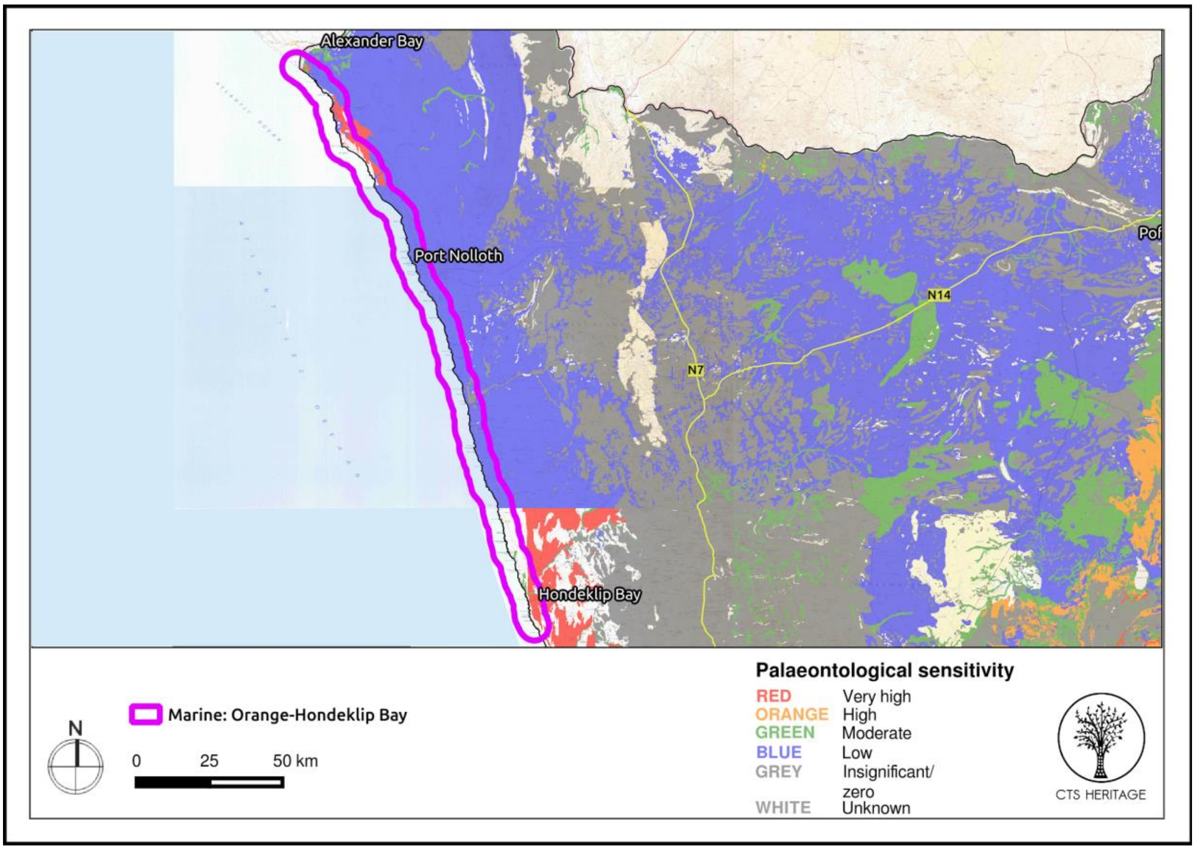

Figure 54. Orange River-Hondeklip Bay Fossil Sensitivity Map (SAHRA 2014).

4.2.6.3 Archaeology

The Namaqualand coastline is extremely rich in archaeological sites and is one of the best-researched areas in South Africa (Dewar 2008; Orton 2012b; Webley 1992, 2002) (Figure 55). This is because of the productive upwelling marine system which results in large numbers of easily-collected shellfish on the rocks. LSA shell middens and shell scatters are distributed throughout the area but the vast majority lie within about 3 km of the coastline. However, sometimes they do extend a few more kilometres inland. These sites contain subsistence remains in the form of marine shellfish, marine and terrestrial animal bones and ostrich eggshell along with cultural materials like stone artefacts, pottery and ostrich eggshell beads. A great advantage to studying the LSA archaeology of Namaqualand is the large number of single occupation open sites. Many have been dated and the work of Dewar (2008) and Orton (2012b) have allowed a better understanding of the LSA sequence here than in many other parts of the country. One coastal shell midden contains the oldest directly dated cattle bone in South Africa (Orton *et al*. 2013). The early domestic livestock bones found in the area make Namaqualand a key region for the study of early stock-keeping in South Africa (Orton 2015, 2016). A large number of shell scatters and middens have been seen along the bank of the Orange River stretching more than 2 km inland (Orton 2010), while many middens and scatters have been recorded around Port Nolloth (e.g. Webley & Orton 2013). Spoegriver Cave, located in the south, was found to contain an LSA deposit probably spanning the entire Holocene (Figure 55). It is significant largely for the early sheep remains found there (Webley 1992, 2002). It also contains the only rock art in the study area, although it is very poorly preserved (Orton, personal observation).

Contact period sites have been excavated at Hondeklipbaai and interpreted to be the camps of Khoekhoen labourers employed to load copper ore from Springbok onto ships (Orton 2009b). Middle and Early Stone Age archaeology is relatively uncommon and tends to be found in the form of low density stone artefact scatters in eroded areas, often on top of deposits of cemented soils (dorbank deposits/hardpan soils). Isolated hand axes on the surface hint at the possibility of fairly widespread buried ESA materials similar to those recorded by Halkett (2002) near Kleinzee and recently discovered in southern Namaqualand (outside the study area) by Orton (2017a). Both sites contained hand axes and cleavers. Boegoeberg 2 is a rock shelter site located in a rocky hill in the north of the study area. It contains a stratified MSA shell midden (Klein *et al*. 1999). Such sites are extremely rare and have very high cultural significance for their scientific value. Large parts of the study area have been completely destroyed by diamond mining and can be regarded as archaeologically sterile.

4.2.6.4 Shipwrecks

The SAHRA Shipwreck Database records more than 60 shipwrecks along this coastline with most having been lost in the vicinity of Port Nolloth (J. Gribble, ACO-Associates, pers.comm. 5 October 2017). Hondeklipbaai is also the location of several wrecks (Turner 1988). A number of 20th century wrecks can still be seen on the rocks around Hondeklipbaai. The mapped distribution of wrecks shows them to be largely on shore or in deep water away from the immediate coastline (Wrecksite 2017).

4.2.6.5 Graves

Unmarked pre-colonial graves are frequently uncovered in coastal dune environments. Many have been found during diamond mining (Dewar 2008; Morris 1992). The locations of such graves cannot be predicted. Very few such graves are ever found intact and a rare example comes from this study area. A seated burial was found beneath a shell midden with an ostrich eggshell bracelet, some conus shells and a melon knife. A lower grindstone had been placed above the head (Orton 2007b).

4.2.6.6 Built heritage

Outside of the towns, the area is practically devoid of built heritage resources. The towns do contain a number of structures older than 60 years and Kleinzee is an excellent example of a company town with the original core dating back to the 1930s.

4.2.6.7 Cultural landscape

The study area has been very strongly anthropogenically altered over the last 85 years since the discovery of diamonds and rehabilitation has been minimal. This has left a heavily scarred landscape with large mining-related infrastructure and spoil heaps present in several places. For the very large number of LSA archaeological sites present, the entire study area can be considered an important Stone Age cultural landscape.

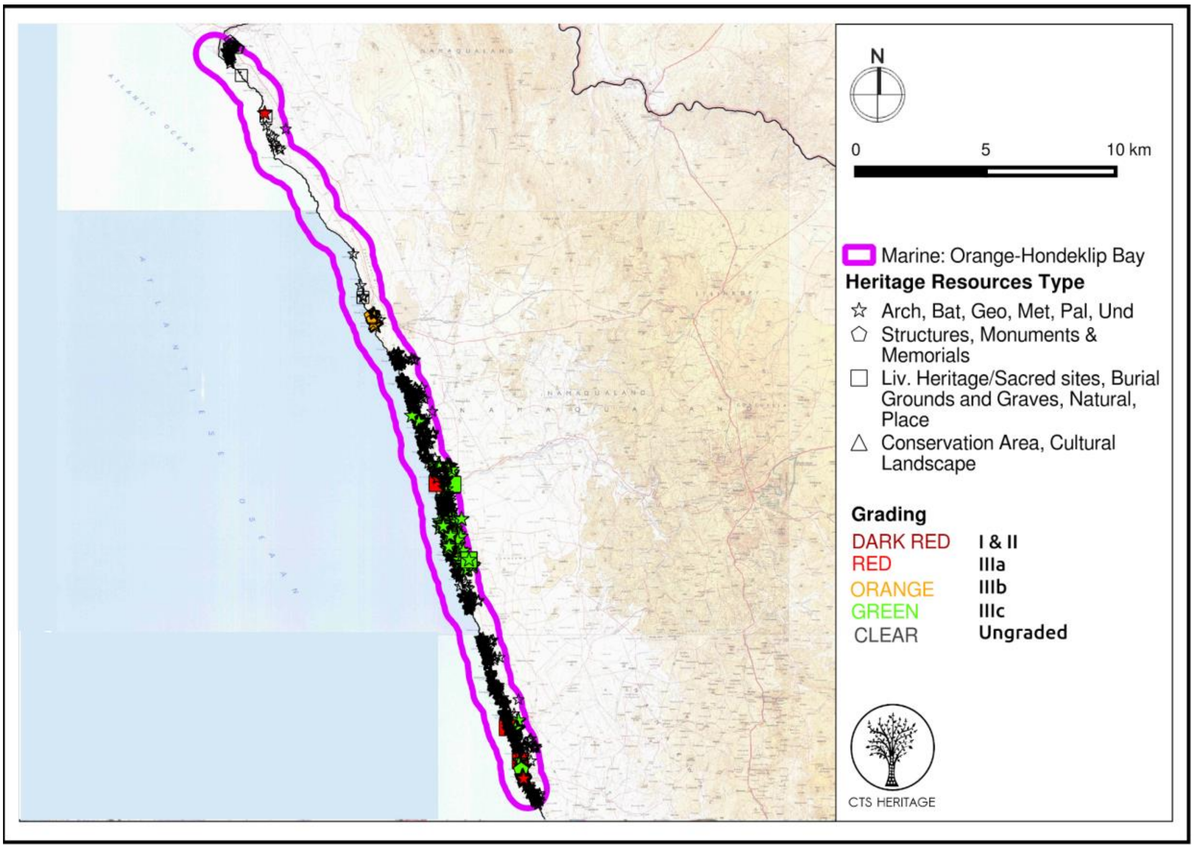

Figure 55. Orange River-Hondeklip Bay heritage resource map.

4.2.6.8 Development guidelines

The many mined-out areas in this study area are ideally suited to aquaculture development, since they have already been sterilised from an archaeological point of view. In unmined areas it is likely to be slightly safer to develop in areas away from dune fields but it should be assumed that archaeological sites are present almost everywhere inside the study area (Figure 56). Because many areas are protected from general access due to mining, the archaeology can be very well preserved. It is highly unlikely that any underwater shipwrecks will be impacted and offshore development could thus occur almost anywhere.

Large-scale aquaculture developments involving substantial excavation or disturbance of consolidated alluvial or coastal deposits (e.g. shelly sands, gravels, aeolianites) as well as estuarine, lagoon or vlei sediments along river courses should be subject to a field-based palaeontological assessment (Figure 56).

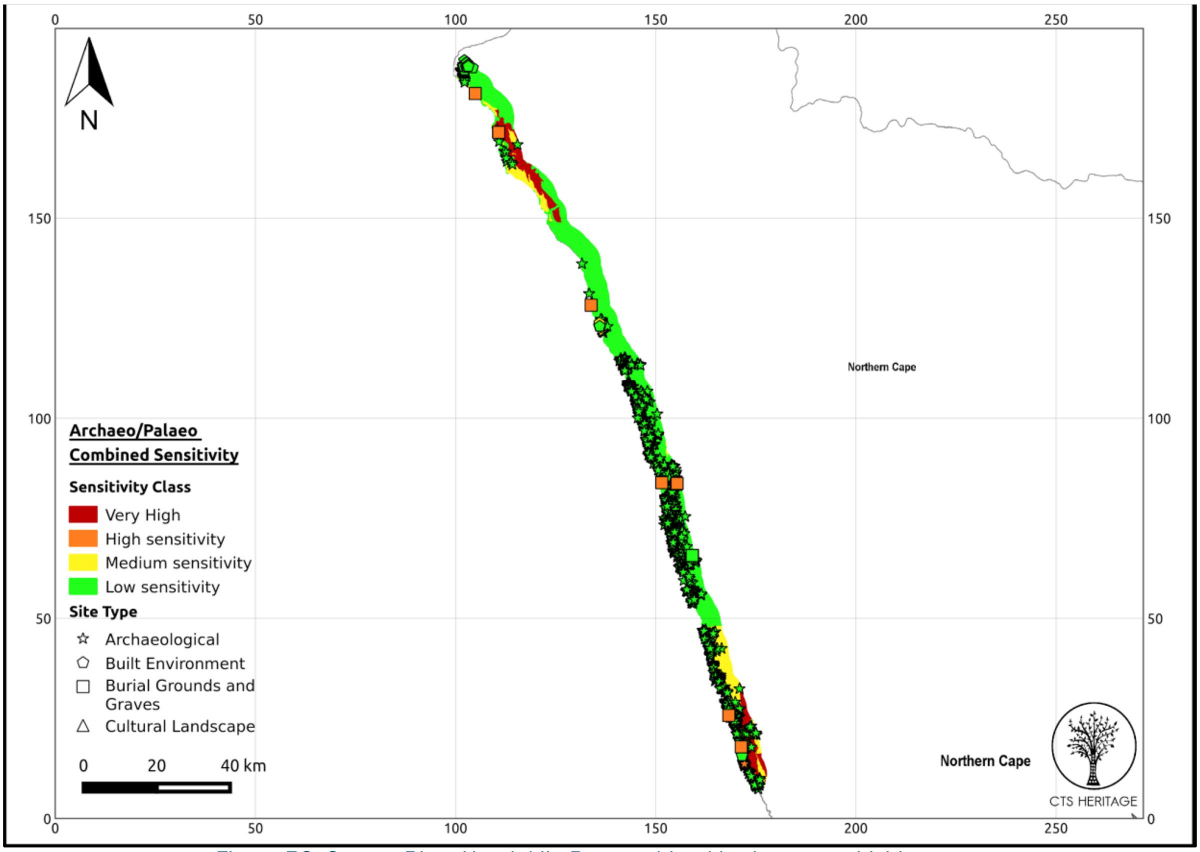

Figure 56. Orange River-Hondeklip Bay combined heritage sensitivities map.

5 KEY POTENTIAL IMPACTS AND THEIR MITIGATION

By far the greatest threat posed to all types of heritage resources is the damage or destruction of sites and resources during the construction of aquaculture infrastructure. Due to the ubiquity of heritage resources throughout the study areas, and the preferential siting of aquaculture facilities near fresh water and/or coastlines, it is almost impossible for construction of these facilities to avoid all heritage resources.
With a project of this scope and scale, determining impacts is a multi-faceted exercise. Each type of development will have a different impact on each resource, with the impacts varying in scale and extent within each of the proposed study areas. Mitigation, similarly, will be variable at each site, for each intervention. This fact notwithstanding, it is still possible to identify impacts that will be common to all aquaculture facilities, regardless of their type, location in South Africa or siting in the landscape.

5.1 Key impacts and mitigation measures relative to heritage

5.1.1 Roads, new and upgraded

5.1.1.1 Description

Where new roads are required to provide access to sites, or existing roads require widening or upgrading, a threat is posed to as yet undetected archaeological and palaeontological sites, as well as graves and sensitive cultural landscapes (Table 1). Roads created or widened near fragile built heritage or existing features of geo-heritage also pose a risk of damage or destruction.

In as much as offshore systems will predominantly make use of existing roads to and from coastal access points, offshore technologies will probably have a lower impact than land-based systems where entirely new facilities need to be designed and built in newly allocated footprints.

Table 1. Risk levels by road construction and/or upgrading for each type of aquaculture production system

Risk of Type 1 Impact	System
High risk system	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
Low Risk	Freshwater dam cage culture
	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks

5.1.1.2 Mitigation

All routes for new roads and all road alignments that require alteration or improvement should be subjected to archaeological walkdowns where these occur in areas that are previously undisturbed, and in areas flagged as having moderate to very high heritage sensitivity.

5.1.2 Vegetation clearing

5.1.2.1 Description

The clearing of site vegetation will pose threats to any locally occurring heritage resources, with the extent of those threats greater for developments that require the clearing of large areas of vegetation, e.g. land-based facilities - pond culture, flow-through and recirculation systems with extensive hatcheries such as is required for abalone farming (Table 2). Where pond and cage culture makes use of existing bodies of water, the impacts will be slightly reduced, as no new ponds will need to be created. Where marine flora needs to be removed to facilitate laying down anchors for offshore aquaculture, impacts may result as these colonising flora can create a protective layer around wrecks.

Table 2. Risk levels posed by vegetation clearing for each type of aquaculture facility

Risk of Type 2 Impact	System
High risk system	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
Low risk	Freshwater dam cage culture
Very low risk	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks

5.1.2.2 Mitigation

All areas proposed for vegetation clearing should be subjected to archaeological walkdowns where these occur in areas that are previously undisturbed, and in areas flagged as having moderate to very high heritage sensitivity. Where high heritage significance sites are identified, these should be mitigated prior to vegetation clearing, while less significant sites should be subject to monitoring during vegetation clearing.

5.1.3 Construction of facilities

5.1.3.1 Description

Further threats are posed during the actual construction phase, where the excavation of foundations for structures poses threats to surficial and sub-surface heritage resources, including palaeontological resources (Table 3). Cultural landscapes, particularly where these are rural, agricultural areas, are sensitive to the bulk and massing of new industrial scale infrastructure, while historic settlements are vulnerable to visual disruption of the surrounding landscape.

Specific sites of intangible heritage would need to be identified through Public Participation Processes, site visits and consultation, and are likely to occur, but an aspect of intangible heritage at the coastal sites is related to access to the coastline. This is an important component in human evolution, human history and a right enshrined in the National Environmental Management: Integrated Coastal Management Act (Act No. 24 of 2008) (Celliers *et al*. 2009).

Where resources cannot be mitigated through excavation, or moved, they should be noted on all development maps, the Environmental Control Officer (ECO) should be alerted to their presence, and a buffer zone should be placed around them to shield them from any damage caused during construction-related activities.

The highest risks to heritage resources in this phase again are the technologies that require large footprints for hatcheries and processing, such as abalone farms. Where pond and cage culture makes use of existing bodies of water, the impacts will be slightly reduced, as no new ponds will need to be created.

Table 3. Risk levels posed by construction of facilities for each type of aquaculture facility

Risk of Type 3 Impact	System
High risk system	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
Low risk	Freshwater dam cage culture
	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks

5.1.3.2 Mitigation

Monitoring of all subsurface foundations should be conducted in areas flagged as having moderate to very high heritage sensitivity, or where significant sites were identified during vegetation clearing. Palaeontological monitoring should be undertaken where deep excavations will be made in areas of high to very high fossil sensitivity.

5.1.4 Trenching for pipes

5.1.4.1 Description

Extensive trenching for the laying of pipes, e.g. for land-based pond culture, and marine and freshwater recirculation and flow through systems, poses threats to surficial and subsurface heritage resources, including palaeontology, and archaeology, particularly in the high sensitivity areas adjacent to the sea where middens are common, palaeontology and burials (Table 4).

Table 4. Risk levels posed by trenching for pipes for each type of aquaculture facility

Risk of Type 4 Impact	System
High risk system	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
Low risk	Freshwater dam cage culture
	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks

5.1.4.2 Mitigation

Trenching in areas flagged as having moderate to very high heritage sensitivity may require monitoring for sub-surface heritage resources. These deposits might occur even where they were not detected by inspection of the construction footprint. Palaeontological monitoring should be undertaken where deep excavations will be made in areas of high to very high fossil sensitivity.

Where significant resources occur, they should be noted on all development maps, the ECO should be alerted to their presence, and a buffer zone should be placed around them to shield them from any damage caused during construction related activities. Only where *in situ* retention of the site is impossible should mitigation through excavation, or relocation of the resource be considered.

5.1.5 Shoreline infrastructure

5.1.5.1 Description

Disturbance to shorelines, e.g. during the construction of pump houses, inlets and outlets for marine recirculated and flow through systems, can particularly affect shipwrecks lying close to shore or on beaches, while intertidal fish traps and onshore shell middens could also be vulnerable to damage and disturbance (Table 5). Burials might be associated with the middens, and on shore burials resulting from older shipwrecks could also be disturbed.

Table 5. Risk levels posed by construction of shoreline infrastructure for each type of aquaculture facility

Risk of Type 5 Impact	System
High risk system	Marine land-based flow through
	Marine land-based recirculation
	Marine land-based pond culture
Low risk	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks
Very low risk	Freshwater land-based flow through
	Freshwater land-based recirculation
	Freshwater land-based pond culture
	Freshwater dam cage culture

5.1.5.2 Mitigation

The siting of any infrastructure directly on the shoreline, whether on rocky shores or sandy beaches, should be subject to inspection by an archaeologist prior to construction taking place. While many coastal midden sites are not necessarily of such significance that they cannot be mitigated through excavation prior to development, the possibility of burials associated with those middens cannot be excluded, and steps to deal appropriately with such discoveries during construction should be included in the Environmental Management Plan (EMP). Should there be known or suspected shipwrecks in the area, a maritime archaeologist should be consulted to assess the likelihood of the location of the infrastructure affecting the wreck. Fish traps are particularly vulnerable to destruction or damage, and areas where they occur should be avoided wherever possible as sites for such infrastructure.

Where significant resources occur, they should be noted on all development maps, the ECO should be alerted to their presence, and a buffer zone should be placed around them to shield them from any damage caused during construction-related activities. Only where *in situ* retention of the site is impossible should mitigation through excavation, or relocation of the resource be considered.

5.1.6 Offshore infrastructure

5.1.6.1 Description

Marine aquaculture facilities that require offshore infrastructure, such as cage culture, rafts, longlines and racks are least likely to impact significant heritage resources (Table 6). Similarly freshwater cage culture in existing dams would be unlikely to have a significant impact on heritage resources. However, these systems all require anchoring, which is achieved through tethering them to concrete blocks that lie on the seabed. These blocks pose a small risk to submerged marine archaeological resources, predominantly in the form of shipwrecks. Further risks are posed by changes to wave regimes and sediment dynamics caused by these interventions, where small changes to the marine environment could have direct or indirect, and cumulative, impacts to submerged heritage.

Table 6. Risk levels posed by offshore infrastructure for each type of aquaculture facility

Risk of Type 6 Impact	System
Low risk	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks
No risk	Freshwater and marine land-based pond culture
	Freshwater dam cage culture
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based flow through

5.1.6.2 Mitigation

All locations for marine offshore aquaculture facilities should be vetted by a marine archaeologist. The placement of concrete anchors in areas that pose high risks to wrecks should be inspected by a marine archaeologist prior to the anchors being put in place. No anchors should be placed on or near wrecks, and the location of the buffers should be moved to provide an adequate buffer around wreck sites as determined by the archaeologist.

5.1.7 People on site

5.1.7.1 Description

The increased presence of people in an area can pose threats to heritage resources both during construction and operational phases of a project (Table 7). The introduction of any people to an area brings with it a risk of damage to heritage resources, either through negligence or intentional vandalism and destructiveness, in the form of removal of artefacts from archaeological sites, theft of fossil material, graffiti and other damage to rock art. Further to this, the presence of large numbers of people can affect the area's sense of place, particularly where workers are housed on site. Threats to built heritage are less severe, but still exist, where existing historic structures might be altered for accommodation, or new, inappropriate structures built that detract from existing ones.

Table 7. Risk levels posed by the presence of people for each type of aquaculture facility

Risk of Type 7 Impact	System
Medium risk	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
	Freshwater dam cage culture
	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks

5.1.7.2 Mitigation

Mitigation can be achieved through education of all people on site during construction and operation of the presence and significance of heritage resources in the vicinity, as well as the legislated protection of them, and possible penalties associated with damage to these resources. Where necessary, sensitive resources that might be of high value - such as fossil sites or similar - should be fenced off and access strictly prohibited.

5.1.8 Increased vehicular traffic

5.1.8.1 Description

Increased traffic to and from site could result in negative impacts to unstable heritage buildings, archaeological built features, such as stone walling or similar structures over 100 years, historical bridges unsuited to the increased quantity, frequency or weight of the traffic, or nearby fragile geological features (Table 8). Furthermore, the traffic poses a threat to cultural landscapes, where such traffic is alien to the sense of place.

Table 8. Risk levels posed by increased vehicular traffic for each type of aquaculture facility

Risk of Type 8 Impact	System
Medium Risk	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
Low Risk	Freshwater dam cage culture
Very low risk	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks

5.1.8.2 Mitigation

Traffic flow to and from site should be regulated in terms of the EMP. Where heavy goods vehicles might negatively impact fragile heritage resources, these trucks should be rerouted, or strict speed limits should be enforced.

5.1.9 Operational activities

5.1.9.1 Description

The ongoing operations at aquaculture facilities pose some further threats to heritage resources, although, except in the case of submerged archaeology, this is likely to be far reduced from the construction phase (Table 9). Threats to general heritage resources during operations come in the form of light and noise pollution affecting cultural landscapes, living heritage and places associated with living heritage. For offshore mariculture facilities, the action of water and sand movement around the anchors could shift them, or reveal previously hidden submerged wrecks, contributing to an ongoing threat during the facility's operational lifetime in this instance.

Table 9. Risk level posed by operation activities for each type of aquaculture facility

Risk of Type 9 Impact	System
Low risk	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks
	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
	Freshwater dam cage culture

5.1.9.2 Mitigation

Measures should be put in place in the EMP to limit light and noise pollution associated with aquaculture facilities where these pose a threat to high or very high significance cultural landscapes, living heritage and places associated with living heritage. Public consultation will need to be undertaken to establish the threats of such events to the living heritage aspects. In terms of possible ongoing threats to maritime archaeology and shipwrecks, a maritime archaeologist should conduct annual assessments of the location and condition of the anchor points in any areas that are high risk for the presence of wrecks.

5.1.10 Site closure and rehabilitation

5.1.10.1 Description

Impacts are unlikely to occur during rehabilitation and post closure, as resources will either have been affected during the construction or operational phase, or mitigated and/or protected (Table 10). Slight risk remains to undetected heritage resources due to landscaping and associated activities, and to fragile resources susceptible to damage due to heavy vehicle traffic to and from site. These activities could also mean an influx of new staff on site.

Table 10. Risk levels posed by site closure and rehabilitation for each type of aquaculture facility

Risk of Type 10 Impact	System
Low risk	Freshwater and marine land-based flow through
	Freshwater and marine land-based recirculation
	Freshwater and marine land-based pond culture
	Freshwater dam cage culture
Very low risk	Marine offshore and nearshore cage culture
	Marine nearshore longlines, rafts and racks

5.1.10.2 Mitigation

As far as possible, all work should be limited to within the construction phase disturbance footprint. An archaeologist familiar with the installation should review the proposed closure and rehabilitation plans and note any areas that may be affected that were not already subject to mitigation at a previous stage. All new staff on site should receive education regarding the presence of any significant heritage resources.

5.2 Cumulative Impacts

Cumulative impacts can be considered to be the combined or incremental effects arising from changes effected by a development in conjunction with other previous, current or future activities. Cumulative impacts cannot be determined at the scope of this study, as such an assessment would require information on the location, density and particular nature of proposed aquaculture developments in relation to other existing and proposed activities, whether of a similar, or different nature.

In order to reduce cumulative impacts, it will be necessary to ensure integrated planning at the regional scale to minimise competing land use and excessive cumulative developmental impacts to heritage resources, be they tangible or intangible.

6 RISK ASSESSMENT

The variable distribution of heritage resources of different types across the landscape complicates determining risk in a project of this scale, and with such fragmented, widely dispersed footprints. With the development areas spread across different rainfall areas, vegetation types, topographies as well as arising from the actions of different groups of people with different subsistence strategies, the indicators that might hold true for predicting a resource in one area may not in another. For instance, in water scarce areas, historic settlements might preferentially be located in valleys, while in high rainfall areas, settlement upslope would reduce flooding risks. The exception, largely, to this complexity lies in palaeontology, where the palaeo-sensitivity of an area can be inferred from the underlying geological substrate which is, for the most part, well known and well mapped across the country. It should be noted that the accuracy of this mapping is dependent on the geological base map available, which, for this report is not sufficiently fine grained to be useful at the site specific scale. Similarly there are areas of the coast that are more likely to contain shipwrecks, particularly areas off rocky shorelines and in the vicinity of historical ports and anchorages. It must also be borne in mind that the exact position of very few wrecks in any of the study areas is known with certainty and, unless archaeological ground-truthing has taken place, wrecks in any of the marine study areas can pose a significant risk to the development of aquaculture infrastructure.

Here again, the usefulness of the various heritage resource maps available to developers and the general public must be stressed. These maps and resources can, at the earliest stage of a development, and as has been demonstrated here, provide an indication of the location of declared and/or graded heritage sites that will need to be avoided and, potentially buffered, as well as the relative sensitivities of different landscapes or regions, based on the palaeontology, density of declared sites, or simply density of certain site types, such as burials (SAHRA 2014, 2017; Wrecksite 2017).

For the purposes of risk assessment for this project, the authors have taken individual heritage resources as the basis for assessment, rather than sources of impact, types of farming technology or location of facilities. This assessment framework has been selected as the most appropriate as the type of resource is a better indicator of the risk posed by each impact.

6.1 Consequence Levels

Table 11. Consequence levels defined for each heritage resource type (adapted from Orton *et al*. 2016 and Sharfman 2016)

Consequence Level	Definition
Archaeology, Palaeontology and Rock Art	
Slight	Destruction of a NCW site without basic recording at assessment phase
Moderate	Damage to a Grade IIIC site without mitigation through recording, sampling or excavation
Substantial	Destruction of a Grade IIIC site without mitigation through recording, sampling or excavation Damage to a Grade IIIB site without mitigation through recording, sampling or excavation
Severe	Destruction of a Grade IIIB site without mitigation through recording, sampling or excavation Damage to a Grade IIIA site is damaged without mitigation through recording, sampling or excavation Damage to a Grade I, II or IIIA site
Extreme	Destruction of a Grade I, II or IIIA site
Shipwrecks	
Slight	Restriction of access to any shipwrecks and associated cargo, debris or artefacts older than 60 years
Moderate	Prevention of access to any shipwrecks and associated cargo, debris or artefacts older than 60 years
Substantial	Alteration of any shipwrecks and associated cargo, debris or artefacts older than 60 years
Severe	Damage to any shipwrecks and associated cargo, debris or artefacts older than 60 years
Extreme	Destruction of any shipwrecks and associated cargo, debris or artefacts older than 60 years
Extreme	Impacts to any graves should be considered extreme and be avoided at all costs. Mitigation through exhumation is possible, but should not be considered an acceptable management strategy.
Built heritage	
Slight	Demolition of a NCW site without basic recording at assessment phase
Moderate	Alteration to a Grade IIIC site without detailed recording at mitigation phase
Substantial	Demolition of a Grade IIIC site without detailed recording at mitigation phase
Severe	Demolition of a Grade IIIB site without detailed recording at mitigation phase Alteration to a Grade IIIA site without detailed recording at mitigation phase Damage to a Grade I, II or IIIA site Highly negative impacts to the setting of one of the above or a conservation-worthy town or protected area
Extreme	Destruction of a Grade I, II or IIIA site Irrevocable change to the setting of one of the above or a conservation- worthy town or protected area that results in the loss of its significance

Cultural landscapes	
Slight	The cultural landscape is NCW Localised intrusion on a Grade IIIC cultural landscape that is not highly visible or noticeable Acceptable visual screening or absorption of development by a Grade IIIB cultural landscape
Moderate	Highly visible or noticeable intrusion on a Grade IIIC cultural landscape Localised intrusion on a Grade IIIB cultural landscape that is not highly visible or noticeable Acceptable visual screening or absorption of development by a Grade IIIA cultural landscape
Substantial	Overwhelming intrusion on a Grade IIIC such that development becomes a focal point Highly visible or noticeable intrusion on a Grade IIIB cultural landscape Localised intrusion on a Grade IIIA cultural landscape that is not highly visible or noticeable
Severe	Overwhelming intrusion on a Grade IIIB such that development becomes a focal point Highly visible or noticeable intrusion on a Grade IIIA cultural landscape
Extreme	Overwhelming intrusion on a Grade IIIA such that development becomes a focal point Any form of compromise to a Grade I or II cultural landscape

6.2 Risk assessment results

Table 12. Risk assessment of impacts per heritage resource type for each sensitivity class

Impact 1	Resource Type	Sensitivity of Study Area	Without Mitigation			With Mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Roads, new and upgraded	Palaeontology	Very high	Severe	Likely	High	Substantial	Not likely	Moderate
		High	Substantial	Likely	Moderate	Moderate	Not likely	
		Medium	Moderate	Likely	Very low	Slight	Not likely	Very low
		Low	Slight	Extremely Unlikely	Very low	Slight	Extremely Unlikely	Very low
	Archaeology	Very high	Extreme	Likely	High	Severe	Not likely	Moderate
		High	Substantial	Likely	Moderate	Moderate	Not likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Likely	Very low	Slight	Not likely	Very low
	Graves	Very high	Extreme	Likely	High	Extreme	Not likely	Moderate
	Built Heritage	Very high	Severe	Not likely	Moderate	Substantial	Extremely unlikely	Very low
		High	Substantial	Not likely	Moderate	Moderate	Extremely unlikely	Very low
		Medium	Moderate	Not likely	Low	Slight	Extremely unlikely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Cultural landscape	Very high	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		High	Moderate	Not likely	Low	Slight	Very unlikely	Very low

		Medium	Slight	Not likely	Very low	Slight	Very unlikely	Very low
		Low	Slight	Very unlikely	Very low	Slight	Very unlikely	Very low
Impact 2	**Resource Type**	**Sensitivity of Study Area**	**Without Mitigation**			**With Mitigation**		
			Consequence	**Likelihood**	**Risk**	**Consequence**	**Likelihood**	**Risk**
Vegetation clearing	Palaeontology	Very high	Slight	Very unlikely	Very low	Slight	Very unlikely	Very low
		High	Slight	Very unlikely	Very low	Slight	Very unlikely	Very low
		Medium	Slight	Very unlikely	Very low	Slight	Very unlikely	Very low
		Low	Slight	Very unlikely	Very low	Slight	Very unlikely	Very low
	Archaeology	Very high	Severe	Very likely	High	Substantial	Not likely	Moderate
		High	Severe	Very likely	High	Substantial	Not likely	Moderate
		Medium	Substantial	Very likely	Moderate	Moderate	Not likely	Low
		Low	Moderate	Likely	Low	Slight	Very unlikely	Very low
	Graves	Very high	Extreme	Likely	High	Extreme	Not likely	Moderate
	Built Heritage	Very high	Severe	Very unlikely	Low	Slight	Extremely unlikely	Very low
		High	Substantial	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Medium	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Low	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
	Cultural landscape	Very high	Severe	Not likely	Moderate	Moderate	Very unlikely	Low
		High	Substantial	Not likely	Moderate	Moderate	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Slight	Very unlikely	Very low

		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low
Impact 3	Resource Type	Sensitivity of Study Area	Without Mitigation			With Mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Construction of facilities	Palaeontology	Very high	Severe	Very likely	High	Moderate	Likely	Low
		High	Severe	Very likely	High	Moderate	Likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Archaeology	Very high	Severe	Very likely	High	Moderate	Likely	Low
		High	Severe	Very likely	High	Moderate	Likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Graves	Very high	Extreme	Likely	High	Extreme	Not likely	Moderate
	Built Heritage	Very high	Severe	Very unlikely	Low	Slight	Extremely unlikely	Very low
		High	Substantial	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Medium	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Low	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
	Cultural landscape	Very high	Severe	Not likely	Moderate	Moderate	Very unlikely	Low
		High	Substantial	Not likely	Moderate	Moderate	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low

Impact 4	Resource Type	Sensitivity of Study Area	Without Mitigation			With Mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Trenching for pipes	Palaeontology	Very high	Severe	Very likely	High	Moderate	Likely	Low
		High	Severe	Very likely	High	Moderate	Likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Archaeology	Very high	Severe	Very likely	High	Moderate	Likely	Low
		High	Severe	Very likely	High	Moderate	Likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Shipwrecks	Very high	Severe	Very unlikely	Low	Substantial	Extremely unlikely	Very low
		High	Substantial	Very unlikely	Low	Moderate	Extremely unlikely	Very low
		Medium	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
		Low	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
	Graves	Very high	Extreme	Likely	High	Extreme	Not likely	Moderate
	Built Heritage	Very high	Severe	Very unlikely	Low	Slight	Extremely unlikely	Very low
		High	Substantial	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Medium	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Low	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
	Cultural landscape	Very high	Severe	Not likely	Moderate	Moderate	Very unlikely	Low

		High	Substantial	Not likely	Moderate	Moderate	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low

Impact 5	Resource Type	Sensitivity of Study Area	Without Mitigation			With Mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Shoreline infrastructure	Palaeontology	Very high	Severe	Very likely	High	Moderate	Likely	Low
		High	Severe	Very likely	High	Moderate	Likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Archaeology	Very high	Severe	Very likely	High	Moderate	Likely	Low
		High	Severe	Very likely	High	Moderate	Likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Shipwrecks	Very high	Severe	Not likely	Moderate	Substantial	Extremely unlikely	Very low
		High	Substantial	Not likely	Moderate	Moderate	Extremely unlikely	Very low
		Medium	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
		Low	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
	Graves	Very high	Extreme	Likely	High	Extreme	Not likely	Moderate
	Built Heritage	Very high	Severe	Very unlikely	Low	Slight	Extremely unlikely	Very low
		High	Substantial	Very unlikely	Low	Slight	Extremely unlikely	Very low

		Medium	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Low	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
	Cultural landscape	Very high	Severe	Not likely	Moderate	Moderate	Very unlikely	Low
		High	Substantial	Not likely	Moderate	Moderate	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low

Impact 6	Resource Type	Sensitivity of Study Area	Without Mitigation			With Mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Offshore infrastructure	Archaeology	Very high	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
		High	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
		Medium	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
		Low	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
	Shipwrecks	Very high	Severe	Not likely	Moderate	Moderate	Extremely unlikely	Very low
		High	Substantial	Not likely	Moderate	Moderate	Extremely unlikely	Very low
		Medium	Moderate	Not likely	Low	Slight	Extremely unlikely	Very low
		Low	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
	Graves	Very high	Extreme	Very unlikely	Very low	Extreme	Extremely unlikely	Very low
	Cultural landscape	Very high	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
		High	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
		Medium	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low

		Low	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low

Impact 7	Resource Type	Sensitivity of Study Area	Without Mitigation			With Mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
People on site	Palaeontology	Very high	Severe	Not likely	Moderate	Severe	Very unlikely	Low
		High	Substantial	Not likely	Moderate	Substantial	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Moderate	Very unlikely	Low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low
	Archaeology	Very high	Severe	Not likely	Moderate	Severe	Very unlikely	Low
		High	Substantial	Not likely	Moderate	Substantial	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Moderate	Very unlikely	Low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low
	Shipwrecks	Very high	Severe	Very unlikely	Low	Severe	Extremely unlikely	Very low
		High	Substantial	Very unlikely	Low	Substantial	Extremely unlikely	Very low
		Medium	Moderate	Very unlikely	Low	Moderate	Extremely unlikely	Very low
		Low	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
	Graves	Very high	Extreme	Not likely	Moderate	Extreme	Very unlikely	Low
	Built Heritage	Very high	Severe	Not likely	Moderate	Severe	Very unlikely	Low
		High	Substantial	Not likely	Moderate	Substantial	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Moderate	Very unlikely	Low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low

	Cultural landscape	Very high	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		High	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		Medium	Slight	Not likely	Very low	Slight	Very unlikely	Very low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low
Impact 8	**Resource Type**	**Sensitivity of Study Area**	**Without Mitigation**			**With Mitigation**		
			Consequence	**Likelihood**	**Risk**	**Consequence**	**Likelihood**	**Risk**
Increased vehicular traffic	Palaeontology	Very high	Severe	Likely	High	Substantial	Not likely	Moderate
		High	Substantial	Likely	Moderate	Moderate	Not likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Extremely Unlikely	Very low	Slight	Extremely Unlikely	Very low
	Archaeology	Very high	Extreme	Likely	High	Severe	Not likely	Moderate
		High	Substantial	Likely	Moderate	Moderate	Not likely	Low
		Medium	Moderate	Likely	Low	Slight	Not likely	Very low
		Low	Slight	Likely	Very low	Slight	Not likely	Very low
	Graves	Very high	Extreme	Not likely	Moderate	Extreme	Extremely unlikely	Very low
	Built Heritage	Very high	Severe	Not likely	Moderate	Substantial	Extremely unlikely	Very low
		High	Substantial	Not likely	Moderate	Moderate	Extremely unlikely	Very low
		Medium	Moderate	Not likely	Low	Slight	Extremely unlikely	Very low
		Low	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
	Cultural landscape	Very high	Substantial	Not likely	Moderate	Slight	Very unlikely	Very low

		High	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		Medium	Slight	Not likely	Very low	Slight	Very unlikely	Very low
		Low	Slight	Very unlikely	Very low	Slight	Very unlikely	Very low
Impact 9	**Resource Type**	**Sensitivity of Study Area**	**Without Mitigation**			**With Mitigation**		
			Consequence	**Likelihood**	**Risk**	**Consequence**	**Likelihood**	**Risk**
Operational activities	Archaeology	Very high	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
		High	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
		Medium	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
		Low	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
	Shipwrecks	Very high	Severe	Not likely	Moderate	Moderate	Extremely unlikely	Very low
		High	Substantial	Not likely	Moderate	Moderate	Extremely unlikely	Very low
		Medium	Moderate	Not likely	Low	Slight	Extremely unlikely	Very low
		Low	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
	Graves	Very high	Extreme	Very unlikely	Low	Extreme	Extremely unlikely	Very low
	Cultural landscape	Very high	Slight	Not likely	Very low	Slight	Extremely unlikely	Very low
		High	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
		Medium	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
		Low	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
Impact 10	**Resource Type**	**Sensitivity of Study Area**	**Without Mitigation**			**With Mitigation**		
			Consequence	**Likelihood**	**Risk**	**Consequence**	**Likelihood**	**Risk**

Site closure and rehabilitation	Archaeology	Very high	Severe	Very unlikely	Low	Substantial	Extremely unlikely	Very low
		High	Severe	Very unlikely	Low	Substantial	Extremely unlikely	Very low
		Medium	Substantial	Very unlikely	Low	Moderate	Extremely unlikely	Very low
		Low	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
	Shipwrecks	Very high	Severe	Very unlikely	Low	Severe	Extremely unlikely	Very low
		High	Severe	Very unlikely	Low	Severe	Extremely unlikely	Very low
		Medium	Slight	Very unlikely	Very low	Slight	Extremely unlikely	Very low
		Low	Slight	Extremely unlikely	Very low	Slight	Extremely unlikely	Very low
	Graves	Very high	Extreme	Very unlikely	Low	Extreme	Extremely unlikely	Very low
	Built Heritage	Very high	Severe	Very unlikely	Low	Slight	Extremely unlikely	Very low
		High	Substantial	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Medium	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
		Low	Moderate	Very unlikely	Low	Slight	Extremely unlikely	Very low
	Cultural landscape	Very high	Severe	Not likely	Low	Moderate	Very unlikely	Low
		High	Substantial	Not likely	Low	Moderate	Very unlikely	Low
		Medium	Moderate	Not likely	Low	Slight	Very unlikely	Very low
		Low	Slight	Not likely	Very low	Slight	Very unlikely	Very low

6.3 Limits of Acceptable Change

The preservation of heritage resources undamaged and *in situ*, is the preferred outcome in any development scenario, and, broadly speaking, any change to the resource itself, or its setting, is likely to be negative, and therefore undesirable. Furthermore, any negative impact on a resource, be it alteration, damage, destruction or removal, can only take place with the correct permits and or permissions, as legislated in the NHRA.

These factors notwithstanding, development is necessary, particularly for socio-economic progress in a developing nation such as South Africa. Indeed, Section 38(3)(d) of the NHRA requires an assessment of the likely impacts to heritage resources relative to the sustainable social and economic benefits that will proceed from the development such that heritage officials are able to weigh pressing needs of communities against the value of local heritage resources. As such, the HIA process should determine limits of change that can be acceptable to a heritage resource, and under what circumstances that change might occur.

A study of this scope, lacking fine grained assessment of heritage resources in each study area is not well suited to addressing issues of limits of change, which are better dealt with at the impact assessment phase. Broad statements can be made, however, that should be reviewed during the impact assessment phase, and revised based on context specific observations.

6.3.1 Palaeontology

Palaeontological sites are often only identifiable as a result of development intervention in the landscape, and the vast majority of these resources, when identified, are of relatively low significance. Where fossil sites are of high heritage significance, preservation *in situ* or mitigation through collection should take place, while moderately significant sites can simply be recorded during the heritage assessment.

As palaeontological sensitivity is predicated on the occurrence of fossil-bearing geological substrates, as illustrated in the SAHRIS Palaeosensitivity Map (SAHRA 2014) and the exposure of these, either naturally in the landscape, or through development-related activities, their presence and degree of sensitivity is spatially variable.

According to Orton (2016) “[u]nacceptable change would apply if those exposed geological sections / palaeontological sites set aside for *in situ* preservation…are damaged or disturbed, or if sites that require mitigation are disturbed prior to that mitigation being effected. Of necessity, palaeontological heritage resources that do not have formal protections (declaration or grading) in place, or that have not been identified during earlier assessments, can only be identified at the EIA Phase. Only then could the number of sites requiring further attention be delineated for any particular area. Formally recognised geological heritage sites and meteorites are very rare in comparison to other types of heritage. While meteorites can be recorded, collected and housed in a museum, geological sites and palaeontological type localities derive their meaning from their location and can therefore not be adequately mitigated; their destruction would be unacceptable unless equally good equivalents can be designated.

6.3.2 Archaeology

Much like the palaeontology, most archaeological heritage sites are of sufficiently low heritage significance that recording them during the HIA phase is sufficient as a means of mitigation. Further, sites without formal protection in the form of grading or declaration, or in areas as yet unsurveyed by a specialist, can only be identified during the HIA process, and, as such, their quantity, distribution and significance can only be determined then.

Significant sites, however, should preferably be conserved *in situ*, and unacceptable change would result from the disturbance of such sites prior to mitigation, or their destruction without mitigation.

6.3.3 Shipwrecks

Shipwrecks are, by virtue of their location underwater or on the immediate coastline, constantly susceptible to change. However, in each case, the specifics of their location have served to preserve whatever of their structure remains intact. Further to this, full recording of submerged heritage is very expensive and time-consuming, while the conservation of material retrieved from wrecks can pose an ongoing expense. For these reasons, avoidance and *in situ* preservation is preferable, and no change should be considered acceptable in the case of shipwrecks.

6.3.4 Graves

All graves are of high heritage significance, and should be conserved *in situ* wherever possible. No change to graves without adequate mitigation can be permitted, and this will require consultation with SAHRA, in terms of Section 36 of the NHRA, as well as public participation, and appropriate relocation (Section 36(4)). Where graves are identified as part of a Section 38 process, and cannot be moved, or where unavoidable disturbance of unmarked graves occurs during development activities, exhumation of such graves may be acceptable, provided that the necessary process has been followed in terms of Section 38.

6.3.5 Built heritage

Built heritage resources can tolerate little change, as they are such visible and accessible resources. Furthermore, mitigation, particularly of high significance resources is very difficult, and usually very expensive. Those built heritage resources in poor condition, of which there are many, particularly in rural areas can, of course, benefit from adaptive reuse or renovation, or are simply not repairable, in which case demolition might be acceptable. Preliminary grading during the HIA field survey is, therefore, essential in order to determine the relative approach appropriate for each feature.

6.3.6 Cultural landscapes

Cultural landscapes are susceptible to loss of integrity, authenticity and sense of place through inappropriate development interventions. The extent of this degradation is context specific, often subjective, and cannot be quantified or calculated at such a broad level of study. In certain cases, existing and enduring cultural landscape patterns - e.g. agricultural and settlement typologies and configurations – lend a particular 'texture' and 'grain' to places. Development interventions within such landscapes should endeavour to interpret and respond with an appropriate fit within such contexts.

Recognizing and acknowledging the dynamic quality of cultural landscapes - in that places change over time (some features endure, certain patterns resonate; others fade, many vanish); and that development is at times necessary (and even desirable) for the continued vitality of places; it is important to identify, protect, enhance and integrate cultural landscape qualities and attributes which contribute significant value to the character of landscape and lend meaning to the interpretation of place (D. Gibbs, David Gibbs Landscape Architect, pers.comm., 24 October 2017). Depending on scale and intensity, 'continuing' cultural landscapes could potentially accommodate responsible development interventions more readily than 'relict' cultural landscapes, which (by definition) would be less resilient to change.

Broadly, however, intrusions on the landscape that dominate it visually should not be considered acceptable in moderate to high sensitivity cultural landscapes, and visual analyses will be useful here to determine viewsheds, buffers and mitigatory measures in order to reduce the degree of intrusion as appropriate. Any interventions in declared and protected cultural landscapes should be avoided.

With regard to the highly complex matter of living heritage, Orton (2016) says the following: "[b]ecause of its intangible nature, most living heritage should survive in the face of development. However, with large-scale population influx, new cultural traditions could arrive and possibly influence the degree to which local traditions continue to be practised…Unacceptable change would occur should local traditions, practices and customs be abandoned or forced out in favour of non-local ones. The addition of a new living heritage layer would not be unacceptable though. The irreparable damage to a place that has strong associations with living heritage…would also be regarded as unacceptable change.

6.3.7 No-go areas

Where no-go areas and buffers have been implemented across the study areas, as represented in each sensitivity map per area, these apply only to visible and known heritage resources, and should be revised during the HIA process. No-go areas and buffers are only required where resources are to be preserved *in situ*, but where this is the appropriate and recommended mitigation method, might apply even to heritage resources of relatively low significance.

Buffers have been determined according to the relative significance of the heritage resources they protect, taking into consideration the buffers usually imposed by the heritage authorities for different resources and degrees of significance. The results of the field assessment during the HIA process will provide significance ratings for all identified sites, which will allow them to be afforded buffers in accordance with the table below (Table 13), and as implemented in this report.

Many resources, particularly archaeological heritage resources, may enjoy further protection from buffers gazetted in terms of different legislation, such as the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA), in buffers provided by riparian areas (500 m), wetlands (1 km) and other natural features (MPRDA, No 28 of 2002, Regulation 2015).

Table 13. Buffers for no-go areas

Category	Sensitivity rating	Applicable Buffer
National and Provincial Heritage Sites, Grades I & II Buffers should extend from the edge of the declared area	Very high	1 km buffer
Graves and graveyards These hold the significance of a Grade IIIa resource, but are usually subjected to different buffer requirements	Very high	20 m buffer from fence line Fence line to be 5 m from visible (outer) graves
Grade IIIa sites	High	100 m buffer
Grade IIIb sites, where these are to be preserved *in situ*	Medium	50 m buffer
Grade IIIc sites and ungraded sites, where these are to be preserved *in situ*	Low	25 m buffer

7 BEST PRACTICE GUIDELINES AND MONITORING REQUIREMENTS FOR HERITAGE

7.1 Planning phase

While the scope of this assessment is extensive, each area proposed for development can be dealt with discretely, during later, site specific development applications. All project areas, barring five freshwater areas, fall within the boundaries of a single province, which reduces the complexity of the heritage application process. For all aquaculture applications in the Northern Cape, North West, Gauteng, Limpopo, Mpumalanga and Free State provinces, as is currently the case, SAHRA will be the commenting authority on archaeological and palaeontological matters, with the PHRAs providing input on matters of built heritage and cultural landscapes. Further to this, SAHRA's maritime unit will be the responsible authority for all near and offshore developments.

To reduce complexity as far as possible, we propose that SAHRA, with the input from relevant PHRAs, be the commenting authority for all Aquaculture projects proposed within all study areas. Where developments fall within areas with PHRAs that are competent to comment on applications in terms of Section 38 of the

NHRA (in whole or part), a Memorandum of Understanding (MoU) should be put in place between SAHRA and the relevant PHRA. The MoUs will lay out the terms by which PHRAs submit their comments to SAHRA for collation into a single, integrated comment. The affected study areas that will require these MoUs comprise four marine areas and one freshwater area within the Western Cape, two marine areas and one freshwater area in the Eastern Cape, and one marine, one freshwater area in KZN. This system will facilitate a unified and consistent approach that reduces bureaucracy, and ensures that no developments are unfairly prejudiced by the area in which they are located. This system further removes complexity from the five freshwater areas that span provincial boundaries, particularly where one of the affected provinces has a PHRA with designated competence in Section 38 and/or 35, as in the Vanderkloof-Gariep area (Eastern Cape Provincial Heritage Resources Authority - ECPHRA) and Free State-KZN Highlands area (Amafa).

Special effort should be made to ensure that the relevant conservation bodies in each area are notified of the outcomes of this assessment and the proposed developments within their areas of interest. Such bodies, in terms of Section 25(1)b should be registered with the relevant PHRA, and their geographic area of interest, and category of heritage interest captured.

A crucial step in the planning phase of aquaculture development must be the consultation of the available heritage resource management tools (SAHRA 2014, 2017; Wrecksite 2017). Palaeontologically sensitive geological strata are provided on the SAHRA Palaeosensitivity Map (SAHRA 2014), while known or formally protected archaeological, grave and built environment sites are viewable on SAHRIS (SAHRA 2017), as is illustrated through the site location maps in this chapter. The SAHRA Maritime Unit maintains a database of known shipwrecks, and this can be released to the public where information is not already listed on SAHRIS (SAHRA 2017) or similar resources (e.g. Wrecksite 2017. Appropriate, proactive use of these resources can provide sufficient basis for the Heritage Authorities to determine that further heritage studies are not necessary in a given area if, for instance, the area is highly disturbed, if sufficient previous work has been conducted in the area to characterise it adequately, or if it can be shown that no significant heritage resources are likely to occur in the area. Further to this, developments proposed for areas that are already zoned for development, such as IDZs, will benefit from the heritage pre-screening that such areas have been subjected to, and can thus expect to have the heritage process pertaining to their application waived, making the selection of these sites preferable.

Due to the high level and broad scope of this study, it is recommended that site specific screening assessments are conducted before any development proceeds in a moderate to very high sensitivity area. This more fine grained assessment will be able to flag more accurately, whether an HIA is required for a given development area. This planning phase should also address issues of possible cumulative impacts caused by the proposed development in relation to existing and planned activities within the area, whether these are further aquaculture developments or other types of agricultural or industrial changes to the landscape.

Heritage assessments that consider all potentially sensitive heritage resources within a proposed development area will need to be compiled in terms of Section 38(3) of the NHRA where requested by the relevant heritage authorities. Such specialist assessments will need to focus particularly on those areas flagged in this exercise as underexplored, particularly cultural landscapes and living heritage.

Archaeological field surveys will necessarily form part of these HIAs as the scoping exercises and the present broad scope of this assessment cannot be expected to identify all resources within heritage sensitive areas. With few exceptions (e.g. mined-out areas in Namaqualand), the locations of shore-based and inland infrastructure will need to be ground-truthed by an archaeologist and/or palaeontologist.

The bio-cultural diversity of many of these study areas is likely to be high and therefore hold significance to the local inhabitants who have lived there for many generations (E. Bailey, Hearth Heritage, pers.comm. 20 October 2017). This diversity in bio-cultural relationships has been internationally recognised as significant and worthy of conservation and would need to be considered and thoroughly researched through public consultation and inclusion in development decisions.

7.2 Construction phase

The construction phase will pose the greatest risk to heritage resources in the landscape. This threat can be minimised through strict adherence to management and mitigation requirements as specified in the Environmental Authorisation (EA) and EMP.

Micro-siting should be undertaken to ensure that sensitive heritage resources and their protective buffer zones can be avoided. The anchor points of all marine infrastructure will need to be considered by an underwater archaeologist to determine the likelihood of wrecks being impacted and hence the need for further studies. Visual considerations will need to be taken into account in terms of the disruption of significant cultural landscapes and the proximity of aquaculture facilities to important visually sensitive heritage sites (e.g. historic buildings and rock art sites).

Monitoring, by a suitably experienced archaeologist, should be undertaken where this has been stipulated. Any changes to the EA that result in proposed disturbance of moderate to high sensitivity areas, not previously subject to heritage surveys, must be assessed before development takes place.

7.3 Operations phase

The above recommendations for the construction phase apply in the operational phase as well. In addition to monitoring ongoing activity on site, the appointed ECO should regularly check such heritage resources as occur within the development footprint that have been conserved *in situ*, whether these are buffered or not, and whether they have suffered any degradation. Furthermore, a marine archaeologist should be allowed to inspect any near- and offshore facilities where sensitivity has been identified on an annual basis to ensure that submerged heritage resources are not being negatively impacted by underwater infrastructure.

7.4 Rehabilitation and post closure

Again, adherence to the terms and plans of the EA are paramount to ensure no new disturbance is caused to areas not previously assessed. Any new disturbances will need to be assessed by the relevant heritage practitioner prior to any activities taking place at those locations.

7.5 Monitoring requirements

All monitoring requirements should be understood in conjunction with the limits of acceptable change described above in section 6.3, and should be conducted to ensure that the conditions listed in the EA are appropriately observed.

Monitoring requirements presented below (Table 14) should be considered as guidelines only, and should be subject to review on a case-by-case basis to refine frequency of inspection and other aspects.

Not all monitoring needs necessarily to be undertaken by an archaeologist, and some could be handled by the ECO, or, in some instances, a specifically designated monitor could receive training in certain aspects of on-site heritage monitoring and management. All monitoring reports will need to be lodged with SAHRA by means of uploading to SAHRIS.

Table 14. Proposed heritage monitoring guidelines *(adapted from Orton et al. 2016)*

Objectives	Methodology	Phase	Responsibility
Construction and Operational Phases			
Avoid any direct or indirect damage to heritage resources flagged for mitigation prior to development	Ensure that the conditions of any Records of Decision (RoD) issued by the heritage authorities have been complied with	Prior to development	ECO
	Obtain approval from heritage authorities prior to commencement of activities	Prior to development	ECO
Avoid any direct or indirect damage to heritage resources to be protected *in situ*	Establish and observe buffers and no-go areas	Prior to commencement of activities on site	ECO/heritage monitor
	Mark all buffers and no-go areas on development and site plans	Prior to commencement of activities on site	ECO/heritage monitor
	Monitoring to ensure buffers are observed	Weekly during site establishment and construction phases, 6-monthly during operational phase	ECO/heritage monitor
Avoid any direct or indirect damage to heritage resources not identified at EIA Phase	Undertake monitoring of such development activities as might disturb any undetected heritage resources, as recommended in the HIA	Daily or as and when required during works in high sensitivity areas as recommended in the HIA	Archaeologist
Identification, protection and rescue of buried palaeontological resources	Undertake monitoring of such excavations and similar activities as might disturb any palaeontological resources, as recommended in the HIA	Daily in areas of high sensitivity and/or areas of intense activity	Palaeontologist
		Weekly/bi-weekly as recommended in the HIA for areas of lower sensitivity and/or impact	Palaeontologist/ ECO with relevant training
Closure and Rehabilitation Phases			
Avoid any direct or indirect damage to heritage resources to be protected *in situ*	Establish and observe buffers and no-go areas	Prior to commencement of rehabilitation activities on site	ECO/Heritage monitor
	Mark all buffers and no-go areas on development and site plans	Prior to commencement of rehabilitation activities on site	ECO/Heritage monitor
	Monitoring to ensure buffers are observed	Weekly during site rehabilitation	ECO/Heritage monitor

The vast majority of open archaeological sites that might be encountered would likely not require *in situ* conservation, although this is obviously the most desirable option. Archaeological mitigation is likely to be relatively easily accomplished, although in coastal contexts the possibility of extensive and time consuming excavations should be borne in mind.

8 GAPS IN KNOWLEDGE

The broadness of the scope of this assessment means that there are fairly extensive gaps in knowledge. Generally these can be linked to two factors:

1. No field survey work or public participation has been done for this heritage resources study, so all inferences are based on known heritage resources in the area. This knowledge is derived from the experience of the contributing authors, which is invaluable, but also on the resources as captured and mapped on SAHRIS, and the accuracy of this data is not always certain.
2. The locations and types of infrastructure, broadly, are not known at the level of this assessment, which limits our ability to pinpoint impacts per development type, per area and per resource.

Further to these two broad issues, specific concerns were raised with regard to several issues. These are addressed below:

3. From a paleontological point of view, the lack of access to the 1:250 000 scale geology maps has challenged the team's ability to make any meaningful assessment of potential impacts and recommendations for future action. The latter, higher-resolution maps are those that are required for standard palaeontological impact assessments as many critical rock formations have small outcrop areas that may not be reflected in the 1: 1 million scale maps. This limitation would need to be addressed through site specific impact assessment at the EIA level.
4. Any cultural landscape assessments are hampered by the size of the study areas, which are too large for a 'blanket' cultural landscape description for each; and although cultural landscapes may be defined at various scales, they are easier to assign a 'sense of place' description at a more local level. Therefore, while it is arguable that any anthropogenic landscape is a 'cultural landscape', though of varying degrees of significance, it is not possible to define landscape character qualities at this scope.
5. Similarly, the scale of the study is too broad to capture individual significant and sensitive built heritage elements, particularly where those are located outside of towns. The study therefore lacks the resolution to determine the nature of the built environment in each study area and the requisite management and mitigatory measures necessary to ensure the protection and conservation of structures in the landscape.
6. The shipwreck data are particularly limited, and especially so on SAHRIS. Not all wrecks are captured to the system, and location data are often unknown, unverified, and/or inaccurate. Again, the absence of a specialist on the team precluded us from refining the information available and presented here.

In conclusion, it is clear that the gaps in knowledge are extensive. Appropriate use of the available heritage management resources (SAHRA 2014, 2017; Wrecksite 2017) can go some way to addressing these gaps through providing the tools to screen out areas of high heritage sensitivity, and identify areas where further heritage studies might not be required.

To mitigate the existing gaps further, however, general heritage surveys will be necessary once development sites are identified, where the development sites are located in areas of high heritage sensitivity. This determination of high heritage sensitivity will, necessarily be made during the EIA phase, once site specific infrastructure footprints have been determined. Specific heritage assessments will also be required at the EIA level by landscape specialists in areas flagged as significant cultural landscapes. Within areas of moderate to very high palaeontological sensitivity, a desktop assessment will be necessary to refine the scale of analysis presented here and flag the potential need for a field assessment or monitoring during excavation work. Further to this, specific desktop assessment by a maritime archaeologist should be undertaken for all proposed near- and offshore developments in coastal areas flagged as high sensitivity for wrecks. It is likely, however, that to determine any wreck's position relative to proposed infrastructure, and certainly their condition and vulnerability to damage, site inspection by a maritime archaeologist would be necessary.

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Appendix to Archaeology, Palaeontology and Cultural Heritage Specialist Assessment

CONTENTS

FIGURES

1 DEFINITIONS - EXTRACTS FROM SECTIONS 2 AND 3 OF THE NATIONAL HERITAGE RESOURCES ACT (NO. 25 OF 1999)[1]

2 IN THIS ACT, UNLESS THE CONTEXT REQUIRES OTHERWISE—

(ii) "archaeological" means—

(a) material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures;

(b) rock art, being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10 m of such representation;

(c) wrecks, being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the Republic, as defined respectively in Sections 3, 4 and 6 of the Maritime Zones Act, 1994 (Act No. 15 of 1994), and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation; and (d) features, structures and artefacts associated with military history which are older than 75 years and the sites on which they are found;

(vi) "cultural significance" means aesthetic, architectural, historical, scientific, social, spiritual, linguistic or technological value or significance; (viii) "development" means any physical intervention, excavation, or action, other than those caused by natural forces, which may in the opinion of a heritage authority in any way result in a change to the nature, appearance or physical nature of a place, or influence its stability and future well-being, including —

> (a) construction, alteration, demolition, removal or change of use of a place or a structure at a place;
>
> (b) carrying out any works on or over or under a place;
>
> (c) subdivision or consolidation of land comprising, a place, including the structures or airspace of a place;
>
> (d) constructing or putting up for display signs or hoardings;
>
> (e) any change to the natural or existing condition or topography of land; and
>
> (f) any removal or destruction of trees, or removal of vegetation or topsoil;

(xiii) "grave" means a place of interment and includes the contents, headstone or other marker of such a place, and any other structure on or associated with such place;

(xvi) "heritage resource" means any place or object of cultural significance;

(xvii) "heritage resources authority" means the South African Heritage Resources Agency, established in terms of Section 11, or, insofar as this Act is applicable in or in respect of a province, a provincial heritage resources authority;

(xviii) "heritage site" means a place declared to be a national heritage site by SAHRA or a place declared to be a provincial heritage site by a provincial heritage resources authority;

(xxi) "living heritage" means the intangible aspects of inherited culture, and may include —

> (a) cultural tradition;
>
> (b) oral history;
>
> (c) performance;

1 Only definitions relevant to the present Chapter are listed.

(d) ritual;

(e) popular memory;

(f) skills and techniques;

(g) indigenous knowledge systems; and

(h) the holistic approach to nature, society and social relationships;

(xxv) "meteorite" means any naturally-occurring object of extraterrestrial origin;

(xxvii) "national estate" means the national estate as defined in Section 3;

(xxxi) "palaeontological" means any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace;

(xxxii) "place" includes —

(a) a site, area or region;

(b) a building or other structure which may include equipment, furniture, fittings and articles associated with or connected with such building or other structure;

(c) a group of buildings or other structures which may include equipment, furniture, fittings and articles associated with or connected with such group of buildings or other structures;

(d) an open space, including a public square, street or park; and

(e) in relation to the management of a place, includes the immediate surroundings of a place;

(xxxvii) "provincial heritage resources authority", insofar as this Act is applicable in a province, means an authority established by the MEC under Section 23;

(xxxviii) "public monuments and memorials" means all monuments and memorials —

(a) erected on land belonging to any branch of central, provincial or local government, or on land belonging to any organisation funded by or established in terms of the legislation of such a branch of government; or

(b) which were paid for by public subscription, government funds, or a public-spirited or military organisation, and are on land belonging to any private individual;

(xiii) "site" means any area of land, including land covered by water, and including any structures or objects thereon;

(xivl) "structure" means any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith;

National estate

3. (1) For the purposes of this Act, those heritage resources of South Africa which are of cultural significance or other special value for the present community and for future generations must be considered part of the national estate and fall within the sphere of operations of heritage resources authorities.

3. (2) Without limiting the generality of Subsection (1), the national estate may include —

(a) places, buildings, structures and equipment of cultural significance;

(b) places to which oral traditions are attached or which are associated with living heritage;

(c) historical settlements and townscapes;

(d) landscapes and natural features of cultural significance;

(e) geological sites of scientific or cultural importance;

(f) archaeological and palaeontological sites;

(g) graves and burial grounds, including —

(i) ancestral graves;

(ii) royal graves and graves of traditional leaders;

(iii) graves of victims of conflict;

(iv) graves of individuals designated by the Minister by notice in the Gazette;

(v) historical graves and cemeteries; and

(vi) other human remains which are not covered in terms of the Human Tissue Act, 1983 (Act No. 65 of 1983);

(h) sites of significance relating to the history of slavery in South Africa;

(i) movable objects, including —

(i) objects recovered from the soil or waters of South Africa, including archaeological and palaeontological objects and material, meteorites and rare geological specimens;

(ii) objects to which oral traditions are attached or which are associated with living heritage;

(iii) ethnographic art and objects;

(iv) military objects;

(v) objects of decorative or fine art;

(vi) objects of scientific or technological interest; and

(vii) books, records, documents, photographic positives and negatives, graphic, film or video material or sound recordings, excluding those that are public records as defined in Section 1(xiv) of the National Archives of South Africa Act, 1996 (Act No. 43 of 1996).

3. (3)Without limiting the generality of Subsections (1) and (2), a place or object is to be considered part of the national estate if it has cultural significance or other special value because of —

(a) its importance in the community, or pattern of South Africa's history;

(b) its possession of uncommon, rare or endangered aspects of South Africa's natural or cultural heritage;

(c) its potential to yield information that will contribute to an understanding of South Africa's natural or cultural heritage;

(d) its importance in demonstrating the principal characteristics of a particular class of South Africa's natural or cultural places or objects;

(e) its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;

(f) its importance in demonstrating a high degree of creative or technical achievement at a particular period;

(g) its strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;

(h) its strong or special association with the life or work of a person, group or organisation of importance in the history of South Africa; and

(i) sites of significance relating to the history of slavery in South Africa.

3 SCOPE OF THIS STRATEGIC ISSUE

3.1 Heritage Resources

3.1.1 Palaeontological and geological sites and resources, and meteorites (S35 of the NHRA)

Palaeontological resources are defined in Section 2 of the NHRA as "fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace", while meteorites are described in the same section as "any naturally-occurring object of extraterrestrial origin".

3.1.2 Archaeological and palaeoanthropological sites and resources (S35 of the NHRA)

These resources are described in Section 2 of the NHRA as "material remains resulting from human activity which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures".

3.1.2.1 Rock art (S35 of the NHRA)

Rock art is described in the NHRA as "being any form of painting, engraving or other graphic representation on a fixed rock surface or loose rock or stone, which was executed by human agency and which is older than 100 years, including any area within 10m of such representation".

3.1.3 Shipwrecks (S35 of the NHRA)

Wrecks are described in the NHRA as "being any vessel or aircraft, or any part thereof, which was wrecked in South Africa, whether on land, in the internal waters, the territorial waters or in the maritime culture zone of the Republic, as defined respectively in sections 3, 4 and 6 of the Maritime Zones Act, 1994 (Act No. 15 of 1994), and any cargo, debris or artefacts found or associated therewith, which is older than 60 years or which SAHRA considers to be worthy of conservation".

3.1.4 Burial grounds and graves (S36 of the NHRA)

According to Section 2 of the NHRA, graves are understood to mean "a place of interment and includes the contents, headstone or other marker of such a place, and any other structure on or associated with such place"

3.1.5 Built heritage (S34 of the NHRA)

Built heritage, or built environment is constituted of structures, defined in S2 of the NHRA as "any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith". For the purposes of this assessment, built environment is also taken to mean groups of structures, such as towns and farmsteads.

3.1.6 Cultural Landscapes (part of the National Estate)

This term is not defined in the NHRA, but "landscapes and natural features of cultural significance;" are included as heritage resources listed as part of the National Estate (S3(2)d). They are defined in the Operational Guidelines for the Implementation of the World Heritage Convention as the "'combined works of nature and of man'…illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal" (United Nations Educational, Scientific and Cultural Organisation 2012).

While living heritage is defined in the Act, it is not subject to any form of protection, although the places associated with living heritage do enjoy protection (S3(2)(b)), and are therefore included under the topic of cultural landscapes for the purpose of this assessment. Living Heritage is defined in the Act (S2(xxi)) as meaning "the intangible aspects of inherited culture, and may include —

(a) cultural tradition;

(b) oral history;

(c) performance;

(d) ritual;

(e) popular memory;

(f) skills and techniques;

(g) indigenous knowledge systems; and

(h) the holistic approach to nature, society and social relationships".

4 PALAEONTOLOGY REPORTS

4.1 Freshwater Study Areas

4.1.1 Freshwater Study Area 1 - Limpopo

4.1.1.1 Topography

The main drainage systems in this study area are the Limpopo River and its tributaries in the north, and most notably the Sandrivier flowing through the central part of the area which transects the prominent west-east trending Soutpansberg ridge via a narrow poort. Low relief terrain to the north of the Soutpansberg range is assigned to the Eastern Limpopo Flats, with the more elevated Polokwane Plain lying to the south (Partridge *et al*. 2010). Towards the east this plain is separated from the Lowveld (e.g. around Thohoyandou) by a dissected Great Escarpment zone - the Ranteveld - running to the south of Louis Trichardt (Makhado). The Lowveld is drained by the Luvuvhu and other east-flowing rivers.

4.1.1.2 Geology

The geology of the Limpopo study area is covered by 1: 250 000 scale geology maps 2228 Alldays, 2230 Musina, 2328 Polokwane, 2330 Tzaneen and 2428 Modimolle (Council for Geoscience, Pretoria) (Brandl 1981, 1986, 1987, 2002, Bullen et al. 1995, Ehlers & Du Toit 2002). A large portion of the area is underlain by very ancient (Archaean) Precambrian basement such as granites, greenstones and various high grade metamorphic rocks. These rocks form part of an ancient continental block, the Kaapvaal Craton. They are up to 3.6 billion years old and in many cases are highly deformed, e.g. within the Limpopo Belt in the northern part of the study area. The Soutpansberg range is built of younger (Proterozoic) Precambrian fluvial "red beds" that are some two billion years old and represent some of the earliest continental sediments accumulated under an oxygenated atmosphere (Barker et al. 2006). The Tshipise Basin running WSW-ESE along the northern edge of the Soutpansberg comprises several narrow, fault-bound strips of Karoo Supergroup sediments of Permian to Jurassic age. Surface exposures are limited, with much of the geological data based on borehole cores. The Karoo succession here includes a range of glacial, braided or meandering fluvial and aeolian sedimentary rocks as well as thin coal seams of Permian and Triassic age. Correlatives of the Dwyka, Ecca and Stormberg successions of the Main Karoo Basin have been recognised, but not Beaufort Group equivalents (Bordy 2006, Johnson et al. 2006). The Karoo rocks are capped by Early Jurassic volcanics of the Lebombo Group (Letaba Formation). A wide range of Late Caenozoic superficial sediments mantle the Precambrian to Mesozoic bedrocks in the Limpopo study area including colluvium, duricrusts, soils, wind-blown sands as well as pan and lake deposits. Substantial alluvial deposits are associated with major drainage lines such as the Sandrivier near Polokwane while alluvial, lacustrine and pan sediments of the Bushveld Basin and upper Limpopo catchment area are assigned to the Rooibokkraal Formation (Botha & Hughes 1992, Partridge et al. 2006).

4.1.1.3 Palaeontology

The palaeontology of the Freshwater 1 study area is very poorly covered in terms of both academic studies as well as the paucity of PIAs, even for sensitive rock units such as the Karoo Supergroup. The igneous and high grade metamorphic Precambrian basement rocks underlying most of the area are devoid of fossils. Microbial mat-related biosedimentary structures such as are known from the Waterberg Group west of the study area have not yet been recorded from the broadly co-eval Soutpansberg Group. While a range of Permian to Early Jurassic plant and animal fossils are reported from the Tchipise Basin, surface exposure of these units is often very limited and fossil records are correspondingly sparse. New coal mine excavations could contribute to supplementing the available information. Coal floras within the lower stratigraphic units (probable Ecca, Molteno and Elliot equivalents) include key Permian and Early Triassic genera such as *Glossopteris* and *Dicroidium*. The overlying fluvial and aeolian red beds (probable Elliot and Clarens equivalents) have yielded important dinosaur bones and trackways from better exposures in the Kruger Park area, east of the present study area (Bordy 2006, Groenewald & Groenewald 2014a). Late Caenozoic alluvial, lacustrine, pan and vlei deposits, often associated with drainage lines, might contain valuable vertebrate remains (e.g. mammalian teeth, bones, horn cores), trace fossils as well as plant material (e.g. wood, plant debris, palynomorphs) but have not been widely investigated. At Kalkbank, c. 64 km NW of Polokwane, a range of fossil mammals that probable date close to the Pleistocene / Holocene boundary are associated with pan calcretes and MSA stone tools (Klein 1984, Hutson & Cain 2008).

4.1.1.4 Survey coverage and limitations

The study area has only been partially surveyed, with low-density cover around the Polokwane area, and medium to low coverage around the Soutpansberg area, resulting in large open areas that have not been subjected to heritage surveys (Figure 1). However, nodes of intensive archaeological research have been conducted throughout the province, meaning that the heritage character of the area is well understood. No PIAs have been conducted in the study area.

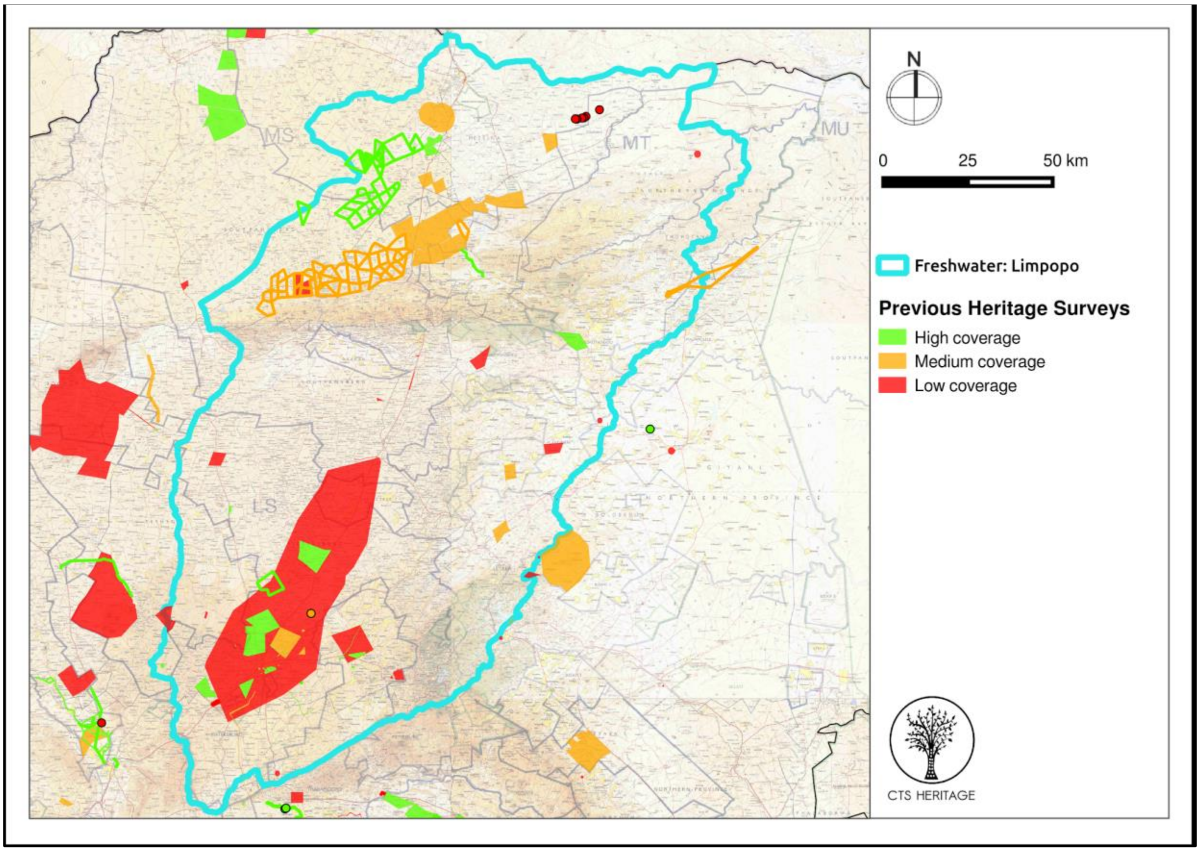

Figure 1. Limpopo previous HIAs map.

4.1.2 Freshwater Study Area 2 - Mpumalanga

4.1.2.1 Topography

This study area spans the highly-dissected Great Escarpment zone near Nelspruit. The steep, east-facing slopes of the Escarpment here form part of the Drakensberg Range, including the Makhonjwa Mountains near Barberton. The Escarpment is deeply incised by the Komati River and its tributaries such as the Crocodile and Sabie Rivers that drain the topographically subdued Lowveld region at its foot. High-lying, dissected terrain west of the escarpment edge in the northern sector of the study area is referred to the Mpumalanga Highlands. The topographically-subdued area in the southwest, near Carolina, lies within the Northeastern Highveld Region, drained by the headwaters of the Olifants and Vaal Rivers (Partridge et al. 2010).

4.1.2.2 Geology

The geology of the study area is covered by the 1: 250 000 maps 2528 Pretoria, 2530 Barberton / Nelspruit, 2628 East Rand and 2630 Mbabane (Walraven 1989a, 1989b). The geology here is highly complex, but can be broken down into a few major elements. The region below the Great Escarpment in the southeast, including part of the Barberton Mountain Land, is underlain by very ancient (c. 3.5-3.0 Ga - billion years old) Precambrian rocks of the Barberton Supergroup and surrounding granites (e.g. Kaap Vaal Pluton, Nelspruit batholith). This geologically-famous Archaean granite-greenstone belt has played an important role in understanding the formation of the earliest oceanic and continental crust, plate tectonic processes as well marine and sedimentary rocks (McCarthy & Rubidge 2005).

The Great Escarpment region and its mountainous hinterland is largely built by Precambrian (Late Archaean to Early Proterozoic) continental and marine sedimentary rocks of the Transvaal Supergroup forming the eastern edge of the Transvaal Basin (Eriksson et al. 2006). The very thick Transvaal Supergroup sedimentary succession youngs broadly towards the west. Resistant-weathering marine and fluvial quartzites of the Wolkberg Group and Black Reef Formation towards the base of the succession are exposed in the steep escarpment slopes. They are capped by thick shallow marine carbonates of the Chuniespoort Group which crop out extensively in the north-eastern part of the study area.

The overlying, highly varied series of Proterozoic sandstones, mudrocks, carbonates, ironstones and minor volcanics of the Pretoria Group were deposited in a wide range of settings, including deep to shallow marine, deltaic, lacustrine, glacial and fluvial environments (Eriksson et al. 2006). Broadly north-south trending outcrop areas of the various Pretoria Group formations underlie the majority of the central portion of the study area above the Great Escarpment. The westernmost portion of the area is underlain by two billion-year old volcanic rocks of the Rooiberg Group and associated intrusive igneous rocks of the Bushveld Complex (Buchanan 2006, Cawthorn et al. 2006).

The Precambrian bedrocks in the south-western corner of the Mpumalanga study area - around Carolina - are unconformably overlain by much younger Karoo Supergroup sediments on the north-eastern edge of the Main Karoo Basin where exposure levels are generally poor. These include small inliers of Permo-Carboniferous glacial rocks of the Dwyka Group as well as a substantial outcrop area of Middle Permian Ecca Group deltaic sediments of the Vryheid Formation (Johnson et al. 2006). The Karoo sediments are locally cut and baked by Early Jurassic dolerites of the Karoo Dolerite Suite.

A wide range of Late Caeonozoic superficial deposits overlie the Precambrian and Palaeozoic bedrocks within the study area but they have received very little geological attention and are not well-differentiated on the 1: 250 000 scale maps. They include alluvial deposits along major water courses and in topographic depressions above the escarpment (e.g. overlying the Silverton Formation outcrop area), scree and well-developed alluvial fans in the Escarpment zone, downwasted surface gravels and soils, among others.

4.1.2.3 Palaeontology

This study area is poorly known in palaeontological terms, and very few field-based palaeontological impact assessments have been undertaken here. Archaean igneous rocks below the Escarpment as well as those of the Early Proterozoic Bushveld Complex and associated Rooiberg Group volcanics in the westernmost portion of the study area are unfossiliferous. However, important examples of early Precambrian (Archaean,

c. 3.5-3.2 Ga) stromatolites and bacterial microfossils have been reported from silicified horizons within the Onverwacht and Fig Tree Groups of the Barberton Supergroup (Schopf 2006). Most of the records are associated with cherty rather than carbonate facies. The biological origins of some, albeit not all, of these claimed fossils, including the stromatolite-like forms, has been subsequently questioned (Altermann 2001, Brasier et al. 2006). Supposed microbial endolithic borings reported from the glassy margins of pillow lavas within the 3.4 Ga Onverwacht Group (Furnes et al. 2004, Banerjee et al. 2006) have recently been reinterpreted as abiogenic mineral structures generated during cooling of the host rocks (Grosch & McLoughlin 2014). Minor stromatolites have been recorded from the Wolkberg Group in Limpopo Province and from possible correlatives of the Black Reef Formation in the Northern Cape, but are not so far known from these horizons in Mpumalanga (cf Button 1973).

The overlying Chuniespoort Group (Malmani Subgroup) platform carbonates host a variety of stromatolites (microbial laminites), ranging from supratidal mats to intertidal columns and large subtidal domes. These biosedimentary structures are of biostratigraphic as well as palaeoecological interest. For example, the successive Malmani dolomite formations are in part differentiated by their stromatolite biotas (e.g. Truswell and Eriksson 1972, 1973, and 1975, Schopf 2006 and Eriksson et al. 1993, 2006, among others). Microbial filaments and unicells have been reported from stromatolites of the Transvaal Supergroup. Several shallow marine to lacustrine carbonate horizons, as well as some siliciclastic sediments, within the Early Proterozoic Pretoria Group have likewise yielded stromatolites and organic-walled microfossils (e.g. Timeball Hill, Daspoort and Silverton Formations). Fossil microbial mat structures are reported from near-coastal sediments of the Magaliesberg Formation.

The Vryheid Formation is internationally famous for its Middle Permian fossil plants of the Glossopteris Flora of Gondwana (e.g. Plumstead 1969, 1973, Anderson & Anderson 1985, MacRae 1999, McCarthy & Rubidge 2005, Johnson et al. 2006, Prevec 2016) and its palaeosensitivity is therefore generally rated as Very High (Groenewald & Groenewald 2014b). Rich plant fossil assemblages - most notably well-preserved compression fossils preserved within shaley facies between coal seams - include rare mosses, lycopods and ferns (sphenophytes and others) as well as abundant and diverse representatives of the glossopterid “seed ferns”, cordaitaleans, conifers and ginkgoales. Other fossil groups represented include diverse palynomorph assemblages (spores and pollens), leaf cuticles, algae, low-diversity non-marine trace fossils and sparse invertebrate faunas (e.g. non-marine bivalves, insects, conchostracan crustaceans). Vertebrate fossils are very poorly represented, comprising disarticulated fish remains (e.g. scales) as well as unsubstantiated reports of occasional “labyrinthodont” amphibians. Thin coals and vascular plant fossils occur widely within the Vryheid outcrop area on the Barberton and Mbabane 1: 250 000 sheets (Walraven 1989a, 1989b, Rubidge 2014, Millsteed 2016a, 2016b).

Late Caenozoic superficial deposits of the Mpumalanga Drakensberg region are poorly studied in palaeontological terms but may contain local concentrations of fossil vertebrate, invertebrate and plant remains as well as trace fossils (e.g. mammalian bones, teeth, horn cores, freshwater or terrestrial molluscs, coalified wood, palynomorphs, calcretised root casts and termitaria) (cf Brink et al. 1999, Brink & Rossouw 2000, Churchill et al. 2000). Key fossiliferous facies are mostly associated with extant or defunct drainage lines and include older consolidated alluvium and terrace gravels, lake, pan and vlei deposits. Any caves generated by karstic (solution) weathering within the “Transvaal Dolomite” outcrop area along the Escarpment (Malmani Subgroup) might be associated with fossiliferous cave breccias (e.g. bones and teeth of Pleistocene mammals) (cf Klein 1984).

4.1.2.4 Survey coverage and limitations

The study area has only been partially surveyed with several clusters of surveys of medium and low coverage and a few small areas with high coverage surveys (Figure 2 and Figure 3). Large areas have not been subjected to heritage surveys, probably due to the fact that no developments occurred in these areas which consist of private farm land. However, nodes of intensive archaeological research have been undertaken throughout the province, meaning that the heritage character of the area is well understood.

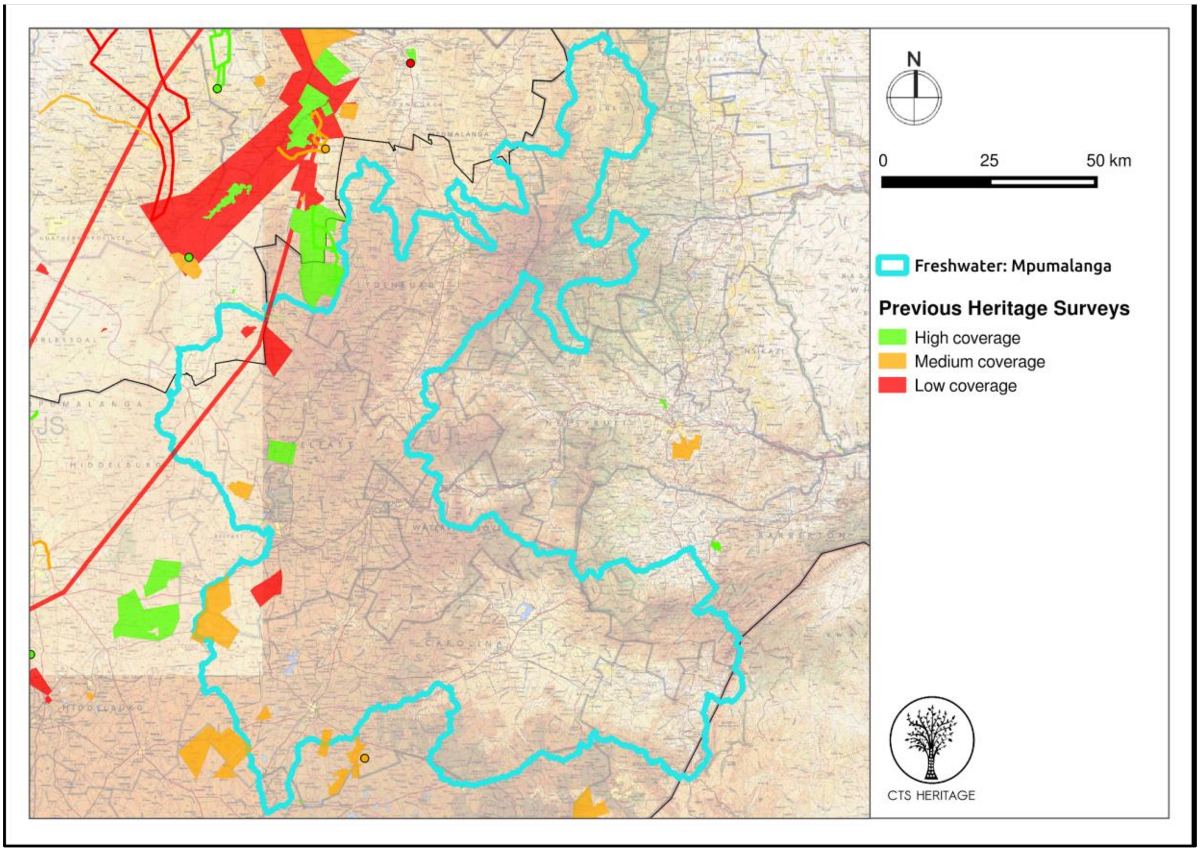

Figure 2. Mpumalanga previous HIAs map.

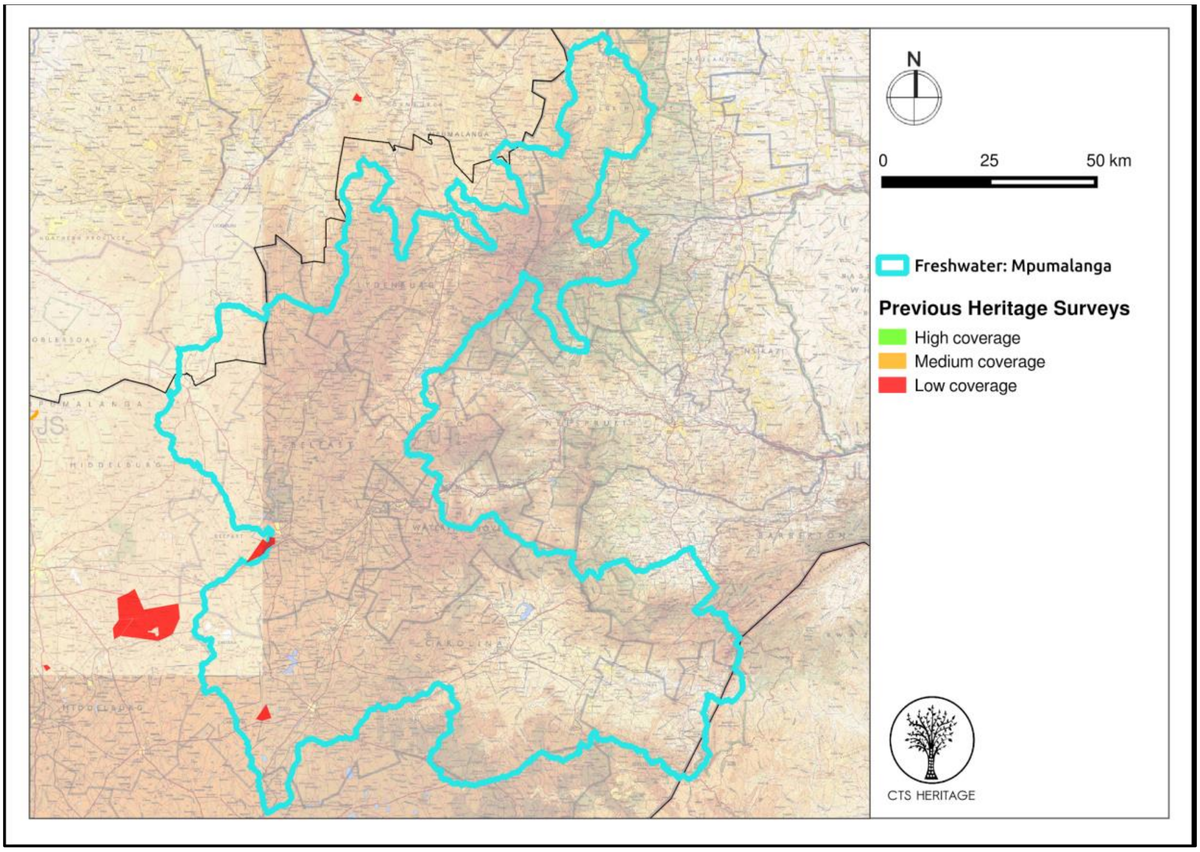

Figure 3. Mpumalanga previous PIAs map.

4.1.3 Freshwater Study Area 3 – Gauteng-North West

4.1.3.1 Topography

This study area belongs to several geomorphic provinces, including the topographically-subdued NW and NE Highveld in the south, the mountainous Bankenveld (or Ranteveld) in the centre, which runs approximately W-E between Zeerust and Pretoria, and the West Transvaal Basin lying to the north of these uplands (Partridge et al. 2010). The upturned, arcuate rocky rim of the Vredefort Dome lies along the southern edge of the study area. North of this the more readily-weathered bedrocks of the Transvaal Supergroup (e.g. Transvaal dolomites) generate gentler, hilly country drained by the Vaal River and its tributaries (e.g. Mooirivier). North of Krugersdorp tough Precambrian metasediments build the east-west Witwatersrand ridge. A sinuous band of resistant-weathering, quartzitic bedrocks of the Pretoria Group build the rugged uplands of the Magaliesberg and Swartruggens ranges, with their stepped series of dissected, south-facing escarpments (Ranteveld). Gentler terrain to the northeast of the Magaliesberg, which is underlain by igneous rocks of the Bushveld Complex and related granites, is drained by the Crocodile River. The subdued terrain of the Marico region north of the Swartruggens reflects readily-weathered mudrock-dominated bedrocks of the Pretoria Group; this bushveld region is drained to the north by the Marico River and its tributaries.

4.1.3.2 Geology

Most of the Gauteng-Northwest study area is outlined on 1: 250 000 geological sheets 2526 Rustenburg (Walraven 1981) and 2626 West Rand, with very small portions overlapping sheets 2524 Mafikeng and 2726 Kroonstad (Council for Geoscience, Pretoria). The highly complex geology of the area spans over three billion years of Earth history and a wide spectrum of igneous, metamorphic and sedimentary geological units. It will only be treated in outline here with brief mention of the most important rock units, the great majority of which are Precambrian in age (cf McCarthy & Rubidge 2005 for details).

The oldest bedrocks are Archaean (early Precambrian) granites and minor basic igneous rocks representing primordial continental and oceanic crust of the Kaapvaal Craton (ancient continental block). These "Swazian" granites and greenstones crop out in the Vredefort and Johannesburg Domes and near Ventersdorp. They are overlain in the same areas by 3 Ga (billion year-old) volcanic and fluvial rocks of the Dominion Group which were deposited in fault-bound basins, reflecting early crustal stretching and incipient rifting of the Kaapvaal continental crust (Marsh 2006). The following thick sedimentary pile of the Witwatersrand Supergroup was laid down in a range of marine shelf, fluvial and even glacial settings between 2.9 and 2.7 Ga (McCarthy 2006). Resistant-weathering quartzites and banded ironstones of this sequence build the Witwatersrand ridge north of Randfontein. Collision-related fracturing and faulting of the Kaapvaal crust around 2.7 Ga led to the eruption of huge volumes of lava intercalated with subordinate fluvial and lacustrine sediments (Van der Westhuizen et al. 2006). These Archaean Ventersdorp Group rocks crop out around the edges of the Vredefort Dome and near Ventersdorp itself. Widespread subsidence and eventual drowning of the craton by shallow shelf seas resulted in deposition of fluvial to shallow marine quartzites (Black Reef Formation) followed by a huge thickness of carbonate sediments with minor cherts and mudrocks (Chuniespoort Group of the Transvaal Supergroup) (Eriksson et al. 1993, 2006). These "Transvaal dolomites" underlie large parts of the south-central portion of the study area. The upper part of the Transvaal Supergroup succession, known as the Pretoria Group, includes a wide spectrum of Early Proterozoic sedimentary rocks laid down in shallow marine, fluvio-deltaic, lacustrine and glacial settings with minor volcanic intervals. Pretoria Group bedrocks underlie large areas north of the Vredefort Dome (e.g. near Potchefstroom). Resistant-weathering subunits (e.g. quartzitic Magaliesberg and Daspoort Formations) build the stepped escarpments of the Magaliesberg and Swartrugggens ranges, while marine mudrocks of the Silverton Formation underlie the lower-lying Bushveld country to the north.

Two major planetary events just over two billion years ago are recorded in the geology of the study area. Firstly, intense volcanic activity on the Kaapvaal Craton, followed by the intrusion of voluminous basic igneous rocks (Rustenburg Layered Suite) and then granites (Lebowa Granite Suite), formed the Bushveld Complex (2.06 Ga) that underlies the Rustenburg area (Cawthorn et al. 2006). Secondly, a massive asteroid impact around 2.02 Ga generated the Vredefort Dome, the core region of the largest known impact structure on Earth (Reimold 2006).

The only Palaeozoic rocks mapped in the study area at 1: 1 000 000 scale are fluvio-deltaic sediments of the Vryheid Formation (Ecca Group, Karoo Supergroup) laid down on the Ecca Sea margins in Middle Permian times (Johnson et al. 2006). Small Ecca Group outcrop areas on the northern edge of the Main Karoo Basin are mapped on the western side of the Vredefort Dome. Late Caenozoic superficial sediments include a wide spectrum of alluvial (e.g. Vaal River), colluvial, lacustrine and pan deposits as well as pedocretes and soils. Numerous cave infills (e.g. limestone breccias and speleothems) scattered across the karstified landscapes of the Transvaal dolomites north of Krugersdorp are of special geological and palaeontological interest here (Clarke & Partridge 2010).

4.1.3.3 Palaeontology

Igneous rocks in the study area (e.g. Archaean basement granites, greenstones, Bushveld Complex, Ventersdorp lavas) are unfossiliferous, while many of the Precambrian sediments are, at most, sparsely fossiliferous. However, given their considerable age, any fossil occurrences are of considerable scientific importance. Equivocal microbial trace fossils (microborings) are claimed from Archaean submarine lavas elsewhere on the Kaapvaal Craton (Barberton region), while carbonaceous material (columnar kerogen, flyspeck carbon) associated with gold deposits in the West Rand Group (Archaean Witwatersrand Supergroup) might be of microbial origin (Mossman et al. 2008).

Lacustrine carbonate horizons within the Ventersdorp Supergroup volcanic succession (Platberg Group) contain stromatolites (laminated microbial mounds) in the northern Free State and possibly within the present study area as well (Schopf 2006). Late Archaean shallow marine carbonate rocks of the Malmani Subgroup (Chuniespoort Group, Transvaal Supergroup) are known for their rich reef-forming stromatolite biotas (sheets, domes and columns) that developed in shallow shelf, subtidal and intertidal zones. Associated mudrocks and cherts contain organic-walled microfossils (e.g. cyanobacteria). Stromatolites and other, simpler forms of subaqueous to subaerial microbial mat bio-sedimentary structures are also recorded from several horizons within the overlying Early Proterozoic Pretoria Group (e.g. Timeball Hill, Daspoort, Silverton and Magaliesberg Formations); associated fine-grained sediments undoubtedly contain microfossil assemblages as well (e.g. Truswell and Eriksson 1972, 1973, and 1975, Schopf 2006 and Eriksson et al. 1993, 2006). Permian fluvio-deltaic sediments of the Vryheid Formation (Ecca Group) are internationally famous for their rich Glossopteris Flora plant assemblages (Anderson & Anderson 1985, MacRae 1999, McCarthy & Rubidge 2005, Johnson et al. 2006, Prevec 2016). Plant compression floras, petrified wood and trace fossils are recorded from Ecca Group bedrocks in the Kroonstad 1: 250 000 sheet area to the south of present study area (Schutte 1993).

The Cradle of Humankind to the north of Krugersdorp represents the pre-eminent palaeontological hotspot within the study area. At numerous cave sites associated with the karstic-weathered Transvaal dolomites here Late Pliocene to Holocene breccias have yielded a wealth of mammalian skeletal remains. They are assigned to the Plio-Pleistocene Makapanian, Cornelian and Florisian mammal faunas of southern Africa and include several extinct hominins (spp. of *Australopithecus, Paranthropus, Homo*) as well as diverse micromammals. Other fossil groups recorded include reptiles (lizards), frogs, birds, land snails, coprolites, stone and bone artefacts and plant remains (e.g. petrified wood, palynomorphs). In addition to a huge academic literature (e.g. Brain 1958, Klein 1984, McKee et al. 1995, Partridge 2000, Tobias 2000 and Avery 2000) accessible, well-illustrated accounts of these world-famous Cradle of Humankind fossil assemblages are provided by MacRae (1999) as well as Hilton-Barber and Berger (2004), Blundell (2006), Bonner et al. (2007) and Clarke & Partridge (2010). A wide spectrum of fossil and subfossil remains may also occur within other Late Caenozoic superficial sediments in the study area, such as older alluvial deposits along the Vaal River and its tributaries (cf Partridge et al. 2006).

4.1.3.4 Survey coverage and limitations

The study area has only been partially surveyed, with several clusters with medium and low coverage and a few small areas with high coverage (Figure 4 and Figure 5). Large areas have not been subjected to heritage surveys probably due to the fact that no developments occurred in these areas as it consists of private farm land. However, nodes of intensive archaeological research occur throughout the province, meaning that the heritage character of the area is well understood.

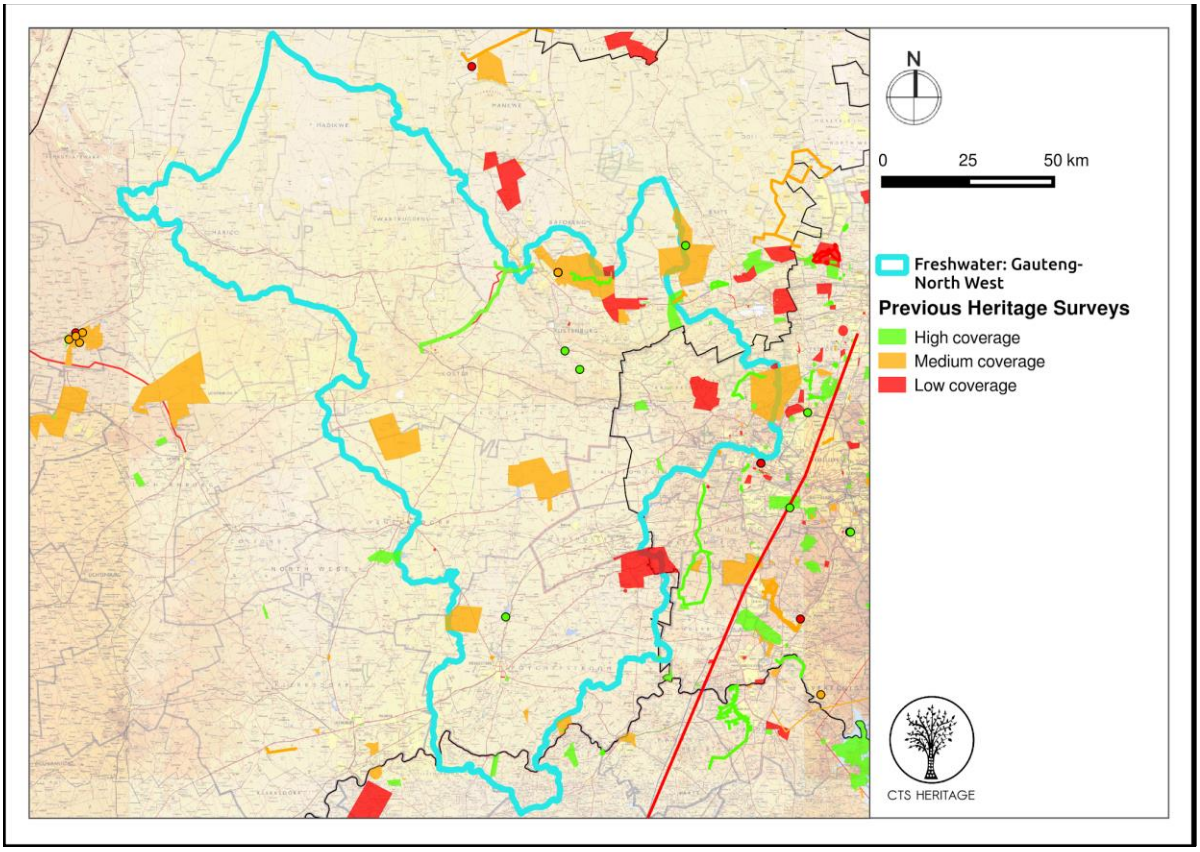

Figure 4. Gauteng-North West previous HIAs map.

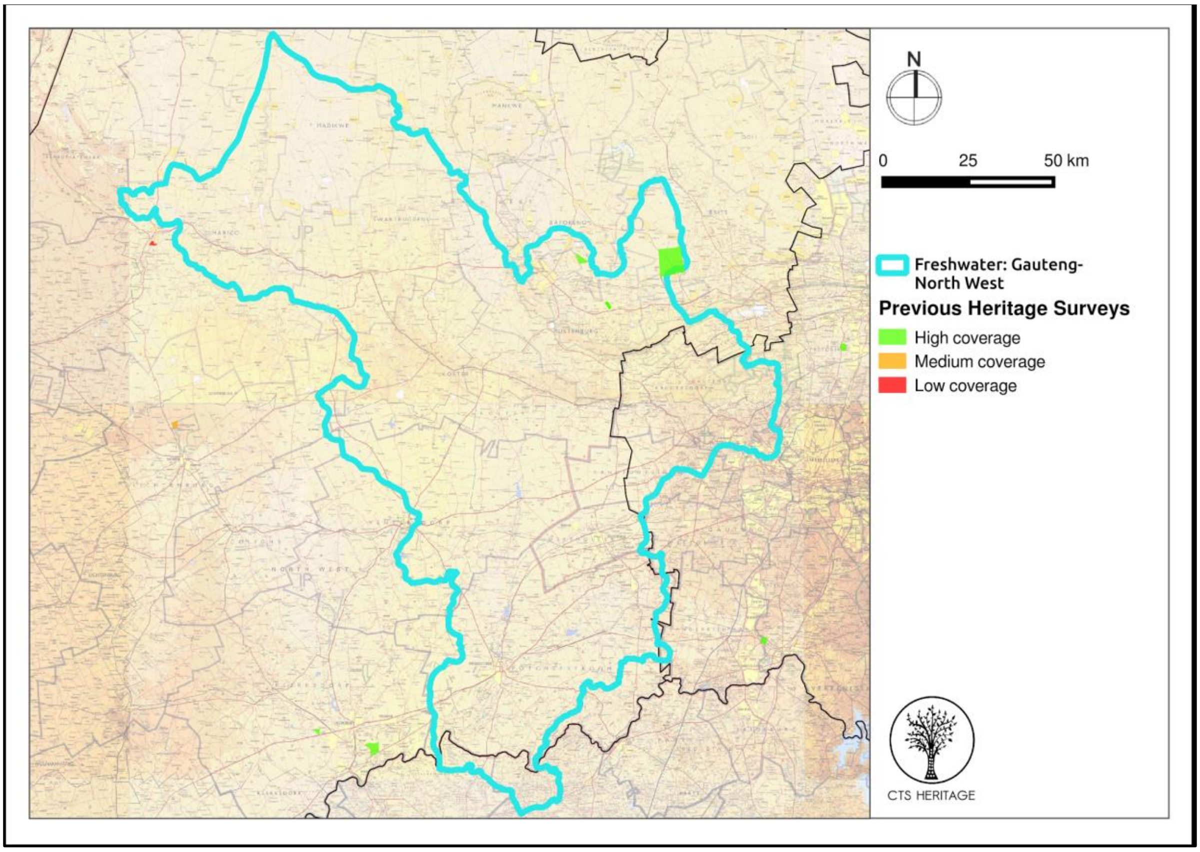

Figure 5. Gauteng-North West previous PIAs map.

4.1.4 Freshwater Study Area 4 – Vaalharts

4.1.4.1 Topography

The core region belongs to the Lower Vaal and Orange Valleys geomorphic province (Partridge et al. 2010) which also extends along major tributaries of these two rivers, such as the Rietrivier and Hartsrivier. The dry Ghaap Plateau forms higher-lying terrain along the north-western margin of the area with a low escarpment facing the broad Vaal-Harts river valley. Due to the karstified carbonate bedrocks underlying the plateau there is little surface drainage here. Topographically-subdued terrain in the northeast towards Bloemhof is drained by the Vaal River and belongs to the Highveld region while more varied country around Kimberley with prominent dolerite koppies is assigned to the Upper Karoo region.

4.1.4.2 Geology

The complex geology of the Vaalharts freshwater study area encompasses a wide range of rock units of early Precambrian (Archaean) to Holocene age. It is outlined on adjoining 1: 250 000 scale geology sheets 2724 Christiana, 2726 Kroonstad, 2822 Postmasburg, 2824 Kimberley, 2826 Winburg, 2922 Prieska and 2924 Koffiefontein (Schutte 1994, Schutte 1993, Bosch 1993, Nolte 1995, Zawada 1992).

Small inliers of Archaean basement rocks of the Kaapvaal Craton (ancient continental block) are seen in the Schweizer-Reneke area close to the northern edge of the study area. They include “Swazian” granites (continental crust) as well as infolded greenstone belts of the Karaaipan Group (oceanic crust). Surrounding the basement inliers, as well as underlying a large portion of the central study area, are Late Archaean lavas and subordinate fluvial to lacustrine sediments of the Ventersdorp Supergroup. This unit reflects a major outpouring of lavas onto the Kaapvaal Craton some 2.7 Ga (billion years ago) (Van der Westhuizen et al. 2006).

The north-western parts of the study area are underlain by a very thick succession of shallow water carbonate rocks (limestones and dolomites) with minor mudrocks, quartzites and cherts. These Ghaap Group (Transvaal Supergroup) sediments were deposited in shallower parts of the Griqualand West Basin when the Kaapvaal Craton was flooded in Late Archaean times (c. 2.64 Ga). The Ghaap Group succession begins with fluvial to marginal marine quartzites plus thin lavas and carbonates of the Vryburg Formation which crop out near Vryburg itself as well as north of Douglas. The following Schmidtsdrift Subgroup running along the foot of the Ghaap escarpment comprises thin stromatolitic platform carbonates (Boomplaas Formation) overlain by offshore mudrocks. Several stacked formations of Late Archaean stromatolitic platform carbonates (Campbell Rand Subgroup) dominate the geology of the Ghaap Plateau region. Archaean bedrocks of the Ventersdorp and Transvaal Supergroup are unconformably overlain by Palaeozoic sediments of the Karoo Supergroup lying on the northern margins of the Main Karoo Basin (Johnson et al. 2006). The Karoo sediments underlie large parts of the central study region, including the area around the confluence of the Orange and Vaal Rivers, as well as most of the flatter-lying eastern sector. Permo-Carboniferous glacial sediments (tillites) of the Dwyka Group at the base of the Karoo succession are associated with spectacular glacially-striated rock pavements in the Kimberley-Douglas area.

Readily-weathered basinal mudrocks of the overlying Prince Albert, Whitehill and Tierberg Formations within the Early to Middle Permian lower Ecca Group were deposited in the largely land-locked Ecca Sea. They crop out in the south-eastern portion of the study area where they generally build low-relief terrain. In the north-eastern sector of the study area, non-marine fluvio-deltaic sandstones, mudrocks and occasional coals of the Vryheid Formation were accumulated in Middle Permian times. They are overlain to the east, around Welkom, by dark mudrocks of the Volksrust Formation, deposited in a range of offshore to lacustrine or lagoonal settings. In Early Jurassic times (c. 183 Ma) the Dwyka and, especially, Ecca Group bedrocks were extensively intruded and baked by dolerites of the Early Jurassic Karoo Dolerite Suite (Duncan & Marsh 2006); prominent-weathering dolerite koppies are seen in the Kimberley-Douglas area, for example. The Kaapvaal Craton crust and overlying rocks were injected by numerous kimberlite pipes of the Kimberley Province in Late Cretaceous times (99-70 Ma) (Skinner & Truswell 2006).

Important categories of Late Caenozoic superficial sediments represented in the study area include thick alluvial deposits (e.g. terrace gravels and sands) along the Orange and Vaal Rivers and their major tributaries, colluvial and downwasted surface gravels as well as pan sediments (e.g. in the Karoo Supergroup outcrop area). In addition there are karstic cave and tufa deposits in areas underlain by carbonate bedrocks (e.g. along the margins of the Ghaap Plateau near Taung) as well as widespread, well-developed calcrete hardpans (Mokalanen Formation) and aeolian sands (Gordonia Formation) of the Pleistocene Kalahari Group reflecting persistent seasonally arid climates in the region (Partridge et al. 2006).

4.1.4.3 Palaeontology

The Vaalharts study area features a wide range of fossil heritage of Archaean to Holocene age (Almond & Pether 2008a; Almond 2011a, 2013a, 2013b). Early Archaean granite-greenstone basement rocks are unfossiliferous, with the possible exception of equivocal microbial trace fossils claimed from submarine lavas in the Barberton region. Important occurrences of Archean stromatolites have been reported from bore cores through lacustrine interbeds within the predominantly volcanic Ventersdorp Supergroup succession, including from the Rietgat and Bothaville Formations that are mapped within the study area. The Ventersdorp lavas themselves, such as the widely-occurring Allanridge Formation, do not contain fossils. Late Archaean shallow marine carbonate rocks of the Ghaap Group (Transvaal Supergroup) are known for their rich reef-forming stromatolite biotas (sheets, domes and columns) that developed in shallow shelf, subtidal and intertidal zones. Associated mudrocks and cherts contain organic-walled microfossils (e.g. cyanobacteria). In the Griqualand West Basin important Late Archaean stromatolite horizons are recorded from the Vryburg Formation, the Boomplaas Formation of the Schmidtsdrift Subgroup near Vryburg (cf Almond 2016a), as well as numerous horizons within the main Campbell Rand carbonate succession of the Ghaap Plateau (e.g. spectacular examples at Boetsap near the plateau edge) (Altermann and Herbig 1991, Altermann and Schopf 1995, Schopf 2006, Eriksson et al 2006).

The glacial successions of the Dwyka Group are normally unfossiliferous, apart from low-diversity trace fossil assemblages in thin interglacial mudrock intervals. However, the northern “valley and inlet” facies or Mbizane Formation which is represented in the study area (e.g. near Douglas) also contains plant remains such as Glossopteris leaves and petrified wood (Von Brunn & Visser 1999). Post-glacial mudrocks of the Early Permian Prince Albert Formation (basal Ecca Group) have yielded diverse marine fossil assemblages near Douglas including shelly invertebrates, various fish groups, trace fossils, petrified wood and palynomorphs (McLachlan & Anderson 1973). Carbonaceous mudrocks of the overlying Whitehill Formation mudrocks exposed, for example, in diamond pipes in the Kimberley area, are known for their well-preserved fossils of mesosaurid reptiles, palaeoniscoid fish and non-marine crustaceans. The Tierberg Formation basinal mudrocks contain low-diversity trace fossil assemblages, transported plant material (e.g. floating wood) and rare microvertebrate debris (disarticulated fish teeth and scales). Middle Permian fluvio-deltaic successions of the Vryheid Formation are renowned for their rich fossil plant compressions and palynomorph assemblages of the Glossopteris Flora (Anderson & Anderson 1985, Prevec 2016); rarer animal remains in these beds include insects, non-marine crustaceans and bivalves as well as fish scales. The fossil record of the succeeding Volksrust Formation is less well-known but includes rare amphibian remains, bivalves, trace fossils and occasional coals with a rich Glossopteris palaeoflora.

Early Jurassic Karoo dolerite intrusions are themselves unfossiliferous. Baking of the surrounding country rocks may have destroyed their fossil content, although in some cases fossil preservation may be enhanced (e.g. moulds of vertebrate remains). Likewise, Late Cretaceous kimberlite pipes do not contain fossils but when associated crater lake deposits are preserved (as in Bushmanland) they may contain rich assemblages of fossil fish, amphibians, plants, palynomorphs (pollens, spores) and even rare dinosaur remains (Smith 1988, 1995). Mammalian faunas of Miocene to Pleistocene age are recorded from alluvial terrace gravels along the Vaal River, for example to the north of Kimberley (Wells 1964, Klein 1984, MacRae 1990, Partridge et al. 2006).

The “Older” Vaal River Gravels (Windsorton Formation) contain a restricted fauna of possible Miocene-Pliocene age while a wide range of Pleistocene mammal remains (bones, teeth) as well as Acheulian stone tools are recorded from the “Younger” Vaal River Gravels or Rietputs Formation. The Rietputs fauna is assigned to the Mid-Pleistocene Cornelian Mammal Age and includes various equids and artiodactyls as well as African elephant and hippopotamus. Further important Pliocene to Holocene fossil mammals – including, most notably, the hominin *Australopithecus africanus* (“Taung child”) - have been collected from several sites on the edge of the Ghaap Plateau near Taung where they are associated with calc-tufa deposits (McKee 1994, Tobias 2000, Partridge 2000). Sporadic fossil remains of vertebrates, plants and traces like calcretised burrows or root casts may occur within other Late Caenozoic superficial sediments such as pan and vlei deposits, calcrete hardpans and aeolian sands. Even downwasted surface gravels may contain concentrations of silicified wood reworked from Karoo-age bedrocks.

Key sites: Boetsap (stromatolites), Douglas (Prince Albert marine fossils) Taung (Taung child and Plio-Pleistocene mammals), Canteen Kopje near Barkly West and Windsorton (Plio-Pleistocene mammals).

4.1.4.4 Survey coverage and limitations

Survey coverage is generally low with the northern part of the study area being particularly poorly surveyed (Figure 6 and Figure 7). The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

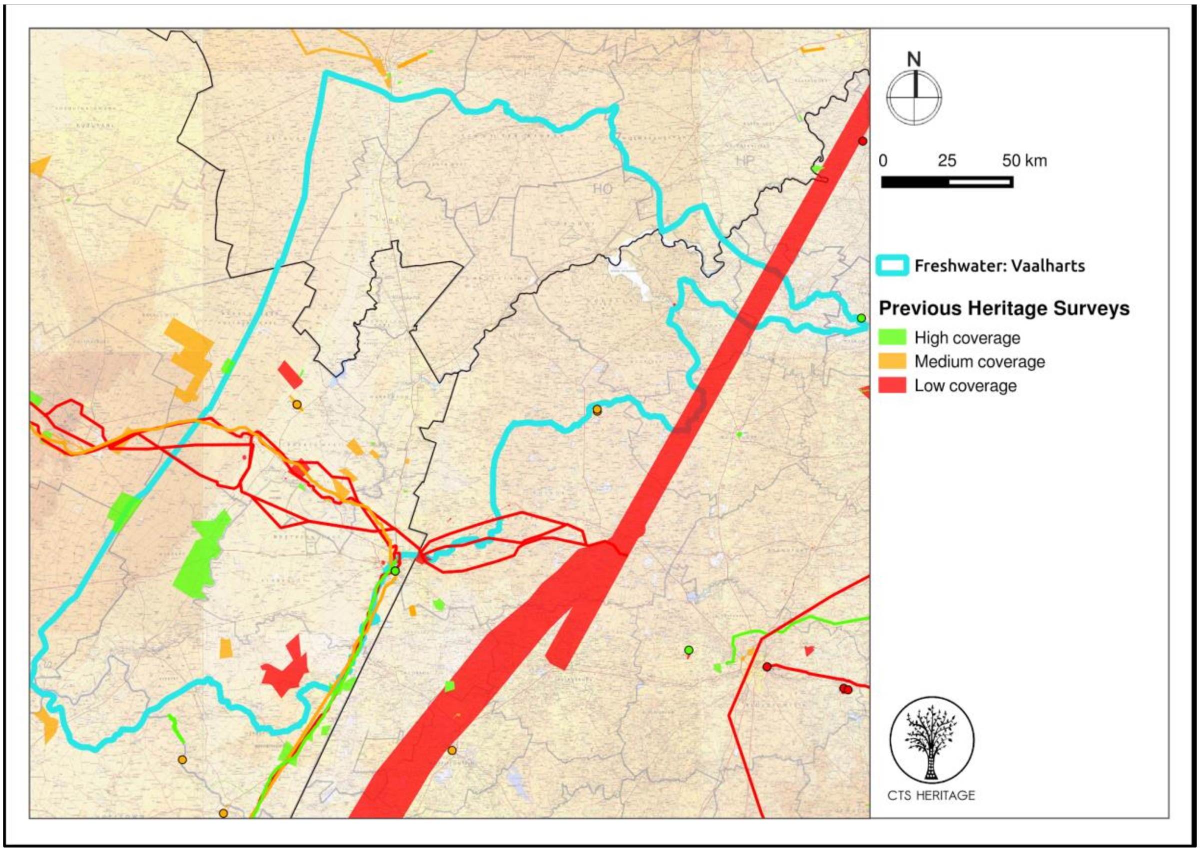

Figure 6. Vaalharts previous HIAs map.

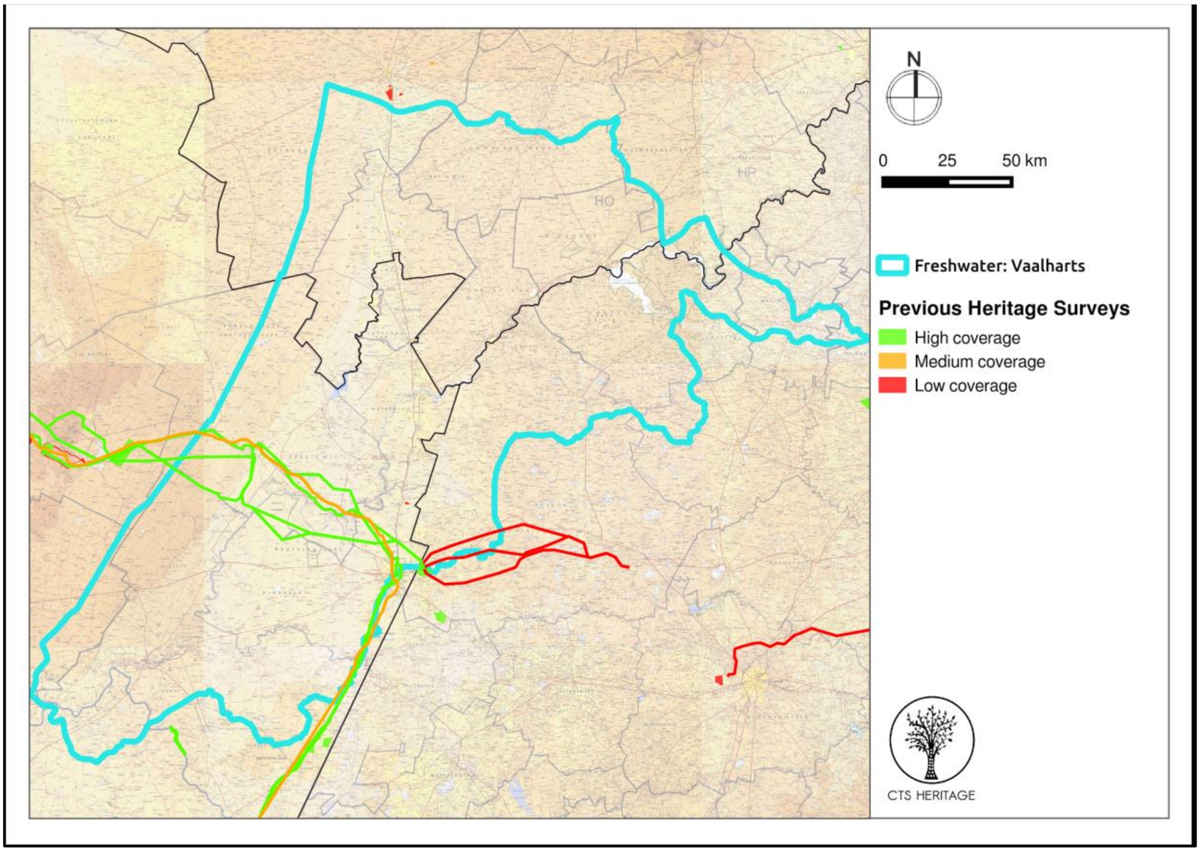

Figure 7. Vaalharts previous PIAs map.

4.1.5 Freshwater Study Area 5 – Free State-KZN Highlands

4.1.5.1 Topography

The Free State-KZN Highlands study area abuts, and in part spans, the Great Escarpment to the northeast of the Lesotho Highlands. It shows a general increase in elevation and topographic relief from the NE to the SW as the foothills of the Drakensberg range are approached. The steep, highly-dissected Great Escarpment zone runs along the eastern edge of the Lesotho Highlands and then heads NE across the study area towards Newcastle (e.g. Oliviershoek and Van Reenen Passes south of Harrismith). Lower-lying hilly terrain below the Great Escarpment is referred to the Ladysmith Basin which is drained by the Tugela River and its tributaries (Partridge et al. 2010). Above the escarpment, hilly to mountainous country of the Eastern Escarpment Hinterland around Harrismith merges northwards into the topographically more subdued Southern Highveld region, which is drained by north-flowing tributaries of the Vaal (e.g. Wilgerivier).

4.1.5.2 Geology

The geology of the Free State-KZN Highlands study area is covered by 1: 250 000 geology maps 2728 Frankfort, 2828 Phuthaditjhaba / Harrismith and 2928 Drakensberg (Muntingh 1989, Johnson & Verster 1994, Lindström 1981). The area lies within the north-eastern sector of the Main Karoo Basin of South Africa and the bedrock geology is dominated by Late Permian to Early Jurassic sedimentary rocks of the Karoo Supergroup (McCarthy & Rubidge 2005, Johnson et al. 2006). The very thick succession of continental sediments, broadly younging towards the southwest, includes representatives of the Ecca, Beaufort and Stormberg Groups.

The region is one of considerable geoheritage significance as well as scenic beauty that is underpinned by the local geology. Lacustrine to lagoonal and offshore marine shales of the Mid to Late Permian Volksrust

Formation (Ecca Group) in the east near Ladysmith are overlain by, and interfinger with, a thick succession of fluvial, lacustrine and possible deltaic sediments of the Adelaide Subgroup. The Lower Beaufort Group rocks underlie over half of the study area and are assigned to the Normandien Formation (incorporating the Estcourt Formation of earlier authors) that is particularly well-represented in this region (Groenewald 1984, 1989; Prevec et al. 2009). The overlying Upper Beaufort (Tarkastad Subgroup) succession of braided to meandering fluvial as well as lacustrine sediments is represented by the Early to Middle Triassic Katberg and Burgersdorp Formations which have extensive outcrop areas in the south-western portion of the study area. Late Triassic to Early Jurassic continental red beds of the Stormberg Group (Molteno, Elliot and Clarens Formations) crop out in the Drakensberg foothills in the central and southwestern portions of the study area. They represent a range of braided fluvial, playa lake as well as sandy desert palaeoenvironments reflecting arid palaeoclimates in the final phases of the Main Karoo Basin. The Karoo sedimentary succession is capped by a thick package of Early Jurassic basaltic lavas and minor sedimentary intercalations of the Drakensberg Group that build the mountainous upper portions of the Drakensberg Escarpment. Related dolerite intrusions (Karoo Dolerite Suite) transect and bake the Karoo Supergroup succession at lower elevations across the study area (Duncan & Marsh 2006).

A wide spectrum of Late Caenozoic superficial sediments - mostly unmapped - mantle the Karoo Supergroup and other bedrocks in the study area. They include thick alluvial deposits associated with major water courses, colluvium (scree, hillwash), surface gravels, lake, vlei and pan sediments, soils, duricrusts and windblown sands, among others. Of particular interest are the colluvial to alluvial gravels, sands and clays and palaeosols of the Masotcheni Formation. This unit occurs widely within the northern KZN-Free State area and is often well exposed within deep erosion gullies or dongas (Johnson & Verster 1994, Lindström 1981, Partridge et al. 2006).

4.1.5.3 Palaeontology

The Free State-KZN Highlands study area is a key region for Karoo Supergroup geology and palaeontology. This reflects the wide stratigraphic range and numerous good exposures of Permian to Jurassic continental sedimentary rocks in the Drakensberg foothills and Great Escarpment zone as a whole. A spectrum of vertebrate (fish, amphibian), invertebrate and plant fossils are known from the Mid to Late Permian Volksrust Formation (Cairncross et al. 2005), with a number of key vascular plant and insect fossil sites known from KZN south of the present study area (Van Dijk 1981, 1998).

Late Permian fluvio-deltaic sediments of the Normandien Formation (including the previously recognised Estcourt Formation) in the eastern and north-eastern portion of the Main Karoo Basin are well-known for their rich fossil Glossopteris Flora plant and insect assemblages (Anderson and Anderson 1985, Van Dijk 2000 and earlier papers, Claassen 2008, Prevec et al. 2009). Plant remains include well-preserved petrified woods that are often reworked into overlying superficial deposits (cf Almond 2015a). Several important Late Permian vertebrate sites from the Daptocephalus (previously Dicynodon) Assemblage Zone of the Normandien Formation as well as from the Early Triassic Lystrosaurus and Cynognathus Assemblage Zones of the overlying Tarkastad Subgroup are recorded from the Main Karoo Basin northeast of the Lesotho Highlands (Kitching 1977, Rubidge 1995, Nicolas 2007, Van der Walt et al. 2010). These include a wide range of fish, amphibians, therapsids, archosaurs and vertebrate traces such as burrows and coprolites.

Triassic to Jurassic continental red beds exposed in the Drakensberg foothills also have a very high palaeontological research potential. Key fossil assemblages here include rich Late Triassic vascular plant and insect assemblages within the Molteno Formation (Anderson & Anderson 1985, Anderson et al. 1998) as well as Late Triassic to Early Jurassic dinosaurs and other terrestrial vertebrates of the Elliot and Clarens Formations (“Euskelesaurus” and Massospondylus Assemblage Zones). Notably, clutches of primitive dinosaur eggs have been found in the Golden Gate National Park, just west of the present study area (Reisz et al. 2010 and refs. therein).

The Early Jurassic Drakensberg Group volcanics are largely unfossiliferous, although there are occasional records of vascular plant remains, vertebrate bones and trackways as well as rare invertebrates (e.g. freshwater crustaceans) from sedimentary intervals between the lavas.

Late Caenozoic superficial deposits of the Karoo region are poorly studied in palaeontological terms but may contain local concentrations of fossil vertebrate, invertebrate and plant remains as well as trace fossils (e.g. mammalian bones, teeth, horn cores, freshwater or terrestrial molluscs, coalified wood, palynomorphs, calcretised root casts and termitaria) (cf Brink et al. 1999, Brink & Rossouw 2000, Churchill et al. 2000). Key fossiliferous facies are mostly associated with extant or defunct drainage lines and include older consolidated alluvium and terrace gravels, lake, pan and vlei deposits. The Pleistocene to Holocene Masotcheni Formation, for example, is often characterised by concentrations of petrified fossil wood reworked from the Karoo Supergroup bedrocks as well as Early to Middle Stone Age stone artefacts (cf Almond 2015a).

4.1.5.4 Survey coverage and limitations

Very little systematic research has been conducted in the area, and large areas have not been subjected to heritage surveys probably due to the fact that no developments have occurred in these areas which consist of private farm land (Figure 8). However, nodes of intensive archaeological research exist adjacent to the study area, meaning that the heritage character of the study area is relatively well understood.

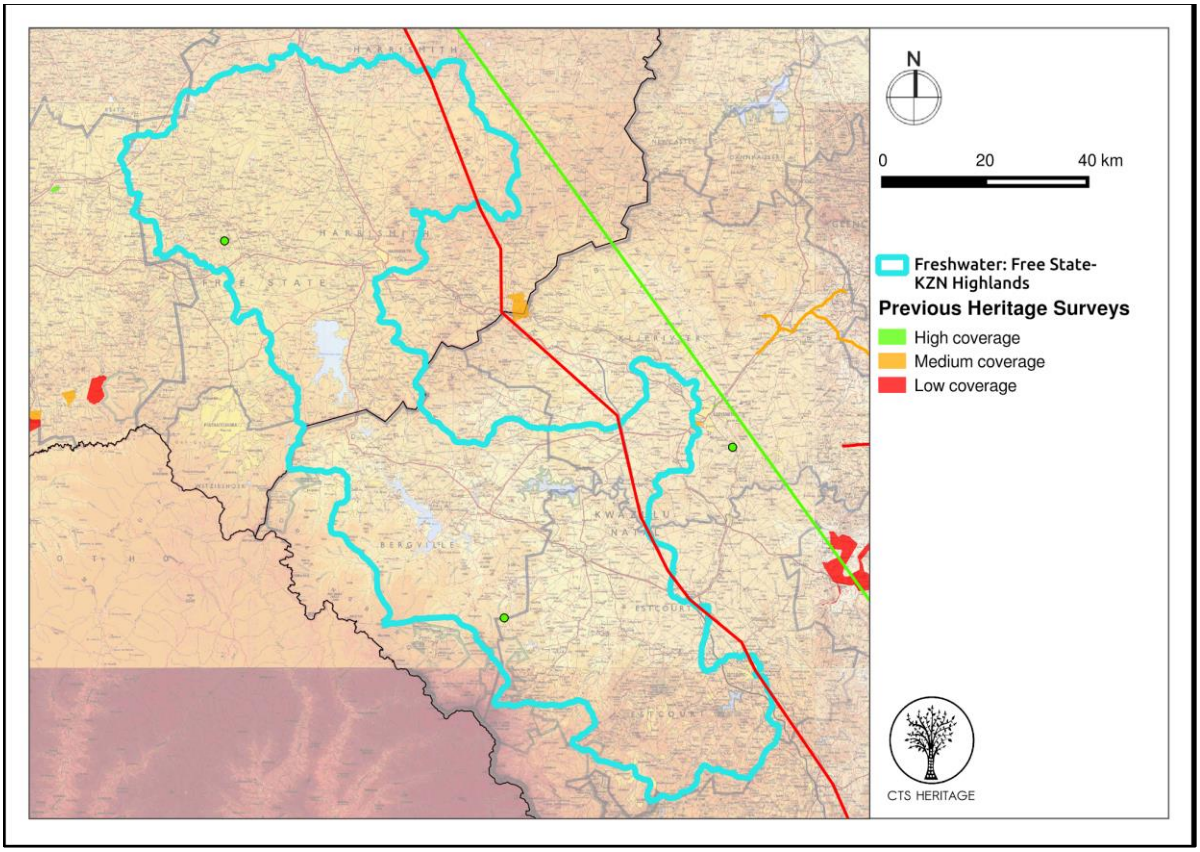

Figure 8. Free State-KZN Highlands previous HIAs map.

4.1.6 Freshwater Study Area 6 – Richards Bay and Marine Study Area 1 – Durban-Richards Bay

4.1.6.1 Topography

The sandy coastal zone of this study area, east of Empangeni, forms part of the low-lying Zululand Coastal Platform that widens towards the north. This topographically-subdued region is crossed by numerous rivers, several of which terminate in sizeable standing water bodies (lakes, lagoons, wetlands) behind the coastal dune cordon. The gently hilly hinterland belongs to the narrow Southeastern Coastal Platform that was subjected to considerable tectonic uplift in Late Caenozoic times (Partridge et al. 2006, 2010). The higher-lying interior region in the west is assigned to the Southeastern Coastal Hinterland (Partridge et al. 2010) which is characterised by a highly-dissected, hilly topography and drained by numerous incised meandering river systems. An east-west trending band of flatter terrain due west of Empangeni is underlain by readily-weathered Karoo Supergroup bedrocks. In general, protracted deep chemical weathering in subtropical climates has resulted in thick development of saprolite (*in situ* weathered bedrock) and very limited fresh bedrock exposure.

4.1.6.2 Geology

The geology of the Durban-Richards Bay study area is highly complex, involving a wide range of tectonic units and sedimentary successions of Early Precambrian to Holocene age. It is covered by 1: 250 000 geological sheets 2930 Durban, 27½32 St Lucia and 2830 Richards Bay / Dundee (Lindström 1987a, Wolmarans & Du Preez 1986, Lindström 1987b) as well as by the recent 1: 50 000 Durban sheet (Clarke et al. 2016). Archaean granitoid, greenstone and highly-metamorphosed basement rocks cropping out on the inner side of the coastal platform in the east, as well as in the far west of the study area (east of Nkandla and around Melmouth) represent very ancient (> 3 Ga = billion years old) continental crust plus minor relicts of oceanic crust building the Kaapvaal Craton. Major blocks of younger (Late Precambrian / Proterozoic) metamorphosed and deformed crustal rocks of the Namaqua-Natal Province crop out on the south-western and southern margins of the study area, NW and NE of Eshowe. These represent slices of one billion-year-old continental crust that have been thrust northwards onto the Kaapvaal Craton as a result of continental collision events (Cornell et al. 2006). The oldest major sedimentary rock package within the study area is the thick quartzitic Natal Group of probable Ordovician age that crops out extensively in the western third of the study area. These fluvial sands and gravels were deposited within a down-faulted basin by braided rivers flowing from the northeast (Marshall 2005, 2006).

A wide range of glacial, lacustrine and continental sediments of Late Carboniferous to Early Jurassic age in the central portion of the Richards Bay study area represent the Karoo Supergroup on the eastern margins of the Main Karoo Basin, as well as building the broadly N-S trending Durban-Lebombo Belt (Johnson et al. 2006). Basal glacial rocks of the Dwyka Group, often preserved in down-faulted blocks, are overlain by predominantly non-marine basinal, fluvio-deltaic and lagoonal sediments of the Ecca Group (Pietermaritzburg, Vryheid and Volksrust Formations). The Beaufort Group is represented in the Durban-Lebombo Belt by the fluvio-lacustrine sandstones, mudrocks and minor coals of the Mid to Late Permian Emakwezini Formation (Bordy & Prevec 2008). The overlying packages of coarse, cross-bedded sandstones (Ntabene Formation), red mudrocks with pedogenic calcretes (Nyoka Formation) and aeolian desert sandstones (Clarens Formation) are equated with the Stormberg Group of the Main Karoo Basin. These are capped by thick basaltic lavas of the Letaba Formation (Lebombo Group) that crop out in the southern extension of the Lebombo Range. Voluminous extrusion of basic lavas, as well as extensive intrusion of Karoo Dolerites into the Karoo Supergroup bedrocks in general, is related to the incipient break-up of the Supercontinent Gondwana in Early Jurassic times (Duncan & Marsh 2006).

With the establishments of the Indian Ocean in Early Cretaceous times, the thick package of near-coastal to shallow marine sediments of the Zululand Group was deposited on the KwaZulu-Natal coastal platform, seawards of the Lebombo Range. In the present study area, these Cretaceous to Paleogene rocks are mostly mantled by younger coastal deposits. However, there are a few small inliers of fossiliferous sandstones and siltstones of the Late Cretaceous St Lucia Formation near the Mfolozi River (e.g. Mfolozi Flats, Mtubatuba) (Dingle et al. 1983, Shone 2006). A complex spectrum of Late Caenozoic (Miocene to Recent) coastal sediments of the Maputaland Group is spread across the low-lying Zululand Coastal Platform. Current 1: 250 000 scale mapping of these units does not reflect the newly-revised stratigraphy and outcrop areas of some of the older units are small (Dingle et al. 1983, Maud & Botha 2000, Roberts et al. 2006). They include several horizons of shelly shallow marine to beach sands and gravels (e.g. Uloa, Port Durnford and Isipingo Formations) intercalated with wind-blown dune sands of various ages (e.g. Umkwelane, Kosi Bay and Sibayi Formations). Lenses of freshwater diatomite, lignite and peat occur at intervals within the wind-blown dune sands (aeolianites).

A broad range of Late Caenozoic superficial sediments - mostly unmapped - mantle the Karoo Supergroup and older bedrocks in the Southeastern Coastal Hinterland. They include thick alluvial deposits associated with major water courses, colluvium (scree, hillwash), surface gravels, lake, vlei and pan sediments, soils, duricrusts and windblown sands, among others. Of particular interest are the colluvial to alluvial gravels, sands, clays and palaeosols of the Late Pleistocene to Holocene Masotcheni Formation. This unit occurs widely within KwaZulu-Natal and is often well exposed within deep erosion gullies or dongas (Lindström 1987b, Botha 1996, Partridge et al. 2006).

4.1.6.3 Palaeontology

Much of the Richards Bay freshwater study area is considered to be of insignificant to very low palaeontological sensitivity due to the underlying Precambrian basement rocks that are unfossiliferous (Groenewald 2011b, 2012). So far there have been no body fossils or trace fossils described from the Ordovician fluvial arenites of the Natal Group of KZN. Finer-grained mudrock facies here might possibly contain traces or organic-walled microfossils such as acritarchs.

The Karoo Supergroup succession cropping out in the central part of the study area is considered to be of medium to very high sensitivity. Important trace fossil assemblages (e.g. arthropod trackways, fish swimming trails) are recorded from laminated interglacial and post-glacial mudrocks of the Mbizane Formation (Dwyka Group) of northern KZN and might also be present in similar facies further south (Savage 1970, 1971, Anderson 1981, Von Brunn & Visser 1999). Basinal mudrocks of the Pietermaritzburg Formation contain locally abundant, low diversity trace fossil assemblages and probably also organic-walled microfossils such as acritarchs, pollens and spores. The fluvio-deltaic Vryheid Formation is internationally famous for its Middle Permian Glossopteris palaeoflora (e.g. Plumstead 1969, 1973, Anderson & Anderson 1985, MacRae 1999, McCarthy & Rubidge 2005, Johnson et al. 2006, Prevec 2016). A variety of vertebrate (fish, amphibian), invertebrate and plant fossils are known from the Mid to Late Permian Volksrust Formation (Cairncross et al. 2005), with a number of key vascular plant and insect fossil sites reported within KZN (Van Dijk 1991, 1998). Important fossil assemblages of vascular plants with sparse animal remains (insects, non-marine molluscs, crustaceans, fish) have been described from the Mid to Late Permian Emakwezini Formation (Bordy and Prevec 2008).

So far there have been no major fossil finds within the Triassic-Jurassic units of the Durban-Lebombo Belt (cf Lindström 1987b) but, judging by their correlatives in the Stormberg Group of the Main Karoo Basin, important trace, plant and vertebrate fossils - including, for example, dinosaur remains - might be expected here in future. Likewise, the overlying Letaba Formation lavas are unfossiliferous but thin sandstone interbeds may prove fossiliferous.

The Zululand Group of KZN represents one of the most important fossiliferous marine successions of Cretaceous age in the RSA (Kennedy & Klinger 1975 and numerous later refs., Dingle et al. 1983, Shone 2006 and refs. therein). Even the small surface exposures of these rocks within the present study area - assigned to the Late Cretaceous to Paleogene St Lucia Formation - have yielded fossil remains. This unit contains rich shelly invertebrate faunas (including key ammonites), microfossils (ostracods, foraminiferans, calcareous nannofossils), petrified wood and other plants as well as rare reptiles and trace fossils. Interestingly, the Richards Bay area provides one of very few on-land sites where a fairly complete succession crossing the key Cretaceous-Tertiary boundary (66 Ma mass extinction horizon) has been found, as shown by foraminiferal and calcareous nannofossil data from borehole cores (Dingle et al. 1983, Maud & Orr 1975, Verhagen et al. 1990).

A wide range of coastal to shallow marine fossil assemblages are reported from the Miocene to Recent Maputaland Group of KZN (Dingle et al. 1983, Wolmarans & Du Preez 1986, Lindström 1987a, 1987b, Maud & Botha 2000, Roberts et al. 2006, Cawthra et al. 2010, Groenewald 2012). The palaeosensitivity of this unit varies from low to locally very high and important unmapped occurrences may be encountered in the shallow subsurface. Shallow marine coquinites (shelly sands and conglomerates) within the basal Uloa Formation of Miocene age contain a wide spectrum of warm-water invertebrates (molluscs, brachiopods, corals, bryozoans, echinoids, coralline algae), microfossils (foraminiferans, calcareous nannoplankton) and sharks' teeth (King 1953). Key fossiliferous units include carbonaceous estuarine to lacustrine muds of the Pleistocene Port Durnford Formation which contains a range of mammalian, reptilian and fish remains, invertebrates such as crustaceans and molluscs, foraminiferans, trace fossils and palynomorphs (Anderson 1907, Scott 1907, Hobday & Orme 1974, Scott et al. 1992). Packages of Pliocene to Holocene coastal aeolianites (e.g. Umkwelane, Kosi Bay, Sibayi Formations) contain lenses of freshwater (interdune) peat, lignite and fossil wood as well as lacustrine diatomite. By analogy with similar deposits elsewhere along the

RSA coast, where they are not leached and rubified ("Berea" facies), these coastal dune sands might also yield local concentrations of mammalian fossils (e.g. associated with hyaena dens), ostrich egg shell, tortoise remains, terrestrial gastropods, anthropogenic middens of marine shells and associated stone artefacts.

The Mid Pleistocene to Holocene Isipingo Formation (previously known as the Bluff Formation) contains a range of shallow marine, beach and coastal dune field fossils including marine oyster beds, freshwater peats and diatomites as well as rare mammal remains (e.g. elephant tusks). Important occurrences of Pleistocene fossiliferous beds of the Isipingo and Port Durnford Formations are located near Durban and along the edge of the Zululand Coastal Plain from Port Durnford northwards. Alluvial, lacustrine, lagoonal and vlei deposits along the coast and in the coastal interior may contain important fossil or subfossil remains of Late Caenozoic mammals, molluscs, plants and palynomorphs, but these have not been systematically recorded. For example, the complex sandy to muddy, organic-rich "Harbour Beds" of mixed alluvial to estuarine and lacustrine origin in the Durban area contain fossil foraminiferans and molluscs (King & Maud 1964, Lindström 1987b). A rich, well-preserved Late Pleistocene mammalian fauna has been recorded in association with the MSA deposits in Sibudu Cave in the Natal Group outcrop area facing the Tongati River, 40 km north of Durban and c. 15 km inland from the Indian Ocean (Plug 2004, Collins 2013).

Many Late Caenozoic superficial deposits of the coastal interior may contain scientifically valuable fossil or subfossil assemblages but for the most part these have not received systematic attention. They include large volumes of alluvial, lacustrine, lagoonal and wetland or vlei deposits that may contain remains of terrestrial vertebrates, non-marine molluscs and crustaceans, trace fossils, vascular plants including wood, palynomorphs (pollens and spores), among others. In KZN the Late Pleistocene to Holocene Masotcheni Formation, for example, is often characterised by concentrations of petrified fossil wood reworked from the Karoo Supergroup bedrocks as well as silcretised rhizoliths (root casts) and Early to Middle Stone Age stone artefacts (Lindström 1987, Botha 1996, Partridge et al. 2006).

4.1.6.4 Survey coverage and limitations

The study area has only been partially surveyed, with large areas that have not been subjected to heritage surveys probably due to less development in these areas which consist of private farm land and state-owned land (Figure 9, Figure 10, Figure 11 and Figure 12). The northern section of the study area has a high coverage of heritage studies (Anderson and Anderson 2008 and 2009, Anderson 2007, 2013), however, and provides a good basis for understanding the local archaeological footprint in the area. Through heritage surveys and nodes of intensive archaeological research, the heritage character of the area can be considered to be well understood.

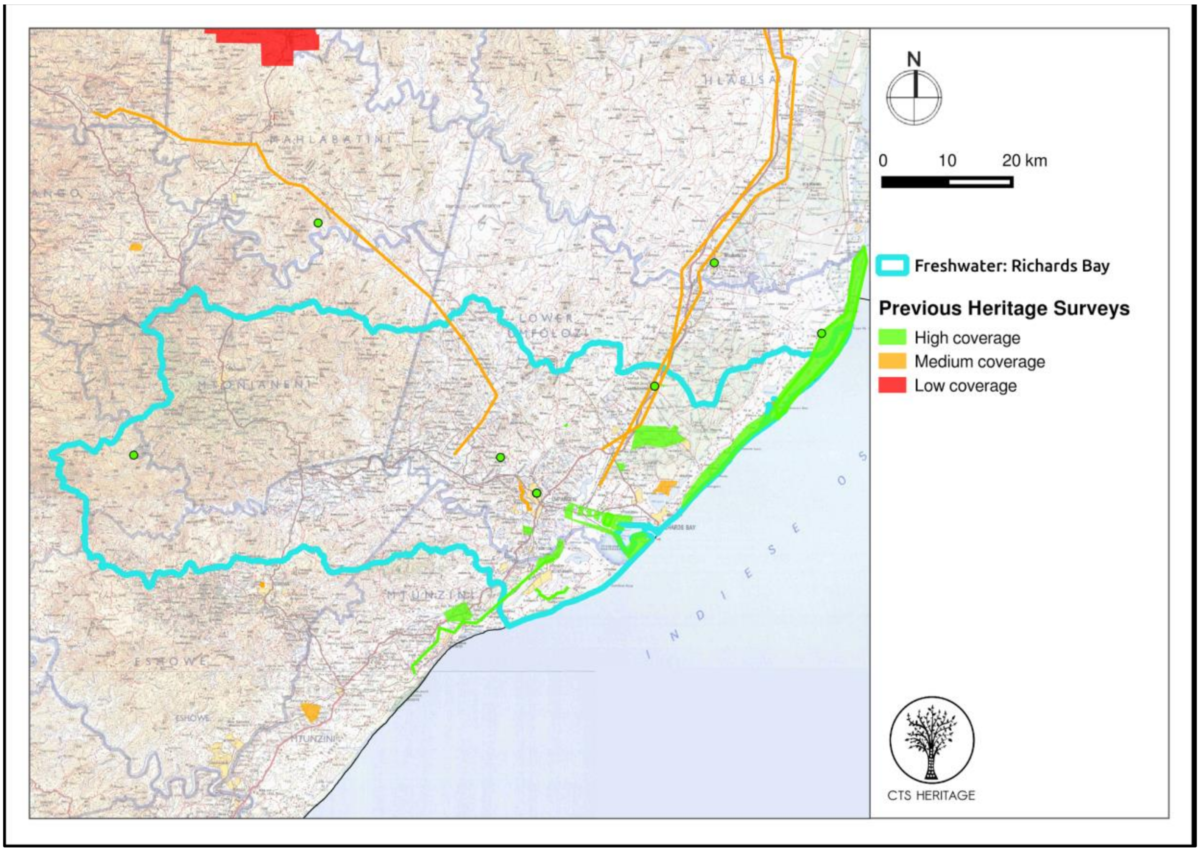

Figure 9. Richards Bay Freshwater Study Area previous HIAs map.

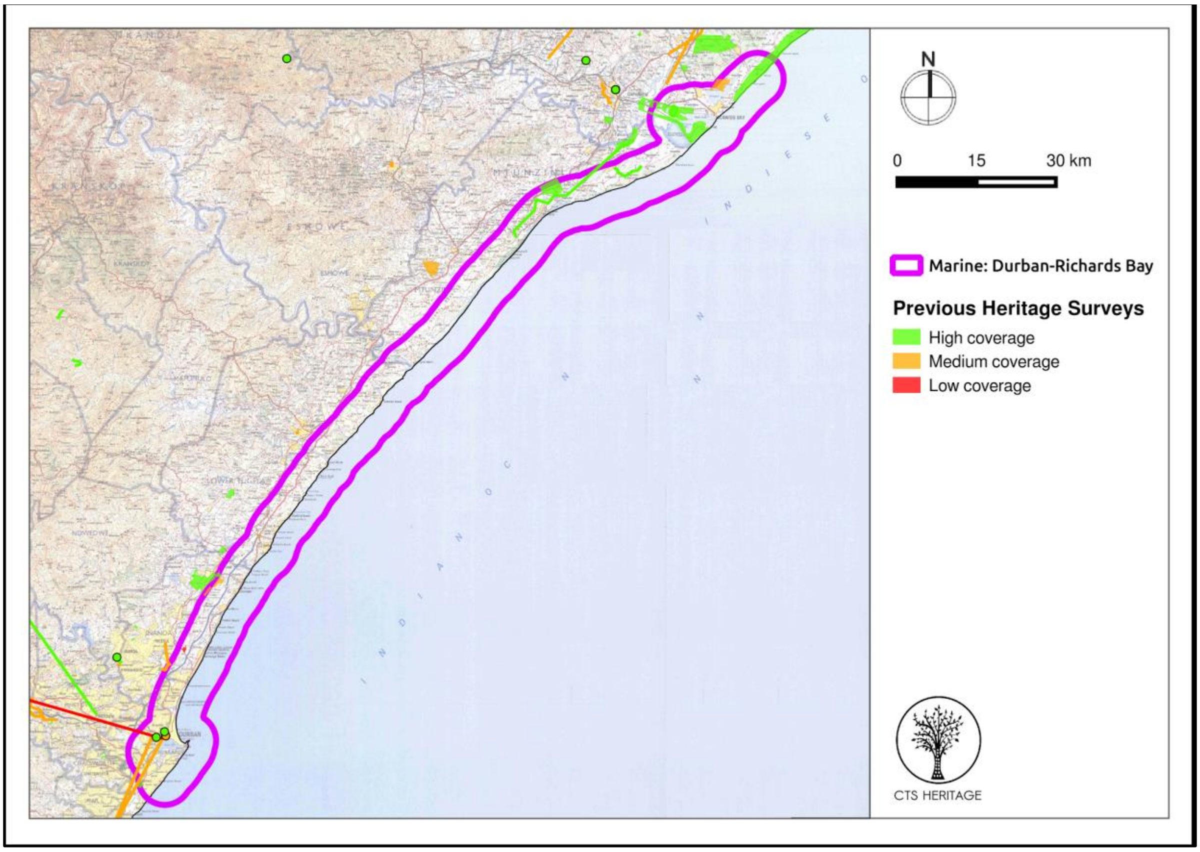

Figure 10. Durban-Richards Bay Marine Study Area previous HIAs map.

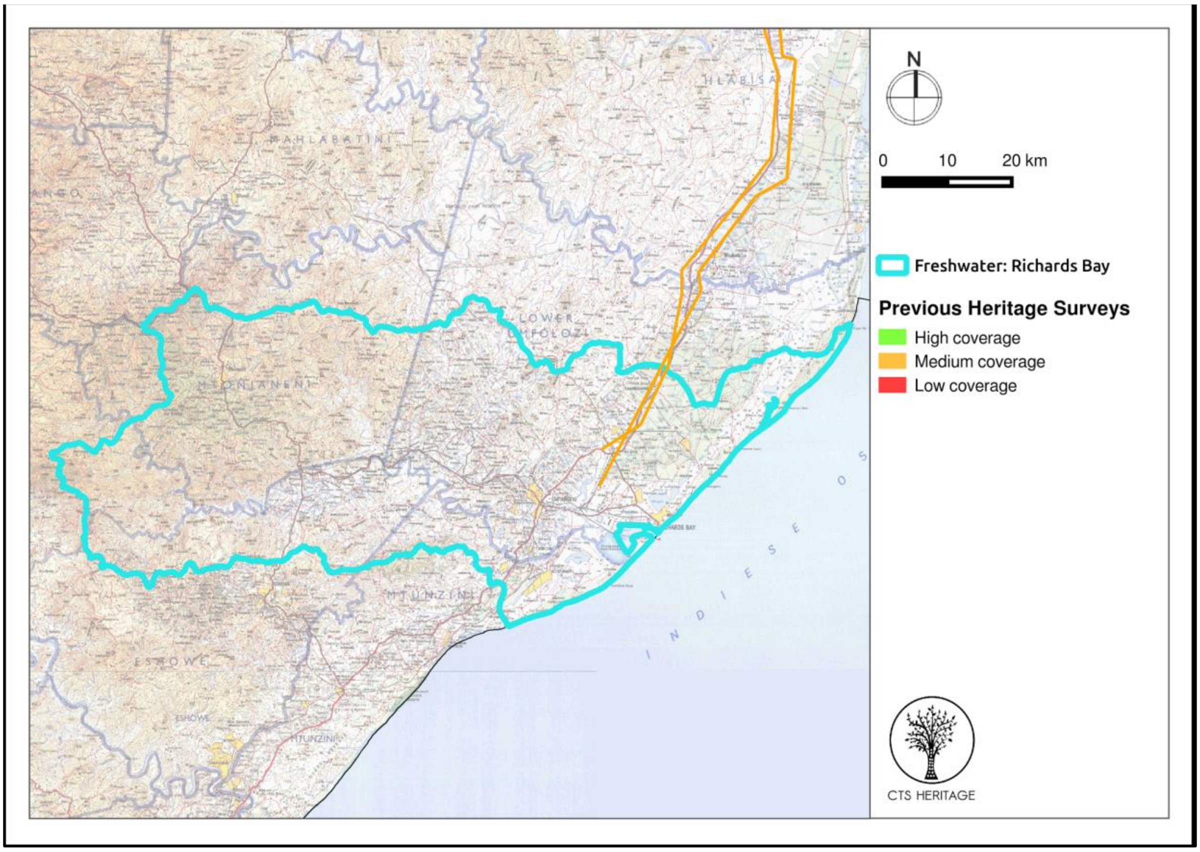

Figure 11. Richards Bay Freshwater Study Area previous PIAs map.

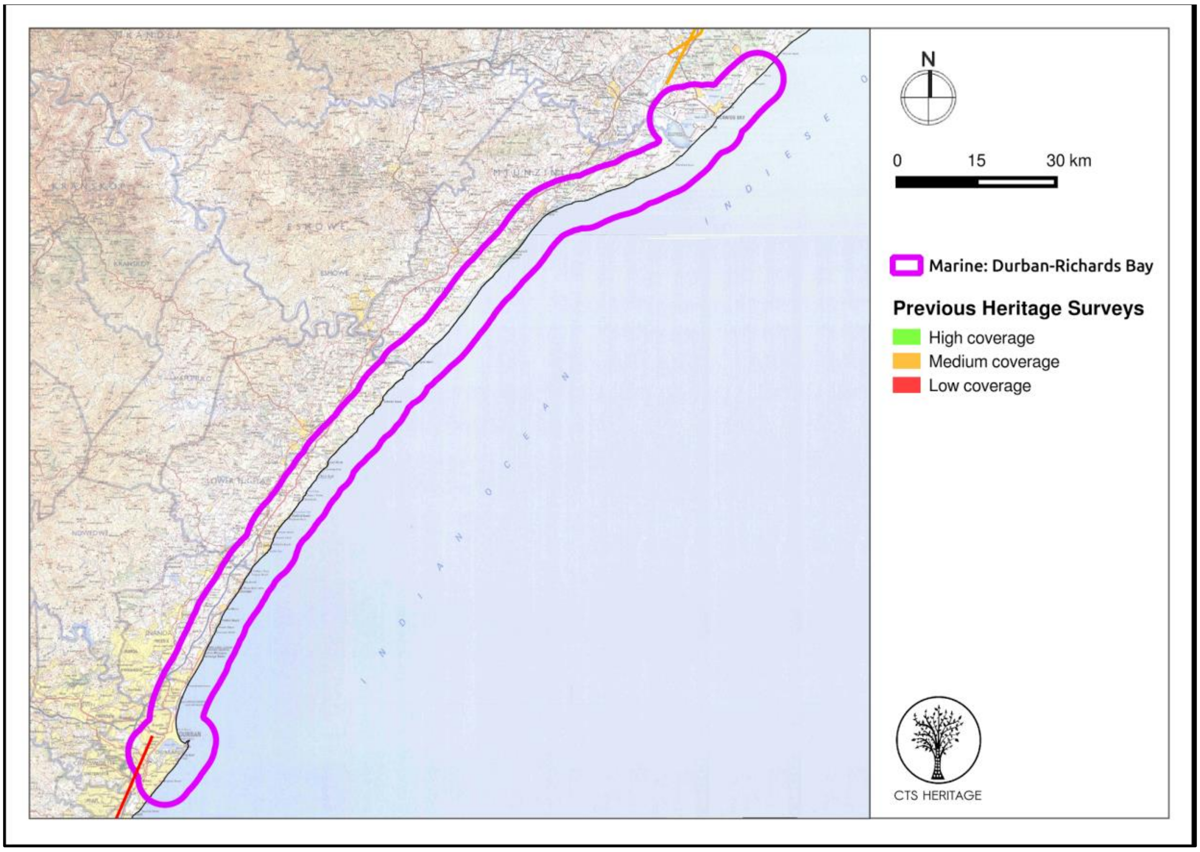

Figure 12. Durban-Richards Bay Marine Study Area previous PIAs map.

4.1.7 Freshwater Study Area 7 – Vanderkloof-Gariep

4.1.7.1 Topography

This part of the interior plateau is assigned to the Upper Karoo as well as the Lower Vaal and Orange River Valleys physiographic regions (Partridge et al. 2010). Overall topographic relief is fairly low in the region as a whole but the landscape here is markedly dissected and broken-up due to protracted denudation in proximity to the Orange River, with strong control on local relief by pervasive intrusions of dark Karoo dolerite. These protrude as innumerable rocky koppies and ridges above the surrounding, less resistant-weathering Karoo Supergroup sediments. Apart from the perennial Orange River itself, with the large Vanderkloof and Gariep Dams along its incised valley, drainage lines in this dry region are small with intermittent flow (e.g. Seekoeirivier).

4.1.7.2 Geology

The geology of the Vanderkloof-Gariep study area is outlined on 1: 250 000 sheets 2924 Koffiefontein, 3024 Colesberg and 3026 Aliwal North (Zawada 1992, Le Roux 1993a, Bruce et al. 1983). Almost the entire region is underlain at depth by marine / lacustrine to continental sediments of the Karoo Supergroup that accumulated within the Main Karoo Basin of Gondwana in Permo-Triassic times (Johnson et al. 2006). The Karoo succession broadly youngs across the study area from west to east. It is largely undeformed and often well-exposed, including key stratigraphic sections across the Ecca-Beaufort boundary as well as the Permo-Triassic boundary that are of considerable geological interest. The oldest Ecca Group sediments cropping out in the west are basinal, turbidite fan and prodeltaic mudrocks of the Tierberg Formation of Early to Middle Permian age that were deposited in a large, fresh- to brackish, land-locked sea or lake (Viljoen 2005). The uppermost, sandier part of the Ecca succession below the Ecca-Beaufort Group boundary probably belongs to the Waterford Formation (storm-influenced shelf or Carnarvon facies) but is not mapped as such. The central part of the study area is underlain by continental sandstones and mudrocks of the Lower Beaufort Group (Adelaide Subgroup) that were laid down by large meandering rivers and in shallow playa lakes in Middle Permian to earliest Triassic times. Equivalents of the Middleton and Balfour Formations are represented here but are not differentiated on the 1: 250 000 geological maps.

Catastrophic climate change at the end of the Permian Period (252 Ma) led to the establishment of more arid conditions in the Main Karoo Basin, as reflected in the Early Triassic red beds of the Upper Beaufort Group (Tarkastad Subgroup) that crop out in the eastern part of the study area. Here a thick, cliff-forming package of braided fluvial sandstones of the Katberg Formation is overlain by maroon floodplain to lacustrine mudrocks plus channel sandstones of meandering river systems of the Burgersdorp Formation (Hancox 2000).

An extensive network of basic dykes, sills and saucer-shaped intrusions of the Early Jurassic Karoo Dolerite Suite cuts across and bakes the Ecca and Beaufort Group country rocks throughout the study area (Duncan & Marsh 2006), while a few Cretaceous kimberlite pipes are mapped just outside the study area (e.g. Jagersfontein). The Ecca Group outcrop area in particular is extensively mantled by Quaternary calcretes. Other Late Caenozoic superficial sediments represented in the study area include alluvial deposits along the Orange and other rivers (no substantial Plio-Pleistocene terrace gravels are mapped here), doleritic colluvium, downwasted surface gravels as well as sheetwash and pan sediments (cf Cole et al., 2004, Partridge et al. 2006).

4.1.7.3 Palaeontology

The Vanderkloof-Gariep study area lies within a key region of the Main Karoo Basin for the study of biostratigraphic, palaeoecological and related evolutionary events across the Ecca-Beaufort and Permo-Triassic boundaries. The Early to Middle Permian basinal mudrocks of the Tierkloof Formation (Ecca Group) contain low-diversity trace fossil assemblages, transported plant debris and occasional microvertebrate remains (e.g. fish teeth, scales). Waterford Formation sandstone-rich successions at the top of the Ecca Group in this part of the Karoo Basin are known for abundant petrified wood as well as well-preserved trace fossil assemblages (Viljoen 2005; Almond 2013b, 2015b). Rich continental fossil biotas of Middle Permian to earliest Triassic age are recorded from the Adelaide Subgroup in this area, including a wide range of reptiles, therapsids ("mammal-like reptiles"), fish and amphibians, freshwater bivalves as well as plant remains and trace fossils (e.g. vertebrate and invertebrate burrows). Representatives of the Pristerognathus, Tropidostoma, Cistecephalus and Daptocephalus (previously Dicynodon) Assemblage Zones have been mapped here (Rubidge 1995, Smith et al. 2012, Viglietti et al. 2015, Almond 2014a).

Evolutionary events within a continental setting during the catastrophic end-Permian mass extinction of 252 Ma have been documented from key stratigraphic sections through uppermost Adelaide Subgroup and lowermost Tarkastad Subgroup close to the Orange River / Gariep Dam, for example near Bethulie (Smith & Botha 2005, Botha & Smith 2006, 2007, Viglietti et al. 2015). Post-extinction biotas of the Lystrosaurus and Cynognathus Assemblage Zones, including locally abundant and diverse vertebrate skeletal remains and trace fossils, are recorded from Early Triassic beds of the Katberg and Burgersdorp Formations (Hancox 2000, Almond 2014a).

Fossil preservation may be variously enhanced or compromised within the thermal aureole of Karoo dolerite intrusions, while the dolerites themselves are unfossiliferous. The Late Caenozoic superficial deposits in the Karoo region are generally of low palaeonsensitivity, but pockets of important Pleistocene mammalian remains (teeth, bones, horn cores) may be found in older consolidated alluvial deposits (cf Bousman et al. 1988, Churchill et al. 2000, Almond 2014a). Downwasted and sheetwashed surface gravels may contain reworked petrified wood blocks and other resistant fossil clasts.

4.1.7.4 Survey coverage and limitations

This study area has received very poor survey coverage with the one notable exception being the now-flooded Gariep Dam that was surveyed by Sampson (1972) (Figure 13 and Figure 14). The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

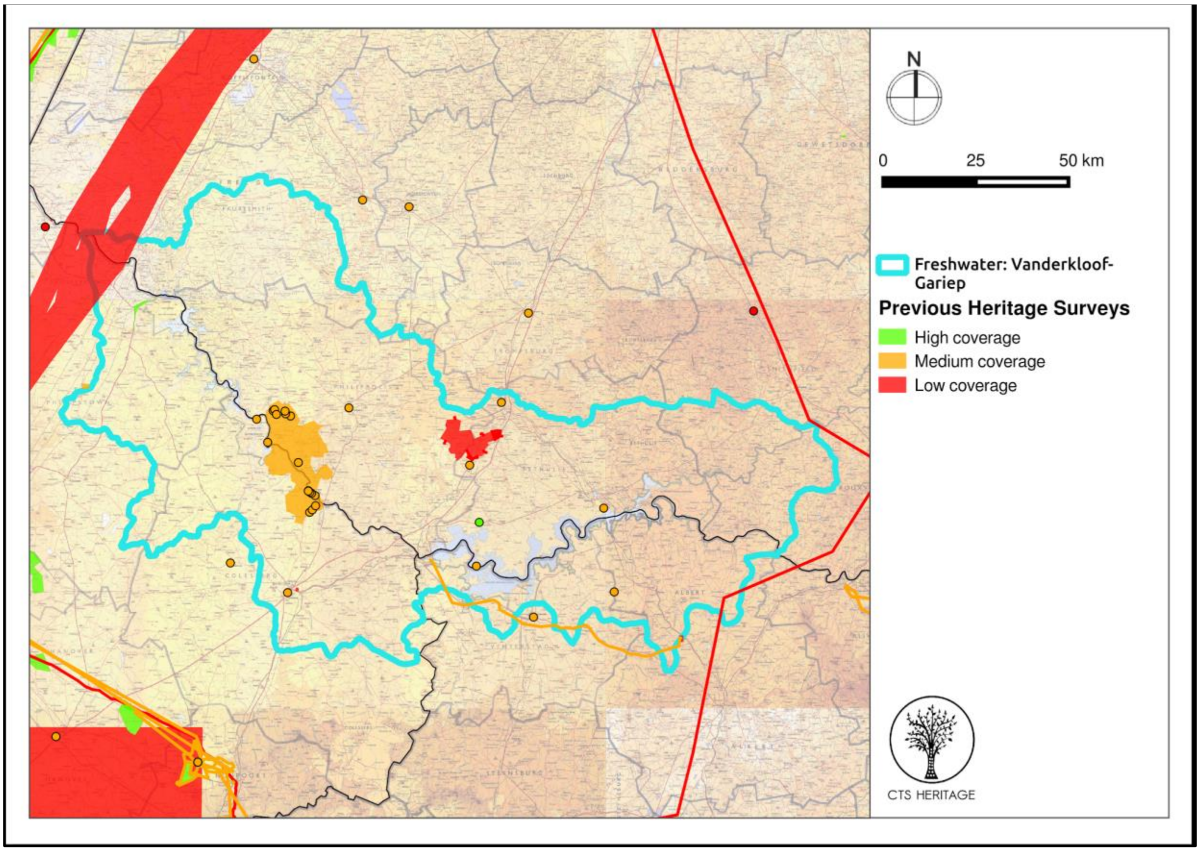

Figure 13. Vanderkloof-Gariep previous HIAs map.

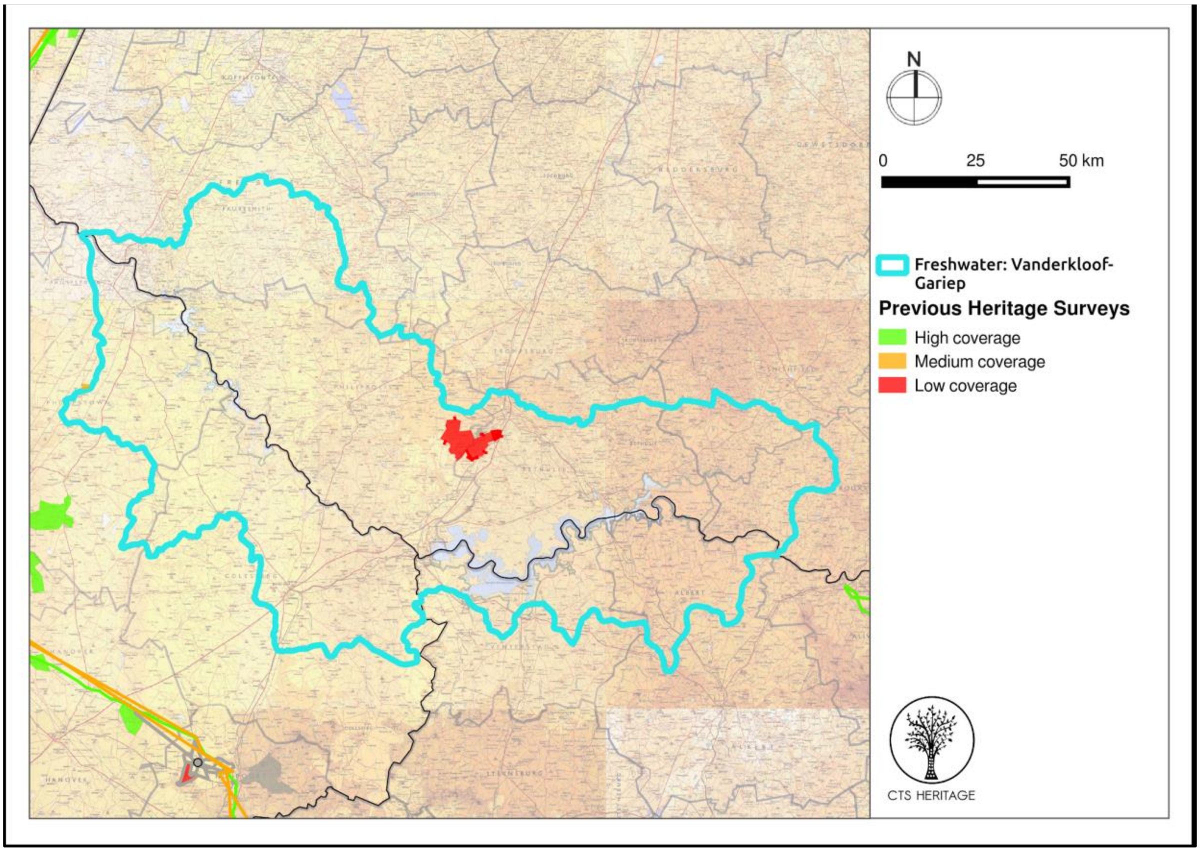

Figure 14. Vanderkloof-Gariep previous PIAs map.

4.1.8 Freshwater Study Area 8 – Eastern Cape and Marine Study Area 2 – East London-Kei

4.1.8.1 Topography

The coastline here is predominantly rocky with a narrow wave-cut bench backed by low cliffs but there are several short stretches with well-developed sandy beaches. The coastal plain features gently hilly terrain up to 200 amsl, and is traversed by several young river systems (e.g. Nahoon, Quelera, Cintsa Rivers) that show deep incision due to at least two episodes of major crustal uplift (250-850 m) in Late Tertiary / Neogene times. The river mouths are often partially or totally blocked by wave and tidally-influenced sand bars backed by short estuaries or lagoons. The dissected coastal plain is assigned by some authors to the late Mesozoic African Surface that is typically associated with deep bedrock weathering (Maud 2008).

The coastal interior (Post-African 1 surface) is also hilly (e.g. Amatole Mountains near Stutterheim) and highly dissected by major older river systems such as the Great Kei and Buffalo Rivers and their tributaries (e.g. Wit Kei, Swart Kei). Topographic relief in the higher-lying, interior-most region around Queenstown and Lady Frere is also high and strongly influenced by prominent-weathering dolerite intrusions, many of which are circular in plan, with internal drainage patterns. In general, levels of bedrock weathering are high within the study area, while thick colluvial and alluvial deposits as well as soils mainly limit bedrock exposures to drainage lines, deeper erosion gullies (dongas), kranzes of resistant-weathering dolerite and sandstone on hillslopes, as well as road and railway cuttings, borrow pits and quarries.

4.1.8.2 Geology

The geology of the study area is covered by 1: 250 000 geology maps 3326 Grahamstown, 3226 King William's Town, 3126 Queenstown and 3228 Kei Mouth (Council for Geoscience, Pretoria). The study area lies within the understudied south-eastern portion of the Main Karoo Basin and is almost entirely underlain by Permo-Triassic non-marine (fluvial and lacustrine) sedimentary rocks of the Beaufort Group (Karoo

Supergroup) (Johnson 1984, Johnson & Caston 1989, Johnson & Le Roux 1994, Johnson et al. 2006). These mainly comprise poorly-differentiated subunits of the Adelaide Subgroup in the south-eastern half of the study area (Middleton and Balfour Formations) as well as the better-understood Tarkastad Subgroup (Katberg and Burgersdorp Formations) in the north-western half. There are also small outliers of Tarkastad Subgroup rocks along the coast near East London (not well shown on the 1: 1 000 000 scale geological map). Small outcrops of Middle Triassic fluvial beds of the Molteno Formation (Stormberg Group) occur in higher ground along the northern margin of the study area. Levels of Karoo bedrock deformation are generally low while near-surface exposures are often reduced to highly-weathered saprolite. Throughout the study area the Beaufort and Stormberg Group bedrocks are intruded and locally baked by an extensive network of Early Jurassic dolerite bodies (sills, dykes, saucers) of the Karoo Dolerite Suite. The coastal occurrences of Beaufort Group rocks within the study area are of considerable geological interest because they provide unusually extensive exposures of comparatively fresh (unweathered) bedrock such as are not available inland.

The Palaeozoic and Mesozoic bedrocks in the study area are extensively mantled with a range of Late Caenozoic superficial sediments such as colluvial slope deposits (scree, hillwash) as well as gravelly to silty alluvium along ancient or extant drainage lines (e.g. river terrace gravels), downwasted surface gravels, pedocretes (e.g. silcretes, calcretes, ferricretes) and soils. Some of the older, more consolidated deposits may be of Tertiary of Pleistocene age.

Small, geologically and palaeontologically-important relicts of lime-rich, shallow marine sediments correlated with the Late Cretaceous Igoda Formation and the Paleogene (Early Tertiary) Bathurst Formation (lowermost Algoa Group) overlie the coastal platform in the Needs Camp area, c. 25 km west of East London (McLachlan & McMillan 1976, McMillan 2009 and refs. therein). Isolated, narrow outcrop areas of younger (Pliocene to Holocene) Algoa Group coastal sediments - including shallow marine deposits as well as wind-blown dune sands of various ages - occur along the outer margins of the wave-cut coastal plain but have not been mapped in detail (cf Maud & Botha 2000, Roberts et al. 2006).

4.1.8.3 Palaeontology

Most of the Eastern Cape study area remains poorly known in palaeontological research terms, although a considerable number of field-based Palaeontological Impact Assessments (PIAs) have been carried out here. The SAHRIS palaeosensitivity map designates the great majority of the study area as being of very high palaeosensitivity, reflecting the wide distribution of Beaufort Group bedrocks here (Almond et al. 2008a). Elsewhere in the South Africa, the Beaufort Group has yielded world-class assemblages of fossil vertebrates, trace fossils, vascular plants and palynomorphs documenting evolutionary and palaeoenvironmental changes within the Permo-Triassic interval on land, including the key end-Permian mass extinction event and subsequent biotic recovery (Rubidge 1995, MacRae 1999, McCarthy & Rubidge 2005, Smith et al. 2012). However, Karoo fossil distribution maps and reviews (Kitching 1977, Nicolas 2007), several PIAs as well as local museum collections (King Williams Town, East London, Queenstown) show only a sparse scatter of fossil vertebrate records as well as concentrations of well-preserved petrified wood within the Adelaide Subgroup in the south of the study area. Several vertebrate finds are from well-exposed coastal outcrops (cf Almond 2011a, 2014b, 2017; Groenewald 2011a; Prevec 2014), while good exposures may also be found inland along major incised valleys such as those of the Buffalo and Great Kei Rivers. There is a higher number of important Tarkastad Group vertebrate and vascular fossil sites towards the north near Queenstown and Lady Frere (Kitching 1977, Gastaldo et al. 2005, Nicolas 2007, Almond 2011b) and fossil vertebrate burrow systems are likely to be found here.

The coastal Katberg Formation outliers contain dispersed reworked clasts of petrified wood that are secondarily concentrated into downwasted surface gravels. Reworked Permo-Triassic petrified woods have also been recorded within silcretes overlying the coastal platform at Fort Grey (Farm Springfontein), some 15 km west of East London (Roberts et al. 2006) as well as within colluvial sands and gravels near Haga Haga (Almond 2017). Due to the scarcity of well-identified vertebrate fossil records the Beaufort Group, fossil biozonation in this portion of the Main Karoo Basin is ill-defined (Rubidge 1995). This lack of fossil records is variously attributable to low levels of fresh bedrock exposure, preservational or palaeoecological factors, or simply to a lack of palaeontological fieldwork. Gess (2012) has demonstrated that better-exposed occurrences of Beaufort Group rocks to the east of the present study area (in the previous

Transkei) do in fact contain important vertebrate fossil remains. Further, the latest Karoo fossil biozonation map infers the presence of the Cistecephalus AZ, Daptocephalus (previously Dicynodon) AZ, Lystrosaurus and Cynognathus AZ within the present study area (Van der Walt et al. 2010).

The Middle Triassic Molteno Formation (Stormberg Group) is also of very high palaeosensitivity. It is renowned for its rich Middle Triassic fossil floras, locally preserved within thin coals, and their associated insect remains (MacRae 1999). Numerous plant fossil sites are mapped along or close to the southern edge of the Molteno Formation outcrop area (Anderson & Anderson 1985), some of which may fall within the present study area. Early Jurassic Karoo dolerites are themselves unfossiliferous and may have compromised fossils preserved within the adjacent country rocks through contact metamorphism.

Ancient, relatively-consolidated superficial sediments overlying Karoo bedrocks and dolerite in the interior may be of palaeontological interest and are indicated as of medium palaeosensitivity on the SAHRIS map. In addition to sporadic vertebrate remains (e.g. mammalian bones, teeth, horn cores) and trace fossils, pre-Holocene alluvial terrace gravels as well as colluvial sands and gravels exposed in erosion gullies may contain locally high concentrations of well-preserved petrified wood reworked from the underlying Karoo Supergroup bedrocks. Isolated vlei, lake and pan deposits (generally not mapped at 1: 250 000 scale) may be associated with defunct or extant drainage lines. They are also palaeontologically sensitive in terms of possible associated organic remains (plant debris, wood, palynomorphs) as well as occasional vertebrate and freshwater invertebrate fossils.

Outliers of Late Cretaceous and Palaeogene fossiliferous marine sediments overlying the elevated wave-cut coastal platform at Needs Camp, c. 25 km west of East London, are of very high palaeosensitivity and protected as Provincial Heritage Sites (Rossouw, undated PIA report). Fossils include a limited range of invertebrates including ammonites, sharks teeth plus a rich diversity of biostratigraphically and palaeoecologically significant microfossils such as ostracods and foraminiferans (McLachlan & McMillan 1976, McMillan 2009 and refs. therein). The known quarry sites lie just outside the present study area, but similar, unrecorded fossiliferous deposits may well be present overlying the coastal platform within the area itself. The stratigraphy and palaeontology of younger, near-coastal subunits of the Algoa Group within the study area is poorly known (Maud & Botha 2000, Roberts et al. 2006). They include possible Plio-Pleistocene shelly marine deposits (cf Alexandria and Salnova Formations) as well as consolidated Pleistocene aeolianites of the Nahoon Formation that at Nahoon Point near East London contain rare hominin footprints (Mountain 1974, Jacobs and Roberts 2009 and refs. Therein). The Pleistocene Nahoon dune sands may contain sparse but important vertebrate remains - as recorded further west along the coast, between East London and Port Alfred - as well as terrestrial gastropods, marine shell fragments, foraminiferans and trace fossils such as rhizoliths (plant root casts), especially in proximity to ancient springs and drainage lines (Le Roux 1989, Rossouw 2015). At Nahoon Point near East London the Nahoon Formation aeolianites contain rare 124 000 year-old hominin footprints (Mountain 1974, Roberts 2007, Jacobs and Roberts 2009 and refs. therein). The fossil record of the younger (Holocene) dune sands and cover sands along the southern African coastline has been summarized by Pether (2008).

Pre-Holocene alluvial terrace gravels as well as colluvial sands and gravels exposed in dongas or erosion gullies may contain sporadic vertebrate remains (e.g. mammalian bones, teeth, horn cores) and trace fossils. These valley deposits, as well as relict silcretes on higher ground, may locally contain high concentrations of well-preserved petrified wood reworked from the underlying Karoo Supergroup bedrocks (cf Roberts & Berger 1997, Almond 2017). Isolated vlei, lake, lagoonal, estuarine and pan deposits (generally not mapped at 1: 250 000 scale) may be associated with defunct or extant drainage lines close to sea level along the coast (e.g. associated with river mouths) as well as on the elevated coastal platform. These may be palaeontologically sensitive in terms of associated organic remains (plant debris, wood, palynomorphs) as well as occasional vertebrate and freshwater invertebrate fossils.

4.1.8.4 Survey coverage and limitations

The study area has only been partially surveyed, with localised areas with high to medium coverage, resulting in large sections that have not been subjected to heritage survey (Figure 15, Figure 16, Figure 17 and Figure 18). Since the area has not been extensively developed, survey coverage is limited and some assumptions have to be made regarding the distribution of heritage resources. However through archaeological surveys and excavations of some sites the heritage character of the area is well understood.

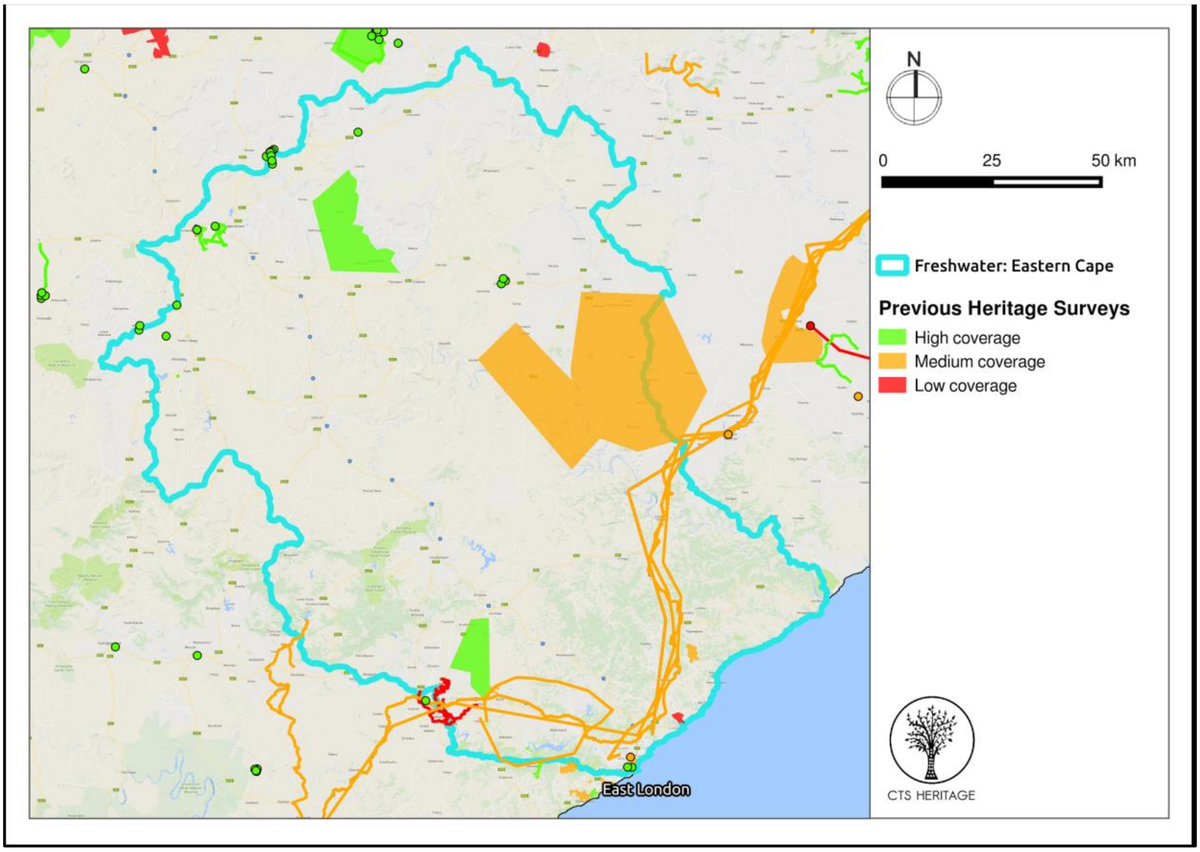

Figure 15. Eastern Cape Freshwater Study Area previous HIAs map.

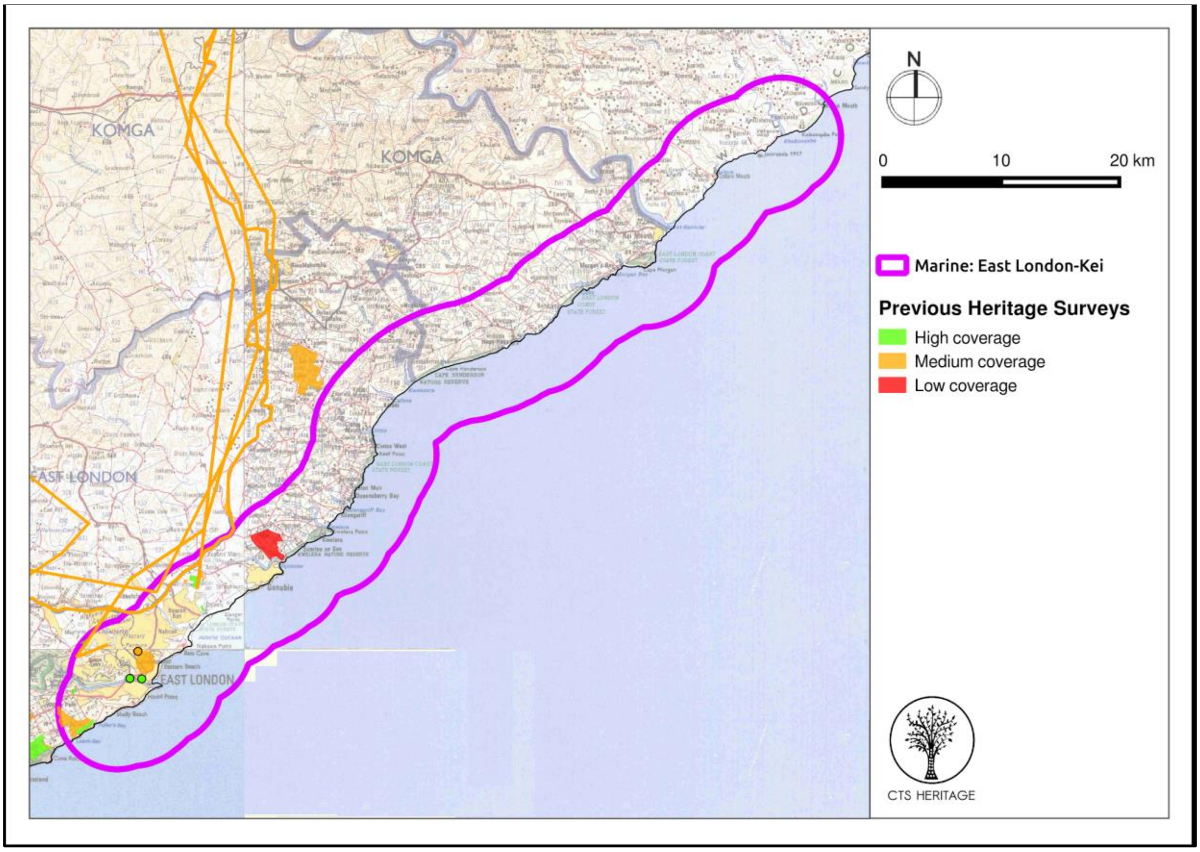

Figure 16. East London-Kei Marine Study Area previous HIAs map.

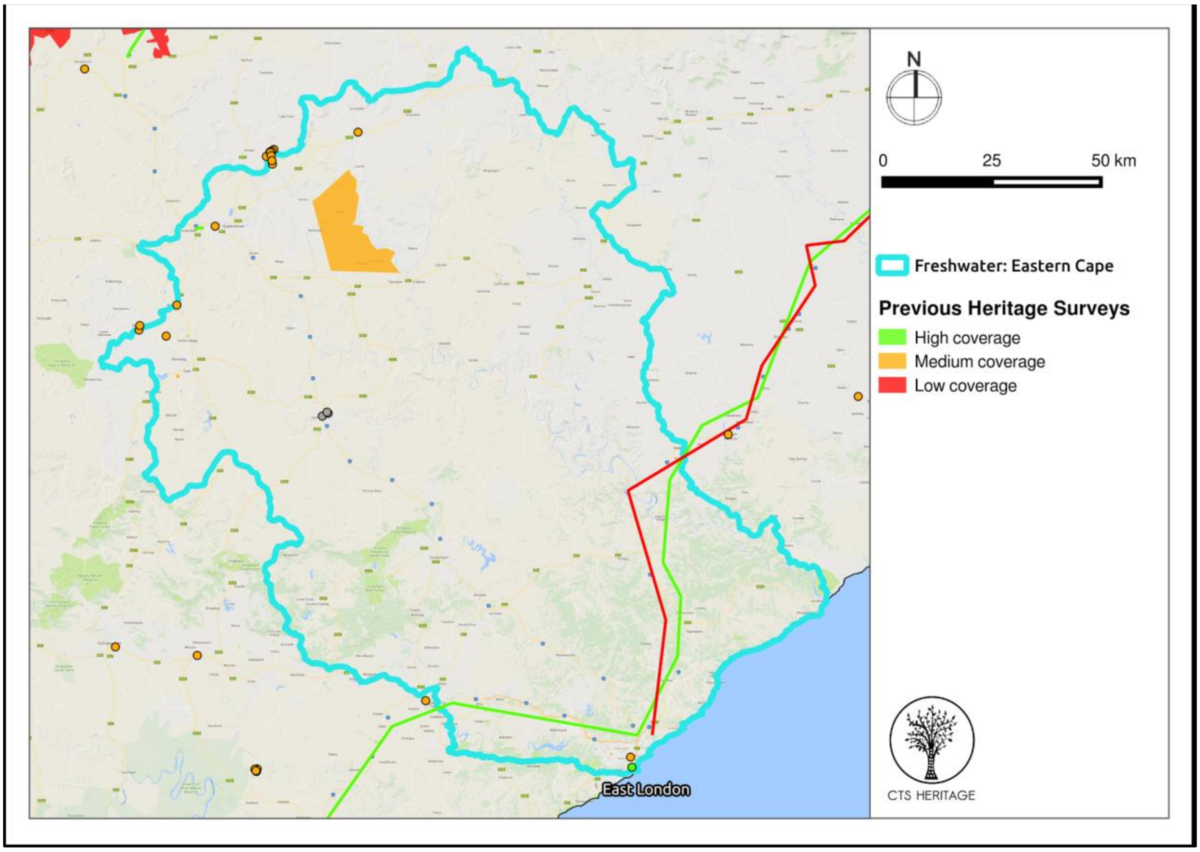

Figure 17. Eastern Cape Freshwater Study Area previous PIAs map.

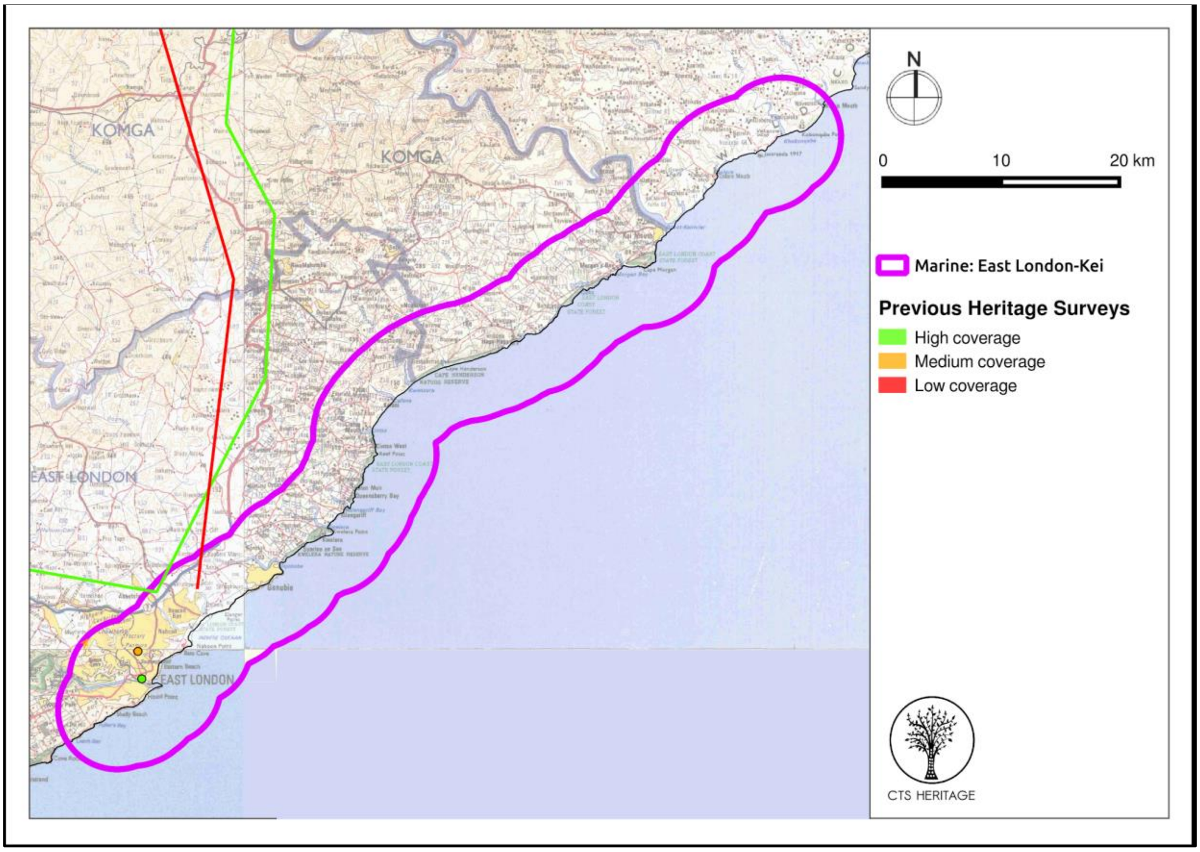

Figure 18. East London-Kei Marine Study Area previous PIAs map.

4.1.9 Freshwater Study Area 9 – Western Cape

4.1.9.1 Topography

The Western Cape freshwater study area encompasses a large tract of predominantly mountainous to hilly country embedded in the syntaxial and central zones of the Cape Fold Mountains (Partridge et al. 2010). Low-lying, hilly terrain in the far west forms part of the inner coastal plain (Swartland Geomorphic Province). This sector, drained by the Berg River, extends to the Cape Flats and False Bay coast in the southwest with isolated granitic uplands towards the north (Perdeberg, Paarlberg). The syntaxial zone of the Cape Fold Belt (CFB) features rugged, deeply-dissected uplands with numerous interconnected mountain ranges stretching from the Kogelberg in the SW to the Dutoitsberge and Hexrivierberge in the NE. The eastern half of the study area centres round the low-lying Worcester – Robertson Karoo which is drained by the Breede River and its tributaries. This region of highly-dissected, hilly country is enclosed between two converging upland ridges of the CFB, the W-E trending Riviersonderend Mountains in the south and the WNW-ESE Langeberg Range to the north. Similar but more arid hilly country to the northeast of the Langeberg (Koo and Keisie areas) belongs to the margins of the Little Karoo region which is drained via Kogmanskloof near Montagu. The south-easternmost sector of the study area, drained by the Riviersonderend, is characterised by rolling gently hilly landscapes (rüens) forming the inner margin of the Southern Coastal Platform. Levels of bedrock exposure in the study area vary from poor on the low-lying coastal plain to high in mountainous regions.

4.1.9.2 Geology

The complex geology of the Western Cape freshwater study area is shown on 1: 250 000 geological sheets 3318 Cape Town, 3319 Worcester, 3320 Ladismith, 3420 Riversdale as well as several published 1: 50 000 geology sheets for the Cape Town area (Council for Geoscience, Pretoria) (Theron 1984, Gresse & Theron 1992, Theron et al. 1991, Malan et al. 1994, Theron et al 1992). A wide spectrum of igneous, metamorphic and sedimentary rock units are represented here. The oldest bedrocks are Late Precambrian (Proterozoic) metasediments of the Swartland and Malmesbury Groups which underlie much of the Swartland Geomorphic Province as well as the southern foothills of the Langeberg and Hexrivierberge Ranges in the Worcester-Robertson Karoo (Gresse et al. 2006). These highly-deformed (folded, cleaved, faulted) metasediments are often highly weathered near-surface and are generally poorly-exposed. During the formation of the supercontinent Gondwana they were intruded and baked by a swarm of Late Precambrian to Early Cambrian granite plutons in later phases of the Saldanian Orogeny (mountain building event), such as the Kuilsrivier, Stellenbosch, Paarl and Robertson Granites in the study area.

Early Cambrian post-orogenic “red beds” of the Klipheuwel Group (including the Franschhoek Formation) occur within narrow fault-bound basins in the Swartland region as well as small inliers in the syntaxial zone of the CFB. The CFB itself is mainly constructed from folded and thrusted sediments of the Ordovician to Early Carboniferous Cape Supergroup that were laid down on the margins of Gondwana and later deformed as a result of continental collisions in Permo-Triassic times (formation of the supercontinent Pangaea).

The higher mountainous terrain is mostly built by resistant-weathering braided fluvial sandstones and quartzites of the Ordovician to Early Devonian Table Mountain Group (TMG). Thin packages of glacial tillites and post-glacial marine mudrocks of the Pakhuis and Cedarberg Formations in the middle of the TMG crop out widely within the CFB but are usually poorly-exposed. Lower-lying foothills and valleys within the CFB, for example along the northern flanks of the Riviersonderendberge and Langeberg as well as in the rüens area near Swellendam, are floored by the Bokkeveld Group (Early to Middle Devonian) and Witteberg Group (Middle Devonian to Early Carboniferous) (Thamm & Johnson 2006). These more readily-weathered impure sandstones, quartzites and mudrocks were deposited in a range of shallow marine, coastal, estuarine as well as lagoonal or lacustrine settings. Moderate to high levels of tectonic deformation, such as cleavage and tight folding, is commonly seen in these beds, especially the mudrock-rich intervals. Erosion of alternating resistant sandstone packages and readily-weathered mudrock packages generates characteristic stepped hillslopes and hogsback topography.

Following an important depositional and erosional hiatus, Late Carboniferous to Middle Permian sediments of the Karoo Supergroup were deposited in the region. They are represented in the study area by a large outlier of folded Karoo rocks to the south and east of Worcester. The Karoo succession here includes a thick basal package of glacial sediments of the Dwyka Group followed by a spectrum of offshore marine, lacustrine and deltaic deposits of the Ecca Group. During crustal stretching preceding the breakup of Gondwana narrow, down-faulted basins that developed along the southern edge of the Langeberg were infilled with thick wedges of continental "red bed" deposits (Uitenhage Group) (Shone 2006). These Late Jurassic to Early Cretaceous alluvial fan (scree), braided and meandering river sediments form striking lumpy hills in the Robertson – Ashton region. Late Caenozoic superficial sediments of the interior include a wide spectrum of cobbly to sandy and silty alluvium (e.g. Breede River Valley), colluvium (scree), soils, spring and cave deposits as well as various pedocretes (e.g. silcrete and ferricrete developed over weathered Bokkeveld and Malmesbury mudrocks). A thin blanket of Miocene to Holocene shallow marine, coastal and river sediments of the Sandveld Group mantles the low-lying coastal plain inland from False Bay (Pether et al. 2000, Roberts et al. 2006). These consist mainly of several packages of calcareous aeolianites of Plio-Pleistocene to Holocene age (Elandsfontein, Springfontein and Witsand Formations). Extensively calcretised Plio-Pleistocene aeolianites of the Elandsfontein Formation build low cliffs along the False Bay coast at Swartklip and Wolfgat. Older Tertiary deposits that have been detected at or below surface in the Cape Flats area include fluvial sands, gravels and peats of the Miocene Elandsfontein Formation (e.g. near Kraaifontein) as well as Miocene to Pliocene shelly gravels of the Varswater Formation (Strandfontein Member).

4.1.9.3 Palaeontology

The Western Cape freshwater study area includes numerous fossiliferous sedimentary rock units, several of which are of high palaeontological sensitivity (Almond & Pether 2008b, Almond 2008b and refs. therein). Late Precambrian to Early Cambrian basement rocks, including the Cape Granites as well as the Malmesbury and Swartland Group metasediments, are generally unfossiliferous, although less weathered and cleaved exposures of the latter might contain microfossils (*e.g.* acritarchs). Thin, marine-influenced intervals within the dominantly fluvial Table Mountain Group (TMG) contain low-diversity trace fossil assemblages (*e.g.* trilobite burrows; Potgieter & Oelofsen 1983) with possible microfossils preserved within mudrock facies. Important latest Ordovician, cold-water marine invertebrates and primitive fish, some showing soft-tissue preservation, are known from post-glacial mudrocks of the Cedarberg Formation (Aldridge *et al*. 1994, 2001, Selden and Nudds 2004), including localities in the Hexrivier Mountains just north of the present study area.

The uppermost TMG beds (Rietvlei Formation) may contain an Early Devonian brachiopod-dominated shelly fauna in more easterly outcrop areas. Early to Middle Devonian mudrocks and wackes of the Lower Bokkeveld Group (Ceres Group) are known for their diverse shelly marine invertebrates (brachiopods, trilobite, echinoderms, molluscs *etc*) and rare fish remains (Oosthuizen 1984, MacRae 1999, Anderson *et al.* 1999a). Middle Devonian estuarine to deltaic sediments of the Upper Bokkeveld Group (Bidouw Subgroup) contain a range of fossil fish such as primitive sharks, acanthodians, placoderms together with non-marine bivalves and transported land plants (*e.g.* lycopods) (Chaloner *et al.* 1980, Anderson *et al.* 1999b). However, most Bokkeveld Group outcrop areas within the present study area, with the exception of the Little Karoo, are too cleaved and weathered to yield useful fossil remains. At the base of the predominantly shallow marine Witteberg Group succession (Wagen Drift Formation) a few shelly invertebrate taxa and scrappy fish remains are recorded. The rest of the Middle to Upper Devonian part of the succession in the Western Cape mainly features shallow marine trace fossil assemblages dominated by helical burrows of *Spirophyton* species.

Diverse lagoonal to lacustrine plant and fish biotas are known from the Late Devonian Witpoort Formation (Gess & Hiller 1995, Gess 2002) and Early Carboniferous Waaipoort Formation (Evans 1998, 1999) elsewhere in the Cape Fold Belt but not so far from the present study area. The Dwyka Group glacial beds at the base of the Karoo Supergroup succession in the Worcester outlier are unfossiliferous. The overlying Early to Middle Permian basinal mudrocks of the Ecca Group contain a range of non-marine trace fossils (*e.g.* arthropod trackways, fish swimming trails) as well as transported plant debris (Almond 2012a). Carbonaceous, finely-laminated mudrocks of the Whitehill Formation have yielded prolific notocarid crustaceans, well-articulated mesosaurid reptiles, palaeonisocid fish, trace fossils as well as a few insect remains (Oelofsen 1987, Visser 1992, Evans 2005). The Uitenhage Group continental beds east of the study area are well-known for their important fossil floras (plant compressions and abundant petrified wood) as well as rare dinosaur remains of Early Cretaceous age (McLachlan & McMillan 1976, Anderson &

Anderson 1985, MacRae 1999). However, so far very few fossils have been found in the Worcester-Robertson outcrop area; they include reworked petrified wood from the basal Enon Formation near Worcester (*cf* Almond 2011b). Most Late Caenozoic superficial deposits in the interior are of low palaeontological sensitivity. However, older consolidated alluvium may contain Pleistocene mammal remains (bones, teeth, horn cores), freshwater molluscs and other fossils such as plant debris and trace fossils. Anthropogenic and natural accumulations of vertebrate remains may occur in caves, while moulds of reedy *vlei* plants are occasionally preserved in silcretes.

A wide range of Miocene to Recent fossils is recorded from coastal and inland exposures of the Sandveld Group in the Western Cape study area (Pether *et al.* 2000, Roberts *et al.* 2006). Miocene vascular plants and pollens (*e.g.* palms) are associated with peat horizons in the Elandsfontein Formation near Kraaifontein and elsewhere in the subsurface. Borehole cores through Miocene-Pliocene palaeovalley infills in the southern Cape Flats contain marine shells, bones and sharks teeth within gravels and marls of the Varswater Formation (Strandfontein Member). Consolidated, often calcretised, aeolianites of the Plio-Pleistocene Langebaan Formation contain a range of terrestrial gastropods, trace fossils (*e.g.* calcretised root casts) as well as rich concentrations of mammalian bones associated with carnivore lairs (*e.g.* Swartklip on the False Bay coast) and *vlei* areas (Hendey & Hendey 1968, Klein 1975, 1983, 1986). Inland outcrops of Pleistocene to Holocene sands of the Springfontein Formation may contain peat horizons with Mediterranean-type pollens. A wide spectrum of fossil remains, such as mammalian bones and teeth, tortoises, land snails, plant debris including peats and charcoal, microfossils and traces, may be found within Holocene dune sands of the Witsand Formation along the present day coastline, especially near ancient wetlands (Pether 2008).

4.1.9.4 Survey coverage and limitations

Although the area is quite well-known in terms of its heritage, surveys have covered only a tiny proportion of the overall study area (Figure 19 and Figure 20). The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

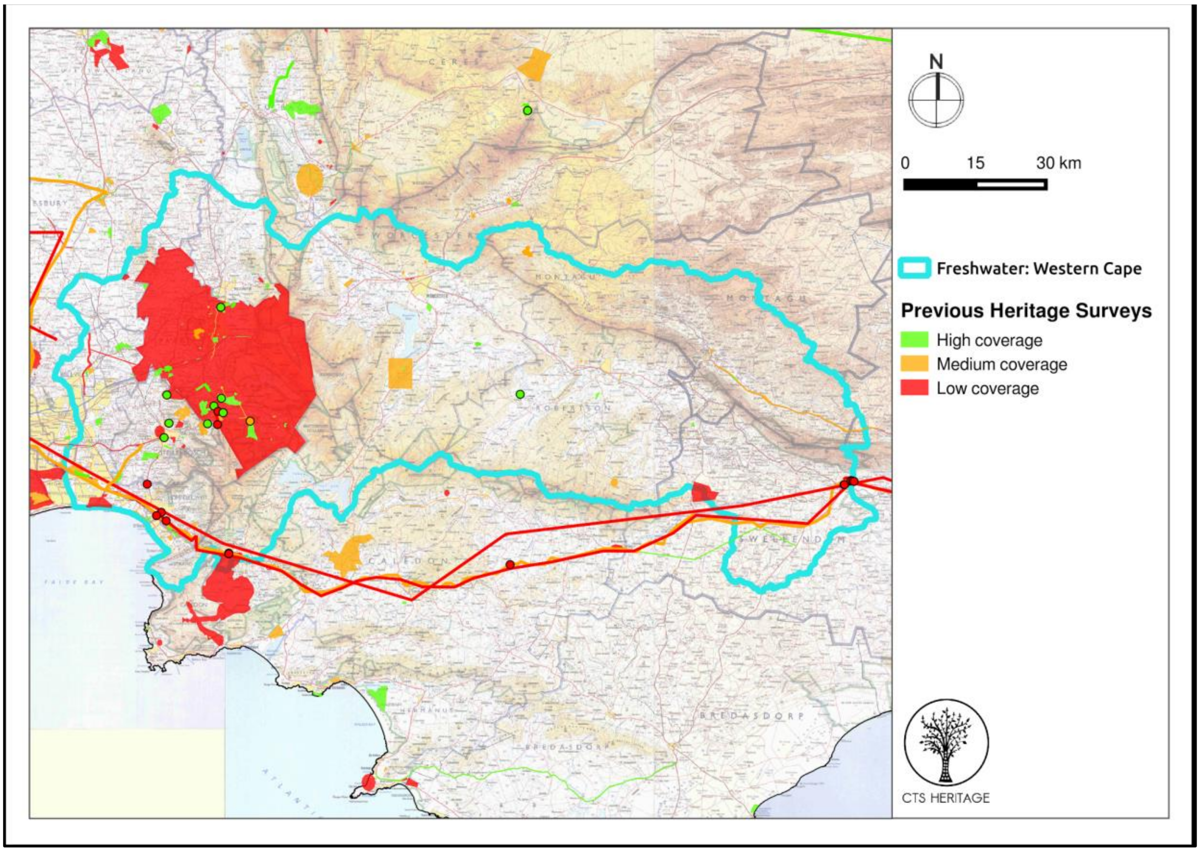

Figure 19. Western Cape previous HIAs map.

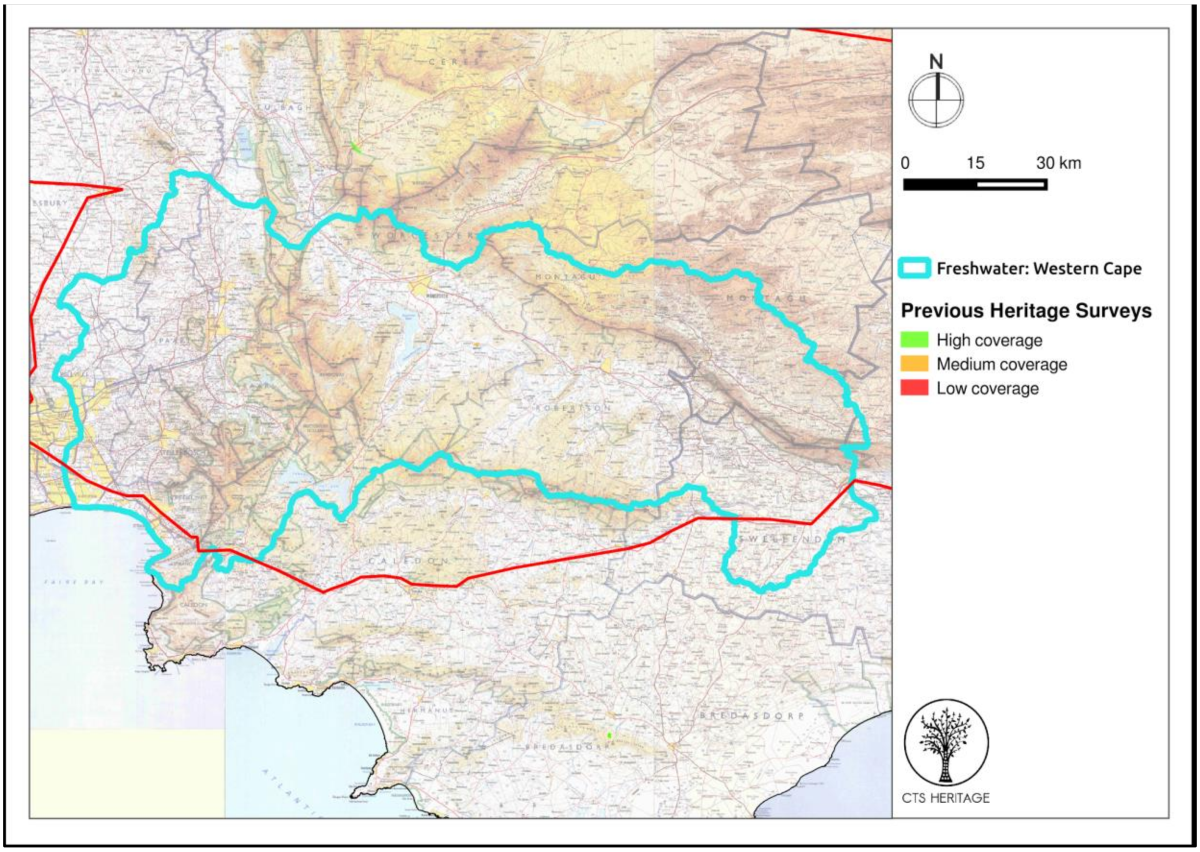

Figure 20. Western Cape previous PIAs map.

4.2 Marine Aquaculture Study Areas

4.2.1 Marine Study Area 3 – Port Elizabeth

4.2.1.1 Topography

The coastal plain here, part of the Eastern Coastal Lowlands region (Partridge et al. 2010), is low-lying and gently-sloping since it is incised across readily-eroded Cretaceous bedrocks of the Algoa Basin. The uplifted, marine-planed coastal platform between the Coega and Sundays Rivers is known as the Coega Plateau. Higher-lying terrain in the west near Port Elizabeth and Cape Recife forms part of the Eastern Cape Fold Mountains; this region is underlain by more resistant Table Mountain Group bedrocks. The coastal plain is traversed by three sizeable rivers, the Swartkops, Coega and Sundays Rivers, with important estuaries at their mouths. A major plume of unconsolidated aeolian sand, the Alexandria Dune Field, extends either side of the Sundays River mouth near Colchester. A cordon of vegetated dunes runs inland of the sandy beaches along substantial stretches of the northern coast of Algoa Bay.

4.2.1.2 Geology

The geology of the Port Elizabeth study area is covered by the 1: 250 000 geology sheet 3324 Port Elizabeth and in more detail by the 1: 50 000 geology sheets 3325DC & DD, 3425BA Port Elizabeth (Toerien and Hill 1989, Le Roux 2000). The various Palaeozoic to Holocene sedimentary rock units represented here have been described by Almond (2010a; see extensive references therein). Folded fluvial quartzites of the Ordovician Peninsula Formation (Table Mountain Group) cropping out beneath Port Elizabeth are better exposed around Cape Recife.

Early Cretaceous estuarine to fluvial mudrocks and sandstones of the Kirkwood Formation (Uitenhage Group) (Dingle et al. 1983, Shone 2006) underlie much of the coastal hinterland between PE and the Swartkops River but are not well-exposed along the coast itself; there are good artificial exposures, however, in the Coega IDZ / Ngqura Port area along the banks of the Coega River. This unit interfingers with, and is overlain by, Early Cretaceous marine to estuarine mudrocks and subordinate sandstones of the Sundays River Formation that crop out inland along the flanks of the Swartkops, Coega and Sundays River Valleys (ibid.).

The outer coastal plain and shallow offshore zones are mantled by a complex set of Miocene to Holocene shallow marine to coastal sediments assigned to the Algoa Group (Maud & Botha 2000, Roberts et al. 2006). The estuarine to marine Alexandria Formation at the base of the Algoa Group succession consists of a basal conglomerate rich in oyster shells overlain by calcareous sandstones, shelly coquinas and thin conglomerates. It represents a composite product of several marine transgressions (marine invasions) and regressions (marine retreats) across the Algoa coastal plain in Late Miocene to Pliocene times, i.e. roughly 7-5 Ma ago. The Alexandria beds are overlain by a series of calcareous aeolianite packages ranging from Pliocene to Holocene age (Nanaga, Nahoon and Schelm Hoek Formations), with intercalations of marine to estuarine shelly sands and gravels of Pleistocene to Recent age (Salnova Formation). “High Level Gravels” and finer-grained alluvial sediments of the Kudus Kloof Formation mantle a stepped series of river-cut terraces along the Sundays River Valley (Hattingh 1994, 2001). They are dated from Miocene to Recent through correlation with fossiliferous marine terraces along the coast. Reddish-brown silts, sands and gravels of the Kinkelbos Formation overlying the Alexandria Formation east of Colchester have been interpreted as Plio-Pleistocene marine or lagoonal deposits (Le Roux 1989).

4.2.1.3 Palaeontology

Fossil heritage recorded from the various sedimentary rock units represented in the Port Elizabeth area has been briefly reviewed by Almond et al. (2008), in more detail by Almond (2010a) and in several subsequent palaeontological desktop and field assessments (e.g. Almond 2011c, 2012b, 2012c, 2013c). The Peninsula Formation fluvial quartzites may contain low-diversity trace fossil assemblages and microfossils, especially in association with thin, marine-influenced mudrock intervals. However, they are tectonically deformed and generally unfossiliferous in the study region.

The Early Cretaceous Kirkwood Formation in the Algoa Basin is renowned for its locally abundant petrified logs, plant compression floras and rare dinosaur remains but little has so far been recorded from the limited near-coastal exposures (Seward 1903, Anderson & Anderson 1985, De Klerk 2000). The estuarine to marine mudrocks and subordinate sandstones of the overlying Sundays River beds have yielded a wealth of Early Cretaceous molluscs (e.g. ammonites, bivalves) and other shelly invertebrates, microfossils, trace fossils as well as very rare marine reptiles (plesiosaurs) (Cooper 1981, 1991, McLachlan & McMillan 1976, MacRae 1999, Shone 2006).

The Port Elizabeth to Colchester area is important for Miocene to Recent fossil marine invertebrates, sharks teeth and coquinites (shell hash) in the Alexandria and Salnova Formations (Algoa Group) (Le Roux 1987, 1993b). An especially diverse assemblage (> 300 taxa) of Pleistocene marine shells from the Salnova Formation is known informally as the “Swartkops Fauna”, recorded for example at Brighton Beach and the Coega estuary (Le Roux 1991, 1993b, Almond 2012b). Pliocene to Holocene dune packages within the Algoa Group (Nanaga, Nahoon and Schelm Hoek Formations) contain locally abundant terrestrial snails and calcretised trace fossils (e.g. plant root casts and rhizocretions), with possible accumulations of vertebrate bones and teeth associated with hyaena dens. The range of potential fossil remains associated with modern coastal dune sands, including vlei peats, ostrich eggshells and mole remains, have been ably summarized by Pether (2008).

Fossils have not yet been recorded from the older (Miocene to Pleistocene) alluvial terrace deposits of the Kuduskloof Formation or from the Plio-Pleistocene lagoonal / marine Kinkelbos Formation. These sedimentary packages have not been intensely searched for fossils, however, and might contain, for example, mammalian bones and teeth, reworked blocks of petrified wood, subfossil plant material as well as freshwater invertebrates (e.g. molluscs, crustaceans).

4.2.1.4 Survey coverage and limitations

Much of the study area was already developed before heritage surveys were regularly conducted (Figure 21 and Figure 22). In the east the Coega area has been very well studied, but the caution provided by Binneman (2010) that Stone Age sites appear to be quite quickly covered by shifting dune sand suggests that further finds could easily be made in areas already surveyed. The most eastern part of the study area has not been surveyed. The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

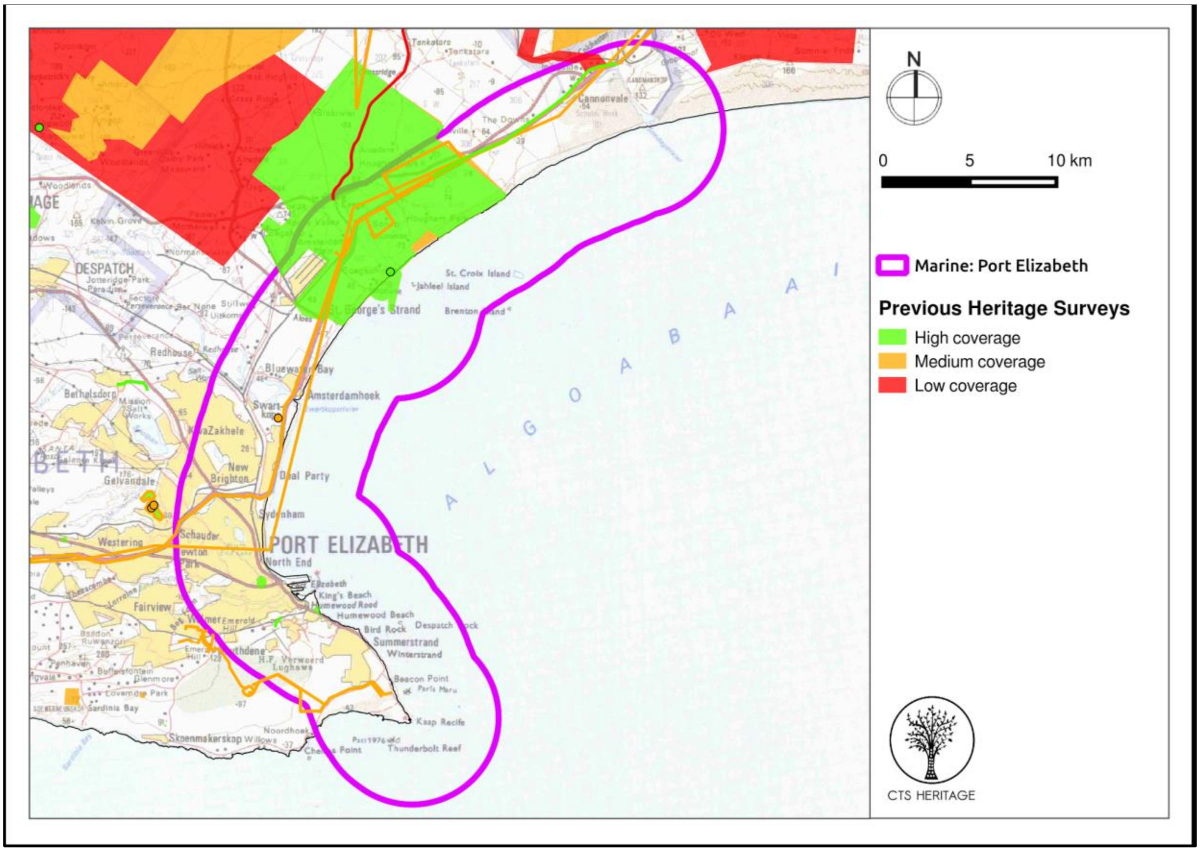

Figure 21. Port Elizabeth previous HIAs map.

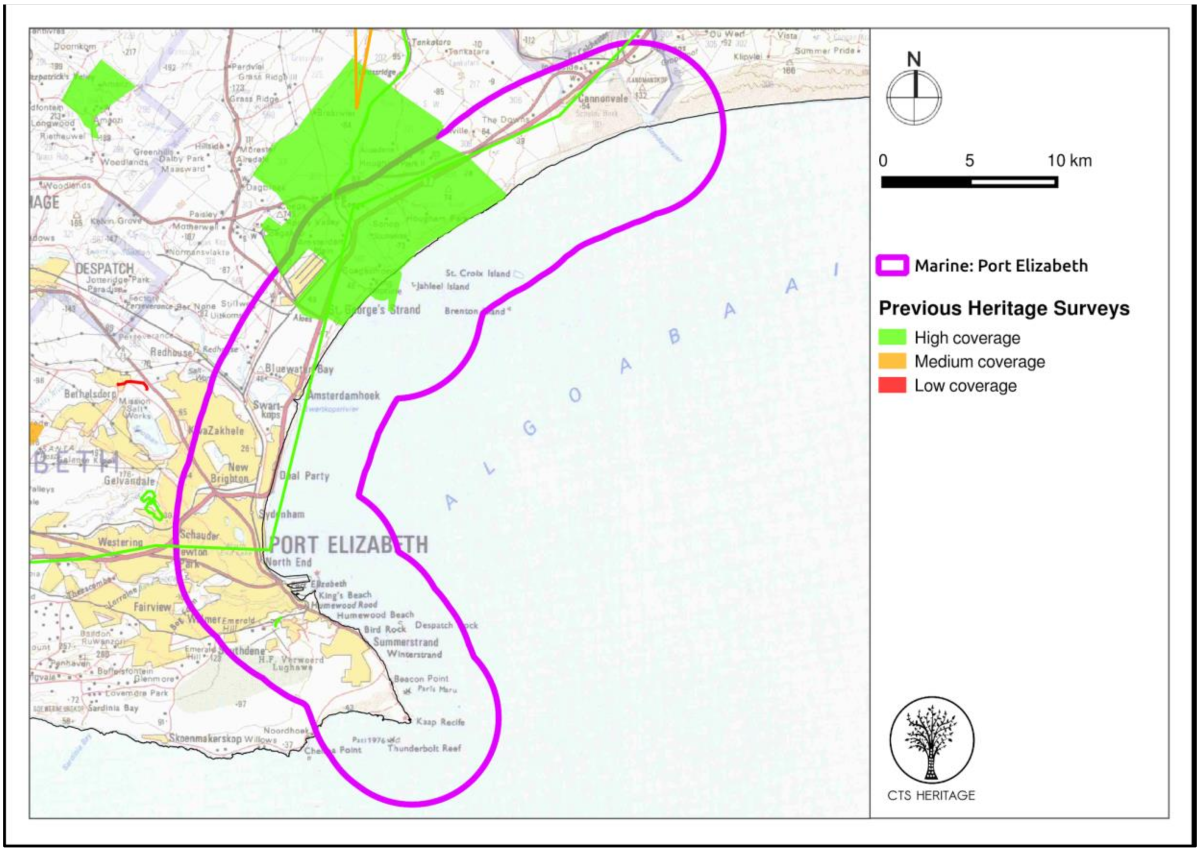

Figure 22. Port Elizabeth previous PIAs map.

4.2.2 Marine 4 – Gouritz to George

4.2.2.1 Topography

The western sector, underlain by sedimentary rocks, features several arcuate bays with sandy beaches (Visbaai, Vleesbaai, Mosselbaai) separated by rocky headlands (e.g. Vleespunt, Cape St Blaize). The eastern sector, from Glentana onwards, is underlain by resistant-weathering igneous rocks and metasediments, generating a more rugged, rocky coastline. The coastal hinterland features a gently seaward-sloping, marine-cut platform known as the George Terrace that is of Tertiary age (Eocene or Miocene), and has been subject to Late Tertiary uplift (Partridge et al. 2006, Roberts et al. 2008a), and forms part of the Southern Coastal Platform of Partridge et al. (2010). Lower-lying terrain to the west of Mosselbaai is referred to the Southern Coastal Lowlands region (ibid.). The Gouritz River is a very ancient (perhaps Cretaceous), deeply-incised drainage system that cuts across the entire coastal platform as well as the CFB running along its inner margin. A number of smaller, younger rivers originating in the CFB traverse the platform and have been incised by coastal uplift (e.g. Grootbrak, Kleinbrak, Kaaimans). Several of these have sandy to muddy estuaries at their mouths.

4.2.2.2 Geology

The geology of the study area is outlined on 1: 250 000 geological sheets 3420 Riversdale and 3322 Oudtshoorn (Malan et al. 1994, Toerien 1979). There are also more detailed 1: 50 000 scale published geological maps for the Mossel Bay and George areas (Viljoen & Malan 1993, Roberts et al. 2008a). The oldest rocks in the area are the Late Precambrian (Proterozoic) metasediments of the Kaaimans Group that crop out along the coast south of George and in the Kaaimansrivier (Gresse et al. 2006). During the Saldanian orogeny (mountain building event) these marine sediments suffered tectonic deformation and metamorphosis, and were also baked by the intrusion of the voluminous Maalgaten Granite pluton (Cape Granite Suite) that dominates the coastal platform around George.

The coastal platform west of Mossel Bay is planed across Silurian to Early Devonian sandstones and quartzites of the Table Mountain Group (Cape Supergroup) that have been compressed into a series of west-east trending folds during the Cape orogeny. The succession includes representatives of the Nardouw Subgroup (Goudini, Skurweberg and Baviaanskloof Formations) that are mainly of braided fluvial origin but include some intervals showing shallow marine influence. Narrow outcrop areas of the overlying Early to Middle Devonian Bokkeveld Group (Cape Supergroup) occur near Mossel Bay and Gouritzmond. These mudrock-dominated marine shelf sediments are highly deformed and weathered in this region, however.

Late Jurassic to Cretaceous continental sediments of the Uitenhage Group infill down-faulted basins related to the incipient breakup of Gondwana along the so-called Worcester-Pletmos line, with outcrop areas in the coastal interior west of Vleesbaai and Mosselbaai (Shone 2006). The Uitenhage succession here includes fluvial to alluvial fan conglomerates and sandstones with minor mudrocks of the Enon, Kirkwood, Buffelskloof and Hartenbos Formations. Coastal exposures of these continental "red beds" are very limited (e.g. Die Punt near Mossel Bay, Vleesbaai).

The lower-lying seaward margins of the coastal plain, especially the Southern Coastal Lowlands region west of Mossel Bay, is blanketed by a complex prism of Miocene to Holocene shallow marine to coastal and estuarine sediments of the Bredasdorp Group (Malan 1989, Maud & Botha 2000, Roberts et al. 2006). This succession starts at the base with Miocene-Pliocene conglomerates, sandstones and coquinas (shell hash) of the De Hoop Vlei Formation. This is overlain by a series of calcareous dune sands, in part consolidated or calcretised, ranging in age from Pliocene to Holocene (Wankoe, Waenhuiskrans and Strandveld Formations). Towards the coast, these aeolianites are intercalated with wedges of shallow marine to coastal or estuarine deposits of similar age range (Klein Brak Formation). Recent superficial deposits include estuarine, alluvial and pan sediments, downwasted surface gravels as well as various soils and cave deposits.

4.2.2.3 Palaeontology

The fossil heritage of most of the sedimentary rock units represented in this study area has been reviewed in previous palaeontological assessments by Almond (2009a, 2010b, 2012d, 2012e, 2016b). The Maalgaten Granite is an unfossiliferous igneous rock, while the surrounding Late Precambrian Kaaimans Group metasediments are probably too deformed and metamorphosed to contain identifiable fossil remains; at most organic-walled microfossils are likely to occur here.

The Silurian to Early Devonian Nardouw Subgroup quartzitic bedrocks contains low diversity shelly fossil and trace fossil assemblages in marine-influenced horizons, such as parts of the Baviaanskloof Formation, but only very poorly-preserved examples are reported from this region (Viljoen & Malan 1993). Likewise, deep chemical weathering and tectonic deformation appear to have largely destroyed shelly invertebrate and other fossils originally preserved within the overlying Devonian Bokkeveld Group. The coarse Late Jurassic Enon Formation conglomerates and alluvial fan breccias at the base of the Uitenhage Group are apparently unfossiliferous, although sparse reworked bone, teeth and petrified wood might occur in these beds.

Finer-grained fluvial gravels, sandstones and mudrocks of the overlying Early Cretaceous Kirkwood, Buffelskloof and Hartenbos Formations have yielded a range of vascular plant remains in the Mossel Bay area, including locally-abundant, well-preserved petrified wood (Seward 1903, McLachlan & McMillan 1976, Anderson & Anderson 1985, Almond 2012e). Rare animal fossils include freshwater crustaceans as well as an isolated sauropod dinosaur tooth found near Vleesbaai. Miocene to Pliocene shallow marine sediments of the De Hoop Vlei Formation at the base of the Bredasdorp Group contain a range of shelly marine invertebrates (bivalves such as oysters, snails, sea urchins etc), sharks teeth and trace fossils (Le Roux 1993b, Maud & Botha 2000, Roberts et al. 2006).

The Pleistocene Klein Brak Formation is known for its rich estuarine to marine shelly biotas (the "Swartkops Fauna"), especially from localities along the lower course of the Klein-Brak River (Malan 1991, Viljoen & Malan 1993). This unit also contains subfossil plant remains (including wood) and palynomorphs (pollens and spores). Plio-Pleistocene coastal aeolianites of the Bredasdorp Group (Wankoe and Waenhuiskrans Formations) contain a small range of terrestrial snails, microfossils and shell debris as well as trace fossils (e.g. calcretsied rhizoliths, termitaria). Important interglacial vertebrate trackways (including elephants) are reported from Waenhuiskrans beds at Still Bay, just west of the present study area (Roberts et al. 2008b). A wide spectrum of subfossil remains, such as mammalian bones and teeth, tortoises, land snails, plant debris including peats and charcoal, microfossils and traces, may be found within Holocene dune sands of the Strandveld Formation along the present day coastline, especially near ancient wetlands (Pether 2008). Important accumulations of terrestrial and marine vertebrates and shellfish, mostly of anthropogenic origin, are recorded within Pleistocene to Holocene cave deposits at coastal sites such as Pinnacle Point near Mossel Bay (Marean 2010).

4.2.2.4 Survey coverage and limitations

Despite much work in the area, the overall study area remains relatively poorly surveyed (Figure 23). However, the information to hand allows a good estimate of the heritage resources likely to be present in the area. The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

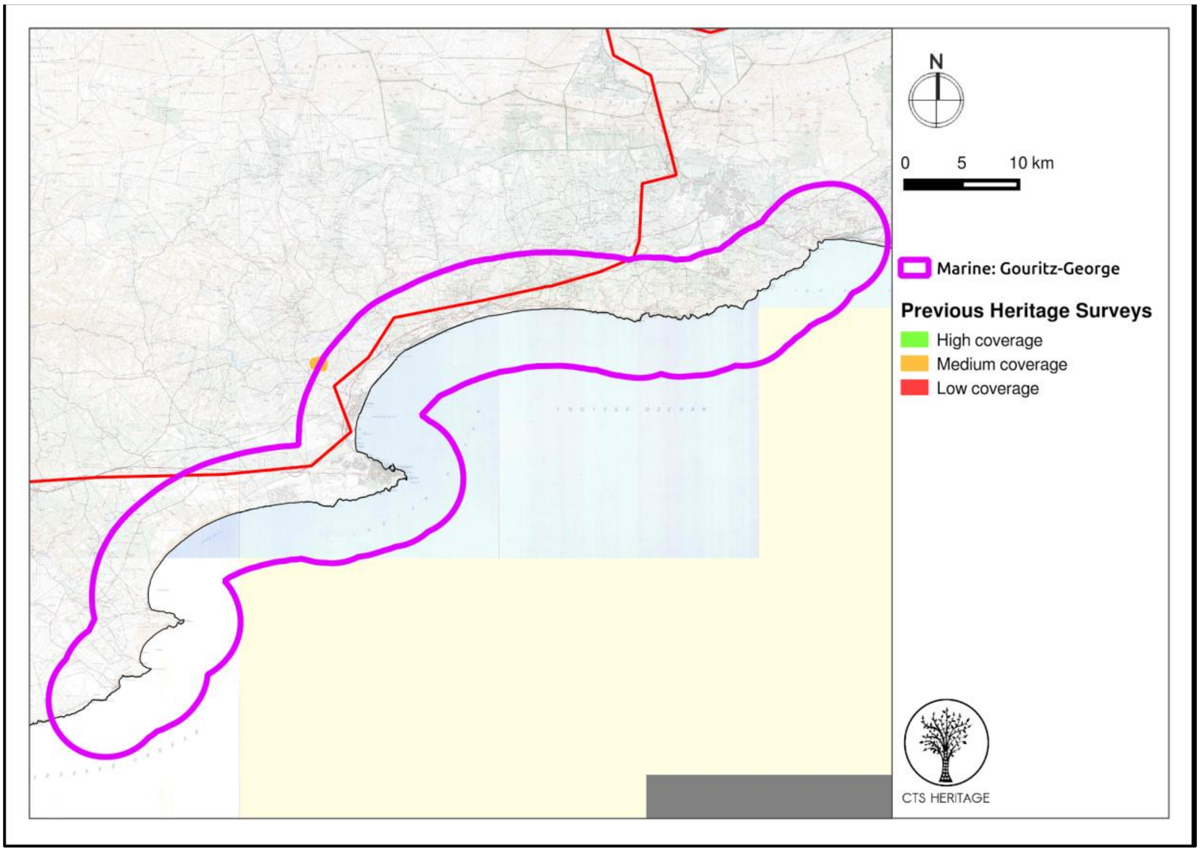

Figure 23. Gouritz-George previous HIAs map.

4.2.3 Marine Study Area 5 – Hermanus to Arniston

4.2.3.1 Topography

The complexity of the coastline and its topographic variety are largely due to the way in which it cuts across the CFB - the Central Cape Fold Mountains Region of Partridge et al. (2010). Resistant-weathering Table Mountain Group quartzites build rocky headlands (e.g. Danger Point, Quoin Rock, Cape Agulhas, Struis Punt), offshore reefs and islands (e.g. Dyer Island), stepped wave-cut platforms close to sea level and steep, rugged mountain slopes near shore, for example between Betty's Bay, Hermanus and Gansbaai. Sandy bays with gently shelving sandy beaches like Walker Bay and Struisbaai occur along lower-lying stretches where more readily-eroded Bokkeveld Group mudrocks underlie the coastal platform. Cordons of vegetated or mobile sand dunes run along the beach inner margins and may expand over a broad coastal platform, as at Agulhas and Struisbaai. From Agulhas eastwards the coastal plain widens out to form part of the Southern Coastal Lowlands with rolling hilly terrain in the interior. Rivers in the west, such as the Botrivier and Kleinrivier, tend to follow the grain of the Cape Fold Belt; both have substantial back-barrier wetlands or vleis at their mouths reflecting the Holocene rise in sea level.

4.2.3.2 Geology

The geology of the study area is outlined on 1: 250 000 geological sheets 3319 Worcester and 3420 Riversdale (Gresse & Theron 1992, Malan et al. 1994). The oldest bedrocks are small, fault-bound inliers of Cape Granite assigned to the Hermanus Pluton (Scheepers & Schoch 2006). They crop out within the CFB inland of Hermanus and Gansbaai, also building a small island north of Bantamsklip. Rocky coastal stretches are largely carved from Ordovician fluvial quartzites of the Peninsula Formation (Table Mountain Group). Tiny outcrop areas of latest Ordovician tillites and overlying post-glacial mudrocks of the Pakhuis and Cederberg Formations occur, for example, near Quoin Point and west of Cape Agulhas (Thamm & Johnson 2006). Due to Permo-Triassic Cape folding and Gondwana break-up in the Cretaceous the Table Mountain Group bedrocks in the region are folded and cut by numerous faults with brecciated zones. Early to Middle Devonian marine mudrocks and wackes of the Lower Bokkeveld Group (Ceres Subgroup) underlie low-lying stretches of the coastal hinterland at depth, in the Botrivier Valley as well as inland of Walker Bay and Struisbaai, but do not crop out along the coast itself. They are generally highly-deformed and deeply-weathered. Relict patches of Tertiary silcretes (silicified sands and gravels) are scattered across Bokkeveld outcrops on the coastal plain. Several tiny outcrop areas of Late Jurassic conglomerates of the Enon Formation (Uitenhage Group) forming part of the Bredasdorp Basin Line are mapped just south of Soetendalsvlei. Most of the coastal platform, especially along the lower-lying stretches, is mantled by Miocene to Holocene shallow marine to coastal and estuarine sediments of the Bredasdorp Group (Malan 1989, Maud & Botha 2000, Roberts et al. 2006). This succession starts at the base with Miocene to Pliocene conglomerates, sandstones and coquinas (shell hash) of the De Hoop Vlei Formation whose type area lies just east of the study area. This is overlain by several packages of calcareous dune sands, in part consolidated or calcretised, ranging in age from Pliocene to Holocene (Wankoe, Waenhuiskrans and Strandveld Formations). Towards the coast these aeolianites are intercalated with wedges of shallow marine or estuarine deposits of similar age range (Klein Brak Formation). The De Hoop Vlei and Klein Brak Formations have only very small outcrop areas in the study area while vegetated to mobile Wankoe and Strandveld aeolianites are widely distributed along the coast. Recent superficial deposits include estuarine, lagoonal, alluvial, vlei and pan sediments, downwasted surface gravels as well as various soils and cave deposits.

4.2.3.3 Palaeontology

Comparatively few fossil sites have been recorded within this study area. The Cape granites are entirely unfossiliferous igneous rocks while the overlying Cape Supergroup sediments are largely of low palaeontological sensitivity due to high levels of bedrock weathering and tectonism. Low diversity trace fossil assemblages, such as trilobite burrows, and perhaps microfossils as well may be associated with marine-influenced horizons within the Peninsula Formation (Table Mountain Group) (Potgieter & Oelofsen 1983). Important latest Ordovician, cold-water marine invertebrates and primitive fish, some showing soft-tissue preservation, are known from post-glacial mudrocks of the Cedarberg Formation (Aldridge et al. 1994, 2001, Selden and Nudds 2004), but not within the present study area where the coastal outcrops are very small. Potentially fossil-rich Devonian mudrocks of the Lower Bokkeveld Group, known elsewhere for their diverse shelly invertebrates and rare fish remains, are generally too weathered to yield recognisable fossil remains (Oosthuizen 1984, MacRae 1999, Almond 2012f). Overlying Tertiary silcretes might contain moulds of fossil reedy plants. The Enon conglomeratic red beds are generally unfossiliferous and the outcrop areas here are tiny. Miocene to Pliocene shallow marine sediments of the De Hoop Vlei Formation at the base of the Bredasdorp Group contain a range of shelly marine invertebrates (bivalves such as oysters, snails, sea urchins etc), sharks teeth and trace fossils (Le Roux 1993b, Maud & Botha 2000, Roberts et al. 2006, Almond 2008a). The Pleistocene Klein Brak Formation is known for its rich estuarine to marine shelly biotas (the “Swartkops Fauna”), recorded near Die Kelders for example (Malan 1991, Viljoen & Malan 1993, Gresse & Theron 1992). This unit also contains subfossil plant remains (including wood), palynomorphs (pollens and spores) and land snails. Plio-Pleistocene coastal aeolianites of the Bredasdorp Group (Wankoe and Waenhuiskrans Formations) contain a small range of terrestrial snails, microfossils and shell debris as well as trace fossils (e.g. calcretised rhizoliths, termitaria). A wide spectrum of subfossil remains - such as mammalian bones and teeth, tortoises, land snails, plant debris including peats and charcoal, microfossils and traces - may be found within Holocene dune sands of the Strandveld Formation along the present day coastline, especially near ancient wetlands (Pether 2008). Important, mostly anthropogenic, accumulations of terrestrial and marine vertebrates - including tortoises and rare hominin bones and teeth as well as shellfish - are recorded within Pleistocene to Holocene cave deposits at coastal and inland sites such as Die Kelders and Byneskranskop near Gansbaai (Grine 2000, Klein & Cruz-Uribe 1983).

4.2.3.4 Survey coverage and Limitations

Although the area has been only patchily surveyed, it has been subject to fairly extensive archaeological research, with archaeological investigations in the area dating back to the 1930s (Goodwin 1938) (Figure 24 and Figure 25). This means that the heritage character of the area is well understood. It is significant to note, however that the only known rock art in the region was only discovered in recently (Galimberti and Wiltshire 2016) although dense coastal fynbos vegetation in this area hampers archaeological visibility.

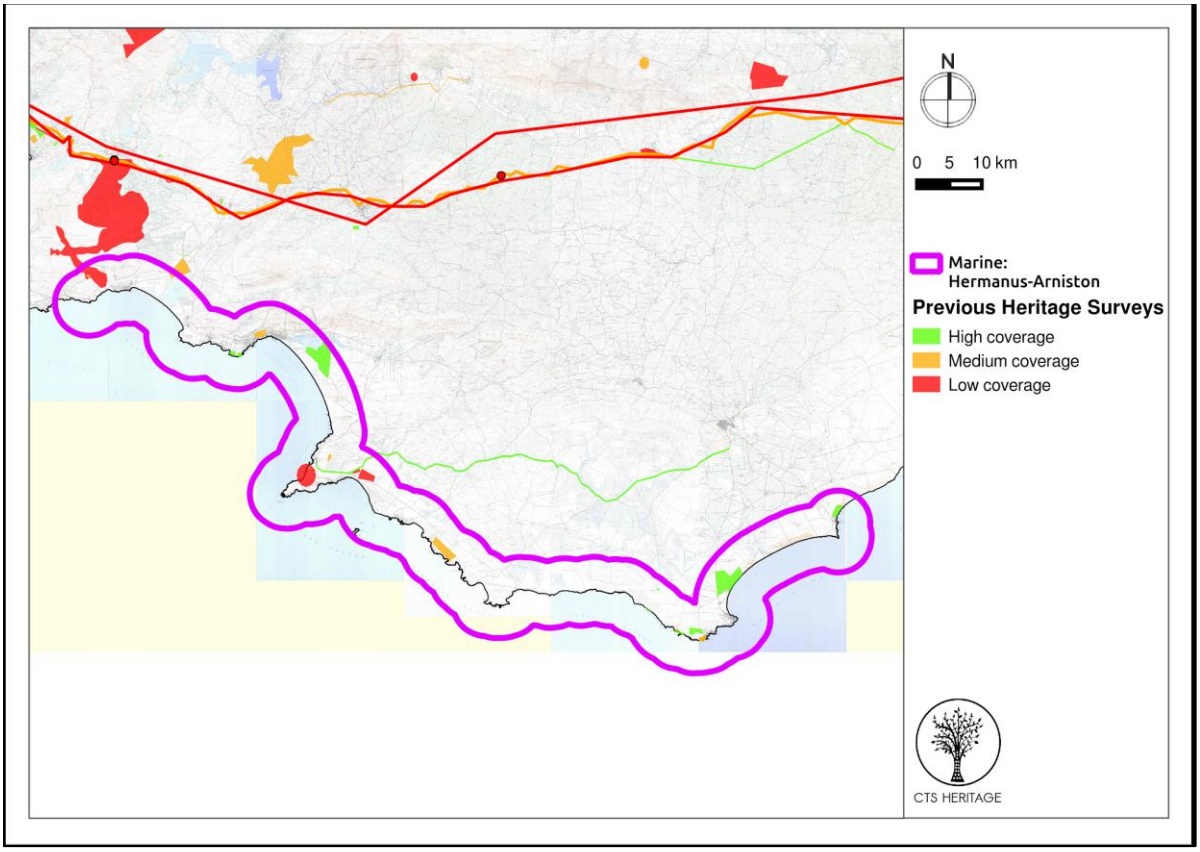

Figure 24. Hermanus-Arniston previous HIAs map.

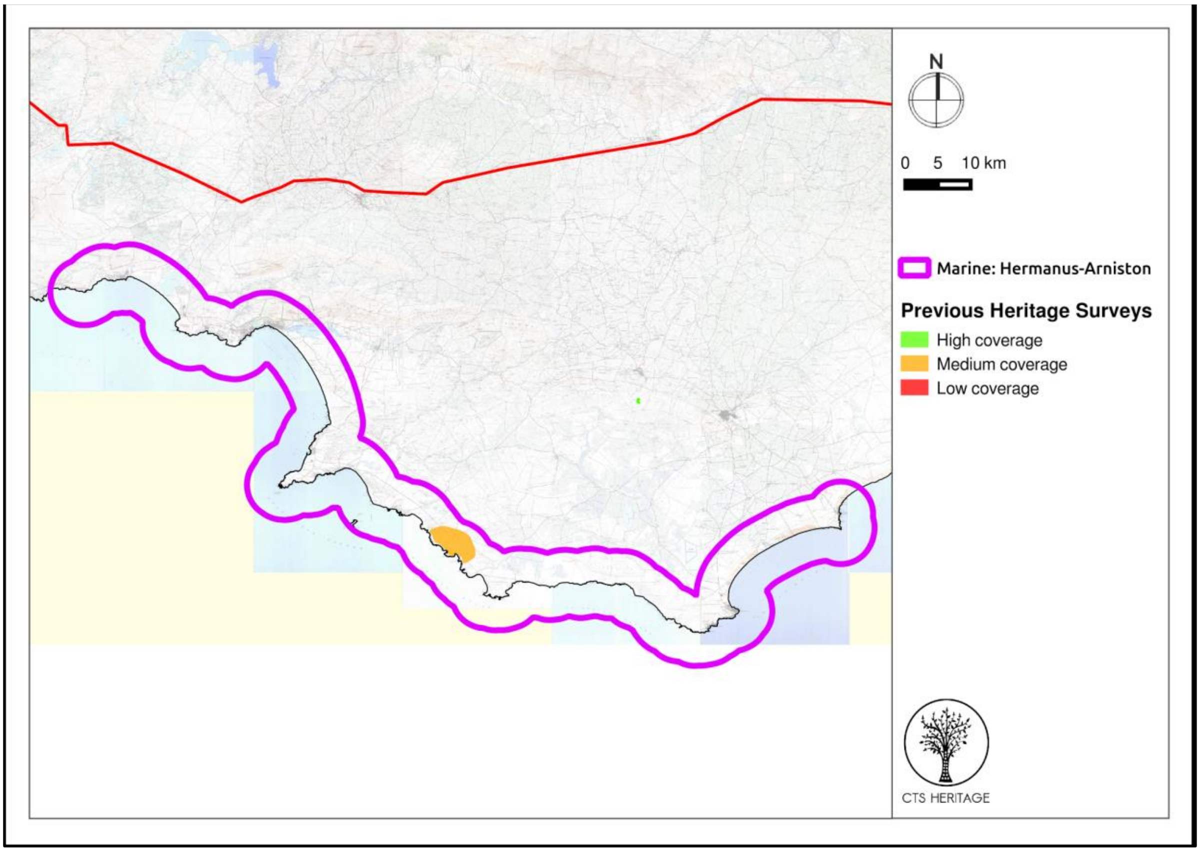

Figure 25. Hermanus-Arniston previous PIAs map.

4.2.4 Marine Study Area 6 – Velddrif to Saldanha Bay

4.2.4.1 Topography

This Vredenburg Peninsula lies within the Swartland Geomorphic Province (Partridge et al. 2010), and its distinctly scalloped shoreline is mostly rocky, with small arcuate sandy beaches separated by rocky headlands. Gently hilly terrain in the peninsular hinterland reflects a sand-draped, marine-planed coastal platform with isolated granitic koppies (e.g. Kasteelberg, Patrysberg). Saldanha Bay to the south is flanked by granitic uplands at Saldanha, Langebaan and the Postberg Peninsula and interconnects with the shallow, sandy Langebaan Lagoon to the southeast. More extensive sandy beaches are found along the northern side of Saldanha Bay as well as around St Helena Bay near Velddrif where the Groot-Bergrivier enters the sea.

4.2.4.2 Geology

The geology of this study area is shown on 1: 250 000 geological sheets 3318 Cape Town and 3218 Clanwilliam as well as on the older 1: 125 000 map sheet 255 (Council for Geoscience, Pretoria) (Theron 1984, Visser & Schoch 1973). The oldest bedrocks are Late Precambrian (Proterozoic) metasediments of the Swartland Group (Moorreesburg Formation) cropping out along the southern coast of St Helena Bay (Gresse et al. 2006). These metasediments are highly-deformed, through folding, cleaving and faulting. They are often highly weathered near-surface and generally poorly-exposed, having been planed-down by marine erosion. In the study area the Swartland bedrocks have been baked and intruded by voluminous granitic bodies of latest Precambrian-Early Cambrian age, the Saldanha and Vredenburg Batholiths, with minor associated extrusive igneous rocks (e.g. ignimbrites on the Postberg Peninsula) (Scheepers & Schoch 2006). These resistant-weathering igneous rocks build the higher ground of the Vredenburg Peninsula and around Saldanha Bay (e.g. Postberg Peninsula) as well as the rocky coastline, offshore islands and reefs in the area.

A complex spectrum of shallow marine, coastal and fluvial sediments of Miocene to Holocene age assigned to the Sandveld Group are found along the coast as well as mantling the raised coastal platform in the study area (Pether et al. 2000, Roberts & Brink 2002, Roberts et al. 2006, Roberts 2006a-e, Pether 2011, 2012). The outer margins of the raised coastal platform are mantled with several packages of consolidated, locally calcretised calcareous aeolianites ("Langebaan Limestones") representing ancient dune cordons and plumes that advanced inland during intervals of falling sea level. They include an older Miocene Prospect Hill Formation and the composite Plio-Pleistocene Langebaan Formation. Quaternary to Holocene quartzose sands of various origins in the interior are assigned to the Springfontein Formation, while modern coastal dune cordon and dune plume sands belong to the Witsand Formation. Buried beneath these cover sands are important pockets or wedges of fossiliferous marine, beach, estuarine and fluvial valley infill deposits of Miocene to Quaternary age. They are mainly known from boreholes and quarries in the interior, such as Langebaanweg near Hopefield (Hendey 1982). Examples include the Oligocene-Early Miocene fluvial valley-infill deposits of the Elandsfontein Formation encountered in the subsurface between Saldanha Bay and Hopefield, phosphatic, shelly marine sands of the mid-Pliocene Uyekraal Formation (e.g. Hoedjiespunt Peninsula), and Quaternary shelly raised beach and estuarine deposits of the Velddrif Formation that crop out close to modern sea level near the Berg River mouth and along the Postberg Peninsula. A range of Pleistocene to Holocene superficial deposits in the coastal hinterland include sandy soils (e.g. heuweltjies veld), colluvium, vlei and pan sediments as well as alluvium, for example along the Berg River.

4.2.4.3 Palaeontology

The Late Precambrian to Early Cambrian basement rocks in the study area are unfossiliferous, although the Swartland Group metasediments might contain microfossil assemblages. A wide spectrum of Miocene to Holocene marine and continental fossil remains are recorded from the Sandveld Group of the Western Cape, with several key palaeontological sites in the broader Saldanha region (Pether et al. 2000, Roberts et al. 2006, Roberts 2006a-e, Almond & Pether 2008b, Pether 2012, Almond 2012e). Buried Oligocene-Miocene fluvial sediments of the Elandsfontein Formation include peat horizons with pollens of yellowwoods and palms. Mid-Pliocene shelly gravels and sands of the Uyekraal Formation, recorded from several sites around Saldanha Bay (e.g. Langebaan, Bomgat, and Sea Harvest) contain phosphatised internal moulds of marine molluscs (including extinct warm water taxa), shark teeth and reworked mammal bones and teeth.

Quaternary shelly beds of the Velddrif Formation cropping out close to modern sea level near the Berg River mouth and Saldanha Bay yield shallow marine and estuarine shelly taxa plus sparse fossil bones. The Miocene Prospect Hill Formation aeolianites near Saldanha contains impressive fossil land snails, tortoise carapaces, rare mammal bones, foraminiferans and biostratigraphically significant fragments of extinct ostrich egg shells.

The succeeding Plio-Pleistocene aeolianites of the Langebaan Formation contain a range of terrestrial gastropods, tortoise remains and concentrations of mammalian bones and teeth (including micromammals) as well as other vertebrate groups that are associated with carnivore lairs and vlei deposits (e.g. Sea Harvest, Hoedjiespunt and Spreeuwal sites in Saldanha Bay) (Avery & Klein 2009). Rare hominid footprints plus pillar-like plant root casts (megarhizoliths) occur within Langebaan Formation calcarenites at Langebaan Lagoon, just south of the present study area (Roberts & Berger 1997). Cranial fragments of *Homo heidelbergensis* are reported from similar-aged dune beds at Elandsfontein c. 20 km inland from Langebaan Lagoon (Singer & Wymer 1968, Klein et al. 2007). The Pleistocene to Holocene Springfontein Formation quartzose sands are very sparsely fossiliferous but palaeosurfaces associated with fossil bones as well as fossil vlei deposits may be expected here. The wide range of subfossil plant and animal fossils recorded from Holocene dune sands of the Witsand Formation, such as mammalian bones and teeth, tortoises, land snails, plant debris including peats and charcoal, microfossils and traces, have been well-summarized by Pether (2008).

4.2.4.4 Survey coverage and limitations

Much development has taken place on the Vredenburg Peninsula in recent years with the result that large numbers of surveys have been carried out (Figure 26 and Figure 27). This affords very good data to work from and allows a reliable characterisation of the archaeological heritage in the study area. The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

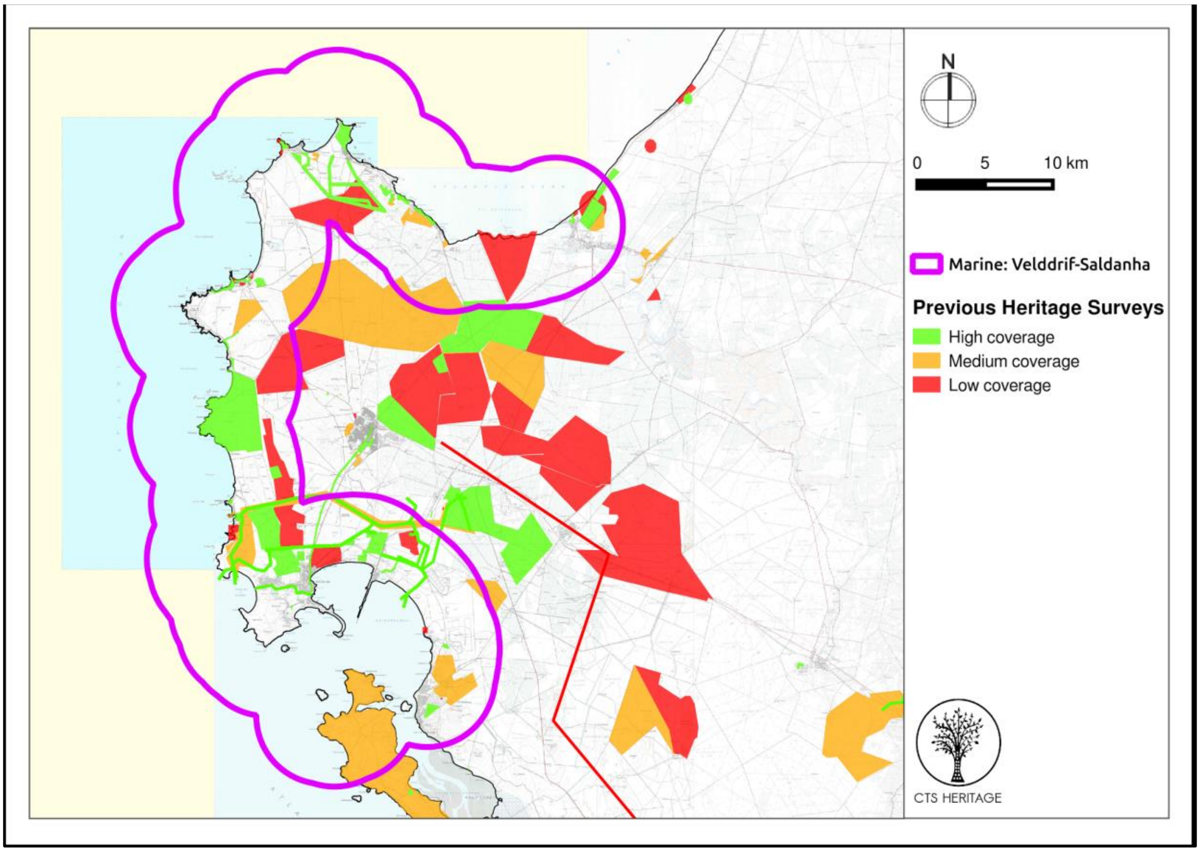

Figure 26. Velddrif-Saldanha previous HIAs map.

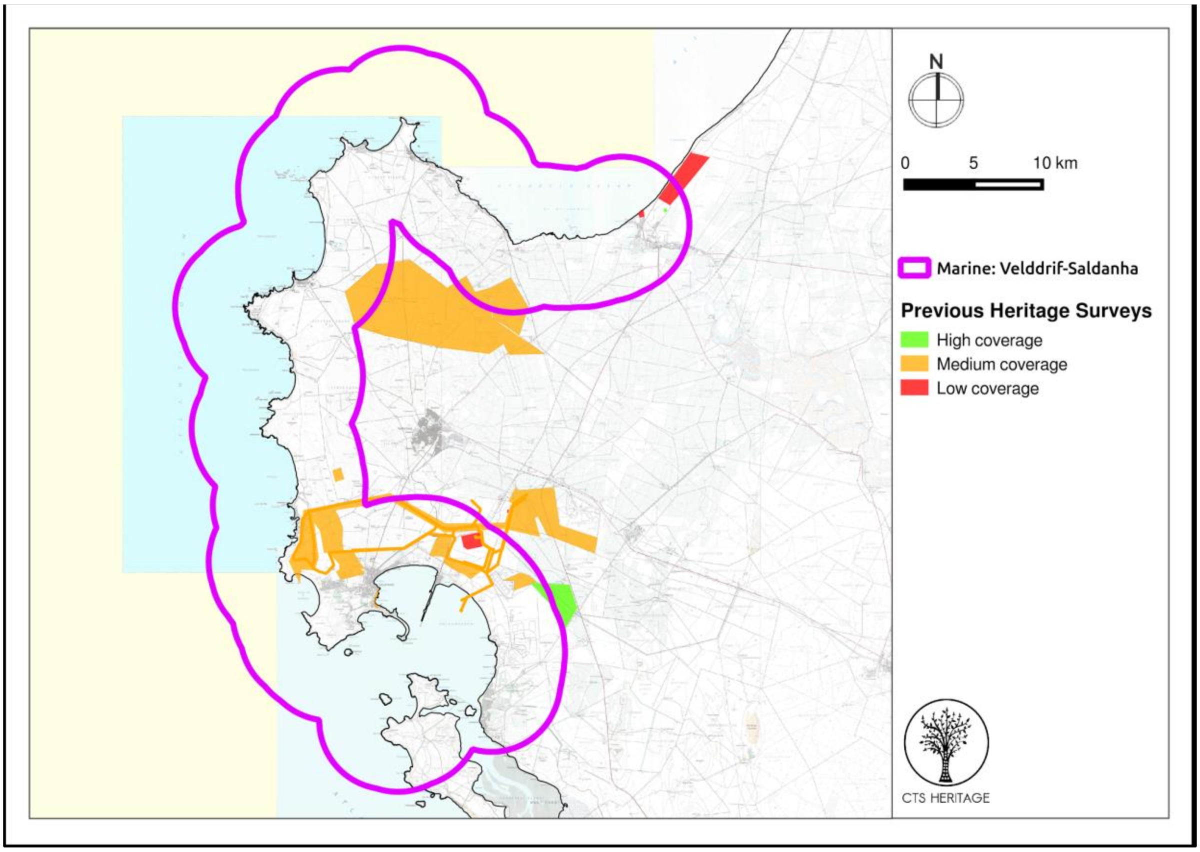

Figure 27. Velddrif-Saldanha previous PIAs map.

4.2.5 Marine Study Area 7 – Strandfontein to Lambert's Bay

4.2.5.1 Topography

The Namaqualand coastline here, falling within the arid Namib Geomorphic Province of Partridge et al. (2010), is fairly straight with slight steps reflecting faulting during initiation of the South Atlantic oceanic rift. The mouths of the few seasonally-flowing river systems - the Jakkalsrivier near Lambert's Bay and the Olifants River in the north - are largely choked with sand and associated with small dune plumes. Much of the coast is fringed by narrow sandy beaches with intervals of rocky coastline and headlands (e.g. Cape Donkin, Bruinpunt) as well as low coastal cliffs, such as between Doringbaai and Strandfontein. The elevated, marine-planed coastal platform reflects crustal uplift during the Late Caenozoic. Its surface is mantled by sandy deposits with a few, low rocky elevations.

4.2.5.2 Geology

The geology of this study area is shown on 1: 250 000 sheets 3218 Clanwilliam and 3118 Calvinia (De Beer et al. 2002). Late Precambrian, highly-deformed metasedimentary bedrocks of the Gifberg Group (Gariep Supergroup) crop out in the lower reaches of the Olifants River as well as along the coast either side of the river mouth. Further south the undulating, elevated coastal platform is carved from more resistant-weathering quartzitic bedrocks of the Table Mountain Group of Ordovician age. Fluvial conglomerates and sandstones of the basal Piekenierskloof Formation crop out along the coast between Groothoekbaai and Doringbaai as well as inland along the Jakkalsrivier. Brownish to maroon, fluvial to intertidal sandstones and mudrocks of the overlying Graafwater Formation are seen on the coast at Donkin's Bay and Doring Bay as well as small inland exposures on the coastal platform. Mature braided fluvial quartzites of the following Peninsula Formation are mapped on the coastal platform inland of Doringbaai and along the Olifants River close to its mouth. Most of the Namaqualand coastal platform from Elands Bay northwards to the Orange River as well as stretches of the coastline itself are mantled by a spectrum of aeolian, fluvial and coastal marine sediments of the Oligocene to Holocene West Coast Group. This important Caenozoic sedimentary succession has been further described, with key references in the Marine Study Area 8 (Orange-Hondeklip Bay) section, below.

4.2.5.3 Palaeontology

The Late Precambrian metasediments of the Aties Formation (Gifberg Group) are probably too metamorphosed and deformed to contain fossil remains, with the possible exception of resilient microfossils. The predominantly braided fluvial sediments of the Ordovician Table Mountain Group are generally unfossiliferous, although subordinate marine-influenced horizons in the Peninsula Formation may contain low diversity trace fossil and microfossil assemblages. A range of trace fossils, including arthropod trackways and complex horizontal to vertical spreiten burrows are known from the distal fluvial to intertidal Graafwater Formation, some of which are reported from coastal outcrops (De Beer et al. 2002, Almond 2008b). The rich palaeontology of the Oligocene to Holocene West Coast Group has been reviewed elsewhere in the section on Marine study area 8 (Orange-Hondeklip Bay). Key fossil assemblages include Oligocene to Miocene peats in channel infills of the Koingnaas Formation, extinct warm-water shelly assemblages and reworked terrestrial mammalian remains within several discrete packages of raised shallow marine to beach deposits of the Miocene to Pliocene Alexander Bay Formation, as well as terrestrial gastropods, tortoises, trace fossils and mammalian bones and teeth in the coastal aeolianites of Miocene to Holocene age (e.g. Graauw Duinen, Olifants River and Swartlintjies Formations). Pleistocene reddened surface sands mantling the coastal plain may also contain fossil bones and land snails along palaeosurfaces.

4.2.5.4 Survey coverage and limitations

Because of the very limited amount of development that has taken place in this area in recent decades, survey coverage is very limited (Figure 28). This has resulted in assumptions being made about the distribution of archaeological resources, but, nevertheless, observations from further afield also support the distribution of archaeological resources as discussed. The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

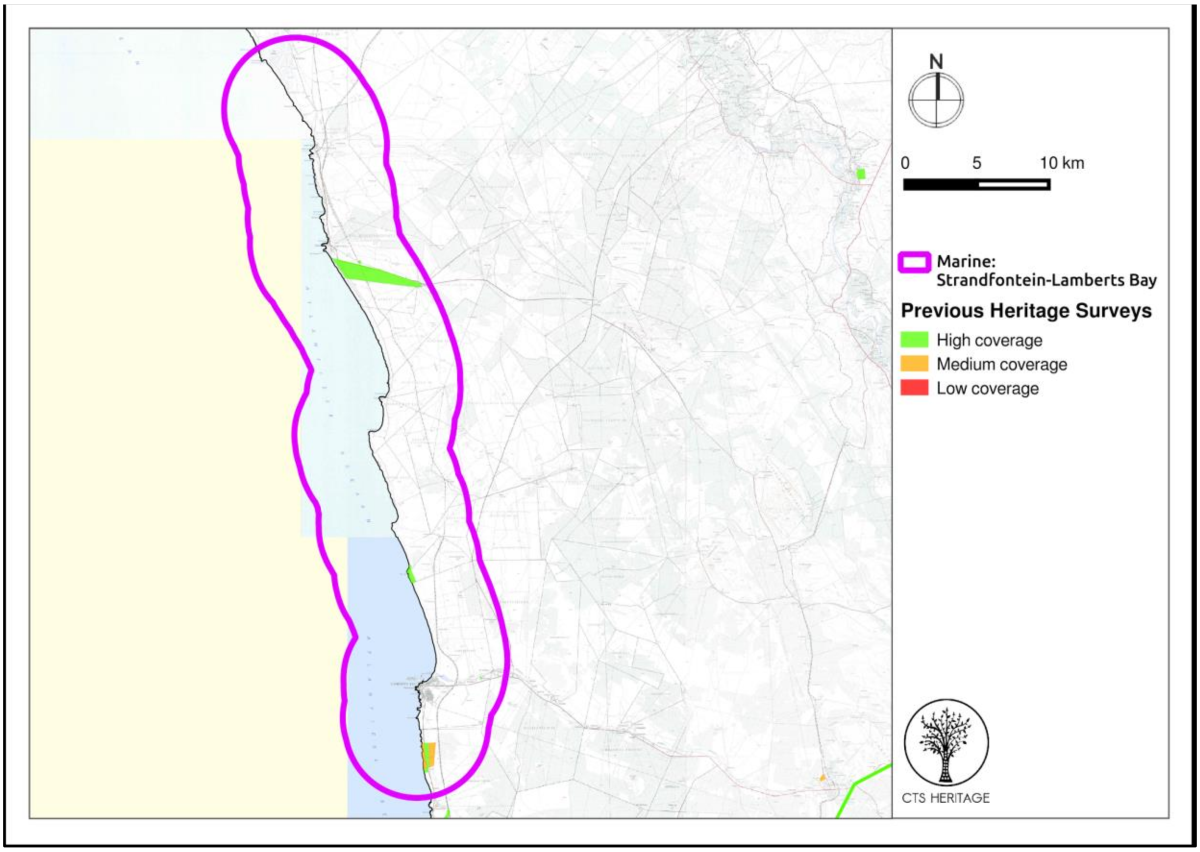

Figure 28. Strandfontein-Lamberts Bay previous HIAs map.

4.2.6 Marine Study Area 8 – Orange to Hondeklip Bay

4.2.6.1 Topography

This is a very arid region, and, apart from the perennial Orange River in the north, is traversed by only a handful of intermittently-flowing rivers, although some, like the Buffels and Spoeg Rivers, have permanent water in their estuaries. The coastline is fairly straight with numerous rocky cliff sections, wave-cut benches and headlands interspersed with small sandy bays. The coastal hinterland is an elevated, marine-planed coastal platform cut across resistant basement rocks. Its undulating surface is mantled by extensive sandy deposits with few, low rocky elevations and occasional sizeable pans. Large sectors of the coastal zone have been extensively disturbed by prospecting and opencast mining, especially in the northern part of the study area.

4.2.6.2 Geology

The geology of this study area is shown on 1: 250 000 sheets 3017 Garies, 3216 Springbok and 2816 Alexander Bay (De Beer 2010, Marais et al. 2001, Minnaar et al. 2011). The coastal platform south of Kleinzee is largely constructed of highly-deformed and metamorphosed granites, gneisses and metasediments (e.g. quartzites) of the Precambrian Namaqua-Natal Metamorphic Province (Cornell et al. 2006). North of Kleinzee the basement rocks cropping out along the coast are mainly Late Proterozoic metasediments belonging to the Gariep Supergroup (Gresse et al. 2006). They comprise diverse marine sediments of the Port Nolloth Group such as sandstones and conglomerates of the Stinkfontein Subgroup as well as carbonates, muds and sands of the overlying Holgat Formation. Between Cape Voltas and the mouth of the Orange River the Gariep bedrocks represent a slice of basaltic oceanic crust (Grootderm Formation, Marmora Terrane) that has been thrust south-eastwards onto the margins of the Kalahari continent during continental collision.

Most of the Namaqualand coastal platform from Elands Bay northwards to the Orange River, as well as stretches of the modern coastline itself, are mantled by a spectrum of aeolian, fluvial and coastal marine sediments of the Caenozoic (Oligocene to Holocene) West Coast Group. The stratigraphy of this highly complex succession is still in flux and outcrop areas of many of the subunits are too small to be mapped at 1: 250 000 scale (Pether 1994, Pether et al. 2000, De Beer et al. 2002, Marais et al. 2001, Roberts et al. 2006, Pether in Almond & Pether 2008a, De Beer 2010, Minnaar et al. 2011, Pether 2017).

The following account refers to the combined Marine Study Areas 7 and 8 (Strandfontein-Lamberts Bay and Orange-Hondeklip Bay). The oldest West Coast Group deposits are deeply-weathered sands, gravels and muds infilling palaeo-channels incised into weathered bedrock (Oligocene-Early Miocene Koingnaas Formation), as well as possibly Miocene-aged silicified gravels and sandstones capping weathered bedrock inland (De Toren Formation). A series of packages of fluvial terrace gravels and channel sands occurring along coastal river valleys have been correlated with the Miocene to Pliocene Orange River Gravels to the north. Three discrete packages of Neogene raised shallow marine to beach deposits are grouped within the composite Alexander Bay Formation. They are now differentiated, in order of decreasing age and elevation above modern sea level, as the Kleinzee Member (Middle Miocene “90 m Package”), Avontuur Member (Early Pliocene “50 m Package”) and Hondeklip Bay Member (Middle Pliocene “30 m Package”). These marine units are intercalated and capped by several packages of coastal terrestrial deposits (aeolianites, palaeosols) of Miocene to Pleistocene age, such as the composite Graauw Duinen Formation and the Pleistocene Olifants River Formation; calcretised aeolianites of the latter unit build sea cliffs just north of the Olifants River mouth. Quaternary to Holocene shallow marine and beach sediments are referred to the Curlew Strand Formation while the modern dune sands are placed in the Swartlintjies Formation. Various units of reddish, unconsolidated quartzose sands, probably reworked from older aeolianites and mainly of Quaternary age, are also mapped on the Namaqua coastal plain (e.g. Olifants River and Koekenaap Formations).

4.2.6.3 Palaeontology

The Precambrian granite-gneisses and other highly-deformed metasediments of the Namaqua-Natal Metamorphic Province are entirely unfossiliferous. The palaeontology of the coastal outcrop area of the Late Precambrian Gariep Supergroup is largely unknown. Poorly-preserved stromatolites (laminated microbial mounds) are recorded from basal carbonates of the Holgat Formation (Bloeddrif Member) in southern Namibia while microfossil assemblages including acritarchs and foraminiferans have been isolated from finer-grained sediments in the upper part of the Holgat Formation (Almond 2009b).

The palaeontological heritage of the West Coast Group provides critical data concerning the age and depositional settings of Caenozoic coastal sediments along the west coast that is also important for diamond mining. These fossils contribute to unravelling the complex history of sea-level change, continental uplift, palaeocurrents and palaeoclimates as well as the biogeography and evolution of terrestrial mammals (including hominins) and marine invertebrates in the southern African region. Key reviews of West Coast Group sediments and fossils are provided by Pether (1994), Pickford & Senut (1997), Pether et al. (2000), De Beer et al. (2000), Roberts et al. (2006), Pether (2007), Pether in Almond & Pether (2008), De Beer (2010) and Minnaar et al. (2011)

The following account refers to the combined Marine Study Areas 7 and 8 (Strandfontein-Lamberts Bay and Orange-Hondeklip Bay). Fossils woods (e.g. yellowwood), pollens and rare silicified bones of Oligocene to Early Miocene age are recorded from peats within the Koingnaas Formation fluvial channel infills. Relict deposits of a possible Paleogene transgression containing fragmentary fossil bones are recorded inland from Doringbaai at elevations of over 100 m amsl. The Miocene to Pleistocene vertebrate faunas recorded from the river gravels of the Arris Drift Formation along the lower Orange River (Corvinus & Hendey 1978, Hendey 1978, 1984, Dingle et al. 1983, Almond 2009b) may also be represented within Neogene fluvial terraces and channels further south along the Namaqualand coast. Rare skeletal remains of archaic Homo sapiens have been recovered from the Orange River mouth (Senut et al. 2000). Lignites (fossil peats) are reported from ancient deposits of the Olifants River north of Strandfontein. The various Miocene to Pliocene packages of shallow marine to beach deposits of the Alexander Bay Formation are each characterised by distinctive biotas of extinct, warm-water shelly invertebrates (e.g. oysters and other bivalves, brachiopods, barnacles). For example, the Middle Miocene Kleinzee Member has the bivalve, *Isognomon gariensis* while the Early Pliocene Avontuur Member and Late Pliocene Hondeklip Bay Member are associated with the bivalves, *Donax haughtoni* and *D. rogersi* respectively. The shelly fossils occur together with fish teeth, marine mammals, trace fossils and reworked terrestrial fossil remains including mammals (e.g. equids, suids, hominoids, elephantids, whales; Pickford & Senut 1997) and reworked petrified wood, much of which is originally Cretaceous in age (Bamford & Corbett 1994, 1995). Comparable marine sediments in the Pleistocene to Holocene Curlew Strand Formation contain modern cold-water shelly faunas (e.g. black mussels).

Miocene to Holocene coastal aeolianites (Graauw Duinen Formation, Olifants River Formation etc) yield a range of terrestrial gastropods, mammalian bones and teeth (e.g. elephantids) and tortoise carapaces associated with palaeosurfaces or vlei deposits as well as trace fossils and stone artefacts (e.g. calcretised root casts, termitaria). Distinctive morphotypes of thick-shelled ostrich eggs within these aeolianites may be of considerable biostratigraphic value (cf Senut & Pickford 1995). The wide range of subfossil plant and animal fossils recorded from Late Quaternary to Holocene dune sands such as the Swartlintjies Formation - for example mammalian bones and teeth, tortoises, land snails, plant debris including peats and charcoal, microfossils and traces - have been summarized by Pether (2008, 2012, 2017). Scattered bones associated with land snails and stone artefacts may also be found in Quaternary cover sands on the coastal plain.

4.2.6.4 Survey coverage and limitations

While large parts of the area have been surveyed to near saturation (perhaps about 20% of the study area), the surveys have focused almost exclusively on the diamond mining areas south of Port Nolloth (Figure 29 and Figure 30). The surveyed areas vary in width and location relative to the coast. Nevertheless, the information to hand allows for a very good understanding of the distribution of archaeological resources in the aquaculture study area. The only archaeological limitation is that we have a very poor understanding of the distribution of buried archaeology at the interface between the unconsolidated surficial sand and the underlying dorbank. Such material cannot be predicted and is virtually impossible to rescue in meaningful quantities. The assessment is limited by the fact that built heritage and the cultural landscape have not been assessed by appropriate specialists.

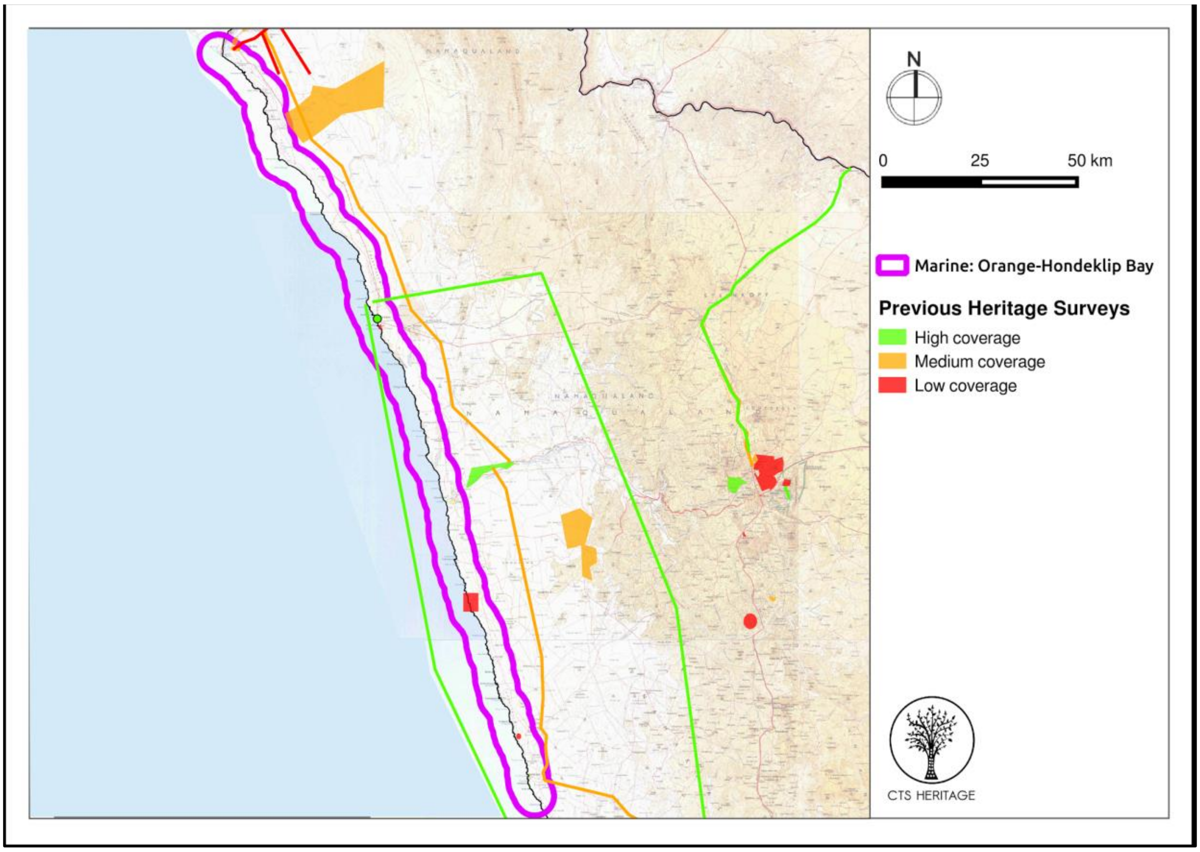

Figure 29. Orange-Hondeklip Bay previous HIAs map.

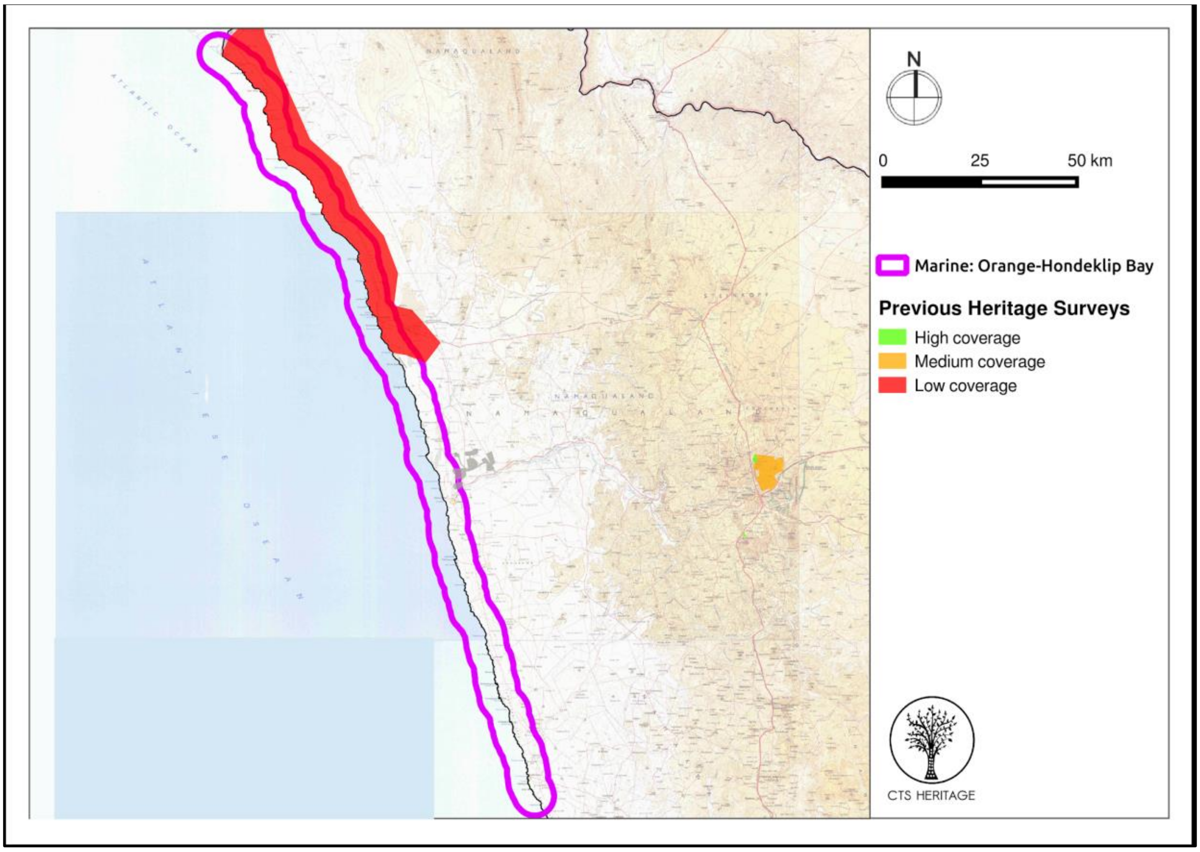

Figure 30. Orange-Hondeklip Bay previous PIAs map.

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