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HWC File No.: HM/SALDANHA BAY/PTN 9 (PTN OF PTN 3) OF FARM 129

Chief Executive Officer/Director
Heritage Western Cape
Protea Assurance Building
Green Market Square
Cape Town
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Attention: Mr Shaun Dyers

Dear Shaun

Integrated Heritage Impact Assessment: Proposed Namakwa Sands Warehouse Storage Shed in Saldanha

1. Introduction and Background

Exxaro TSA Sands (Pty) Ltd ('Exxaro') intends to construct a warehouse storage shed ('the Shed') on the property of the Namakwa Sands Smelter Plant at Saldanha Bay ('the Project') for the temporary storage of products prior to export via the Port of Saldanha. In the short term (for approximately the first two years), the Shed will be used to store ilmenite produced by an Unattritioned Magnetic Material (UMM) Plant planned for the Namakwa Sands Mine at Brand-se-Baai. In the long term, the proposed Shed will also be used to store other final products from Namakwa Sands, for which Exxaro is currently renting storage space elsewhere in the Saldanha Bay area at a high cost.

SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by Exxaro as the independent Environmental Assessment Practitioner (EAP) to undertake a Basic Assessment (BA) process, which is required in terms of the National Environmental Management Act 107 of 1998, as amended (NEMA), and the Environmental Impact Assessment (EIA) Regulations, 2010 (promulgated in terms of NEMA).

Archaeology and Palaeontology specialist studies were undertaken as part of the BA process to identify features of heritage value that may be affected by the proposed development, and make recommendations to avoid disturbance of such features. The Archaeology specialist study was undertaken by Professor Andrew Smith of UCT's Archaeology Contracts Office, and a Palaeontology specialist study was undertaken by John Pether (independent specialist). The relevant sections of their reports, such as the impact assessments and recommendations, were incorporated and copies of the specialist reports appended to the BA Report.

A Notice of Intent to Develop (NID) was compiled and submitted to Heritage Western Cape (HWC) with the draft BA Report on 10 February 2012, in terms of Section 38 (1) (a) and (c) of the National Heritage Resources Act (Act No. 25 of 1999) (NHRA), as the proposed access road exceeds 300 m in length and the development footprint exceeds 5 000 m^2. In HWC's interim comment, dated 22 February 2012, HWC requested that SRK submit an integrated Heritage Impact Assessment (HIA) and include the findings of the Archaeology and Palaeontology studies with an integrated set of recommendations. This report is submitted in response to that request.

2. Project Description

The Namakwa Sands Smelter Plant is located on Portion 9 (a portion of Portion 3) of the Farm Yzervarkensrug no 129, to the north of the R79 and to the east of the Sishen-Saldanha railway. The property is zoned for industrial use. The site of the proposed Shed is to the west of the existing Smelter Plant on a vacant piece of land (refer to site plan in Figure 1: Site Plan). Although the site falls outside an existing Smelter Plant internal fenceline, the Shed and associated infrastructure will fall within the Namakwa Sands Smelter Plant property boundary.

A number of sand / gravel roads and pathways traverse or run along the edges of the site. There are no buildings or structures other than a disused sewer reservoir

The proposed development will entail (refer to layout plan in Figure 2):

- A new **warehouse Shed** with a 40 000 ton storage capacity and dimensions of approximately 150 m (length) x 45 m (width) x 15m (height). The proposed Shed will be similar to, but slightly larger than existing warehouse sheds at the Smelter Plant. The Shed will be divided into three bays by 3 m high concrete walls against which material will be stacked. The distribution and stacking of material in the Shed will be done with front-end loaders.
- A new **rail off-loading station**. Material will be transported through the roof of the Shed into a central bay via a new conveyor from a new rail off-loading station at the existing rail yard on the eastern side of the Site. The existing rail yard will be modified to cater for the new rail off-loading station without causing interruptions to current off-loading operations at the Smelter. The rail off-loading station will have a 44 ton off-loading capacity. Receiving of material will also be possible by back-tip and side-tip road trucks.
- A new **road load-out station**. Material will be transported via a conveyor into 12 ton weighflask at a new road load-out station on the southern side of the Shed. Road trucks will transport the material to the Saldanha Port via the existing Namakwa Sands haul road.
- A new sealed (premix surface) **access road** (approximately 700 m in length) between the existing truck haul road and the development.
- A new permanent **lay-down area** of approximately 7020 m^2 adjacent to the Shed. The laydown area will be a cleared area for construction activities and the temporary storage of containers during transit.
- Modifications to the Smelter's existing stormwater drainage system.
- Modifications to the Namakwa Sands Smelter Plant power supply network. Because the area is physically far removed from current power supply, modifications to the 11kV network may be required.
- The area immediately surrounding the warehouse Shed will be paved to mitigate dust-generation.
- Dust extraction points will be added to all the transfer points within the development. Any dust generated will be extracted and ducted to a central dedusting bag house unit.

All new plant equipment and infrastructure of the proposed development will fall within the Exxaro property boundary.

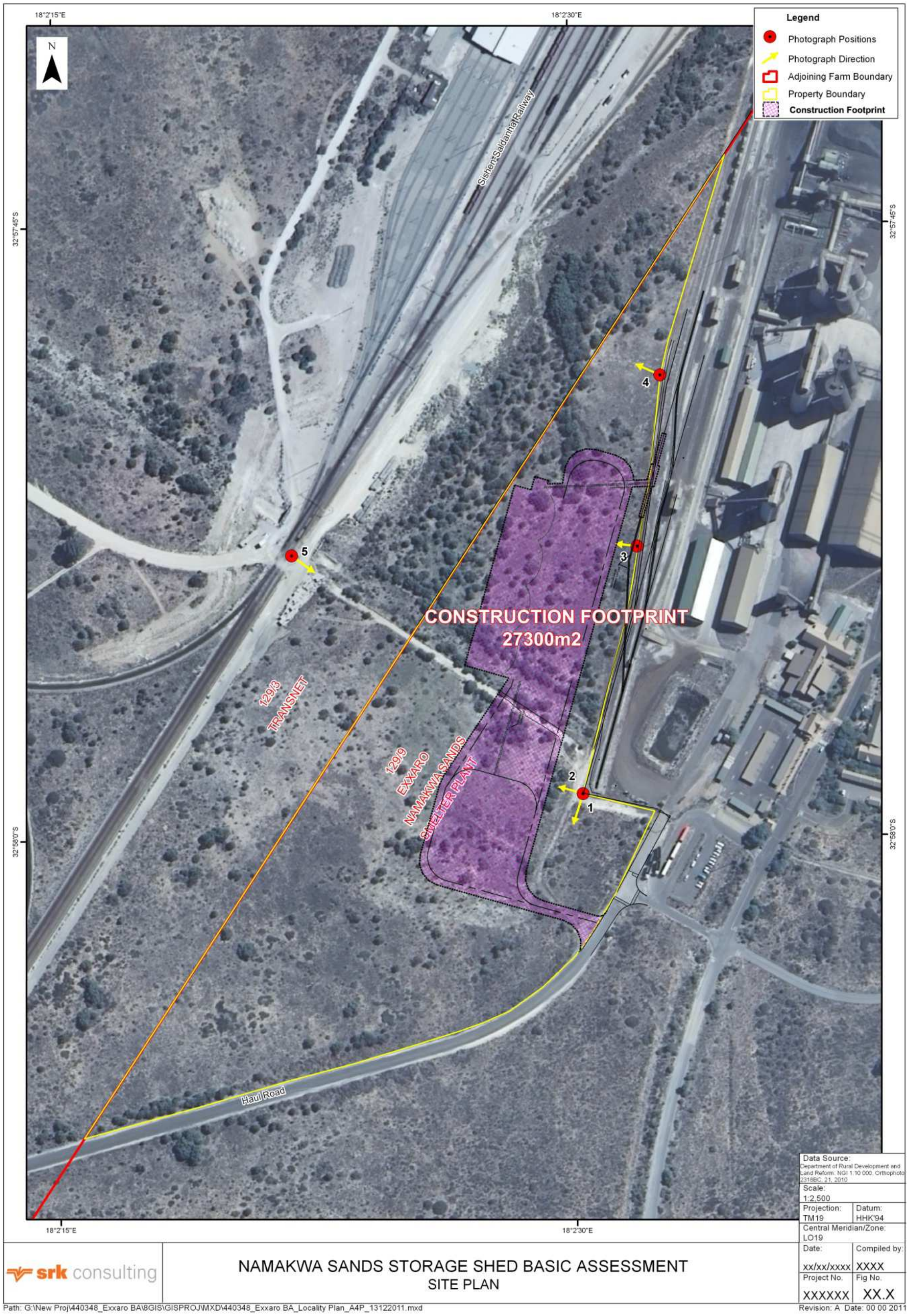

Figure 1: Site Plan

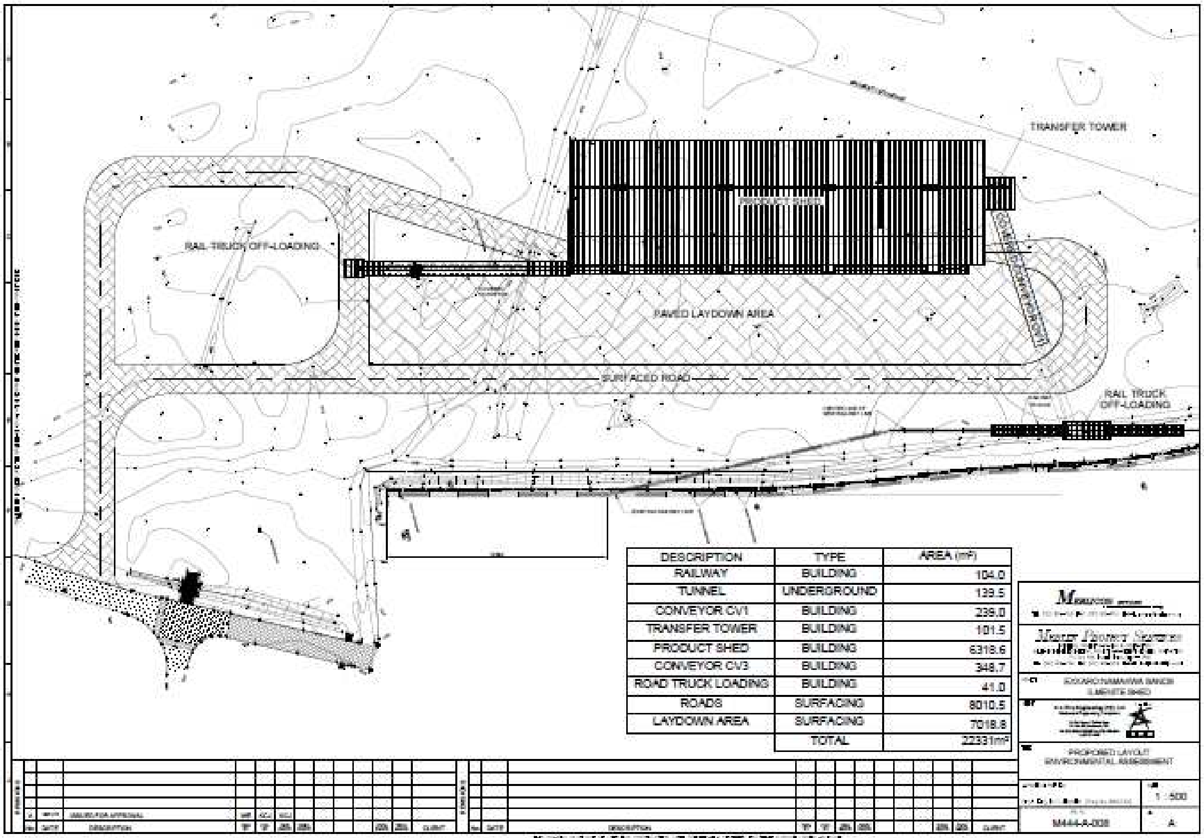

Figure 2: Layout Plan of the Proposed Shed

3. Summary of Specialist Findings

The Site is located in the Saldanha industrial area, within the property of and immediately adjacent to the Namakwa Sands Smelter Plant, which was built and commissioned in the 1990's. The Site was used as a construction camp and laydown area during construction of the Plant, evidence of which can still be found on site in the form of rubble, etc. Historically, the land was used for small-scale agricultural purposes (e.g. grazing). The disturbed nature of the Site and the condition of the vegetation cover suggests that the Site had been ploughed in the past.

The Saldanha Bay area is nationally and internationally known to be rich in archaeological and paleontological resources. The Site is located within 10km of the West Coast Fossil Park highlighting the sensitivity of the palaeontology and archaeology of the region. In addition, a number of projects have been carried out by the Agency for Cultural Resource Management since 1994, including in the Saldanha Steel area (ArcelorMittal) about 2km southwest of the Site. Witklip, the granite batholith dominating the skyline to the north of the Site, has been the study of Later Stone Age archaeology (Smith et al. 1991; Smith 2006 in Smith 2011), and is part of an important debate on the origins of herding at the Cape (Sadr 2003; Smith 2008 in Smith 2011). Surface collection of 19th century glass, ceramics, bone, buttons and other artefacts from a shepherds hut were found on the surface at Saldanha Steel (Kaplan 1996a in Smith 2011). Often surface indications may be rare, and it is when monitoring deep excavation during the construction phase of a project that prehistoric residues are found. This was the case where Middle Stone Age (MSA) and Later Stone Age (LSA) tools were found at the Saldanha Steel site (Kaplan 1996b in Smith 2011). MSA and LSA flakes have been documented on the Duferco Steel Mill site, less than 1 km to the south west of Saldanha

Steel (Kaplan 1997a in Smith 2011). Middle Pleistocene occurrences and the recovery of human remains in the Langebaan Limestone deposits at Sea Harvest, in Saldanha Bay, has provided some of the earliest evidence we have in the world for the human exploitation of coastal resources, more than 100 000 years ago, and at Hoedjiespunt (limestone) in Saldanha Bay evidence was found of early modern humans, dated to about 125 000 years ago. Due to the excellent preservation of ancient fossils from the rapid carbonate cementation of sediments in which bone has been buried in the calcareous aeolianites (fossil dunes) and shallow marine silts, ancient fossil sites have been found at the Varswater quarry near Langebaanweg dated to around 5 million years ago. Within fossilized dunes, a number of hyena lairs produced Pleistocene (1.6 million – 200 000 years) faunas, including herbivores and carnivores, at Hoedjiespunt and Sea Harvest in Saldanha Bay and nearby Besans Klip quarry at Vredenburg. An EIA for the proposed Alpha Saldanha Cement Project in Saldanha Bay revealed the presence of an unusual Mid-Miocene (± 11-12 million years) fauna, including the shell of a giant extinct ostrich like bird. Monitoring of bulk earthworks by the archaeologist at Saldanha Steel also exposed rare and previously unknown crocodilian and other fossil remains from the Miocene Period, from deposits underlying deep calcareous formations during excavations for descaling pits. Important vertebrate fossils (bones) embedded in the aeolianites of the Langebaan and Varswater Formation, were also recently found in cuttings and exposures, and among the spoil dumps alongside the existing residue dam at the Namakwa Sands (Kaplan 2006b in Smith 2011).

Studies were undertaken by an archaeology and a palaeontology specialist to identify resources of heritage value within the Site.

The archaeologist reported that two pieces of ostrich eggshell and some flaked calcrete nodules were the only prehistoric materials observed on site. A few pieces of black mussel were also found but were uncalicified and therefore likely to be modern. Surface observations indicate that the archaeological value of the Site is likely to be low, but subsurface materials may only be uncovered once deep excavations take place during construction. Please refer to the Archaeology Report (attached as **Appendix A**) for further details.

While nothing is known about the palaeontological resources on the Site itself, the larger region is known for its palaeontological sensitivity (e.g. the nearby West Coast Fossil Park). The geology of the Site indicates that palaeontological material is likely to occur, but without existing cuttings or excavations on Site, it was not possible to identify such resources during the site visit. . Please refer to the Palaeontological Report (attached as **Appendix B**) for further details.

Therefore, while there may be subsurface archaeological and/or paleontological resources present on site, such resources can only be uncovered through excavation.

4. Assessment of Impact on Heritage Resources

No impacts on heritage aspects are associated or expected with the operational and decommissioning phases of this project. During construction, excavation activities on site may disturb, damage or destroy any subsurface, in-situ archaeological and/or palaeontological material, resulting in a loss of heritage resources. The potential impact is assessed to be of ***medium*** significance without mitigation, but can be reduced to ***low*** with the implementation of recommended mitigation (refer to Table 1).

Table 1: Potential impacts on heritage resources during the Construction Phase

Nature of impact:	*Loss of heritage resources through the potential disturbance and destruction of in-situ (subsurface) archaeological and paleontological material during construction.*
Extent and duration of impact:	**Local** (restricted to excavation areas during construction phase).and **long term** (permanent).
Probability of occurrence:	**Probable**
Degree to which the impact can be reversed:	**Irreversible**
Degree to which the impact may cause irreplaceable loss of resources:	**High**
Cumulative impact prior to mitigation:	Increased development in the region places pressure on the status of these resources. The expansion of the Smelter Plant, although in an industrial area, may result in a permanent loss of resources and a loss of opportunities that may arise from a significant fossil occurrence (e.g. tourism, employment). However, the discovery of potential resources on site is difficult without the occurrence of excavations or cuttings.
Significance rating of impact prior to mitigation (Low, Medium, Medium-High, High, or Very-High)	**Medium (–ve)**
Degree to which the impact can be mitigated:	**Medium - High**
Proposed mitigation:	Appointment of a suitably qualified expert to monitor excavation by heavy construction equipment. If anything is uncovered, it must be systematically recorded and removed.
Cumulative impact post mitigation:	The potential impact on archaeological/palaeontological resources will be minimal if construction activities are monitored. The impact may in fact be positive for archaeology/palaeontology as construction excavations furnish the "windows" into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden resources. This is provided that mitigation measures are implemented effectively.
Significance rating of impact after mitigation (Low, Medium, Medium-High, High, or Very-High)	**Low (-ve/+ve)**

5. Recommended Mitigation Measures

The Archaeological specialist and the Palaeontological specialist each provided recommendations in their respective specialist reports to mitigate the potential impact on heritage resources during the construction phase of the proposed project. These mitigation measures have been integrated and presented in Table 2 below. This table also provides an indication of the responsible party and the performance indicators and required monitoring methods in order to ensure the effective management of the potential impact on heritage resources.

The archaeology and palaeontology studies found that although surface indications suggest that the heritage value of the site is low, sub-surface materials may only be uncovered once deep excavation takes place during construction. It is therefore recommended in the archaeology and palaeontology reports that a suitable expert (experienced archaeologist or palaeontologist) is appointed to monitor the site during construction and to inspect sections which may be exposed to ensure any heritage material uncovered during excavation can be identified, recorded and documented.

Table 2: Mitigation Measures and Management Plan for Potential Impact on Heritage Resources (Construction Phase)

Aspect	Mitigation Measure	Responsible Party	Performance Indicator	Monitoring Method
Archaeological and Paleontological Material	Appoint a suitably qualified and experienced archaeologist / paleontologist to monitor excavation by heavy construction equipment.	Namakwa Sands	Appointment of archaeologist / paleontologist. Incidences of subsurface heritage material uncovered.	Records of findings / disturbances. Records of permits. Report from archaeologist / paleontologist.
	Report any human remains disturbed, exposed or uncovered during excavations and earthworks to the South African Heritage Resources Agency or Heritage Western Cape.			
	Obtain a permit from the relevant Heritage Authority should damage and/or destruction of any artefacts of heritage or archaeological/paleontological value be unavoidable, before such excavation can take place.			

Ms Pippa Haarhoff of the West Coast Fossil Park has been recommended by the specialists as the suitably qualified expert to monitor excavation during the construction phase.

6. Conclusion

There was a lack of cuts/excavations for the archaeologist and palaeontologist to accurately assess the occurrence of subsurface archaeological material and/or fossils on site. As per the recommendations of the specialists, the appointment of a suitable expert to monitor the construction phase is an appropriate measure to counteract this gap in knowledge. This will ensure that any subsurface heritage material uncovered during the construction phase can be identified, recorded and documented.

7. References

Smith, A.B., 2011. *Archaeology Report: Proposed New Warehouse for the Exxaro Namaqua Sands Smelter, on Portion 3 Yzervarkensrug 129, Saldanha Bay.* Department of Archaeology, University of Cape Town.

Pether, J., 2012. *Palaeontological Report: Proposed Construction of Warehouse Storage Shed at Namakwa Sands Smelter Plant, Saldanha Bay, Western Cape, Exxaro TSA Sands (Pty) Ltd.*

Yours faithfully,

SRK Consulting

SRK Consulting – Certified Electronic Signature

srk consulting

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Scott Masson
Environmental Consultant

Appendix A: Archaeology Specialist Report

ARCHAEOLOGICAL REPORT

Proposed new warehouse shed for the Exxaro

Namakwa Sands Smelter, on Portion 3 Yzervarkensrug 129

Saldanha Bay

JANUARY 2011

Report prepared for
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1. INTRODUCTION

Instruction was given by Scott Masson of SRK Consulting (South Africa) (Pty) Ltd for an archaeological assessment of the site of a proposed warehouse storage shed to be built alongside the Exxaro Smelter at Saldanha Bay. The building will measure 150 x 45m in area. In addition, a new rail truck off-loading station, as well as a new road load-out station will be built. There will also be modifications to the stormwater drainage and power line facilities.

A site visit was conducted on 5 December 2011, and contact made with Hugo van der Merwe, Exxaro Namakwa Sands Senior Projects Engineer, who identified the preferred location for the position of the warehouse shed.

The site is open veld to the west of the existing smelter. It is a sandy environment with very active dune moles, and considerable infestation by Rooikrans alien vegetation. The site was also used as a camping area for construction workers while the smelter was being built in the 1990s. Signs of this occupation can be seen, but the site is remarkably clean of dumping. Such occupation, however, would have resulted in some disturbance of the topsoil.

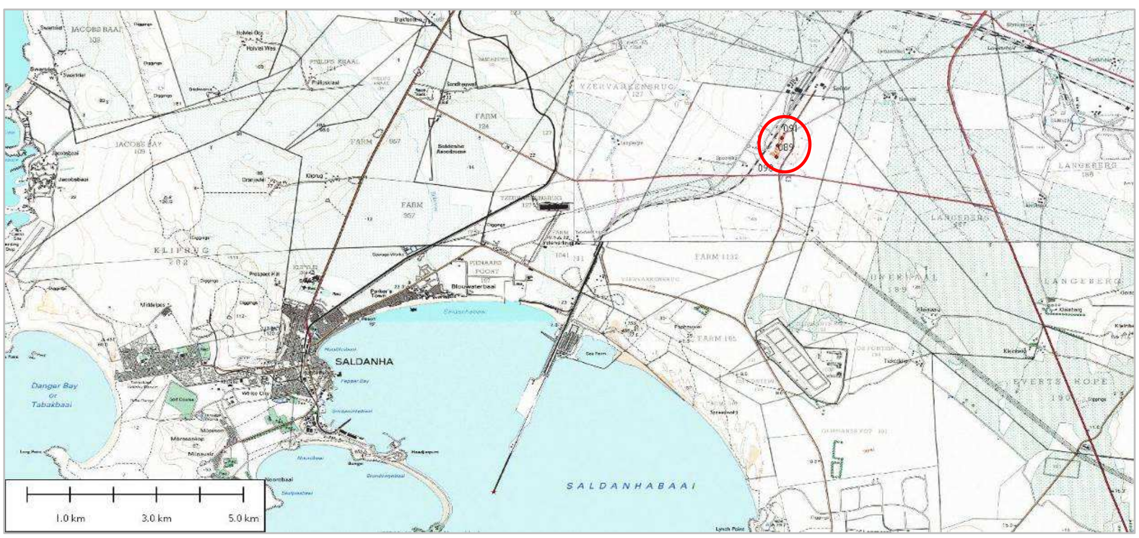


Figure 1: Location of the Exxaro Smelter and area surveyed indicated by a red circle (Ref: 1:50 000 3218CA & CC VELDRIF)

2. DESKTOP SURVEY

The target site, next to the existing Exxaro Namakwa Sands Smelter Plant at Saldanha Bay (on Portion 3 of Farm Yzervarkensrug 129), is close to the West Coast Fossil Park, less than 10 km away. This alerts us to the sensitivity of the palaeontology and archaeology of the region. In addition, a number of projects have been carried out by the Agency for Cultural Resource Management since 1994 (Kaplan 1994, 1996a, 1996b, 1997a, 1997b, 2006a, 2006b), including the Saldanha Steel area. Witklip, the granite batholith dominating the skyline to the north of the target site has been the study of Later Stone Age archaeology (Smith *et al*. 1991; Smith 2006), and is part of an important debate on the origins of herding at the Cape (Sadr 2003; Smith 2008).

Surface collection of 19th century glass, ceramics, bone, buttons and other artefacts from a shepherds hut were found on the surface at Saldanha Steel (Kaplan 1996a). Often surface indications may be rare, and it is when monitoring deep excavation during the construction phase of a project that prehistoric residues are found. This was the case where Middle Stone Age (MSA) and Later Stone Age (LSA) tools were found at the Saldanha Steel site (Kaplan 1996b). MSA and LSA flakes have been documented on the Duferco Steel Mill site, less than 1 km to the south west of Saldanha Steel (Kaplan 1997a).

Middle Pleistocene occurrences and the recovery of human remains in the Langebaan Limestone deposits at Sea Harvest, in Saldanha Bay, has provided some of the earliest evidence we have in the world for the human exploitation of coastal resources, more than 100 000 years ago, and at Hoedjiespunt (limestone) in Saldanha Bay evidence was found of early modern humans, dated to about 125 000 years ago.

Due to the excellent preservation of ancient fossils from the rapid carbonate cementation of sediments in which bone has been buried in the calcareous aeolianites (fossil dunes) and shallow marine silts, ancient fossil sites have been found at the Varswater quarry near Langebaanweg dated to around 5 million years ago.

Within fossilized dunes, a number of hyena lairs produced Pleistocene (1.6 million – 200 000 years) faunas, including herbivores and carnivores, at Hoedjiespunt and Sea Harvest in Saldanha Bay and nearby Besans Klip quarry at Vredenburg.

An EIA for the proposed Alpha Saldanha Cement Project in Saldanha Bay revealed the presence of an unusual Mid-Miocene (± 11-12 million years) fauna, including the shell of a giant extinct ostrich like bird. Monitoring of bulk earthworks by the archaeologist at Saldanha Steel also exposed rare and previously unknown crocodilian and other fossil remains from the Miocene Period, from deposits underlying deep calcareous formations during excavations for descaling pits. Important vertebrate fossils (bones) embedded in the aeolianites of the Langebaan and Varswater Formation, were also recently found in cuttings and exposures, and among the spoil dumps alongside the existing residue dam at the Namakwa Sands (Kaplan 2006b).

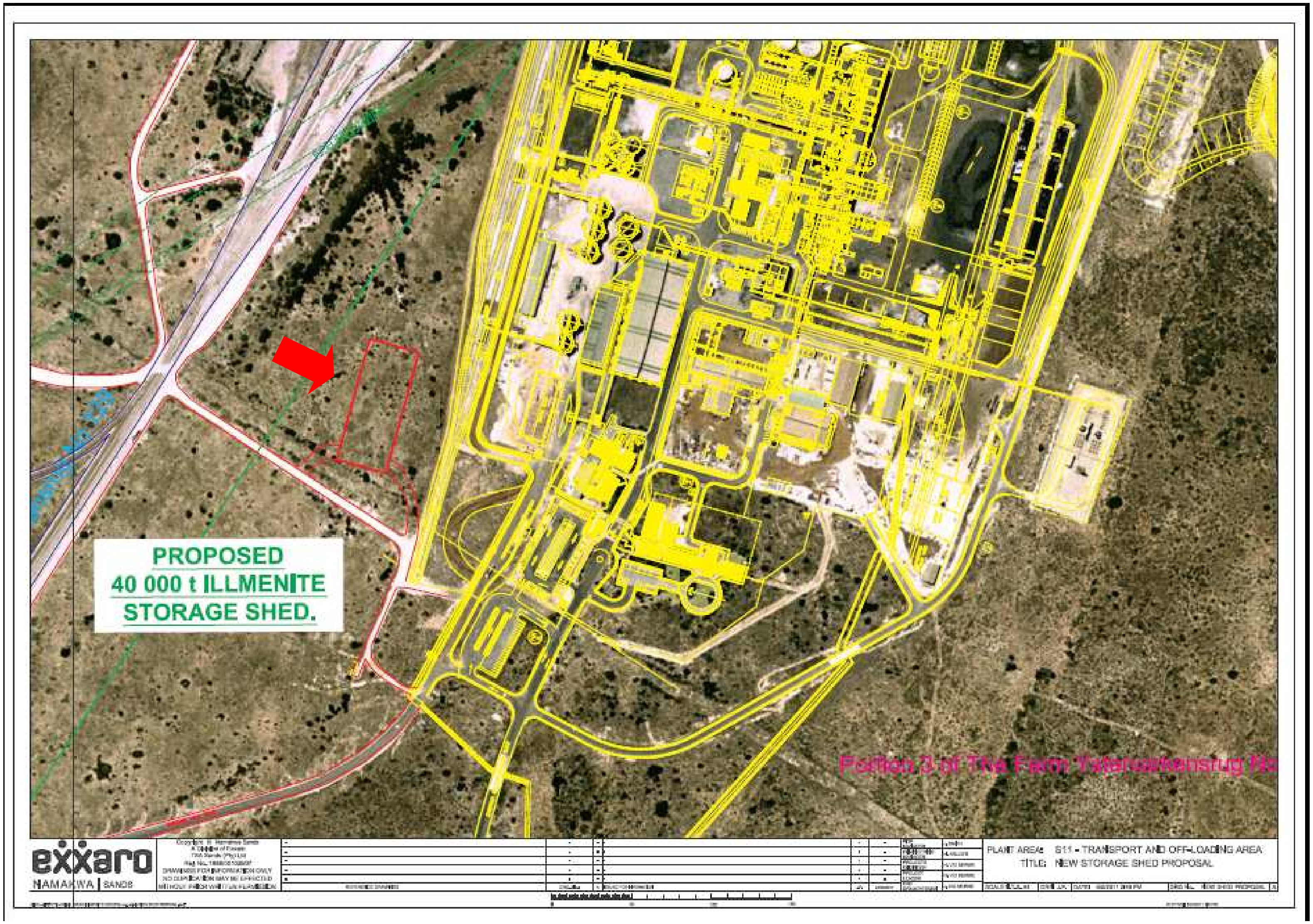
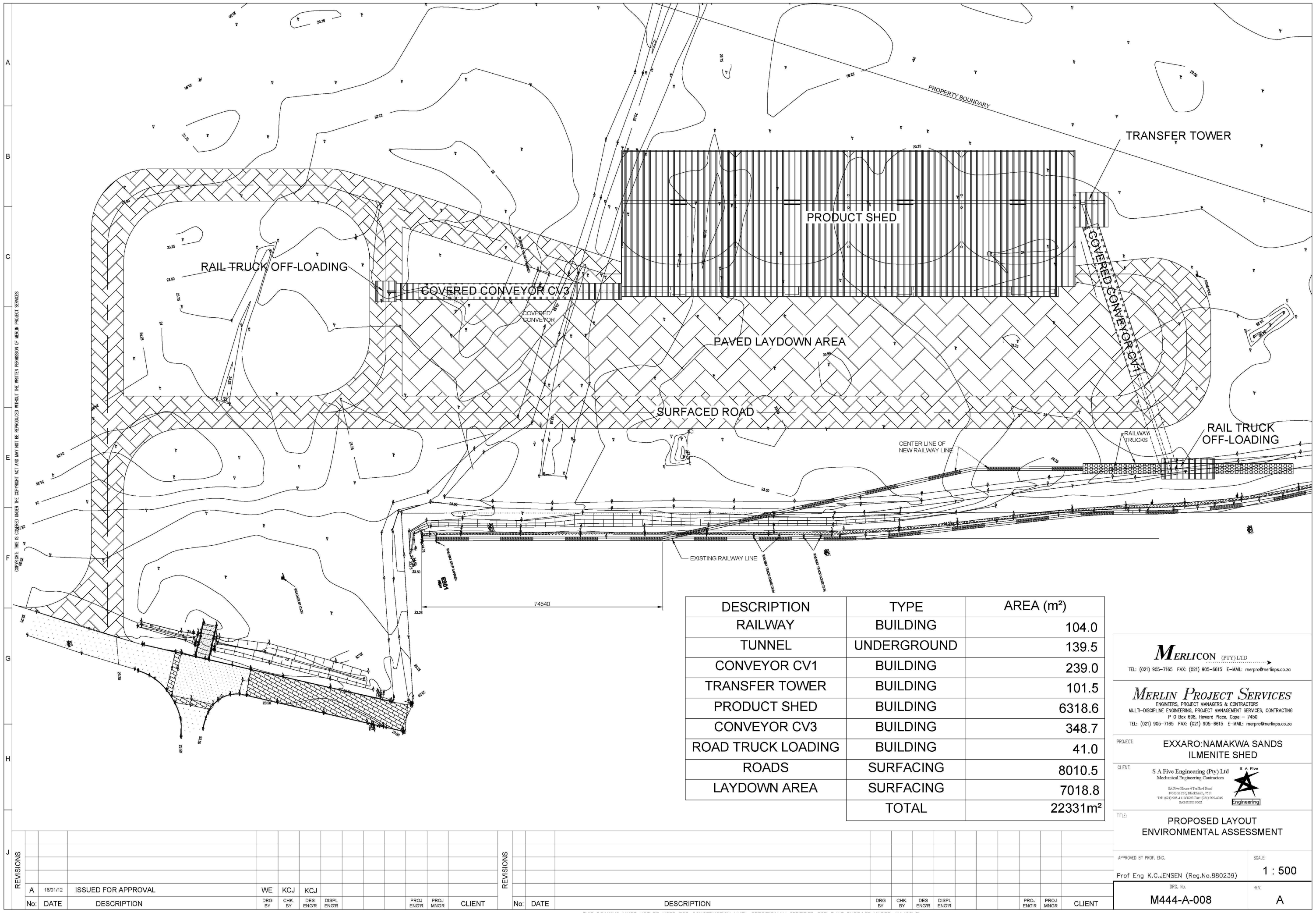


Figure 2: Proposed location of warehouse (red outlined rectangle) (Ref: Supplied by SRK Consulting)



DESCRIPTION	TYPE	AREA (m²)
RAILWAY	BUILDING	104.0
TUNNEL	UNDERGROUND	139.5
CONVEYOR CV1	BUILDING	239.0
TRANSFER TOWER	BUILDING	101.5
PRODUCT SHED	BUILDING	6318.6
CONVEYOR CV3	BUILDING	348.7
ROAD TRUCK LOADING	BUILDING	41.0
ROADS	SURFACING	8010.5
LAYDOWN AREA	SURFACING	7018.8
	TOTAL	22331m²

Figure 3: Detailed layout for the proposed warehouse shed (Ref: Supplied by SRK Consulting)

3. METHODOLOGY

The entire area was walked, and a track created on a Garmin GPS 60 unit. Open areas where dune moles had been digging were specifically assessed for sub-surface indications of cultural material, and anything found was marked on the GPS instrument (Figure 4) and photographed (Figure 5).

Figure 4: Aerial photograph showing the area covered during the foot survey (orange line) (Ref: Google Earth 2011)

4. RESULTS

Only in one place was any prehistoric material noted. This included two pieces of ostrich eggshell, and some flaked calcrete nodules with very rough flakes (Figures 5).

Figure 5: Calcrete nodule, and ostrich eggshell fragments, GPS 092 (32˚ 57' 48.6895S: 18˚ 02' 30.8529E)

In addition a few pieces of the black mussel, *Choromytilus meridionalis*, were also seen (GPS 091, 32˚ 57' 43.3724S: 18˚ 02' 33.9893E), but as these were uncalcified, could have been modern.

All other cultural debris was certainly modern; including plastic and paper, and other indications of occupation by the construction workers was limited to trees being cut using steel tools.

There were no constraints to the survey.

5. CONCLUSIONS & RECOMMENDATIONS

Surface indications suggest that the heritage value of the site is low, but, since the Saldanha area is very sensitive archaeologically and palaeontologically, it must be recognised that sub-surface materials may only be uncovered once deep excavation takes place during building construction, and when ditches are dug to modify the drainage and power connections.

It is recommended that once excavation with heavy equipment occurs, that an archaeologist be asked to monitor the site and to inspect sections which may be exposed before wall construction, etc. takes place.

Table 1: Impact rating of proposed development on subsurface archaeological and palaeontological material

POTENTIAL IMPACT ON SUBSURFACE ARCHAEOLOGICAL MATERIAL	
Nature of impact:	*Disturbance of in situ archaeological material*
Extent and duration of impact:	*Extent will be local as only the footprint will be affected and only during the construction phase (short term)*
Probability of occurrence:	*Low-medium*
Degree to which the impact can be reversed:	*Irreversible*
Degree to which the impact may cause irreplaceable loss of resources:	*High*
Cumulative impact prior to mitigation:	*Loss of archaeological resources in the region*
Proposed mitigation:	*Appointment of a suitably qualified archaeologist to monitor excavation by heavy construction equipment. If anything uncovered, must be systematically recorded and removed*
Cumulative impact post mitigation:	*Cumulative impact will be minimal if construction activities are monitored*
Significance rating of impact after mitigation (Low, Medium, Medium-High, High, or Very-High)	*Low*

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Appendix B: Palaeontology Specialist Report

PALAEONTOLOGICAL REPORT
(Desktop Study)

PROPOSED CONSTRUCTION OF WAREHOUSE STORAGE SHED AT NAMAKWA SANDS SMELTER PLANT, SALDANHA BAY WESTERN CAPE
EXXARO TSA SANDS (PTY) LTD

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24 JANUARY 2012

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SUMMARY

Exxaro TSA Sands (Pty) Ltd (‘Exxaro’) proposes to construct a warehouse storage shed on the property of the Namakwa Sands Smelter Plant (Figure 1). SRK Consulting (SRK) has been appointed by Exxaro to undertake an Environmental Impact Assessment (EIA) of the proposed project, as required by the National Environmental Management Act.

This study forms part of the Basic Assessment process and it assesses the probability of palaeontological materials (fossils) being uncovered in the subsurface and being disturbed or destroyed in the process of bulk earth works.

For the evaluation of the palaeontological impact it is the extent/scale of the deeper excavations to be made that are the main concern. The construction footprint is shown in Appendix 4 and the layout in Appendix 5. The shed will involve the excavation of trenches for the foundations of the walls: 150 + 45X4 = 330 m. This assumes linear foundations and not raft foundations or piling. The offloading and load-out facilities will likely also require some earth works. Further excavations will be made for the installation of stormwater drainage and probably for supporting infrastructure (trenches for power cabling, pipelines). For the most part, these earth works are not expected to exceed 2 m in depth. The preparation of the floor area is assumed to involve disturbance of the shallow subsurface over a large area (~7000 m^2).

Beneath a thin cover of sand, the project site is underlain by calcareous aeolianites (old dune sands) and calcretes (“surface limestones”) of the **Langebaan Formation** (Figure 3). These strata do not appear to be very fossiliferous to the cursory eye, but the fossils that have been found are of profound scientific value, raising international interest in the region. The Langebaan Formation aeolianites have been a prime source of information on Quaternary faunas and archaeology. Notably, some fossil finds have been made in the immediate area.

Monitoring by on-site personnel and field inspections by a palaeontologist/trained fossil excavator are recommended during construction of excavations. Appendices 1 and 2 outline monitoring by construction personnel and general Fossil Find Procedures.

It is recommended that Ms Pippa Haarhoff, manager of the West Coast Fossil Park, react to the reporting of chance finds by on-site personnel and also carry out field inspections at appropriate stages in the making of the excavations. Ms Haarhoff will liaise with local authorities, HWC, Exxaro Namakwa Sands and their contractors to carry out the inspections and liaise with the appointed palaeontologist w.r.t. nature of exposures, fossil finds and in the compilation of the report.

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The author is an independent consultant/researcher and is a recognized authority in the field of coastal-plain and continental-shelf palaeoenvironments and is consulted by exploration and mining companies, by the Council for Geoscience, the Geological Survey of Namibia and by colleagues/students in academia pursuing coastal-plain/shelf projects.

Expertise

- Shallow marine sedimentology.
- Coastal plain and shelf stratigraphy (interpretation of open-pit exposures and on/offshore cores).
- Marine macrofossil taxonomy (molluscs, barnacles, brachiopods).
- Marine macrofossil taphonomy.
- Sedimentological and palaeontological field techniques in open-cast mines (including finding and excavation of vertebrate fossils (bones).

Membership Of Professional Bodies

- South African Council of Natural Scientific Professions. Earth Science. Reg. No. 400094/95.
- Geological Society of South Africa.
- Palaeontological Society of Southern Africa.
- Southern African Society for Quaternary Research.
- Heritage Western Cape. Member, Permit Committee for Archaeology, Palaeontology and Meteorites.
- Accredited member, Association of Professional Heritage Practitioners, Western Cape.

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1 INTRODUCTION

Exxaro TSA Sands (Pty) Ltd ('Exxaro') proposes to construct a warehouse storage shed on the property of the Namakwa Sands Smelter Plant (Figure 1). SRK Consulting (SRK) has been appointed by Exxaro to undertake an Environmental Impact Assessment (EIA) of the proposed project, as required by the National Environmental Management Act.

This assessment forms part of the Basic Assessment process and it assesses the probability of palaeontological materials (fossils) being uncovered in the subsurface and being disturbed or destroyed in the process of bulk earth works.

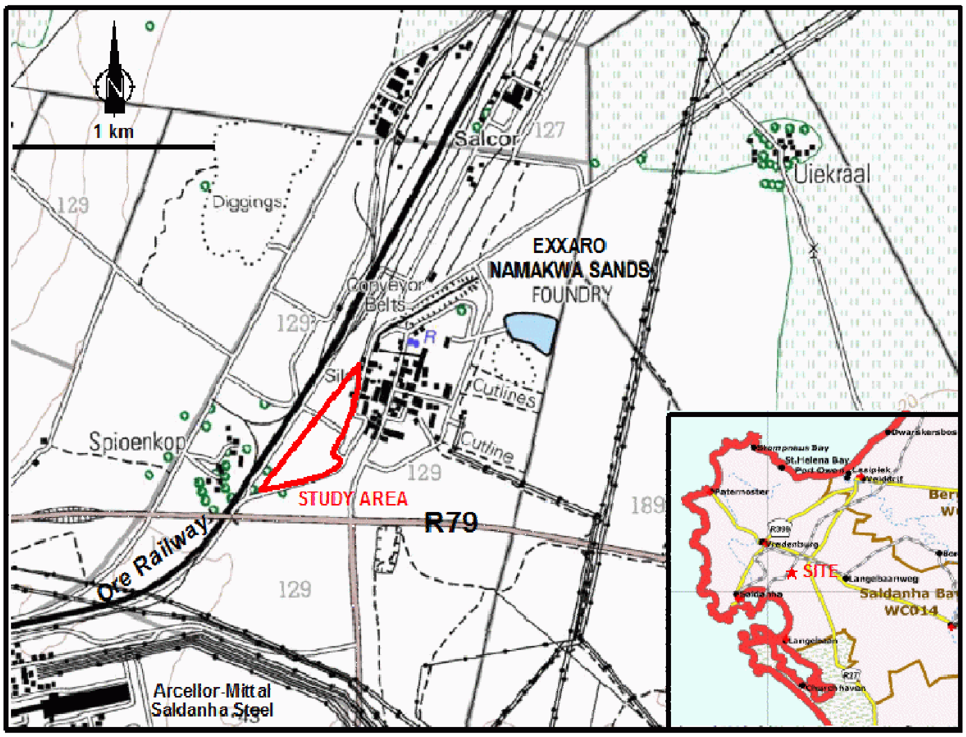

Figure 1. Location of the study area for the proposed heavy mineral storage shed and supporting facilities. Extract from 3218CA_CC_2003_ED5_GEO.TIF 1:50000 topo-cadastral sheet (Chief Directorate: Surveys and Mapping).

The proposed shed is to be used to store ilmenite from the Namakwa Sands heavy-mineral sands mine at Brand-se-Baai on the Namaqualand coast and other final products from the Smelter Plant. The construction footprint is shown in Appendix 4 and the layout in Appendix 5. The three stockpiles of material are intended to be stored in three bays in a structure of dimensions 150X45 m, with a 40 000 ton capacity. Supporting facilities include a rail truck and road truck offloading station, a road truck "load-out" station, a new 700 m road linking to the existing haul road to the port, a lay-down area next to the shed, and surrounding paving with incorporation into the storm water drainage system.

Palaeontological interventions mainly happen once fossil material is exposed at depth, *i.e*. once the EIA process is done and construction commences.
The main purposes of this palaeontological assessment are to:

- Outline the nature of possible palaeontological/fossil heritage resources in the subsurface of the study area.
- Suggest the mitigatory actions to be taken with respect to the occurrence of fossils during bulk earth works.

The action plans and protocols for palaeontological mitigation must therefore be *included in the Environmental Management Plan (EMP)* and embodied in the Agreed Terms of Reference for the appointed heritage assessment/mitigation practitioner.

Included herein is a general fossil-finds procedure for the appropriate responses to the discovery of paleontological materials during construction of the foundation excavations of the product stockpile shed.

Figure 2. Simulated oblique aerial view of the site, looking north. The study area is shown in red. The 25 m asl. contour is highlighted in yellow. From Google Earth with 5 m contour overlay.

2 APPLICABLE LEGISLATION

The National Heritage Resources Act (NHRA No. 25 of 1999) protects archaeological and palaeontological sites and materials, as well as graves/cemeteries, battlefield sites and buildings, structures and features over 60 years old. The South African Heritage Resources Agency (SAHRA) administers this legislation nationally, with Heritage Resources Agencies acting at provincial level.

According to the Act (Sect. 35), it is an offence to destroy, damage, excavate, alter or remove from its original place, or collect, any archaeological, palaeontological and historical material or object, without a permit issued by the South African Heritage Resources Agency (SAHRA) or applicable Provincial Heritage Resources Agency, *viz*. Heritage Western Cape (HWC).

Notification of SAHRA or the applicable Provincial Heritage Resources Agency is required for proposed developments exceeding certain dimensions (Sect. 38).

3 THRESHOLDS

The extent of subsurface disturbance and exposure exceeds 300 m in linear length and 5000 m2 (NHRA 25 (1999), Section 38 (1)). It must therefore be assessed for heritage impacts that includes assessment of potential palaeontological heritage (a PIA).

For the evaluation of the palaeontological impact it is the extent/scale of the deeper excavations to be made that are the main concern. The shed will involve the excavation of trenches for the foundations of the walls: 150 + 45X4 = 330 m. This assumes linear foundations and not raft foundations or piling. The offloading and load-out facilities will likely also require some earth works. Further excavations will be made for the installation of stormwater drainage and probably for supporting infrastructure (trenches for power cabling, pipelines). For the most part, these earth works are not expected to exceed 2 m in depth. The preparation of the floor area is assumed to involve disturbance of the shallow subsurface over a large area (~7000 m^2).

As elucidated below, the affected subsurface of the site has a distinct probability of containing fossils that will be exposed during earth works.

4 APPROACH AND METHODOLOGY

4.1 AVAILABLE INFORMATION

The point of departure is the geological map of the area *viz*. 1:125000 Sheet 255 and the accompanying explanation (Visser & Schoch (1972, 1973). The relevant part of the geological map is reproduced as Figure 3. Since then, ongoing research has added various refinements of the geology, but the map remains essentially valid. The later research contributions relevant to this assessment are cited in the normal manner as references in the text and are included in the References section.

Quarries and borrow pits in the surrounding area, such as the quarry just east of the Namakwa Sands plant, as well as pipe/cabling trenches and trail pits made in the vicinity of the site in the recent past (Namakwa Sands SALKOR, Saldanha Steel), have shown the nature of the underlying substrata and their fossil potential (Pether, 2009, 2010).

4.2 ASSUMPTIONS AND LIMITATIONS

The assumption is that the fossil potential of the formation underlying the site (Langebaan Formation) will be typical of that found in the region and more specifically, similar to that already discovered nearer to the site. Scientifically important fossil bone material is expected to be sparsely scattered in these deposits and much depends on spotting this material as it is uncovered during digging *i.e.* by monitoring excavations.

A limitation on predictive capacity exists in that it is not possible to predict the buried fossil content of an area or formation other than in such general terms. Certain processes/agents can produce significant concentrations of fossil bones, but the possibility of these specific buried palaeoenvironments being present is only hinted at by the general setting of a site.

5 GEOLOGICAL AND PALAEONTOLOGICAL SETTING

5.1 ASPECTS OF THE REGIONAL GEOLOGY

The older bedrock of the region consists of **Malmesbury Group** shales. Their origin dates from over 560 Ma (Ma: million years ago, Mega-annum), when mainly muddy sediments were deposited on the margins of an ancient ocean. The ocean basin subsequently was compressed by tectonic forces and the Malmesbury sediments were transformed to shales and were then intruded by molten magma that cooled to form the crystalline "**Cape Granites**" that are now exposed as hills around Vredenburg and Darling. These bedrock formations are not of palaeontological interest.

During the early history of the coastal plain it was deeply eroded by courses of the ancestral Berg River and the soft Malmesbury shales along the coast have mostly been eroded away to below sea level, while the hard granites form the hills (Figures 3 & 4). During the early Miocene about 20 Ma, rising sea level caused the rivers in these valleys to "back up", filling the valleys with river (fluvial) sediments and peat beds with plant fossils. This fluvial valley fill is the **Elandsfontyn Formation**, the oldest formation of the **Sandveld Group** of coastal deposits. It is not exposed, being covered by marine deposits and ancient dunes.

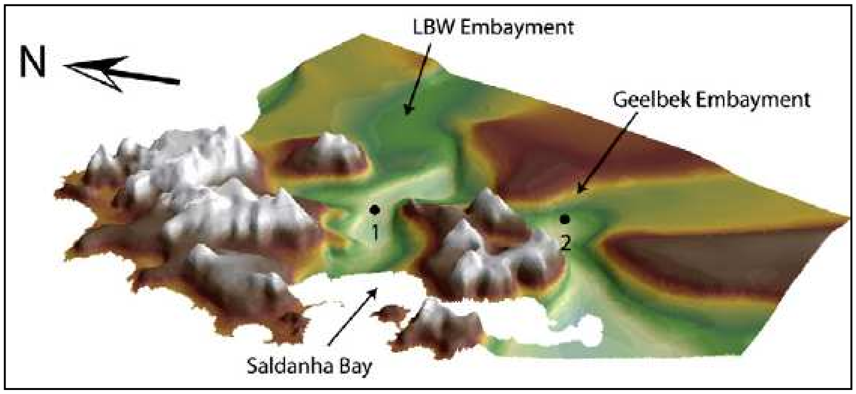

Figure 3. Bedrock topography showing early Cenozoic fluvial erosion. From Roberts et al., 2011, Fig 6A. 1=Fossil Park, 2=borehole S22.

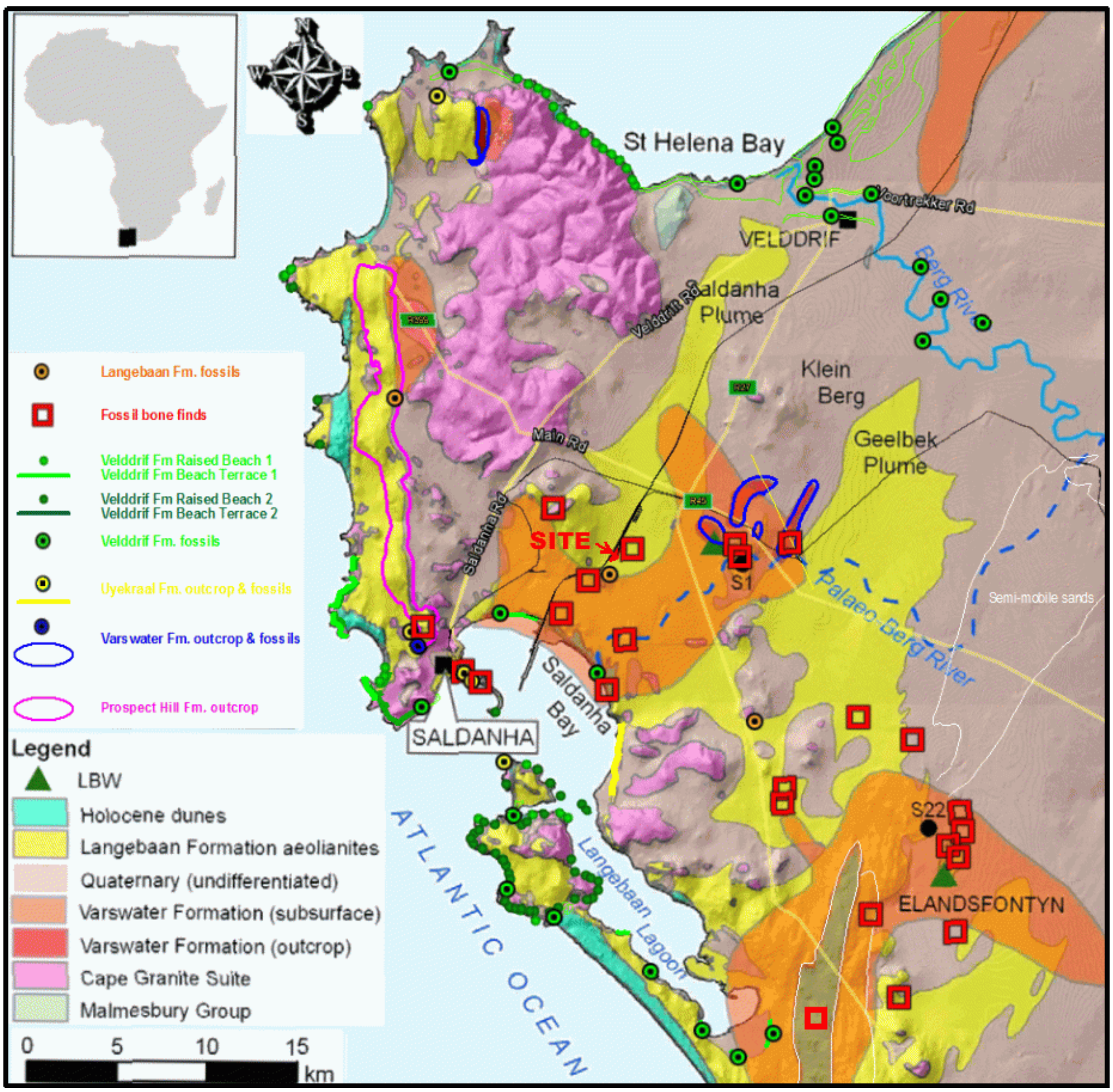

Figure 4. Simplified geology of the region. Adapted from fig. 1 of Roberts et al., 2011. The added symbols and lines denote features and formations of palaeontological interest.

The wide valleys were inundated during periods of high sea level, forming large embayments within which estuarine and marine-related deposits have been preferentially preserved. The subsurface extent of these deposits, called the **Varswater Formation**, is shown in Figure 4. The type locality of the Varswater Formation is the exposures at the West Coast Fossil Park. There the fossils from the upper part show that the age of the deposits is about 5 Ma and that the origin of the deposits is related to the early Pliocene sea-level highstand.

The subsurface extent of the Varswater Formation shown in Figure 4 reflects the occurrence of phosphatic marine sediments in boreholes that has been taken to be all Varswater Formation. It is clear, from observations wider afield, that the Varswater Formation so defined includes marine deposits of quite different ages. For instance, west of the West Coast Fossil Park (LBW, Figure 4), the flat plain that extends towards the coast is underlain by younger marine deposits of middle Pliocene age ~3 Ma. Rogers (1983) named these marine deposits the Uyekraal Shelly Sand Member of the Bredasdorp Formation. It has a capping hardpan calcrete, beneath which is green-hued shelly, gravelly sand with phosphatic casts (steinkerns) of molluscs and shark teeth (Rogers, 1982, 1983). Note that the Uyekraal Shelly Sand Member is not formally recognized and is currently subsumed in the Varswater Formation, but it is deserving of being a separate formation called the "**Uyekraal Formation**", Sandveld Group.

At various places around Saldanha Bay are exposures of shelly marine deposits with Pliocene assemblages and these are the eroded fringes of the Uyekraal Formation: Leentjiesklip, Hoedjiespunt peninsula, Diazville lower quarry, Duyker Eiland (Figure 4). On the basis of extinct fossil shells, the Uyekraal shelly beds are correlated with the Hondeklip Bay Fm. of Namaqualand, a substantial, prograded marine formation built out seawards from a sea-level maximum of 30-35 m asl. (Pether, 1994; Pether *et al*., 2000). Similarly, the Uyekraal Fm. will be extensive beneath the outer several km of the low-gradient coastal plain, but will be largely eroded from the steeper bedrock areas of the Vredenburg Peninsula. The Uyekraal Formation is the youngest marine formation that has a warm-water shell fauna in open-coast deposits and a significant number of extinct species.

"Raised beaches" of the **Velddrif Formation** occur along the coast below ~15 m asl. In Figure 4, the occurrences of these shelly deposits is shown by the green symbols, lines and polygons fringing the coast and in the current Berg River embayment. These were deposited during the Quaternary Period and the oldest "raised beach" may be as old as 1.2 Ma. The Velddrif Formation is not of concern within the scope of the project.

Aeolianites or "dune rocks/fossil dunes" overlie the marine deposits of the coastal plain. The calcareous aeolianites are evident in the coastal landscape as the ridges, low hills and mounds beneath a capping calcrete crust, or "surface limestone" in old terminology. Until recently the calcareous aeolianites of the west coast of the southern Cape have all been lumped in the **Langebaan Formation** or "Langebaan Limestones" (Figure 4, yellow plumes), thus including various aeolianites of different ages as an "amalgam" of the dune plumes that formed on the coastal plain, at differing places and times.

This is reflected in the different ages indicated from fossils found at various places. For instance, the inner aeolianite ridge stretching north from Saldanha Bay up the coast to near Paternoster has been found to have fossil eggshell fragments of extinct ostriches (*Diamantornis wardi*). Based on dated occurrences in East Africa and Arabia, an age of 12-9 Ma is indicated. These aeolianites, previously belonging to the Langebaan Formation, are now called the **Prospect Hill Formation** (Roberts & Brink, 2002) (Figure 4).

The considerable extent of the **Langebaan Formation** aeolianites is evident in Figure 4 and attests to the persistence of strong southerly winds and the availability of sand on beaches. Much of the aeolian sand is tiny fragments of shell. The cementing of this "calcarenite" is generally quite weak, but much denser cementing has taken place in the uppermost part of the fossil dunes in the form of a "carapace" or capping of calcrete (Figure 6). The calcrete is a type of cemented soil called a pedocrete, formed in the near-surface by evapo-transpiration after the dunes became inactive and became vegetated. The aeolianites contain further calcretes and leached *terra rosa* soils at depth, attesting to a number of periods of reduced rates of sand accumulation, surface stability and soil formation. There are more marked breaks between periods of sand accumulation, shown by erosion surfaces or very thick calcretes formed over a long time.

The dune plumes accumulated episodically, under the influence of climate (windiness, rainfall) and available sand source areas (sea-level position, sediment supply), with erosion and re-deposition of previous dunes also taking place in some areas, separated by periods of stability and soil formation. The most favourable sand supply conditions seem to have prevailed at sea levels below present, in the range of 10-40 m bsl. The oldest parts of the Langebaan Formation just postdate the ~3 Ma Uyekraal Fm., the youngest parts postdate the Velddrif Formation and are as young as ~60 ka.

The **Springfontyn Formation** is an informal category that accommodates the mainly non-calcareous, windblown sand sheets and dunes that have covered parts of the landscape during the Quaternary. Its areal extent is depicted on the geological map (Figure 4) as "Quaternary undifferentiated". Visser & Schoch (1972, 1973) differentiate the coversand by its surface appearance into 2 surficial units, **Q2** (older cover) and **Q1** (younger cover). The Springfontyn Fm. consists of the sequences beneath these "coversands", *i.e*. SubQ2 and SubQ1.

Unit Q2 is characterized by its surface manifestation as the distinct "heuweltjiesveld", the densely dot-patterned landscape of low hillocks that are termitaria made by *Microhodotermes viator*. Its true areal extent is not immediately appreciated as it laps onto bedrock and onto the Langebaan Fm., but for the purposes of geological mapping (Figure 4) these overlap areas are not shown. It is also apparent that Q2 underlies large areas now covered by Q1.

The dot-patterned "heuweltjiesveld" is merely the surface-soil characteristic of Unit Q2. Not much detail is known about Unit Q2 at depth (Sub-Q2). Pedogenic layers of ferruginous concretions, clayey beds and minor calcretes occur among sandy-soil beds. Clearly Q2 will differ from place to place according to the local setting. In this area, in addition to mainly windblown sands from the south, Sub-Q2 will likely comprise the local colluvial/hillwash/sheetwash deposits, small slope-stream deposits, alluvium in the lower valleys and vlei and pan deposits.

Surface **Unit Q1** is a younger “coversand” geological unit and is “white to slightly-reddish sandy soil” (Visser & Toerien, 1971; Visser & Schoch, 1973). These are patches of pale sand deposited in geologically-recent times. In places these sands are undergoing semi-active transport and locally have been remobilized into active sandsheets and dunes.

Chase & Thomas (2007) have cored Q1 coversands in a regional survey of various settings along the West Coast and applied optically stimulated luminescence (OSL) dating techniques to establish the timing of sand accumulation. Their results indicate several periods of deposition of Q1 during the last 100 ka, with activity/deposition at 63–73, 43–49, 30–33, 16–24 and 4–5 ka. Notably, underlying sands produced dates from ~150 to ~600 ka, reflecting the accumulation of Unit Q2 in the middle Quaternary.

The latest addition of dunes to the coastal plain is shown in Figure 4 as “Holocene dunes”, otherwise known as the **Witzand Formation** (Rogers, 1980), for obvious reason. These are sands blown from the beach in the last few thousand years and added to the fossil dune cordon or “sand wall” parallel to the coast, or have blown further as dune plumes transgressing a few kilometres inland.

5.2 *GEOLOGY OF THE STUDY AREA*

The study area is situated between 23-25 m asl. within the Langebaanweg palaeo-embayment (Figure 3) and is located on top of Langebaan Formation aeolianite and calcrete (Figures 4 & 5). In Figure 5 the yellow hue shows the extent of calcreted aeolianite cover under a thin sandy soil. The 25 m asl. contour illustrates the topographic setting of the study area/SALKOR railhead (Figures 2 & 5) which is located in a broad, shallow depression trending southwest. To the west is the aeolianite-covered, granite-cored hill of Besaansklip. Subdued aeolianite ridges form the eastern flank of the depression. An outcropping granite high (G3) suggests the aeolianite ridges are anchored on underlying topography (Figure 5).

During the mid-Pliocene sea-level high the ~30 m asl. palaeoshoreline lapped around the granite hill of Besaansklip. The associated marine Uyekraal Formation is expected beneath the Langebaan aeolianites. However, this formation is unlikely to be intersected in shallow excavations.

5.3 *EXPECTED PALAEONTOLOGY*

5.3.1 *Fossils in aeolian settings*

Many fossils are associated with old, buried surfaces in the aeolianites (palaeosurfaces), usually formed during wetter or less windy periods, with reduced rates of sand accumulation and with soil formation showing the surface stability. The common fossils include shells of extinct land snails, fossil tortoises, ostrich incl. egg fragments and generally sparsely scattered bones. Conversely “blowout” erosional palaeosurfaces may carry fossils concentrated by the removal of sand by the wind.

The bone concentrations most commonly found are due to hyaenas. The bones often occur in the lairs of hyaenas, such as tunnels made into the softer material beneath a calcrete “roof” (Figure 6). These most often occur on slopes where some erosion of the calcrete, producing overhangs and crevices, has facilitated the making of a burrow. Burrows made by aardvarks are also exploited by hyaenas. Hyaena lairs can be found at depth in the aeolian deposits, where they relate to buried palaeosurfaces.

Figure 5. Simulated oblique aerial view of the site, looking north. The study area is shown in red. The 25 m asl. contour is highlighted in yellow. Extract from Visser & Schoch (1972), 1:125000 Map Sheet 255: 3217D & 3218C (St Helenabaai), 3317B & 3318A (Saldanhabaai). Viewed in Google Earth with 5 m contour overlay.

Dissolution hollows formed by water locally ponding and dissolving the calcrete are another site of local fossil trapping. These can also be exploited to make burrows and lairs. These dissolution features are called “karst” and surprisingly deep “pipes” can form in this manner, usually filled with reddened sediment. Such dissolution pipes can directly trap small animals and accumulate fossils. The fossil concentrations in animal lairs and dissolution features are “superimposed” into an older, cementing aeolianite.

Hollows between dunes (interdune areas) are the sites of ponding of water seeping from the dunes, leading to the deposits of springs and small vleis. These are usually muddy, with plant fossils, but being waterholes, are usually richly fossiliferous, with concentrations of large mammal bones due to predator activity, including Stone Age hunters.

Figure 6. Fossil bone concentration (circled) in the infill of a cavity below the calcrete capping of the Langebaan Formation.

More specifically, trial pits made prior to the excavation of the second slimes dam at Namakwa Sands Smelter revealed that a particularly thick calcrete underlies the area. Such thick calcrete develops beneath long-lived surfaces on old formations, where increments of deposition have been small. The thick calcrete is polyphase in origin and disguised within it are discrete, small phases of sand deposition separated by cryptic palaeosurfaces on which fossils may occur. Fossils in cemented aeolianites and calcretes are quite difficult to spot as they are usually coated with white limey deposit (Figure 7) and do not stand out well amongst the nodules and general bumpiness of a fresh exposure.

Notably, sporadic fossil bone finds are a feature of the SALKOR area, apparently in the context outlined above.

Another aspect of the site is its situation in a broad, gentle depression trending southwest. It is possible that, during wetter climates in the past, an ephemeral drainage may have occupied the depression. Such deposits may be disguised in the thick calcrete, with concentrations of bone material eroded from underlying aeolianite and also washed in from the surrounding area.

5.3.2 Buried archaeological material

It is possible that archaeological material may occur locally within the thin, loose sand cover covering the capping calcrete of the aeolianite. This is indicated by “out of place’ marine shell (limpets, mussels), pottery pieces and quartz or silcrete stone tools. Buried archaeological material may also occur on top of the calcrete or in crevices and solution pits in it. Early and Middle

Stone Age artefacts and associated fossil bones are found within and below the capping calcretes.

Figure 6. Example of fossil antelope jaw from a shallow trench into the calcrete capping of the Langebaan Formation at SALKOR. Image courtesy André Carstens.

6 NATURE OF THE IMPACT OF BULK EARTH WORKS ON FOSSILS

Fossils are rare objects, often preserved due to unusual circumstances. This is particularly applicable to vertebrate fossils (bones), which tend to be sporadically preserved and have high value w.r.t. palaeoecological and biostratigraphic (dating) information. Such fossils are non-renewable resources. Provided that no subsurface disturbance occurs, the fossils remain sequestered there.

When excavations are made they furnish the "windows" into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, provided that efforts are made to watch out for and rescue the fossils. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. The loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible.

The status of the potential impact for palaeontology is not neutral or negligible.

Although coastal dunes and coversands are not generally very fossiliferous, it is quite possible that fossiliferous material could occur. The very scarcity of fossils makes for the added importance of watching for them.

There remains a medium to high risk of valuable fossils being lost in spite of management actions to mitigate such loss. Machinery involved in excavation may damage or destroy fossils, or they may be hidden in “spoil” of excavated material.

7 *SIGNIFICANCE*

The fossils that have been found in the Langebaan Fm. aeolianites are of profound scientific value, raising international interest in the region. The Langebaan Fm. aeolianites have been a prime source of information on Quaternary faunas and archaeology.

At the Diazville lower quarry, Langebaan Fm. aeolianite overlying the mid-Pliocene, marine Uyekraal Formation enclosed vertebrate material indicative of a late Pliocene or younger age (Roberts & Brink, 2002) (Diazville Member). The fossil suid (bushpig) from Skurwerug dates the fossil dune-plume there to the early Pleistocene ~1.2 Ma (Hendey & Cooke, 1985).

At Elandsfontein a fossil interdunal vlei was exposed by deflation, the large number of fossil bones and ESA tools indicate an age of ~600 ka (Klein et al., 2007). Notably, prior to the wind erosion of coversands at Elandsfontein, there would have been no indication of the fossil wealth just below, which included a cranium of the pre-modern human *Homo heidelbergensis*.

At Geelbek Dunefield the deflation hollows located between the wind-blown, actively-mobile sand dunes are a source of mammalian fossils and Stone Age tools, with more being constantly exposed (Kandel *et al*., 2003). The older aeolianites surrounding Geelbek dunefield exhibit three sequential calcretes which are dated at ~250, ~150 and ~65 ka, *i.e*. stability/soil formation during glacial periods (Felix-Henningsen et al., 2003).

At Spreeuwal on the shore of Saldanha Bay, fossil vlei deposits are exposed in the intertidal zone and contain large mammal bones and some MSA artefacts (Avery & Klein, 2009). The larger mammal component includes extinct species and others not recorded historically in the Western Cape. Small mammals, birds, reptiles, amphibians, freshwater gastropods and ostracods also occur.

At Kraalbaai the aeolianite with human tracks preserved in it (Kraal Bay Member) is dated to 117-79 ka (Roberts & Berger, 1997). Dating of aeolianites near Cape Town by luminescence methods shows accumulation during MIS 7 and MIS 5 (interglacials), with calcrete formation in the intervening glacial (ice age) periods (Roberts *et al*., 2009).

Examples of hyaena bone accumulations in dens within the partly-lithified dune rocks are the Sea Harvest and Hoedjiespunt sites in Saldanha Bay. Hoedjiespunt is the find site of fossil teeth of a hominid in deposits 200-300 ka old. The Sea Harvest site produced an essentially modern human tooth that is older than 40 ka. Both sites provided considerable samples of the faunas of those times, thanks to the brown hyaenas.

The general significance of coastal-plain fossils involves:

- The history of coastal-plain evolution.
- The history of past climatic changes, past biota and environments.
- Associations of fossils with buried archaeological material and human prehistory.
- For radiometric and other dating techniques (rates of coastal change).
- Preservation of materials for the application of yet unforeseen investigative techniques.

8 IMPACT ASSESSMENT

The Impact Significance Rating Methodologyemployed by SRK is attached as Appendix 3.

Potential impact:	Permanent loss of palaeontological material
Nature of impact:	Construction activities (excavations) will result in a negative direct impact on the probable fossil content of the affected subsurface. Fossils and significant observations will be lost in the absence of management actions to mitigate such loss. This loss of the opportunity to recover them and their contexts when exposed at a particular site is irreversible. Conversely, construction excavations furnish the “windows” into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. The impact is positive for palaeontology, <u>provided that efforts are made to watch out for and rescue the fossils</u>.
Extent and duration of impact:	The physical extent of impacts on potential palaeontological resources relates directly to the extents of subsurface disturbance in the construction area, *i.e*. local. Score = 1.. The cultural, heritage and scientific impacts are of regional to national extent, as is implicit in the NHRA 25

	(1999) legislation and, if scientifically important specimens or assemblages are uncovered, are of international interest. This is evident in the amount of foreign-funded research that takes place by scientists of other nationalities. Loss of opportunities that may arise from a significant fossil occurrence (tourism, employment) filters down to regional/local levels. The construction period is short term (<2years). The period over which the excavations are made is the "time window" for mitigation. The impact of both the finding or the loss of fossils is permanent (long term). The found fossils must be preserved "for posterity"; the lost, overlooked or destroyed fossils are lost to posterity. Score = 3.
Probability of occurrence:	The likelihood of impact is probable *i.e*. it is likely to occur under most conditions.
Degree to which the impact can be reversed:	Irreversible without mitigation.
Degree to which the impact may cause irreplaceable loss of resources:	High
Cumulative impact prior to mitigation:	Permanent loss of fossils. The Saldanha Bay area is nationally and internationally known to be rich in fossils. Increased development in the region places pressure on the status of these fossils. The expansion of the Smelter Plant, although in an industrial area, may result in a permanent loss of resources and a loss of opportunities that may arise from a significant fossil occurrence (e.g. tourism, employment). However, the discovery of potential resources on site is difficult without the occurrence of excavations or cuttings.
Significance rating of impact prior to mitigation (Low, Medium, Medium-High, High, or Very-High)	Medium (-ve). Local (1) + Medium Intensity (2) + Long-term Duration (3) = Medium (6) Probability Classification = Probable Therefore Medium Significance rating according to SRK rating.

Degree to which the impact can be mitigated:	Medium.
Proposed mitigation:	Monitoring of construction-phase excavations by a suitably qualified palaeontologist and rescue & documentation of fossil finds.
Cumulative impact post mitigation:	The potential impact on palaeontological resources will be minimal if construction activities are monitored. The impact may in fact be positive for palaeontology as construction excavations furnish the "windows" into the coastal plain depository that would not otherwise exist and thereby provide access to the hidden fossils. This is provided that mitigation measures are implemented effectively.
Significance rating of impact after mitigation (Low, Medium, Medium-High, High, or Very-High)	Low (-ve/+ve). Difficult to determine but will depend on amount of fossils and success of mitigation.

8.1.1 Confidence

The level of confidence of the probability and intensity of impact is medium to high.

9 RECOMMENDATIONS

Note that the probable presence of fossils in the subsurface does not have an *a priori* influence on the decision to proceed with the development. However, mitigation measures are essential. The potential impact has a moderate influence upon the proposed project, consisting of implemented mitigation measures recommended below, to be followed during the construction phase.

Monitoring by on-site personnel and field inspections by a palaeontologist/trained fossil excavator are recommended during construction of excavations.

Appendices 1 and 2 outline monitoring by construction personnel and a general Fossil Find Procedures.

It is recommended that Ms Pippa Haarhoff, manager of the West Coast Fossil Park, carry out field inspections at appropriate stages in the making of the excavations. Ms Haarhoff has the requisite experience for seeing and excavating fossil material. She can be available to react to the reporting of chance finds by on-site personnel. As she is closer at hand, this arrangement is more cost-effective, with faster response times.

Ms Haarhoff will liaise with local authorities, HWC and Exxaro Namakwa Sands and their contractors to carry out the inspections during and at completion of excavations, involving:

- Inspect the exacavations and spoil heaps for fossil content.
- Photographically record occurrences.
- Retrieve fossil bone finds. Given the nature of the deposit, these are expected to be finds of broken bone exposed in chunks of calcrete. All bone-bearing pieces should be collected.
- Liaise with the appointed palaeontologist w.r.t. nature of exposures, fossil finds and in the compilation of the report.

In the event of a significant fossil occurrence, additional geological and palaeontological expertise must be brought to bear in order to more completely record the context.

9.1 MONITORING

Table 4. Basic measures for the Construction EMP

OBJECTIVE: To see and rescue fossil material that may be exposed in the various excavations made for installation foundations and cabling.		
Project components	Foundation excavations, trenches for cabling and pipes, spoil from excavations.	
Potential impact	Loss of fossils by their being unnoticed and/ or destroyed.	
Activity/ risk source	All bulk earthworks.	
Mitigation: target/ objective	To facilitate the likelihood of noticing fossils and ensure appropriate actions in terms of the relevant legislation.	
Mitigation: Action/ control	**Responsibility**	**Timeframe**
Inform staff of the need to watch for potential fossil occurrences.	Exxaro Namakwa Sands, Environmental Site Officr (ESO), contractors.	Pre-construction.
Inform staff of the procedures to be followed in the event of fossil occurrences.	ESO/palaeontology specialist.	Pre-construction.
Monitor for presence of fossils	Contractor personnel and ESO.	Construction.
Liaise on nature of potential finds and appropriate responses.	ESO and palaeontology specialist.	Construction.
Excavate main finds, inspect pits & record	Palaeontology specialist.	Construction.

selected, key/higher-risk excavations.		
Obtain permit from HWC for finds.	Palaeontology specialist.	Construction
Performance Indicator	Reporting of and liaison about possible fossil finds. Fossils noticed and rescued.	
Monitoring	Due effort to meet the requirements of the monitoring procedures.	

It is probable that sparse, valuable bone fossils will go undetected, even with the most diligent mitigation practicable. On the other hand, the finding and recovery of fossils will have a positive impact ranging from local to international in extent, depending on the nature of the finds

10 APPLICATION FOR A PALAEONTOLOGICAL PERMIT

A permit from Heritage Western Cape (HWC) is required to excavate fossils. The applicant should be the qualified specialist responsible for assessment, collection and reporting (palaeontologist).

A permit has not been applied for prior to the making of excavations. Should fossils be found that require rapid collecting, application for a retrospective palaeontological permit will be made to HWC immediately.

The application requires details of the registered owners of the sites, their permission and a site-plan map.

All fossil finds must be recorded and the fossils and their contextual information (a report) must be deposited at a SAHRA-approved institution.

11 REPORTING

Should fossils be found a detailed report on the occurrence/s must be submitted. This report is in the public domain and copies of the report must be supplied to the IZIKO S.A. Museum and Heritage Resources Western Cape. It must fulfil the reporting standards and data requirements of these bodies.

The report will be in standard scientific format, basically:

- A summary/abstract.
- Introduction.
- Previous work/context.
- Observations (incl. graphic sections, images).
- Palaeontology.

- Interpretation.
- Concluding summary.
- References.
- Appendices

The draft report will be reviewed by the client, or externally, before submission of the Final Report.

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13 GLOSSARY

~ (tilde): Used herein as “approximately” or “about”.

Aeolian: Pertaining to the wind. Refers to erosion, transport and deposition of sedimentary particles by wind. A rock formed by the solidification of aeolian sediments is an aeolianite.

AIA: Archaeological Impact Assessment.

Alluvium: Sediments deposited by a river or other running water.

Archaeology: 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.

asl.: above (mean) sea level.

Bedrock: Hard rock formations underlying much younger sedimentary deposits.

Calcareous: sediment, sedimentary rock, or soil type which is formed from or contains a high proportion of calcium carbonate in the form of calcite or aragonite.

Calcrete: An indurated deposit (duricrust) mainly consisting of Ca and Mg carbonates. The term includes both pedogenic types formed in the near-surface soil context and non-pedogenic or groundwater calcretes related to water tables at depth.

Clast: Fragments of pre-existing rocks, *e.g*. sand grains, pebbles, boulders, produced by weathering and erosion. Clastic – composed of clasts.

Colluvium: Hillwash deposits formed by gravity transport downhill. Includes soil creep, sheetwash, small-scale rainfall rivulets and gullying, slumping and sliding processes that move and deposit material towards the foot of the slopes.

Coversands: Aeolian blanket deposits of sandsheets and dunes.

Duricrust: A general term for a zone of chemical precipitation and hardening formed at or near the surface of sedimentary bodies through pedogenic and (or) non-pedogenic processes. It is formed by the accumulation of soluble minerals deposited by mineral-bearing waters that move upward, downward, or laterally by capillary action, commonly assisted in arid settings by evaporation. Classified into calcrete, ferricrete, silcrete.

ESA: Early Stone Age. The archaeology of the Stone Age between 2 000 000 and 250 000 years ago.

EIA: Environmental Impact Assessment.

EMP: Environmental Management Plan.

Ferricrete: Indurated deposit (duricrust) consisting predominantly of accumulations of iron sesquioxides, with various dark-brown to yellow-brown hues. It may form by deposition from solution or as a residue after removal of silica and alkalis. Like calcrete it has pedogenic and groundwater forms. Synonyms are laterite, iron pan or "koffieklip".

Fluvial deposits: Sedimentary deposits consisting of material transported by, suspended in and laid down by a river or stream.

Fm.: Formation.

Fossil: Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the disturbance or structure produced in sediments by organisms, such as burrows and trackways.

Heritage: That which is inherited and forms part of the National Estate (Historical places, objects, fossils as defined by the National Heritage Resources Act 25 of 1999).

HIA: Heritage Impact Assessment.

LSA: Late Stone Age. The archaeology of the last 20 000 years associated with fully modern people.

LIG: Last Interglacial. Warm period 128-118 ka BP. Relative sea-levels higher than present by 4-6 m. Also referred to as Marine Isotope Stage 5e or "the Eemian".

Midden: A pile of debris, normally shellfish and bone that have accumulated as a result of human activity.

MSA: Middle Stone Age. The archaeology of the Stone Age between 20-300 000 years ago associated with early modern humans.

Palaeontology: The study of any fossilised remains or fossil traces of animals or plants which lived in the geological past and any site which contains such fossilised remains or traces.

Palaeosol: An ancient, buried soil whose composition may reflect a climate significantly different from the climate now prevalent in the area where the soil is found. Burial reflects the subsequent environmental change.

Palaeosurface: An ancient land surface, usually buried and marked by a palaeosol or pedocrete, but may be exhumed by erosion (*e.g*. wind erosion/deflation) or by bulk earth works.

Peat: partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps.

Pedogenesis/pedogenic: The process of turning sediment into soil by chemical weathering and the activity of organisms (plants growing in it, burrowing animals such as worms, the addition of humus *etc.*).

Pedocrete: A duricrust formed by pedogenic processes.

PIA: Palaeontological Impact Assessment.

SAHRA: South African Heritage Resources Agency – the compliance authority, which protects national heritage.

Stone Age: The earliest technological period in human culture when tools were made of stone, wood, bone or horn. Metal was unknown.

Type locality: The specific geographic locality where the stratotype of a layered stratigraphic unit is situated. The name also refers to the locality where the unit was originally described and/or named.

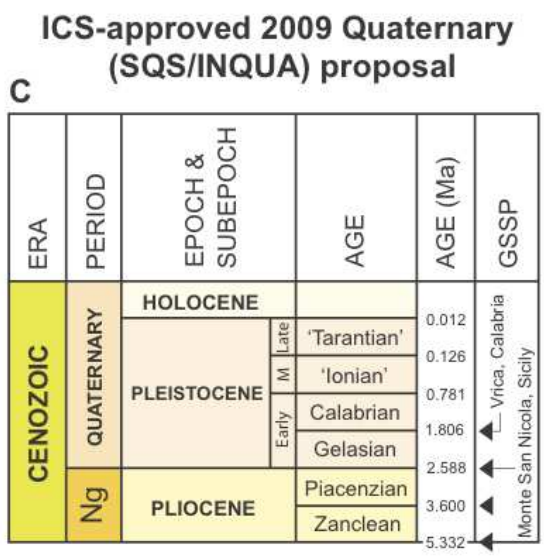
13.1 *GEOLOGICAL TIME SCALE TERMS (YOUNGEST TO OLDEST).*

ka: Thousand years or kilo-annum (10^3 years). Implicitly means “ka ago” *i.e.* duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Generally not used for durations not extending from the Present. Sometimes “kyr” is used instead.

Ma: Millions years, mega-annum (10^6 years). Implicitly means “Ma ago” *i.e.* duration from the present, but “ago” is omitted. The “Present” refers to 1950 AD. Generally not used for durations not extending from the Present.

Holocene: The most recent geological epoch commencing 11.7 ka till the present.

Pleistocene: Epoch from 2.6 Ma to 11.7 ka. Late Pleistocene 11.7–126 ka. Middle Pleistocene 135–781 ka. Early Pleistocene 781–2588 ka (0.78-2.6.Ma).



Quaternary: The current Period, from 2.6 Ma to the present, in the Cenozoic Era. The Quaternary includes both the Pleistocene and Holocene epochs. The terms early, middle or late in reference to the Quaternary should only be used with lower case letters because these divisions are informal and have no status as divisions of the term Quaternary. The sub-divisions 'Early', 'Middle' or 'Late' apply only to the word Pleistocene. As used herein, early and middle Quaternary correspond with the Pleistocene divisions, but late Quaternary includes the Late Pleistocene and the Holocene.

Pliocene: Epoch from 5.3-2.6 Ma.

Miocene: Epoch from 23-5 Ma.

Oligocene: Epoch from 34-23 Ma.

Eocene: Epoch from 56-34 Ma.

Paleocene: Epoch from 65-56 Ma.

Cenozoic: Era from 65 Ma to the present. Includes Paleocene to Holocene epochs.

Cretaceous: Period in the Mesozoic Era, 145-65 Ma.

Jurassic: Period in the Mesozoic Era, 200-145 Ma.

Precambrian: Old crustal rocks older than 542 Ma (pre-dating the Cambrian).

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14 APPENDIX 1 – MONITORING FOR FOSSILS

A regular monitoring presence over the period during which excavations are made, by either an archaeologist or palaeontologist, is generally not practical.

The field supervisor/foreman and workers involved in digging excavations must be encouraged and informed of the need to watch for potential fossil and buried archaeological material. Workers seeing potential objects are to report to the field supervisor who, in turn, will report to the Environmental Site Officer (ESO). The ESO will inform the archaeologist and/or palaeontologist contracted to be on standby in the case of fossil finds.

To this end, responsible persons must be designated. This will include hierarchically:

- The field supervisor/foreman, who is going to be most often in the field.
- The Environmental Site Officer (ESO) for the project.
- The Project Manager.

Should the monitoring of the excavations be a stipulation in the Archaeological Report, the contracted Monitoring Archaeologist (MA) can also monitor for the presence of fossils and make a field assessment of any material brought to attention. The MA is usually sufficiently informed to identify fossil material and this avoids additional monitoring by a palaeontologist. In shallow coastal excavations, the fossils encountered are usually in an archaeological context.

The MA then becomes the responsible field person and fulfils the role of liaison with the palaeontologist and coordinates with the developer and the Environmental Site Officer (ESO). If fossils are exposed in non-archaeological contexts, the palaeontologist should be summoned to document and sample/collect them.

Other alternatives could be considered, such as the employment of a dedicated monitor for the construction period. For instance, a local person could be detached from or trained by personnel at the West Coast Fossil Park.

14.1 CONTACTS FOR REPORTING OF FOSSIL FINDS.

West Coast Fossil Park

- Pippa Haarhoff: 083 289 6902, 022 766 1606, pippah@iafrica.com

Iziko Museums of Cape Town: SA Museum, 021 481 3800.

- Dr Graham Avery. 021 481 3895, 083 441 0028.
- Dr Deano Stynder. 021 481 3894.

Heritage Western Cape

- Justin Bradfield. 021 483 9543
- Jenna Lavin: 021 483 9685

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15 APPENDIX 2 - FOSSIL FIND PROCEDURES

In the context under consideration, it is improbable that fossil finds will require declarations of permanent "no go" zones. At most a temporary pause in activity at a limited locale may be required. The strategy is to rescue the material as quickly as possible.

The procedures suggested below are in general terms, to be adapted as befits a context. They are couched in terms of finds of fossil bones that usually occur sparsely, such as in the aeolian deposits. However, they may also serve as a guideline for other fossil material that may occur.

In contrast, fossil shell layers are usually fairly extensive and can be easily documented and sampled (See section 15.5).

Bone finds can be classified as two types: isolated bone finds and bone cluster finds.

15.1 ISOLATED BONE FINDS

In the process of digging the excavations, isolated bones may be spotted in the hole sides or bottom, or as they appear on the spoil heap. By this is meant bones that occur singly, in different parts of the excavation. If the number of distinct bones exceeds 6 pieces, the finds must be treated as a bone cluster (below).

Response by personnel in the event of isolated bone finds

- **Action 1:** An isolated bone exposed in an excavation or spoil heap must be retrieved before it is covered by further spoil from the excavation and set aside.
- **Action 2:** The site foreman and ESO must be informed.
- **Action 3:** The responsible field person (site foreman or ESO) must take custody of the fossil. The following information to be recorded:
    - Position (excavation position).
    - Depth of find in hole.
    - Digital image of hole showing vertical section (side).
    - Digital image of fossil.
- **Action 4:** The fossil should be placed in a bag (*e.g.* a Ziplock bag), along with any detached fragments. A label must be included with the date of the find, position info., depth.
- **Action 5:** ESO contacts the standby archaeologist and/or palaeontologist. ESO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of isolated bone finds
The palaeontologist will assess the information and liaise with the developer and the ESO and a suitable response will be established.

15.2 BONE CLUSTER FINDS

A bone cluster is a major find of bones, *i.e*. several bones in close proximity or bones resembling part of a skeleton. These bones will likely be seen in broken sections of the sides of the hole and as bones appearing in the bottom of the hole and on the spoil heap.

Response by personnel in the event of a bone cluster find

- **Action 1:** Immediately stop excavation in the vicinity of the potential material. Mark (flag) the position and also spoil that may contain fossils.
- **Action 2:** Inform the site foreman and the ESO.
- **Action 3:** ESO contacts the standby archaeologist and/or palaeontologist. ESO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of a bone cluster find

The palaeontologist will assess the information and liaise with Exxaro and a suitable response will be established. It is likely that a Field Assessment by the palaeontologist will be carried out asap.

It will probably be feasible to “leapfrog” the find and continue the excavation farther along, or proceed to the next excavation, so that the work schedule is minimally disrupted. The response time/scheduling of the Field Assessment is to be decided in consultation with developer/owner and the environmental consultant.

The field assessment could have the following outcomes:

- If a human burial, the appropriate authority is to be contacted. The find must be evaluated by a human burial specialist to decide if Rescue Excavation is feasible, or if it is a Major Find.
- If the fossils are in an archaeological context, an archaeologist must be contacted to evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.
- If the fossils are in a palaeontological context, the palaeontologist must evaluate the site and decide if Rescue Excavation is feasible, or if it is a Major Find.

15.3 RESCUE EXCAVATION

Rescue Excavation refers to the removal of the material from the “design” excavation. This would apply if the amount or significance of the exposed material appears to be relatively circumscribed and it is feasible to remove it without compromising contextual data. The time span for Rescue Excavation should be reasonably rapid to avoid any or undue delays, *e.g*. 1-3 days and definitely less than 1 week.

In principle, the strategy during mitigation is to “rescue” the fossil material as quickly as possible. The strategy to be adopted depends on the nature of the occurrence, particularly the density of the fossils. The methods of collection would depend on the preservation or fragility of the fossils and whether in loose or in lithified sediment. These could include:

- On-site selection and sieving in the case of robust material in sand.
- Fragile material in loose/crumbly sediment would be encased in blocks using Plaster-of Paris or reinforced mortar.

If the fossil occurrence is dense and is assessed to be a "Major Find", then carefully controlled excavation is required.

15.4 MAJOR FINDS

A Major Find is the occurrence of material that, by virtue of quantity, importance and time constraints, cannot be feasibly rescued without compromise of detailed material recovery and contextual observations.
A Major Find is not expected.

Management Options for Major Finds
In consultation with Exxaro and the environmental consultant, the following options should be considered when deciding on how to proceed in the event of a Major Find.

Option 1: Avoidance

Avoidance of the major find through project redesign or relocation. This ensures minimal impact to the site and is the preferred option from a heritage resource management perspective. When feasible, it can also be the least expensive option from a construction perspective.

The find site will require site protection measures, such as erecting fencing or barricades. Alternatively, the exposed finds can be stabilized and the site refilled or capped. The latter is preferred if excavation of the find will be delayed substantially or indefinitely. Appropriate protection measures should be identified on a site-specific basis and in wider consultation with the heritage and scientific communities.

This option is preferred as it will allow the later excavation of the finds with due scientific care and diligence.

Option 2: Emergency Excavation

Emergency excavation refers to the "no option" situation wherein avoidance is not feasible due to design, financial and time constraints. It can delay construction and emergency excavation itself will take place under tight time constraints, with the potential for irrevocable compromise of scientific quality. It could involve the removal of a large, disturbed sample by excavator and conveying this by truck from the immediate site to a suitable place for "stockpiling". This material could then be processed later.

Consequently, emergency excavation is not a preferred option for a Major Find.

15.5 EXPOSURE OF FOSSIL SHELL BEDS

Response by personnel in the event of intersection of fossil shell beds

- **Action 1:** The site foreman and ESO must be informed.
- **Action 2:** The responsible field person (site foreman or ESO) must record the following information:
  - Position (excavation position).
  - Depth of find in hole.
  - Digital image of hole showing vertical section (side).
  - Digital images of the fossiliferous material.
- **Action 3:** A generous quantity of the excavated material containing the fossils should be stockpiled near the site, for later examination and sampling.
- **Action 4:** ESO contacts the standby archaeologist and/or palaeontologist. ESO to describe the occurrence and provide images asap. by email.

Response by Palaeontologist in the event of fossil shell bed finds

The palaeontologist will assess the information and liaise with Exxaro and a suitable response will be established. This will most likely be a site visit to document and sample the exposure in detail, before it is covered up.

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The **significance** of an impact is defined as a combination of the **consequence** of the impact occurring and the **probability** that the impact will occur. The criteria used to determine impact consequence are presented in the Table below.

Criteria used to determine the Consequence of the Impact

Rating	Definition of Rating	Score
A. ***Extent****– the area in which the impact will be experienced*		
None		0
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. ***Intensity****– the magnitude or size of the impact*		
None		0
Low	Natural and/or social functions and processes are negligibly altered	1
Medium	Natural and/or social functions and processes continue albeit in a modified way	2
High	Natural and/or social functions or processes are severely altered	3
C. ***Duration****– the time frame for which the impact will be experienced*		
None		0
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years	3

The combined score of these three criteria corresponds to a **Consequence Rating**, as set out in the Table below:

Method used to determine the Consequence Score

Combined Score (A+B+C)	0 – 2	3 – 4	5	6	7	8 – 9
Consequence Rating	Not significant	Very low	Low	Medium	High	Very high

Once the consequence is derived, the probability of the impact occurring will be considered, using the probability classifications presented in the Table below.

Probability Classification

Probability of impact – the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

The overall s**ignificance** of impacts will be determined by considering consequence and probability using the rating system prescribed in the table below.

Impact Significance Ratings

Significance Rating	***Consequence***		***Probability***
Insignificant	Very Low	&	Possible
	Very Low	&	Improbable
Very Low	Very Low	&	Definite
	Very Low	&	Probable
	Low	&	Possible
	Low	&	Improbable
Low	Low	&	Definite
	Low	&	Probable
	Medium	&	Possible
	Medium	&	Improbable
Medium	Medium	&	Definite
	Medium	&	Probable
	High	&	Possible
	High	&	Improbable
High	High	&	Definite
	High	&	Probable
	Very High	&	Possible
	Very High	&	Improbable
Very High	Very High	&	Definite
	Very High	&	Probable

Finally the impacts will also be considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in the Table below.

Impact Status and Confidence Classification

Status of impact	
Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a 'benefit')
	– ve (negative – a 'cost')
	Neutral
Confidence of assessment	
The degree of confidence in predictions based on available information, SRK's judgment and/or specialist knowledge.	Low
	Medium
	High

The impact significance rating should be considered by the competent authorities in their decision-making process based on the implications of ratings ascribed below:

- **Insignificant**: the potential impact is negligible and **will not** have an influence on the decision regarding the proposed activity/development.
- **Very Low**: the potential impact **should not** have any meaningful influence on the decision regarding the proposed activity/development.
- **Low**: the potential impact **may not** have any meaningful influence on the decision regarding the proposed activity/development.
- **Medium**: the potential impact **should** influence the decision regarding the proposed activity/development.
- **High**: the potential impact **will** affect the decision regarding the proposed activity/development.
- **Very High**: The proposed activity should **only** be approved under special circumstances.

In the EIA practicable mitigation measures are recommended and impacts rated in the prescribed way both without and with the assumed effective implementation of mitigation measures.

Mitigation measures are either:

- **Essential**: must be implemented and are non negotiable; and
- **Optional**: must be shown to have been considered and sound reasons provided by the Client if not implemented.

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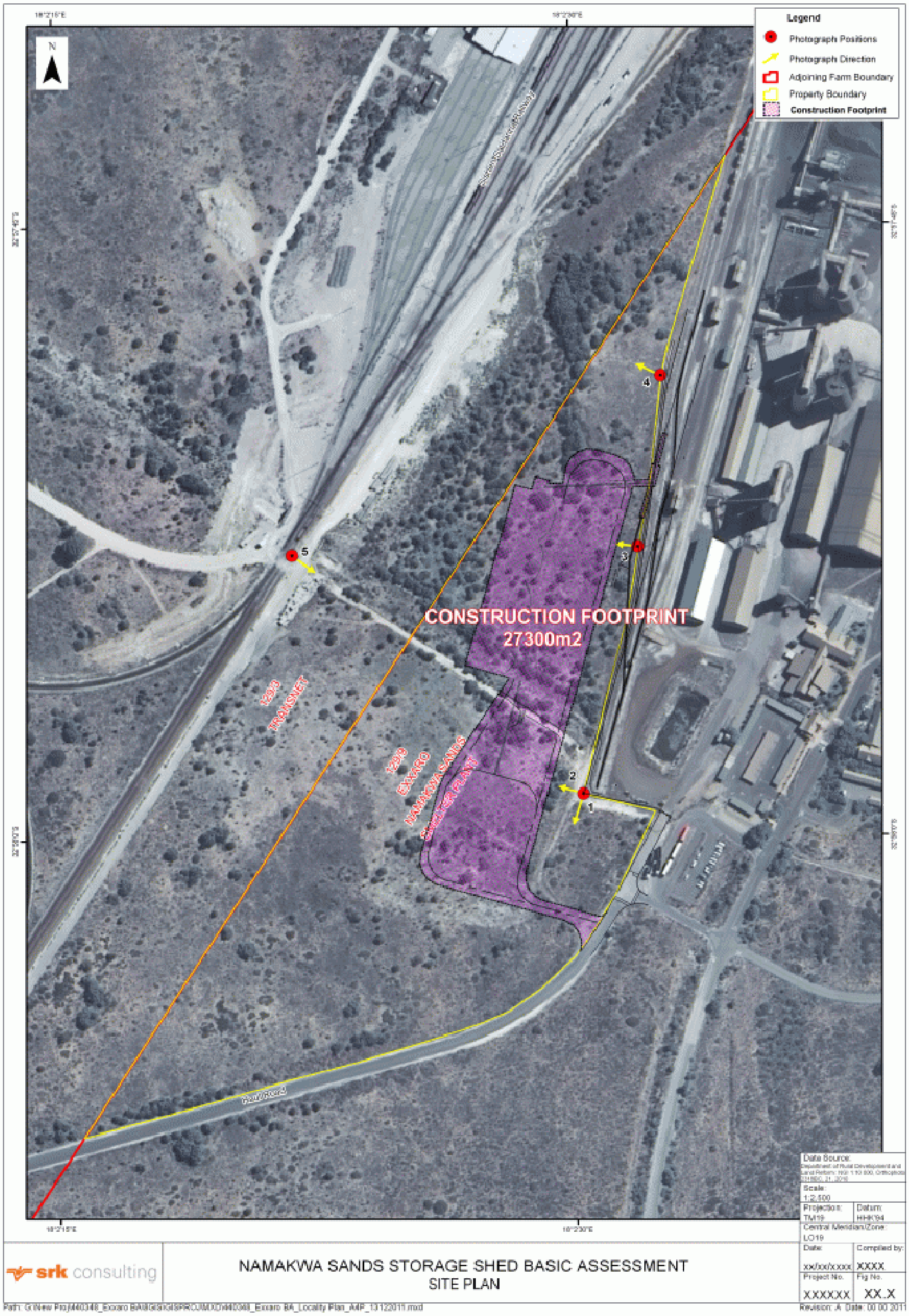
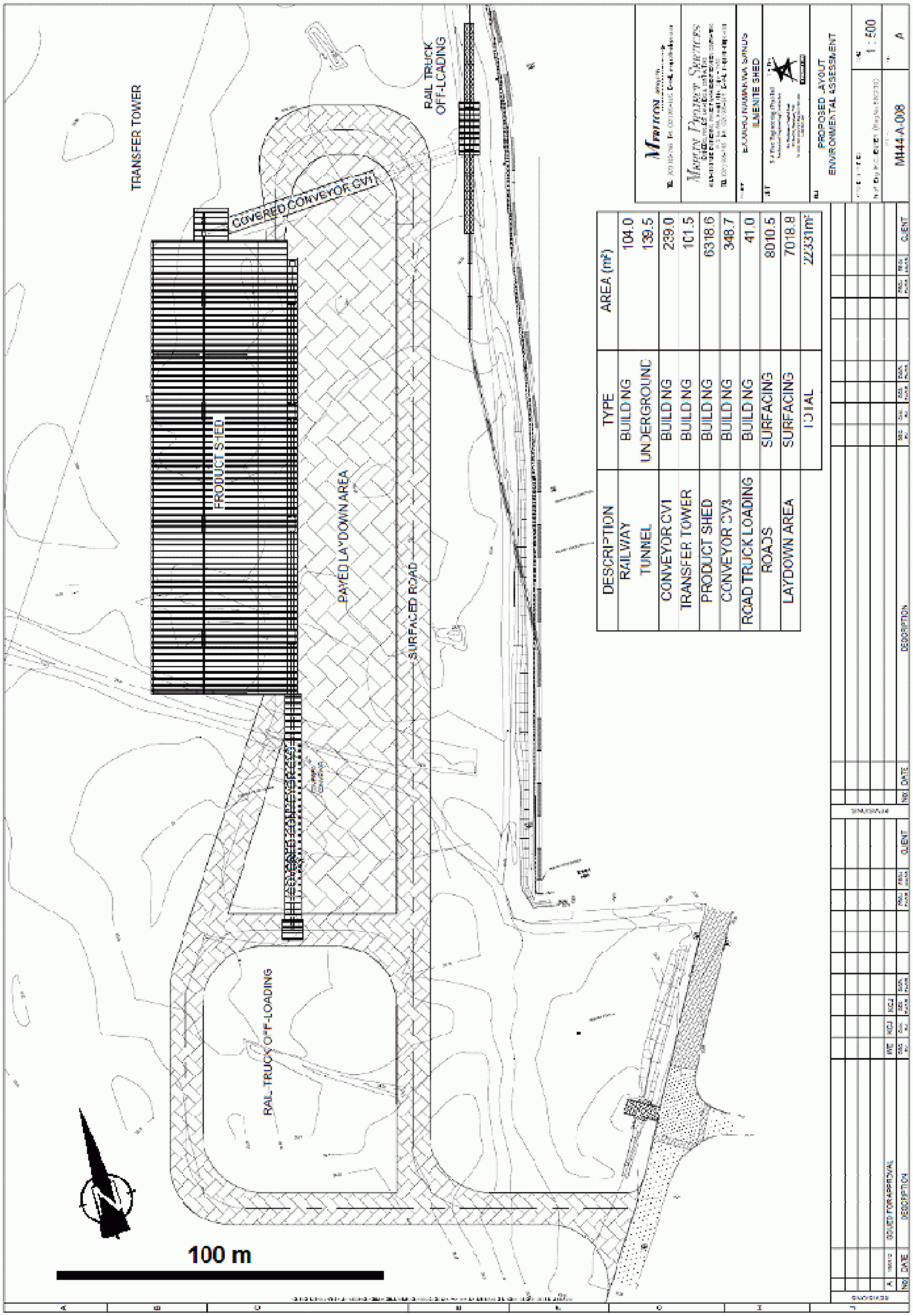
17 APPENDIX 4 – CONSTRUCTION FOOTPRINT



Provided by SRK Consulting.

18 APPENDIX 5 – CONSTRUCTION LAYOUT



Provided by SRK Consulting.