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9 DESCRIPTION OF THE EXISTING ENVIRONMENT

This chapter provides an overview of the baseline conditions of the three proposed alternative sites. Information for this chapter has been distilled from the specialist studies and provides a condensed version of the information contained in these studies. For further detail regarding the condition of the environment, readers are referred to the specialist studies themselves in Appendix E of the EIR.

This chapter ends with a series of sensitivity maps that indicate the environmental sensitivity of the environment from the perspective of each of the specialists, as well as a composite sensitivity map for each site compiled from overlays of the specialists' sensitivity maps. The composite maps give an indication of which areas on each site are less and more sensitive to development.

Panoramic photographs of the alternative sites are included in Appendix A.

9.1 Physical environment: Duynefontein

9.1.1 Geology

The stratigraphy for Duynefontein is typical of the Cape Peninsula and the southern West Coast. The existing NPS at Duynefontein is underlain by the Neoproterozoic rocks of the Malmesbury Group, intruded by the late Neoproterozoic Cape Granite Suite and Cretaceous dolerite dykes. Some 40 km to the south, the high topography of the Cape Peninsula is composed of the overlying Palaeozoic rocks of the Table Mountain Group. Most of the coastal plain around the site is covered with Cenozoic-age sand (**Figure 9-1** with legend depicted in **Figure 9-2**).

Only the Tygerberg, Moorreesburg and Franschhoek Formations of the Malmesbury Group crop out within the Duynefontein site vicinity. The Moorreesburg formation consists of a succession of gritstone, limestone, quartz schist and some greywacke that are complexly deformed. The Tygerberg Formation constitutes a relatively monotonous succession of deep-water, turbiditic meta-sediments folded into simple folds, and is generally highly weathered. The Franschhoek Formation is confined to the south-eastern part of the site vicinity, between Malmesbury and Klipheuwel

A swarm of dykes traverse the coastline between Milnerton and Bloubergstrand and a dyke also occurs within the site area of Duynefontein. These form part of extensive suite of dolerite dykes that intruded throughout the south-western Cape and along the Atlantic margin during the Early Cretaceous.

9.1.2 Seismological risk

The primary hazard considered in terms of Seismological risk is 'Local vibratory ground motion' resulting from geological events (fault rupture), which, in terms of its potential consequences, constitutes the most serious geo-scientific threat to a Nuclear Power Station. The geo-scientific assessment[1] that forms part of this EIA therefore aims to provide evaluations to obtain an estimate of the seismic hazard including safe shutdown earthquake ground motion, the hazard for deformation at or near the surface and permit adequate engineering solutions to actual and potential geologic and seismic effects at the three proposed sites.

[1] Geo-scientific investigations are guided by Nuclear Regulatory Codes, especially U.S. Nuclear Regulations, which is regarded as the most rigorous and conservative international regulatory framework available, and requires geological and geophysical investigations of increasing resolution in concentric regulatory radii of 320, 40 and 8 km around each proposed site.

The existing Koeberg Nuclear Power Station (KNPS) considers a 320 km regulatory radius for prominent seismogenic sources and fault structures which implies that its regional area of investigation contains some of the most faulted parts of the Cape Fold Belt, namely the western branch and the syntaxis, with current prominent seismicity in the Ceres–Tulbagh area.

The site further lies within 20 km of one of the most important NW-SE trending zones of faulting in the SW Cape, namely the Vredenburg-Stellenbosch fault zone and its related faults, many of which are of appreciable displacement. These faults have been active from the Saldanian Orogeny (ca. 550 Ma – 500 Ma ago) to the Mesozoic breakup of Gondwana.

Seismic Hazard Analysis (SHA) was previously undertaken for the three sites (including Duynefontein) by the Council for Geoscience (CGS), employing a probabilistic SHA (PSHA) methodology called the Parametric-Historic PSHA.

The development of the Parametric-Historic PSHA methodology by the CGS was motivated by the uncertainty and incompleteness of the seismic catalogue. Following a review of this methodology, it was pointed out that the Parametric-Historic SHA methodology used to calculate these baseline figures does not fully conform to the latest guidelines set out by the US Nuclear Regulatory Commission (US-NRC). The review therefore required that an appropriate PSHA be carried out as defined by the Senior Seismic Hazard Analysis Committee (SSHAC) in the United States. After the conclusion of a SSHAC Level 3 study the results will form the new baselines in an updated Chapter of a Site Safety Report (SSR). However, the baseline values which are presently available to rank the sites for suitability are the results obtained from the Parametric-Historic methodology, with a Peak Ground Acceleration (PGA) value of 0.27 g calculated for the Duynefontein site.

The value does not exceed the PGA of 0.3 g typically used in the seismic design of NPSs, although the value at the Duynefontein site is close to the 0.3 g threshold. It should however, be noted that the ground motion response spectra developed in the above PSHA differs markedly from the design basis response spectra used in the design of NPP. The more modern PSHA spectra for rock sites have less energy in the frequency range below 20 Hz but higher above this frequency. This characteristic of the modern response spectra result in reduced structural response and hence, the seismic demand is likely to be exceeded by the seismic capacity of the NPP As a comparison, it is noted that the SANS 10 160 loading code for industrial buildings at Duynefontein prescribes a design PGA of 0.15 g.

9.1.3 Geotechnical suitability

Geotechnically speaking, Duynefontein is characterised by the following:

- The site soil profile differs from Thyspunt and Bantamsklip in that it is almost homogeneously 20 m thick everywhere on the site;
- The geotechnical properties of these soils are relatively consistent across the site;
- The groundwater table is elevated on this site and occurs between 4 and 10 m below natural ground level;
- The soils have no cohesion and when saturated, will require innovative slope stabilisation techniques for any proposed excavations;
- The overburden sands are underlain by Malmesbury rocks consisting of a succession of greywacke, hornfels, mudstone, siltsone and shale, all of varying competence; and
- The greywacke and hornfels are more competent than the mudstone, siltstone and shale, which are all more prone to weathering.

9.1.4 Dune geomorphology

There is a large dune field at Duynefontein that forms part of the Atlantis corridor dune field (**Figure 9-3**), which formed during the Holocene. The dune field is mostly naturally vegetated, consisting of parabolic dunes. The patches of mobile transverse dunes are naturally unvegetated. The transverse dunes move northward, driven by the dominant southerly wind.

The alteration of vegetated and unvegetated dunes is due to sand being supplied to the dune field in pulses. The patches of mobile transverse dunes have been artificially vegetated in places, mostly in the southern end. The Duynefontein EIA corridor lies at the southern end of this dune field. Koeberg Nuclear Power Station was constructed on the southern extremity of the dune field during the mid-1980s. This has to some extent disturbed the dune field dynamics and cut off the source of sand in the southern portion of the dune field.

9.1.5 Hydrology

The site is located within the Berg River Water Management Area and within the West Coast Rivers sub area. This catchment has negligible yield from surface water and is entirely reliant on groundwater and water transfers. Uncertainties include the groundwater potential as well as the possible impacts of coastal resorts on the primary aquifers (use and pollution). Furthermore, the recharge of these aquifers is low due to the low precipitation in the area. Saline intrusion from over-abstraction near the coast is a potential threat. The stressed nature of the catchment would require that alternative sources of water be found for both construction and operation.

The area is characterised with a low rainfall (average annual precipitation less than 500 mm) and besides the Salt River, Diep River and minor pans and dams, there are no notable surface water features. The drainage lines are non-perennial and flow manifests as sheet flow during major storm events.

Based on an analysis of extreme high water levels, and taking into account possible climate change, it is recommended that the floor level of the plant should not be lower than 8.9 mamsl (metres above mean seal level).

9.1.6 Geohydrology

The site overlies two aquifer systems, namely the southern extent of the upper intergranular Atlantis Primary Aquifer (Atlantis Aquifer) and the deeper weathered, fractured-rock (secondary) aquifer system of the Malmesbury Group. The thickness of the primary aquifer at the site varies between 17 and 25 m, as the rest groundwater level is some 2 to 5 mblg (metres below ground level) and the overall thickness of the sediments is between 14 and 27 m. The results of the various drilling programs at the site indicate a profile consisting of 3 to 4.5 m of slightly calcareous sand, becoming organic rich with shell fragments below 7.5 m. The lower profile consists of pebbly sand grading into gravels. The secondary aquifer is a semi-confined system which is considered to be in hydraulic connection with the overlying primary aquifer. These two aquifer systems are generally separated by a weathered (clay) zone in the bedrock. The clay horizon constitutes an aquitard, as it has a low permeability that retards and restricts the vertical movement of groundwater, but does not prevent the movement of the groundwater.

The Atlantis Aquifer is an important and significant primary aquifer with two well-fields (Witzand and Silwerstroom) managed by the City of Cape Town. The Witzand Well-field is situated 3 km north-east of the site and supplies water to the surrounding towns, predominantly to Atlantis. This well-field is situated in the most productive portion of the Atlantis Aquifer system. The Silwerstroom Well-field is situated 9.5 km north of the site. Other than production boreholes at the Witzand and Silwerstroom Well-fields, there are many other existing boreholes in the area, including private production and monitoring boreholes.

Borehole yields of >10 ℓ/s are obtained from production boreholes in the primary aquifer. Replacement boreholes in the Witzand Well-field drilled during 1996 yielded between 16 and 18 ℓ/s. Boreholes drilled into sands along the areas north-east of the site were reported to yield in excess of 5 ℓ/s (Parsons, 2002). Borehole yields in the range of 0.5 to 5 ℓ/s are common in the sands underlying the existing KNPS. It is generally accepted that boreholes drilled into the secondary aquifer yield considerably less than the primary aquifer, i.e. <2 ℓ/s.

The water table ranges between 2 and 5 m below ground level. The depth to groundwater mimics surface topography. Seasonal and tidal impacts are the dominant factors influencing

local groundwater level fluctuations. Groundwater flows in a south-westerly direction towards the coast.

According to the DWA *Quality Guidelines for Domestic Water Supplies* (DWAF 1998), the electrical conductivity ranges for groundwater from the site are classified as ideal to marginal for drinking purposes and represents slightly saline conditions. There appear to be no existing sources of groundwater contamination in the EIA Corridor Area.

9.1.7 Freshwater supply

The following conclusions regarding freshwater supply were reached in the freshwater supply study for Duynefontein:

- There is extensive use of groundwater in the surrounding area;
- The Aquarius Well-field was previously developed to supply groundwater to the Koeberg Nuclear Power Station (KNPS) but use of this has been ceased recently because of quality constraints. This well-field requires extensive rehabilitation but could supply the required construction and partial operational demand;
- The KNPS is connected to the municipal water supply scheme;
- Additional surface water supply from existing municipal supply sources cannot be guaranteed;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

9.1.8 Oceanography

Duynefontein is a highly exposed section of sandy coastline. The site is characterised by a shallow sloping sandy beach with a reasonably stable sediment transport regime. The site is underlain by the rocks of the Malmesbury Group of Precambrian age at a depth of between 5 and 12 m below Chart Datum (CD) (PRDW, 2008e).

a) Beach profile and bathymetry

The characteristic profile is a steep drop off at the beach edge followed by a gradually sloping area reaching 30 m approximately 3 km from the shoreline. The bathymetry adjacent to the site is shown in **Figure 9-5**.

b) Currents

The currents at Duynefontein are predominantly wind-driven. The currents near the surface reach 1 m/s and have a dominant direction of 340°, in response to the dominant south-easterly winds. The currents near the seabed are weaker and the directions are more evenly distributed between northward and southward.

c) Coastal erosion

Three contour lines (the vegetation line, the high water mark and the +5 m Mean Sea Level (MSL) contour line) were digitised on each of the available geo-referenced aerial photographs. Generally, the beaches to both the north and south of the existing Koeberg site appear to be dynamically stable for the period of observation from the aerial photographs. An accretional trend is evident on the northern section of Van Riebeeckstrand, while some erosion is evident on the Ou Skip north beach.

9.1.9 Background Radiation

Exposure to ionizing radiation arises from naturally occurring sources (such as from outer space and radon gas emanating from rocks in the Earth) and from sources with an artificial origin (such as medical diagnostic and therapeutic procedures; radioactive material resulting from nuclear weapons testing. People living near the sites receive a background radiation dose that is estimated to be less than 2 mSv/y and therefore lower than the average global dose. The annual dose reported by the operating Koeberg NPP and based on allowable discharges of artificial nuclides, is a small fraction of the natural background dose, i.e. < 0.010 mSv/y.

a) Terrestrial surface water radioactivity

Water samples were collected from dams on the site, a smallholding in the Duynefontein township, and the Langeberg farm located east of the site. The municipal water supplied to the Duynefontein township was also sampled. Overall, all samples contained low levels of naturally occurring radioactive material (NORM) radioactivity. Extremely low NORM was measured in a sample from a dam on the smallholding in the Duynefontein township, the nearest water body in the public domain to the Koeberg NPP. Elemental uranium concentration measurements confirmed the low uranium radioactivity levels. The results are all below the world health organisation (WHO) guideline value of 10 µg/ℓ for drinking water.

b) Groundwater radioactivity

NORM levels were low in all borehole water samples at Duynefontein except for Ra-226 in two boreholes. Concentrations equal to 253 mBq/ℓ and 205 mBq/ℓ and an order of magnitude higher than the rest of the samples were reported.

c) Seawater radioactivity

Seawater samples were collected from the surf zone north and south of the Koeberg NPP. The results of gamma spectrometric analysis are listed in the Radiological study. No detects were reported for artificial radionuclides.

d) Soils, sediment and beach sand radioactivity

Radioactivity in soil is mainly NORM and has its origin in the rock from which it is derived. Only trace amounts of artificial radioactivity can normally be detected in soils. It can be found on most land surfaces even though sites such as Thyspunt are remote from any nuclear facility.

Radioanalysis results of soil and sediment samples reported detects for the two key nuclides Cs-137 and Sr-90. These specific nuclides are indicators of the global presence of artificial radioactivity and the lingering presence of the more than 520 atmospheric nuclear weapons tests conducted between 1945 and 1980. These radionuclides are also regarded as being of major importance when assessing the impact areas of accidental releases in the contamination of food and environmental samples, i.e. air, water, milk, meat, other foods, vegetation, and soil.

Bottom sediments of water bodies are often used as indicators of contamination due to past discharges from NPPs. Many nuclides released into water, whether it be NORM following natural events or NPP discharges, are adsorbed onto particulate material which accumulates with time as bottom sediment. Radioactivity that accumulates over time on intertidal beach sand may result in external exposure of people. Nuclides in sediment are also part of aquatic food chain contamination that can be detected in non-human biota radioanalysis.

The radioanalysis results indicate low levels of NORM for the dunes and sandy soils at the Duynefontein site. No artificial radionuclide detects were reported for the soil samples. Sediment samples contained low levels of NORM and at levels similar to the soil radioactivity levels. A detect for Cs-137 was reported for only one sediment sample.

The lowest radioactivity concentrations in all samples collected were reported for beach sand. No artificial radionuclide was detected in the beach sand. The NORM radioactivity levels are also extremely low. This is in contrast to some areas further north along the West Coast where beach sand contains elevated levels of NORM, e.g. at Strandfontein and Brand-se-Baai where heavy mineral sands are being mined. Heavy mineral sands contain higher than normal uranium and thorium soil concentrations.

9.2 Physical environment figures: Duynefontein

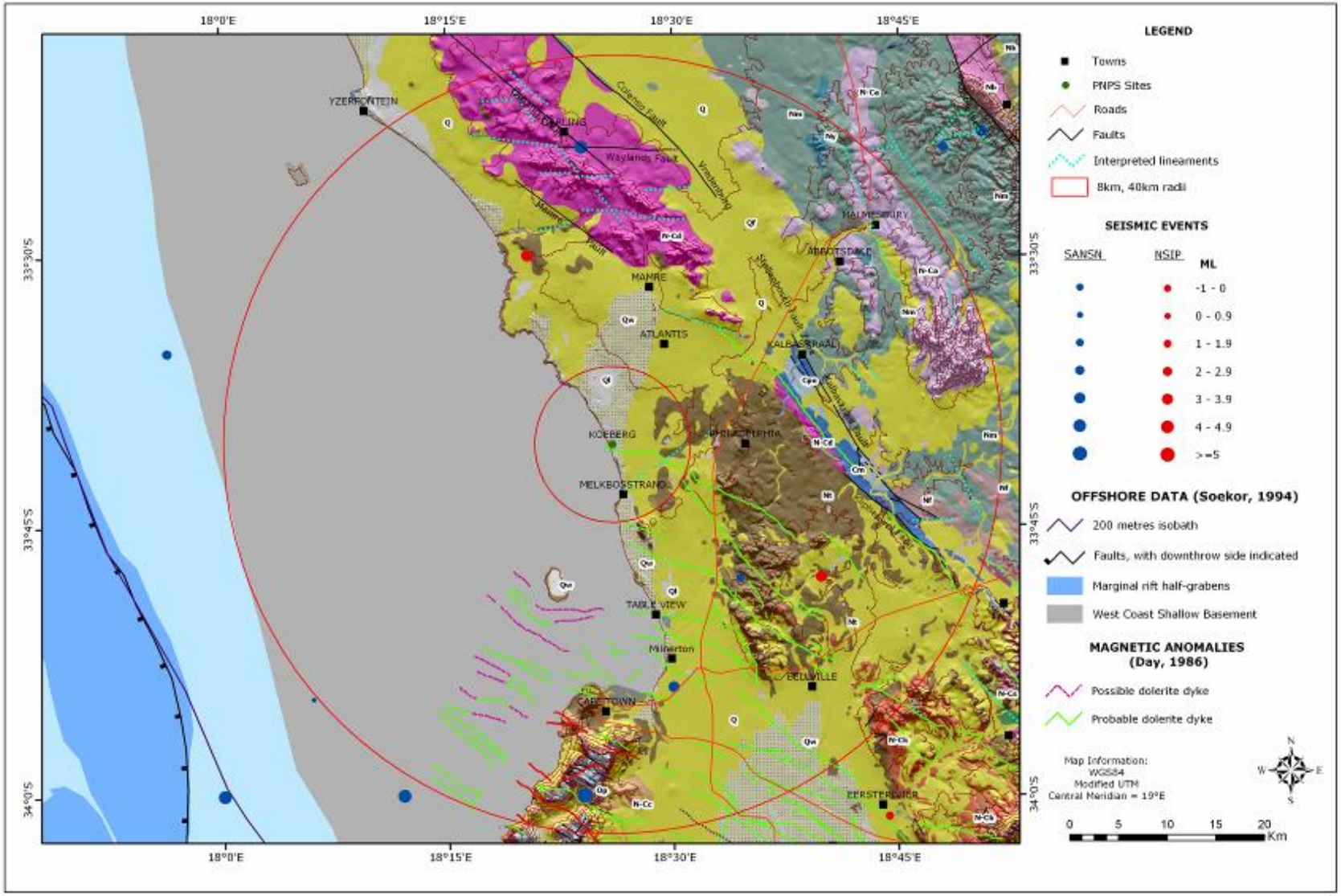

Figure 9-1: Geological map of Duynefontein and environs

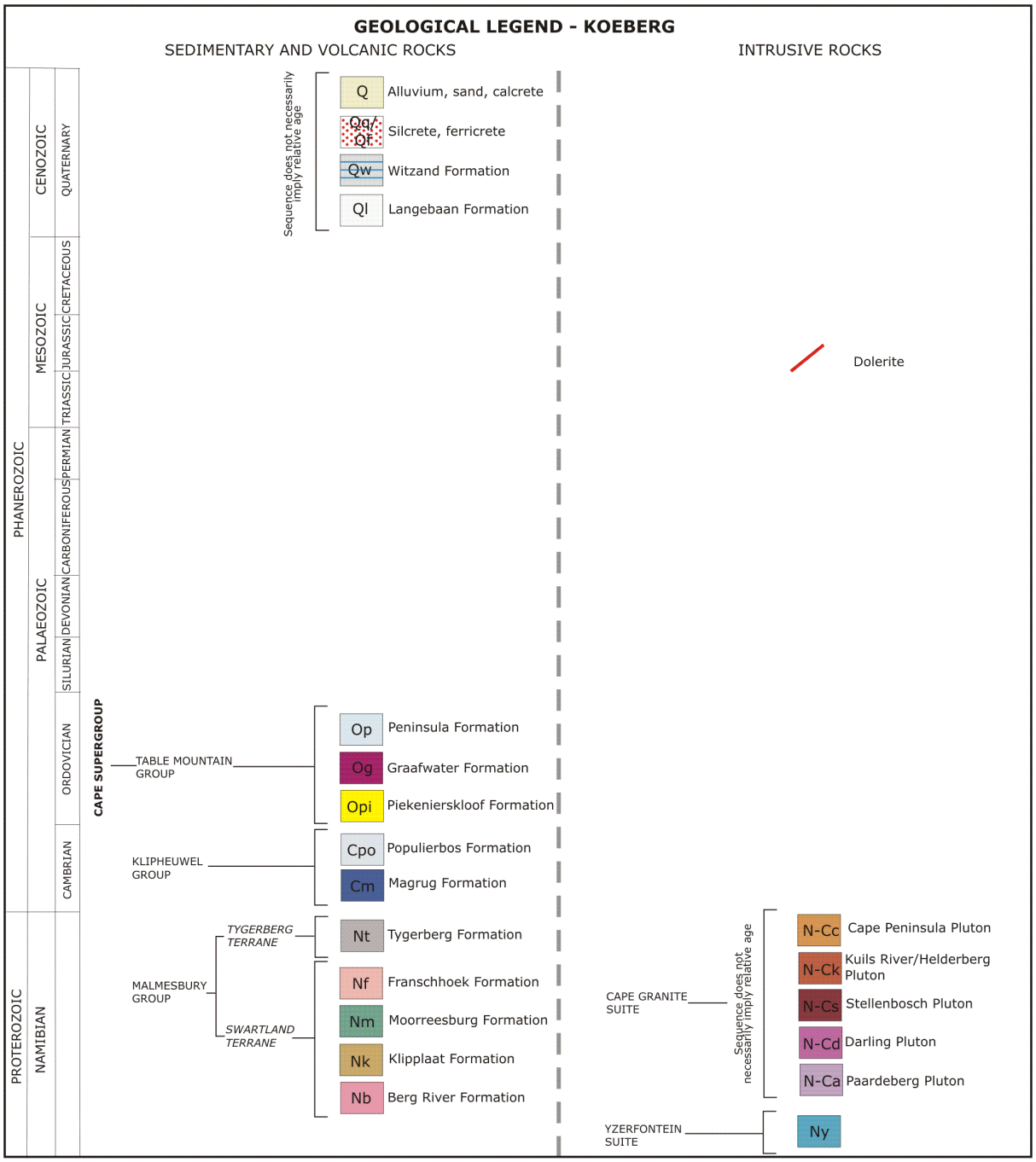

Figure 9-2: Legend for the Duynefontein geological map

Figure 9-3: Atlantis corridor dune field in relation to the Duynefontein site

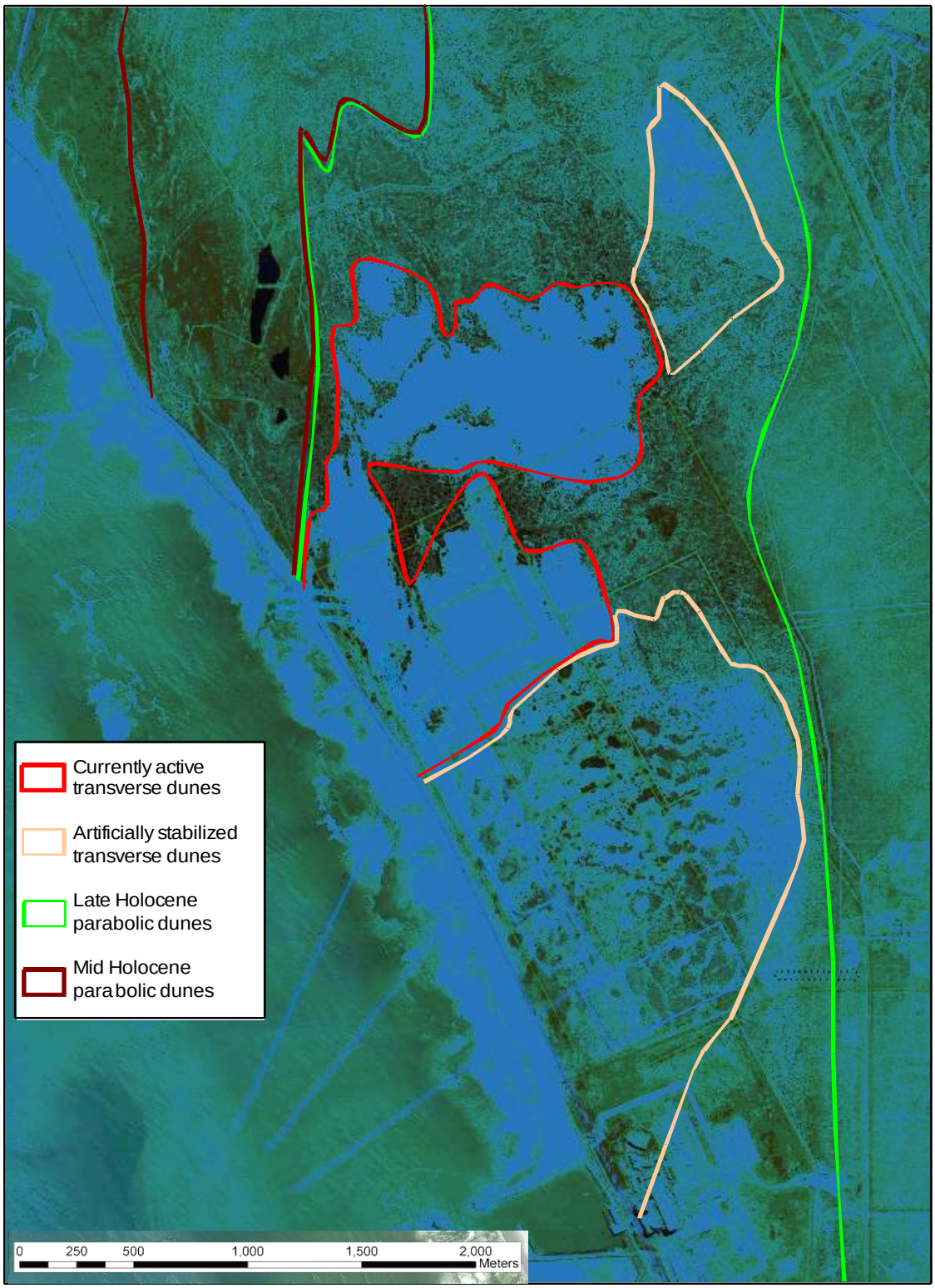

Figure 9-4: Dune varieties in the Atlantis corridor dune field at Duynefontein

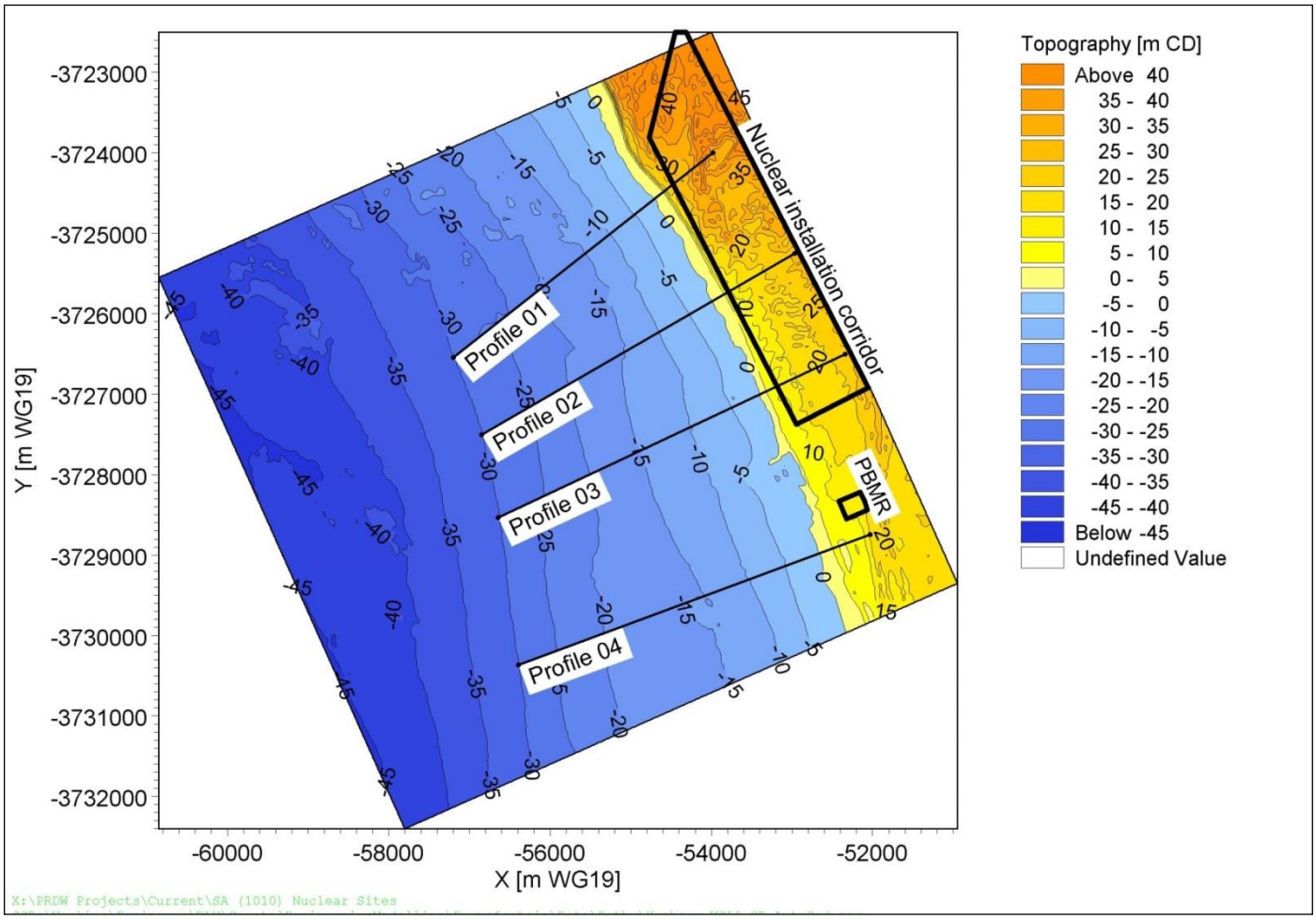

Figure 9-5: Profile locations and bathymetry for Duynefontein

9.3 Physical environment: Thyspunt

9.3.1 Geology

The geology of the Thyspunt site (**Figure 9-6** with legend in **Figure 9-7**) is typical of most south-eastern Cape coastal regions with a broad, raised marine platform of Miocene and Pliocene age cut into older rocks of variable resistance. None of the Precambrian rocks (i.e. Gamtoos Group and Cape Granites) outcrop in the Thyspunt Site Vicinity, but form the floor, or basement, to the mapped formations. The Gamtoos Group is unconformably overlain by the Table Mountain Group, which comprises the basal unit of the Cape Supergroup. It is predominantly composed of supermature quartzose sandstone and accumulated through marine, glacial and fluvial depositional process during the Ordovician and Silurian Periods. It is conformably superseded by the argillaceous Bokkeveld Group with the basal Ceres Subgroup unit found north of St. Francis Bay. The Cape Supergroup was intensely distorted by the Permo-Triassic Cape Orogeny, a compressional deformation event which produced the Cape Fold Belt mountain chain along the southern coast of South Africa. The northerly-directed compression resulted in widespread flexural-slip folding, commonly with fold asymmetry and décollement occurring in the upper stratigraphic units.

9.3.2 Seismological risk

The Humansdorp-Thyspunt area is relatively fault-free compared with other sectors of the Cape Fold Belt. The closest on-land major faults are the Gamtoos and Kouga faults, which are respectively 39-45 km and 42 km from the site. Offshore geological coverage obtained, indicates two potentially hazardous offshore faults within the 40 km radius from the site. The Plettenberg fault, a 100 km long, steeply SW dipping normal fault with a throw of some 5600 m extends to within 18 km of the site.

The baseline PGA value determined during the Seismic Hazard Analysis undertaken by the CGS for the Thyspunt site is 0.16 g. Thyspunt is the site with the biggest margin to accommodate change to this value. As a comparison, it is noted that the SANS 10 160 loading code for industrial buildings prescribes a design PGA less than 0.05 g for the Thyspunt site.

9.3.3 Geotechnical suitability

Geotechnically speaking, the site is characterised by the following:

- The site soil profile varies considerably in thickness as one moves inland, ranging from 0 m thick (at the sea) to almost 60 m thick within the dune area;
- The geotechnical properties of these soils are consistent across the site and random calcrete zones are encountered;
- An intergranular aquifer exists at the site, the groundwater table daylights at the sea and there is a variance in depth to the groundwater table in the dune area;
- The soils have no cohesion and when saturated, will require innovative slope stabilisation techniques for any proposed excavations;
- Two dominant geological formations are encountered under the soils, namely the Skurweberg and Goudini Formations;
- The Skurweberg Formation is located nearer the sea and the Goudini Formation more inland;
- The quartzitic sandstone Skurweberg Formation is marginally more competent (harder and more resistant to erosion) than the carbonaceous sandstone Goudini Formation; and
- A historical erosion depression containing cobbles exists in the Goudini Formation and this cobble layer influences groundwater flow direction in a South Easterly direction.

9.3.4 Dune geomorphology

The low-relief Cape St. Francis headland hosts the most spectacular and last two remaining active examples of large-scale mobile headland-bypass dune fields on the south coast of South Africa (**Figure 9-8**). The corridors of transverse dunes run parallel to the dominant westerly to south-westerly wind. The mobile dune fields are very dynamic. A feature of the Cape St. Francis dune fields is the formation of pans, often 1-2 m deep, in the interdune areas during high rainfall events. The eastern third quarter of the dune field is drained by the Sand River, which flows episodically during periods of high rainfall. Floods transport appreciable volumes of sand to the Kromme estuary. Sand moves from west to east through these dune fields, due to the predominantly westerly winds.

Since 1942 the dune field has become progressively more vegetated, both within the dune field and along the northern margin. This is caused mostly by various invasive alien *Acacia* species, predominantly Rooikrans. Dune height varies along the length of the dune field. Dunes are on average 20 m high in the west, and gradually become smaller towards the east, where the average height is 5 m.

There is only one fairly permanent river channel in the westward sloping portion of the dune field. This is a short channel of the Penny Sands River (name introduced in this EIA process), which soaks away in the high dunes in this area. In wetland terminology this is a “channelled valley bottom wetland”. The other short channels shown in the westward sloping portion of the dune field only exist for short periods of time after high rainfall events. Groundwater “daylights” in many interdune areas within the Oyster Bay dune field at Thyspunt to form ponds and wetlands in the interdune areas (also known as dune slacks).

Text box:

During the period that the Draft EIR was available for comment from March to June 2010, a number of stakeholders with an interest in the Thyspunt site claimed that there could be a significant risk of “debris flows” at the Thyspunt site. These stakeholders included Prof. Fred Ellery of Rhodes University. These claims were based on, amongst others, deposits laid down by the Sand River, the presence of quicksand in previous floods of the Sand River and the November 2007 flood that damaged the R330 at St. Francis. In support of the claims regarding the risk of debris flow, Prof. Ellery provided evidence (in the form of photographs of alluvial deposits), as well as reference to evidence collected by other specialists and academics. The details of this evidence and the findings in response to these claims are documented Appendix E30). It should be noted that the Dune Geomorphology Report was amended to include the 2011-2012 floods assessment.

The risk of debris flow, liquefaction and damage to roads at the Thyspunt site

During the period that the Draft EIR was available for comment from March to June 2010, a number of stakeholders with an interest in the Thyspunt site claimed that there could be a significant risk of “debris flows” at the Thyspunt site. These stakeholders included Prof. Fred Ellery of Rhodes University. These claims were based on, amongst others, deposits laid down by the Sand River, the presence of quicksand in previous floods of the Sand River and the November 2007 flood that damaged the R330 at St. Francis. In support of the claims regarding the risk of debris flow, Prof. Ellery provided evidence (in the form of photographs of alluvial deposits), as well as reference to evidence collected by other specialists and academics. The details of this evidence and the findings in response to these claims are documented Appendix E30). It should be noted that the Dune Geomorphology Report was amended to include the 2011-2012 floods assessment.

The potential for debris flow at Thyspunt

The dune geomorphology specialist, Dr. Werner Illenberger, came to the following conclusions regarding the potential for debris flow at the Thyspunt site and in the surroundings:

- Slopes in the area that are steep enough to initiate debris flows are ridges formed by arms of parabolic dunes and sidewalls of previously mobile dune fields. However, these ridges are composed entirely of sand, and debris flows cannot form in pure sand because water soaks away rapidly into sand;
- The Sand River slopes at 0.67º, which is too shallow to form or sustain debris flows;
- Relevant specialists such as Koos Reddering have studied the photographs of the deposits using image enhancement, and have identified features that could be cross-bedding and soft-sediment deformation, although these are vague, and cannot be positively identified as originating from debris flows. Koos Reddering has mapped the geology of the area in detail and has never seen any debris flow deposits; and
- Relevant and knowledgeable specialists including Jenny Burkinshaw, Izak Rust, Pete Illgner and Dr. Illenberger himself have never found evidence of debris flows or debris flow deposits in many field visits to the area, including some visits made shortly after flood events of the Sand River.

The opinion of the above specialists is that the supposed debris flow deposits provided by Prof. Ellery are river flood deposits of sand, some mud, a few pebbles, and some plant debris, that were entrained and later deposited by the Sand River when in flood. The Sand River carries a high sediment load ("hyper-concentrated flow"), so sedimentary structures are often poorly developed. The sediments were probably deposited by a flood event of the Sand River.

It is concluded that there are no debris flows or debris flow deposits in the Sand River. There are no other environmental conditions in the Cape St. Francis area that are conducive to the formation of debris flows. Thus debris flows do not pose a threat to a potential nuclear power station and its associated infrastructure at the Thyspunt site.

The potential for liquefaction of sand

One of the concerns raised by stakeholders at St. Francis was that liquefaction of sand could take place within the mobile dune fields, and amongst vegetated dunes and wetlands that the Eastern Access Route (See Chapter 5 for a description of this route) to the Thyspunt site would traverse, resulting in quicksand that could engulf vehicles, hence making access routes to the possible nuclear power station and its associated infrastructure at the Thyspunt site unsafe.

To this concern, Illenberger (2010) found that quicksands often occur in the mobile dunes of the Oyster Bay dune field: many people have experienced all-terrain vehicles being bogged down while driving through the dune field during wet periods. The quicksands are mostly formed when loosely consolidated sand is inundated. A front end loader that was trapped in quicksand during the 2007 floods is an example of this.

It is concluded that vehicles would not be engulfed in quicksands in the Oyster Bay dune field unless they drive on the bed of the Sand River or around inter dune ponds. Vehicles travelling on the R330 are not in any danger of being engulfed in quicksands. The proposed "Eastern Access Route" to the Thyspunt site that would cross vegetated dunes and wetlands would be built to correct engineering specifications including geotechnical surveys with boreholes, etc. It would be designed with suitable foundations to accommodate any poor founding conditions, so that vehicles can safely use the road. The proposed nuclear power station would be founded on solid rock and so quicksands or liquefaction of sand could not have any effect on it.

9.3.5 Hydrology

The site is located within the Fish to Tsitsikamma Water Management Area and within the Krom-Seekoei sub area, as defined in the Integrated Strategic Perspective (ISP) for the Fish to the Tsitsikamma Water Management Area.
The total yield from the sub-area was calculated at 47.4 mm^3/annum after transfers and return flows and the total user requirements as 46.2 mm^3/annum. The sub area is therefore approximately in balance. The 1.2 mm^3 surplus is due to a surplus in the upper Krom River, which indicates additional capacity to the Nelson Mandela Metro.

The area is characterised by a few dams on the Krom River. The most notable of these dams is the Impofu Dam. The available surface water in this region is allocated to Port Elizabeth and Humansdorp.

On a local scale, the site has a number of wetland areas, which are fed primarily by groundwater.

No long-term precipitation records are available at Thyspunt, with gauges only having been installed in January 2008. These records do not present sufficiently long-term data records to be included in this study. Records from nearby weather stations indicate a mean annual precipitation of between and 558 and 694 mm.

Based on an analysis of extreme high water levels, and taking into account possible climate change, it is recommended that the floor level of the plant should not be lower than 14.9 m amsl.

9.3.6 Geohydrology

The superficial deposits of the Algoa Group (the primary aquifer of the study area) are classified as a primary or intergranular aquifer. Groundwater flow and storage takes place within the original pore spaces between constituent grains. The upper boundary of the aquifer is the water table and this aquifer is therefore unconfined. Due to the rapid flow of groundwater through the Algoa Group sediments, the proximity to the coast and relative impermeability of the fractured rock aquifer, limited interconnection between the intergranular aquifer and fractured rock aquifer is envisioned in the Thyspunt area.

The detailed geohydrological study at the site has revealed evidence that the intergranular aquifer can be characterised as an economically viable aquifer. As such this aquifer can be utilised as a potential water supply source during construction and possibly as a domestic water supply source for the proposed nuclear power station.

Boreholes drilled in the Algoa Aquifer revealed high blow yields ranging from 5 to 10 ℓ/s, especially where the basal cobble layer is well developed. In comparison, boreholes that only intersected the fine grained sand revealed much lower blow yields, from 0.1 to 0.8 ℓ/s. Yield testing of the latter boreholes, however, also showed that much larger volumes of water can be abstracted from the aeolian sands. Boreholes with aeolian sands, as well as the cobble layer gave moderate to high yields (from 2 to 5 ℓ/s).

Formations in the Table Mountain Group yielded moderate to high yields. The Nardouw Aquifer, for instance, was intersected just below the Algoa Group. This aquifer is highly fractured with water bearing fractures encountered at depths varying from about 20 to about 110 m below ground level. The fractures are moderate to high yielding, ranging from 2 to less than 5 ℓ/s.

There appear to be no existing sources of contamination within the EIA Corridor. However, there may be potential sources up-gradient and to the north, e.g. fertilisers, animal wastes, septic tanks, etc. The site is located in a pristine area. As there are no existing contamination threats, the quality of groundwater at the site therefore represents ambient conditions. Measured electrical conductivity values in the groundwater vary from 51 mS/m to 82 mS/m

(relatively good quality) and the pH values are neutral to slightly alkaline, varying from 7.1 to 7.9. There was no indication of a freshwater-saline interface that should theoretically be present at the coast.

9.3.7 Freshwater supply

The following conclusions regarding freshwater supply were reached in the freshwater supply study for Thyspunt:

- There is extensive use of groundwater in the surrounding area;
- There are coastal springs at the site;
- The surrounding towns are supplied with water from the Churchill and Impofu Dams and from groundwater;
- There is scope for further development of local groundwater resources for construction supply both on-site and in the surrounding area;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The main option for surface water supply with least local and regional impact is import of water from the Orange River Scheme;
- Surface water and to a lesser extent groundwater, is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

9.3.8 Oceanography

The Thyspunt site is located on an exposed section of coastline that faces towards the prevailing south westerly deep sea swell. This is a highly stable section of coastline with respect to marine sediment dynamics. The significant headlands of Seal Point and Cape St. Francis form an isolated coastal cell with sediment feeds or losses unlikely to occur into or out of the cell from the adjacent sections of coastline. There are no major rivers discharging into this section of coastline.

a) Beach profile and bathymetry

A number of cross-sections have been taken along the Thyspunt site coastline. The Bathymetry of the seabed adjacent to the Nuclear Installation Corridor is shown in **Figure 9-9**.

b) Currents

Currents have been measured at the Thyspunt site starting in February 2008 at two sites. The dominant current direction is towards the east and the current speeds are moderate near the surface and low near the seabed.

c) Coastal erosion

Three contour lines (the vegetation line, the high water mark and the +5 m MSL contour line) were digitised on each of the available geo-referenced aerial photographs. For Slangbaai and Thysbaai, the closest beaches to the nuclear installation corridor, though signs of both erosion and accretion are noticed in the analysis of the aerial photographs, these are believed to be indications of long term variations about dynamically stable beach shapes.

9.3.9 Background Radiation

Exposure to ionizing radiation arises from naturally occurring sources (such as from outer space and radon gas emanating from rocks in the Earth) and from sources with an artificial

origin (such as medical diagnostic and therapeutic procedures; radioactive material resulting from nuclear weapons testing. People living near the sites receive a background radiation dose that is estimated to be less than 2 mSv/y and therefore lower than the average global dose. The annual dose reported by the operating Koeberg NPP and based on allowable discharges of artificial nuclides, is a small fraction of the natural background dose, i.e. < 0.010 mSv/y.

a) Terrestrial surface water radioactivity

Different types of water sources were sampled and were collected for radioanalysis. The Radiological study concluded that overall, all samples contained low levels of NORM radioactivity and no artificial radioactivity could be detected. Elemental uranium concentration measurements confirmed the low uranium radioactivity levels and are below the WHO guideline value of 10 µg/ℓ.

b) Groundwater radioactivity

Radioactivity concentrations were included in the analysis of 15 water samples at Thyspunt, collected during a hydrosensus of farms located near the site. It included gross alpha and beta radioactivity, uranium isotopes, and artificial radionuclides such as Cs-137. The radioactivity levels of U-238 and U-234 were extremely low and the maximum levels reported were 21.9 mBq/ℓ and 29 mBq/ℓ, respectively. No artificial radioactivity was detected.

c) Seawater radioactivity

Seawater samples were collected from the surf zone at the Oyster Bay beach and Thysbaai. Only two radionuclides were detected above MDA values and at very low concentrations in the large volume samples (25 ℓ) that were collected:

- Th-228: 0.009 1 Bq/ℓ;
- K-40: 9.33 Bq/ℓ.

Both these nuclides are NORM. No detects were reported for artificial radionuclides. Other artificial radionuclides included in the analysis, all below the MDA, are typical of radioactivity discharged by nuclear power plants using seawater as coolant.

d) Soils, sediment and beach sand radioactivity

Radioanalysis results of the soil samples demonstrate the large variations that can be found in a relatively small area such as the Thyspunt site and its adjacent towns and farm areas. Sand dunes that make up most of the site and nearby town areas have the lowest radioactivity concentrations. Higher levels can be measured in farm soil samples. The use of phosphate-rich fertilizers on farms is known to result in higher K-40 radioactivity than found in most natural soils. The radioanalysis results for NORM activities were all at low levels for soil samples. All samples had C-137 detects with the maximum levels.

The sediment samples contained slightly elevated concentrations of NORM when compared to the soil samples from areas adjacent to the dams. Whereas Cs-137 was detected in all surface soil samples, no Cs-137 was reported for the sediment samples.

Radioactivity concentrations in beach sand are significantly lower than for soil and sediment.

9.4 Physical environment figures: Thyspunt

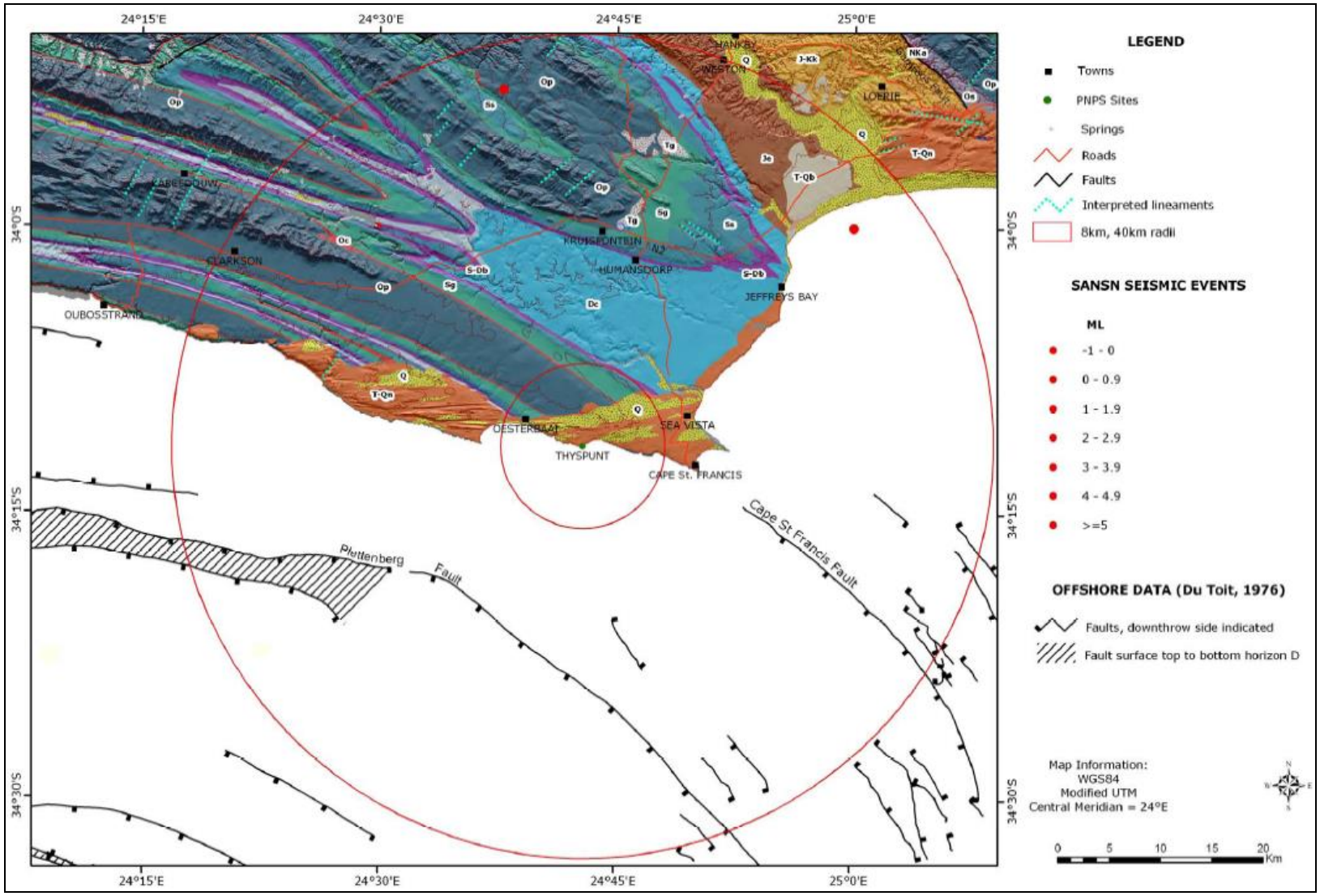

Figure 9-6: Geological map of Thyspunt and environs

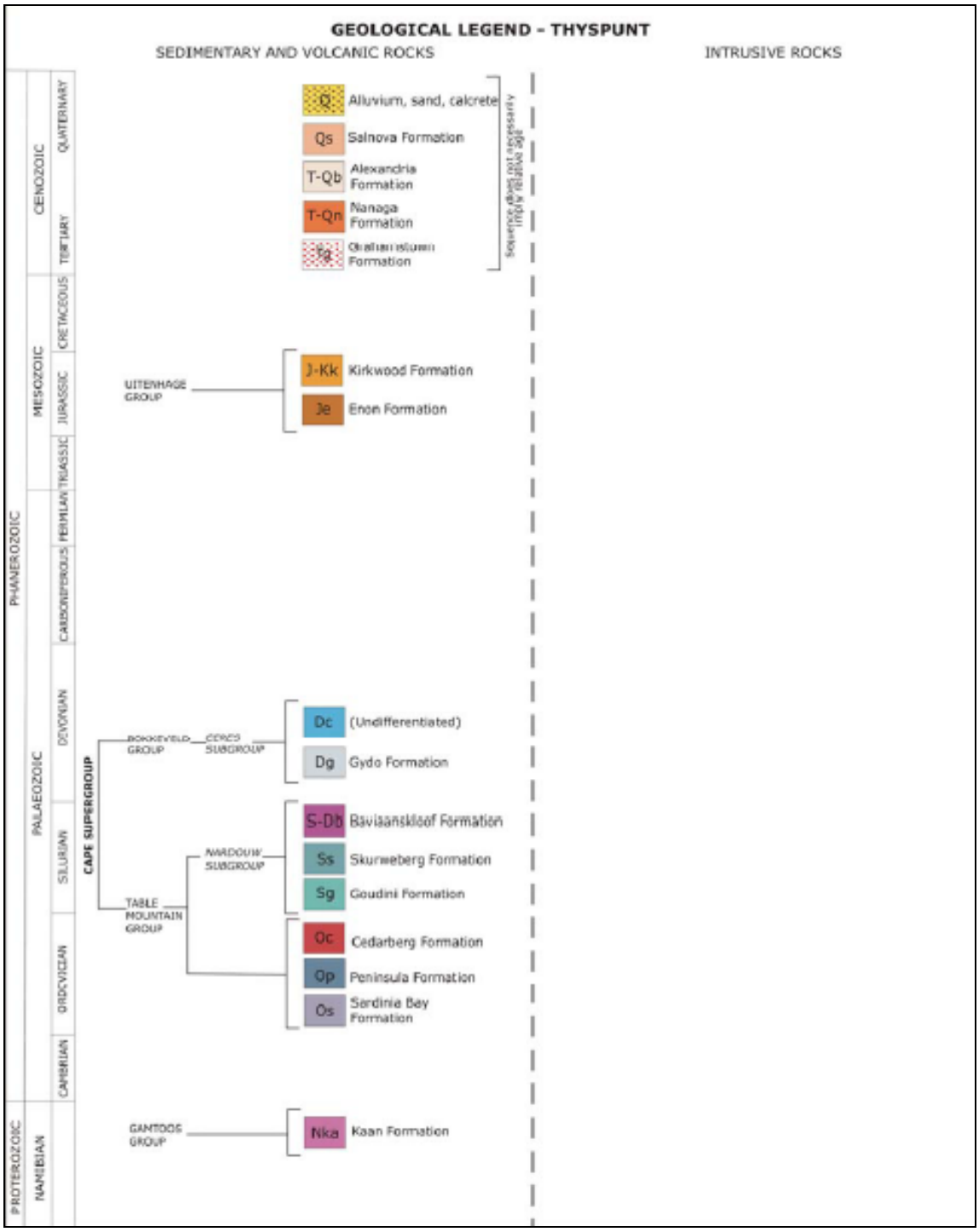

Figure 9-7: Legend for the Thyspunt geological map

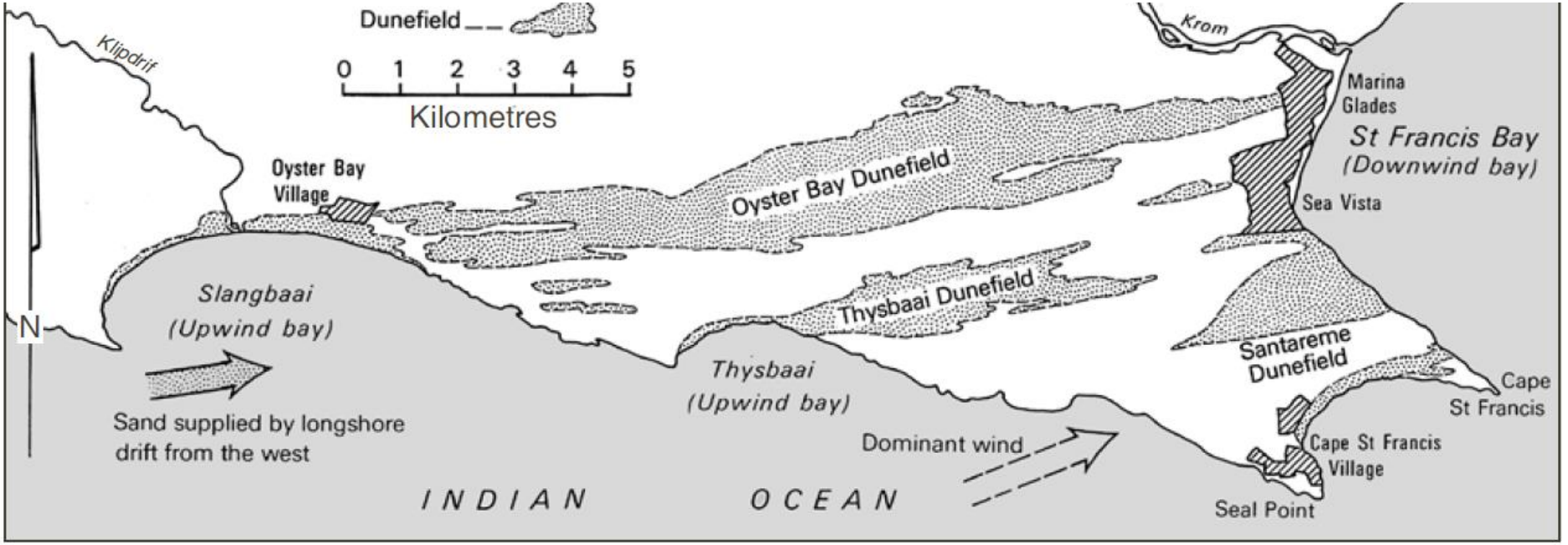

Figure 9-8: Illustration of the original St. Francis headland bypass dune field system (including portions like the Santareme dune field, which have since been destroyed)

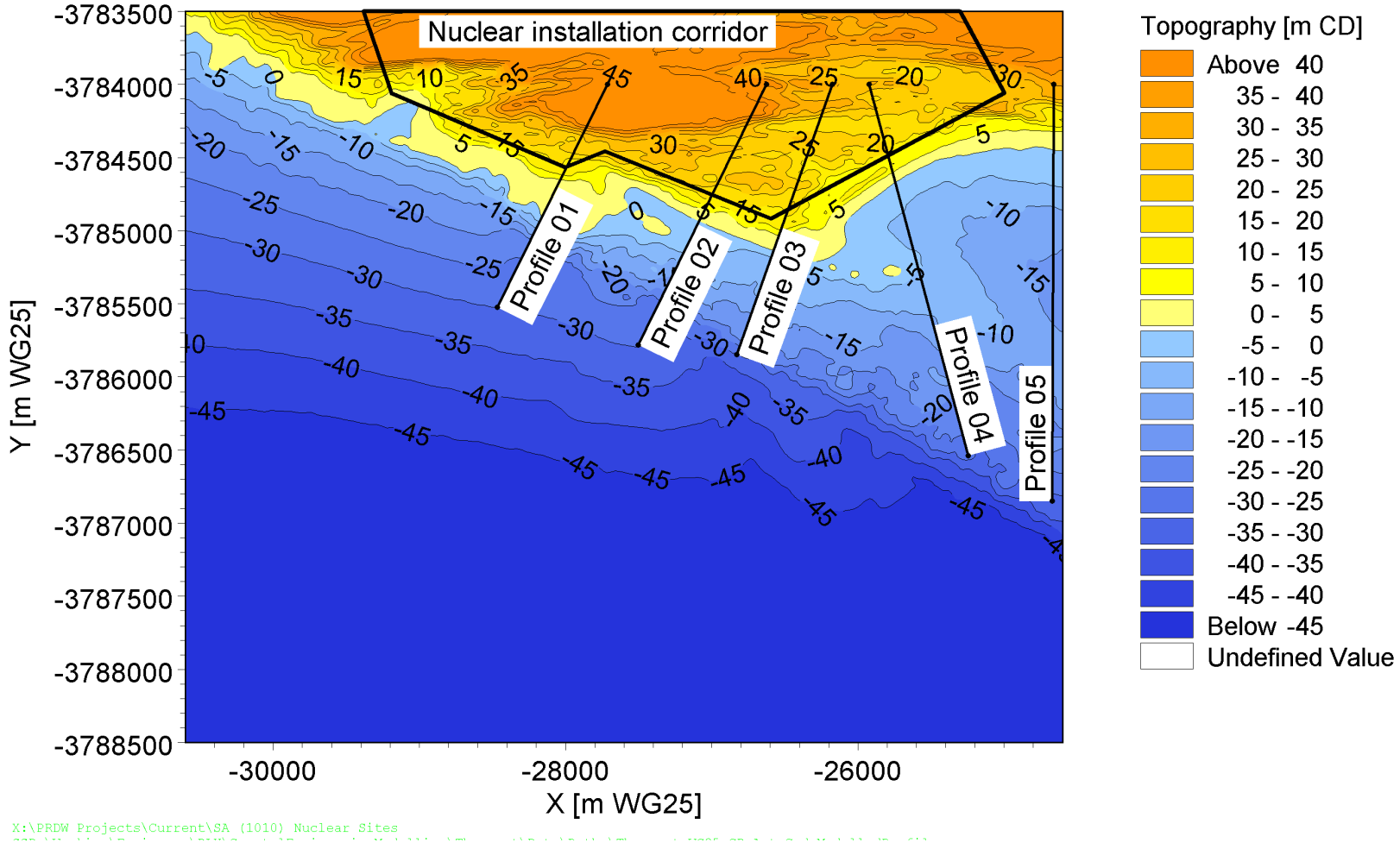

Figure 9-9: Profile locations and bathymetry for Thyspunt

9.5 Biophysical environment: Duynefontein

9.5.1 Air quality and climate

a) Land use and topography

Land use in the immediate vicinity of the Duynefontein site is characterised by industrial activity in the form of Koeberg (an existing NPS). No industrial air pollution sources other than the Koeberg NPS exist in the immediate Duynefontein area. Industrial processes are present at Atlantis (Open Cycle Gas Turbine Power Station, brickworks and other smaller commercial activities) about nine km northeast, landfill operations at Vissershok (5 km southeast) and a Petroleum refinery (21 km south-southeast of the Duynefontein site. Vehicles along the main roadways (e.g. R27) and nearby residential areas also contribute to the airshed, especially oxides of nitrogen. Large tracts of cultivated land extend ~5 km to the east of the site. The closest river to the site is the Diep River ~25 km to the south.

Residential areas **(Figure 9-10)** in the vicinity of the proposed operations include Duynefontein (2 km south) and Melkbosstrand (~5 km southeast). Larger residential developments within a 15 km radius are Atlantis and Tableview. It is clear that the immediate area has a population density of less than 500 people per km^2 (Census data 2007, Statistics South Africa **(**Figure 9-11**)).**

Although within the immediate vicinity of the site the topography is relatively undulating, the topography further away rises towards the north east (Atlantis, 200 m) with the Dassenberg to the north of the site and east (Olifantskop, 360 m) to southeast (Kanonberg, 430 m) (**Figure 9-12).**

b) Meteorology

Wind Field

The wind roses reflecting day and night-time conditions at the Duynefontein site are given in **Figure 9-13.** The wind regime largely reflects the synoptic scale circulation. The flow field is dominated by south-easterly wind, clearly reflecting the South Atlantic High Pressure anticyclonic circulation which dominates the region throughout much of the year. Differential heating and cooling of the air along the coastline (due to the ocean and land mass) provides a characteristic diurnal shift in the wind field. Calm periods with an increase in east-north-easterly off-shore flow are more prevalent during the night-time. In contrast, an increase in westerly (on-shore) winds is observed during day-time conditions.

During winter months (July to August), an increase in frequency of east-north-easterly winds occur **(Figure 9-13).** An increase in the frequency of southerly winds during summer months (December to February) is observed with a greater number of moderate to strong winds (5 - 10 m/s). Autumn months are associated with a greater frequency of calm wind conditions, with the smallest number of calms occurring during winter and spring months. Note the high percentage of winds from the southerly sector in summer in contrast to the northerly winds, which dominate in winter.

South-south-easterly winds dominate, with approximately 13% occurrences during a year. This wind direction also experiences the highest frequency of strong winds, i.e. winds in excess of 12 m/s occurring 0.2% of the year. Although most of the strong winds occur from the south to south-easterly sector (~1.5% above 10 m/s), relatively frequent strong winds are also evident from the west-north-west to the north-north-west (~0.3% above 10 m/s). Wind

speeds from the north-east to easterly sector are the lowest on average (~2.5 m/s), compared to the average of 5.6 m/s from the south to south-easterly sector. The average wind speed of the west-north-west to the north-north-west sector is about 4.4 m/s.

Atmospheric Stability

On an annual basis, the highest frequency of stability class occurrence is neutral (30.7%) followed by slightly stable (26.1%). The mean wind speeds with these two stability classes are 3.1 m/s and 2.3 m/s, respectively. Extremely unstable conditions occur 20% of the time with a mean wind speed of 3.2 m/s, while extremely stable conditions occur only 5.5% of the time with a mean wind speed of 1.3 m/s.

Ambient Air Temperature

As indicated in **Table 9-1,** dry-bulb temperatures measured at the Duynefontein site are largely influenced by the close proximity of the cold ocean current, which has a moderating effect on the temperatures. The temperatures are measured at a height of 10 m, which also has a moderating effect. The lowest temperature recorded at the Duynefontein site was above freezing (2.2°C on 2 August 1981) and the maximum was 38.2°C (13 September 2005).

Table 9-1: Means and extremes of dry-bulb temperature at the Duynefontein site measured at 10 m above ground level (1980 to 2007)

Month	Average Daily Maximum (°C)	Extreme Maximum (°C)	Average Daily Minimum (°C)	Extreme Minimum (°C)
January	25.4	38.1	15.9	10.5
February	25.5	38	16.1	9
March	24.3	36.6	15.3	9
April	21	35.5	13.3	5.5
May	19.1	33.6	11	5.7
June	19.4	31.4	9.6	4.1
July	19.5	29	9.2	2.8
August	17.2	32	8.2	2.2
September	19.7	38.2	10.4	2.3
October	20.4	37.2	11.6	5.4
November	22.6	36.3	13.6	6.3
December	22.9	37.4	14.5	9.3
Annual	21.4	38.2	12.4	2.2

Atmospheric Moisture

No record of relative humidity is available for Duynefontein.

Precipitation

Duynefontein occurs in a winter rainfall season area. Precipitation falls throughout the year but generally summers are dry while the winters are wet. Mean Annual Precipitation (MAP) at Duynefontein for the period 1980 to 2007 is 374.8 mm. Thunder has been recorded at the Duynefontein site.

Snow and Frost

Although there has been no evidence of snow at the Duynefontein site, records obtained from Cape Town International Airport indicate that there is a possibility of snowfall. Frost has been observed on occasion during the months of June until late August.

c) Air quality

Current Non-Radionuclide Air Quality Levels

The Duynefontein site experiences urban air pollution, including dioxides such as Sulphur dioxides (SO_2), Nitrogen dioxides (NO_2) etc. (potential sources include Chevron refinery, boilers and motor vehicle exhaust pipes), oxides of nitrogen (NO_2 and NO_3 generally grouped as NO_x) (all combustion sources with a significant contribution from motor vehicle exhaust pipes), particulate matter (due to emissions from the petroleum refinery, boilers, other combustion sources, diesel vehicles, bush and open fires, paved and unpaved haul roads, areas exposed to wind erosion and domestic fires), and volatile organic compounds (such as benzene, toluene, xylene). Quantifications of these levels are available in the air quality specialist report (Airshed 2010).

The long-term sulphur dioxide levels are generally low when compared to the annual average World Health Organisations (WHO) guideline of 50 µg/m³ (see Appendix A for summary of air quality guidelines). However, the monitoring results report regular transgressions of the WHO short-term, 10 minute guideline of 500 µg/m³. These exceedances are normally associated with southerly wind directions, i.e. blowing over Chevron refinery and other industrial areas of Cape Town. There appears to be a neutral long-term trend in sulphur dioxide concentration over this period **(Figure 9-14).** The onsite sulphur dioxide measurements (0.92 to 1.78 µg/m³) are considerably lower than the observations at Table View.

In contrast to sulphur dioxide, there is a clear upwards trend in ambient PM10 (Particulate matter with diameter of 10 µm or less) particulate air concentrations **(**Figure 9-15**).** An extrapolation of this trend indicates the potential to significantly exceed the annual average SANS 1929:2004 limit of 30 µg/m³. Although the proposed NPS site is further to the north (approximately 14 km from the monitoring location), it is expected that the current levels of ambient particulate air concentrations would be fairly significant.

A downwards trend is observed in the nitrogen dioxide concentrations from 2000 to 2007, as shown in Figure 9-16**.** This is especially interesting since motor vehicle exhausts contribute a significant portion of this pollutant. The annual average guideline provided by the World Health Organisation is 40 µg/m³. The measurements have been below this limit. The onsite nitrogen dioxide measurements, ranging between 6.2 and 11.4 µg/m³ are relatively similar to the latest observations at Table View.

Radionuclide Dispersion Model Results

Based on the measured nuclide emission releases for Koeberg for the period 1984 – 2003), the spatial radiation dose per annum was predicted. **Figure 9-17** illustrates the highest dose distribution.

The highest on-site inhalation and immersion radiation dose for the current Koeberg NPS is predicted to be 1.8 µSv, approximately 875 m north-northwest of Koeberg. The highest inhalation and immersion radiation dose predicted in a radius of 2 km from Koeberg is 0.7 µSv, also north-northwest of the power station. Based on the NNR regulations, the highest predicted dose is less than 0.2% of the annual effective dose limit of 1000 µSv for members of the public and about 0.7% of the dose constraint of 250 µSv. Similarly, the maximum predicted dose at a distance of 2 km from Koeberg NPS is less than 0.1% of the annual effective dose limit and less than 0.3% of the dose constraint.

9.5.2 Flora

Two vegetation types (Cape Flats Dune Strandveld and Cape Flats Sand Fynbos) are found on the site, whilst eleven plant communities were identified (Figure 9-18). Of the latter, one was a small wetland. There is general correlation between soil characteristics and plant community, but with the grouping into calcareous dunes and non-calcareous sand plain

fynbos. Both vegetation types are rare and have an Endangered status. Habitat rarity is also moderate for the proposed footprint. The dune and sand plain flora was shown to be distinctive to the site, yet linked with West Coast floras. Of the 280 species found on the site, 32 are rare. Species rarity is highest in the sand plain fynbos, as is localised endemism, but is substantially lower on the transverse dunes and this is echoed in the low endemism there. However, both habitat and species rarity rises appreciably when the sand plain fynbos vegetation is crossed for the planned power lines. Sensitivity is locally high due to the presence of mobile and potentially mobile dune sand, with fire proneness being high in the sand plain fynbos. Conversely, vegetation resilience is low. The transverse dune system at Duynefontein is endemic, with this system type poorly represented on the Cape West Coast; however a better preserved system does exist along the west coast at Yzerfontein.

9.5.3 Wetlands

The wetlands at Duynefontein are all classified **wetland depressions,** which occur within a largely flat landscape, indicative of a plain landscape setting. Two categories of such wetlands were identified, namely **seasonal wetlands** and **artificial wetlands**. Seasonal wetlands are mostly located in the south western portion of the site, where they are separated from the coast by a line of low dunes, and collectively comprise an extensive mosaic of seasonally inundated dune slack wetland. **Artificial wetlands**, which are the product of past human activities on the site, are represented by one seasonally inundated depression created along the main NPS access road, but mainly comprise permanently inundated to saturated wetlands which occur in the vicinity of the existing Koeberg NPS, in places along internal roads, along the boundary fence line and in the northern portion of the site, just north of the dune field **(Figure 9-20**).

9.5.4 Vertebrate fauna

The Duynefontein site currently houses the Koeberg Nuclear Power Station (KNPS), and the Koeberg Nature Reserve[2] lies immediately to the north, although all undeveloped parts of the Koeberg site are managed as part of nature reserve. This Nature Reserve was identified as one of 11 priority conservation sites in a study encompassing the region along the West Coast between Blouberg and Silwerstroomstrand, inland to the N7 National Road.

a) Habitats

The faunal habitats within the footprint of the proposed Nuclear-1 are generally in fair to good condition because they have been cleared of alien vegetation and rehabilitation of the habitats is well advanced

b) Amphibians

There are 9 possible species, 8 of which are of probable or confirmed occurrence. One Threatened species, the Cape Caco *Cacosternum capense* (Vulnerable), could possibly breed in seasonal wetlands, but it is unlikely to occur within the proposed footprint. However, it's possible occurrence is an indication that seasonal wetlands should be protected wherever possible. Rose's Rain Frog *Breviceps rosei* is a Western Cape endemic species confined to coastal dune habitats. Maintenance of a coastal corridor is considered important to prevent fragmentation of this species' distribution range.

c) Reptiles

[2] This is a formally declared nature reserve in terms of the Western Cape nature conservation ordinances applicable at the time of its establishment

There are 53 possible species, 40 of which are of probable or confirmed occurrence. Two provisionally Red Listed species, Gronovi's Dwarf Burrowing Skink *Scelotes gronovii* (Near Threatened) (**Figure 9-21**) and Southern Adder *Bitis armata* (Vulnerable), are of probable occurrence, and one, Blouberg Dwarf Burrowing skink *Scelotes montispectus* (Near Threatened), is of confirmed occurrence. Local impact on these species is likely to occur within the footprint. As with Rose's Rain Frog, these species are Western Cape endemics confined to coastal habitats. Maintenance of a coastal corridor is important to prevent fragmentation of their distribution ranges.

d) Mammals

There are 56 possible species, 39 of which are of probable or confirmed occurrence. The only Threatened species which may occur are the Whitetailed Mouse *Mystromys albicaudatus* (Endangered) and Honey Badger *Mellivora capensis* (Near Threatened; Friedmann and Daly 2004). Local research suggests that the mouse is more likely to occur on heavy soils than on sandy soils, so its occurrence at Koeberg may be limited to relatively small patches of suitable habitat, and these are not likely to be situated near to the coast (C. Dorse *pers. comm*.). The Honey Badger has been recorded at Blaauwberg (C. Dorse *pers. comm*.), but it is less likely to occur in coastal areas such as Duynefontein. It is a species that should be able to easily escape from the construction site during site clearance. Four species of bat that have the status of Near Threatened, are likely to be only visitors to Duynefontein, with their roosting and breeding sites elsewhere. The Bontebok (Vulnerable), is an introduced species which need not be directly impacted by the proposed developments, unless it is poached.

e) Birds

There are 203 possible species, 158 of which are of probable or confirmed occurrence. Several Threatened seabird species occur on the coast, e.g., Crowned Cormorant *Phalacrocorax neglectus* (Vulnerable), Bank Cormorant *Phalacrocorax coronatus* (Near Threatened), Caspian Tern *Hydroprogne caspia* (Near Threatened). However, these are unlikely to be negatively impacted by the proposed Nuclear-1 because, in light of the experience at KNPS, the power station will have a neglible impact on the marine environment.

The relatively protected environment in and around Koeberg harbour provides excellent habitat for seabirds and shorebirds to roost and even breed. Swift Terns *Sterna bergii* and African Black Oystercatchers *Haematopus moquini* (Near Threatened), in particular, have been recorded breeding in numbers and these represent regionally important breeding colonies. It is essential that disturbance of these colonies is kept to an absolute minimum. Nuclear-1 will not be using or affecting Koeberg harbour, but construction activities in the vicinity have the potential to cause damaging disturbance.

Several Threatened species of raptor occur on site. The Black Harrier *Circus maurus* (Near Threatened) is known to breed at Duynefontein, and the Marsh Harrier *C. ranivorus* (Vulnerable) may breed in the large coastal wetland area in the northern part of Duynefontein. It is unlikely that either of these species breed on the proposed Nuclear-1 footprint.

f) Sensitive areas

The mapping of faunal sensitivity (**Figure 9-58**) was based primarily on (a) scarce habitats important to the maintenance of faunal diversity, (b) areas important for ecological corridors, and (c) areas occupied by particularly sensitive species. In the case of Duynefontein, the areas identified as having high faunal sensitivity were:

- All wetlands, with a 100 m buffer. Wetlands have a central role in maintaining faunal diversity and faunal populations. Buffers are essential to provide semi-aquatic species with terrestrial habitat and corridors of access for terrestrial species.
- The coastal corridor (200 m above the current 100-year high-water line). A coastal corridor provides fauna with access to coastal resources and allows movement along the coast. The width of the corridor needs to take future sea-level rise into account.
- A 100-m corridor between KNPS and the Nuclear-1 development corridor. This corridor prevents an unbroken wall of development separating inland habitats from coastal habitats.
- The mobile-dune field. The ecology of the dune field is highly dynamic and easily disrupted by alteration of patterns of sand movement, therefore obstructions – especially at the coastal point of origin – need to be avoided. Such disruption has already occurred with the construction of KNPS, but the balance of the dune field needs to be protected as far as possible.
- Areas to the north have greater conservation value because their long-term prospects of protection are better, and the Koeberg Nature Reserve could potentially be expanded to the north.

9.5.5 Invertebrate fauna

a) Ant species

Twenty-two ant species were collected, with an estimated total diversity of approximately 27 species. No invasive Argentine Ant (*Linepithema humile*) specimens were found, but these may prove to occur on the site closer to the existing developments, where no surveys were carried out during the present survey. Another widespread tramp species, *Hypoponera eduardi*, was found, but this species is not yet considered of major conservation concern.

Two undescribed ant species of special interest were collected at Duynefontein (**Figure 9-22**). These were:

- *Tetramorium* sp. (an undescribed species related to *T. flaviceps*) found in the Dune Thicket on Transverse Dunes. However, attempts to locate this species again during fieldwork in January 2010 were unsuccessful; and
- *Monomorium* sp. (an undescribed species related to *M. damarense*) found in the Dwarf Dune Thicket.

b) Butterflies

The summed probable total species count for Duynefontein is low (at 23.1) with a very low Red List species probability of 0.01, but it must be borne in mind that these figures can be compared directly only to the other sites surveyed during this study. There are three main vegetation types of relevance to butterflies at the site – Atlantis Sand Fynbos (ASF) in the south-eastern corner of the site and Cape Flats Dune Strandveld (CFDS) over most of the rest of the site, with a transitional zone in between.

A total of 12 species were found on Duynefontein. None of these are local endemic species, six are regional endemic species and two are South African endemic species.

c) Other invertebrates

A summary of the other invertebrates on the site, besides ants and butterflies, is listed below:

- **Velvet worms** (Onchyophora): none found.
- **Spiders:** One specimen of *Harpactira atra* (Theraphosidae), a protected baboon spider species common in the south-western Cape was observed during the survey; another

was also seen by the terrestrial vertebrate fauna investigation team. A trapdoor spider, probably of the Nemesiid genus *Pionothele* was found during January 2010.

- **Scorpions** (Arachnida: Scorpiones): A West Coast endemic scorpion species, *Uroplectes variegates*, was found to be abundant in the proposed footprint area (it is likely to be found over the entire site).
- **Soldier flies** (Mydaidae): none found.
- **Heelwalkers** (Mantophasmatodea): none found.
- **Monkey beetles** (Hopliini): several specimens of 1 species found; most were inactive and hiding under rocks.
- **Millipedes** (Myriapoda): - 3 species were found.
- **Jewel beetles** (Buprestidae): none found.
- **Spoonwing lacewings** (Nemopteridae): none found.
- **Horseflies** (Tabanidae): none found. The only long-tongued flies observed were *Australoechus hirtus* (Bombyliidae).

The area of the KNPS footprint appears to be significant in terms of the invertebrate diversity it is expected to maintain, and this is supported by the fact that the only known specimen of an undescribed ant species (*Tetramorium* sp.) was previously collected in this area.

However, prior to construction of the KNPS, this area was an unvegetated dune field. Stabilisation of the dunes by planting of grass and invasion by *Acacia cyclops*, in combination with the KNPS preventing natural inflow of sand from the south, have resulted in the establishment of the plant communities now present. This in turn would have resulted in establishment of a very different invertebrate community from that which was present prior to construction of the KNPS. Significant species such as the undescribed *Tetramorium* would probably have established themselves here subsequent to the development of vegetation cover, and they would presumably have moved in from surrounding vegetated areas. It can therefore be assumed that this species will also be found in surrounding areas.

Thus, while the particular pattern of dune structure and vegetation within the proposed footprint that provides habitat for invertebrate species may be unique on the Duynefontein site and also not well-conserved in neighbouring areas, 1) this is not the natural state of the area and 2) most indigenous species present can be assumed to have colonised from other natural areas and to be represented in such areas.

It is unlikely that the Duynefontein study site will host any listed Red Data invertebrate of the Western Cape Province.

9.5.6 Marine biology

The area under consideration is located north of Melkbosstrand on the west coast and falls within the Southern Benguela ecoregion and the south-western Cape inshore ecozone. This region is dominated by the cold Benguela Current system, in which high biological productivity is supported by the upwelling of cool nutrient rich waters. However, this section of coast is characterised by low marine species richness and very low endemicity. Nonetheless, some south coast species extend to this site, giving it slightly elevated species richness and endemicity rates, when compared to northern areas along this coast. Recent work has classified the threat status of sandy and rocky shores in this region as vulnerable and moderately protected (Sink et al. 2012). To place this in context, the same report also stated that 47% of marine and coastal habitat types along the South African coast are threatened. No sites of special biological significance occur within the area.

This site is typified by long sandy beaches, interspersed with short stretches of rocky-shore. Such beaches are notable for the low number of species they support, and the fact that they are physically controlled. As a result of the dominance of physical parameters, such as water movement, these beaches are very resilient to disturbance. All the beach species found here

have extensive geographical distributions. There are no sites of special conservation value for marine species within the immediate area.

While the South African west coast supports highly productive fisheries, these are focused offshore. Nearshore fish productivity remains high, but diversity is low. A number of fish have been recorded in the harbour of KNPS, the most common of which are the Southern harder *Liza richardsoni* and the catshark *Poroderma africanum.*

As far as marine mammals are concerned, Southern right whales (Eubalaena australis) and humpback whales (Megaptera novaeangliae) use the inshore waters of the west coast on a seasonal basis. Seasonality on the west coast is later than on the south coast due to feeding in upwelling areas in the southern Benguela. Numbers peak in the Saldanha Bay area (and probably Table Bay too) in spring and summer (Sep.-Feb.). Southern right whales regularly use very shallow, nearshore waters (<2 km from shore) when moving along the coast, thus bringing them into potential contact with the proposed development site. While a number of marine mammals are known to frequent the west coast, only the South African fur seal *Arctocephalus pusillus pusillus* has been recorded spending extended periods in the immediate area of the site.

The marine environment demonstrates relatively high tolerance to disturbance and is thus rated as having low sensitivity.

9.6 Biophysical environment figures: Duynefontein

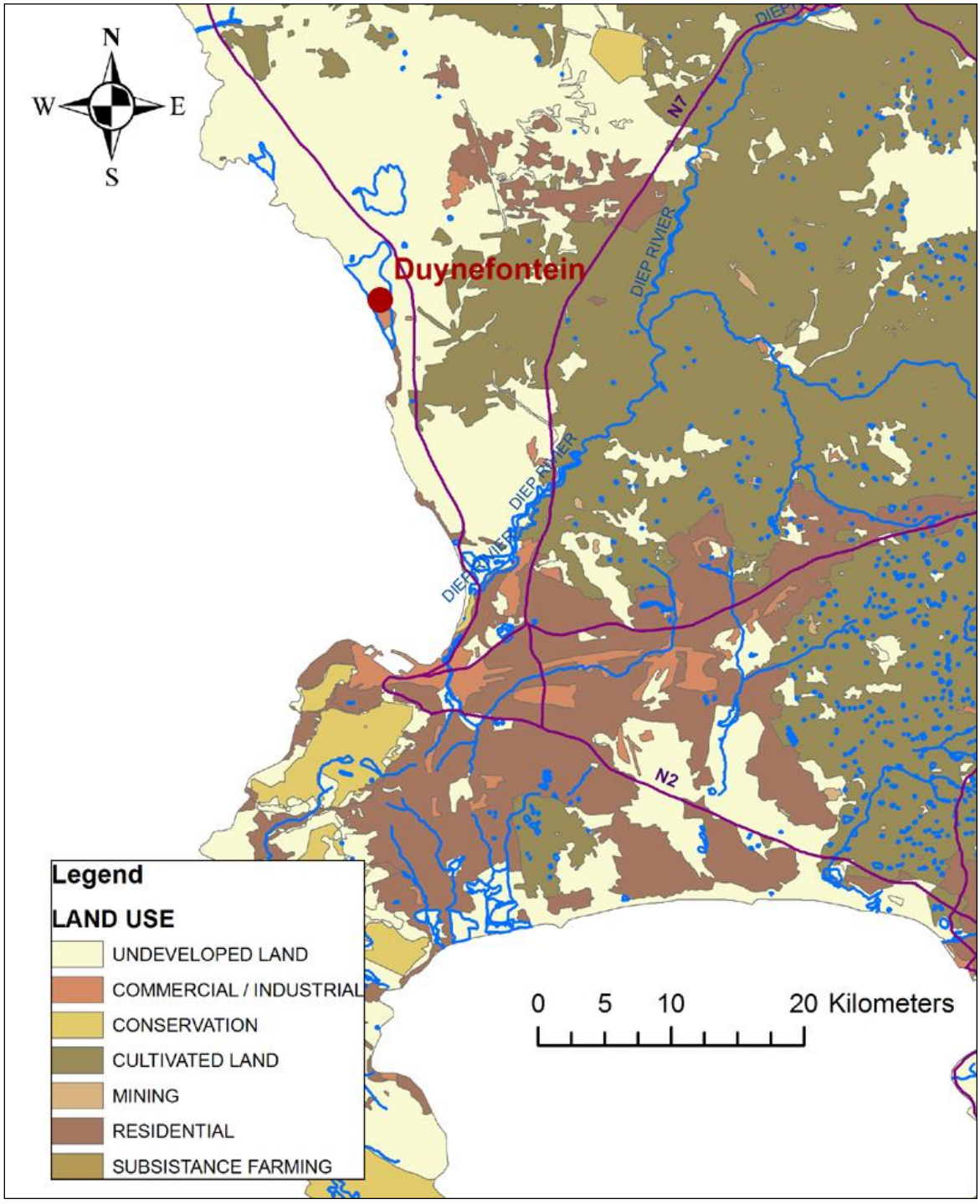

Figure 9-10: Land use in the vicinity of the Duynefontein site

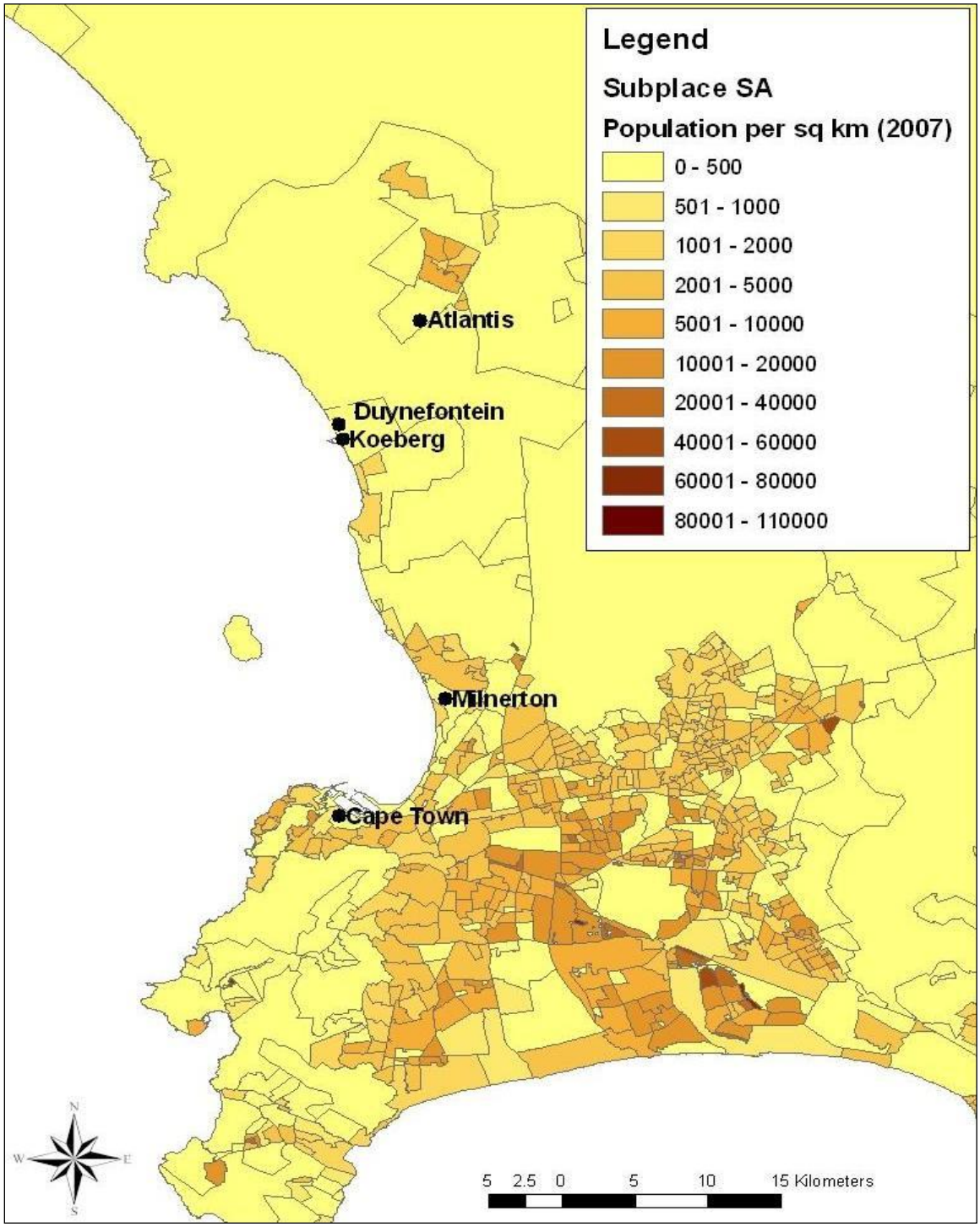

Figure 9-11: Population density in the vicinity of the Duynefontein site

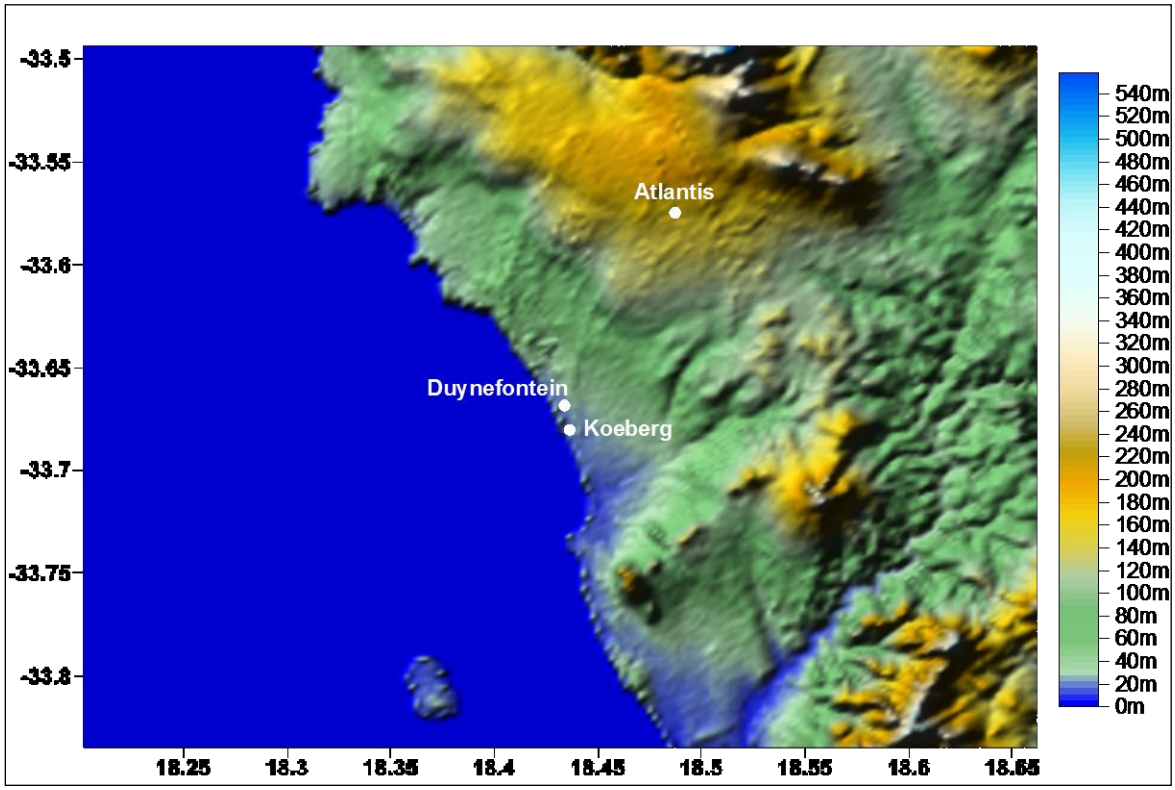

Figure 9-12: Shaded relief profile of the Duynefontein study area

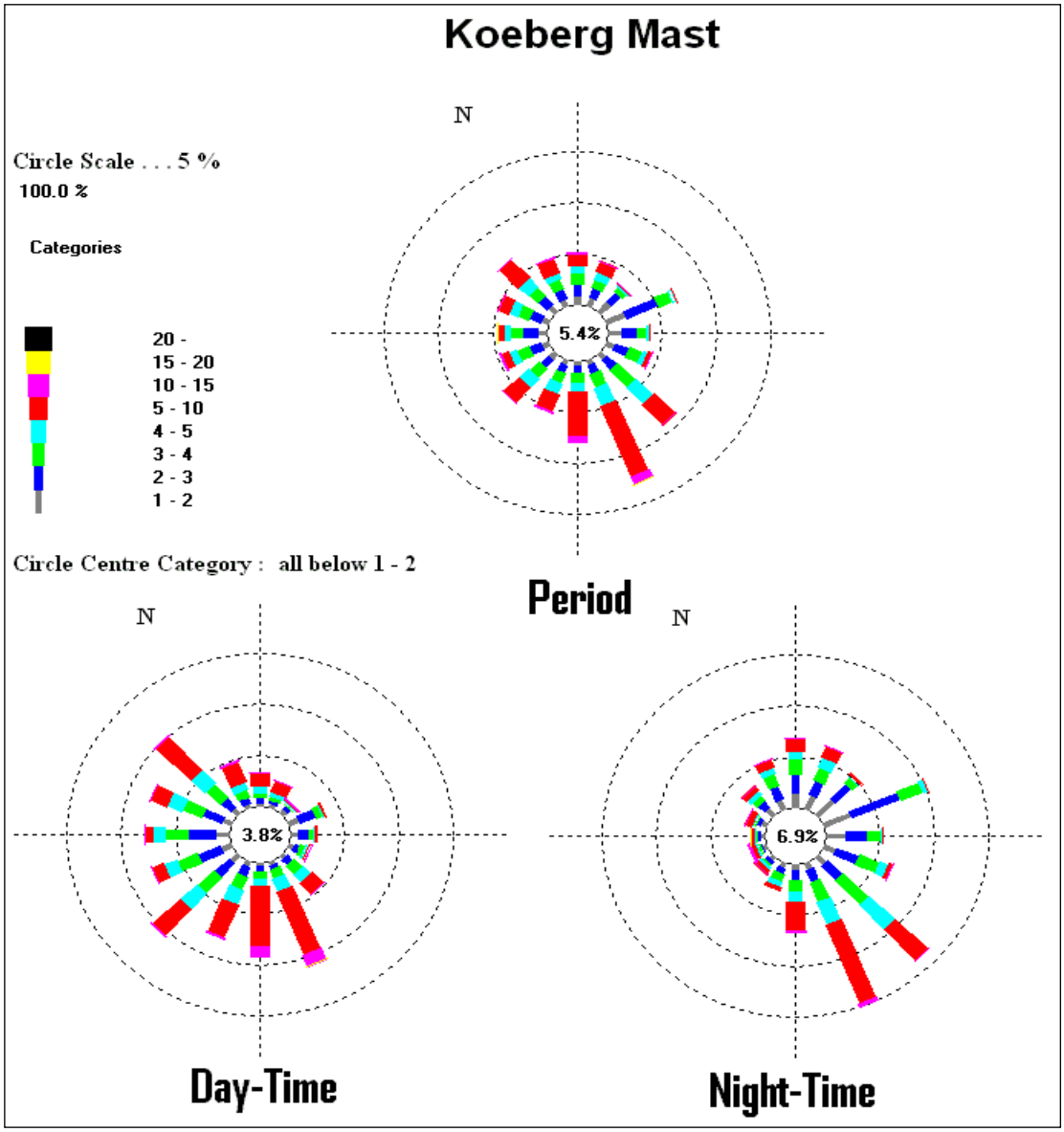

Figure 9-13: Period, day- and night-time wind roses for Duynefontein

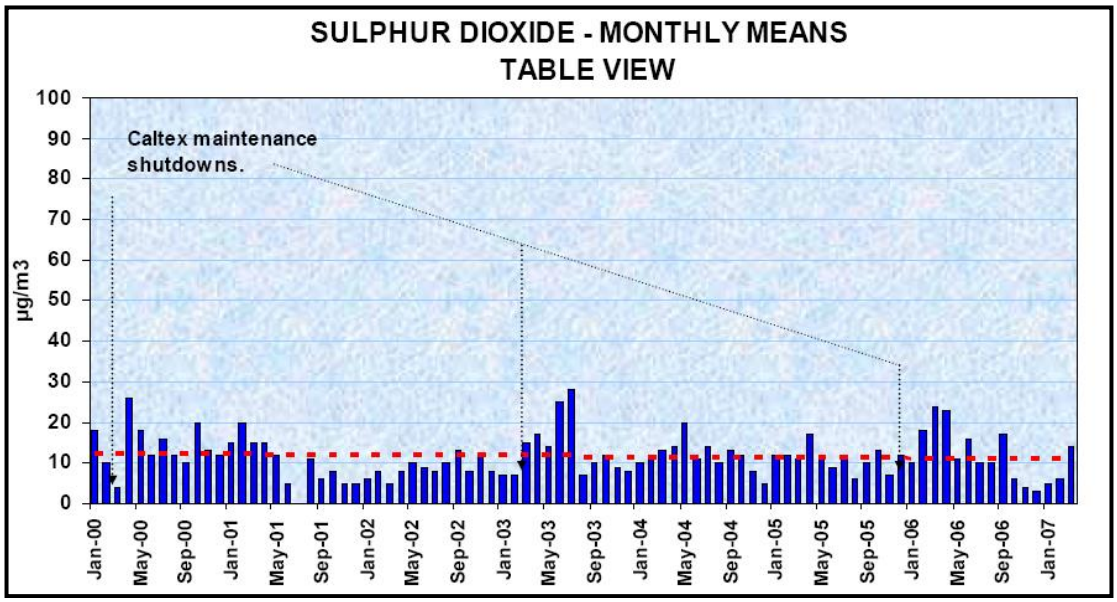

Figure 9-14: Recorded monthly mean sulphur dioxide levels in Table View. The red line indicates the linear trend

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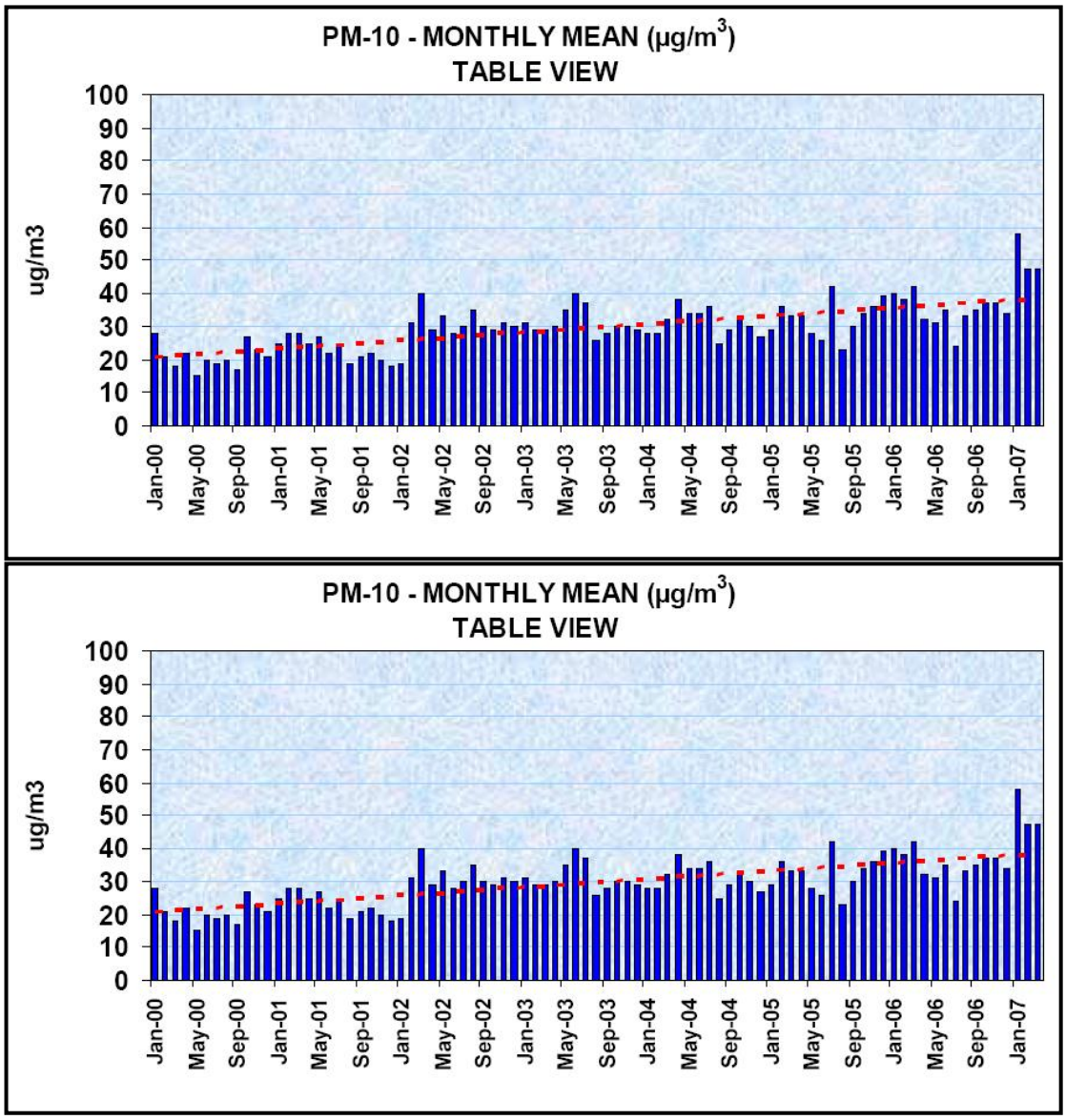


Figure 9-15: Recorded monthly mean PM10 particulate matter levels in Table View. The red line indicates the linear trend

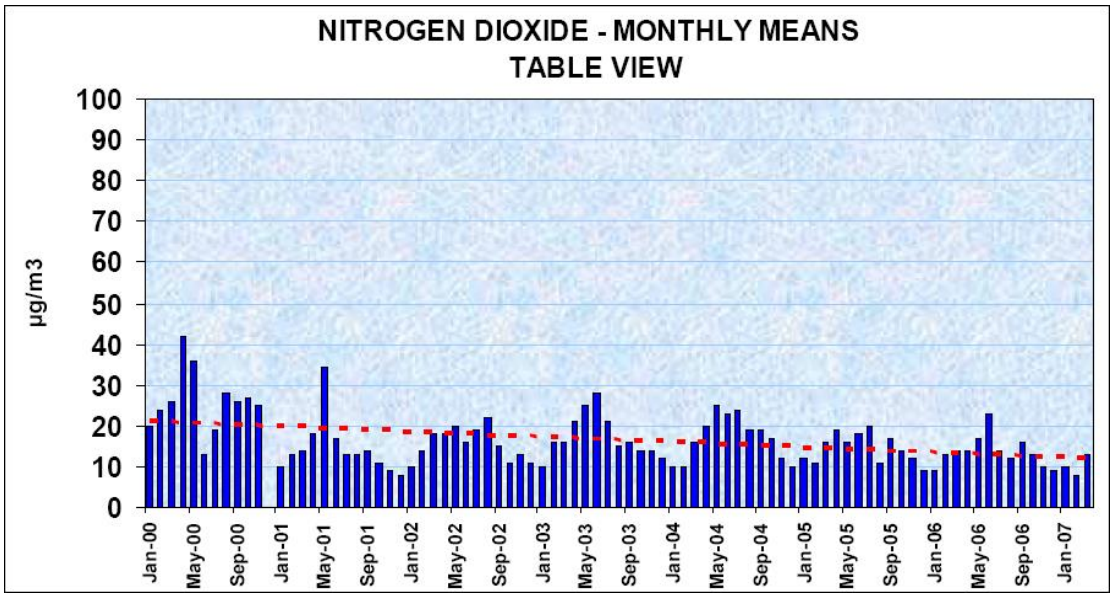


Figure 9-16: Recorded monthly nitrogen dioxide levels in Table View. The red line indicates the linear trend

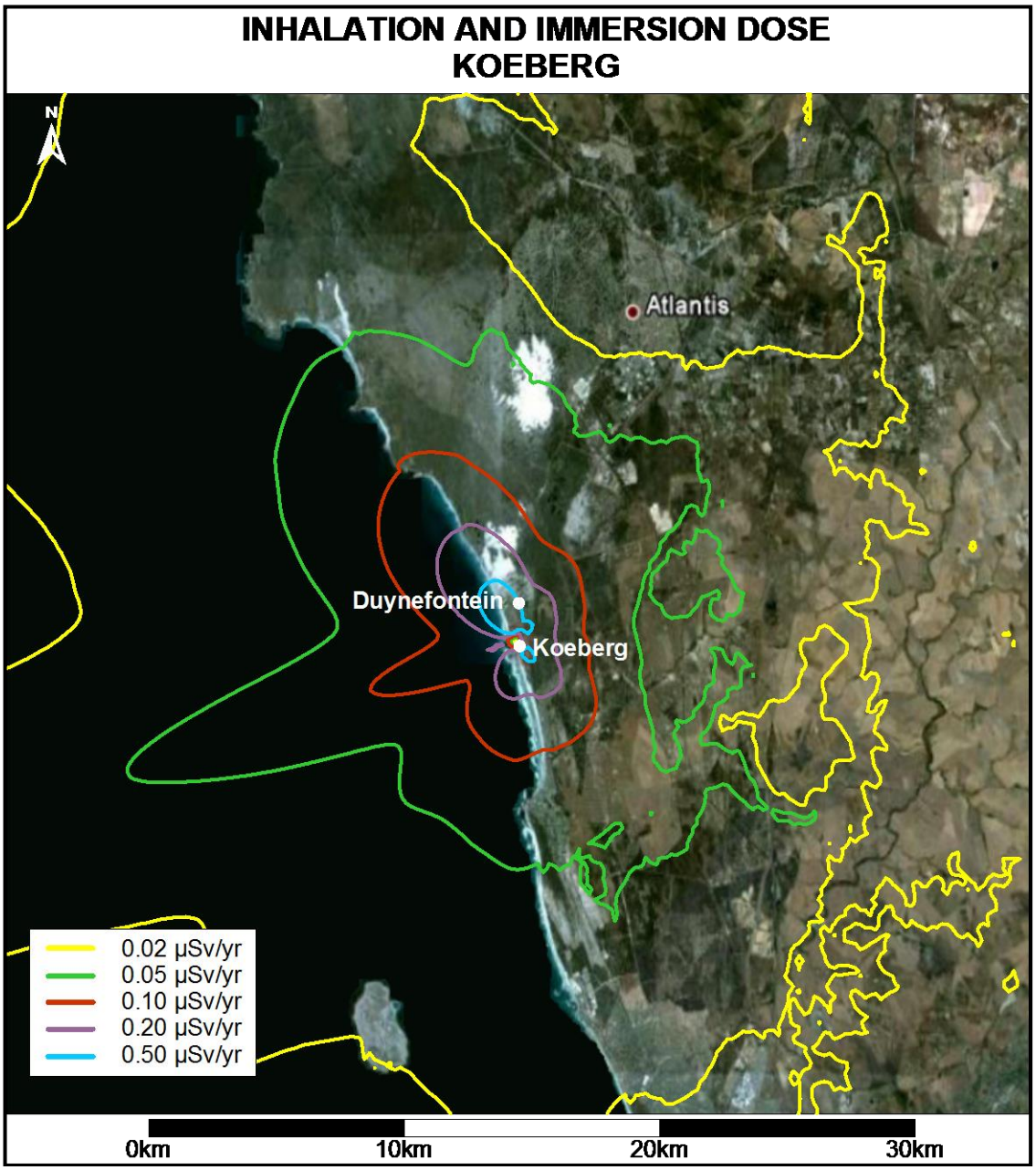


Figure 9-17: Predicted maximum annual inhalation and immersion radiation dose (µSv) for the Duynefontein site

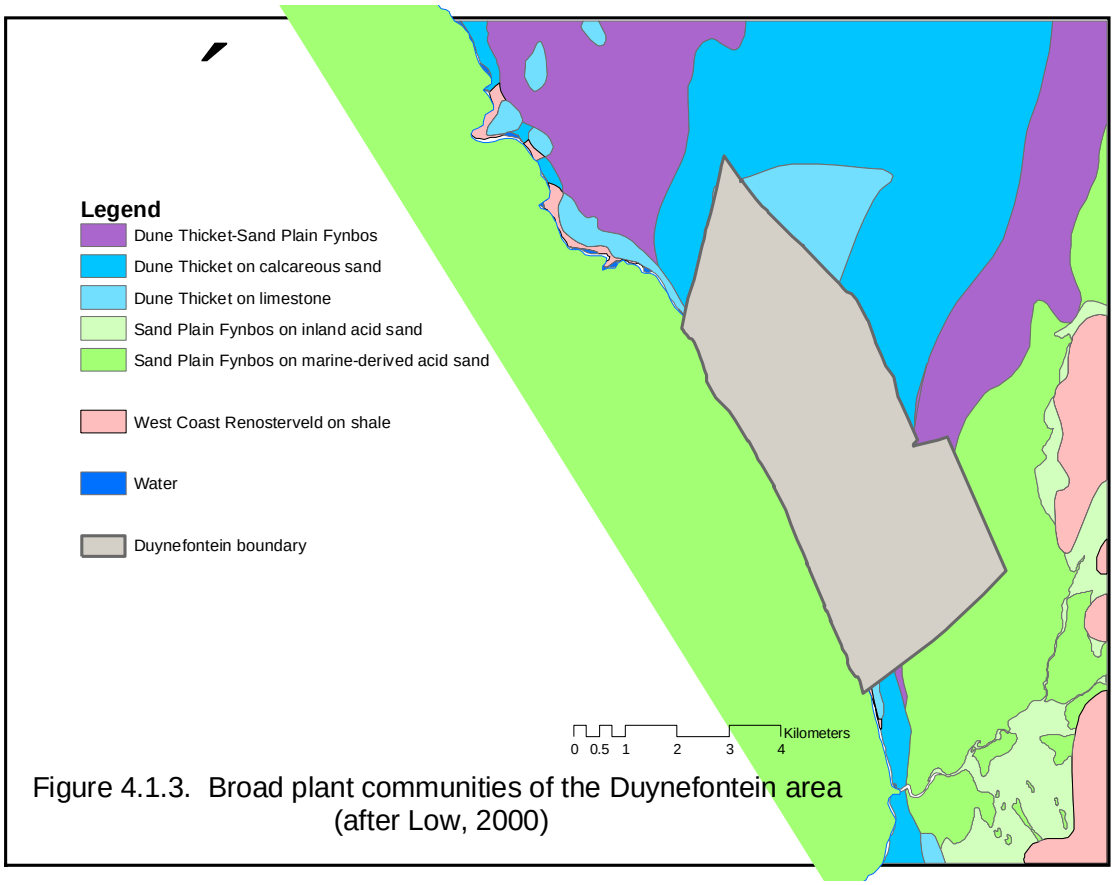


Figure 4.1.3. Broad plant communities of the Duynefontein area (after Low, 2000)

Figure 9-18: Broad plant communities of the Duynefontein site and surroundings

Figure 9-19: A view of the affected environment at the Duynefontein site, looking south towards Koeberg Nuclear Power Station

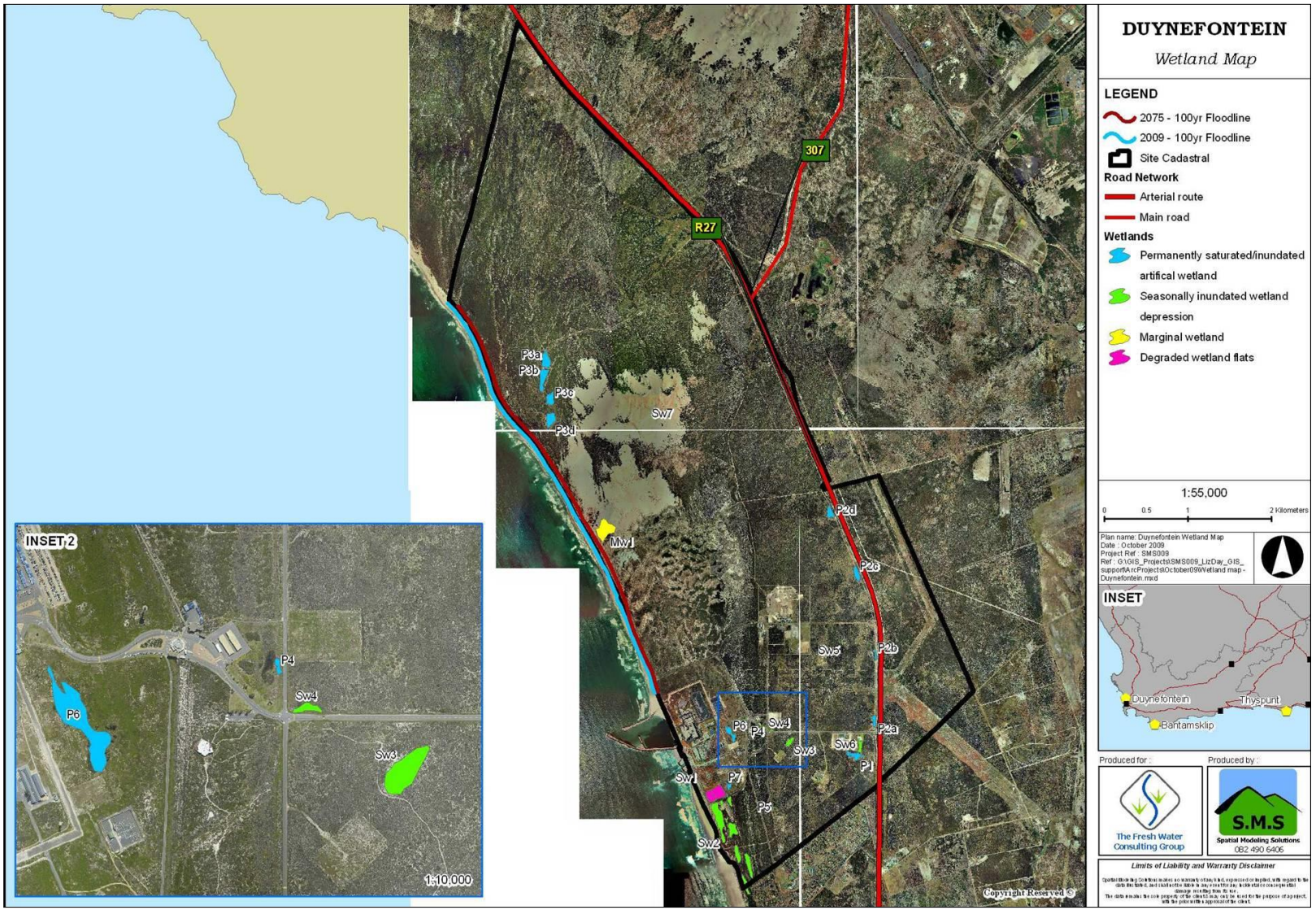


Figure 9-20: Duynefontein wetlands map

Figure 9-21: The Blouberg Dwarf Burrowing Skink *Scelotes montispectus*, a recently described and potentially threatened species, found at Duynefontein (Photo: M. Burger)

Figure 9-22: An undescribed *Tetramorium* ant species found at Duynefontein

9.7 Biophysical environment: Thyspunt

9.7.1 Air quality and climate

a) Land Use and Topography

At Thyspunt, the land use in the local study area (typically less than 10 km) includes a large portion of vacant land. From approximately 2.5 km north of the site, the land use type consists of large tracts of cultivated land (**Figure 9-23**). Farming activities mainly include fodder for dairy cows, sheep (predominantly beyond 10 km, northwest of the site) and cattle (meat). Limited game farming occurs towards the north of the site, with wheat fields present to the west and north of the site. The N2, which extends in an east-west direction, is ~20 km north of the site with the Klipdrif River and the Krom River ~7 km to the west and north of the site, respectively.

The absence of any industrial activities in the vicinity of Thyspunt results in very low current air pollution levels. Cape St. Francis is located 13 km east of the site, and Humansdorp, which is relatively more industrialised, is located approximately 18 km north of the site. However, the prevailing winds, i.e. easterly and westerly, offer little opportunity to carry air pollution from Humansdorp to the site.

Larger residential areas in the vicinity of the proposed operations include Humansdorp (~18 km north northeast), Jeffreys Bay (~25 km northeast), St. Francis Links (~10 km east), Sea Vista (~12 km east) and Cape St. Francis (~12 km, east-southeast), (**Figure 9-23**). Smaller residential developments closer to the proposed site include Oyster Bay (~3 km west), Amaninzi (10km northeast) and Klippepunt (~10 km west).

The population density is predominantly less than 500 people per square kilometre **(Figure 9-24)** Increased densities are shown for Humansdorp and Jeffreys Bay (2 000 to 5 000 per km^2).

Resistant rock structures in the vicinity of the Thyspunt site are visible in the increase in relief extending from the northwest to the southeast between layers of lower relief (**Figure 9-25**).

b) Meteorology

Wind Field

From the historical dataset produced by Eskom (1987), it is clear that the most dominant wind direction in this region is from the west northwest to northwest. The western sites of Brakkeduine and Klippepunt are characterised by winds of a greater northerly direction than Thyspunt and De Hoek. Off-shore wind flows occur about 30 % of the time at all the sites. It is important to also note the very low frequency of calm wind conditions (~2 %). More frequent stronger winds come from a west northwest to northwest direction. Some noticeable mild winds also occur from the northeast direction but these are infrequent. The wind speed tends to increase to mid-afternoon as the instability is highest at around 14h00. Furthermore, the frequency of frontal systems and coastal low pressure systems forces a variable daily surface wind speed at all the sites. The offshore flow, i.e. northerly winds are characterised by slow wind speeds and somewhat frequent occurrence (much less than the north-westerly winds but noticeable) indicating the effect of land breezes. The occurrence of onshore flow i.e. southerly winds is negligible at all sites in this region.

According to the 21-month observations at Thyspunt, westerly winds dominate, with approximately 20.5% occurrences during the period. This wind direction also experiences the

highest frequency of strong winds, i.e. winds in excess 10 m/s occurring 1.5% of the year. Winds in excess of 15 m/s occur 0.1% of the period. Strong winds in excess of 15 m/s also occur from the west-south-west (~0.03%) and south-west (~0.02%). Winds from the north-north-east to northerly sector are on average the lowest (~3.9 m/s), compared to the average of 6.2 m/s from the east-north-east and eastern sector, and 5.8 m/s from the west-south-west to western sector.

The western wind component is prevalent during all four seasons (**Figure 9-26**). However, the eastern wind component is more prevalent during spring and summer. The frequency of strong westerly winds increases during winter months (July to August). Winter also witnesses an increased amount of wind from the west-north-west.

Atmospheric Stability

On an annual basis, the highest frequency of stability class occurrence is neutral (68.2%) followed by slightly stable 11.6%. The mean wind speeds with these two stability classes are 5.9 m/s and 5.7 m/s, respectively. Extremely unstable conditions occur 3.1% of the time with a mean wind speed of 2.9 m/s, while extremely stable conditions occur only 1.8% of the time with a mean wind speed of 2.4 m/s.

Ambient Air Temperature

The ambient air temperature statistics for Cape St. Francis are summarised in **Table 9-2**. The table contains the average daily maximums, minimums and extreme maximums and minimums. The average daily maximum and minimum temperature recorded at Cape St. Francis were 22.8°C (January and February) and 11.2°C (July), respectively. The extreme maximum and minimum were 36.5°C (May) and 5.0°C (August), respectively.

Table 9-2: Means and extremes of temperature for Cape St. Francis for the period 2004 to 2007

Month	Average Daily Maximum (°C)	Extreme Maximum (°C)	Average Daily Minimum (°C)	Extreme minimum (°C)
January	22.8	27.4	18.5	12.9
February	22.8	28.3	18.4	14.1
March	21.8	25.5	16.7	12.9
April	19.6	25.3	14.7	9.1
May	19.4	36.5	13.3	7.1
June	18.8	29.0	11.7	6.8
July	18.1	28.0	11.2	6.6
August	17.9	30.5	11.6	5.0
September	18.1	24.4	12.9	7.0
October	19.2	25.5	14.2	8.5
November	20.9	31.1	15.9	11.2
December	22.0	25.0	17.4	12.6
Annual	20.1	36.5	14.7	5.0

Atmospheric Moisture

Relative humidity has been recorded since January 2008. The average relative humidity appears to be the same as at Bantamsklip, i.e. around 78% with the lowest recording during August, i.e. 9.9 %.

Precipitation

The rainfall season for the Thyspunt area is classified as all year round. .The mean annual precipitation is expected to be between 600 mm and 800 mm. The rainfall observations

made at the weather station in Cape St. Francis recorded an annual average of 610.9 mm for the period 2004 (June) to 2007. Ignoring 2004, the mean annual average rainfall is 587.9 mm.

Snow and Frost
No snow or frost has been recorded at Thyspunt.

c) Air quality

Similar to Bantamsklip, no ambient air sampling data are available to provide historical air pollution concentration quantities at Thyspunt. A three-month sampling exercise was completed during March to May 2009. The observed monthly average sulphur dioxide and nitrogen dioxide concentrations were 0.40 µg/m³ and 1.51 µg/m³, respectively. These concentrations are considered to be low and typical of conditions away from air pollution generating activities.

The closest source of potential air pollution is Oyster Bay, approximately 3 km from the site. The air emissions typically include fugitive dust from building activities and unpaved road surfaces, and combustion products from domestic fires and vehicle emissions. Due to the sparse population, these emissions are not considered significant.

The increased human activities at Cape St. Francis would result in increased levels of air pollution. However, it is located 13 km east of the site and would therefore have minimal impact at the site. The relatively more industrialised Humansdorp is located approximately 18 km north of the site, but with the easterly and westerly prevailing winds, offer little opportunity to carry air pollution to the proposed NPS site.

9.7.2 Flora

Five major vegetation types occur on the site (conservation status in brackets): Algoa Dune Strandveld (Least Threatened) (LT), Southern Cape Dune Fynbos (LT), Tsitisikama Sandstone Fynbos (Vulnerable) (V), Cape Seashore Vegetation (LT) and Cape Lowland Freshwater Wetlands (V) (**Figure 9-27**). This translates into nine major plant communities with six wetland types and a river system. Three hundred and eighty three plant species were recorded on site, with a very low rare species count (14 or 3.7%), compared with other coastal areas which might exhibit >5%. Analysis of on site floras shows a clear distinction between calcareous and non-calcareous habitats, and with total carbon playing a key role as one moves inland from the coast, through primary dunes, stable dunes and forest. Species rarity is generally low, with the exception of one or two habitats. Likewise habitat rarity is fairly low except for the transverse dunes, coastal limestones and wetlands. Endemism is also low, with only one local endemic found there. Sensitivity is greatest on both mobile and stable dunes, with most of the site showing high tolerance to droughting. All fynbos communities show high proneness to burning. Habitat resilience is lowest for the mobile dunes, coastal limestones and wetlands. The headland bypass dune system at Thyspunt is endemic to the area and the biggest on the South African coastline.

9.7.3 Wetlands

The Thyspunt site is characterised by extensive mobile dune fields, which are closely associated with the wetland systems. The wetlands occur mostly in the low-lying interdune “slack” areas. The eastern quarter of the Oyster Bay dune field drains into the Sand River – an “episodic” river, which comprises largely shallow subsurface flow, save during flood episodes, when it carries runoff and subsurface flow from the dunes and surrounding farmland and other developed areas into the Krom River.

Groundwater interactions play an important role in determining the function and distribution of many of the wetlands on and in the vicinity of Eskom’s Thyspunt site Groundwater flows

across the site as predominantly from north-west to south east, with discharge along the beaches and rocky outcrops into the ocean, and into the Sand River aquifer in the east.

Three types of wetlands occur on the site (**Figure 9-28**):

- **Wetland depressions** within the mobile dune fields – these wetlands are also referred to as **dune slack wetlands**. These are depressions that occur in an otherwise sloped terrain. The wetlands form against the leeward toe of the mobile dunes and collectively comprise an extensive band of seasonally (or at least non-permanently) inundated pools, ranging from less than 30 cm in depth to over 2 m. They are aligned in a west-east direction, becoming more extensive in the east.
- **Permanently to seasonally saturated hillslope seeps** (including the Langefonteinvlei wetland complex on the eastern boundary of the site)**;** and
- **Permanently to seasonally saturated valley bottom wetlands.**

There is a high degree of certainty about the mechanisms that feed the hillslope seeps like Langefonteinvlei (they are fed from aquifers). However, there is still a degree of uncertainty about the mechanisms feeding the dune slack wetlands. Several hypotheses have been proposed for the latter, but no conclusion has been reached.

9.7.4 Vertebrate fauna

The site lies within the Cape Floristic Region, which is largely restricted to the Western Cape and Eastern Cape provinces. This is an exceptionally biodiverse region with very high levels of species endemism. As mentioned for Bantamsklip, the CFR has been identified as a global Biodiversity Hotspot and is the focus of the Cape Action for People and the Environment. The site is registered with the DEA as a Natural Heritage Site.

The site is environmentally varied and complex, with several distinctly different habitat types, a complex topography with complex drainage, and a varied coastline. Despite the proximity of the towns of Cape St. Francis in the east and Oyster Bay in the west, the site is remarkably wild and unspoilt.

a) Habitats

Habitats on site are largely comprised of the following veld types: Algoa Dune Strandveld (Least Threatened) covering the majority of the area, Southern Cape Dune Fynbos (Least Threatened) on a relatively large area, a narrow coastal strip of Cape Seashore Vegetation (Least Threatened), and a relatively small area of Tsitsikamma Sandstone Fynbos (Vulnerable) on an inland extension of the site. The inland “panhandle” portion of the site has been largely transformed by agriculture. In addition there are small patches of thicket which have matured into low forest; also thickets of invasive alien vegetation, mainly Rooikrans *Acacia cyclops* and Port Jackson Willow *A. saligna*. Between the coastal and inland portions of the site lies and extensive transverse mobile-dune field with interspersed vegetated areas and seasonal wetlands.

b) Amphibians

There are 15 possible amphibian species, all of which are of probable or confirmed occurrence. None of the species is threatened, but there are nevertheless some important conservation issues around amphibians on site. The wetlands in the dune field are occupied by a number of species and these have been the subject of special surveys. A population of Cape Sand Toad *Vandijkophrynus angusticeps* is of special interest because it is at the eastern extremity of its range here. The population is probably isolated from all other populations of this species and may, therefore, be genetically and even taxonomically distinct, and should be regarded as a rare, important and sensitive population requiring the highest levels of protection.

Also of considerable interest are the frogs that occupy the coastal wetlands and seeps above the rocky shoreline. Six species (Common Platanna *Xenopus laevis,* Common River Frog *Amietia angolensis,* Bronze Caco *Cacosternum nanum*, Striped Stream Frog *Strongylopus fasciatus*, Clicking Stream Frog *Strongylopus grayii*, Cape Sand Frog *Tomopterna delalandii*) were observed in these habitats, which is an unusual species richness for localities so close to the sea. It can be assumed that these species are also all breeding here. Along with the occurrence of other types of freshwater-associated species (see below), this community of amphibians is of special scientific and conservation interest and needs to be protected.

Penther's Rain Frog *Breviceps adspersus pentheri,* a fossorial terrestrial frog, is a range-restricted taxon endemic to the Eastern Cape Province and therefore of special conservation significance. It is of probable occurrence on the inland “pan-handle” part of the site.

c) Reptiles

There are 62 possible reptile species, 50 of which are of probable or confirmed occurrence. Probably occurring species that are provisionally Red Listed are FitzSimons' Long-tailed Seps *Tetradactylus fitzsimonsi* (Vulnerable) and Tasman's Girdled Lizard *Cordylus tasmani* (Vulnerable). In addition*,* Péringuey's Coastal Leaf-toed Gecko *Cryptactites peringueyi* (Critically Endangered) is of possible occurrence. This extremely range-restricted Eastern Cape endemic species is known from only two localities, one of which is the Krom River estuary, situated only a few kilometers to the east of the site. If it does occur, it is likely to be associated with vegetation in the splash zone along the coast.

Herald Snake *Crotaphopeltis hotamboeia* and Cape Girdled Lizard *Cordylus cordylus* were found very near to the sea, in association with the coastal wetlands. The Herald Snake is a specialist predator of frogs. These findings strengthen the impression that a community of wetland-associated species exists immediately adjacent to the marine environment.

None of the anticipated Threatened species was confirmed during the field survey (September 2009). However, one provisionally Red Listed species that was not anticipated was found, namely Elandsberg Dwarf Chameleon *Bradypodion taeniabronchum* (Endangered) (**Figure 9-29**). This is a new locality for this species, and it is well removed from other known localities. Its DNA is undergoing analysis because it may be genetically distinct from other populations of the species. If this is found to be the case, it would further underline the population’s conservation importance, and that of the Langefontein wetland.

d) Mammals

There are 58 possible mammal species, 44 of which are of probable or confirmed occurrence. Only three species are Red Listed as Threatened or Near Threatened, namely Fynbos Golden Mole *Amblysomus corriae* (Near Threatened), Honey Badger *Mellivora capensis* (Near Threatened) and Blue Duiker *Philantomba monticola* (Vulnerable). The Blue Duiker and Honey Badger are almost certain to occur.

At the coast, especially at or near to coastal wetlands, there was abundant spoor of Cape Clawless Otter *Aonyx capensis* and Marsh Mongoose *Atilax paludinosus,* as well as antelope, probably Bushbuck *Tragelaphus scriptus* and Common Duiker *Sylvicapra grimmia*. These provided further evidence of the ecological importance, as well as the richness and sensitivity of the coastal wetlands.

There have been reliable reports of Leopards *Panthera pardus* occurring and possibly breeding on site. While the Leopard is not a Threatened species, its occurrence in coastal environments has become rare. This species is symbolic of the wild, unspoilt nature of the site, and of an ecosystem that is intact and functioning in, or quite close to, it’s original condition. Leopards can survive, and possibly thrive, in this environment because a number of suitable prey species still occur in good numbers (confirmed), e.g., Bushpig, Vervet

Monkey, Common Duiker, Bushbuck and Red Necked Spurfowl. It is this intactness of the ecosystem which makes Thyspunt a site of substantial conservation importance for fauna, especially as it is located at the coast where most ecosystems have been radically altered.

e) Birds

There are 206 species of possible occurrence, 61 of which were confirmed during the site visit.

Several Threatened and Near Threatened species are of likely or confirmed occurrence on site: Blue Crane *Anthropoides paradiseus* (Vulnerable), Black-winged Lapwing *Vanellus melanopterus* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened), African Marsh Harrier *Circus ranivorus* (Vulnerable), Black Harrier *Circus maurus* (Near Threatened), Secretarybird *Sagittarius serpentarius (*Near Threatened), White-bellied Korhaan *Eupodotis senegalensis* (Vulnerable), Denham's Bustard *Neotis denhami* (Vulnerable), Knysna Woodpecker *Campethera notata* (Near Threatened) and Knysna Warbler *Bradypterus sylvaticus* (Vulnerable). Threatened seabirds are likely to roost and/or forage at the coast, viz., Roseate Tern *Sterna dougalli* (Endangered) and Damara Tern *Sterna balaenarum* (Endangered).

Threatened birds likely to occur on the inland portion of the Thyspunt site, and be particularly affected by transmission lines there, are Blue Crane, Denham's Bustard, White-bellied Korhaan and Secretarybird.

There is a coastal locality which appears to be important as a roost site for terns of a variety of species. This is at the head of the sheltered bay just to the west of Thyspunt itself **(Figure 9-30)**. It is also along the shoreline of this bay that the greatest concentration of coastal seeps occurs. The proximity of marine and freshwater ecosystems in this area (see above) is believed to be the result, in part, of the sheltered nature of the bay which protects the coastal seeps from saltwater invasion by wave action. The sheltered nature of the bay also creates a suitable roost site for seabirds. This bay should be viewed as a sensitive locality requiring the highest level of protection.

f) Sensitive areas

The mapping of faunal sensitivity (**Figure 9-65**) was based primarily on (a) scarce habitats important to the maintenance of faunal diversity, (b) areas important for ecological corridors, and (c) areas occupied by particularly sensitive species. In the case of Thyspunt, the areas identified as having high faunal sensitivity were:

- All wetlands, with a 100 m buffer. Wetlands have a central role in maintaining faunal diversity and faunal populations. Buffers are essential to provide semi-aquatic species with terrestrial habitat and corridors of access for terrestrial species. The Langefontein wetland is home to the Elandsberg Dwarf Chameleon (Endangered). The coastal seeps represent a rare and unusual ecosystem.
- The coastal corridor (200 m above the current high-water line; Prestedge et al. 2009). A coastal corridor provides access to coastal resources and allows movement along the coast.
- Most of the central mobile-dune field. The ecology of the dune field is highly dynamic and easily disrupted by alteration of patterns of sand movement, therefore obstructions need to be avoided. Areas containing wetlands have been indicated as having high sensitivity, otherwise medium.
- All areas containing forest (defined mostly as "thicket" by Low 2008). Many species are obligate residents of thicket and forest, and many more regularly use the resources found in these habitats, therefore they are essential in the maintenance of faunal diversity on site. The resolution of types of thicket (*viz*., strandveld thicket,

dune forest, alien thickets) was not possible (Barrie Low pers. comm.), so parts of the thicket areas would, in fact, be of medium sensitivity.

- The inland area covered by Tsitsikamma Sandstone Fynbos. This is classified as a Vulnerable vegetation type (Mucina and Rutherford 2006) and, together with its rocky substrate, was found to be a rich habitat for reptiles and a probable breeding habitat for Denham's Bustard (Vulnerable) and Blue Crane (Vulnerable) and foraging habitat for Secretary bird (Near Threatened).
- All other natural areas are of medium sensitivity.
- Areas transformed by agriculture (on the inland portion) are of low sensitivity.

9.7.5 Invertebrate fauna

a) Ant species

Twenty-one species were collected in total with an estimated diversity of approximately 26 species (Michaelis-Menten estimate). No Argentine Ant (*Linepithema humile*) specimens were found and it is considered unlikely that this species is present on the site.

Two undescribed ant species, one extremely rarely encountered ant species and one probably undescribed species were identified at Thyspunt. These are:

- *Tetramorium* sp. (an undescribed species related to *T. emeryi* and *T. erectum*), found on Unvegetated Dunes
- *Monomorium* sp. (an undescribed species related to *M. disertum*);
- *Diplomorium longipenne* (a monotypic genus that appears to be endemic to the Western / Eastern Cape border region of South Africa. It has to date only been recorded from George, Willowmore and Port Elizabeth).
- *Camponotus* sp. (A probably undescribed arboreal species). Specimens of this species, which was first found in natural Tall Thicket / Forest within the potential NPS footprint area and in similar habitat well to the west of the footprint area, were taken to the South African Museum in Cape Town in January 2010. No matching specimens could be found in this collection, although the species appears closely related to two un-named species from Tanzania. It is very likely that the Thyspunt specimens represent an undescribed species, but this remains to be confirmed.

b) Butterflies

The summed probable total butterfly species count for Thyspunt is high at 42.6 but the Red List species probability of 0.01 is very low. It must be borne in mind that these figures can be compared directly only to the other sites surveyed during this study. A total of 22 species were surveyed, of which none are locally endemic, three are regionally endemic and 3 are endemic to South Africa. **Thyspunt has the highest overall butterfly diversity of the three sites, and also potentially the largest number of rare and/or endemic species.**

c) Other invertebrates

A summary of the other invertebrates on the site, besides ants and butterflies, is listed below:

- **Velvet worms** (Onchyophora): one specimen of velvet worm was found at the edge of a field on the inland (agriculturally transformed) portion of the Thyspunt site.
- **Spiders (**(Arachnida: Araneae: Mygalomorphae): none found.
- **Scorpions** (Arachnida: Scorpiones): none found.
- **Soldier flies** (Mydaidae): none found.
- **Heelwalkers** (Mantophasmatodea): none found.
- **Monkey beetles** (Hopliini): none found.
- **Millipedes** (Myriapoda): 3 species found.

- **Jewel beetles** (Buprestidae): none found.
- **Spoonwing lacewings** (Nemopteridae): none found.
- **Horseflies** (Tabanidae): none found.

It is unlikely that the Thyspunt study site will host any listed Red Data invertebrate of the Eastern Cape Province.

9.7.6 Marine biology

Thyspunt falls within the Agulhas ecoregion. Coastal habitats in this region are considered to have a threat status of least threatened to vulnerable and to be moderately to well protected (Sink et al. 2012). Although the general area is one of high marine species richness and high rates of endemicity, site surveys detected no rocky or sandy shore species endemic to the south coast. Species of conservation concern occurring in this region include the abalone (*Haliotis midae* - endangered), African penguin (*Spheniscus demersus* - vulnerable), Cape gannet (*Morus capensis* – vulnerable) Cape cormorant (*Phalacrocorax capensis* - near threatened), African black oystercatchers (*Haematopus. moquini* - near threatened), Caspian tern (*Sterna caspia* - near threatened) and humpback dolphins (*Sousa chinensis* (plumbea form) – vulnerable). In addition, fish species such as Red Steenbras (*Petrus rupestris*) and Black Musselcracker (*Cymatoceps nasutus*) have wide distributional ranges that include the Thyspunt area. These fish have not been listed on the IUCN red data book but stocks are considered severely depleted. No sites of special biological significance occur within the designated area, although fish traps of historical interest occur to the west of the site.

Due to the restricted access at this site these shores have been protected from all forms of utilisation. A lucrative fishery for chokka squid *Loligo vulgaris* is located in inshore waters along this region of coast.

Since the mid-1980s a coastal jigging fishery for *Loligo reynaudii* has developed along the south coast. While the species has an extensive distribution, the economically important part of the stock is distributed in the area between Plettenberg Bay and Port Alfred where spawning aggregations of squid are targeted by the fishing industry. Catches are determined to a large extent by the successful formation of numerous large aggregations. Catches are determined to a large extent by the successful formation of numerous large aggregations

Shore and ski boat based recreational angling occurs extensively along the Eastern Cape coast, including in the general Cape St. Francis area. Although both demersal and pelagic fisheries operate in the area offshore from Thyspunt, these fisheries occur outside the area that will be impacted by the development of a power station and so are not considered further within this report.

As far as marine mammals are concerned, four species are regularly observed in the vicinity of Thyspunt. These are the Indo-Pacific bottlenose dolphin and Indo-Pacific humpback dolphin, which are resident year round, and the southern right whale and humpback whale, which are common in winter months. The Bryde's whale and long beaked common dolphin are also resident species in the Agulhas Bank area and occur here regularly, especially in conjunction with small prey fish such as sardine, but usually remain >2 km from shore are thus likely to have limited interactions with the proposed project. As with Bantamsklip, humpback dolphins are the marine mammal species of most concern in this area. Studies in Algoa Bay in the early 1990s and Plettenberg Bay in the early 2000's identified 70 and 63 individuals using each area respectively, with a high proportion (>70%) of identifiable individuals, suggesting population sizes not much larger than this using each area. Some individuals are known to move between these sites and the total population moving along this section of coast (including Thyspunt) may be in the region of 400-500 animals. Recent indications from Algoa Bay have shown smaller group sizes and lower sighting rates than those recorded in the early 1990s, this may be indicative of a population decrease and all care should be taken to reduce impacts on this population.

Although plankton productivity is not considered to be high in this area, when compared with the west coast, nearshore waters are subjected to moderate sporadic coastal upwelling and resulting plankton blooms during summer. The highly dynamic nature of the open water environment translates into low sensitivity to disturbance.

9.8 Biophysical environment figures: Thyspunt

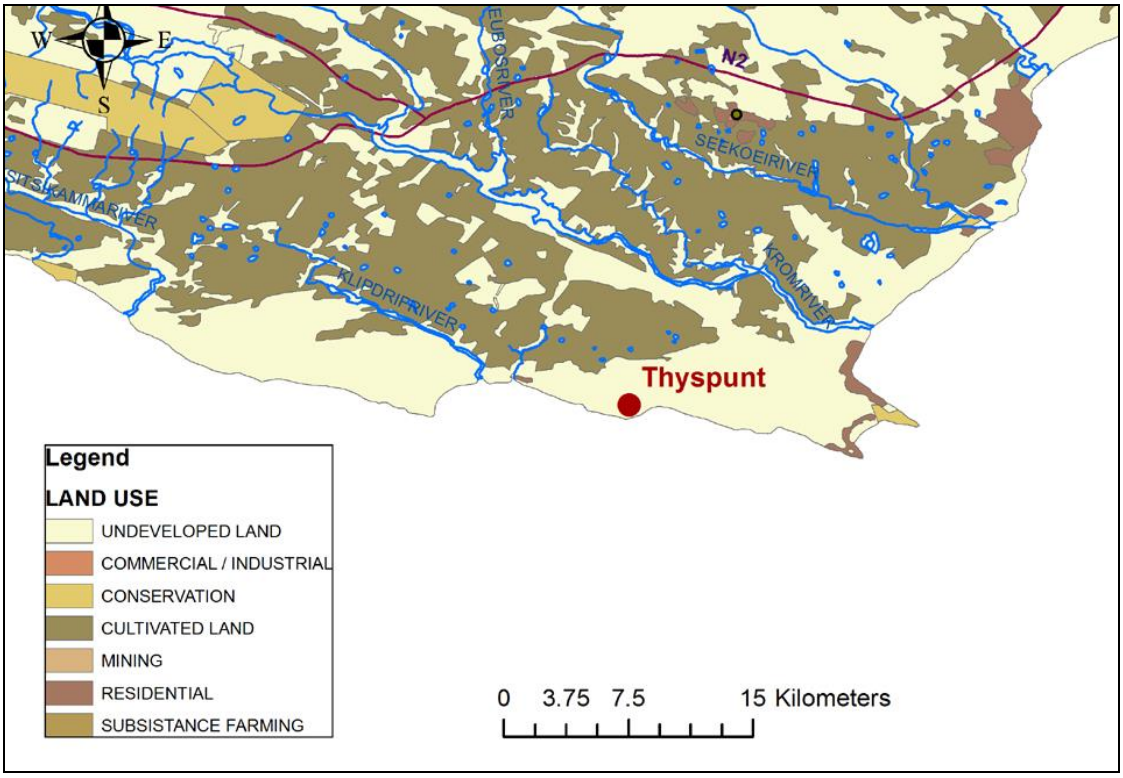


Figure 9-23: Land use in the vicinity of the Thyspunt site

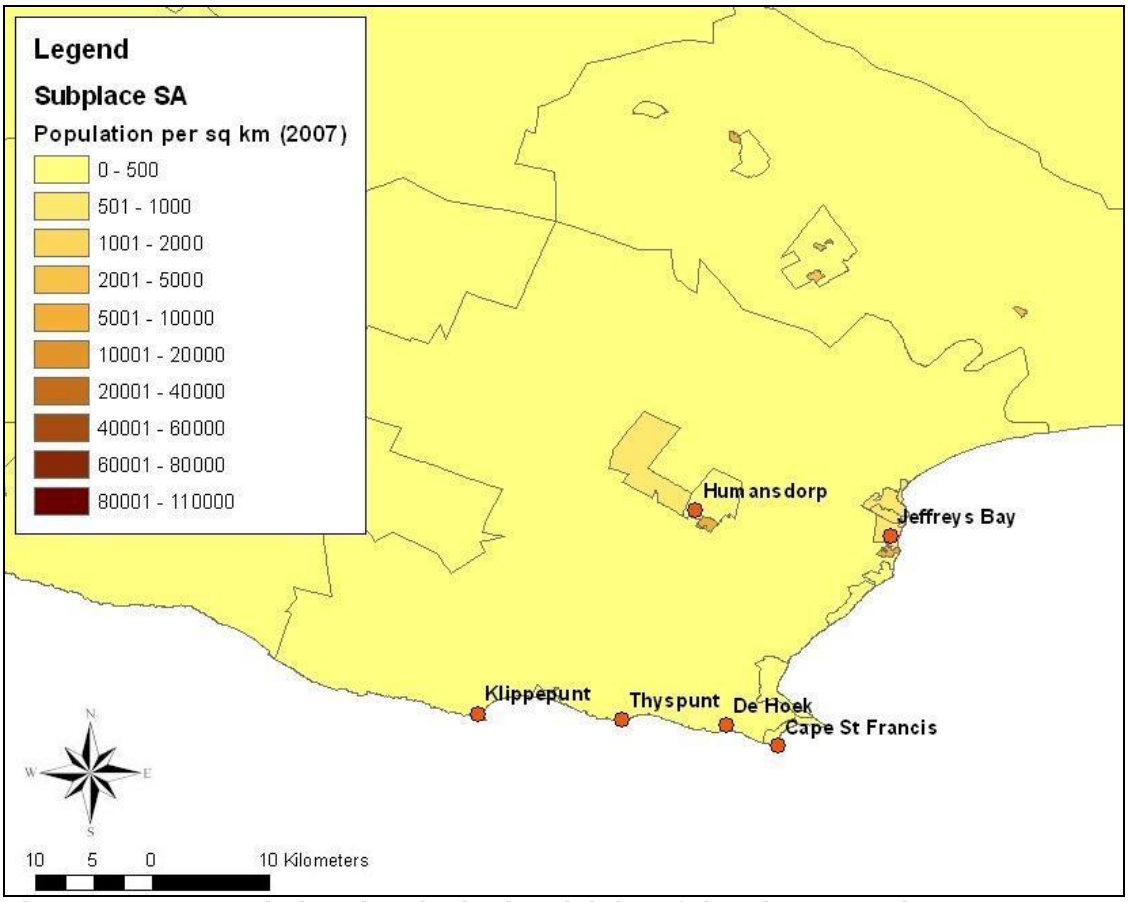


Figure 9-24: Population density in the vicinity of the Thyspunt site

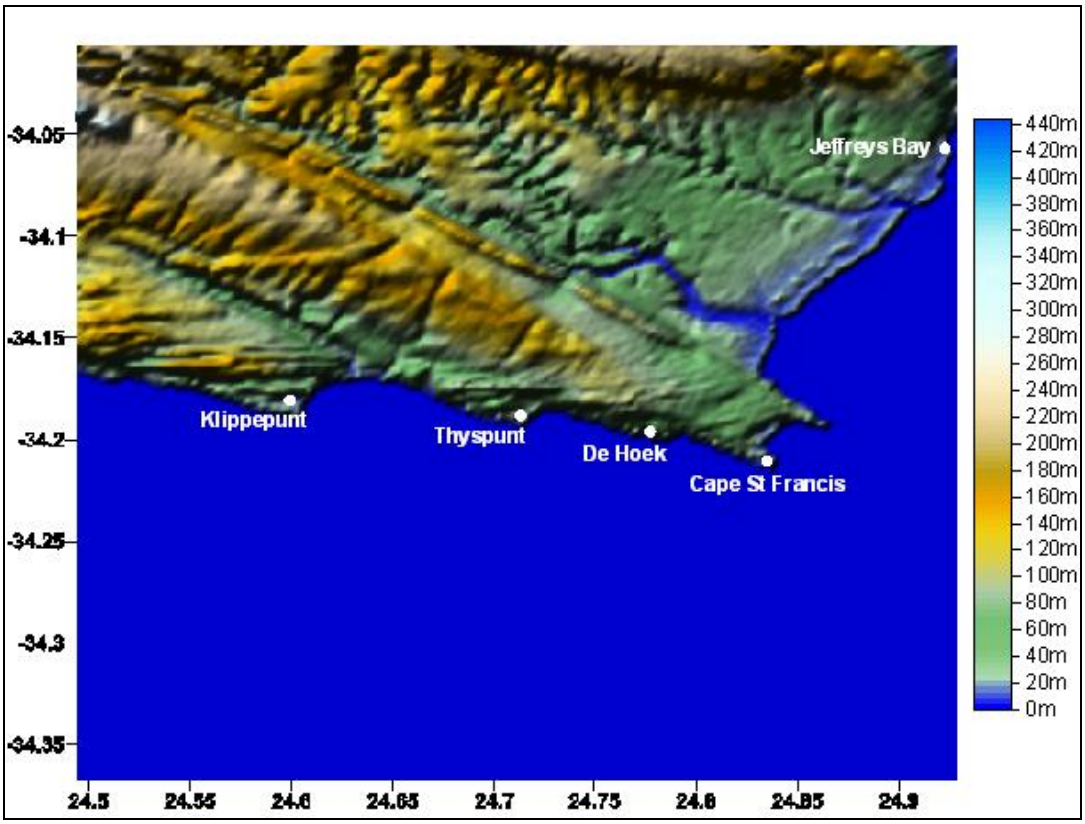


Figure 9-25: Shaded relief profile of the Thyspunt site surroundings

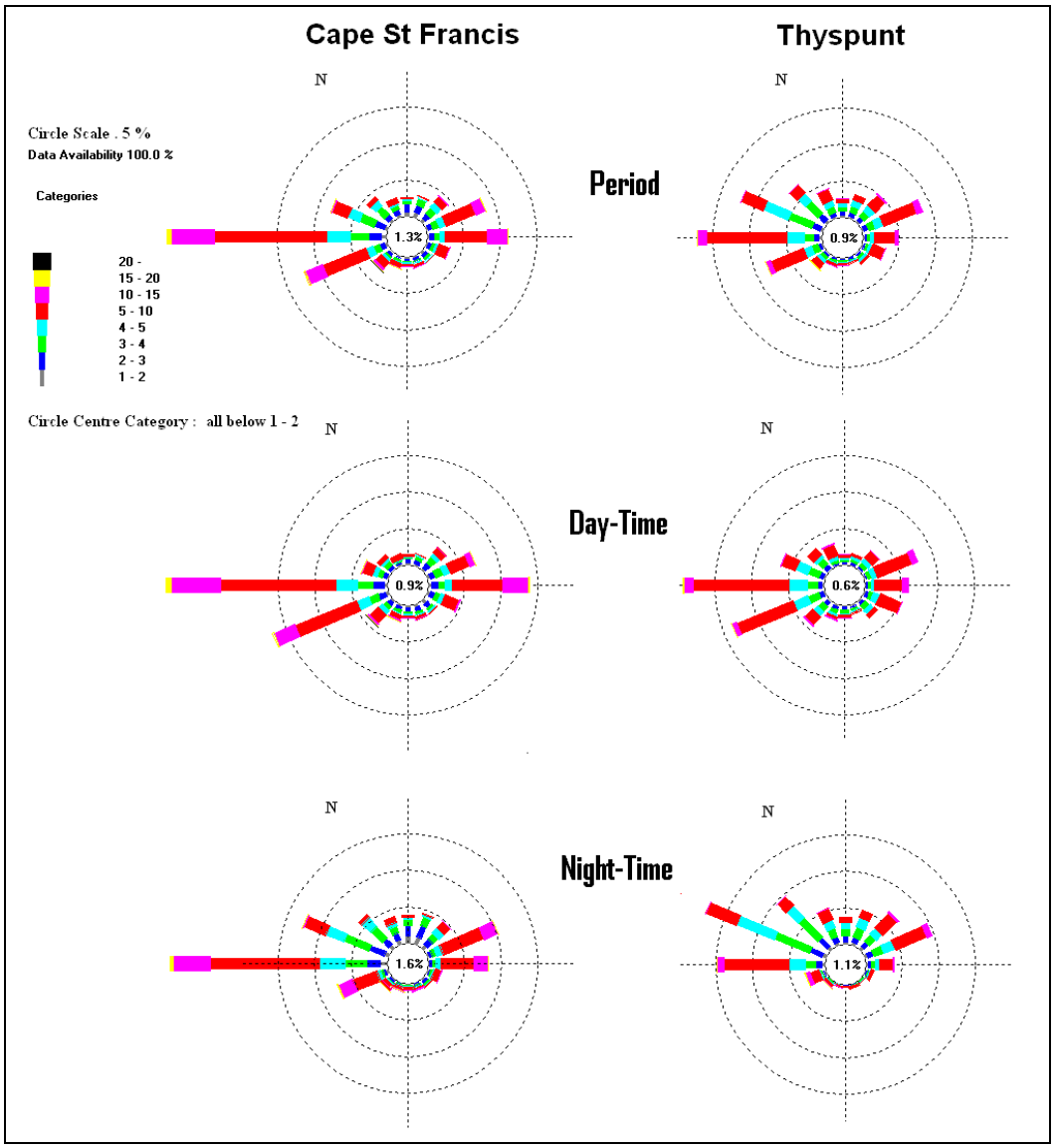


Figure 9-26: Wind roses for Cape St. Francis and Thyspunt

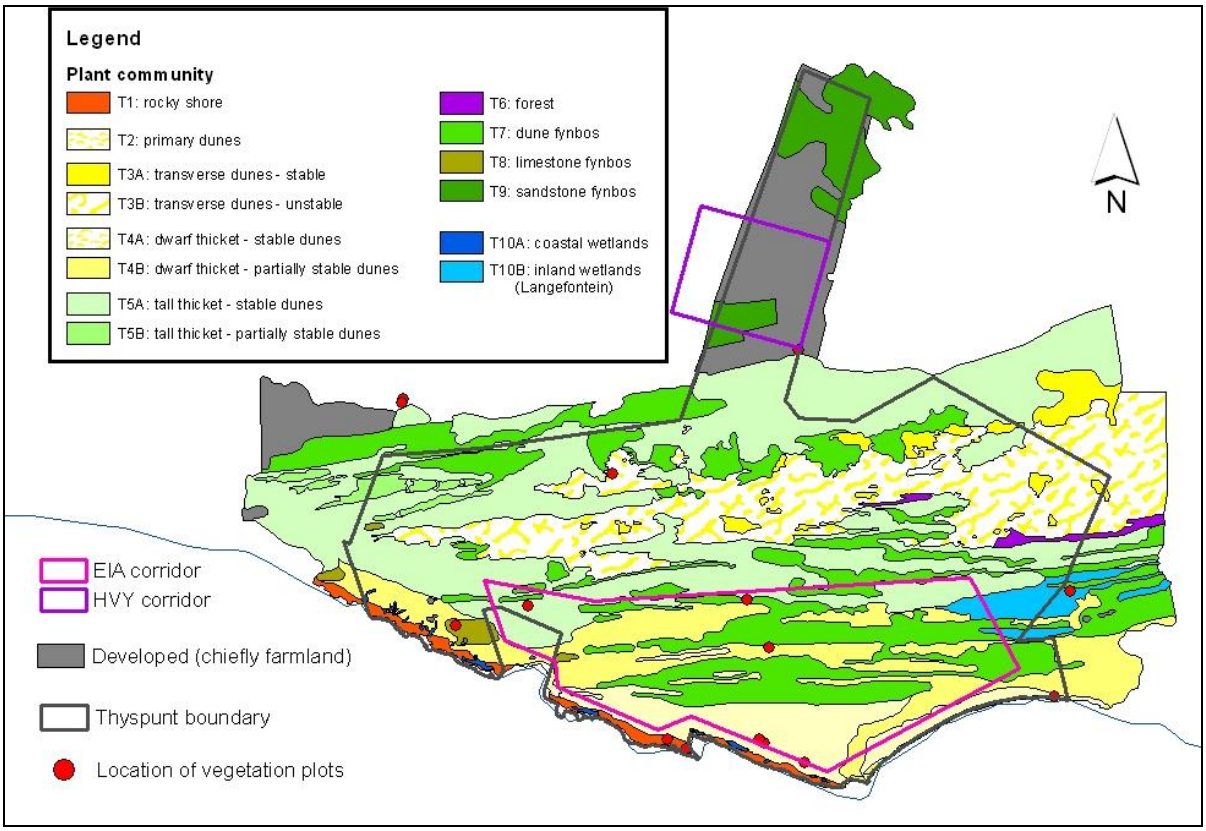


Figure 9-27: Botanical communities of Thyspunt

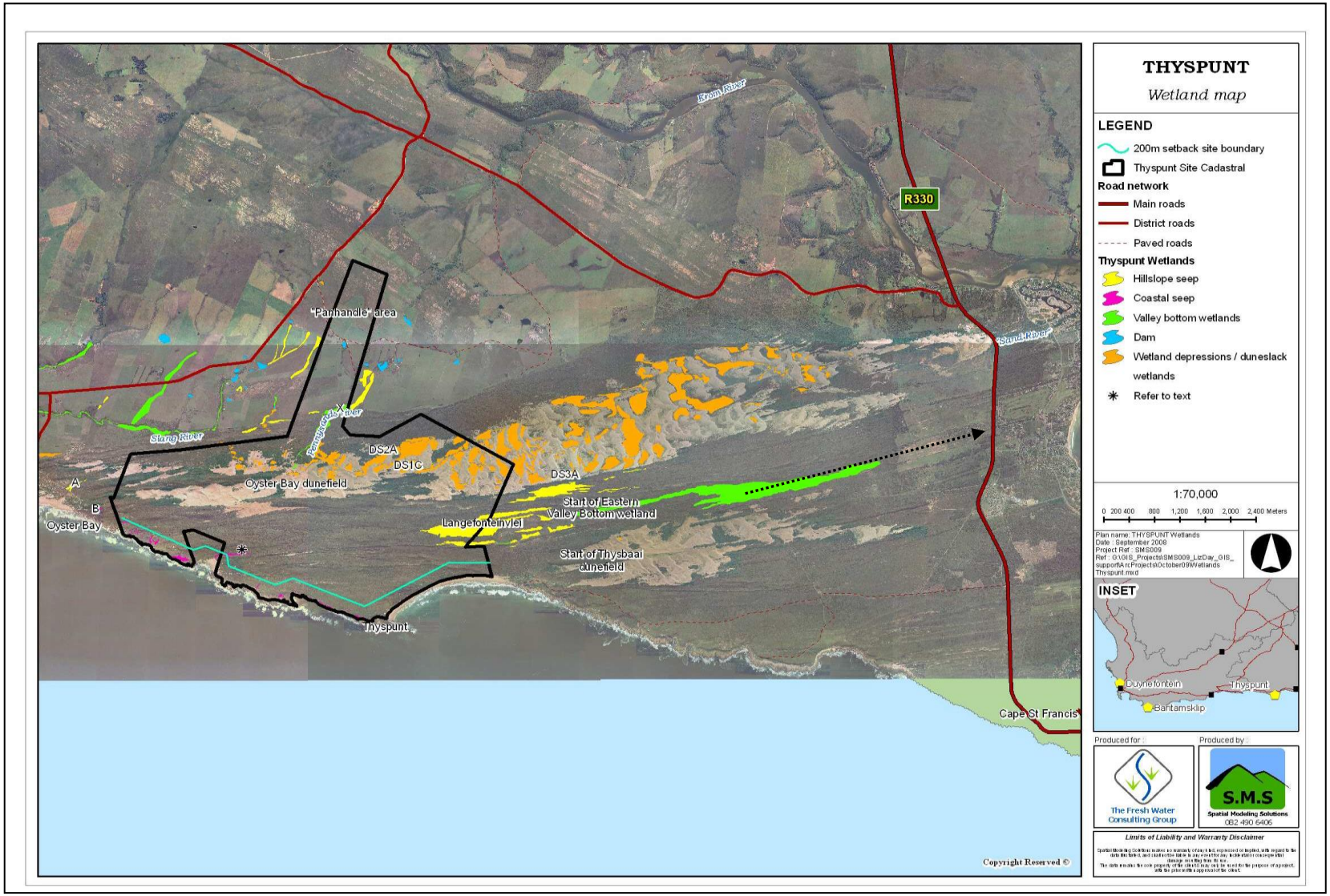


Figure 9-28: Wetlands at Thyspunt

Figure 9-29: Elandsberg dwarf chameleon found at Langefonteinvlei wetland

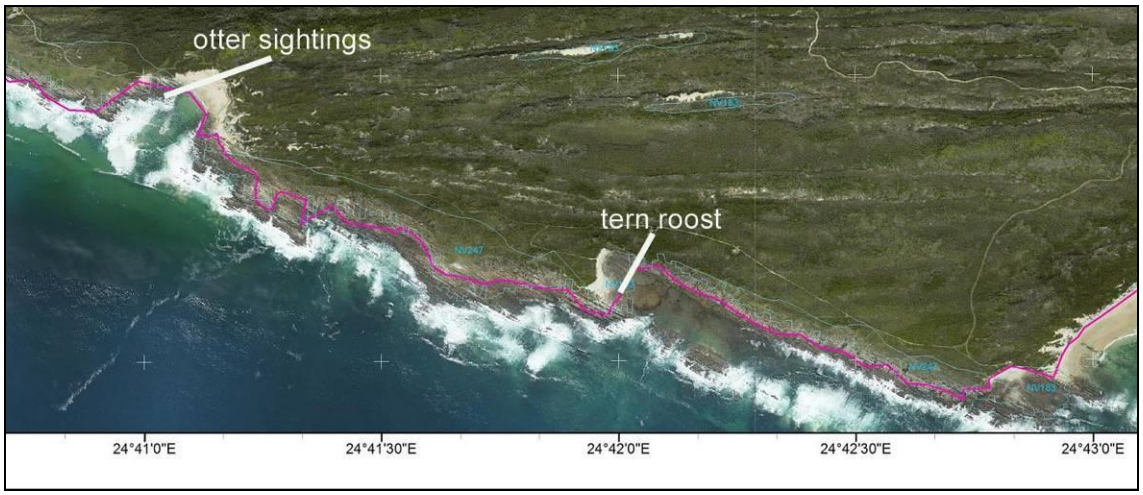


Figure 9-30: Location of tern roost and otter sightings

9.9 Socio-economic environment - Duynefontein

9.9.1 Economic environment

Overview of the economy

The Duynefontein site is located in District B within the City of Cape Town. The city generates approximately 82% of the GGP of the Western Cape. Provincially, the Western Cape recorded a growth rate of 5.9 % in 2006. This was above the country's growth rate of 5.4 % for the year. The provincial GDP of R174,303 million was the third largest in the country. The Western Cape has an estimated population of between 5.18 - 5.30 million. The province's main economic activities are finance and business services, manufacturing, and wholesale and retail trade. Tourism is a very important sector, but is split between several of Statistics South Africa's broad industrial classifications.

Cape Town has a relatively diverse economy with approximately 93 % of businesses being SMMEs, contributing 50% of total output and 40 % of total formal employment. However, there is a shift towards the services sector with the largest areas of growth being identified in finance, business services, trade, catering, accommodation, tourism and transport and communications. Manufacturing, which accounts for 19.4 % of employment, is in decline. Unemployment has remained high at 20.7 % (2005), but it appears that the trend has been for unemployment to decrease since 2003. The total population of the City of Cape Town for 2007 is estimated at 3.2 million, of which District B accounts for approximately 5.3% (170 000). Unemployment in District B was around 15.6 % in 2005 – significantly lower than the City's unemployment rate.

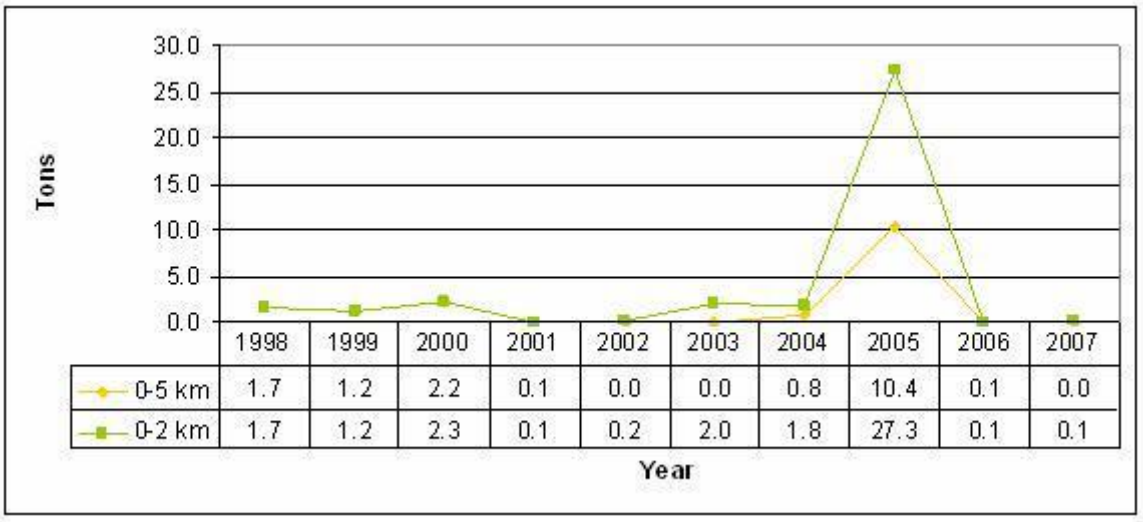
District B is one of the largest in the city and has some of the fastest growing areas, including Big Bay, Melkbosstrand, West Beach, Century City, Sunningdale and Parklands. There is a mix of urban, rural and farming areas. Most of the district is regarded as affluent, especially along the Atlantic coast. However, it also includes pockets of lower-income areas such as Atlantis and informal settlements with poor access to amenities and other services (especially economic opportunities). Century City is a key residential and commercial node in the city and will become increasingly so as the area is further developed. The majority of the land available for expansion of the City lies in the north. Thus, over the next 10 - 20 years this area is likely to become of increased importance in the Cape Town economy.

The most significant economic activity areas in the district are Table View, Killarney and Montague Gardens. Killarney and Montague Gardens are two of the City's most important industrial areas. Apart from industrial activity, the other noteworthy sectors include agriculture, tourism and retail trade. The commercial sector is growing in importance in District B.

a) Fishing

The Eskom NPS site at Koeberg and Duynefontein is not in a major commercial fishing area. Sardine trawlers operate just outside the present 2 km x 3.2 km exclusion zone laid down in the National Key Points Act (and sometimes in fact enter the zone) while ski boat fishermen catch snoek and rock lobster. According to senior staff interviewed at Marine and Coastal Management, the NPS has had no discernible effect on localised stock because of the absence of a reef, as it is located on a sandy stretch of coastline. Moreover, the impact on water temperature dissipates very quickly from the NPS outlet point, but in the small localised area both the growth speed and the size of rock lobster and abalone tend to increase.

Data for commercial fishing in the area between Blaauwberg Beach and Bok Point are shown in **Figure 9-31.** The Nuclear-1 site is located about midway between these points.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0-5 km	1.7	1.2	2.2	0.1	0.0	0.0	0.8	10.4	0.1	0.0
0-2 km	1.7	1.2	2.3	0.1	0.2	2.0	1.8	27.3	0.1	0.1

Figure 9-31: Commercial Fishing, Blaauwberg Beach-Bok Point, 1998-2007 (Tons)

b) Industry

The 20 km radius around Duynefontein largely includes small rather than large industries (such as light industry), but these industries are not clustered with the exception of those at Atlantis. Large industries are located mainly outside this radius in areas such as Epping.

The industrial sector within a 20 km radius of Duynefontein is dominated by the Chevron (Caltex) oil refinery and four cement companies. The Chevron refinery produces 74 000 barrels of refined product per day and employs 390 persons. In addition, there are 800 - 900 contractors at any one time, rising to 2 000 during the six-week biennial turnaround. The cement industry estimates its production in the area at 2 million tons of aggregate and about 120 000 m^3 of cement per annum. The turnover is estimated at between R300 - 350 million per annum, and total permanent employment at 150.

One of the largest industries at Atlantis is Bokomo Foods, which operates two factories. These preceded the construction of the KNPS. Bokomo employs 800 persons and has plans for expansion at Atlantis. With the closure of a number of industries since the withdrawal of incentives, serviced land at Atlantis is available at a reasonable price, and the Chamber of Commerce is attempting to promote the location. Although Atlantis was an artificial growth point and has not been an ideal location for industry, its appeal is likely to increase as the Cape Town metro region expands northwards.

The business sector is interested in securing a stable supply of power, and is not concerned about a second power station at Duynefontein, provided that safety measures are in place. Industries at Atlantis, including the food industry, adjoin the Duynefontein site but do not have a negative view of the nuclear power station. During field interviews, the business sector indicated that it believes that the technology will be more advanced than at the KNPS and that, therefore, the risk will be able to be managed. It further believes that it makes economic sense to provide new reticulation infrastructure parallel to that already existing at Koeberg. As

Nuclear-1 would be located in a zone that is already in effect an industrial area, the sense of place would not be a significant factor.

c) Tourism

Tourism around the Duynefontein site is largely represented by the Greater Northern Cape Town tourism region. This includes Atlantis, Bellville, Blaauwbergstrand, Century City, Durbanville, Edgemead, Goodwood, Langa, Melkbosstrand, Milnerton, Parow, Pinelands, Sunset Beach and Table View.

This area is characterised by a wide diversity of enterprises in the tourism industry, and it is difficult to differentiate between the tourist assets of the area itself and those of the Greater Cape Town and West Coast destinations. However, within the immediate site proximity, activities are focused on sea and eco-tourism activities such as kite-surfing, windsailing, golf, hiking and mountain biking. The area has a well-developed tourism infrastructure with a strong supply of services, facilities and amenities, including up-market golf estates. A number of large hotel developments are currently underway, and there are plans for a further golf estate near Melkbosstrand. According to the Tourism Impact report (**Appendix E 22**), the annual turnover of accommodation establishments in the area is R497.8 million per annum.

Estate agents believe that the direction of city expansion will be to the north. Urban growth in the form of holiday resorts and retirement complexes has already leapfrogged from Melkbosstrand to Atlantis to Grotto Bay, Yzerfontein and Jakkalsfontein. The opening of the KNPS in 1984 has not stopped the growth of Blaauwbergstrand (which has been particularly rapid in the last 15-20 years) and Melkbosstrand where growth is of a more recent vintage. Beachfront houses at Blaauwbergstrand are popular buys for foreigners who have paid up to R16.5 million for a property. At Big Bay house prices have been in the R4-6 million range. The Atlantic Beach Golf Estate is a prime facility in Melkbosstrand with units selling for up to R3.5 million. Inland, the Durbanville area is highly sought after with property prices ranging from R2 - 4.5 million.

d) Agriculture

There are a number of different agricultural activities in a 20 km radius of the Duynefontein site. In recent years there has been a shift from dairying and wheat farming to vineyards, and there are some up-market wine estates in the Durbanville and Vissershok areas. Based on responses collected during fieldwork, there has never been any concern that that the KNPS adversely affects these estates. A game farm has been established north of Silverstream Road and a number of equestrian stables have moved from Milnerton to Grotto Bay. Pig farming is conducted in the Philadelphia area.

e) Civil structures

Table 9-3 contains information on the various civil structures that are located in the 20 km radius around the Duynefontein site. This information was collected from the City of Cape Town's Planning Districts Socio-economic Analysis. Data were also collected from the Cape Town map book produced by Map Studio. Unfortunately, data on civil installations are very scarce for the City of Cape Town. Thus, it is possible that this does not fully account for all the civil structures.

Table 9-3: Civil Structures in a 20 km radius around Duynefontein

Structure	District B: West Coast
Hotel	7
Clinic	6
Hospital	5
Shopping mall	29
Post office	6
Law court	1
School	31
Service station	21
Religious site	9
Library	6
Caravan park	2
Police station	2
Fire station	3
Traffic department	1
Railway station	2
Water treatment works	3
Country club	2
Airfield	1
Refinery	1
Cement factory	1
Guest cottage/conference centre	1
Bus terminal	1
Wine estate	5

Source: Planning Districts Socio-economic Analysis 2007

9.9.2 Demographic statistics

Projections suggest a marked slowing down of provincial population expansion over the next 10 years. It is estimated that by 2016, just less than 5,4 million people will live in the Western Cape of which just less than 4 million will live in the City of Cape Town. The expected headcount represents an increase of 428 000 individuals over the decade, equivalent to an average annual growth rate of 0,8 %.

The Province experienced net emigration between 1985 and 1990, totalling around 30 000 individuals. From 1991 to 2000, the removal of influx control legislation contributed to rapid in-migration of about 38 000 to 41 000 people a year.

However, from 2000 onwards the rate of migration has slowed and is projected to continue with this downward trend. Thus, while net in-migration between 1991 and 2000 is estimated to have added 394 000 individuals to the population, from 2001 to 2015 the Western Cape will gain only 177 000 people, or an average of 11 800 per year.

Internationally, migration is often seen as a threat by both sending and receiving regions. Receiving regions tend to feel that in-migrants represent a burden to their economies and government budgets, while sending regions often perceive a loss of scarce skills and expertise in the short term.

9.9.3 Visual character

The Duynefontein site is adjacent on to the north side of the existing Koeberg Nuclear Plant.

a) Topography

The landform rises very gently (1:75 slope) from the coast inland to the N7 over a distance of approximately 15 km. A slightly higher (50 m amsl) landform, possibly a consolidated dune, forms a crescent around the Duynefontein site as its centre. This large shallow bowl is evident in the viewshed analysis. **Refer to Figure 9-33.**

The coastal area between the sea and the R27 is a dune field with hummock dunes on the landward side of the beach.

b) Vegetation

The vegetation cover of the general area between the coast and the R27 consists of Strandveld and Duneveld.

Between the R27 and the N7 the vegetation is variable due to agricultural practices. Wetlands occur in the lower areas associated with the Sout River, which flows in a south-westerly direction.

Of particular importance is the historic avenue of bluegum trees which line the Ou Kaapse Weg, the R304.

c) Sense of place

The sense of place is drawn from the remoteness of the location and the flat dune field. The cold sea water and onshore winds add to the desolation experienced. This is tempered or downgraded by the visual prominence of the KNPS 2 km to the south.

d) The character of the site and surroundings

The landscape character is one of natural bleakness and desolation caused by the wind factor, the shifting sands of the low dune field and the extensive views up and down the coast and inland. The visual dominance of the existing KNPS 2 km to the south links this edge to an industrial type character.

e) Surrounding land use

The current land use between the coastline and the R27 for a distance of 5 km each side of the site is undeveloped and is mostly in its natural state. However, large areas of the vegetation seaward of the R27 have been invaded by the Port Jackson Wattle. The site is located within the area of the Koeberg Nature Reserve. This area is a popular safe area for walking and is well used by the surrounding communities.

The towns of Atlantis and Melkbosstrand are industrial and holiday focused respectively. The Atlantis industrial zone is between 5 and 10 km from the site and lies west of the residential areas.

f) Landscape diversity

The landscape diversity is determined more by landform than by land use. This is because of the general undeveloped and natural condition of the landscape. The vegetation is sparse and low in the dune field.

The hills to the north-east of the R27 and east of the N7 provide vertical diversity in the landscape, but at a distance of 15 km from the site. This is in contrast to the generally flat coastal terrace over which the R304 has been routed.

There is little landform variation to provide visual diversity within a 5 km radius.

The views along the coastline are of open sandy beaches with no vertical elements, natural or man-made. There is some vertical diversity inland where hills appear.

g) Climatic effects on visibility

The wet and misty weather in winter is brought onshore by the predominant east – north - easterly winds, which have an average wind speed of approximately 45 km per hour during the months of May to September.

The generally clear summer weather is driven by the predominant southerly winds, which also have an average wind speed of 11.16 km per hour.

9.9.4 Heritage resources and archaeology

The Duynefontein site is situated just outside the Cape Town urban edge and includes large tracts of coastal Fynbos and an active dune field. Other than the coastal dunes, the topography is relatively flat. The existing power station (**Figure 9-35**) and infrastructure represent an industrial enclave in what is essentially a rural context. The KNPS, which has now been in place for more than two decades, is a well-known landmark visible from Robben Island, Table Bay and Table Mountain.

When bulk excavations were undertaken on site in the 1970s, fossiliferous deposits were encountered in several of the affected geological strata. Furthermore, Pleistocene fossils and Early Stone Age artefacts were encountered. Archaeologists from the Iziko Musems of Cape Town then conducted a survey of what is today the Koeberg Nature Reserve, noting the presence of Late Stone Age middens from the Holocene, as well as Pleistocene fossil bone accumulations at several localities within the nature reserve.

a) The regional heritage context

In recent years the West Coast has become famous for its fossil wealth. Just inland of Langebaan is the largest Miocene (5-6 million years old) fossil deposit in the world, parts of which are on display at the West Coast Fossil Park. This material was deposited in sandbar sediments at the mouth of the proto-Berg River (an ancient river and estuary that was the precursor to the Berg River), the course of which changed over the millennia in response to sea level changes.

The excavation for the existing KNPS exposed fossiliferous formations of similar age. Close to Hopefield, further inland, are the Pleistocene fossil beds at Elandsfontein (last million years) famous for the discovery of the early human species *Homo ergaster* (Saldanha man). On the edges of the Langebaan lagoon Dr Dave Roberts and Dr Lee Berger discovered the 200 000 year old footprints of an early modern human fossilized in calcrete sediments. At Hoedjiespunt, Professor John Parkington has excavated on the site of an ancient hyena lair where skull fragments and teeth of an early human were found showing that parts of the individual were consumed by hyenas more than 300 000 years ago. Nearby, fossilized within

the calcretes and aeoleanites are shell fish, animal bone, ashy hearths of people who lived in the area more than 100 000 years ago. Further south at Yzerfontein, Prof Richard Klein, Iziko Museums of Cape Town and the UCT ACO team has been conducting an ongoing project on a Middle Stone Age shell midden, one of the earliest known.

b) Palaeontological heritage

The bedrock is weathered shale of the Tygerberg Formation (Malmesbury Group) and is ~600 Ma (Mega-annum - million years old), highly deformed and metamorphosed deep-sea turbidites. It has no intrinsic palaeontological potential. However, the softer zones in the bedrock were colonized by boring bivalves when the bedrock was last a seabed, producing *Gastrochaenolites* trace fossils (*Glossifungites* ichnofacies). These features exhibited no offsets due to shear forces in the bedrock, which was taken as reassurance that the area had been seismically quiescent since the Pliocene 2-5 Ma ago.

The bedrock is overlain by a fossiliferous marine gravel basal to a sequence dominated by bioturbated, slightly muddy, fine quartz sand, ~10 m thick, that has been dubbed the "Duynefontyn Member" of the Varswater Formation. A thin peaty sand caps the sequence. The "Duynefontyn Member" is richly fossiliferous and includes:

- Teeth, bones and scales of sharks, rays and bony fish;
- Fossil whale bone, dolphin and seal teeth;
- Marine birds, incl. the type specimens of a unique extinct penguin, *Nucleornis insolitus*;
- Terrestrial mammals, incl. bovid, hare;
- Terrestrial reptiles, snake and tortoise; and
- Terrestrial plant pollen in the peaty sands.

The "Duynefontyn Member" is interpreted to be a regressive sequence of barrier beach coast succeeded by subtidal and intertidal facies of coastal tidal flats which are overlain by freshwater, peaty marsh deposits of coastal *vleis*.

The peaty sands are erosively overlain by a basal gravelly sand unit with gastropod casts and shark teeth, the "Gastropod Bed". The latter is overlain by a mixed fine and coarse quartz sand unit, yellow-brown in colour and becoming paler upwards, which is regarded as an aeolianite. This is the Springfontyn Formation. Some terrestrial fossils from this formation are seemingly of middle-Pleistocene age.

The section is capped by calcareous sands and calcrete which should probably be relegated to the Langebaan Formation aeolianite. Middle Stone Age artefacts occur in the calcrete. Closer to the coast the Springfontyn Formation is truncated by the sea-level highstand of the Last Interglacial 128-119 ka (ka: kilo-annum, thousand years ago), when shelly beach sands were deposited.

c) Pre-colonial heritage

In 1973, Richard Klein discovered the palaeontological site known as *Duynefontein 2* – fragments of fossil animal bone which had been un-earthed during geotechnical trial excavations for South Africa's first nuclear power station (see **Figure 9-35**). The site *Duynefontein 2* was excavated annually between 1998 and 2003. It produced a wealth of Pleistocene fauna (about 300 000 years old) and resulted in numerous publications of the findings in international journals, establishing the name "Duynefontein"[3] as a place of world

[3] Spelling used referring to the archaeological site published as "Duynefontein 2" as opposed to place name 'Duynefontein".

class scientific discovery. Klein closed the excavations once he had obtained a substantial sample of animal bone representing the diversity of species believed to be in the area during the mid-late Pleistocene. Scientists hope that this area will one day yield very rare human remains – the age and geological context are considered promising. Despite the ongoing work by Klein and others, it is not clear exactly how extensive the Duynefontein palaeontological resource is. The fact that the fossil material has been excavated at only a single locality at Duynefontein is likely to be a function of the fortuitous geotechnical excavation where the material was initially identified. It remains unknown how much more lies buried under the dune of the Witsand formation, although according to Avery (pers. comm.) pockets of fossil bone have been observed from time to time in the dune field when sand movement allows.

The coastal regions of the Western Cape were occupied in pre-colonial times by peoples who exploited marine resources for their livelihood. Human occupation of the coast is archaeologically reflected in the thousands of shell midden sites and rock shelter deposits that mostly date after the last 6 000 years. About 2 000 years ago the economic order changed with appearance of Khoekhoen herder groups in the Western Cape. Herder sites, such as at those at Kasteelberg, show occupation between 1 800 and 1 600 years ago. European explorers had contact with many of the Khoekhoen groups along the coast. These peoples included the CochoqQua, whose territory stretched from Saldanha Bay to Vredenburg, and the ChariGuriQua or GuriQua who occupied the lower Berg River area, St. Helena Bay and points around Piketberg.

Shell middens have been observed locally at Blouberg Beach, Atlantic Beach and within the Koeberg Nature Reserve. The implications of this are that shell midden material could be encountered in the form of surface archaeological sites, or as buried lenses anywhere within the study area. Late Stone Age sites (the heritage of the Khoekhoen and San peoples of Southern Africa) were relatively numerous along the Western Cape coast and can be observed close to any area of rocky shoreline where shell fish and other marine resources could be exploited. These kinds of sites, which are mostly less than 5 000 years old, and characterized by piles of shellfish, stone artefacts and from time to time pottery, have been observed in the Koeberg Nature Reserve (although no comprehensive survey has been completed until now).

Unfortunately, outside of any area that is either isolated or protected, shell middens have suffered from disturbance caused by people, construction activities, property development and off-road vehicles to the extent that a once common (but finite) heritage resource has become alarmingly threatened. While compliance authorities are aware that heritage resources of this type are increasingly endangered, there is as yet no overall regional strategic conservation goal in place that would direct any strategic action within the heritage community. Nevertheless, intact shell middens have become highly valued heritage resources. Heritage authorities (HWC, SAHRA) have responded to this situation by identifying several middens for Provincial Heritage Site nomination.

d) Colonial period heritage

The landscape inland and to the north of Duynefontein is dominated by agricultural land which has its origin in early Dutch East India company grants and quitrents[4] (the Farm Duynefontein 34 being one of them). Some of the original farm boundaries can still be identified within the contemporary cadastral layout. Although along the southern portion of the West Coast many of the early farms have become sub-divided and broken up by

[4] A quitrent is a grant of land given for 15 years for which an annual rent is paid. Quitrent tenure was introduced to South Africa in 1732.

developments such as Atlantis Industrial Township, Brickfields, Western Province Shooting range and various sand mining operations. A number of notable farm names and associated structures have survived - Groot Olifantskop (Keert de Koe), Vaatjie, Brakkefontein and Donkergat are but a few that have been recently identified as containing early fabric. Within this area, research into the heritage of early colonial settlement is limited with only site identification surveys being completed to date.

The earliest colonial period history pertaining to the Duynefontein study area is reflected in primary archival documentation. Reference is made to a Hermanus Dempers as 'inhabitant and owner of the 'Opstal' on the loan place named 'Duynefontein'.

Dempers became the owner of the then extensive property in 1799, but it is unclear who the first grantee was. It is indicated in a complaint letter lodged by Dempers (dated 26 Sept 1811) that 'tenants' were cutting wood that belonged to him. These tenants were apparently awarded certain land rights in 1731, and paid rent to the Cape Government. The struggle over marginal land is demonstrated in the competing livelihoods at Duynefontein. Dempers was a brickmaker and as such was "always in great want of bushes and other small wood and for that reason never cut away any wood in the vicinity of his house, but always saved it in order to let it grow to greater perfection." The 'illegal' cutting of wood "even about his house" exposed his "cultivated ground to be blown away." He laments that "to his greatest sorrow in what manner some persons make ill use of the privileges which they have obtained" and begs the authorities to protect him against the "attempts of those who are striving to injure him".

When the property was surveyed in 1834 for the quitrent grant, there is no indication of houses or any built structures. There is, however, a 'Kraal Ordannantie' which features on the diagram as well as the later 1890 SW Cape survey map.

The colonial period history of Duynefontein is noteworthy; however it does not reveal any particular significance in terms of associations with events or important historical personalities. The early surveyor's diagrams have been superimposed over modern plans of the farm in an effort to locate the historic kraal. The kraal location appears to be outside of the study area. The site of Demper's house is not known as is that of any of his tenants.

e) Cultural Landscape

The heritage survey of the study area did not reveal any aspects of the cultural landscape and associated person-made structures that are of any particular significance, or protected by the NHRA. The layering of the landscape reflects a multitude of pre-colonial layers, the early colonial farming element is invisible being dominated by the 20th century landscape of industry and nature conservation. Before the existing power station was built, the study area was a rural landscape of sandy and mainly un-farmed land and prior to the construction of the R27, very remote. Although through the efforts of the Koeberg Nature Reserve staff, the property has retained its wilderness qualities in places, the NPS is an exceptionally powerful visual intrusion, which together with its support structures, and access road has completely transformed the character of the site into a peculiar combination of an industrial and rural ambience.

9.9.5 Agricultural practices

There is no agricultural production within the proposed site (EIA corridor). The potential for agricultural production on the proposed site is very limited, mainly as a result of the poor soil (sand dunes). As the site envelope only consists of sand dunes no soil samples were taken for this site. There is no commercial cultivation within the 800 m emergency zone but some mixed farming is being undertaken on the border of the 3 km zone.

There are broad bands of land use around the proposed site, the first being bare open vegetation close to the coast, the second the farming areas, and then the residential areas in and around Melkbosstrand and Atlantis.

The majority (approximately 80%) of the northern area is dominated by shrubland. There is a large urban area in Atlantis with industrial activity around the residential areas. There is an area that has been prepared for residential development, marked on the map as land degraded in preparation for development.

There are two distinct areas that that are dominated by smallholdings which mainly consist of subsistence farming. A wide range of enterprises produce agricultural goods but this is mainly for home consumption with very little commercial production taking place.

On one farm (Vaaitjie) there is a sand mine and adjacent brick-making business with excavations for brick-making material. Apollo Brickmakers produce an average of 3 500 000 bricks per day.

a) Current agricultural production in the surrounding area

Agricultural production around Koeberg consists of commercial farms (large to medium scale) producing mainly grapes, dairy and wheat. The two most popular farming activities in the surrounding area are wheat and grape farming. However, many small-scale subsistence or semi-commercial farms are found just out of the Atlantis industrial and residential areas.

An important point that should be noted is that a very large portion of the 16 km radius of the Koeberg site is taken up by the presence of an extensive sand dune that is located across the R307 road from the Atlantis industrial park. This has very limited agricultural potential.

Many of the wine farms also grow an alternate crop like wheat or run cattle. The dairy farms mainly sell to Clover Dairies, and the sheep farms mainly to local butcheries in the Cape. There is an egg hatchery which produces 1 700 000 eggs a month, selling to Pioneer Food / Bokomo. Most of the farms have small irrigation dams, frequently emptied throughout the year.

The small-scale farms in and around Atlantis do not contribute on a commercial basis. Such farms grow a small amount of vegetables, and run some chickens and one or two goats mainly for home consumption.

A summary of the information collected from each farm is given in the Appendix 1 of the Agricultural Impact Assessment.

Farming practices for the area around the Duynefontein site are summarised in **Table 9-4**.

Table 9-4: Farming practices (number of farms)

Farming practice	No. of farms
LIVESTOCK	
Dairy	2
Beef	6
Sheep	2
Pigs	1
Poultry	1
Game	0
CROPS	
Vines	4
Wheat	7

Fynbos	0
Vegetables	3
Other agriculture	3
Total properties	31

From the data in this table it is clear that the Duynefontein area is characterised by mixed farming with 12 of the properties carrying livestock, of which ten are dairy, beef or sheep.

9.9.6 Tourism industry

Duynefontein falls into the City of Cape Town. The Integrated Development Plan for the area clearly states that Cape Town is recognised as the gateway to the Western Cape. The environment is one of Cape Town's strongest assets driving tourism, and development initiatives for the next three years focus on the expansion of infrastructure that will improve access to, and the enhancement of, the local tourism experience. Tourism around the Duynefontein site is largely represented by the Greater Northern Cape Town tourism region. This includes Atlantis, Bellville, Blaauwbergstrand, Century City, Durbanville, Edgemead, Goodwood, Langa, Melkbosstrand, Milnerton, Parow, Pinelands, Sunset Beach and Table View.

This area is characterised by a wide diversity of enterprises in the tourism industry. It is difficult to differentiate between the tourist assets of the study area itself and those of the Greater Cape Town and West Coast destinations. However, within the immediate site proximity, activities are focused on sea and eco-tourism activities such as kite-surfing, windsailing, golf, hiking and mountain biking. The area has a well-developed tourism infrastructure with a strong supply of services, facilities and amenities. The area promotes a seafront residential sense of place emphasising proximity to the coast and to the Greater Cape Town tourist hub.

Three large-scale hotel developments are currently underway in Blaauwbergstrand along with numerous residential developments in all of the listed areas, including plans for a further golf estate near Melkbosstrand. These developments are a response to the accommodation requirements of the area, and it may be assumed that they will follow regional occupancy trends. When completed, these projects, as reported by the Tourism Impact Assessment conducted as part of this EIA, will increase the figures given in **Table 9-5**. Large-scale road and access developments are also currently in progress.

Table 9-5: Quantitative representation of tourism industry in the Duynefontein area

Accommodation beds	2,408
Average rate per night	528
Average annual occupancy (days)	231.05
Sub-sector turnover p.a.	R 293,756,158
House lets	1,463
Average cost per day	R 583
Average annual occupancy (days)	239
Sub-sector turnover p.a.	R 204,071,792
Total turnover p.a.	**R 497,827,950**

9.9.7 Noise

Figure 9-39 displays the proposed plant layout of the Duynefontein site north of the KNPS on an aerial photograph of the area. The closest occupied noise sensitive land is the residential suburb of Duynefontein, with the nearest residences approximately 1 800 m south of the existing NPS and approximately 2 900 m south of the proposed Nuclear 1 infrastructure area. The closest distance of the proposed infrastructure to the R27 would be 2000 m.

9.9.8 Control Zones

At the Duynefontein site the Koeberg NPS has a greater Protective Action Zone (PAZ) and Urgent Protective Action Planning Zone (UPZ) than prescribed by the European Utility Requirements (EUR) for Nuclear-1. The PAZ is a 5 km zone and the UPZ is a 16km zone at Koeberg NPS. Due to the existing Koeberg NPS on the Duynefontein site the proposed Nuclear-1 exclusion and evacuation zones will be concurrent with Koeberg's existing exclusion and evacuation zones. The Duynefontein residential area falls within this 5 km PAZ radius of Koeberg NPS. Although Melkbosstrand and Bloubergstrand, fall within the 16 km UPZ.

Currently a 2 km seaward exclusion zone exists around the sea shore bordering the Koeberg NPS as per the Sea-Shore Act, 1935 (Act No. 21 of 1935). No general activity (swimming, operation of sea vessels etc.) is allowed within the 2 km by 3.2 km area of the sea shore adjacent to KNPS and Melkbosstrand is bisected by the 5km radius and falls, for practical purposes, within the PAZ for emergency planning purposes.

Many of the Koeberg NPS staff reside in the Duynefontein & Melkbosstrand residential areas located south of the site.

9.9.9 Transportation

a) Road network

The West Coast Road (R27) and the N7 are primary regional and national distributors as shown in **Figure 9-40**. The R27 runs in a north-south direction and links Cape Town with the west coast areas. It is located approximately 2.5 km east of the site and provides the main access to the Duynefontein site.

The R27 links with the west coast towns of Langebaan, Vredenburg, Saldanha and Velddrif. The N7 also runs in a north-south direction linking the main towns of the Western Cape and Northern Cape.

b) Railway network

There are two railway line branches, as shown in **Figure 9-40**, running in north-south directions from Cape Town.

The line from Cape Town to Namaqualand runs past Kalbaskraal and has two branches to Malmesbury and towards Saldanha. This line is approximately 24 km east of the site. The Atlantis goods line runs approximately 6 km east of the site, from Cape Town's CBD, traversing Table View and ending in Atlantis. It connects with the suburban rail system at Chempet Station.

c) Airports

The existing major and minor airports and landing strips in the vicinity of the site are shown in **Figure 9-40** and are listed as follows:

Major airports and landing strips:

- Cape Town International Airport;
- Ysterplaat and Langebaan (Military airfields); and
- Stellenbosch airfield.

Minor airports and landing strips:

- Diepkloof airfield;
- Rosenburg farm airstrip;
- Saldanha airfield; and
- Kersefontein airfield.

d) Harbours

The existing harbours in the vicinity of the proposed Nuclear-1 are shown in **Figure 9-40** and are listed as follows:

- The Port of Cape Town; and
- The Port of Saldanha.

9.9.10 Urban Land-use

The Blaauwberg District can be divided into two broad land use sections namely an urban core and agricultural/ conservation areas. The largest portion of the urban core is located in the south of the District, whereas substantial portions of agricultural and conservation uses are located on the northern side of the District.

Growth in this District is concentrated within new development areas including Sunningdale, Parklands and along the west coast. Commercial activities are generally concentrated along Koeberg Road, Blaauwberg Road and Parklands Main Road as well as commercial centres at major intersections.

9.10 Socio-economic environment figures - Duynefontein

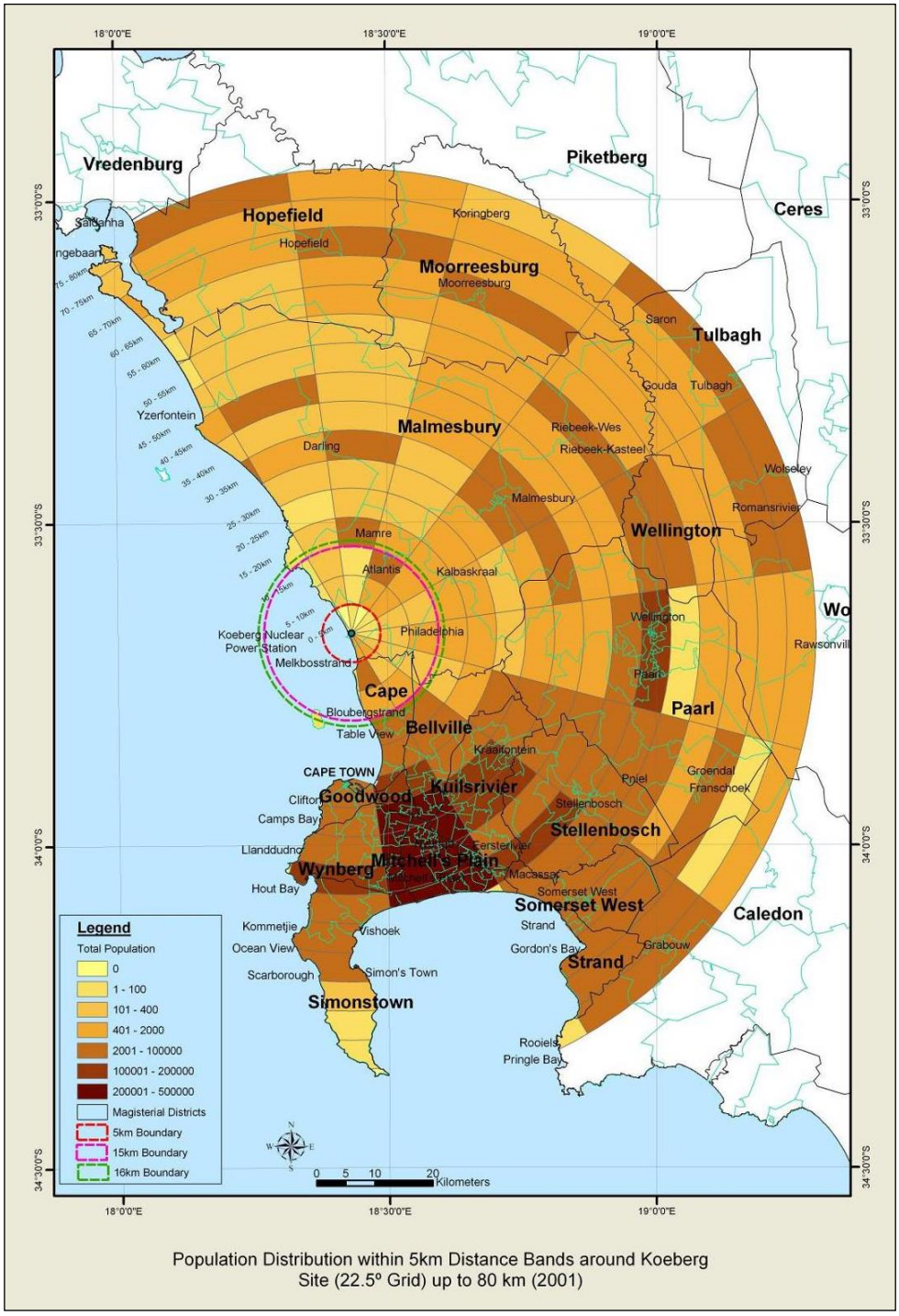


Figure 9-32: Population Distribution within 5km radii of Duynefontein

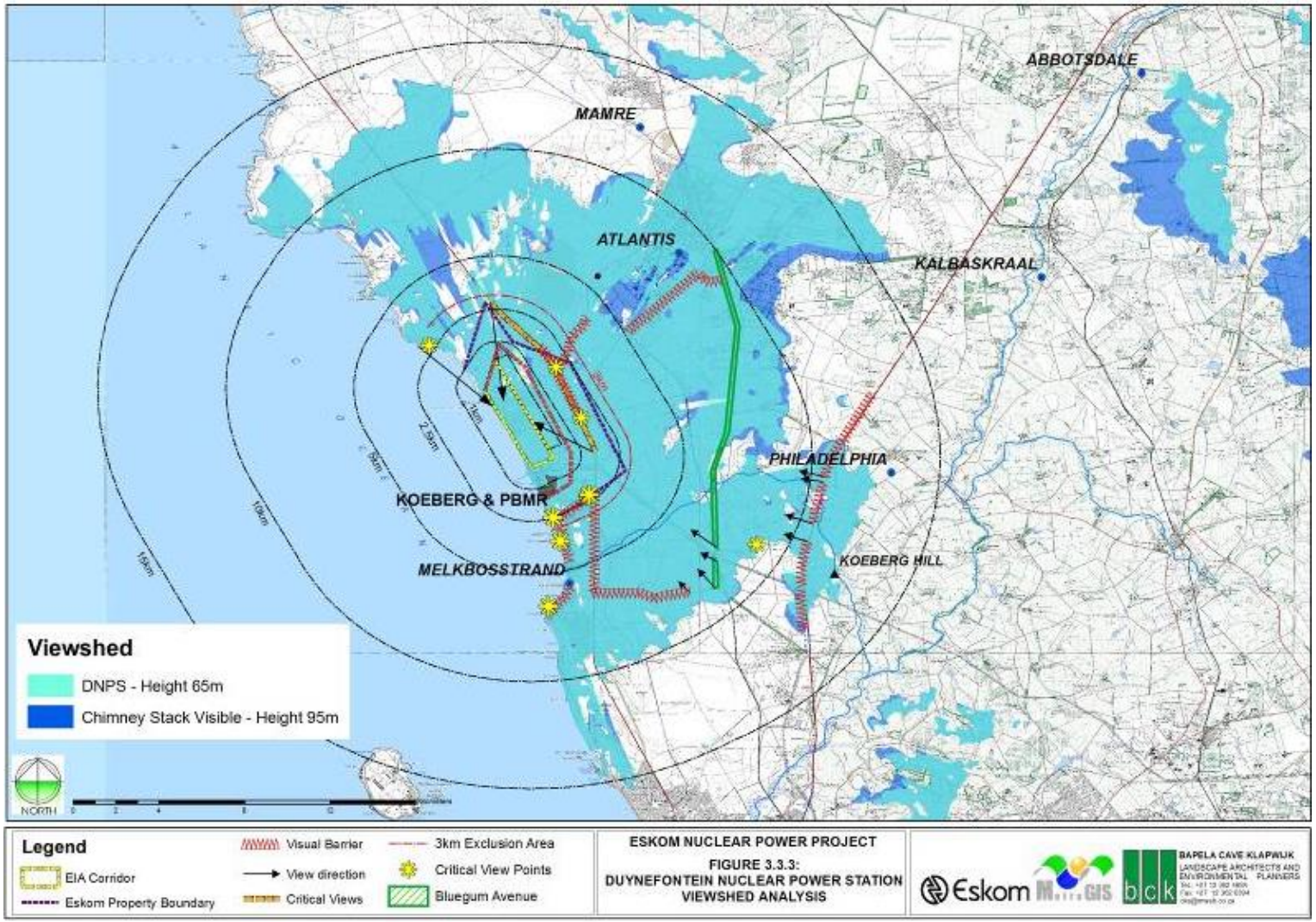


Figure 9-33: Duynefontein Nuclear Power Station viewshed analysis[5]

[5] It should be noted that the PBMR project has been shelved by Eskom and is no longer considered as part of this assessment.

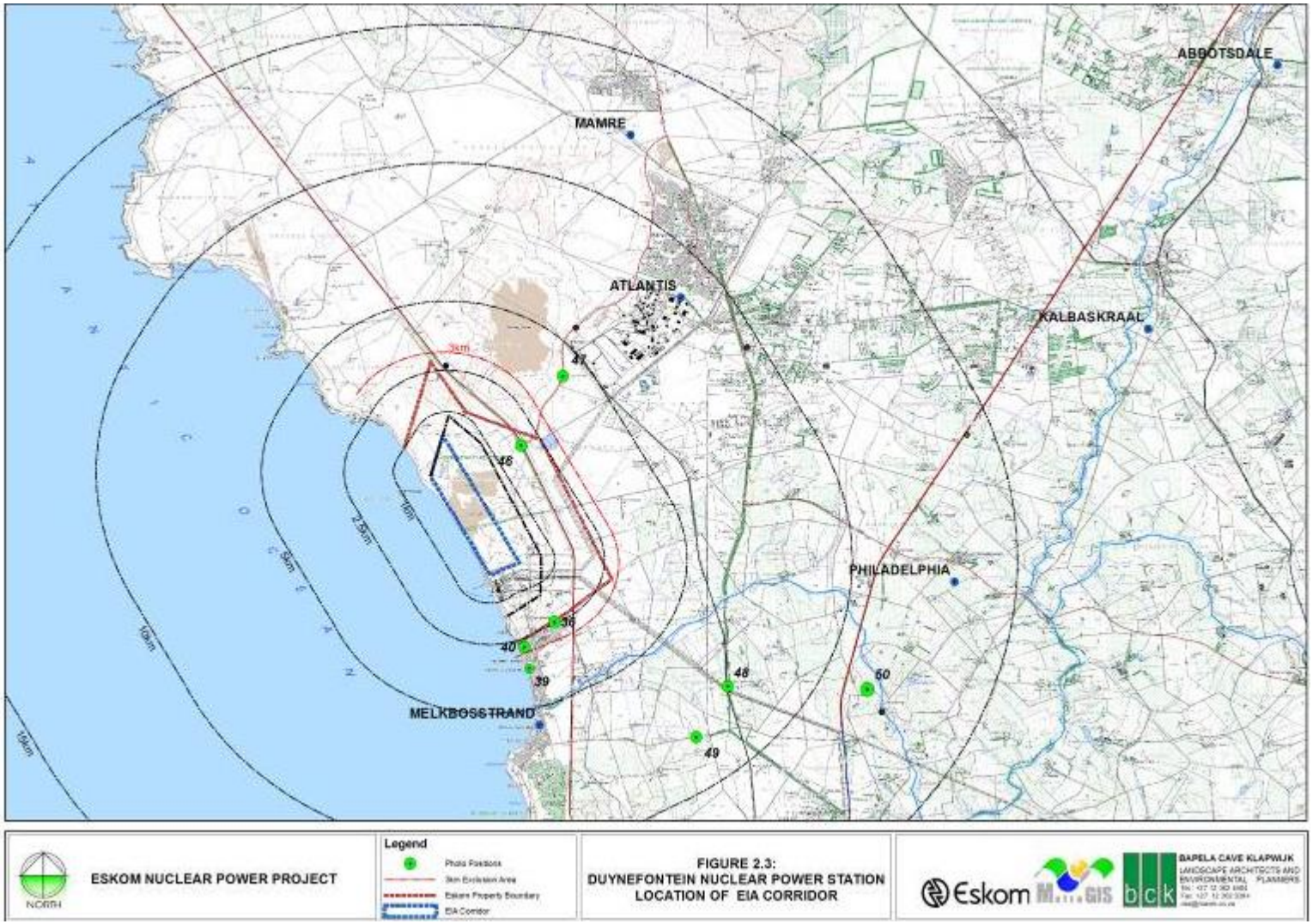


Figure 9-34: Duynefontein Nuclear Power Station: Location of EIA corridor

(Above) View over the study area towards the existing Koeberg power station

(Left) Fossilised metapodial of a medium bovid found close to Duynefontein 1 archaeological site

(Bottom left) Duynefontein 2 archaeological/palaeontological site in 2008

(Bottom right) Duynefontein 2 archaeological/palaeontological site in 2000.

Figure 9-35: Heritage features at the Duynefontein site

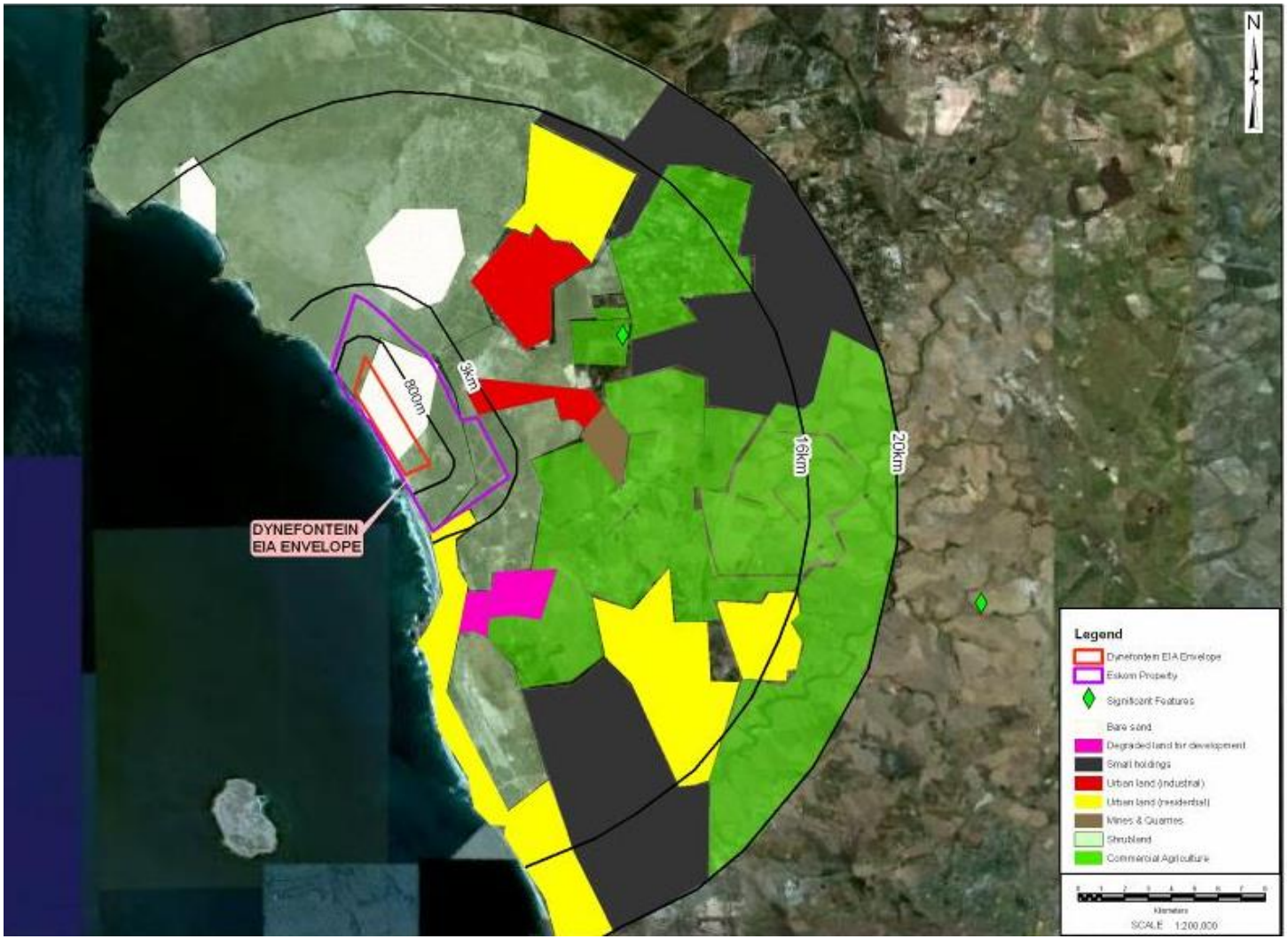


Figure 9-36: Land use map - Duynefontein

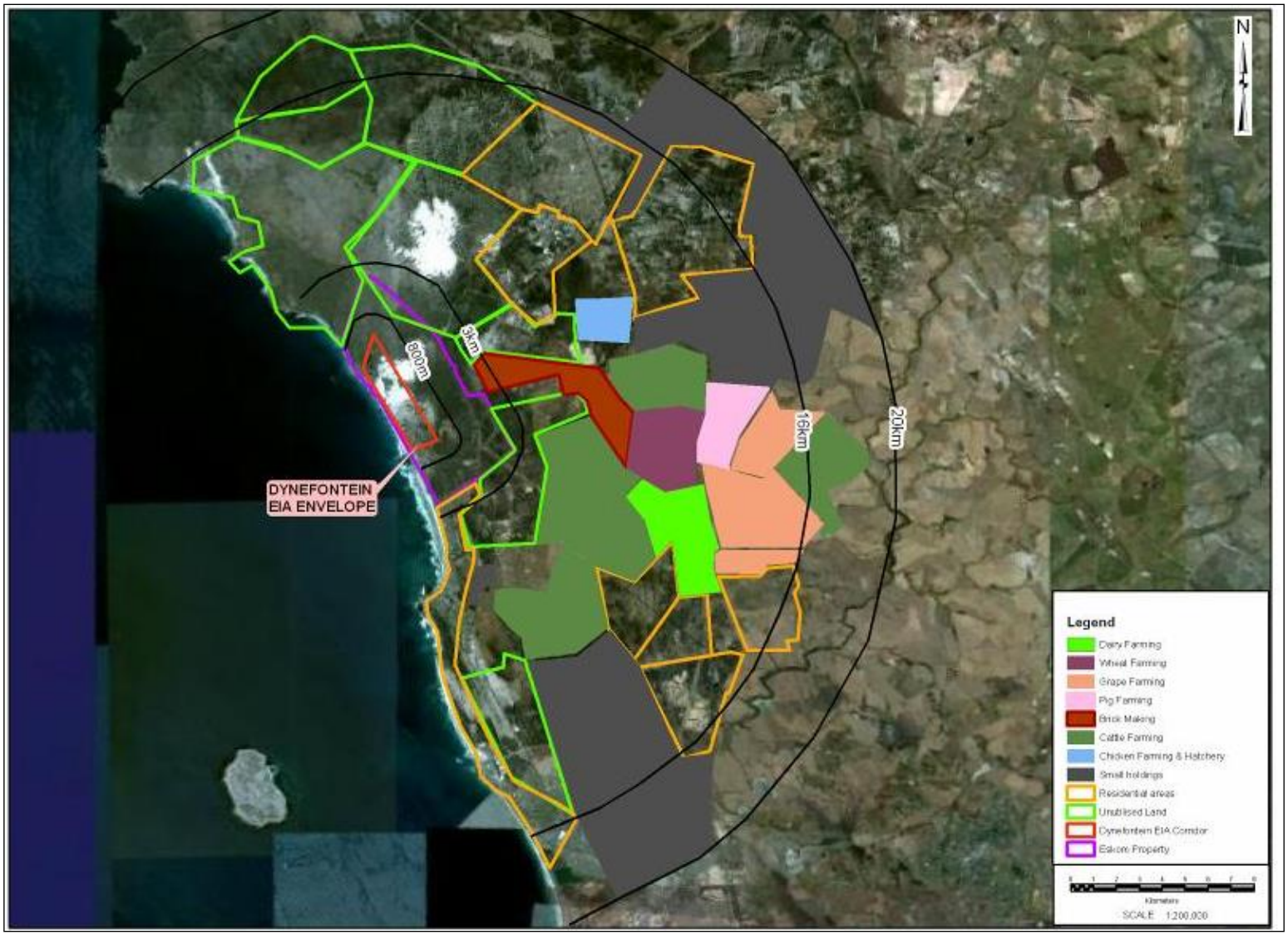


Figure 9-37: Types of farming - Duynefontein

Figure 9-38 Duynefontein site location and sphere of tourism impact (Not to scale)

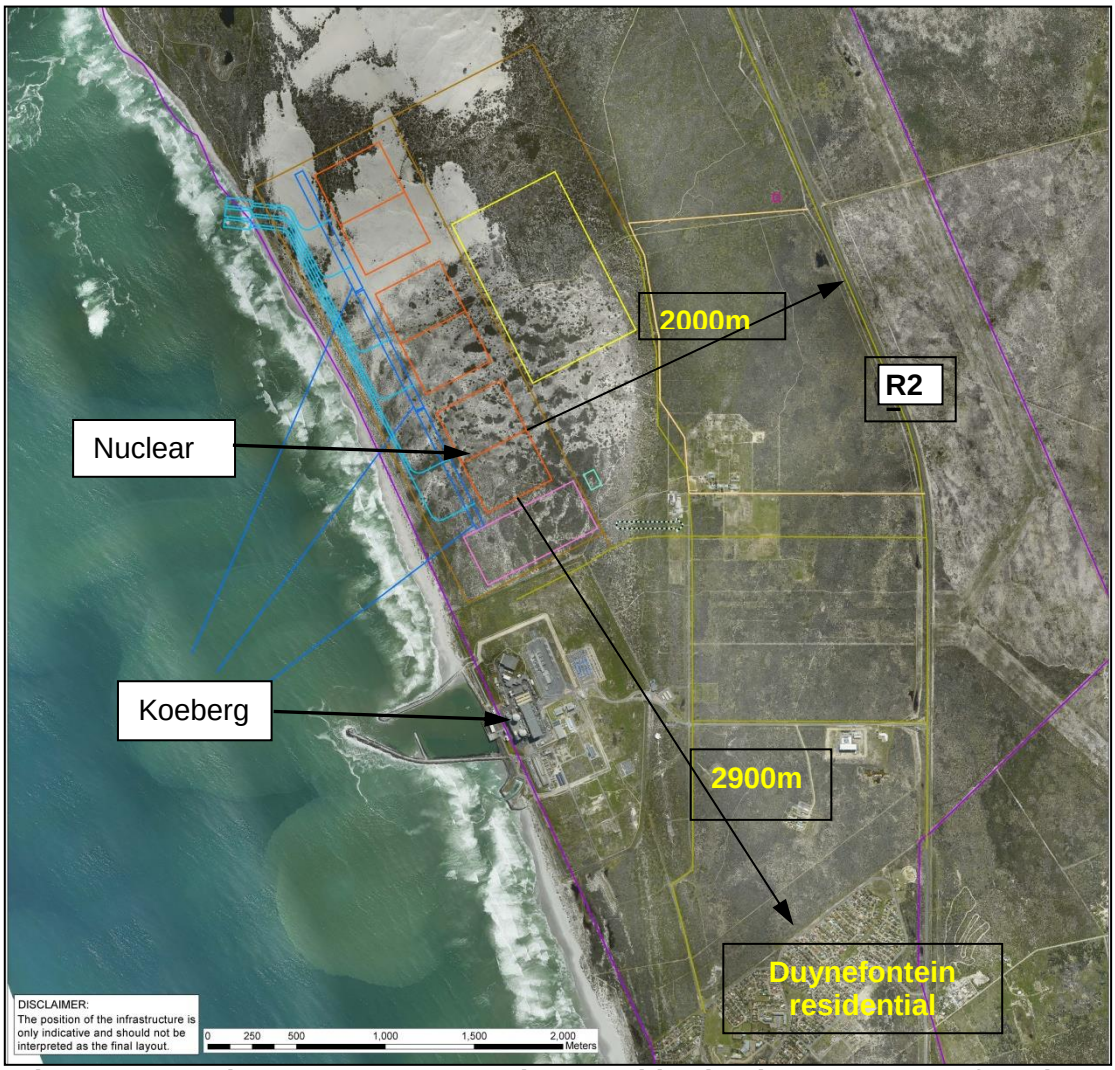


Figure 9-39: Distance to nearest noise-sensitive land uses at Duynefontein

Figure 9-40: Duynefontein transport network

9.11 Socio-economic environment - Thyspunt

9.11.1 Economic environment

a) Overview of the economy

The Thyspunt site is located within the Kouga Local Municipality, which forms part of the Cacadu District Municipality in the Eastern Cape. A 20 km radius encompasses parts of Wards 1-6. According to the 2008-12 Integrated Development Plan (IDP). There is a population of approximately 28,000 in this area. Not included in this is Jeffreys Bay, which is reputed to be the fastest growing town in South Africa.

Provincially, the Eastern Cape recorded a growth rate of 5.2 % in 2006. This was marginally below the country's growth rate of 5.4 % for the year. The provincial GDP of R92 551 million in 2006 was the fourth largest in the country. The Eastern Cape has an estimated population of between 6.34-6.60 million. The province's main economic activities are finance and business services, general government services and manufacturing. Tourism is a very important sector, but is split between several of Statistics South Africa's broad industrial classifications. The Kouga economy is fairly diversified.

b) Agriculture

The area under the jurisdiction of the Agri Tsitsikamma East Agricultural Society covers parts of the Kouga and Tsitsikamma districts. It covers an area beyond the 20 km radius from the Thyspunt site. The main activity is dairying: the area around Humansdorp is the largest milk producer in South Africa. There are approximately 60 000 dairy cows producing a total of 820 000 litres per day valued at R900 million per annum. There are also approximately 5 000 head of beef cattle, and total beef production (from beef cattle and slaughtered calves) amounts to R37 million per annum. Dohne merino sheep produce wool valued at R1.2 million per annum and mutton at R5.5 million per annum. The area also produces 450 tons of wheat per annum. Using the 24 month average price of wheat, this translates into approximately R1 million per annum

c) Tourism

The tourism market around the Thyspunt site includes Oyster Bay and the St. Francis Bay area (comprising the village of St. Francis, Port St Francis and Cape St. Francis). The tourism asset is predominately centred in St. Francis village which contains the main beaches and a well-known canal area St Francis in fact was founded as a tourism destination. It has a strong eco-tourism brand with an emphasis on water sports, golf and hiking. According to the Tourism Impact report (**Appendix E22**), the tourist season is extremely short, being concentrated in a ten-day period in December-January and over the Easter week-end. Officials of the local municipality stated that the normal population of 4,000 rises to 30,000 over Christmas and New Year, and around 8 000 over Easter. There is no hotel, and accommodation is based on bed-and-breakfast establishments (B&Bs), guesthouses and house lets. The turnover of accommodation establishments was estimated at R77.7 million per annum.

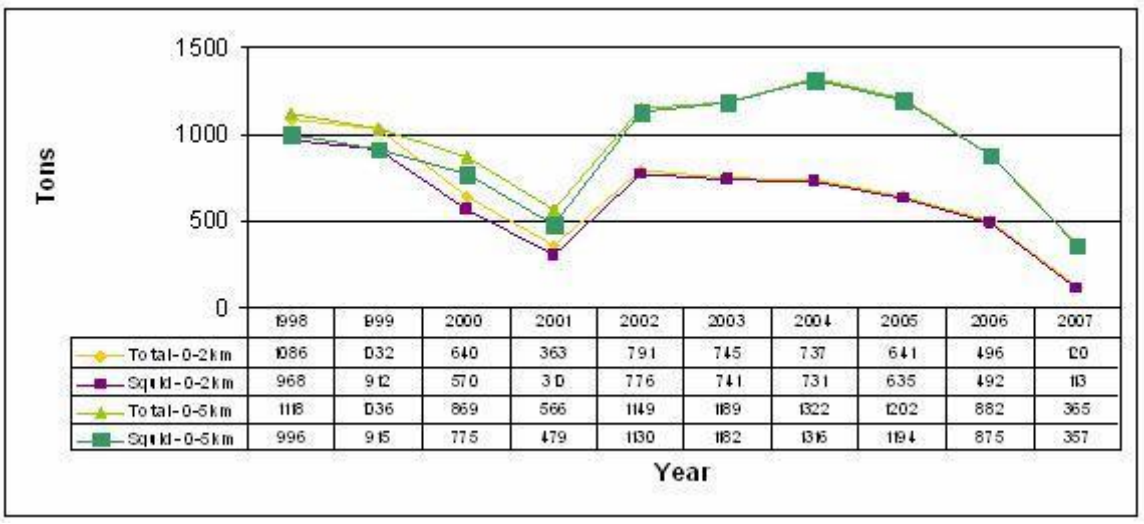
Although Jeffreys Bay is beyond the 20 km radius of Thyspunt, there are strong negative perceptions in sections of the population there about the impact of a NPS. This was ascertained both during field interviews and through the comments in the interested and affected parties' response trail. Thus, Jeffreys Bay is dealt with briefly. Tourism dominates the economy of the town, and is heavily based on surfing. The normal population of 40,000 swells to 100,000 over Christmas and New Year and to 50 000 during the Billabong Pro International surfing competition over ten days in July....

In normal years property prices have reflected the premium market that is the St Francis brand, but since 2008 prices were hit by the national economic downturn. A number of new premium housing estate developments have found it difficult to sell units, and one planned development has been abandoned. Prices over the last few years have ranged from R3-7 million for canal houses, up to R7 million for beachfront houses, and R1-3 million for non-waterfront houses in the village of St. Francis.

d) Fishing

Fishing activities around St Francis Bay are part of an industry that exploits the area between Port Alfred and Plettenberg Bay, using the harbours at Port Elizabeth and Port St. Francis. At the time of the initial assessment, the fleet consisted of 136 vessels of which 36 are based at Port St. Francis and the balance at Port Elizabeth. The capital cost of a fully equipped vessel is between R2.5-6.0 million, with an average cost of R3 million for boats in Port St. Francis.

Data for commercial fishing in the area between Seal Point and Slang River, of which Thyspunt is the midpoint, are shown in **Figure 9-41**.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total-0-2km	1086	1032	640	363	791	745	737	641	496	120
Squid-0-2km	968	912	570	310	776	741	731	635	492	113
Total-0-5km	1118	1036	869	566	1149	1189	1322	1202	882	365
Squid-0-5km	996	915	775	479	1130	1182	1315	1194	875	357

Figure 9-41: Commercial fishing, Seal Point-Slang River, 1998-2007 (Kg)

The industry does not have sufficient information on the effects of a NPS on marine life, but is concerned about possible impacts on pelagic (hake) and inshore (squid) catches. It does not believe there would be any effect on demersal (deep-sea) fishing. Its main concern relates to the demarcation of an exclusion zone at Thyspunt of an assumed similar size to that at Koeberg which is 3.2 km wide and extends 2 km into the ocean from the shore. Eskom has advised the authors, however, that the exclusion zone at Thyspunt and Bantamsklip will not exceed 1 km of coastline and 1 km out to sea. The closure of such an area off Thyspunt would have no more than a slight impact on pelagic fishing. Longline catches of hake have averaged 2 500 tons per annum in the Eastern Cape and 800 tons per annum for Port St. Francis-based vessels at an average price of €5.50/kg. During field interviews with the local fishing industry, it was found that two of the richest fishing grounds are in Thysbaai and Oyster Bay, and catching occurs between 500 metres and up to 5 km offshore.

The concentration of squid shifts according to month and weather conditions, and the chokka squid catch fluctuates from year to year depending on sea temperature and wind conditions. Over the last 20 years the annual catch has ranged between 2 000 and

14 000 tons in the Eastern Cape with an average of 7 000 tons. However, the catch fluctuates significantly. There was a significant decrease is catches during the 2012/ 2013 season but the reasons for this are not yet known. The Port St. Francis-based companies average about 1,000 tons per annum. Squid is the most viable fishing industry in the area, almost the entire catch being exported to the EU.

According to the information supplied by the South African Squid Management Industrial Association (SASMIA) (2007), between 1999-2005 an average of 33.2% of the total annual Eastern Cape catch originated in the area between 10 nautical miles (18.52 km) east and west of the proposed Thyspunt NPS site. Data from SASMIA show that in 2005 the Eastern Cape squid industry employed 2,300 fishing crew, 150 management staff and 1 500 factory staff. The industry generated approximately R400 million in foreign exchange per annum.

Port St. Francis has a small harbour that cannot accommodate larger vessels, which catch an average of 250 tons each per annum. Entry is restricted to smaller vessels catching an average of 50 tons each per annum. Port Elizabeth, by contrast, can accommodate larger vessels.

Since fishing activities have significant linkages in terms of local employment and procurement of provisions, the effects for labour and supplies would be serious. The industry at Port St. Francis consists largely of small medium and micro enterprises which depend entirely on squid fishing and would not be able to divert their vessels so as to capture trawl and other (demersal or pelagic) revenue streams.

The largest company at Port St. Francis also operates a fish processing factory in Humansdorp. The Humansdorp factory salts, grades, packs and freezes fish. Hake is trucked to Johannesburg and air freighted to EU markets (mainly Spain and Portugal) while squid is exported by sea, mainly to Europe. The factory employs mainly women, the number varying between 20 - 140 at any one time depending on the work load.

The Port St. Francis boats are manned by local (St. Francis-Humansdorp-Jeffreys Bay) fishermen while Port Elizabeth's fishing companies also draw some of their crew from the St. Francis area. Altogether, an estimated 1 000 fishermen are from the local area. The number of men per boat ranges from 12 - 24 depending on the size of the vessels. All groceries for the Port St. Francis vessels are purchased locally as are fuel, engineering services, fishing tackle and some transport services. The impact of the fishing industry on the local economy can be seen in the closed season when employment falls, turnover of supplier's declines, spending power in the village falls and the incidence of housebreaking rises.

However, the industry is not universally popular in the area. It receives continuing criticism that the lights on the boats are so bright that they destroy the sense of place of the local inhabitants, especially those at Cape St. Francis and Oyster Bay.

e) Retail and trading

The largest retail sector in a 20 km radius of the Thyspunt NPS is at Jeffreys Bay. This sector is growing, and two shopping malls opened in late 2008 expanding total retail space by 400 – 500 %. A major retail chain estimates the total turnover of the sector at R250 million per annum. The largest single enterprise in the town is the leisure apparel manufacturer and trader, Billabong, which employs 400 persons in its operations consisting of a factory print shop (finishing and embroidering imported surfing and leisure apparel) as well as wholesale and retail outlets. This enterprise estimates the total turnover in the Jeffreys Bay economy at a minimum of R500 million per annum.

The trading sector in Humansdorp consists largely of food and clothing retail stores but there is no shopping centre. A major retailer estimates the total annual turnover at R168 million.

In the St. Francis area (including Cape St. Francis and Oyster Bay), the total turnover is estimated at R70 million per annum. Turnover shows large seasonal variations in line with the seasonal variation in population size. The sector is dominated by food stores but there are some clothing and boutique outlets. A new shopping centre opened in July 2008.

f) Civil installations

Table 9-6 contains information on the various civil structures that are located in the area of the Thyspunt site. This information was collected from the Kouga Municipality's most recent Spatial Development Framework and IDP. It is possible that this does not fully account for all the civil structures but it was the only information that the municipality was able to provide.

Table 9-6: Civil structures within 30 km of the Thyspunt site

Structures	Ward 1	Ward 2	Ward 3	Ward 4	Ward 5	Ward 6	Total
Library	1	0	0	0	2	1	4
Parks	1	3	6	2	2	2	16
Sports facilities	1	2	1	2	1	2	9
Recreational facilities	2	3	0	0	1	3	9
Cemeteries	0	1	2	1	1	4	9
Primary schools	5	3	0	-	5	-	13
Secondary schools	0	0	0	-	3	-	3
Police stations	-	1	0	-	1	-	2
Hospitals/clinics	1	2	0	-	4	-	7
Community centres	2	5	-	-	4	-	11
Day-care centres	1	-	-	-	-	-	1

9.11.2 Demographic statistics

Provincially, the Eastern Cape recorded a growth rate of 2.4% in 2014. This was marginally below the country's growth rate of 2.8% for the year. The Eastern Cape has an estimated population of between 6,34 and 6,60 million.

The Thyspunt site is situated within the Kouga Local Municipality which falls within the Cacadu District Municipality in the Eastern Cape Province.

Cacadu District Municipality

Local Municipality	Seat	Population (2011)	Area (km²)	Density (inhabitants/ km²)
Camdeboo	Graaff-Reinet	50,993	12,422	4.1
Blue Crane Route	Somerset East	36,002	11,068	3.3
Ikwezi	Jansenville	10,537	4,563	2.3
Makana	Grahamstown	80,390	4,376	18.4
Ndlambe	Port Alfred	61,176	1,841	33.2
Sundays River Valley	Kirkwood	54,504	5,994	9.1
Baviaans	Willowmore	17,761	11,668	1.5

Kouga	Jeffreys Bay	98,558	2,670	36.9
Kou-Kamma	Kareedouw	40,663	3,642	11.2
Total		*450,584*	*58,243*	*7.7*

The total population of the Kouga Municipality was documented as 98 558 in 2011, 70 695 in 2001, compared to 62 542 in 1996. The CSIR, DBSA and National Department of Provincial and Local Government estimate the population growth for the Kouga Municipality on 2..4% per annum between 2000 and 2010. Growth and development around coastal towns since 2005 was phenomenal and it is suggested that this figure is much higher than was indicated.

The District Municipality also deals with vast differences in population density from one area to the next, for example Jansenville (2.3km²) has a total population of 10,537 compared to Kouga (36.9km²), which has a population of 98 558. Kouga has the highest population density in the District.

The variations in density have an impact on the cost of service delivery (appropriate level of services) and puts pressure on existing infrastructure and housing delivery requirements.

9.11.3 Visual character

a) Topography

The site falls within the fynbos biome, and is dominated by South coast dune fynbos and Sand River primary dune community. The site has considerable habitat diversity in the form of a number of contrasting vegetation types, including subtropical forest thicket.

The dune field has been stabilised nearer to the coast by vegetation, both indigenous and exotic. The vegetation on the windward side of the dune is wind-pruned and dense. The vegetation in the “slack”, the valley between the dunes, is also relatively dense, but taller than other more exposed vegetation due to these areas being sheltered from the wind.

b) Vegetation

The site is dominated by dune fynbos and Sand River primary dune community. The site has considerable habitat diversity in the form of a number of contrasting vegetation types, including subtropical forest thicket.

The dune field has been stabilised nearer to the coast by vegetation, both indigenous and exotic. The vegetation on the windward side of the dune is wind-pruned and dense. The vegetation in the “slack”, the valley between the dunes, is also relatively dense, but taller than other more exposed vegetation due to these areas being sheltered from the wind.

c) Sense of place

The sense of place of the site and surroundings is predominantly related to the remoteness of the general location and the jagged and narrow solid rock shoreline, which rises relatively steeply to the sand covered rock terrace. This interface between land and sea is rugged and private, as access to the Eskom property is prohibited. Views landward are restricted by the series of parallel vegetated dunes.

The setting offers privacy with a wildness that touches all of the senses, because of its relative remoteness.

d) The character of the site and surroundings

The rocky and varied coastline of that location is backed by a vegetated dune field, which rises to approximately 110 mamsl. The area has an unspoilt natural character. The restricted visual access of the site reinforces the remote natural landscape character. It should be noted that the Red Cap Wind facility is located north of the dune fields of the site thus the surrounding character of the site is changing.

e) Surrounding land use

The land use between the coast and the ridgeline of inland vegetated dunes is primarily *de facto* conservation, since Eskom currently manages the land to remove alien vegetation and interfere minimally in natural process.

The western edge of the site abuts the coastal village of Oyster Bay while the eastern edge borders land that is undeveloped and in private ownership.

This land has a number of private houses that were built before Eskom bought the land, mostly holiday homes which are built near the edge of the consolidated dunes and overlook the rocky sea shore. Refer to **Figure 9-43** and **Figure 9-44.**

It is noted that at the time of writing an application for a township was lodged on the farm Ongegunde Vryheid east of the site and adjacent to the western town boundary of Cape St. Francis. This property is known as Rocky Coast Farm. The current proposal is for a cluster layout in the vicinity of existing houses. The balance of the area will be managed for conservation.

f) Landscape diversity

The diversity of the site and immediate surroundings is made up of the varied rocky coastline and small bays. The latter provide secluded havens in the natural and undisturbed land and sea interface. The dune field is uniformly green and rises in a series of parallel dunes, which give a uniform visual effect. Some holiday homes to the east of the site are visually prominent and out of context as they perch on the edge of the terrace and rocky shore (**Figure 9-43** and **Figure 9-44)**. There is some vertical diversity in the topography and vegetation inland from the coast.

g) Climatic effects on visibility

The wet and misty weather in winter is brought onshore by the predominant westerly winds . Onshore wind at the sea surface is mostly experienced through October to March, during which time there is increased vertical motion in the waves.

9.11.4 Heritage resources and archaeology

Thyspunt is a coastal site situated on the south coast of the Eastern Cape between the holiday towns of Cape St. Francis and Oyster Bay. Like Bantamsklip, the area is rural in character. Economic activities in the immediate area are mainly dairy farming; however there is a fishery at Cape St. Francis. Oyster Bay is a small upmarket holiday/retirement community. Infrastructure in the town is limited and the population is highly seasonal. Cape St. Francis is a developed upmarket community which supports a relatively small permanent population of mostly retired persons. During the summer holiday season the population increases dramatically – the area is well set up for tourism being replete with hotels, restaurants and B&B facilities. Outdoor activities are clearly important as themed adventures, diving and surfing, big game fishing and golfing facilities are available. The area is cherished for its scenic beauty – dramatic dunes and beachscapes, natural heritage and mild climate. Accelerated property development activities have had a devastating impact on the functioning of the large headland-bypass dune system which is a significant natural feature of the area. The interruption of the natural feeding and flow of aeolian sands

has resulted in vegetation changes and the cessation of sand deposition at St. Francis Bay Beach, which is now severely eroded. Eskom's land holding in the area has in part put a brake on property development expanding westwards from St. Francis.

The Thyspunt study area, which is a natural heritage site, includes a number of landforms that have played a role in the distribution and quantity of heritage sites. The most inland portion (a long panhandle of land) consists of cultivated meadows that have been leased out for dairy farming. Between the agricultural lands and the coast is an extensive dune field, a very large stretch (15 km) of which is active shifting sand. Towards the coast the dunes are stable and vegetated with a mixture of dense coastal thicket and coastal Fynbos. Wetlands are found in many of the dune bays, while amongst the active dunes pools of fresh water accumulate on ancient land surfaces exposed in the deeper blowouts. The vegetated dune peaks reach a maximum height of 10 mamsl – the gradient towards the shoreline consisting of a series of substantial parallel undulations. The coastline is characterised by mostly an active rocky shoreline apart from a stretch of beach at Thysbaai. Springs flow into the sea at the interface of the dune complex and bedrock – freshwater pools and wetlands along the shoreline are numerous. The immediate shoreline vegetation is lush and often swampy under foot. There are two small sheltered bays (at White Point and Tony's Bay). Tony's Bay contains an extensive stone fish trap complex. Wild life noted in the study area includes small and medium bovids, bush pigs, small carnivores, numerous avian species. Like Bantamsklip the shoreline would have provided prehistoric communities with ample marine resources.

The human made environment at Thysbaai is limited to the existing Eskom workshop, conservation office and accommodation facility and several small cottages (shacks). Eskom has "inherited" various informal access arrangements set up by previous landowners of the property. The cottages are used by various families for holidays and fishing trips. Notable among these is the St. Andrews shack, which is used by the St Andrews school of Grahamstown for outdoor education, recreation and may be hired by persons associated with the school. The "shack" apparently is a source of cherished memories for generations of past pupils and teachers since the 1960's (**Appendix 4 of the Heritage Impact Assessment**). Access to the cottages is via a sandy track (suitable for vehicles with off-road capability) from Oyster Bay, although access can also be gained from the Cape St. Francis side of the property. The only other built elements on the site are various small "dams" at spring eyes close to the shore from which residents collect fresh water, various storage tanks and a single abandoned 19th century house on the edge of the agricultural land in the inland portion.

The Thyspunt site has been subject to previous heritage related studies, in particular by Dr Johan Binneman of Albany Museum, Grahamstown. He has published several papers and completed a PhD dissertation on the archaeology of the area. In addition, stakeholders in the broader area include various Khoikhoi groups who are concerned about the future of their heritage.

a) Regional heritage context

A deeds survey has revealed that farms were first granted in this area by the British colonial government in the 1820's, while it would appear that large tracks have remained "Crown" or government land until recently.

Virtually no published information is available with respect to the colonial period history of Oyster Bay and Cape St. Francis; however it is known that the Kromme River was historically navigable for light steamers and small sailing craft. The history of the place relates to its beginnings as a small informal port. During the 19th century the coastal shipping trade played an important economic role as it was the only way available way to move large quantities of goods at relatively high speed. The 19th century light house at Seal Point, Cape St. Francis is the only proclaimed heritage site in the immediate area. A search of web-based material has revealed that Leighton Hulett and members of the Hulett family were the first people to develop the area when they established a holiday home in what was a wilderness area in 1954. According to La Cock and Burkinshaw the area was largely

undeveloped in 1960, apart from a few holiday cottages. In 1967 the first canals were excavated and by 1970 there were about 161 holiday houses in the area. Hence most of the built environment is of very recent construction.

b) Palaeontology

The palaeontological potential of Thyspunt is in many ways similar to Bantamsklip in terms of geological context. However the dune field complex at Thyspunt is large and deep, which means that there is a very high potential for Pleistocene palaeontology and archaeology to exist below the dune bodies.

The proposed nuclear corridor at Thyspunt is situated on top of a low-lying coastal platform that has been carved by wave action into resistant, quartzite-dominated sediments of the Nardouw Subgroup (upper Table Mountain Group / TMG). The TMG platform surface mostly lies between 4 to 8 mamsl, rising to a maximum of 10 mamsl, and is mantled with a thin veneer of late Cenozoic coastal sediments of the Algoa Group. Various formations within the Algoa group are potentially moderately fossiliferous.

Of greater concern is the more recent Pleistocene palaeontology that is exposed from time to time in the active dune system. Fossil remains within the active dune system have been reported. Fossil bone found lying on palaeosoles associated with hyena coprolites and suggests that hyena activity during the Pleistocene may have been responsible. Also identified were extinct mammal species (*Pelorovis antiquus* – giant buffalo) that suggests that the fossil material dates to within the Pleistocene. Binneman commented on the high frequency of Middle Stone Age material within the deflated areas in the dunes, some of which he considered to be relatively undisturbed.

c) Pre-colonial heritage

The south coast was one of the first areas recognised by professional archaeologists as being important for the study of South African prehistory. South coast sites and places have lent their names to many stone tool industries, including the Mossel Bay Industry from the Cape St Blaize site and the Robberg from Nelson Bay Cave. Already, Goodwin is prompted to state, “The southern Cape, from Port Elizabeth to Swellendam, is by far the most important archaeological area in Southern Africa…This is the southern wall of the continent, against which culture after culture has made its last stand before inevitably disappearing under the next wave of peoples.” He continues “Here South Africa has evidence of value to the world of prehistory and it is essential that it should be protected so far as it is humanly possible.” Regrettably, this has not been the case.

Recent studies have fulfilled Goodwin’s assertion about the heritage significance of the Southern Cape. The Southern and Eastern Cape Coast has seen human occupation since the Early Stone Age. It has been suggested that the human presence in the Southern Cape dates back as long as 700 000 years ago. Sites such as Blombos at Still Bay, Klasies River Mouth near Humansdorp (west of the study area) which have been rigorously scientifically excavated and studied have revealed the earliest evidence known to human-kind about the behaviour of early modern humans and the evolution of abstract thought or symbolic behaviour. Sites that have the potential to provide this kind of evidence are limited to a mere handful in the old world, and as such have extraordinary value.

The archaeological site “Klasies River Mouth” which lies west of the study area near Humansdorp is perhaps the most significant archaeological site close the study area. It was first reported to archaeologists at the South African Museum in 1955. The massive sequence of deposits contained within this coastal cave has been subject to study by local and international teams of archaeologists since the 1960’s. Excavations were conducted in the 1960s by Singer and Wymer who described four phases of Middle Stone Age occupation, including a Howiesons Poort level between phases II and III and two Later Stone Age phases.

Smaller but more thorough excavations have since been undertaken by Hillary Deacon during the 1970's and 1980's on the Klasies River Mouth. These revealed more detail about the dating of the site and the palaeo-environmental conditions. Both excavations yielded fragmentary human remains associated with MSA deposits. These fragments, dated to around 90 000 years ago with some as old as 120 000 years, probably don't reflect intentional burials and it has even been suggested that they were the result of cannibalism. The human specimens would appear to be morphologically modern and aspects of modern behaviour and cognition are attested to by Deacon and his post-graduate students. The early humans created middens in selected areas for waste disposal. Deacon (1995) suggests that cannibalism is always associated with symbolic behaviour. If cannibalism is evidenced by the fragmentary nature of the KRM remains, they therefore may indicate modern cognitive abilities. The Howiesons Poort levels have been argued to show modern thought too: the choice of artefact type and material – which was imported from as far as 20 km away – is thought to be stylistic. However, no evidence for fishing and an apparent reliance on docile, young or aged prey animals that were fairly easy to hunt would indicate that food procurement strategies were not fully developed, indicating that fully modern levels of technological sophistication had still not been reached. Klasies River Mouth is thus one of a small suite of internationally significant archaeological sites (limited to southern Africa) that are pivotal to our understanding of the emergence of modern human behaviour.

At Thyspunt and Cape St. Francis a number of studies have been completed on the numerous later Stone Age sites and shell middens of the Holocene period.

Feast excavated a burial from dunes in the Cape St. Francis area some 150 m from the shore. The burial was accompanied by a shell necklace and a grindstone was placed above his/her cranium. Near the cranium, too, were several pieces of ochre and some stone flakes and chips. The burial has been dated to the mid-Holocene, approximately 5 000 years ago.

Further excavations at Cape St. Francis revealed a human buried with a dog. The dog bones have been dated to 1150 years ago. As dogs may have accompanied herders, these finds suggest the presence of Khoekhoen pastoralists in this area.

Cairns excavated several circular stone platforms in this area as well as a human burial. The stone platforms are most likely to be hearths, possibly used to cook shellfish meat. These platforms have been identified at a number of other sites along the south coast at Slang River, Noetzie and Pearly Beach.

Deflation horizons at Oyster Bay, west of Cape St. Francis have yielded the first known occurrence of an open-air Howiesons Poort assemblage. These stone artefacts have been proven to be contemporaneous with hyena coprolites from the same horizons, allowing for palynological examinations of the environmental conditions during the early Last Glacial. The studies showed that the landscape during the Last Glacial period accommodated complex patchworks of vegetation and was generally cooler with the climate closer to inland conditions.

Johan Binneman of Albany Museum, Grahamstown, has conducted by far the most detailed archaeological work in the area. He has completed surveys of the Cape St. Francis Dune field, visited and sampled sites at Thyspunt on a number of occasions since the early 1980's as well as completed a preliminary survey commissioned by Eskom.

Binneman has identified a suite of sites in the area that contain artefactual material characteristic of the full range of archaeological sites that are known to have occurred over the last 7 000 - 10 000 years. In addition his studies revealed the presence of a never before described artefact tradition (the Kabeljous industry) which occurred in this area during the mid-late Holocene.

Within the study area he described microlith rich sites characteristic of the mid-Holocene (5 000 - 6 000 years ago), the late Holocene, as well as ceramic rich sites which may be attributed to the Khoekhoen herders of the last 2 000 years. Significantly Binneman also

identified numerous ESA and MSA artefacts including Howiesons Poort scatters on paleosoles exposed in the Thyspunt Dune Field. Some of these are associated with fossil hyena droppings (coprolites) as well as fossilised bones of extinct mammals such as the Giant Buffalo (*Pelorovis antiquus*).

In his PhD dissertation Binneman remarked on the extraordinary variety and richness of the suite of archaeological sites in the area. He comments that most of the sites lie within 300 m of the coast. Nilssen. who recently did mitigation work at the St. Francis Links Golf Estate located numerous shell middens several kilometres from the ocean. Many of these were buried or obscured by sand and vegetation – a factor that must be considered in the evaluation of heritage significance in this study.

d) Colonial period heritage

Like other parts of the South Coast during the Later Stone Age, the introduction of pastoralism roughly 2 000 years ago was a significant event that broke the ancient tradition of hunting and gathering that had been the method of human subsistence for thousands of years. Before colonisation of the Eastern Cape by the British in the early 19th century, Khoekhoen herders formed powerful transhumant communities (herding cattle and sheep) throughout the coastal plain and from time to time into the Great Karoo. They enjoyed dominance as far as the Great Fish River where they shared a loose border with farming communities to the East. European farmers (Trekboere) were the vanguard of formal colonisation and accelerated granting of land by the British Colonial Government. Land which was viewed as a shared resource by the Khoekhoen was no longer available to them.

Research conducted as part for this study has shown that the area known as Thyspunt was made up of farm Thyspunt (Farm 744) and the Farm 741 both in the Humansdorp District. Farm 741 has always been unregistered state land and as such there is no title deed for it.

Farm 744 on the other hand is made up of portions of the farms Welgeleë, Buffels Bosch and Langefontein. All three farms were originally granted in 1816 or 1817, in other words, early in British colonial rule. The farms have been extensively subdivided but ownership of the portions largely remained within the same group of families.

Farm Welgeleë (Farm 743) comprises Lot A of farm Welgelegen (Farm 735) and Portion C, Portion 15 and remainder of Portion D of the farm Buffels Bosch. The farm Welgelegen was first granted in 1817 in perpetual quitrent to Hendrik van de Watt; portion A was divided of in 1886 when H.J. Potgieter and 4 others sold it to Hendrik Frederick Peter Sinn. The original title deed diagram indicated one fresh water spring, no built structures and described the land partly as grazing land, partly as sand and thicket.

Farm Buffels Bosch was initially granted on quitrent in 1816 to Wessel Hendrik Moolman. It was re-granted in 1890 under the Act “The Land Beacons Amendment and Extensions Act” (Act No. 9 of 1879) to Herman Jacobus Potgieter and 15 others who all held shares in the farm. The oldest title deed diagram only shows the swamp and two roads but no structures or springs. The diagram of 1886 shows a network of new roads, at the convergence of which four buildings are indicated next to two springs, furthermore three dams were present and the swamp (probably the water bodies to the north of the dune field) is also still indicated. Portions 3 and 4 were divided of the original farm in 1891. Portion 9 was divided off Portion 4 in 1957.

Farm Langefontein (Farm 736) was only named as such when it became part of the Humansdorp District. It was originally Erf 467 in Oesterbaai. It was granted in quitrent in 1817 to Hendrik van der Watt. Portion 1 was divided of in 1963 when Tzitzikama Estate (Pty) Ltd sold it to Anthony Auret. The Surveyor General diagrams show the run-off of a spring to the ocean across the farm and a road along the coastline from the one end of the farm to the other.

Hence the colonial period heritage of the site is unremarkable and no doubt typical of a great many others in the area. The existing farm buildings at Welgelegen (apparently all

fairly modern) probably relate to the site of the early 19th century structures indicated on diagrams. A single small historic cottage on the inland portion of the study area was probably a *Bywoners* cottage

e) Cultural landscape

The cultural landscape qualities of the study area refer mainly to its natural heritage and high biodiversity. A rare aspect of the area is the active dune field – a headland bypass system almost 15 km in length, which together with the wide range of archaeological and palaeontological resources on it, place it among a few surviving landforms of this kind and size around the country. The wilderness qualities of this portion of the coast in contiguity with the archaeological heritage are exceptional and make a substantial contribution to the character of the region.

9.11.5 Agricultural practices

The Agricultural Impact Assessment reports that there is currently no agricultural production on the proposed site (EIA envelope), but given the land use on farms north of the site, there is the potential for agricultural development. This would mainly be the allocations of planted pastures for dairy production on the northern portion of the site.

There is no agricultural production within the 800 m emergency zone. The 3 km emergency zone borders onto a dairy farm on the northern side of the proposed site but will have no impact on agricultural activities.

The area north of the site is considered to be a prime dairy production area, and the estimated value of pasture land is in the region of R 20 000 – 25 000 per hectare.

The land use within a 20 km radius of the Nuclear-1 site is dominated by commercial dairy farming as indicated in **Figure 9-48**. About 65 % of the entire body of land within the radius is used for commercial agriculture. Strandveld (thicket) is found along the coastline together with a larger portion of bare sand in the form of dunes (the Sand River). The residential areas are Humansdorp, St. Francis, Cape St. Francis and Oyster Bay. Humansdorp is the most populated residential area as the other areas consist predominantly of holiday homes, occupied only seasonally. There is a large area of degraded land which is indicated in **Figure 9-49**. The causes of degradation appear to be wind erosion and perhaps overgrazing in the past. The rest of the area is reasonably well vegetated and no significant degradation was evident.
Existing agro-industrial developments are the Woodlands Dairy in Humansdorp (which markets its products nationally) and large silos situated near Humansdorp. These silos are used for storing wheat but, due to the changing regional trend from wheat to dairy, are not being fully utilised.

Further afield within a 30km radius (**Figure 9-49**), other features to note include scattered natural forest outcrops and the Kob River, which is a tourist attraction in-season for recreational camping and fishing activities close to Jeffreys Bay.

a) Current agricultural production in the surrounding area

The Thyspunt area is dominated by dairy farming. Within the 16km radius there is only one other farm type which is a large property (over 2,000 ha in extent) carrying a flock of 6 500 sheep. The farms supply milk to dairies such as Woodlands, Parmalat, Nestlé and Clover. Woodlands Dairy and Clover Dairies together produce an average of 700,000 litres of milk a day to sell, and make dairy products such as cheese, butter and yoghurt.

The dairy farms consist mainly of cultivated pastures and maize production (mostly for silage) for dairy cows. Much of the natural vegetation in the area is shrub land with the occasional outcrop of alien bushveld. Many of the farms produce their own silage for their own use or to sell to other local farmers. Some land is used for wheat production.

A summary of the information collected from each farm is given in the Appendix 1 of the Agricultural Impact Assessment.

The farming practices close to the Thyspunt site are summarised in **Table 9-7.**

Table 9-7: Farming practices (number of farms)

Farming practice	No. of farms
LIVESTOCK	
Dairy	16
Beef	0
Sheep	1
Pigs	0
Poultry	0
Game	1
CROPS	
Vines	0
Wheat	0
Fynbos	0
Vegetables	0
Other agriculture	3
Total properties	26

From the data in this table it is clear that the Thyspunt area is predominately a milk-producing area with dairy production on 16 of the 26 properties.

9.11.6 Tourism industry

Thyspunt falls under the Cacadu District Municipality. The Integrated Development Plan (IDP) (Cacadu 2007) states that tourism is becoming an increasingly important economic activity for the area and is earmarked as a key element in local economic development strategies. The municipality has identified a number of natural, historical and cultural features that could be further exploited to attract local, domestic and international tourists to the area, and is currently drafting a tourism development master plan and arranging funding to promote local tourist initiatives and construct an effective communication and marketing system. The tourism market around the Thyspunt site includes Oyster Bay, St. Francis Bay, Cape St. Francis, Port St. Francis and Humansdorp. **Figure 9-53** illustrates the spatial context of the site.

Although Jeffreys Bay falls outside the immediate sphere of direct influence of Nuclear-1 at Thyspunt, it is discussed briefly here because of its position in the surfing industry and because of the perception that surfing at Jeffreys Bay may be affected by Nuclear-1. Aside from the strong sports-tourism market it represents, the surfing community has a very pronounced environmental consciousness. It has made considerable efforts to voice its objections to the proposed nuclear power station in the form of international surfing-media publications, while a formal petition indicating boycotts and sponsorship withdrawal has been signed by most of the local surfing market and a number of the top international merchandise brands connected with the sport and their top sponsored performers.

The Billabong Pro surfing tournament is held annually in Jeffreys Bay. This event is held here because Jeffreys Bay is widely recognised as South Africa's premier surfing spot with the world's longest right-hand wave break. This event is to be one of eleven world championship events and the most important surfing event in the country. However, as of 2012, the Billabong Pro Jeffreys Bay surfing competition was officially downgraded to an ASP 6-Star event by the Association of Surfing Professionals (ASP) and no longer forms part of the ASP world championship tour However, the value of this event remains. To

indicate the value of the surfing-tourism market, **Table 9-8** shows the approximate income generated from the ten days of the Billabong Pro.

Table 9-8: Approximate visitor expenditure during the BP Billabong Pro

Average number of visitors per day	5,000
Approximate average daily visitor expenditure	R 500
Duration (days)	10
Approximate value of visitor spending	R 25,000,000

The total turnover in the Jeffreys Bay economy is estimated by local business at about R500 million per annum, of which 80 % is related to surfing.

The tourism asset within the radius is predominantly centred in St Francis. Indeed, the area was founded as a tourism destination. It has a strong eco-tourism brand with emphasis on water sports (including surfing, sailing and fishing) and other outdoor activities such as golf and hiking.

In discussing tourism it is necessary to make assessments of a marine and visual nature due to the inherent coastal setting of the relevant tourism product – visual aesthetics and marine resources are two of the defining characteristics. Thus, the reports of the Marine and Visual specialists were consulted in order to correlate pertinent conclusions.

The Marine Environmental Specialist Report identified no particular marine species endemic to the south coast, nor were any rare or endangered species or species of biological significance found. However, the importance of shore- and ski boat-based recreational angling was emphasised. The squid fishing industry was also reported on, but this has little bearing on tourism.

The Visual Impact Assessment describes the sense of place of the Thyspunt site and its surroundings as predominantly related to the remoteness of the general location. The area promotes a strong “green” community of quiet and remote exclusivity, emphasised by luxurious coastal living in a relatively unspoilt natural location. A well-developed tourism infrastructure exists with a broad range of services and facilities. Three large hotels are planned and two further sectional-title holiday residential developments are under construction.

The tourist season at St Francis is extremely short, being concentrated into a ten-day period in December-January and over the Easter week-end. The normal population of 4,000 rises to 30,000 over Christmas and New Year and perhaps to 8,000 over Easter. There is no hotel, but B&Bs and guest houses offer 1,200 beds while there are approximately 300 houses that are let during the peak seasons. Average annual occupancy rates are estimated at 40 % for B&Bs and 5 % for house lets.

Humansdorp has no real tourism industry with minimal facilities and services. It acts predominately as a transition node for tourists en route to St Francis or Jeffreys Bay. The only tourist activity is extremely seasonal and revolves around an overflow from St Francis and Jeffreys Bay during the Christmas and Billabong Pro peaks.

The size of the tourism industry in the Thyspunt area is quantified in **Table 9-9** on the basis of information obtained in the field.

Table 9-9: Quantitative representation of the tourism industry in the Thyspunt area

Accommodation beds	1,200
Average rate per night	R 350

Average annual occupancy (days)	146
Sub-sector turnover p.a.	R 61,320,000

House lets	300
Average cost per day	R 3,000
Average annual occupancy (days)	18.25
Sub-sector turnover p.a.	R 16,425,000

Total turnover p.a.	**R 77,745,000**

It will be noted that the average price of house lets is higher around Thyspunt than at the other alternative sites. This is explained by the up-market, prestige nature of tourism in this area compared to Bantamsklip. In the areas surrounding Duynefontein there is a large stock of various kinds of accommodation leading to relatively low rates for house lets.

9.11.7 Noise

Figure 9-54 displays the proposed Nuclear-1 plant layout on an aerial photograph of the Thyspunt site. The Nuclear-1 infrastructure site would be 4.2 km east of residential land at Oyster Bay. Most of the residences are located on the slopes of a dune overlooking the coast and are exposed to surf noise with a $L_{Req,d}$ in excess of 50 dBA depending on the distance from the shoreline. An $L_{Aeq,T}$ of 43 dBA was measured behind the dune on the road leading to the Umzamowethu township. The only audible sound was that of the distant surf.

A green rectangle shows the location that was previously proposed for the High Voltage (HV) yard, where it was proposed to locate two Open Cycle Gas Turbine (OCGT) peaking power plants with a combined electrical capacity of 50 MW. However the location of the HV yard is currently proposed within the construction substation area on the site. Outlined in green circles are the nearest farm residences. One residence (small circle) is situated just outside of the HV yard boundary. The remaining two farm residences are each situated approximately 1,000 m from the proposed HV yard. The typical $L_{Req,d}$ for the farm residences is 45 dBA.

It was observed from a study of elevation contours that the terrain in the vicinity of the proposed Duynefontein site was similar to that at Thyspunt in so far as this would influence the propagation of noise inland, away from the coastline. The almost flat topography of the land areas extending at least 750 m around both sites would have negligible influence on the propagation of noise away from the noise sources.

9.11.8 Transport

a) Road network

The N2 runs in an east-west direction connecting the main centres along the east coast, such as Port Elizabeth, George and Cape Town as shown in **Figure 9-55**.

The N2 links to the N7 via Cape Town. Access to the N2 from Thyspunt is via Humansdorp along the R330 or the unsurfaced Oyster Bay Road. The R330 is a surfaced road that runs from Humansdorp in a southerly direction past St. Francis Bay to Seal Point on the coast. The existing unsurfaced road, which runs from Humansdorp south to Oyster Bay, is in fairly good condition during the dry season and requires more maintenance during the wet season.

b) Rail network

There are currently two railway services operating on the railway lines in the Cacadu District Municipality, as shown in **Figure 9-55,** and these are as follows:

- Alicedale – Grahamstown; and
- Port Alfred – Bathurst.

The Alicedale – Grahamstown service is mostly used by work seekers and shoppers travelling to Grahamstown, whereas the Port Alfred – Bathurst service is mostly used by tourists to explore the Bathurst area.

c) Airports

The main air access to the Cacadu District is via the Port Elizabeth Airport as shown in **Figure 9-55**. However, there are other airports in the District performing significant regional functions.

The provincial government owned airfield in Ndlambe Municipality is leased by a private company that owns the property around the facility and is utilised for training pilots. About 200 to 250 learners are taught to fly an aircraft per year for both commercial and air transport plane licenses.

The facility has three grass runways and no sophisticated landing instruments are used due to unavailability of tarred runways and other facilities. The private company has requested funding from the Province to surface one of the runways.

Airports that can accommodate light aircraft are located at St. Francis Bay, Humansdorp and Paradise Beach.

d) Harbours

The main sea access to the Cacadu District is via the national harbour in Port Elizabeth as shown in **Figure 9-55**. However, there are other harbours performing significant regional functions in the District.

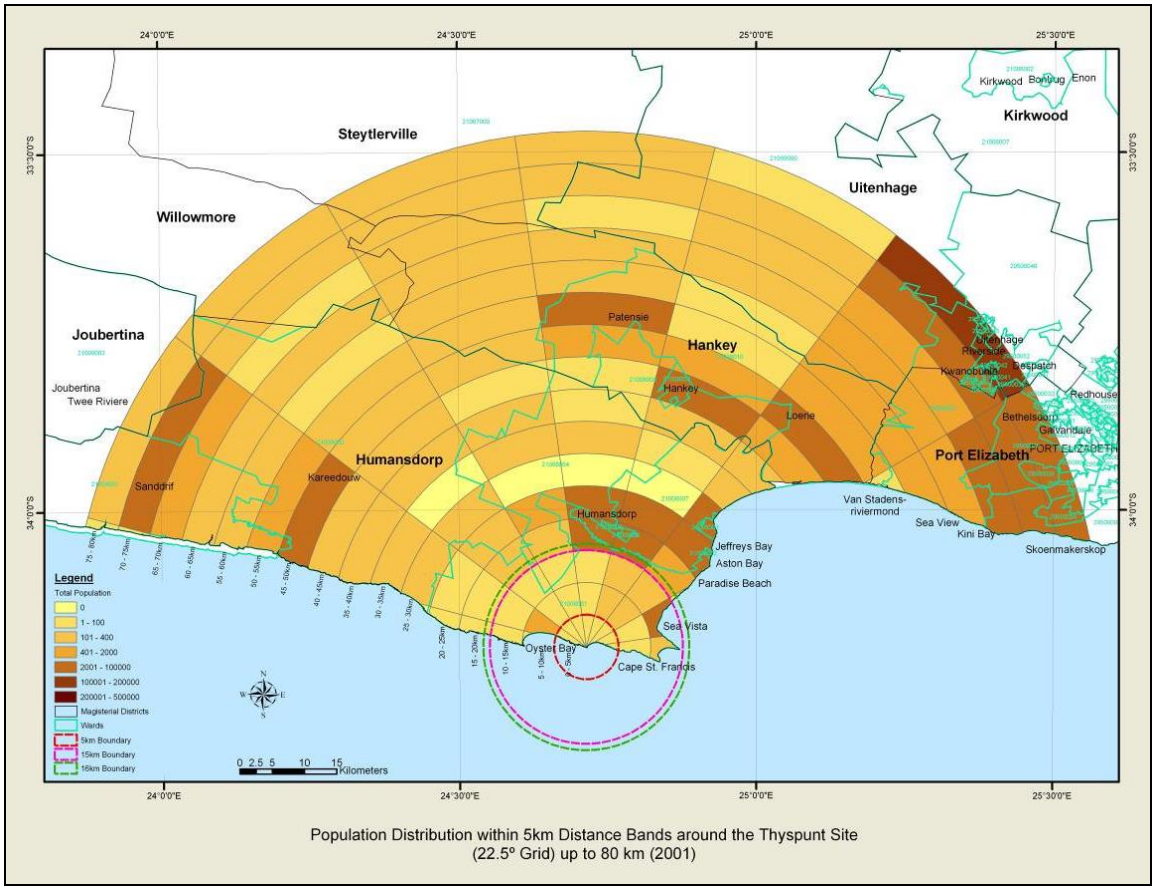
There are small boat harbours that have been constructed by private developers at Port Alfred and Port St. Francis. These are mainly used commercial and recreational purposes.

9.11.9 Urban Land-use

The Thyspunt site is zoned 'Agricultural', but is not currently used for agricultural purposes. It is kept vacant for the purpose of the proposed nuclear power plant and auxiliary uses. After initial discussion with the Municipality, it was proposed that site be rezoned from 'Agriculture' to 'Special' for a nuclear facility to accommodate the proposed Nuclear 1 facility. The remainder portions are to be rezoned from 'Agriculture' to 'Open Space Zone 3', so that uses such as game farms are permitted.

The land uses in the vicinity include intensive farming (mostly dairy farms) and game farms (south of Humansdorp and Jeffrey's Bay). The dune strip central to the site also has important ecological significance.

9.12 Socio-economic environment figures – Thyspunt



Population Distribution within 5km Distance Bands around the Thyspunt Site
(22.5° Grid) up to 80 km (2001)

Figure 9-42: Population Distribution within 5km distance radii of Thyspunt

Figure 9-43: Typical house placement east of site

Figure 9-44: Holiday home on beach east of site

(Above) Coastal midden at White point, Thyspunt

(Above right) Decorated ceramic from a Dune Field site, Thyspunt

(Right) Stone feature on dune midden at Thyspunt

(Below) A large shell midden at Thyspunt vegetated with low shrubs and grasses. Coastal

middens are often distinguishable by the low vegetation cover.

Figure 9-45: Middens and decorated ceramics at Thyspunt

(Above) Tidal fish traps at Tony's Bay, Thyspunt

(Left) The St. Andrews cottage shack built from old packing cases has been used as a "getaway" by persons associated with the school.

(Below left) This cottage close to Welgelegen is the only generally protected building in the study area

(Bottom left) Lath and beam ceiling in the abandoned cottage remain intact.

(Bottom right) Victorian window frame at the abandoned cottage.

Figure 9-46: Tidal fish traps and built structures at Thyspunt

Figure 9-47: Borrow pit area

Figure 9-48: Woodlands dairy

Figure 9-49: Land use map - Thyspunt

Figure 9-50: Extensive silage production on most farms

Figure 9-51: Silage bales

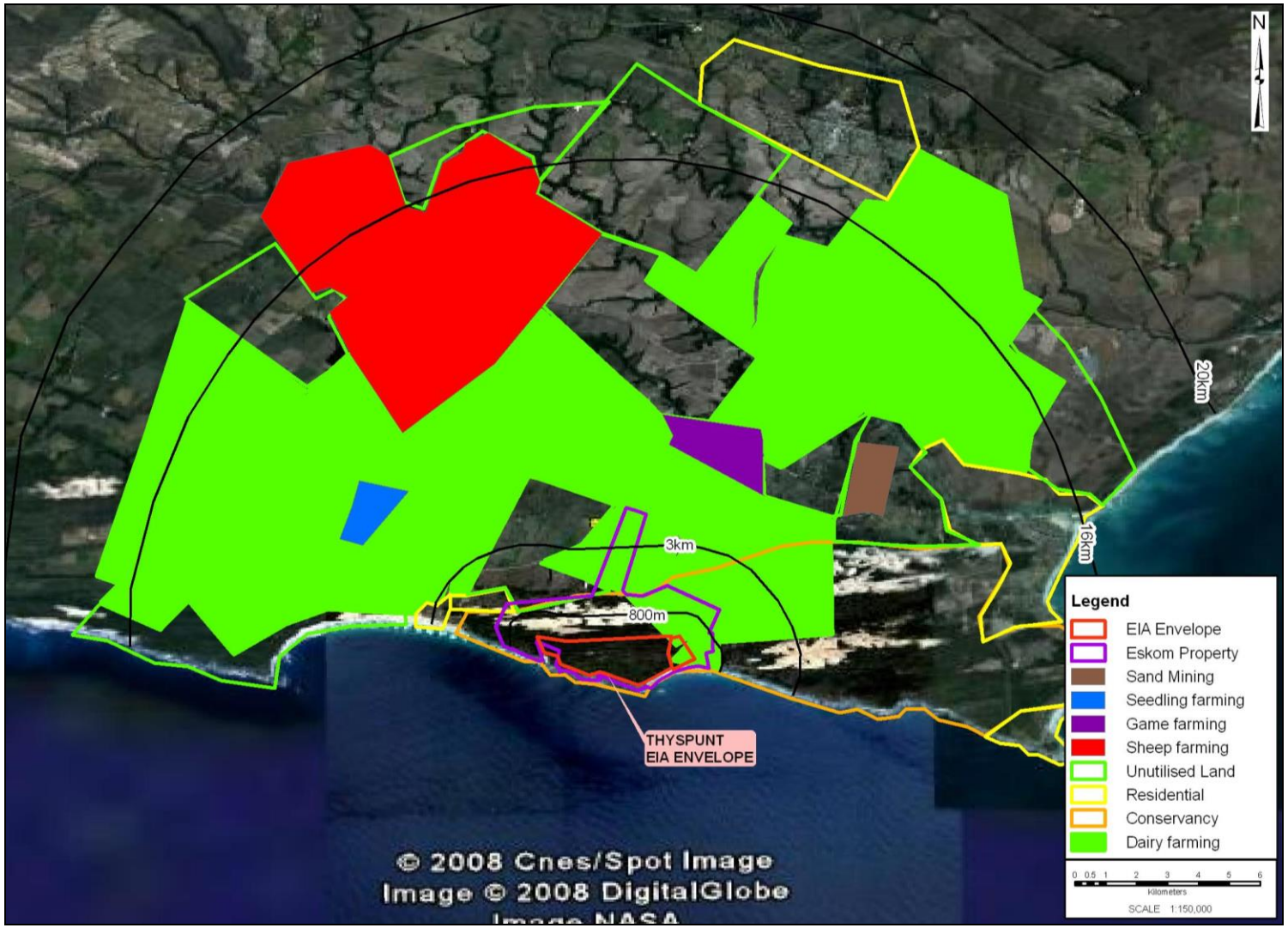


Figure 9-52: Types of farming - Thyspunt

Figure 9-53: Thyspunt site location and sphere of tourism impact (Not to scale)

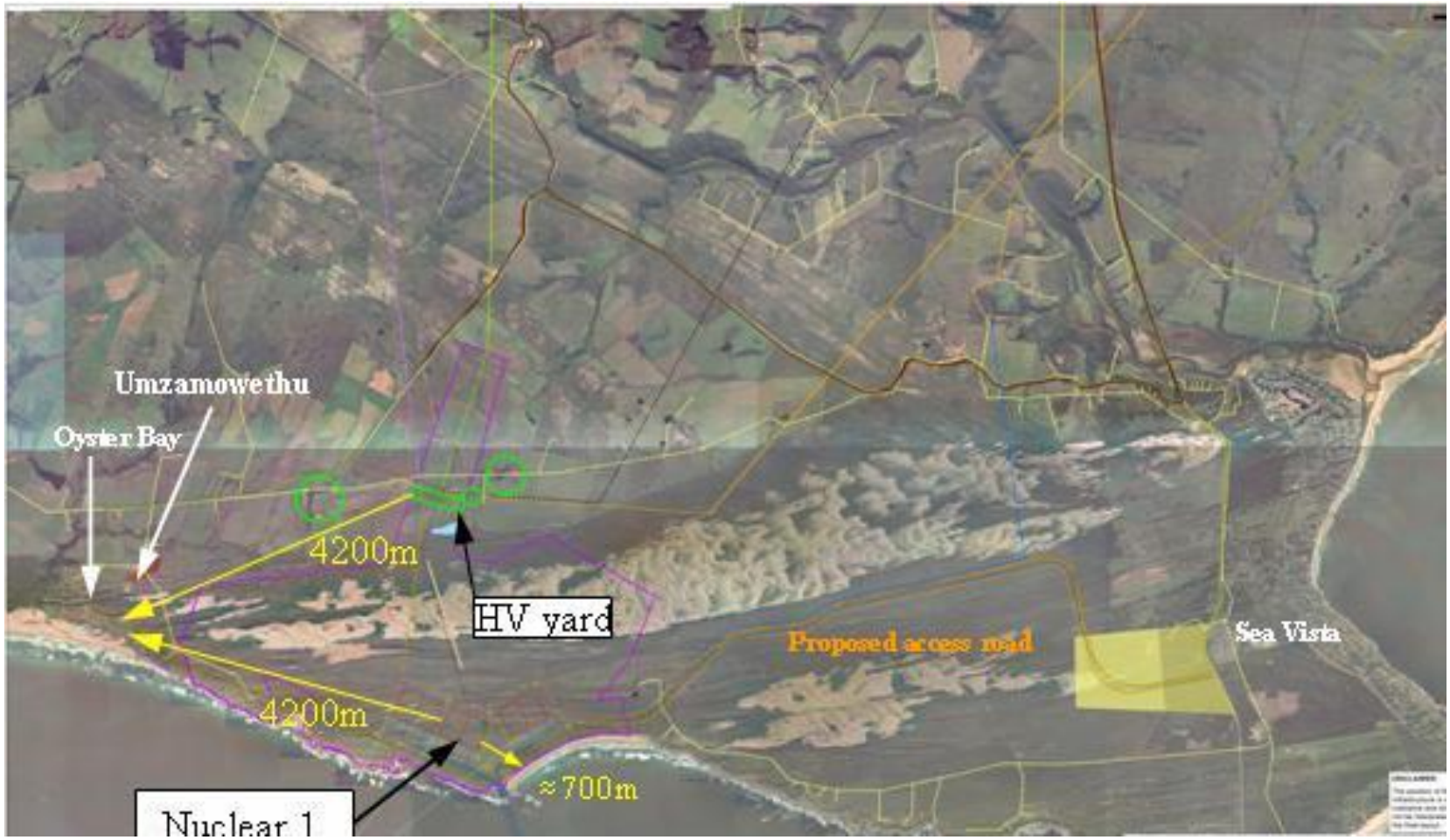


Figure 9-54: Distance to nearest noise-sensitive land uses at Thyspunt

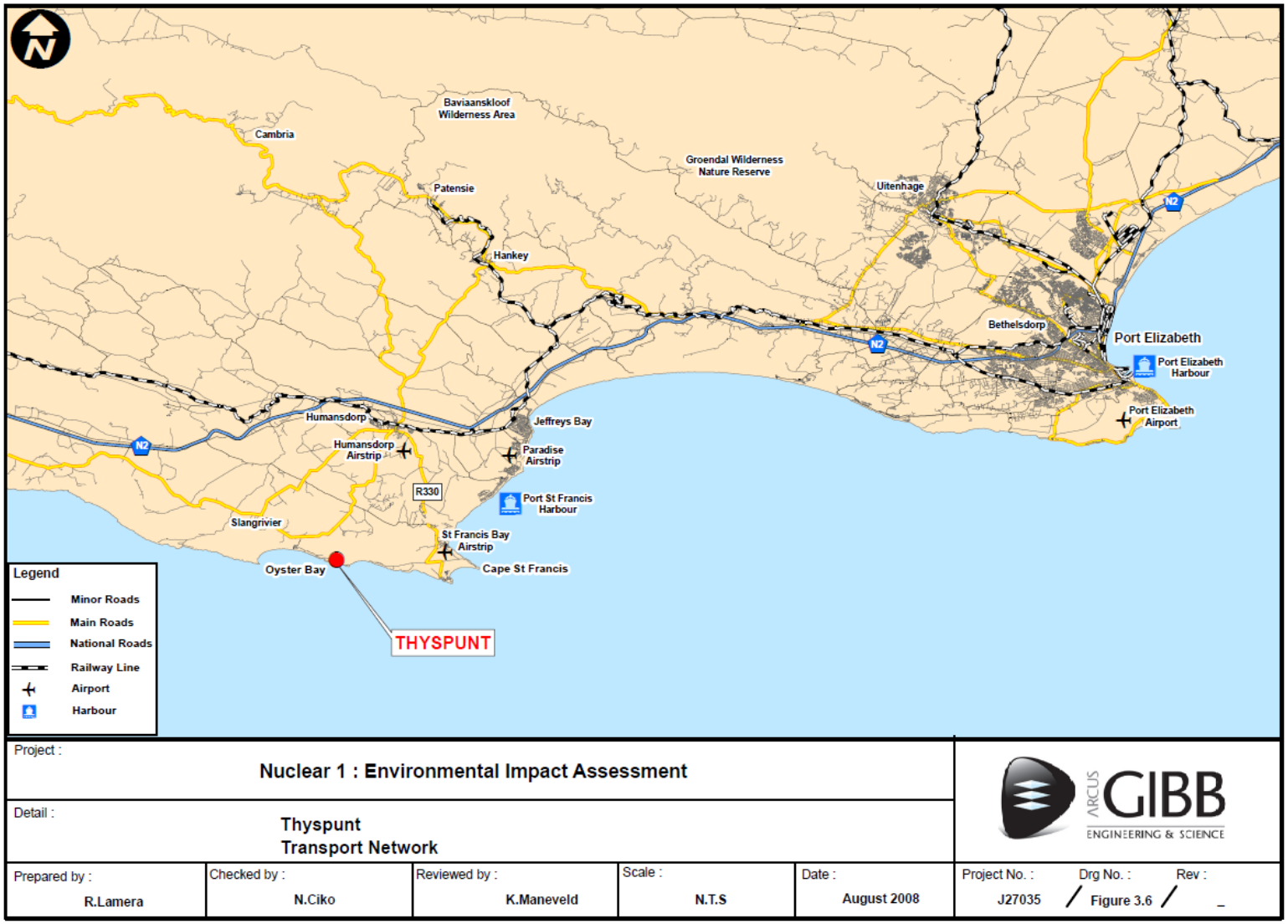


Figure 9-55: Thyspunt transport network

9.13 Sensitivity mapping of the alternative sites

Based on the environmental sensitivities discussed above, relevant specialists whose findings had implications for the sensitivity of the sites on the sites were required to map the sensitivities and indicate areas of highest sensitivity (where impacts would be most significant and where they would prefer that the power station should not be located. In this context, sensitivity refers to the ability of the particular resources to receive change (impact). High sensitivity implies that any change or activity will likely result in substantial impacts. Low sensitivity implies that changes are unlikely to result in substantial impacts.

Each specialist was requested to map sensitivities on a three point scale; namely low, medium and high sensitivity. Numerical values and colours were attached to these sensitivities (respectively 1, 2 and 3 or low, medium and high). The individual sensitivity maps of the relevant specialists were then overlaid in Geographic Information System software and the resulting composite numerical values were then divided into three equal categories to create composite sensitivity maps for each site, showing the overall environmental sensitivity for each site.

These composite sensitivity maps have important implications for planning and location of infrastructure on the sites, since the areas of lowest sensitivity are most suitable for development because they are likely to be subject to the lowest degree of impact. The results of the sensitivity mapping and overlays are indicated in **Figure 9-56** to **Figure 9-69** below.

Important:
It must be emphasized that these maps represent areas of relative or comparative environmental sensitivity per site and are useful to find zones of low environmental sensitivity on a site where impacts will be of low significance. However, sensitivities should not necessarily be compared across sites i.e. an area of medium environmental sensitivity on the Thyspunt site might not necessarily experience the same level of impact from disturbance as an area of medium sensitivity on the Duynefontein site.

9.13.1 Duynefontein sensitivity maps

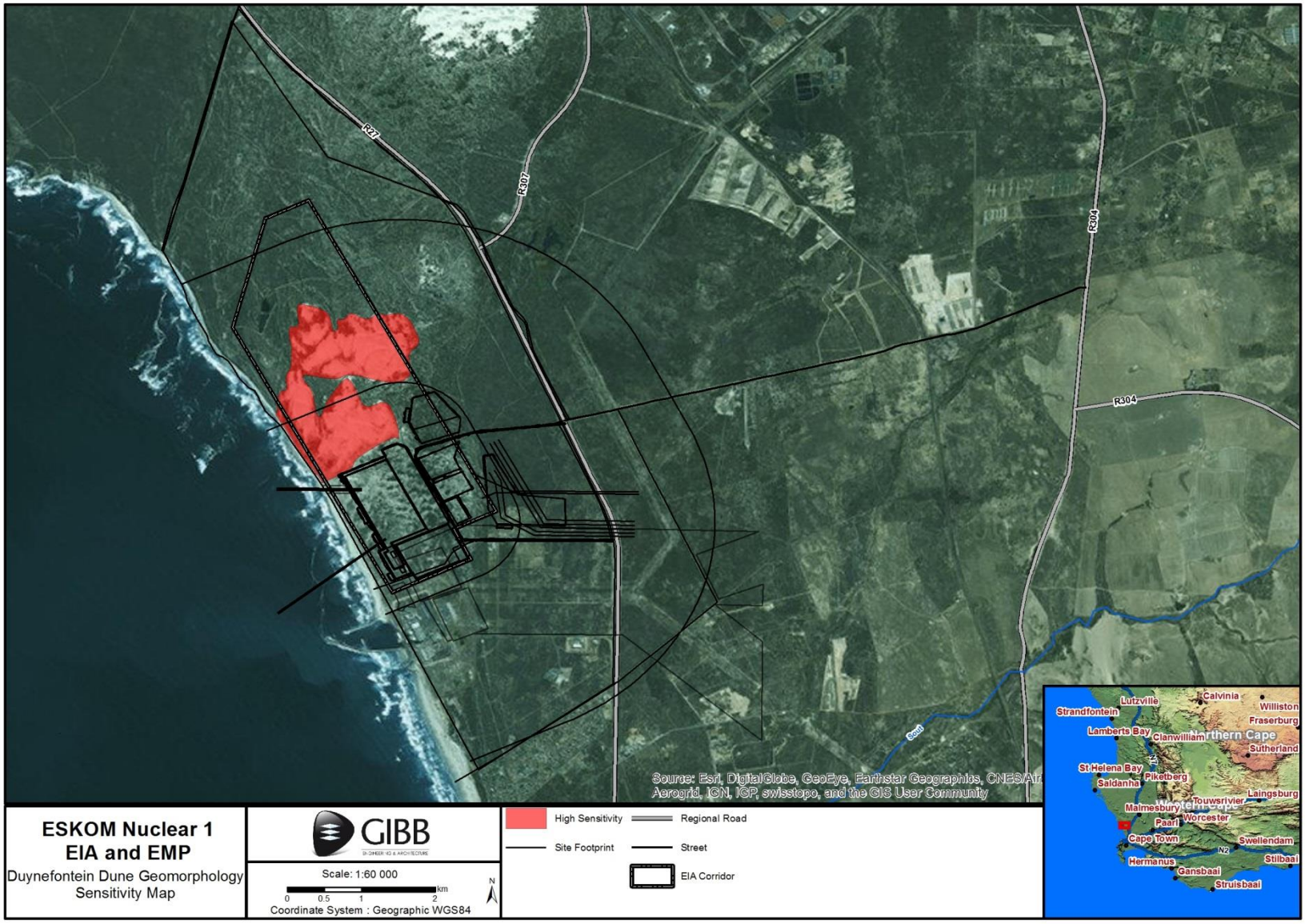


Figure 9-56: Duynefontein dune geomorphology sensitivity map

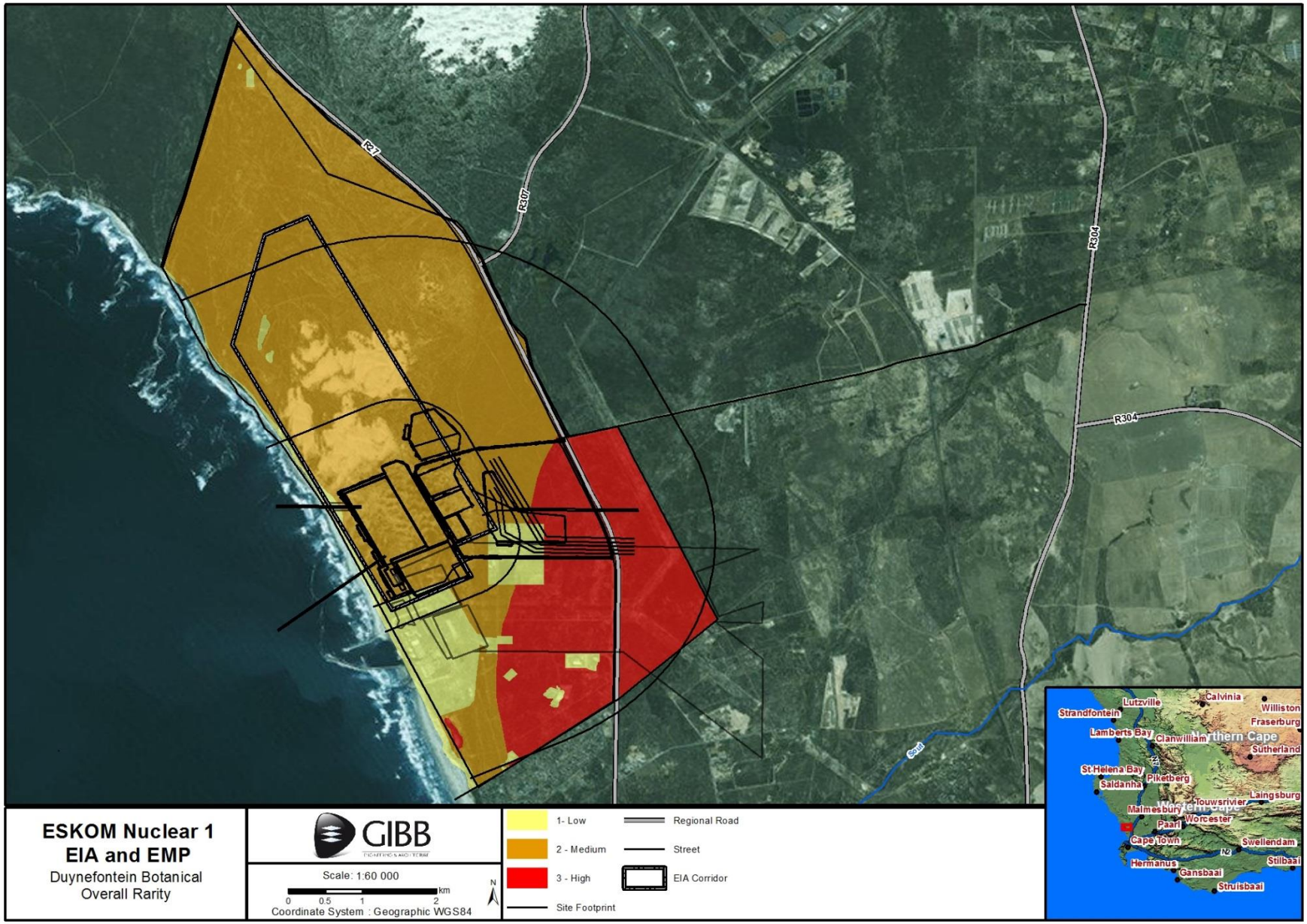


Figure 9-57: Duynefontein botanical rarity sensitivity map

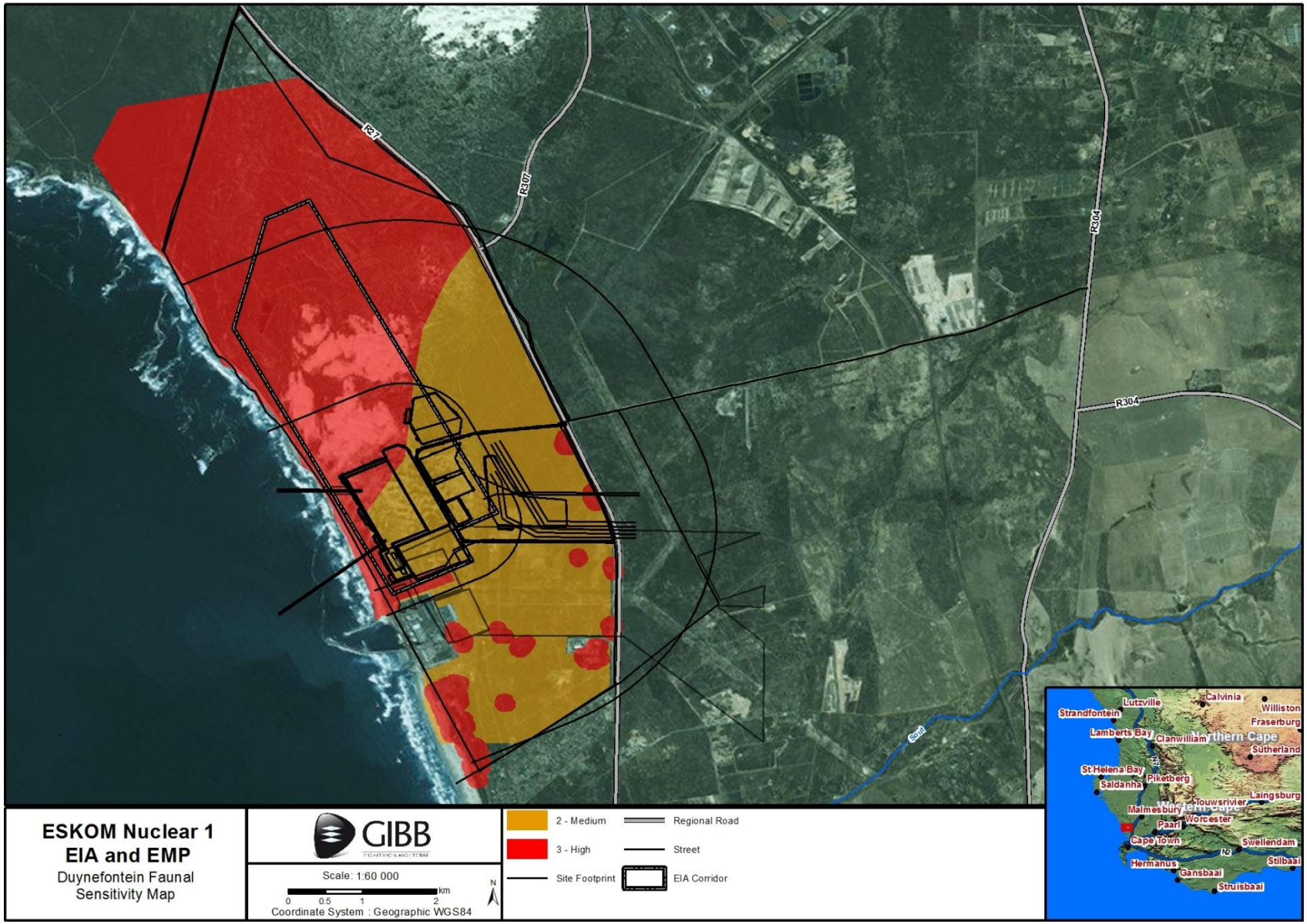


Figure 9-58: Duynefontein vertebrate fauna sensitivity map

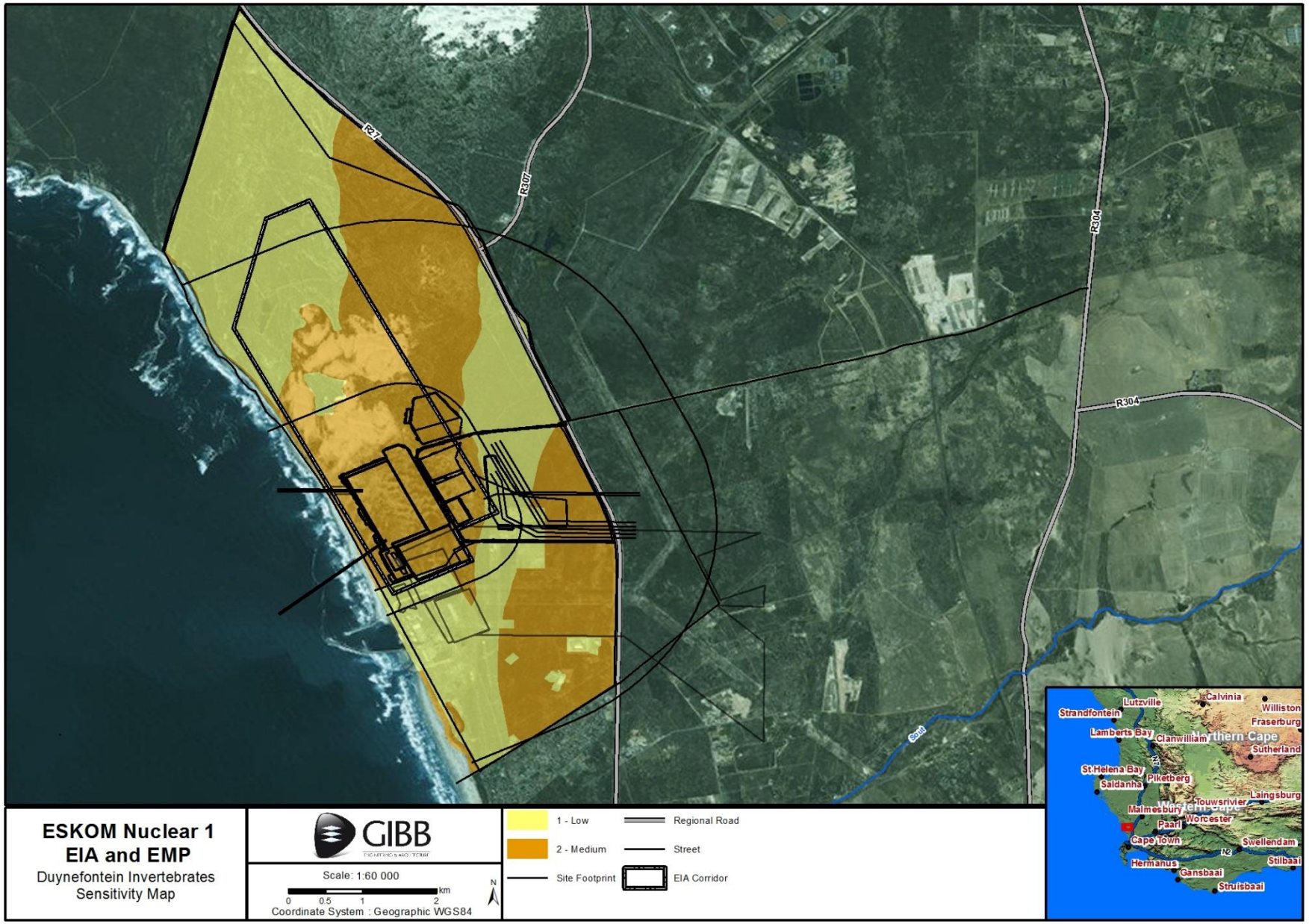


Figure 9-59: Duynefontein invertebrates sensitivity map

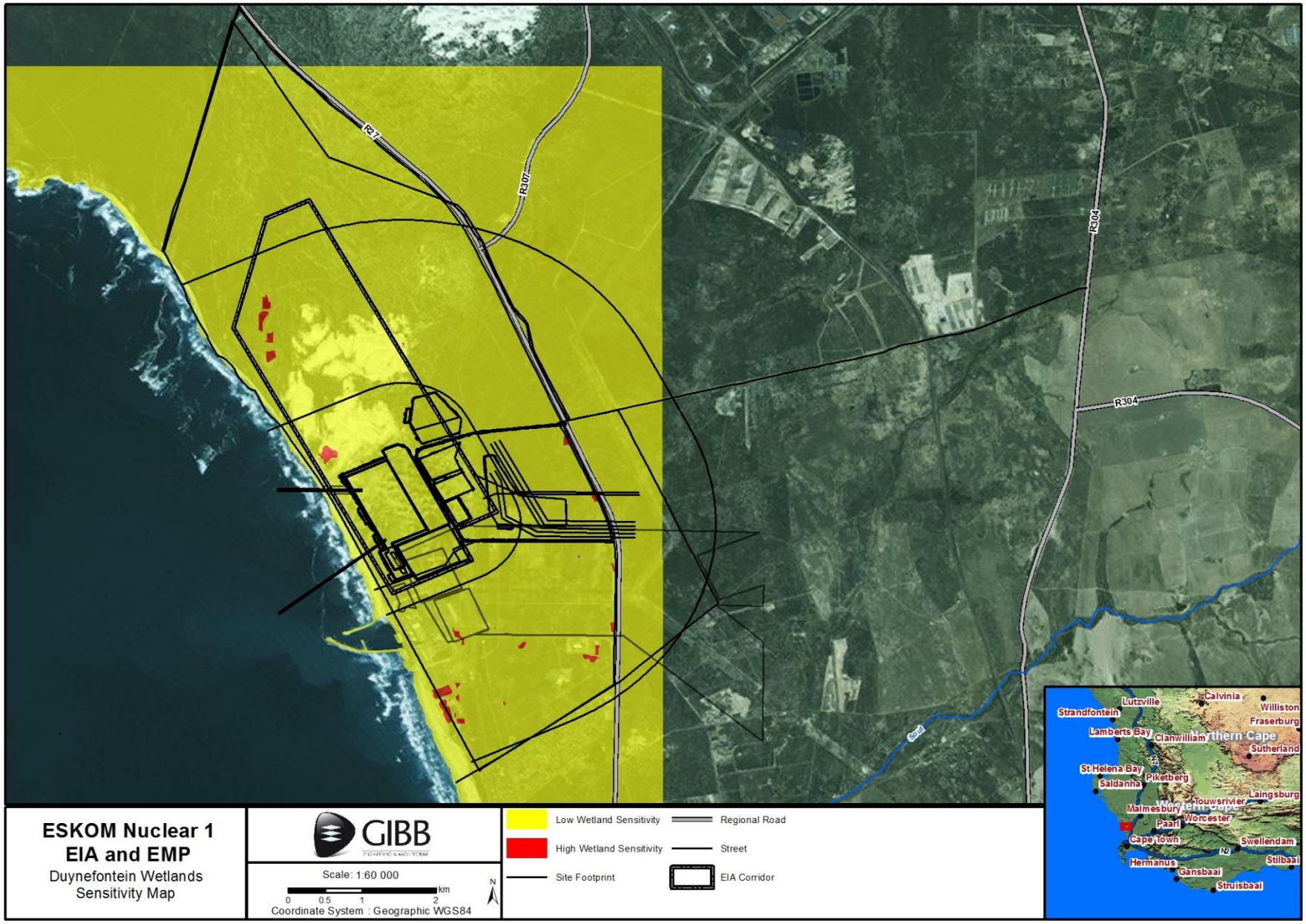


Figure 9-60: Duynefontein wetland sensitivity map

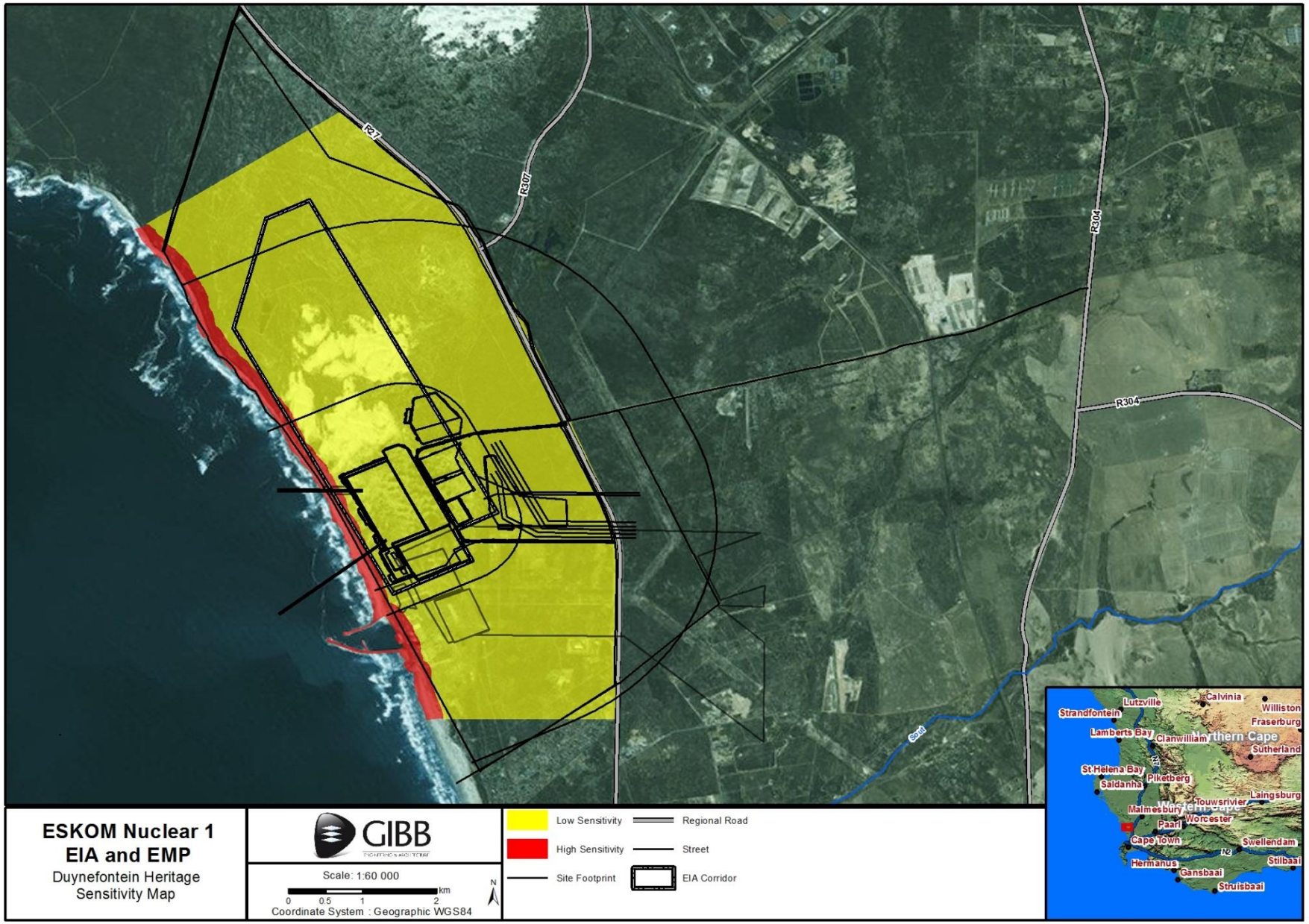


Figure 9-61: Duynefontein heritage sensitivity map

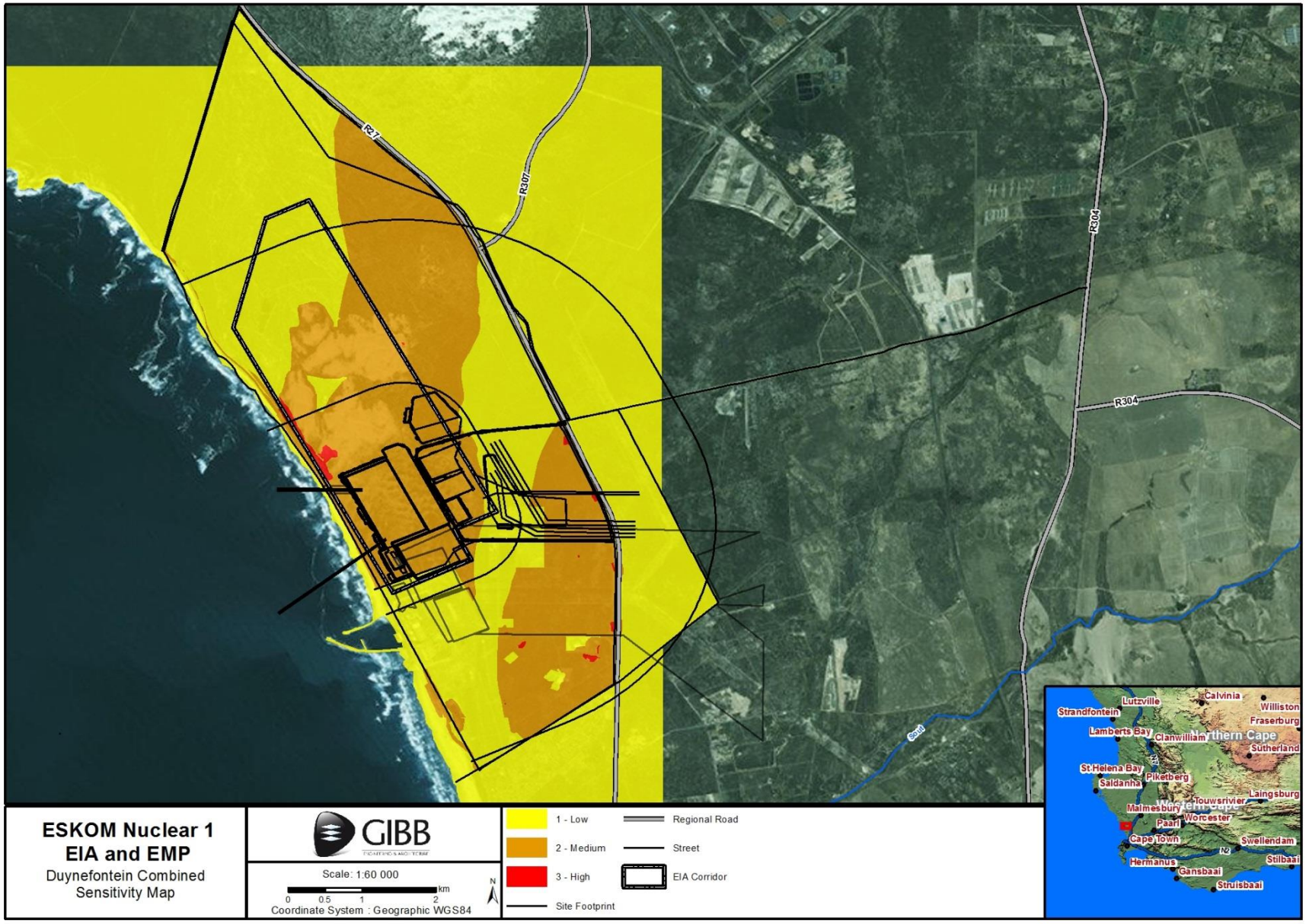


Figure 9-62: Duynefontein composite sensitivity map

9.13.2 Conclusion on Duynefontein environmental sensitivity

The combined sensitivity map for Duynefontein indicates that the majority of the EIA corridor, especially the southern portion thereof close to the KNPS, is an area of medium environmental sensitivity. The sensitivity categories that contribute the most to this area of medium sensitivity are botanical sensitivity, faunal sensitivity (the majority of the northern portion of the site is indicates to have a high faunal sensitivity) and invertebrates (the majority of the southern portion of the EIA corridor has a medium invertebrate sensitivity). It is only the far northern approximately 20% of the EIA corridor that has a low sensitivity.

In spite of the medium sensitivity in the southern portion of the EIA corridor (relatively higher than the northern portion of the EIA corridor), it still makes better sense from an environmental perspective to construct Nuclear-1 in the southern portion of the EIA corridor close to the KNPS, as it concentrates the impacts close to an area that has already been transformed. The area directly to the north of the KNPS has also been previously impacted by the construction of the KNPS, as it was used as a spoil dump site and subsequently revegetated. Developing Nuclear-1 as far south as possible also avoids impacts on the mobile portion of the Atlantis Dune Field. The mobility of this dune field was significantly affected at the time of the construction of the KNPS, as the power station was built in the southern portion of the dune field and the adjacent dunes were artificially stabilised by the planting of indigenous plants.

9.13.3 Thyspunt sensitivity maps

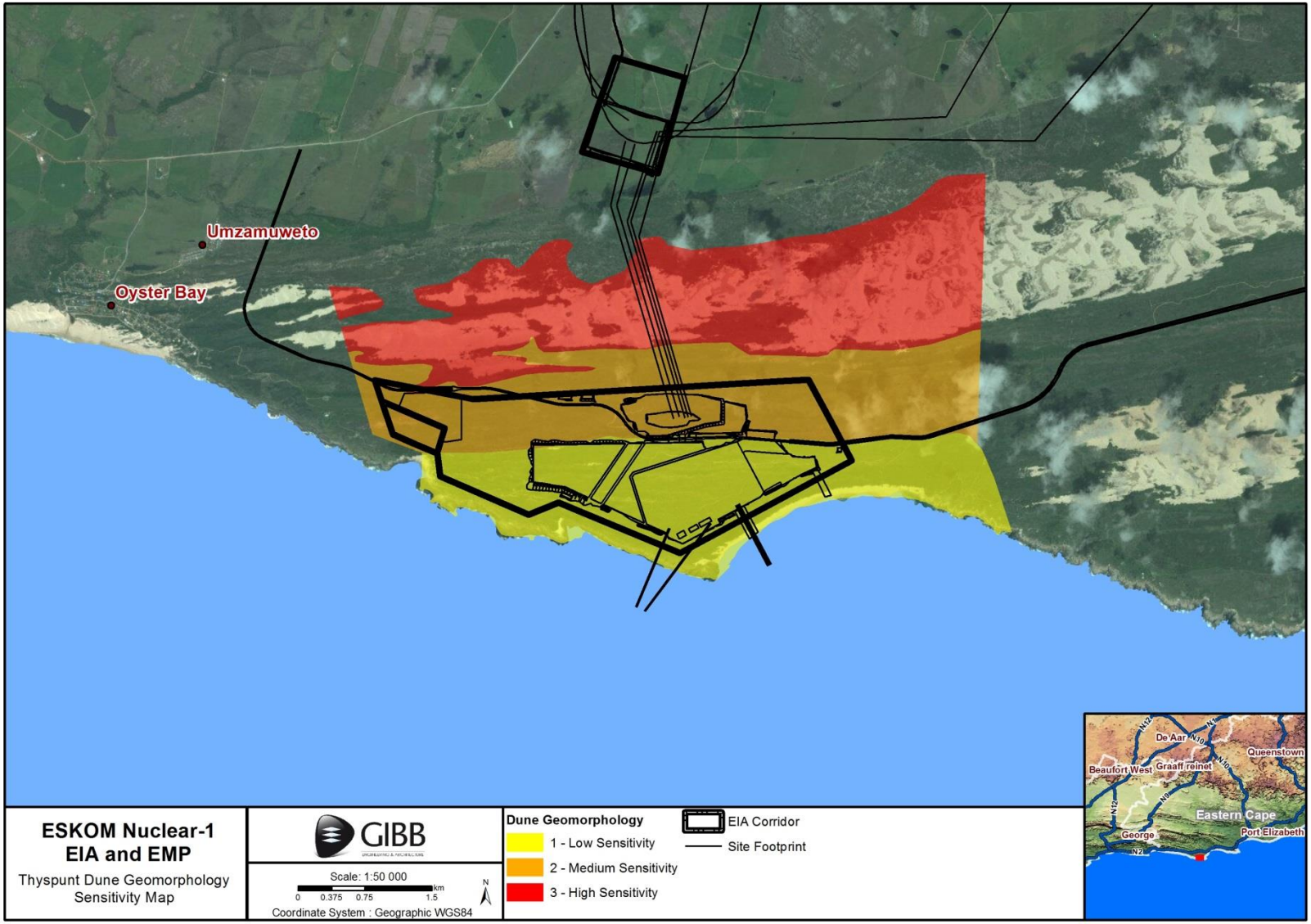


Figure 9-63: Thyspunt dune geomorphology sensitivity map

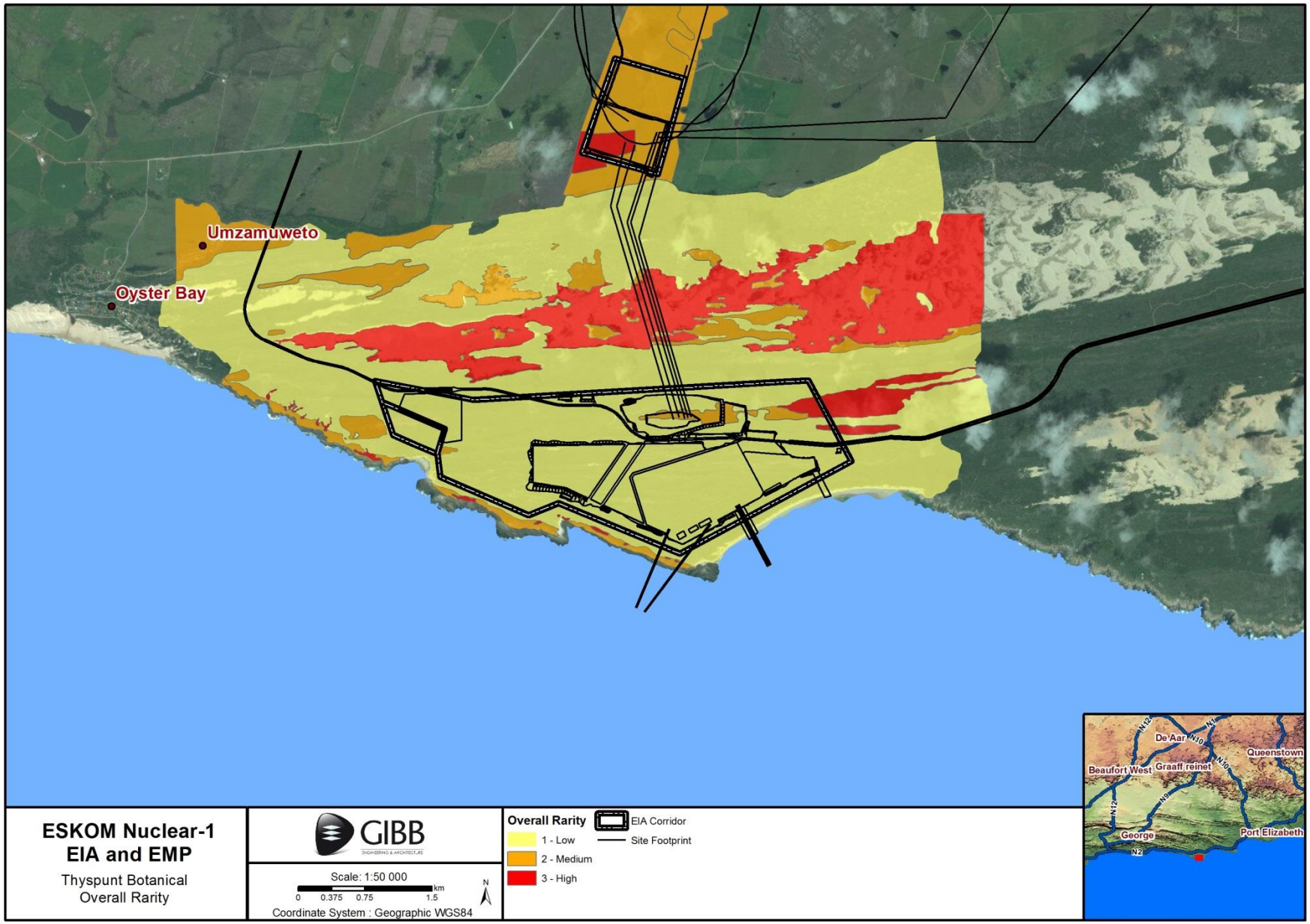


Figure 9-64: Thyspunt botanical rarity map

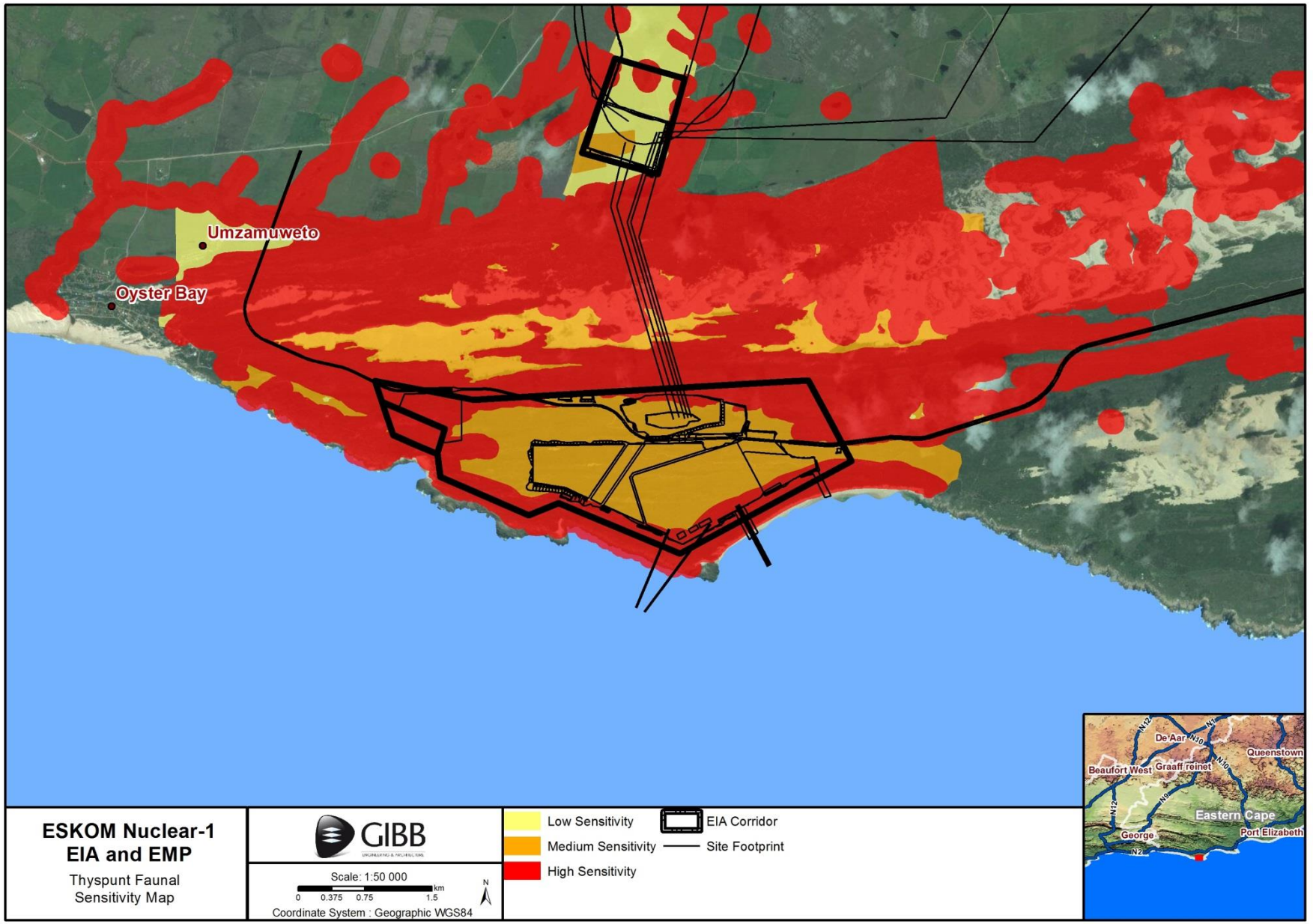


Figure 9-65: Thyspunt faunal sensitivity map

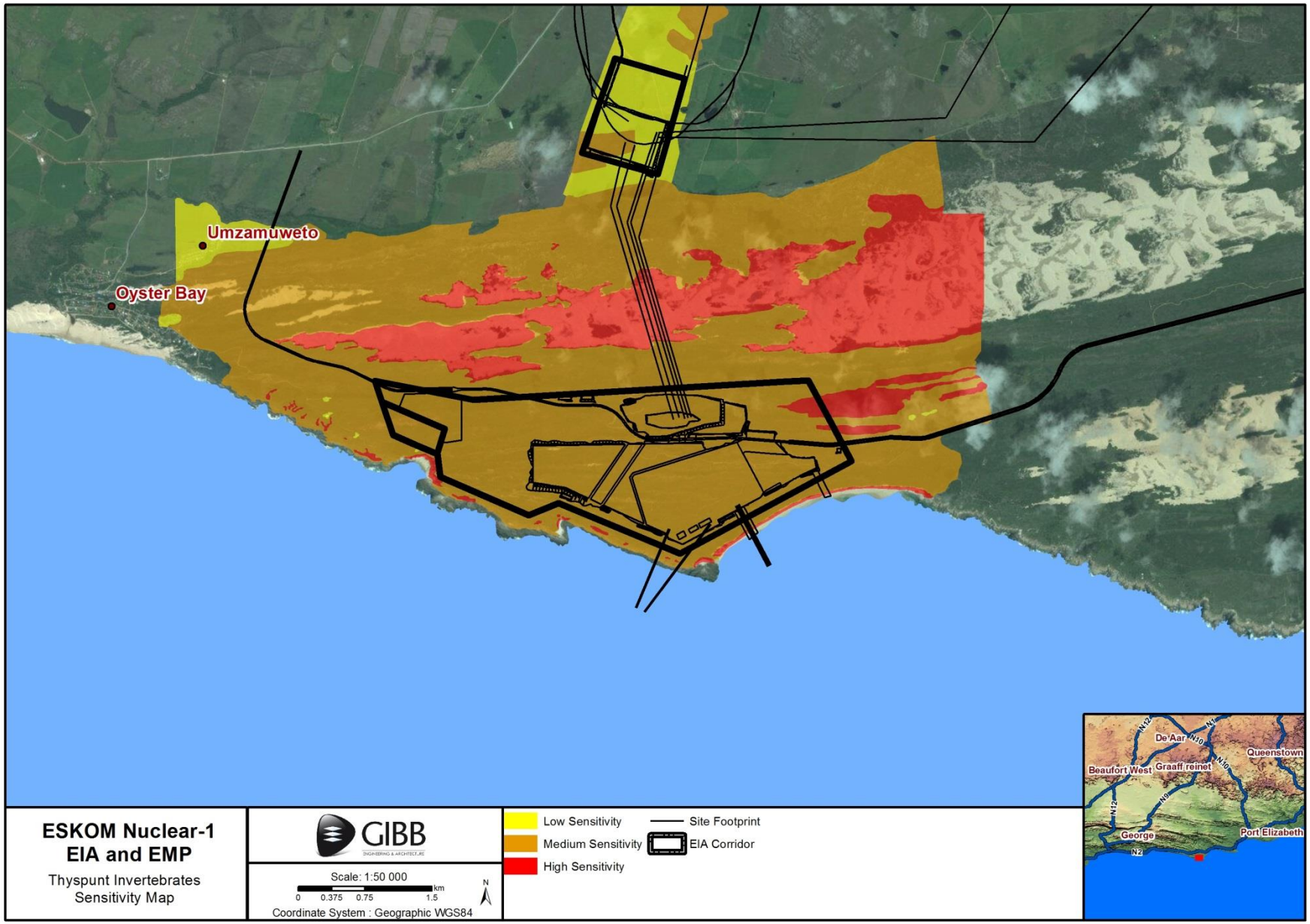


Figure 9-66: Thyspunt invertebrate sensitivity map

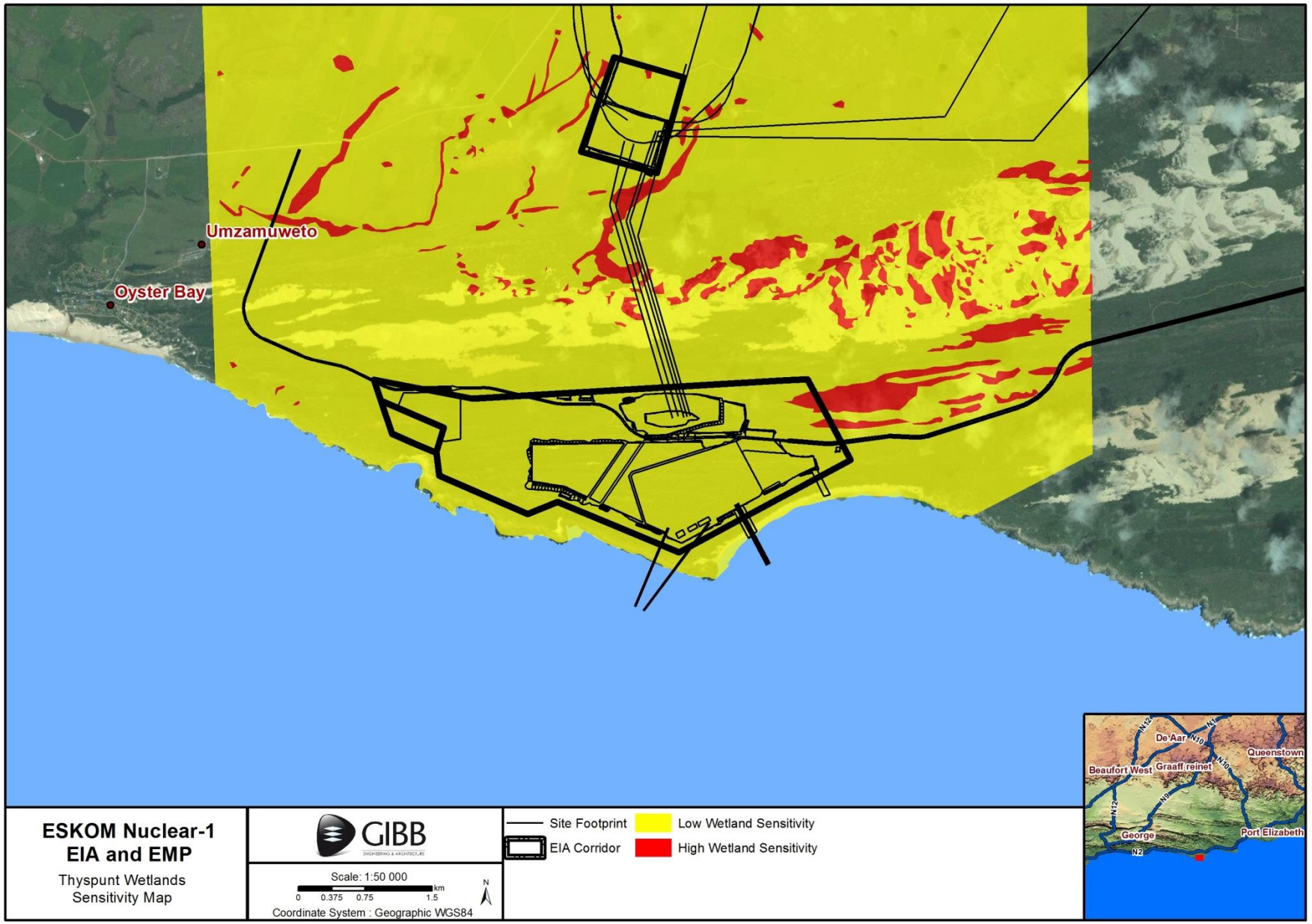


Figure 9-67: Thyspunt wetlands sensitivity map

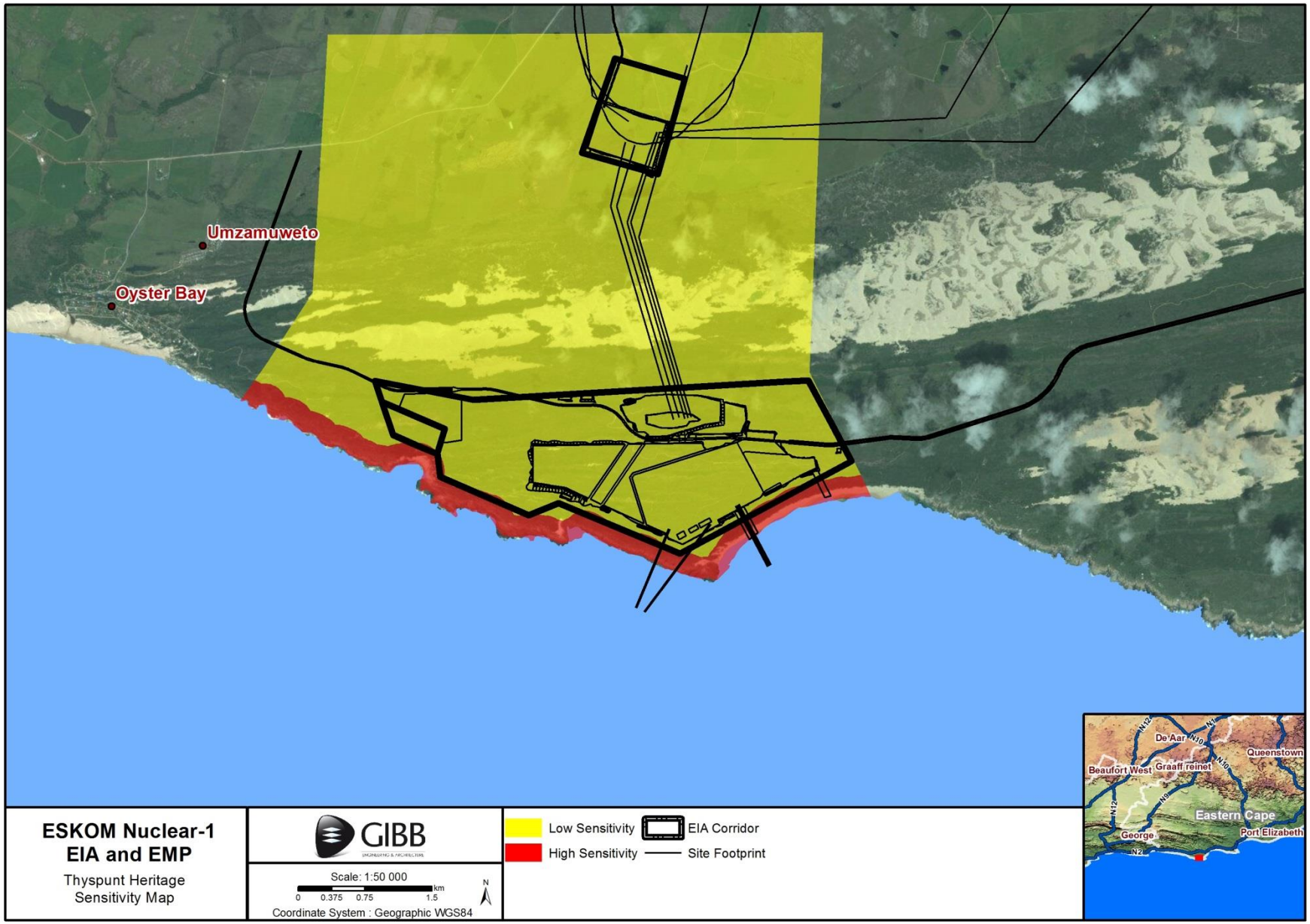


Figure 9-68: Thyspunt heritage sensitivity map

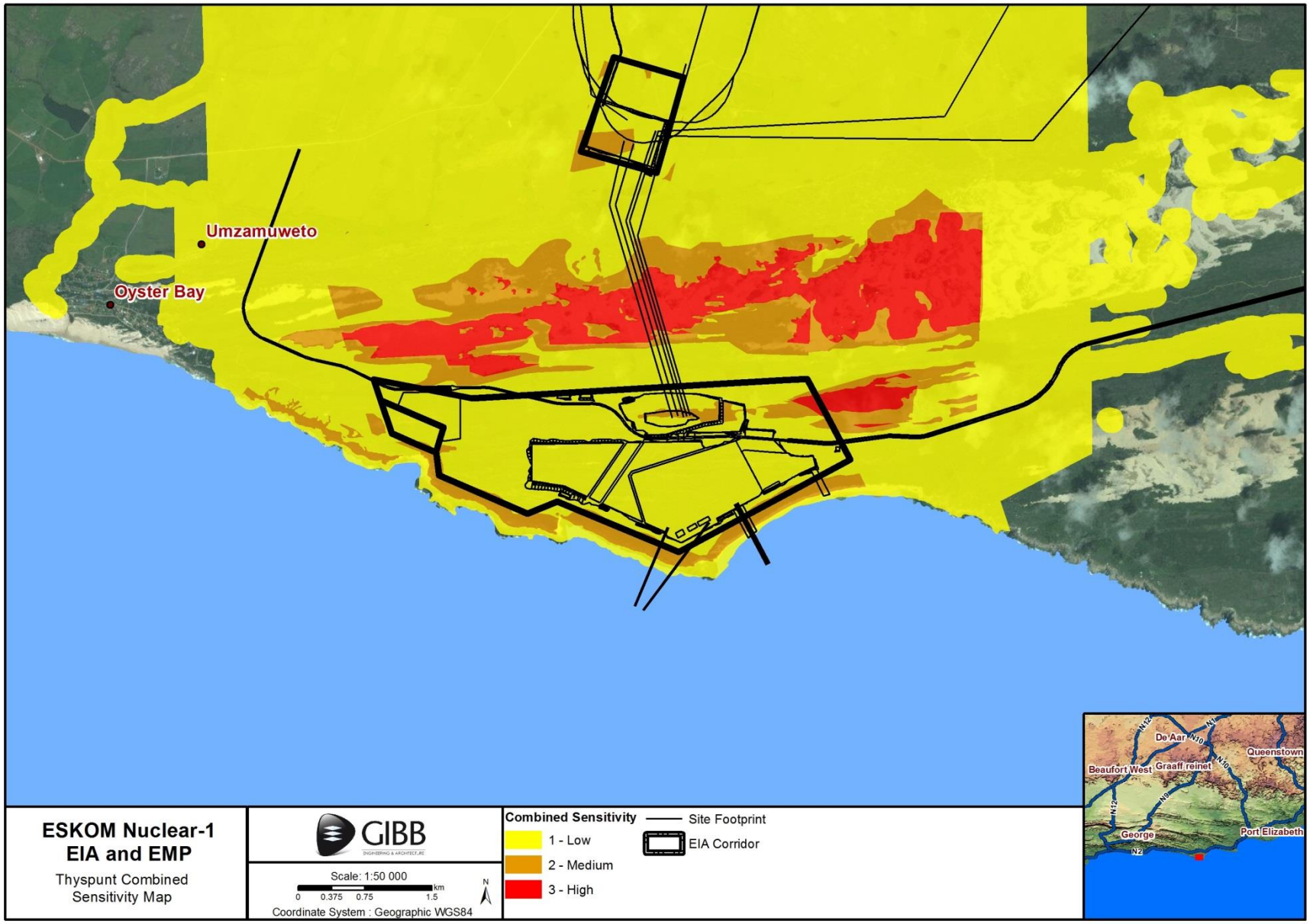


Figure 9-69: Thyspunt composite sensitivity map

9.13.4 Conclusion on Thyspunt environmental sensitivity

The southern portion of the Thyspunt site, south of the Oyster Bay Mobile Dune Field, has a relatively low environmental sensitivity whilst the dune field itself has a high environmental sensitivity. The dune field and the Langefonteinvlei wetland east of the EIA corridor are botanically sensitive, and both of these features are also sensitive in terms of wetland functionality. In terms of fauna the drainage lines have high sensitivity but the central portion of the EIA corridor has medium sensitivity. In terms of invertebrates the majority of the site has medium sensitivity, but the dune field and the Langefonteinvlei are sensitive. From a heritage perspective, the coastal strip is most sensitive while the inland portion of the EIA corridor is not sensitive.

The two most sensitive zones of the Thyspunt site are the Oyster Bay Mobile Dune Field across the northern portion of the site and the Langefonteinvlei wetland, to the east of the EIA corridor. The proposed position of the power station is therefore in the least environmentally sensitive portion of the site.

9.14 Systems Depiction of the Receiving Environment

Based on the specialist studies and assessment of the sites, specific components of the receiving environment can be determined. These components and the way they interact are common to both sites and also the fact that these interactions ultimately impact human well-being. It can be shown that certain components of this receiving environment will pose a risk to the Nuclear Power Station (*viz.* seismic activity) and similarly the power station will pose certain risks to the receiving environment. These risks are assessed within Chapter 10 of this Revised Draft Environmental Impact Report (RDEIR) Version 2.

Figure 9-70 illustrates the way the various components of the receiving environment interact with each other as well as outlining the key components of the receiving environment that pose a risk to the NPP. It can be seen that surface water runoff is a greater risk to the NPP at the Thyspunt site (due to potential debris flows etc) than at the Duynefontein site. Likewise seismicity is a greater concern at the Duynefontein site than at the Thyspunt site due to the site having a higher PGA. It should be noted that rise in sea level is considered to pose a risk to the NPP, however the power station has been located above the future high water mark as well as on a terrace. Therefore this component of the receiving environment is not considered to be of great concern to the NPP at either site.

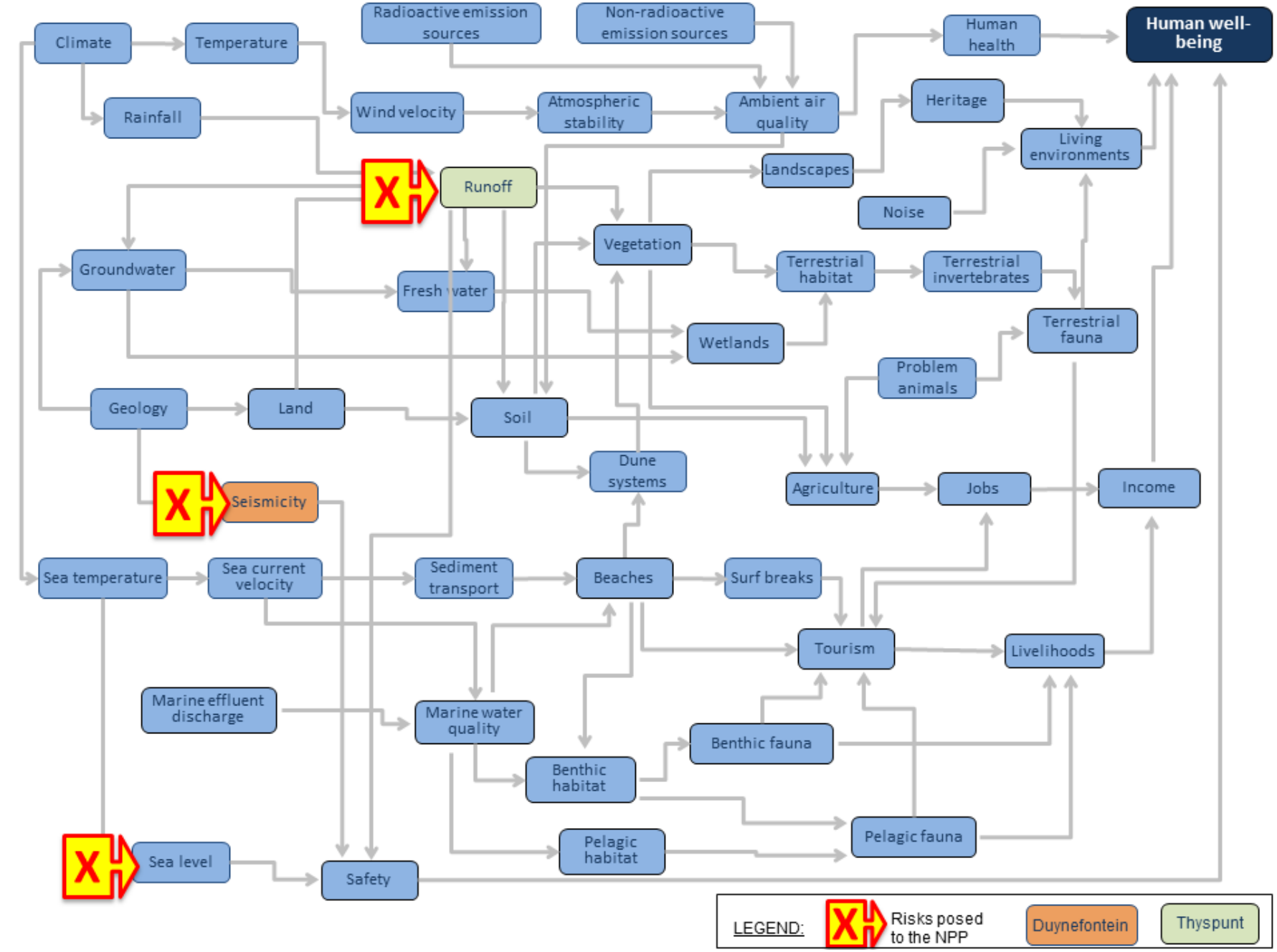


Figure 9-70: Systems Depiction of the Receiving Environment