9 ENVIRONMENTAL IMPACT ANALYSIS

9.1 Introduction

This chapter provides a summary of the potential impacts that have been assessed by the various specialists. The aspects and potential impacts assessed were based on a combination of the following:

- Issues identified by interested and affected parties during the public participation process;
- Issues identified by specialists as a result of background “desktop” research;
- Experience of relevant specialists with projects of a similar nature or in a similar environment; and
- Environmental resources and conditions identified by specialists during site surveys (i.e. field-based ground-truthing).

Mitigation discussed here are a high level, and not all detailed mitigation measures are reflected in this Chapter. However, all relevant mitigation measures identified in specialist reports have been incorporated into the Draft Environmental Management Plan (EMP) in **Appendix F**.

Three main categories of potential impacts are considered:

- Firstly, potential impacts that the environmental conditions may have on the development i.e. aspects related to the suitability of the environment for development (**Section 9.3** to **9.7**). These studies include the following:

    - Geology and geological risk assessment;
    - Seismological risk assessment;
    - Geotechnical suitability assessment;
    - Hydrological assessment;
    - Geo-hydrological assessment; and
    - Freshwater supply study.

- Secondly, potential impacts of the development on the biophysical environment (**Section 9.8** to **9-15**). These studies include the following:

    - Air quality and climate assessment;
    - Dune Geomorphology assessment;
    - Botanical assessment;
    - Freshwater ecology (wetland) assessment;
    - Terrestrial vertebrate fauna assessment;
    - Terrestrial invertebrate fauna assessment; and
    - Marine biology assessment.

- Thirdly, potential impacts of the development on the social and economic environment (**Section 9-16** to **9-27**). These studies include the following:

    - Economic impact assessment;
    - Social impact assessment;
    - Visual impact assessment;
    - Heritage impact assessment;
    - Agricultural impact assessment;
    - Tourism impact assessment;
    - Noise impact assessment;
    - Human health risk assessment;
    - Transportation assessment;

- o Emergency response;
- o Site control and access; and
- o Impacts of nuclear waste disposal.

Apart from the above-mentioned potential impacts, factors relating to the integration of electricity produced at the nuclear power station into South Africa's electricity transmission network have also been considered (**Section 9-27**).

The Chapter has been structured firstly by impact category (e.g. botanical impacts, impacts on fauna, impacts on invertebrates, etc.) then by site and lastly by project phase. Tabular ratings of potential impacts are provided, together with a short discussion about the impact. However, for a full discussion of potential impacts, readers are referred to the relevant technical specialist studies (**Appendix E**).

9.2 Assumptions and limitations

The key assumptions and limitations (i.e. uncertainties and gaps in knowledge) relevant to the EIA Phase are discussed below.

9.2.1 Limitations

The following limitations are relevant to the study:

- The initial application was for a single site (one of three alternative sites). During the course of 2009, Eskom announced its intention to apply for a combined authorisation for the construction, operation and decommissioning of a nuclear power station on all three alternative sites, based on the expected changes to EIA legislation. However, at the time of writing, such amendments had not yet been promulgated and the application has therefore reverted to the original application for authorisation of a single site. Such changes in approach may be confusing to members of the public. The changes in approach to the application are explained in **Chapter 1**.
- As a result of the timing of the Applicant's request to continue with the EIA Phase in 2009, the commencement of fieldwork for specialist studies has in some instances been undertaken outside of the ideal season sampling season. In such cases, additional fieldwork in the appropriate season has been commissioned to ensure adequate confidence in the specialist's predictions. Ongoing future studies have been and will continue to be commissioned by Eskom in the future to add to the technical knowledge-base, against which on-going monitoring can be undertaken.
- At the time that the economic impact assessment was prepared, the results of the seismic risk assessment were not yet available. Therefore, potential costs associated with the design and construction of a structure that would be able to withstand seismic risks has not been included in the economic impact assessment (**Appendix E17**).
- Limitations as documented by technical specialists in **Appendices E2 to E27**, but not listed here.
- The proposed emergency planning zone of 800 m radius around the proposed power station places limitations on the degree to which the power station footprint can be moved around on the site to adapt to the site's environmental sensitivities. The power station may not be any closer than 800 m from a public road. This places restrictions especially at the Bantamsklip site, where a public road divides the site virtually equally into a southern and northern portion.
- It is a requirement of Section 32(2)(e)(iv) of the EIA regulations (Government Notice No. R 385 of 2006) that the EIR must include copies of any representations, objections and comments received from registered Interested and Affected Parties (I&APs). In this instance, all such representations, objections and comments are included verbatim in the Issues and Response Reports (IRRs) appended to this Report. Inclusion of the original written comments as appendices to the report is

impractical due to the volume of these documents. Therefore, these documents will be made available for viewing on request by the public participation office (ACER Africa), if required.

9.2.2 Assumptions

The following assumptions are relevant to the study:

- At the time of compiling the EIR, Eskom had not yet decided on a vendor for the supply of nuclear power station equipment. Thus, an "envelope" of data was used. This envelope includes the highest possible values for various aspects for a range of different nuclear technology vendors. It is assumed that the design specifications of the proposed plant by the approved vendor will conform to the "envelope". If any of chosen vendor's power station characteristics fall outside of the specified envelope, it may have to be re-assessed from an environmental point of view (depending on the degree of variance).
- It has been assumed that mitigation measures identified in this EIR, the EMP and in specialist studies will be effectively implemented and continual improvement in environmental outcomes through methodology, technology etc. be implemented.
- It is assumed that should authorization be granted for the construction, operation and decommissioning of a nuclear power station any of the alternative sites, Eskom will manage access to the power station site. It is further assumed that Eskom will manage the remainder of the site assessed in this EIA (i.e. outside the 31 ha), as well as any additional land purchased or managed by Eskom (e.g. servitudes purchased over adjoining land) for conservation purposes.
- It is assumed that the NNR (being mandated by the NNRA) will respond to Eskom's formal application for a nuclear installation license for the siting, construction, operation, decontamination and decommissioning of the proposed nuclear power station and that the proposed nuclear power station will not be constructed before this license is obtained.
- As advised by the DEA and in terms of the Constitution of the Republic of South Africa (Act No. 108 of 1996) and the NEMA, it is assumed that the DEA is responsible for assessing the potential impacts of the power station on the environment. It is further assumed that in recognition of the dual but distinct responsibility with respect to the assessment of radiation hazards, the DEA, is the lead authority on environmental matters and the NNR is the decision-making authority with respect to radiological issues. It is further assumed that the DEA and the NNR will work in close collaboration on the assessment of nuclear related matters with respect to Nuclear-1 and that specialist studies relating to radiological issues have been included for information in this EIR, as the DEA will not consider radiological impacts in decision-making.
- Any infrastructure not specified in this EIR and the Application Form (and it revision) fall outside the scope of the application for authorisation.
- Authorisations other than the EIA authorisation (e.g. water use licenses, authorisations for heritage site excavations, borrow pit authorisations, licenses for the removal of protected trees, waste permits and other plans, etc.) falls outside the scope of this application. The Applicant will apply for these authorisations through separate processes.
- The EMP will be regarded as a dynamic document and will be kept updated by the Applicant as new information becomes available.

FACTORS INFLUENCING THE SUITABILITY OF THE SITES FOR A NUCLEAR POWER STATION

9.3 Geotechnical suitability of the sites

The geotechnical assessment assesses the suitability of the soil and geological conditions for the construction of structures. The geotechnical assessment was based on a desk study of historical information as well as on extensive data gathered through intrusive field investigations.

9.3.1 Duynefontein

The key findings of the geotechnical investigation at Duynefontein are as follows:

- 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, and 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, siltstone 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.

9.3.2 Bantamsklip

The key findings of the geotechnical investigation at Bantamsklip are as follows:

- The site soil profile varies less in thickness than the Thyspunt site as one moves inland, ranging from 0 m thick (at the sea) to almost 20 m thick within the dune area;
- The geotechnical properties of these soils are consistent across the site and significant calcretised zones are encountered;
- The groundwater table is situated just above the bedrock;
- The soils have no cohesion and when saturated, will require innovative slope stabilisation techniques for any proposed excavations, but the presence of calcrete will provide some assistance in this regard;
- The bedrock is dominated by quartzitic sandstones of the Peninsula Formation; and
- These quartzitic sandstones are highly jointed, but competent and present a more competent wave cut platform than at Thyspunt.

9.3.3 Thyspunt

The key findings of the geotechnical investigation at Thyspunt are as follows:

- 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
- An 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 Conclusion

Potential environmental impacts that could alter the functioning of the natural geotechnical environment are related to:

- Slope instability in rocks and soils during and post construction resulting in safety risks to people and to a lesser extent the environment;
- Geotechnical conditions (and specifically overburden thickness and groundwater profiles) dictating that large site disturbances will occur in excavations (that will need to be battered back to angles in the range of 20º); and
- The disposal of excavated spoil.

The potential impacts related to slope stability imposing safety risks without mitigation measures have low significance and consequences at all of the sites, as slope stability design techniques will be employed to deal with these issues. Standard slope stabilisation techniques in sands will almost certainly mean that excavated slopes will need to be battered back to flat angles (i.e. cut back to acute angles in the range of 20º) to limit the potential for slope failure. This leads to the overriding impact (resulting from flat slope angles) of larger volume excavations being required, leading to larger excavation footprint disturbances and a need for disposal of greater volumes of spoil. The potential impacts associated with this are of significance at varying degrees on all of the sites depending on the final footprints chosen.

Table 9-1: Geotechnical suitability at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Soil slope failure leading to safety risks										
Without mitigation	Negative	Local	Medium	Short term	Probable	Medium	Yes	Medium	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	Medium	Yes	High	Low	**Low**
Failure of rock slopes leading to safety risks										
Without mitigation	Negative	Local	Low	Short term	Probable	High	Yes	Medium	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	High	Yes	High	Low	**Low**
Excessive site disturbance resulting in environmental damage										
Without mitigation	Negative	Local	Medium	Medium term	Definite	Medium	No	High	High	**Medium**
With mitigation	Negative	Local	Medium	Short term	Improbable	High	No	High	High	**Medium**

Table 9-2: Geotechnical suitability at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Soil slope failure leading to safety risks										
Without mitigation	Negative	Local	Low	Short term	Improbable	High	Yes	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	High	Yes	High	Low	**Low**
Failure of rock slopes leading to safety risks										
Without mitigation	Negative	Local	Low	Short term	Improbable	High	Yes	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	High	Yes	High	Low	**Low**
Excessive site disturbance resulting in environmental damage										
Without mitigation	Negative	Local	Low	Medium term	Definite	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	High	No	High	Low	**Low**

Table 9-3: Geotechnical suitability at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Soil slope failure leading to safety risks										
Without mitigation	Negative	Local	Medium	Short term	Highly Probable	Medium	Yes	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	High	Yes	High	Low	**Low**
Failure of rock slopes leading to safety risks										
Without mitigation	Negative	Local	Medium	Short term	Highly Probable	Medium	Yes	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	High	Yes	High	Low	**Low**
Excessive site disturbance resulting in environmental damage										
Without mitigation	Negative	Local	High	Medium term	Definite	Medium	Yes	High	High	**Medium**
With mitigation	Negative	Local	High	Medium term	Highly Probable	Medium	Yes	High	Medium	**Medium**

9.4 Seismic suitability of the sites

Stress release in the earth's crust causes movement along faults at surface or at depth, resulting in earthquakes with noticeable to severe ground movement especially in unconsolidated media. Seismic shockwaves and aftershocks are transmitted with velocities and amplitudes dependent on the rock media through which they travel. The design of a nuclear facility has to be able to survive a "design basis" seismic event, which is determined by the characteristics of the site. It is possible to engineer a design capable of meeting the seismic criteria (generally accepted internationally to be in the order of 0.3 g Peak Ground Acceleration [PGA] for intra-plate sites similar to South Africa) and therefore the safety requirements. There is no physical upper limit for the seismic design of a nuclear power stations, but increasing the specification to seismic criteria above 0.3 g increases both cost and time required for design of the power station[1].

The assessment of potential environmental impacts related to the seismic risk associated with a nuclear power station is significantly interrelated to other areas of impact assessment, particularly geology and geotechnical factors. Hence, much of the work involved in the characterisation of the seismic hazard at a particular site is involved with the identification of seismic sources, characterization of their activity, development of attenuation of ground motion between the source and the power station site, and the site response below the Nuclear Island.

9.4.1 Objectives

The objective of the seismic hazard analysis is to:

- develop the design basis and beyond design basis seismic events;
- develop the design basis and beyond design basis ground motion;
- screen the site for surface rupture;
- investigate the site for consequential effects such as liquefaction of sands, slope instability, ground settlement, fire and flooding etc. which need to be designed out;
- ensure that the vendor's nuclear power station is suitable for the site and that the site/ nuclear power station are licensable to the NNR requirements; and
- incorporate lessons learnt from experience e.g. the 2007 earthquake which caused shutdown of the Kashiwazaki Kariwa nuclear power station in Japan.

Once the seismic hazard has been developed for a site, it must be determined whether a standard export nuclear power station can be built on the site. The greater the margin between the site seismic design basis (i.e. the demand) and the nuclear power station seismic design basis (i.e. the capacity) the less risk involved. This is particularly so in the case of nuclear power station sites in South Africa where the seismic hazard analysis are still to be confirmed by an international accepted procedure such as the Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 study.

A "design basis seismic event" is an event that is used in the conservative design of systems and components of the nuclear power station that are important to safety. For a standard nuclear power station it is the seismic event against which the standard design is verified to ensure that the power station can be built on the specific site under consideration. A "beyond design basis seismic event" is an event that is used to ensure that there are no 'cliff edge' effects in the power station design to endanger the fundamental safety functions..

[1] The Koeberg Nuclear Power Station aseismic bearings are understood to have added 10% to the civil construction cost of the plant and the extra design and analysis required for such a system could increase the overall project schedule by some 24-36 months (*pers. comm*. Dave Nicholls, Nuclear Engineer Eskom).

9.4.2 Methodology

With the revival of interest in nuclear power generation around the world, the regulations relating to the assessment of seismic hazard have recently been revised, resulting in a new approach to the determination of the seismic design basis nuclear power stations. The United States' Nuclear Regulatory Committee (USNRC) Regulatory Guideline RG 1.208 is currently considered as one of the leading and appropriate methodologies to use in the definition of site-specific probabilistic seismic hazard analysis (PSHA). The PSHA is the internationally accepted methodology for assessing the seismic hazard at a specific nuclear power station site as it caters for the uncertainties inherent in the understanding of the seismo-tectonic environment, as well as the completeness of the seismic catalogue.

In areas such as South Africa where the rate of seismic activity is low and the history of recorded seismic events is limited to a number of decades, RG 1.208 recommends the use of experts whose diverse opinions on the distribution of seismic sources in the region surrounding a particular site are used to develop a range of seismo-tectonic models for the PSHA.

Eskom has adopted RG 1.208 as the standard for the recalculation of the seismic hazard at the three sites under consideration for Nuclear-1, with the intent of undertaking SSHAC Level 3 studies on each of the sites.

The SSHAC level 3 studies are expected to either confirm or supersede the existing palaeo-seismic studies and probabilistic seismic hazard analyses that were developed for the sites prior to 2006. These studies will:

- Reconfirm existing seismic sources, particularly those off-shore;
- Attempt to determine the age of last movement for seismic sources comprising geological features;
- Establish/ confirm the activity rates for the seismic sources;
- Attempt to improve the attenuation relationships currently used in South Africa by analyzing local data; and
- Develop ground motions which can be used for nuclear power station design, based on the dominant earthquakes expected to influence each of the sites.

In addition, the site response at the underside of the foundation for each of the sites will be developed based on geological, geotechnical and geophysical data. The acquisition of these data will also be part of the SSHAC level 3 study.

To date no seismic hazard disqualifiers have been identified on any of the sites. However, there remains a possibility that the SSHAC level 3 studies could increase or decrease the seismic hazards. As the SSHAC process will only be completed within the next 2 to 3 years, it is likely that development on the first site will already have begun and hence, to minimize risk it is recommended that the site currently having the lowest assessed seismic hazard be developed first.

The seismic hazard varies between the three sites and is discussed separately for each site. A summary of the comparison of seismic suitability of the sites is summarised in **Table 9-4** below.

9.4.3 Duynefontein

(a) Vibratory ground motion

Recent geo-scientific surveys served to largely confirm the position of known faults and delineate some new features within the Duynefontein Site Region area, Site Vicinity area and the Site Area. The prime objective of the surveys around Duynefontein was to find evidence of a fault that could have been responsible for the 4 December 1809 event which occurred in the vicinity of Milnerton. Several candidates have been identified offshore, but the onshore extension of these structures remains uncertain. The multibeam echo-sounder surveys conducted as part of this study resulted in a more accurate position for the fault scarp known to have been located about 8 km from Duynefontein site with a number of additional faults being identified.

Since nuclear power stations are designed to stringent seismic requirements (which consider an earthquake having a probability of exceedance in the order of $1x10^{-4}$ per annum as the design basis), developed in according with a site specific Seismic Hazard Assessment, the structural design of the buildings and equipment is performed on a very conservative basis. Hence, if the seismic hazard is characterized according to current state of the art methodologies accepted by nuclear regulatory bodies worldwide, the presence of a nuclear power station will not increase the risk of damage to the environment or injury to the population as the result of an earthquake.

A SSHAC level 3 PSHA study is planned to quantify the site specific seismic hazard at Duynefontein. Seismic hazard studies completed to date however, indicate that the design basis PGA (~0.3 g) is equal to the limit of that used in the design of export nuclear power stations (0.3 g).

Therefore with the current state of knowledge, there are no disqualifiers for this site and from a seismic hazard perspective there are no sensitive areas that need to be avoided at Duynefontein. The significance of the impact of vibratory ground motion on the nuclear power station is high but the likelihood of it occurring is improbable.

It is noted that the Duynefontein site has the highest seismic hazard. Despite this, the site is suitable for the development of a nuclear power station. This is evidenced by the construction of Koeberg nuclear power station, where a standard export power plant, having a seismic design basis of 0.2 g, was modified through the introduction of aseismic bearings below the Nuclear Island. The National Nuclear Regulator at the time further qualified Koeberg to a seismic design basis of 0.36 g.

Hence, it is evident from the Koeberg experience that mitigation measures for a new power station can be implemented to suit the site-specific seismic design basis. However, the disadvantage to such action is additional operating and capital cost, as well as lead and construction time.

(b) Mitigation measures

- The geotechnical and structural civil engineers shall assign the appropriate “seismic design criteria” for the design of utilities, including on-site and off-site water reservoirs;
- Geologic, seismo-tectonic, palaeo-seismic and instrumentally recorded events must be used to provide expected ground motions and derived seismic design parameters for each site;
- The ground motion and seismic design parameters are to be used as design input for determining the design basis ground motion or Safe Shutdown Earthquake (SSE) while the site is operational as well the regulatory period after its decommissioning;
- Additional geologic investigations aimed at reducing the uncertainties regarding the geological model for the Site Vicinity area shall be conducted. This includes the finalization of outstanding issues related to fault characterization, followed by the compilation of potential seismic source models to be derived from the existing information, with the purpose to build a suite of alternative seismo-tectonic models that

reflect the uncertainty that exists regarding the capabilities of identified sources. This information will then be utilized in the SSHAC level 3 PSHA;

- Micro-seismic monitoring should also continue during operation of the NPS, and even after decommissioning if re-use of the site is considered; and
- It is also recommended that strong-motion accelerographs be installed on rock outcrops in the free field and on the nuclear island as recommended by the USNRC regulatory guidelines.

9.4.4 Bantamsklip

(a) Vibratory ground motion

To date no evidence of prehistoric strong ground motion could be found in this area, which presently displays very subdued seismicity, but this needs to be confirmed by future on-land palaeo-seismic investigations.

As with the Duynefontein site, the nuclear power stations are designed to stringent seismic requirements and if the seismic hazard is properly characterized, presence of a nuclear power station will not increase the risk of damage to the environment or injury to the population as the result of an earthquake, over and above that resulting from normal seismic risk. Therefore based on available data at this stage of the geo-scientific investigations, the seismic hazard does not preclude a nuclear power station at the proposed Bantamsklip site.

However, without the appropriate and complete SSHAC level 3 PSHA study, no final conclusions can be made about the suitability of the site although seismic hazard studies completed to date indicate that the design basis PGA (~0.23 g) is less than that used in the design of export Nuclear power plants (0.3 g). With the current state of knowledge there are no sensitive areas that need to be avoided at Bantamsklip. The significance of the impact of vibratory ground motion on the nuclear power station is high but the likelihood of it occurring is improbable.

(b) Mitigation measures

The proposed mitigation measures at the Bantamsklip site are identical to those proposed for the Duynefontein site in **Section 9.4.3.**

9.4.5 Thyspunt

(a) Vibratory ground motion

At the current stage of the geo-scientific investigations, the seismic hazard does not preclude a nuclear power station at the proposed Thyspunt site. The geologic structure of greatest importance is the offshore Plettenberg Bay and Cape St. Francis Faults. Geological information along a number of existing faults has been updated, and several new and inferred faults have been identified, but to date none of them have been demonstrated to be capable.

As with the Duynefontein and Bantamsklip sites the nuclear power stations are designed to stringent seismic requirements and if the seismic hazard is robustly characterised, the presence of a power station will not increase the risk of damage to the environment or injury to the population as the result of an earthquake, over and above the existing seismic risk. Therefore based on available data at this stage of the geo-scientific investigations, the seismic hazard does not preclude a nuclear power station at the proposed Thyspunt site.

Again, without the SSHAC level 3 PSHA study, no final conclusions can be made about the suitability of the site, although seismic hazard studies completed to date indicate that the design basis PGA (~0.16 g) is less than that used in the design of export Nuclear power plants (0.3 g). The current seismic hazard assessments of the sites indicates that Thyspunt is the site having the lowest amplitude of peak ground acceleration and hence, seismic risk. The significance of the impact of vibratory ground motion on the nuclear power station is high but the likelihood of it occurring is improbable.

(b) Mitigation measures

The proposed mitigation measures at the Bantamsklip site are identical to those proposed for the Duynefontein site in **Section 9.4.3.**

In addition, it is recommended that the foundations of critical structures should not straddle the contact between the Goudini and Skurweberg formations. From a seismic hazard perspective there are no sensitive areas that need to be avoided at Thyspunt.

9.4.6 Cumulative impacts

Potential impacts related to the proposed development would involve hazards associated with site-specific soil conditions and ground shaking during earthquakes. Since hazardous events of this type occur infrequently in the regions considered and display high return periods, the cumulative impact resulting from geological, tectonic and seismological environment is expected to be low.

When considering the three alternative sites together, the potential impact on each site would be specific to that site and would not be common or contribute to the potential impacts on other sites as the sites are separated by distances sufficient to exclude cumulative effects.

The size and nature of the geological and seismological environment is such that it is not spatially localised. This is important in cases where more than one nuclear facility may be built and operated at a specific locality. While some variation in the impact of a geological hazard on individual facilities may occur, such a hazard will have a potential impact on all facilities present at an affected locality.

9.4.7 Conclusion

At Thyspunt the onshore regional pre-Quaternary geology and tectonics are well understood and currently there are no disqualifiers for this site. Future investigations will continue to characterize the Plettenberg Bay and Cape St. Francis faults. The relatively low design basis PGA calculated for Thyspunt indicates that it has the lowest seismic risk and the highest confidence that a standard export Nuclear power plant will meet the seismic design requirements (**Table 9-4**).

At the Bantamsklip site the onshore regional pre-Quaternary geology and tectonics are well understood. Many faults have been identified in the region surrounding Bantamsklip, but they are located in an area of very subdued seismicity and no evidence of prehistoric strong ground motion. Surface deposits makes the characterisation of fault capability of the numerous faults located in relatively close proximity to the proposed site location exceedingly difficult. There is consequently significant uncertainty regarding the seismo-tectonic model for Bantamsklip. Further palaeo-seismic investigations will be required in the near future. Currently, there are no disqualifiers for this site. The margin between the site seismic hazard and the standard power station design basis is however, reduced compared to Thyspunt and hence the level of confidence that a standard export nuclear power station will meet the seismic design requirements is reduced (**Table 9-4**). Without additional geo-scientific investigations and a more comprehensive SSHAC, significant additional design work, with time and costs implications, may therefore be required if a nuclear power station were to be located at the Bantamsklip site.

At Duynefontein the onshore regional pre-Quaternary geology and tectonics are well understood and a prime objective of the surveys around Duynefontein was to find evidence of a fault(s) that could have been responsible for the 4 December 1809 Milnerton event. Additional investigations are required to characterize the faults and develop the seismic source model. Currently, there are no disqualifiers for the Duynefontein site. The site seismic hazard is equal to the standard power station design basis of 0.3 g and hence this site has the lowest level of confidence that a standard export power station will meet the seismic design requirements (**Table 9-4**). Without additional geo-scientific investigations and a more comprehensive SSHAC, significant additional design work, with time and costs implications, may therefore be required if a nuclear power station is to be located at Duynefontein.

Although the regional geology and broad scale tectonic history related to all three sites are well understood, an appropriate and complete SSHAC level 3 PSHA study for each of the sites will be undertaken. This study is intended to reduce the uncertainties regarding the geological models for all the sites, finalize outstanding issues related to fault characterisation, and develop potential seismo-tectonic source models, with the purpose of building a suite of alternative models that reflect uncertainty.

9.4.8 Recommendations

Although all sites are suitable from a seismic perspective, according to the 2002 Council for Geoscience specialist report (Duynefontein = 0.3 g, Bantamsklip = 0.23 g and Thyspunt = 0.16 g), it is recommended that the SSHAC level 3 reconfirmation process must continue.

The SSHAC level 3 investigations could change the PGA values produced by seismic hazard analysis for each site. Thereafter, the seismic design of the chosen vendor can be re-confirmed. Note that the standard earthquake design basis for the vendors under consideration is 0.3 g.

At this point in the seismic hazard assessment process, the largest seismic margin exists for the Thyspunt site i.e. the site hazard is 0.16 g and the standard export nuclear power station is designed for 0.3 g. Hence, this site represents the lowest risk in meeting the plant design value. At the other sites the seismic margin is less, and if the SSHAC site-specific design basis PGA were to exceed the vendor design PGA, then mitigating action would be required. This mitigation may be in the form of aseimic bearings or a revised design. Mitigation will have a significant impact on Eskom’s programme for Nuclear-1 and the costs would be increased considerably.

Hence, from a seismic ranking perspective, Thyspunt is recommended as the preferred site, followed by Bantamsklip and Duynefontein.

Table 9-4: Summary of the current seismic hazard status on Duynefontein, Bantamsklip and Thyspunt

Aspect of seismicity	Thyspunt	Bantamsklip	Duynefontein
Design basis seismic event			
PGA estimated from palaeo-seismic investigations & the Council for Geoscience 2002 seismic hazard analysis	0.16 g	0.23 g	0.3 g (until further information becomes available for the location of the Milnerton seismic source)
Probabilistic Seismic Hazard Assessment	To be determined as part of the SSHAC process		
Ground Motion Response Spectra	To be determined as part of the SSHAC process		
Seismic Source Characterisation			
Geology within 8 km of the site	No significant onshore faults within the 8 km radius of the site. No offshore information close to the shore. Close by faults: Cape St. Francis and Plettenberg Ongoing investigations as part of the SSHAC process	The 40 km radius around the site includes many major faults with displacements ranging between tens of metres to hundreds of metres. Close by faults: Groenkloof fault, Elim fault, Baardskeerdersbos fault	The site 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. Four new faults (not yet shown to be capable) have recently been inferred in the Site area including the NE facing Melkbos Ridge scarp and the Table Bay Fault. Other close by faults include the Mamre fault and the postulated Milnerton fault

Aspect of seismicity	Thyspunt	Bantamsklip	Duynefontein
			geophysical investigations and further palaeoseismic work be performed in the area
Surface Rupture on the site	No evidence for this potential hazard but will be confirmed as part of the SSHAC process and on exposure of the bedrock during construction.		
Caving / collapse under the site	No evidence of such hazards obtained during the geotechnical investigations		
Consequential effects such as liquefaction, slope instability, settlement, fire and flood	To be investigated and designed out		
Operating Experience	To be incorporated into the nuclear power station design		
Confidence level for the nuclear power station meeting the seismic hazard requirements of the site NOW without mitigation	High for a DBE = 0.25g High for a DBE = 0.3g	Low for a DBE = 0.25g Medium for a DBE = 0.3g	Low for a DBE = 0.25g Low for a DBE = 0.3g
Confidence level for the nuclear power station meeting the seismic hazard requirements of the site at completion of the SSHAC process without mitigation	High for a DBE = 0.25g High for a DBE = 0.3g	Medium for a DBE = 0.25g High for a DBE = 0.3g	Low for a DBE = 0.25g Medium for a DBE = 0.3g
Confidence level for the nuclear power station meeting the seismic hazard requirements of the site at completion of the SSHAC process with mitigation	High for a DBE = 0.25g High for a DBE = 0.3g	High	High

Table 9-5: Seismic suitability of all sites

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Vibratory ground motion at Duynefontein										
Without mitigation	Negative	Local to Regional	Low to high	Permanent	Improbable	Low	Yes	Low	High	High
With mitigation	Negative	Local to Regional	Low to medium	Permanent	Improbable	Medium	Yes	Medium	Low	High
Vibratory ground motion at Bantamsklip										
Without mitigation	Negative	Local to Regional	Low to high	Permanent	Improbable	Low	Yes	Medium	High	High
With mitigation	Negative	Local to Regional	Low to medium	Permanent	Improbable	Medium	Yes	High	Low	High
Vibratory ground motion at Thyspunt										
Without mitigation	Negative	Local to Regional	Low to high	Permanent	Improbable	Low	Yes	High	High	High
With mitigation	Negative	Local to Regional	Low to medium	Permanent	Improbable	Medium	Yes	High	Low	High[2]

[2] Assuming the NPS is designed to withstand vibratory ground motion, as is standard, the potential impact on the sites will be negligible and the significance low. However if the NPS is not designed to this standard, the significance of the potential impact on the sites will be high.

9.5 Geological suitability of the sites

The assessment of potential impacts related to geological risk is not only significantly interrelated to the seismic hazard of the site but also to the water quality in the area.

Geology and soils effects may differ from those of other disciplinary areas of assessment because many proposed projects or actions will not actually cause effects *on* the geology of soils of an area. Effects, rather, are normally associated with geology or soils as opposed to causing any physical or chemical changes in the characteristics of the actual geology or soils.

The proposed project could have a significant environmental impact if it would:

- Expose people or structures to potential substantial adverse effects, involving:
  - Surface rupture;
  - Subsurface stability; and
  - Volcanic activity;
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse.

This section and the Geological Hazard Assessment therefore identifies and evaluates geologic conditions at the project site that could affect, or be affected by implementation of the proposed project and recommends mitigation measures to avoid or lessen potential impacts. A summary of the potential impacts is given in **Table 9.5** below.

9.5.1 Duynefontein, Bantamsklip and Thyspunt

The potential impacts on the sites and the significance of the potential impacts for all of the sites under consideration are identical and will thus be treated as one discussion in the sections to follow.

(a) Surface Rupture

- This refers to the identification of any capable faults that may cause surface deformation as a result of tectonic faulting. According to the guidelines provided by the US Nuclear Regulatory Commission and specifically 10 CFR100, capable fault is defined as a fault that exhibit on or more of the following:
  - Movement at or near the ground surface at least once within the past 35 000 years or movement of a recurring nature within the past 500 000 years.
  - Macro-seismicity instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
  - A structural relationship to a capable fault according to the above two points such that movement on one could be reasonably expected to be accompanied by movement on the other.

The impact intensity of surface rupture will vary depending on where it occurs, but is in general expected to be low for the natural environment and medium for the nuclear power station.

The intensity of the environmental impact resulting from surface rupture may increase in the event that it causes critical damage to the nuclear power station facility. The significance of the potential impact is low and the likelihood of it occurring improbable and remains low after mitigation.

(b) Subsurface stability

Subsurface stability refers to any potential surface or subsurface subsidence, solution activity, subsidence or uplift. The Thyspunt and Bantamsklip sites are underlain by quartzitic sandstones of the Table Mountain Group, which are stable and highly resistant to weathering.

No evidence of liquefaction-induced structures was observed at Duynefontein, but it is well-known that the 4 December 1809 M>6 events in Cape Town induced extensive liquefaction (primarily in the wetlands around Rietvlei), as far north as Bloubergsvlei, a farm located only 11 km south east of the Koeberg nuclear power station In addition the sand of the Duynefontein plume of the Witzand Formation is an important aquifer that serves as a source of potable water for municipal areas within the area served by the City of Cape Town. Water can therefore be expected to accumulate on the interface between Cenozoic-age deposits and the deeply weathered clays of the Malmesbury Group. Also, clay layers within successions such as the Springfontyn Formation could act as aquicludes, preventing effective drainage and inducing conditions in sands that are ideal for liquefaction by seismic shaking.

The likelihood of this event occurring is however improbable but if it were to occur the significance would be medium.

(c) Volcanic activity

Any active or recently active volcanoes within the site vicinity of a nuclear power station would constitute a risk to such a facility. However sedimentary rocks of various ages dominate the surface geology at all three sites. Intrusive rocks are primarily represented by the (Neoproterozoic) Cape Granite Suite at Bantamsklip and Duynefontein as well as Mesozoic dyke swarm between Milnerton and Bloubergstrand (Duynefontein). There is no evidence to suggest any Cenozoic-age volcanic activity at any of the three alternative sites that would pose a risk to a nuclear power station.

The nature of the lithology on the sites suggests that the likelihood of a volcanic event of occurring is unlikely. However if such an event were to occur the significance of the potential impact will be Low - High depending on the nature (including scale) of the event.

(d) Cumulative impacts

Potential geological impacts related to the proposed development involve hazards associated with site-specific soil conditions, erosion, slope stability, surface rupture and groundshaking during earthquakes. Since hazardous events of this type, as well as seismological activity, occur infrequently in this region and display high return periods, the cumulative, incremental impact resulting from repeated events in the geological, tectonic and seismological environment is expected to be low.

The three localities under review are thus considered suitable locations for nuclear power stations following extensive investigations and to date no geological evidence has been found that would halt the development of a nuclear power station at any of these sites.

(e) Mitigation measures

- Foundations of the structures to be sunk into solid bedrock where required;
- Construct vibration/shock absorbers between the turbines and the solid rock foundations;
- A thorough assessment of the area excavated for nuclear power station footprint to uncover the presence of any undetected capable faults;
- Incorporating the results of the geological investigations to aid in the selection of an appropriate nuclear power station design; and
- The results of the geological and seismological studies should be used as design input for determining the Safe Shutdown Earthquake Ground Motion (SSEGM) during operation as well the regulatory period after its decommissioning.

9.5.2 Conclusion

The nature of the geological environment is different from most of the other disciplinary areas included in the environmental impact study, as the proposed nuclear power stations will have very little effect on the geological environment. In contrast the potential impact of the geological environment on a nuclear power station and associated infrastructure is much bigger and may pose a risk to the proposed development.

Given the long return periods employed in geological studies the geological risk remains relatively constant throughout the different project phases of construction, operation and decommissioning. The three proposed nuclear power station sites are furthermore exposed to very similar geological environments. Changes in the geological environment resulting from the mass movement of rock or soft sediment are considered improbable, especially as all three sites are situated on stable plains far away from potentially unstable slopes of higher gradient.

Generally, fault rupture and volcanic activity represents more serious geological hazards to a nuclear power station, as they have the potential to cause the failure of the facility's safety systems. There is however no evidence of any recent volcanic activity within the site region of any of the three proposed sites.

In summary, current information related to the site suggest that there is a low geological risk and no disqualifiers for any of the three proposed sites and surrounding natural environment.

Table 9 – 5: Summary of Geological Hazard Impacts on the Duynefontein, Bantamsklip and Thyspunt sites

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Vibratory ground motion										
Without mitigation	Negative	Local	Low-Medium	Short term	Improbable	High to medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Improbable	High to medium	No	High	Low	**Low**
Surface rupture										
Without mitigation	Negative	Local to regional	Low-High	Long term to permanent	Improbable	High to medium	No	Medium	Low	**Low**
With mitigation	Negative	Local	Low	Long term to permanent	Improbable	High to medium	No	Medium	Low	**Low**
Subsurface stability										
Without mitigation	Negative	Local	Medium to high	Permanent	Improbable	Medium	No	High	Medium	**Low**
With mitigation	Negative	Local	Medium to low	Permanent	Improbable	Medium	No	High	Medium	**Low**
Volcanic activity										
Without mitigation	Negative	Local	Medium to high	Permanent	Improbable	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Medium to low	Permanent	Improbable	Medium	No	High	Medium	**Medium**

9.6 Hydrological suitability of the sites

The hydrological assessment investigated the suitability of the sites in terms of the hydrological conditions and features streams, rivers and other forms of watercourses. It assesses the potential for the generation of stormwater and the potential impacts that this may have on the sites. A summary of the potential impacts is given in **Table 9-6** below.

9.6.1 Duynefontein

The direct potential impacts relating both to the construction and operational phases of the project are directly related to increased run off associated with the hardened surfaces. In turn this also increases the erosion potential in and around the site. Stormwater can potentially wash pollutants in and around the site to the neighbouring watercourses and the ocean, should mitigation measures not be put into place.

During the construction phase, it is predicted with a high level of confidence that the potential impact the project will have at this site will be of low significance. The implementation of recommended mitigation measures will further significantly negate the residual adverse impacts.

The potential cumulative impacts are of low significance at a local level, the reason being that this site is isolated and the most significant cumulative impact relates to the commercial and residential activities in the area. Lower potential impact is expected during the construction phase than the operational phase, as residential development is only expected to take place in time. Increased run-off from hardened surfaces will impact on surface water bodies and the ocean should mitigation measures not be implemented.

An insignificant potential impact is predicted on a regional level due to no significant water resources in close proximity to the proposed nuclear power station. The negative environmental potential impacts become insignificant on a national level during both construction and operational phases.

9.6.2 Bantamsklip

The direct potential impacts relating both to the construction and operational phases of the project are directly related to increased run off associated with the hardened surfaces. In turn this also increases the erosion potential in and around the site. As with the Duynefontein site and the Thyspunt site (discussed below), stormwater can potentially wash pollutants in and around the site to the neighbouring water courses and the marine environment, should mitigation measures not be put in place.

During the construction phase, it is predicted with a high level of confidence that the potential impact of the project will be low. The implementation of recommended mitigation measures will further negate the residual impacts. Confidence in the impact prediction is lower for the operational phase, a result of extrapolated rainfall data which are not available for the 1:10 000 rainfall event as is required for this type of activity.

The potential cumulative impact is low at a local level, the reason being that this site is isolated and the most significant potential cumulative impact relates to the commercial and residential activities in the area. A lesser impact is expected during the construction phase than the operational phase, as residential development is only expected to take place in time. Increased run off from hardened surfaces will impact on the surface water bodies and the ocean should mitigation measures not be implemented.

A potential impact of low significance is predicted on a regional level due to no significant water resources in close proximity to the proposed nuclear power station. The negative potential environmental impact becomes insignificant on a national level during both construction and operation.

9.6.3 Thyspunt

The direct potential impacts relating both to the construction and operational phases of the project are directly related to increased run off associated with the hardened surfaces. In turn, this also increases the erosion potential in and around the site.

During the construction phase, it is predicted with a high level of confidence that the significance of the potential impact will be low. The implementation of recommended mitigation measures will further reduce the adverse impacts. Confidence in the impact prediction is lower for the operational phase, a result of extrapolated rainfall data which is not available for the 1:10 000 rainfall event as is required for this type of activity. The 1:10 000 year event is specifically selected in the case of nuclear installations with a view to build in a large safety factor.

The potential cumulative impacts have a low significance at a local level, the reason being that the site is isolated and the most significant cumulative impact relates to the commercial and residential activities in the surrounding area.

Lesser impact is expected during the construction phase than the operational phase as residential development is only expected to take place in time. Increased run off from hardened surfaces will impact on the surface water bodies and the ocean, should mitigation measures not be implemented.

Impacts of low significance are predicted on a regional level with the potential for marginal impact on the one surface water body in close proximity to the site. The negative environmental impact becomes insignificant on a national level during both construction and operational phases, when implementing mitigation measures.

9.6.4 Mitigation

An internationally accepted approach is the application of BMPs when considering mitigation measures. The BMPs approach is defined as “A Multi-disciplinary approach in applying appropriate technology to preserve the environment and comply with accepted safety standards”. The BMPs can be applied to the following phases of development:

(b) Planning and design phase (Pre-Development)

- Plan the final locality and level of the plant area in order to minimise the impact of the flood hazards;
- Take into account the extreme water levels from the ocean – the minimum level of the plant area should be 13.9 mamsl and 8.9 mamsl respectively at Duynefontein, Bantamsklip and Thyspunt; and
- Ensure that the plant footprint should, if possible, not be positioned within a water course area.

(b) Construction phase

During the construction phase it will be important to:

- Separate “clean” stormwater run-off from “dirty” stormwater run-off and minimise the inflow of “clean” stormwater run-off into the construction site. The “clean” stormwater run-off is defined as surface water emanating from “virgin” undeveloped catchments and “dirty” stormwater would emanate from areas with construction activities.
- Ensure that a stormwater diversion embankment is constructed around the perimeter of the site to ensure that both catchment run-off and sea water ingress is prevented. This diversion embankment could possibly be constructed to later be incorporated with the final plant level and platform.

- Ensure that a temporary stormwater collection sump is installed during foundation excavation activities to allow excess run-off to drain to a defined low area (sump) where any transported sediment could be contained and stormwater pumped out. Depending on the nature and content of the sediment this could be pumped to a temporary holding facility and then transported to a waste disposal site. Further details would be obtained from more detailed water quality studies at a later stage. In terms of Regulation 704 (June 1999) of the National Water Act, 1998 (Act No. 36 of 1998) at least the 1:50 year run-off volume with an 800 mm freeboard would need to be contained. The 1:50 year flood event is significant in the design of the pollution mitigation measures while the 1:10 000 flood event parameter is relevant to nuclear safety.

(b) Operational Phase

At the operational phase it is important to:

- Have designed, sized and implemented all required stormwater control and mitigation measures so as to comply with applicable design standards, thereby ensuring the safety of the plant as well as the conservation of the surrounding environment.
- Define any "dirty" stormwater run-off from the plant area and prevent this from leaving the plant area. This must be achieved by implementing "dirty" water collection channels at the perimeter of the plant area. To allow for a sufficient hydraulic gradient and flow velocity, the channels should be positioned so as to drain half the site into the south-western corner and the other half into the south-eastern corner. In terms of IAEA Safety Guide No NS-G-3.5, (IAEA, 2003) the drainage system needs to handle up to the 1:50 year storm event.
- The entire plant run-off would need to be contained in dirty water containment ponds. This is currently a conservative approach as not all the plant run-off possibly needs to be classified as "dirty" run-off, thereby reducing the amount of storage required. Further details and refinements would be determined from more detailed water quality control studies.
- In addition to the above, the average monthly operating volume (i.e. that volume accumulating from the plant area due to average monthly rainfall and run-off) would also need to be taken into account. Due to the current uncertainties of the plant size, dirty water areas and imperviousness, a water balance has not yet been carried out. This must be carried out at design phase.
- Implement a surface water monitoring protocol that monitors for the following variables in surface water:
    - Electrical conductivity
    - pH
    - Turbidity
    - ICP metal scan
    - Volatile Organic Compounds
    - Nutrients
    - Radioactive isotopes
- Monitor and maintain stormwater structures; and
- Maintain a data management system for the storing and analysis of all monitoring data.

9.6.5 Conclusions

For the currently proposed EIA corridor for nuclear plant and auxiliary buildings of the sites there is a potential flood hazard at low points along the coastal frontage of the corridor in the event of an unusually high water level. A flooding hazard due to ponding also exists at each of the sites at the construction phase, due to the open excavations for the plant foundations.

Potential sea level rise due to global warming has little effect on the nuclear power station and climate change should also have a minor effect on the nuclear power station considering the absence of major watercourse on the sites.

Due to hardening of surfaces at the plant and auxiliary works the stormwater run-off volumes and peaks are expected to increase by about 25 to 40 times when compared to the pre-development conditions. All impacts can, however, be reduced with the implementation of mitigation measures.

The major characteristics that differentiate the impacts on the environment at the three sites mainly relate to rainfall, the presence of seasonal wetlands and non-perennial watercourses. Thyspunt has the highest rainfall as well as seasonal wetlands and a non-perennial water course. At Duynefontein the impact on the seasonal wetlands is less since the rainfall is the lowest of the three sites. Rainfall at Bantamsklip is higher than Duynefontein, but there are no directly affected sensitive hydrological features or any ecologically sensitive wetlands. **The direct hydrological impacts at all three sites are *low* in significance.**

Table 9-6: Hydrological suitability at Duynefontein, Bantamsklip and Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction Phase										
Flooding of construction equipment and infrastructure due to rising sea levels										
Without mitigation	Negative	Regional	Low	Short term	Improbable	Low	No	High	Low	**Low**
Flooding of construction equipment and infrastructure due to highest astronomical tide										
Without mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Low	**Low**
Flooding of construction equipment and infrastructure due to extreme high water level										
Without mitigation	Negative	Regional	Medium	Short term	Improbable	Medium	No	High	Medium	**Low**
Spilling of containment dams due to frequent high rainfall events										
Without mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Low	**Low**
Ponding around construction works due to frequent high rainfall events										
Without mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Flooding of construction equipment and infrastructure due to flooding of surface water courses										
Without mitigation	Negative	Regional	Low	Short term	Probable	High	No	High	Low	**Low**
Operational Phase										
Flooding of construction equipment and infrastructure due to rising sea levels										
Without mitigation	Negative	Regional	Low	Short term	Improbable	Low	No	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Flooding of construction equipment and infrastructure due to highest astronomical tide										
Without mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Low	**Low**
Flooding of construction equipment and infrastructure due to extreme high water level										
Without mitigation	Negative	Regional	Medium	Short term	Improbable	Medium	No	High	Medium	**Low**
Spilling of containment dams due to frequent high rainfall events										
Without mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Ponding around construction works due to frequent high rainfall events										
Without mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Flooding of construction equipment and infrastructure due to flooding of surface water courses										
Without mitigation	Negative	Regional	Low	Short term	Probable	High	No	High	Low	**Low**

9.7 Suitability of the sites in terms of freshwater supply

Water requirements for a 4 000 MWe nuclear power station will be as follows:

- Normal requirement : 70 L/s
- Construction peak : 104 L/s
- Site establishment : 23 L/s

There are however no rivers or perennial streams at any of the three sites and as the nuclear power station will be developed at a coastal site where groundwater is near the end of the flow path, the only existing groundwater use that could be directly affected is that from coastal springs. Any impacts on these springs, according to the Fresh Water Supply Assessment, will be of a very localised extent. In terms of safety and assurance of supply and given the periodic droughts that affect the areas, the already scarce water supply situation and global warming impacts, establishment of a desalination plant is a very favourable alternative and is in fact Eskom's preferred alternative at all three sites (see **Chapter 5** for the discussion of alternatives).

The potential impacts of the construction and operation of the nuclear power station is summarised in **Table 9-7** to **Table 9-9** below.

9.7.1 Duynefontein

(a) Sea water intrusion

Sea water intrusion could be caused by pumping of supply boreholes (or dewatering/groundwater control measures). This would be a *localised* potential impact of *low* significance but could have a *medium* reversibility. However, there is currently no on-site use of groundwater. Sea water intrusion occurred during dewatering operations for the foundations for Koeberg nuclear power station but there are no reports of adverse impacts and this was of a very localised extent.

(b) Installation of beach wells

The installation of beach wells will result in *local* impact in the shore zone of *low* significance and *short* duration.

(c) Cumulative impacts

The existing Koeberg nuclear power station is supplied with fresh water from municipal sources and potentially from the Aquarius Wellfield (water of poor quality is therefore only being used for game watering). Use of municipal water would put additional strain on local supplies, and supply could not be guaranteed.

9.7.2 Bantamsklip

(a) Sea water intrusion

As with the Duynefontein site and the Thyspunt site in the section below, this could be caused by pumping of supply boreholes (or dewatering/ groundwater control measures). This would be a *localised* potential impact of *low* significance but could have a *medium* reversibility. However, there is no on-site use of groundwater and no viable aquifers and so this impact is seen as of *low* consequence and significance.

(b) Installation of beach wells

The installation of beach wells will result in *local* potential impact in the shore zone of *low* significance and *short* duration.

9.7.3 Thyspunt

(a) Drying up of coastal springs

These are mainly fed by groundwater from the superficial deposits and are of local importance only, for domestic water supply and ecology. Domestic use will stop as the on-site houses will be vacated prior to the commencement of construction. Use of deep (>100 m) boreholes in the TMG Aquifer away from these springs will minimise impacts. Any such potential impacts will be *local*, of *low significance* and have a *high* reversibility.

(b) Sea water intrusion

This potential impact would be a *localised* impact of *low significance* but could have a *medium* reversibility.

(c) Installation of beach wells

Local potential impact in the shore zone of *low* significance and *short* duration is expected at the Thyspunt site.

9.7.4

9.7.5 Mitigation

Mitigation measures are the same for all three sites and involve the following:

- Use of groundwater during construction.
  - Only use deep (>100 m depth) boreholes on site.
  - Apply sustainable pumping rates derived from credible geo-hydrological testing and analysis.
  - Set target groundwater levels for maximum allowable drawdown.
  - Implement a monitoring programme to provide early warning of any detrimental effects of pumping.
- Long-term groundwater control measures around the nuclear power station during construction
  - Detailed site investigation and numerical simulation to predict effects.
  - Injection of pumped groundwater back into the aquifer to maintain groundwater levels.
  - Coastal location of the nuclear power station.
  - Use of surface water during construction.
  - Tap into a regional scheme rather than a local scheme.
  - Relatively small volumes of water required.
  - Use desalinated water.
  - Installation of beach wells during construction
  - Draw-up an environmental management plan prior to installation.
  - Monitor water levels and quality.
- Disposal of brine during construction.
  - Monitoring by a Marine Ecologist of disposal in the surf zone.
- Use of groundwater during operation.
  - Only use deep (>100 m depth) boreholes.
  - Apply sustainable pumping rates derived from credible geo-hydrological testing and analysis.
  - Continue and expand the monitoring programme to provide early warning of any detrimental effects of pumping.

- Long-term groundwater control measures around the nuclear power station during operation
  - Detailed site investigation and numerical simulation to predict effects.
  - Use of passive systems such as sheet piles/cutoff slurry wall.
  - Coastal location of the nuclear power station.
- Use of surface water during operation.
  - Tap into a regional supply scheme rather than a local scheme.
- Use desalinated water during operation.
  - Source of sea water.
  - Siphon-off from cooling water intake
- Disposal of brine during operation.
  - Disposal by mixing with cooling water discharge
- Atmospheric releases from the nuclear power station (normal plant operation).
  - Coastal location of nuclear power station.
  - Design containment.
  - Monitoring of atmospheric releases.
  - NRR requirement for annual release limits.
- Release of liquid effluent (normal plant operation).
  - Coastal location of the nuclear power station-only some coastal springs could be affected.
  - Containment structures.
  - Monitoring.
- Emergency containment plans.

9.7.6 Conclusion

There is extensive current use of groundwater in the area surrounding the Duynefontein site (Atlantis) but not at Duynefontein itself. The Koeberg power station is connected to the municipal water supply scheme and Nuclear-1 water use would place an additional burden on this source. Desalination of sea water is the most viable alternative for an assured water supply with least environmental impact and it would not be affected by climate change.

There are no viable aquifers in the Bantamsklip area and local and regional surface water sources are fully utilized. The alternative option for surface water supply is import of water from the Riviersonderend-Breede River scheme. However, 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.

There is extensive use of groundwater in the surrounding area and coastal springs at Thyspunt. Local and regional surface water resources are under stress and additional draw-off to supply a nuclear power station would exacerbate this situation. The main alternative for surface water supply with least local and regional potential impact is import of water from the Orange River Scheme. However, desalination of sea water is the most viable option for an assured water supply with least potential environmental impact and would not be affected by climate.

Table 9-7: Summary of Freshwater Supply Impacts at the Duynefontein Site

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction phase										
Sea water intrusion										
Without mitigation	Negative	Local	Low	Short term	Possible	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Possible	Medium	No	High	Low	**Low**
Installation of beach wells										
Without mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Operational phase										
Sea water intrusion	Negative	Local	Low	Long term	Possible	Medium	No	High	Low	**Low**
Without mitigation	Negative	Local	Low	Long term	Possible	Medium	No	Medium	Low	**Low**
With mitigation										

Table 9-8: Summary of Freshwater Supply Impacts at the Bantamsklip Site

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction phase										
Sea water intrusion										
Without mitigation	Negative	Local	Low	Short term	Probable	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Probable	Medium	No	High	Low	**Low**
Installation of beach wells										
Without mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Operational phase										
Sea water intrusion										
Without mitigation	Negative	Local	Low	Long term	Possible	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Long term	Possible	Medium	No	Medium	Low	**Low**

Table 9-9: Summary of Freshwater Supply Impacts at the Thyspunt Site

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction phase										
Drying up of coastal springs										
Without mitigation	Negative	Local	Low	Short term	Probable	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Probable	Medium	No	High	Low	**Low**
Sea water intrusion										
Without mitigation	Negative	Local	Low	Short term	Possible	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Possible	Medium	No	High	Low	**Low**
Installation of beach wells										
Without mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Operational phase										
Drying up of coastal springs										
Without mitigation	Negative	Local	Low	Long term	Possible	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Long term	Possible	Medium	No	High	Low	**Low**
Sea water intrusion										
Without mitigation	Negative	Local	Low	Long term	Possible	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Long term	Possible	Medium	No	Medium	Low	**Low**

9.8 Impacts on flora and ecosystem functioning

9.8.1 Duynefontein

(a) Loss of habitat and species

At Duynefontein an area has been managed by Koeberg as a reserve and will continued to be managed in this manner. Most of the proposed EIA corridor and HV yard is located in Cape Flats Dune Strandveld. This vegetation type has a rarity ranking of Endangered (i.e. high rarity). The primary dunes (Cape Seashore vegetation - Least Threatened and low rarity) might also be impacted, depending on what coastal setback is created. Such loss will be locally, regionally and nationally significant and permanent. The footprint would be located in habitat of high rarity. Such loss would be permanent and local, regional and national

All phases are located in areas which have low species rarity. Red Data species losses would be localised and permanent

The **powerlines and access roads** from the proposed nuclear facility would cross the transitional transverse dunes/parabolic dunes (Cape Flats Dune Strandveld) as well as Atlantis Sand Fynbos. Both are Endangered or have high rarity. This would lead to possible local, regional and national losses of this system

Habitat rarity for the transitional transverse dune vegetation is medium whilst that of the acid sandy acid flats is very high. Losses at a local, regional and national level would thus be significant. Species rarity in the transitional vegetation is low, but very high on the sandy acid flats.

(b) Loss of dunes and dune ecosystem function

According to the botanical specialist, construction of a nuclear facility would potentially lead to the loss of most of a large transverse dune system endemic to the lower Cape West Coast. The Duynefontein system is regarded is remarkable for its size (nearly 1 000 ha) and location at the coast. This system is poorly represented in the region, although there is a similar large transverse dunefield to the north-east at Witzand and a similar, but larger, more intact system north of Yzerfontein (protected within the West Coast National Park).

This finding of the botanical specialist contrasts with the findings of the dune geomorphology specialist. According to the dune geomorphology specialist (Illenberger *pers. comm.* 2010), although the dune system at Duynefontein has value, it has been extensively disturbed in the past, Koeberg was built within the southern portion of this system in the mid 1980s, and the dune system is therefore far from pristine. In order to minimise the impact of wind blown sand on Koeberg and its associated infrastructure, the area around Koeberg was artificially stabilised through the establishment of vegetation, Koeberg significantly compromises the supply of sand to the northern portion of the dunefield, although sand supply to the northern portion of the dune field has not been completely interrupted. Illenberger's opinion is that, from a geomorphological point of view, the impact of the proposed Nuclear-1 on the dune systems would be insignificant, provided that the footprint of the power station is kept to the periphery of the dune system.

(c) Loss of ecosystem function in sand plain fynbos

This system would be affected by and large by the construction of power lines to the south and east of the nuclear facility, as well as access roads. This would lead to the partial loss of ecosystem function, particularly where the pylon bases are located and roads are constructed.

(d) Impacts of sea level rise

The maximum predicted water surface elevation above mean sea level (amsl), taking climate change into account, is 11.2 m, 1.1 m above the present maximum. A 1:100 year sea level floodline based upon the year 2075, allowing for 60 years' operation after possible completion in 2015 has been. It has been noted that the coastline is sandy and that beach erosion is likely to be high, both along the coast as well as if the coastline is breached. In the latter scenario, flooding could occur behind the dunes immediately on the coast.

Primary and transverse dunes would be the most affected, with likely impacts on the functioning of the latter. However, part of the coastline is a raised beach located upon older Pleistocene calcretes and limestones and this is likely to reduce the potential impact of sea level rise to some extent.

(e) Cumulative impacts

Impacts likely to be incurred in the long term and over the operational phase of the facility are chiefly those which would lead to loss of natural habitat fragment and in any way compromise ecosystem functioning. These include loss of the mobile and endemic transverse dunes and associated habitats. If more than one facility is constructed, then losses of transverse dunes habitat as well as impacts on the Sand Plain Fynbos would increase. The construction of a PBMR in the south would also likely compound losses of habitat and compromising of ecosystem functioning.

(f) Continued conservation of the site

The continued management of the Koeberg Nature Reserve, which entails the whole of the site outside the present nuclear power station, is considered a positive impact. Current multiple-use of the reserve is extensive and conservation management would continue with the new nuclear power station.

Potential impacts likely to be incurred in the long term and over the operational phase of the facility are chiefly those which would lead to loss of natural habitat fragment and in any way compromise ecosystem functioning. These include loss of the mobile and endemic transverse dunes and associated habitats. If more than one facility is constructed, then losses of transverse dunes habitat as well as potential impacts on the sand plain fynbos would increase. The construction of a PBMR in the south would also likely compound losses of habitat and compromising of ecosystem functioning (see Low 2008).

(g) Mitigation

- Any construction of structures associated with the facility should be consolidated where possible, to minimise fragmentation and thus reduce the compromising ecosystem functioning;
- Where possible, power lines should be routed away from sensitive habitats and systems. These include the mobile transverse dunes and the transition between the transverse and parabolic dunes, and the acid sand plain fynbos, to the south-east of the planned facility. Number of pylons should be kept to a minimum (i.e. longer power line spans used) and power line supports where possible located in previously disturbed areas;
- For each phase of construction within natural veld, a search and rescue operation is required which will identify all plants which are either extremely rare (i.e. Endangered or Critically Endangered) or which can be used in site rehabilitation.

- A rehabilitation plan which should ensure that all areas disturbed in the development of the proposed facility are satisfactorily rehabilitated with locally occurring indigenous species. This must include the collection of appropriate plant material prior to construction's commencing, the storage of such material and/or the growing on of suitable material. Plants would need to be at least two to three years old for use in rehabilitation and thus sampling should commence during the construction period, at least three years before commissioning of the nuclear power station.
- At least two years before commencement of construction an on-site nursery with manager needs to be set up at Duynefontein. A list of appropriate species needs to be drawn up and both seed and cuttings collected, planted out and suitably hardened off.
- Topsoil (0 – 300 mm depth) must be removed from any area being disturbed temporarily or permanently, and stockpiled. Piles should be no more than 1.5 to 2 m high to avoid decrease in aeration, but also too rapid decomposition of organic matter, the latter essential for providing a good start for new plants.
- Stockpiles should be placed in previously disturbed areas and should definitely not be located on natural vegetation. This would lead to the death of the latter.
- Planting of nursery-grown and translocated species should be undertaken at a density set by the rehabilitation specialist, but generally at no less than 1 m apart. Time of planting should be just prior to the commencement of the rainy season in the Western Cape (April/ May) so that plants are provided with good moisture conditions prior to the onset of the summer season some six months later
- A 200 m wide coastal corridor must be maintained between the nuclear power station and the high water mark.

9.8.2 Bantamsklip

(a) Loss of habitat and species

The extent of the proposed EIA corridor and HV Yard comprises some 322 and 207 ha respectively, with the nuclear power station likely to be in the order of 230 ha. Virtually the entire EIA corridor and HV Yard is located on the Least Threatened (i.e. low rarity*)* vegetation type, namely Overberg Dune Strandveld. All phases are located in habitat that either has no Red Data species, or has low to medium rarity. An area of high rarity (coastal limestones) may be affected in the south-east of the footprint, depending on the placement of the nuclear power station within the EIA corridor.

(b) Loss of ecosystem function

Construction of the nuclear power station could lead to the loss of partially stable transverse and stable deflated parabolic dunes. Both these dune systems are, however, well-represented along this coastline. The transverse dunes at Bantamsklip are severely impacted by invasive *Acacia cyclops* rooikrans, and these have artificially stabilised much of this naturally mobile system. However, construction on the eastern end of the western transverse dune system could lead to management challenges in the longer-term, as natural dune movement would still be eastwards. Depending on the placement of the nuclear power station within the EIA corridor, the functioning of the rare coastal limestones on the northern portion of coastline may be also be affected.

(c) Impacts of sea level rise

The maximum predicted water surface elevation above mean sea level (amsl), taking climate change into account, is 10.8 m, 1.4 m above the present maximum. A 1:100 year sea level floodline has been determined for Bantamsklip. It has been noted that the coastline is sandy and that beach erosion is likely to be high, both along the coast as well as if the coastline is breached. In the latter scenario, flooding could occur behind the dunes immediately on the coast. Primary and transverse dunes would be the most affected, with likely impacts on the functioning of both.

(d) Cumulative impacts

Impacts likely to be incurred in the long term and over the operational phase of the facility will include those that fragment and otherwise compromise ecosystem functioning. This applies in particular to the transverse dune systems and coastal limestones. If an additional nuclear power station is constructed (as part of Nuclear-2 and Nuclear-3), then additional losses of the western and eastern transverse dune systems are likely to occur.

(e) Conservation of the site

Whilst the dune systems are fairly well-conserved along the coastline between Hermanus and Cape Agulhas, the inland systems have demonstrated higher rarity and greater conservation importance. The inland systems are on the whole poorly conserved. Any additions to those vegetation types with <10 % protected would make significant contributions to conservation in the region. If a nuclear facility is built at Bantamsklip it would bring some 2 300 ha (the balance of the site after construction of the nuclear power station) of protected natural vegetation to the western Agulhas Plain. To ensure that the benefits of conservation continue to be felt after decommissioning, Eskom would need to retain ownership of the land in perpetuity, or the land would need to be handed over to a conservation body such as CapeNature or South African National Parks Board.

(f) Mitigation

- The coastal limestones should be avoided and if possible, although not essential, the transverse dunes should be avoided.
- Any construction of structures associated with the facility should be consolidated where possible, to minimise fragmentation and thus reduce the compromising ecosystem functioning.
- Internal power lines should not cross the rare and sensitive natural vegetation in the north of the site. Rather they should be routed away from such habitats and where possible placed along the outside of the area.
- Search and rescue operations, rehabilitation plans, a nursery and topsoil management must be the same as for Duynefontein
- A 200 m wide ecological corridor as a minimum width for serving as a conduit for pollinating and fruit-translocating fauna and an enabling area for essential ecological processes, such as dune mobility, pollination, and preservation of major communities.

9.8.3 Thyspunt

(a) Loss of habitat and species

The proposed EIA corridor will impact on the Least Threatened vegetation type (i.e. low rarity*)*, namely Algoa Dune Strandveld, with a smaller area of Southern Cape Dune Fynbos (also Least Threatened) also affected. A small part of the Langefontein Wetland in the eastern extremity of the EIA corridor could also be impacted – such losses would be highly significant and permanent. With the exception of the Langefontein wetlands (very high rarity), the corridor is located mainly in habitat of very low and low rarity. All part of the EIA corridor are located in habitat which either has no Red Data species or has low rarity.

The proposed power line alignment would cross stable parabolic and unstable (mobile) transverse dunes between the EIA corridor and the HV Yard. The communities affected here are Least Threatened (i.e. low rarity). The community of highest rarity and highest sensitivity that would be affected is the band of transverse dunes that runs through the centre of the EIA corridor from east to west.

Potential impacts of the proposed eastern access road (from Cape St. Francis) will have a low impact. Impact of the western access road (between the eastern boundary of Oyster Bay and along the coast to the nuclear power station) would have a high potential impact on the northern transverse dunes and mobilising parabolic dunes in this area. The vegetation types affected are all Least Threatened and the alignment could be designed to pass through habitats of low rarity, in particular avoiding any tall thicket and coastal forest which occurs here in patches. However, the dilemma with this alignment is in how the endemic Oyster Bay Cape St. Francis headland bypass dune is viewed. The northern access road (running roughly south from HV Yard) would cut through the mobile northern transverse dune system as well as stable and partially stage parabolic dunes. It would then cross the sandstone wetlands north of the transverse dunes and follow a route over degraded sandstone fynbos within and outside of the "panhandle". Most of the route crosses Southern Cape Dune Fynbos or Algoa Dune Strandveld, which are both Least Threatened (Low rarity). The stabilised dunes along the route are of Low rarity with the mobile transverse dunes being of High rarity, coupled with high sensitivity. The sandstones (Tsitsikamma Sandstone Fynbos are by and large severely degraded, but are nevertheless of low rarity as well. Species rarity, both unweighted and weighted, is very low. The band of wetlands within the transverse dunes as well as just north of the transverse dune system are rated as having High rarity, and are also endemic.

(c) Loss of ecosystem function

Construction of the power station in its proposed present locality would lead to the loss of fairly extensive tracts of partially stable parabolic and stable deflated parabolic dunes. These dunes are well-represented on the Thyspunt site as well as elsewhere along the Eastern Cape coastline. Loss of ecosystem function within these communities is probably low as large, connected tracts of this system would still remain intact post-construction, In addition, there are indications, based upon historical aerial photographs, that the area has been increasingly stabilised in recent times, with a general reduction in extent of mobile sand.

The greatest concern would be the potential loss of wetland function for both the Langefontein and the coastal wetlands (to the south of the site). These two systems are extremely rare and endemic and are essentially irreplaceable. Ongoing monitoring of wetlands system before, during and after any construction phase is of critical importance. Proper understanding how system function as well as best practice design to mitigate loss of water from wetland system.

Construction of power lines along the proposed alignment would have a negligible effect on dune ecosystem functioning, as long as pylons avoid the mobile part of the transverse dunes. Construction of the eastern access road would have negligible impact on ecosystem function. The western access road could have significant impacts on the functioning of the dune system. The northern access road is regarded as highly undesirable as it crosses a mobile dune system which is likely to be heavily compromised by permanent structures built across the flow of sand (eastwards). In addition wetland function could be impacted due to the complex nature of these habitats, which are interwoven with the transverse dunes, and which act as special habitat along the northern boundary of these dunes.

(c) Impacts of sea level rise

The maximum predicted water surface elevation above mean sea level (amsl), taking climate change into account, is 7.4 m, 1.3 m above the present maximum. The coastline is sandy and that beach erosion is likely to be high, both along the coast as well as if the coastline is breached. In the latter scenario, flooding could occur behind the dunes immediately on the coast, especially at Thysbaai itself.

(d) Cumulative impacts

Impacts likely to be incurred in the long term and over the operational phase of the facility will include those which fragment and in any way compromise ecosystem functioning. Key areas of concern are the coastal wetlands and Langefontein, which could be severely compromised in the long term if appropriate mitigation measures are not introduced. The western access road would permanently compromise the western end of the northern transverse dune, whilst construction of a road and, to a certain extent, power lines across the middle of the same transverse dunes could also create long term impacts if mitigation is inadequate. Construction of further nuclear power station phases could also cause further permanent losses of wetland habitat and functioning.

(e) Conservation of the site

The Oyster Bay-Cape St. Francis headland bypass dune (HBD) and its associated wetlands are seen as a key priority for conservation. However, this system is under-conserved with only two reserves five reserves in the intact part of the HBD. None of these (Eskom's Thyspunt Natural Heritage Site, the Rebelrus Private Nature Reserve, Derek Cook Thula Moya, (500 ha) Links Nature Reserve (100 ha) or Sand River Sanctuary Private Nature Reserve) has any statutory status. The HBD is being threatened by urban and related development such as the St. Francis Golf Course and Links. Already 19 % of the HBD has been developed, mainly through residential expansion or golf courses. If a nuclear facility were to be built at Thyspunt it would include some 2 400 ha or more depends of land Eskom buys of four major dune types in a conservation area If Eskom follows the example of Duynefontein (Koeberg Private Nature Reserve), a similar reserve could be created here. This would be a mayor benefit to the conservation of this area and unique dune system. To ensure that the benefits of conservation continue to be felt after decommissioning, Eskom would need to retain ownership of the land in perpetuity. A preferred option for security of the land would be to hand it over to a conservation body such as Eastern Cape Nature Conservation, CapeNature or South African National Parks Board.

(f) Mitigation

- The sensitive coastal environment, including any mobile or semi-mobile dunes, should be avoided. In particular both the coastal wetlands and the Langefontein wetlands should be avoided and a suitable buffer of minimum 200 m wide created.
- Where rare habitat, such as the coastal wetlands, stands to be lost or compromised, for example by draw down of groundwater, every effort should be made to adjust development footprints so that such habitat is avoided or loss is minimised.
- The western access road must be avoided.
- For the proposed alignment of the northern access road and powerlines, these should be routed away from rare and sensitive systems, in particular wetlands and the transverse dunes. Any permanent structure on these dunes is viewed as an unmitigatible potential impact for the time-being.
- Any construction of structures associated with the facility should be consolidated where possible, to minimise fragmentation and thus reduce the compromising ecosystem functioning. Power lines have less of fragmentation impact than roads more flexible in implementation.
- Internal power lines should not cross the rare and sensitive natural vegetation in the north of the site. Rather they should be routed away from such habitats and where possible placed along the outside of the area.
- Search and rescue operations, rehabilitation plans, a nursery and topsoil management must be the same as for Duynefontein
- A 200 m wide ecological corridor as a minimum width for serving as a conduit for pollinating and fruit-translocating fauna and an enabling area for essential ecological processes, such as dune mobility, pollination, and preservation of major communities.

9.8.4 Conclusion

Of the three sites, Bantamsklip will experience the least impact on botanical communities and species, as the ecosystems on this site are fairly common along this section of coastline, provided the nuclear power station is situated on the eastern half of the EIA corridor, away from the limestone fynbos.

Of Thyspunt and Duynefontein, Thyspunt has by far the greatest diversity of vegetation communities, including extensive and highly sensitive wetlands, particularly the Langefontein wetland complex in the eastern portion of the site. The headland bypass dune system is also sensitive to disturbance and acknowledged as a unique coastal feature, although is has been greatly impacted by the development of Oyster Bay to the west and St. Francis to the east. Additionally, there is still some uncertainty regarding the interaction between the dunes and wetland systems. Of the three proposed access roads, the eastern access road will cause the most significant impacts, followed by the western and northern access roads.

The EIA corridor at Duynefontein is characterised by a mobile dune system, which has been extensively impacted historically by the Koeberg Nuclear Power Station. The system is regarded as sensitive botanically. **However, according to the dune geomorphology specialist, the system is not highly valuable due to its impacted nature.** There is a well-protected very similar system further north along the Western Cape coast at Yzerfontein in the West Coast National Park. Therefore, in spite of the botanical specialist's concerns about the impacts on the dune system at Duynefontein, this is not regarded as a significant impact.

Of the three alternative sites, Thyspunt will experience the highest level of potential impact (i.e. is least preferred), followed by Duynefontein (intermediate preferred) and Bantamsklip (most preferred).

Of the three alternative sites, Bantamsklip and Thyspunt will potentially benefit the most from the establishment of a protected area (provided it is handed over to conservation authorities after decommissioning), as neither of these sites currently has formal protected status. Thus the Thyspunt and Bantamsklip sites may also get the greatest possible benefit from the establishment of a power station, provided that it is placed and constructed in such a way that the most sensitive ecosystems are not affected. The No-Go alternative in the case of these alternative sites may be even more costly than the development of a power station, since the sites would then in all probability be sold and may be subject to residential or other forms of development that could result in impacts of greater significance than the development of a power station. Due to the large safety zones of a nuclear power station (at least 800 m radius from the nuclear power station), a sizable portion of the site would effectively be conserved. There is no such guarantee of a portion of the site being conserved in the event of other forms of development.

Table 9-6: Impacts on flora at Duynefontein: nuclear power station and spoil

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of habitat (present location)										
Loss of unvegetated and partially vegetated dune vegetation	Negative	Local	High	Permanent	Definite	Low	No	High	High	**High**
With mitigation (no mitigation for habitat loss)	Negative	Local	High	Permanent	Definite	Low	No	High	Low	**Medium to low**
Loss of ecosystem function										
Loss of endemic transverse dune	Negative	Local, regional, national	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation (locate footprint away from affected area)	Neutral	Local to regional	Low to medium	Permanent	Highly probable	High	No	High	Low to medium	**Medium**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (translocate or grow on affected species	Neutral	Local	Low	Short-term	Probable	High	No	High	Low	**Low**
Climate change (rise in sea level)										
Loss of coastal habitat/ possible impacts on nuclear power station	Negative	Local to regional	High	Permanent	Definite	Low	Yes	High	High to medium	**High**
With mitigation (coastal corridor and nuclear power station setback from coast	Neutral	Local to regional	Medium	Permanent	Definite	Low	Yes	High	Medium	**Medium**
Cumulative impacts										
Loss of species, habitat and ecosystem functioning	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (locate footprint away from affected area)	Neutral	Local to regional	Low to medium	Short-term	Highly probable	Medium	No	High	Medium	**Medium to low**

Table 9-7: Impacts on flora at Duynefontein: powerlines and access roads

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of habitat (present location)										
Loss of dune habitat	Negative	Local, regional, national	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (align powerlines to avoid rare and sensitive habitat)	Negative to neutral	Local	Low to medium	Short-term	Highly probable	Medium	No	High	Medium	**Medium**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative	Local, regional, national	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (locate bases of powerlines to avoid RD species)	Neutral	Local	Medium to low	Short-term	Highly probable	High	No	High	Low	**Low**

Table 9-8: Impacts on flora at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of habitat – coastal sand fynbos										
Loss of coastal fynbos	Negative	Local, Regional, National	High	Permanent	Definite	Low	Yes, to a certain extent	High	Medium	**Medium**
With mitigation (move footprint – no mitigation for loss of habitat)	Negative	Local, Regional, National	High (cannot avoid developing here)	Permanent	Highly probable	Low	Yes, to a certain extent	High	Medium to low	**Medium to low**
Loss of habitat – coastal limestones										
Loss of limestone fynbos	Negative	Local, Regional, National	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation (move footprint – no mitigation for loss of habitat)	Negative	Local, Regional, National	Low	Short-term	Highly probable	High	No	High	Low	**Low**
Loss of transverse dunes										
Loss of semi-mobile transverse dunes	Negative	Local, Regional	High	Permanent	Definite	Low	No	High	Medium	**High**
With mitigation (move footprint – no mitigation for loss of habitat)	Negative	Local, Regional	Low	Short-term	Highly probable	High	No	High	Low	**Low**
Loss of ecosystem function										
Loss of transverse dune function	Negative	Local, Regional	High	Permanent	Probable	Low	Yes	High	High	**High**
With mitigation (move footprint)	Neutral	Local, Regional	Low	Short-term	Highly probable	High	No	High	Low	**Low**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative	Local, Regional, National	High	Permanent	Highly probable	Low	Yes	High	High	**High**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
With mitigation (move footprint; translocate or grow on affected species)	Negative to neutral	Local, Regional, National	Medium	Medium	Probable	Medium	Yes, to some extent	High	Medium	**Medium**
Climate change (rise in sea level)										
Loss of coastal habitat/ possible impacts on nuclear power station	Negative	Local to regional	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation (coastal corridor and nuclear power station setback from coast	Neutral	Local to regional	Medium	Permanent	Definite	Low	Yes	High	Medium	**Medium to low**
Cumulative impacts										
Loss of species, habitat and ecosystem functioning	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (locate footprint away from transverse dunes and coastal limestones)	Neutral	Local to regional	Low to medium	Short-term	Highly probable	Medium	No	High	Medium	**Medium**

Table 9-9: Impacts on flora at Thyspunt: nuclear power station and spoil

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of habitat										
Loss of dune fynbos and thicket	Negative	Local	High	Permanent	Definite	Low	No	High	High	**High**
With mitigation (alternative site focuses on this habitat) (no mitigation for habitat loss)	Negative	Local	High	Permanent	Definite	Low	No	High	High	**High**
Loss of dunes										
Loss of semi-mobile parabolic dunes, rocky shore, coastal limestones)	Negative	Local	High	Permanent	Highly probable	Low	No	High	High	**High**
With mitigation (locate footprint away from these habitats)	Neutral	Local	Low	Short-term	probable	High	No	High	Low	**Low**
Loss of ecosystem function										
Loss of coastal habitat and adjacent wetland function	Negative	Local to regional	High	permanent	Probable	Low	yes	High	High	**High**
With mitigation (locate footprint away from affected areas)	Negative to Neutral (success of mitigation for wetlands unsure)	Local	Low	Short-term	Highly probable	High	No	High	Low	**Low**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (translocate or grow on affected species	Negative to neutral	Local	Medium	Permanent	Probable	Medium	No	High	Medium	**Medium**
Climate change										
Loss of coastal habitat/ possible impacts on nuclear power station	Negative	Local to regional	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation (coastal corridor and nuclear power station setback from coast	Neutral	Local to regional	Medium	Permanent	Definite	Low	Yes	High	Medium to low	**Medium to low**
Cumulative impacts										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of species, habitat and ecosystem functioning	Negative	Local, regional, national	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (locate footprint away from wetlands)	Neutral	Local to regional	Low to medium	Short-term	Highly probable	Medium	No	High	Medium	**Medium**

Table 9-10: Impacts on flora at Thyspunt: Powerlines

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of habitat										
Loss of dune habitat	Negative	Local	High	Permanent	Highly probable	Low	Yes, to some extent	High	High	**High**
With mitigation (align powerlines to avoid rare and sensitive habitat)	Negative to neutral	Local	medium	Medium-term	probable	Medium	No	High	Medium	**Medium**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative to neutral	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (locate bases of powerlines to avoid RD species)	Neutral	Local	Low	Short-term	Probable	High	No	High	Low	**Low**
Cumulative impacts										
Loss of species, habitat and ecosystem functioning	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (avoid crossing transverse dunes)	Neutral	Local to regional	Low to medium	Permanent to Short-term	Highly probable	Medium	No	High	Medium	**Medium**

Table 9-11: Impacts on flora at Thyspunt: High Voltage Yard

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of habitat										
Loss of low quality sandstone fynbos	Negative to neutral	Regional	High	Permanent	Definite	Low	Yes, to some extent	High	Medium	**Medium**
With mitigation (relocate HV Yard)	Neutral	Local	medium	Short-term	Probable	High	No	High	Low	**Low**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative to neutral	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (relocate footprint of Yard)	Neutral	Local	Medium	Short-term	Probable	High	No	High	Low	**Low**
Cumulative impacts										
Possible loss of species, habitat and ecosystem functioning	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	Medium	**Medium**
With mitigation (locate footprint away from good quality sandstone fynbos)	Neutral	Local	Low	Short-term	Highly probable	High	No	High	Low	**Low**

Table 9-12: Impacts on flora at Thyspunt: Eastern Access Road

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of dunes										
Loss of dune fynbos and thicket	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation (no mitigation for habitat loss, but can avoid good quality and rare sites)	Negative to neutral	Local	Medium	Permanent	Highly probable	Low	No	High	Medium	**Medium**
Loss of wetlands										
Loss of wetlands to east of Langefontein	Negative	National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (realign to avoid wetlands; bridge over wetland)	Negative to neutral	Regional to local	Medium	permanent	Probable	Medium	Yes, to some extent	High	High	**Medium**
Loss of ecosystem function										
Possible loss of wetland function	Negative	Local to regional	High	permanent	Probable	Low	yes	High	High	**High**
With mitigation (realign away from sensitive wetlands)	Neutral	Local	Low	Short-term	Highly probable	High	No	High	Medium	**Medium**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (realign to avoid RD species and/or translocate or grow on in nursery)	Negative to neutral	Local	Low to medium	Short-term	Probable	High	No	High	Low	**Low to medium**
Cumulative impacts										
Loss of species, habitat and ecosystem functioning	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (locate footprint away from mobile dunes and wetlands)	Neutral	Local	Low	Medium to Short-term	Highly probable	High	No	High	Medium	**Medium**

Table 9-13: Impacts on flora at Thyspunt: Western Access Road

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of dunes										
Loss of dune fynbos and thicket	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation (no mitigation for habitat loss, but can avoid good quality and rare sites)	Negative to neutral	Local	Medium	Permanent	Highly probable	Low	No	High	Medium	**Medium**
Loss of wetlands										
Loss of wetlands near Oyster Bay	Negative	National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (realign to avoid wetlands; bridge over wetlands)	Negative to neutral	Regional to local	Medium	Permanent	Probable	Medium	Yes, to some extent	High	Medium to low	**Medium to low**
Loss of ecosystem function										
Loss of part of western transverse dune and possibly wetland function	Negative	Local to regional	High	Permanent	Probable	Low	yes	High	High	**High**
With mitigation (realign away from sensitive dunes) only partial mitigation	Neutral	Local	Low	Short-term	Highly probable	High	No	High	Medium	**Medium**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (realign to avoid RD species and/or translocate or grow on in nursery)	Negative to neutral	Local	Low to medium	Short-term	Probable	High	No	High	Low	**Medium to low**
Cumulative impacts										
Loss of species, habitat and ecosystem functioning	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (cannot be mitigated to avoid compromising dune mobility and loss of wetland habitat)	Negative	Local, regional, national	High	Permanent to Short-term	Highly probable	Low	Yes	High	High to medium	**High**

Table 9-14: Impacts on flora at Thyspunt: Northern Access Road

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of habitat										
Loss of transverse and stable dune habitat	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (no mitigation for permanent destruction in dunes, to avoid rare and sensitive habitat although could be placed on columns)	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	Medium	**High**
Loss of Red Data species										
Loss of locally occurring Red Data species	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (locate bases of powerlines to avoid RD species)	Neutral	Local	Low	Permanent	Highly probable	High	Yes	High	Low	**Medium to low**
Loss of ecosystem function										
Loss of transverse dune and interconnected wetland function	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (avoid crossing transverse dunes); low confidence in any other mitigation measures until more is known about the transverse dune behaviour and whether it has adequate resilience	Neutral	Local to regional	Low to medium	Permanent to Short-term	Highly probable	Medium	No	High	High	**High**
Cumulative impacts										
Loss of species, habitat and ecosystem functioning	Negative	Local, regional. National	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation (avoid crossing transverse dunes)	Neutral	Local to regional	Low to medium	Permanent to Short-term	Highly probable	Medium	No	High	High	**Medium**

9.9 Impacts on dune geomorphology

9.9.1 Duynefontein

(a) Impacts related to groundwater and surface water as far as they affect dunes

Groundwater and surface water have no potential impact on the mobile or artificially vegetated dunes.

(b) Dynamics of mobile dunes (with specific reference to the viability of constructing infrastructure, transmission lines and access roads)

Mobile dunes upwind of infrastructure, transmission power lines and access roads will be blown onto this infrastructure. This will have a high level of impact on the infrastructure. Mobile dunes downwind of infrastructure and access roads will be starved of sand supply. Mobile dunes will cease to exist when the ground level drops to the interdune level, and the area will become naturally vegetated. This environmental impact will be low, as natural processes will be mimicked, albeit at an accelerated rate.

(c) Dynamics and stability of the artificially vegetated (fixed) dunes and naturally vegetated Late Holocene parabolic dunes (with relation to the construction of infrastructure, transmission lines and access roads)

Major disturbance or damage to the vegetation on the artificially vegetated dunes will re-mobilise the dunes. Similarly the Late Holocene dunes will be re-mobilised by disturbance of plant cover.

(d) Impact of climate change

A retreat of the coastline in response to higher sea level may shift or create new sandy beaches that supply wind-blown sand to dunes. Mobile dunes and dunefields may thus be created in areas that are currently vegetated. This would require monitoring and suitable management in the distant future. Wind speed is expected to increase by 10 %, and storminess is expected to increase. Because wind-blown sand transport rate is roughly proportional to the cube of wind speed, sand transport rate and correspondingly dune movement rates of mobile dunes would increase by about 30 %. This will not have any potential environmental impact.

Rainfall decrease and temperature increase will have no effect on mobile dunes. Plants on vegetated dunes will be stressed by rainfall decrease and temperature increase, so blowouts will form more easily.

(e) Mitigation

The mobile dunes can be stabilised with drift fences, brushwood and with pioneer indigenous dune vegetation prior to planting to prevent mobile sand from covering infrastructure.

9.9.2 Bantamsklip

(a) Impacts related to groundwater and surface water as far as they affect dunes

Groundwater and surface water have no potential impact on the mobile or artificially vegetated dunes.

(b) Dune dynamics and stability of the artificially vegetated mobile dunes and Late Pleistocene vegetated dunes

Any disturbance or damage to vegetation of the artificially vegetated mobile dunes can be rehabilitated by re-planting the dune sand with suitable pioneer species of indigenous vegetation to re-stabilise the dune sand and using brushwood and drift fences where necessary. The Late Pleistocene parabolic dunes have a moderately developed soil with nutrient-rich fines so soil exposed during construction and in soil stockpiles will be liable to wind erosion that winnows these fines out of the soil.

(c) Impacts due to climate change

A retreat of the coastline in response to higher sea level may shift or create new sandy beaches that supply wind-blown sand to dunes. Mobile dunes and dunefields may thus be created in areas that are currently vegetated. This would require monitoring and suitable management in the distant future.

Wind speed is expected to increase by 10 %, and storminess is expected to increase. Because wind-blown sand transport rate is roughly proportional to the cube of wind speed, sand transport rate and correspondingly dune movement rates of mobile dunes (that currently are only found off the site, towards Pearly Beach) would increase by about 30 %. This will not have any environmental impact.

Rainfall decrease and temperature increase will have no effect on mobile dunes. Plants on vegetated dunes will be stressed by rainfall decrease and temperature increase, so blowouts will form more easily.

(d) Mitigation

- The mobile dunes can be stabilised with drift fences, brushwood and with pioneer indigenous dune vegetation prior to planting to prevent mobile sand from covering infrastructure.
- Minimise area being cleared for construction at any one time, wet down these areas. Wet down soil stockpiles, cover stockpiles with brushwood.
- Rehabilitation of vegetated Late Pleistocene dunes to their natural state will be difficult, as climax vegetation will have to be re-introduced once the pioneer vegetation is established.
- A suitably qualified environmental officer must supervise the rehabilitation of vegetation on the Late Pleistocene parabolic dunes.

9.9.3 Thyspunt

(a) Impacts of the proposed Northern Access Road on the Oyster Bay dunefield

When this option was first mooted, it was for a route along the eastern side of the “panhandle”, where dunes are lower (maximum height about 10 metres). The route currently under consideration runs along the western side of the “panhandle”, where transverse dunes are about 30 m high, as dune height increases westward. There is a maximum dune height that this option could handle, in the order of 10 m. This option is thus not viable for the route along the western side of the “panhandle”. In addition, large cut and fill will be required as two large vegetated dune ridges would have to be crossed. Thus large unvegetated surfaced would be created that could result in sand being deposited blown about. The viable route in this instance is thus the route via the eastern side of the “panhandle” (see **Section d** below as well as **Figure 9.1**)

(b) Impacts of the disposal of topsoil

Three alternatives exist for the disposal of topsoil, namely:

- Disposal in the mobile dune field;
- Disposal in the vegetated dune field; and
- Disposal in the “panhandle” north of the Oyster Bay dune field

For disposal in the mobile dune field, spoil would be removed to the mobile dunefield where it is dumped in areas of mobile dunes where no vegetation is growing. The spoil would be left to the elements of nature. The overall impact of this is very high, as the nature and dynamics of dunes that would eventually form would be different from the existing dunes, interdune wetlands would be destroyed, and any material finer than about 60 microns would be carried away as dust, with a high impact on down-wind areas where the dust will eventually settle. This option is fatally flawed, as all the impacts are unacceptably high, and cannot be mitigated.

If spoil would be disposed within the vegetated dunefield, the stockpile would have a surface area of about 350 000 m², roughly 5 % of the total surface area of the vegetated dunefield on the Eskom property. The stockpile will be 25 m high, higher than many of the dune ridges. The dunes and the vegetation on the vegetated dunefield will be destroyed, and the very distinctive natural of dune ridge topography will be completely altered. Airflow will be modified significantly, leading to localised speed-up of winds that may result in blowouts and re-mobilizing of dunes.

If spoil would be disposed in the “panhandle”, spoil would have to be moved from the excavation over the sand dune. For this option, the spoil will need to be transported across the vegetated and mobile dunefields by means of a temporary conveyor belt with supports at a close spacing and an associated construction road; or via a temporary haul road. If a conveyor belt were to be used, there would be insignificant damage to mobile dunes, but it will probably be best to route the conveyor to avoid mobile dunes because of the difficulty of construction and high operational maintenance in mobile dunes. As the structures would be temporary, drift-fences installed by hand can be used to temporarily stop wind-blown movement of dunes in places where it is difficult to avoid mobile dunes. In the vegetated dunefield supports for the conveyor belt will need to be closely spaced and the temporary construction road will entail crossing the vegetated dune ridges with a road that would need cut and fill to create a road with a smooth gradient. Terraforce or similar blocks would have to be used to stabilise the sides of the cut and fill, as stabilising by vegetating the slopes will be difficult and slow. There will be little effect on the stability of the dunes, apart from the risk of slumping during the construction phase

(c) Impacts due to climate change

A retreat of the coastline in response to higher sea level may shift or create new sandy beaches that supply wind-blown sand to dunes. Mobile dunes and dunefields may thus be created in areas that are currently vegetated. This would require monitoring and suitable management in the distant future.

Wind speed is expected to increase by 10 %, and storminess is expected to increase. Because wind-blown sand transport rate is roughly proportional to the cube of wind speed, sand transport rate and correspondingly dune movement rates of mobile dunes would increase by about 30 %. This will not have any potential environmental impact.

Winds at Thyspunt will have a larger proportion of easterly winds, so the seasonal reversal of mobile dune movement will be higher, and overall sand transport rate and correspondingly dune movement rates will decrease. As the proportion has not been quantified, the amount of decrease cannot be estimated.

Temperature increase will have no effect on mobile dunes. Plants on vegetated dunes will be stressed by temperature increase, so blowouts will form more easily.

(d) Mitigation

- The northern access road must be relocated eastward to where maximum dune height is below 10 metres (see **Error! Reference source not found.**).
- Avoid wetland areas wherever possible.
- Because of issues such as wetland fragmentation, culverts must be so closely spaced that they virtually form a bridge over wetlands that have to be crossed, to allow groundwater flow and wetland functioning.
- The road reserve and width disturbed during construction must be kept as narrow as possible, not more than 20 m.
- Monitoring and repair of possible uncontrolled blowouts or water erosion that may occur as a result of windy or rainy periods during rehabilitation and recovery phases must be undertaken.
- Special rehabilitation techniques may have to be developed to ensure that the wetlands, surface water and groundwater dynamics recover fully.
- Terraforce or similar blocks must be used to stabilise the sides of the cut and fill in dunes, as rehabilitation by vegetating the slopes will be difficult and slow. There will thus be little effect on the stability of the dunes, apart from the risk of slumping during the construction phase.
- A suitably qualified ECO must be appointed to supervise the construction phase and rehabilitation of the construction road.

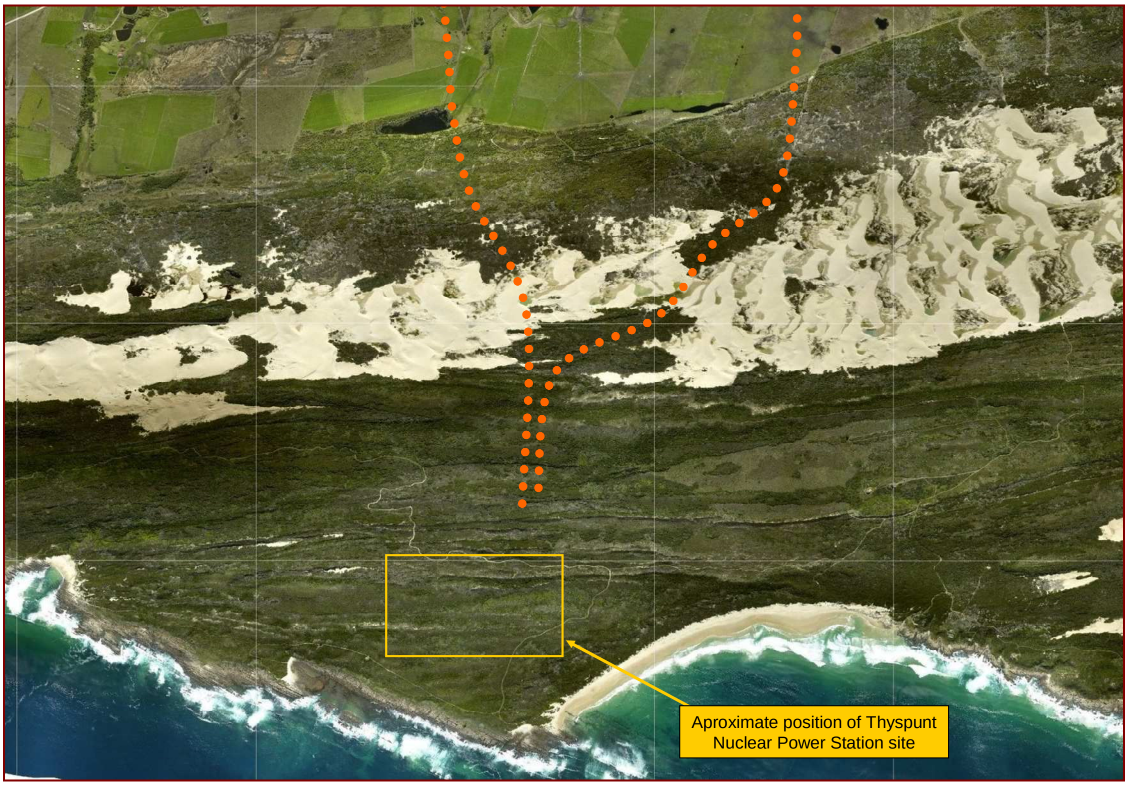


Figure 9-1: Proposed position of the northern access road and the recommended (more eastern) position

9.9.4 Conclusion

Groundwater does not “daylight” at Duynefontein or Bantamsklip. Thus, there are no impacts related to the interaction between groundwater and dune dynamics at these sites.

Access roads and transmission lines can be built across the mobile dunes at Duynefontein and Bantamsklip, with operational impacts ranging from medium to low. Access roads and transmission lines at Duynefontein can be built across the artificially vegetated dunefield and the naturally vegetated parabolic dune fields with low operational impacts. Access roads and transmission lines can be built across the artificially vegetated dune fields and older naturally vegetated parabolic dunes at Duynefontein with low operational impacts after careful rehabilitation. In both cases, mobile dunes in the vicinity of infrastructure would need to be artificially stabilised.

At Duynefontein, topsoil and spoil stockpiles located on the mobile dunes will have medium operational impacts. Topsoil and spoils stockpiles located on the artificially vegetated dune fields or the naturally vegetated parabolic dunefield will have low operational impacts. At Bantamsklip, topsoil and spoils stockpiles located on the artificially vegetated dune fields or on the older naturally vegetated parabolic dunes will have low operational impacts.

The interaction between dunes systems and wetlands is more complex at Thyspunt, since groundwater “daylights” in many inter-dune areas within the Oyster Bay dunefield to form wetlands. The dune dynamics interacts with wetland, groundwater and surface water. Thus, any disturbance of the Oyster Bay dunefield may cause significant secondary impacts on wetlands. Furthermore, as a result of the location of the proposed construction of transmission lines, haul roads and conveyor belts between the nuclear power station in the south and the HV yard in the north, the impacts on dune geomorphology at Thyspunt will be much more extensive than at the other two sites.

The construction of the northern access road at Thyspunt would cause a significant impact on the Oyster Bay dune field. The presently proposed alignment traverses the western portion of the Oyster Bay dunefield where the dunes are highest, resulting in very large cuttings. An alternative alignment through the eastern portion of the dunefield is therefore recommended.

Should the road be built, two alternative methods are proposed to allow sand to continue to be transported across the road. One option is an aerodynamically smooth hard-surfaced road slightly raised above the inter-dune surface with frequent culverts. The other (very expensive) option is an aerodynamically shaped bridge that crosses the mobile dunes and inter-dune wetlands. These structures would have highly significant impacts during construction but lower operational impacts.

Transmission lines are proposed to cross the Oyster Bay dunefield from the nuclear power station in the south to the HV yard in the “panhandle” in the north. The operational impacts of towers spaced at 300 - 400 m intervals[3] would range from medium in the case of access roads being used for construction, to low in the case of helicopters being used for construction. Using towers spaced at 800 m intervals (a very expensive option that would also result in unacceptably high visual impacts) would result in no activities or structures being located within the mobile dunes and thus the impact would be eliminated.

A temporary conveyor belt or haul road may be built across the mobile Oyster Bay dunefield to carry spoils to the “panhandle”. The environmental impact after the conveyor belt or haul road is removed and rehabilitation is completed would be low.

[3] Thus a single pylon would be placed in the middle of the dunefield with adjacent towers outside the dunefield.

Table 9-15: Impacts on dune geomorphology at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Dynamics of mobile dunes										
Mobile dunes upwind of infrastructure	Negative	Local	High	Permanent	Definite	High	No	High	Medium	**Medium**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Negative	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Mobile dunes downwind of infrastructure	Negative	Local	Low	Permanent	Highly probable	Low	No	High	Low	**Low**
Mitigation: none										
Stability of the artificially vegetated dunes - constructing infrastructure, transmission lines and access roads										
Constructing infrastructure and access roads	Neutral	Local	High	Permanent	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Stability of the naturally vegetated late Holocene parabolic dunes - constructing infrastructure, transmission lines and access roads										
Constructing infrastructure and access roads	Neutral	Local	High	Permanent	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Topsoil stockpile on mobile dunes										
Mobile dunes blowing onto stockpile	Negative	Local	High	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Topsoil stockpile on the artificially vegetated dunes										
Impact on the artificially vegetated dunes	Neutral	Local	Low	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Topsoil stockpile on naturally vegetated Late Holocene dunes										
Impact on Holocene parabolic dunes	Neutral	Local	Low	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Spoils stockpile on mobile dunes										
Mobile dunes blowing onto stockpile	Negative	Local	High	Short term	Definite	High	No	High	Medium	**High**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Spoils stockpile on artificially vegetated dunes										
Impact on the artificially vegetated dunes	Neutral	Local	Low	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Spoils stockpile on the naturally vegetated Late Holocene dunes										
Impact on Holocene parabolic dunes	Negative	Local	Low	Permanent	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Spoils stockpile on the mobile dunes										
Mobile dunes blowing onto stockpile	Negative	Local	High	Short term	Definite	High	No	High	Medium	**High**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Spoils stockpile on the artificially vegetated dunes										
Impact on the artificially vegetated dunes	Neutral	Local	Low	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Spoils stockpile on the naturally vegetated Late Holocene dunes										
Impact on Holocene parabolic dunes	Negative	Local	Low	Permanent	Highly probable	High	No	High	Low	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Potential impacts of climate change										
Creation of new active mobile dunefields due to sea-level rise	Neutral	Local	High	Permanent	Possible	High	No	Moderate	High	**High**
Mitigation: none										
Blowout increase due to rainfall decrease and temperature increase	Negative	Local	Low	Short term	Highly probable	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**

Table 9-16: Impacts on dune geomorphology at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Stability of the artificially vegetated dunes - constructing infrastructure, transmission lines and access roads										
Constructing infrastructure and access roads	Neutral	Local	High	Permanent	Definite	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Stability of the naturally vegetated late Pleistocene parabolic dunes - constructing infrastructure, transmission lines and access roads										
Exposure of soil to wind erosion	Negative	Local	Medium	Short term	Definite	Medium	No	High	Medium	**Low**
With mitigation: reduce wind erosion	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Very low**
Damage of vegetation	Negative	Local	Medium	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: careful rehabilitation	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Very low**
Topsoil stockpile on the artificially vegetated dunes										
Impact on the artificially vegetated dunes	Neutral	Local	Low	Short term	Highly probable	High	No	High	Very low	**Very low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Topsoil stockpile on the naturally vegetated late Pleistocene parabolic dunes										
Exposure of soil to wind erosion	Negative	Local	Medium	Short term	Definite	Medium	No	High	Medium	**Low**
With mitigation: reduce wind erosion	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Very low**
Damage of vegetation	Negative	Local	Medium	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: careful rehabilitation	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Very low**
Spoils stockpile on the artificially vegetated dunes										
Impact on the artificially vegetated dunes	Neutral	Local	Low	Short term	Highly probable	High	No	High	Very low	**Very low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**
Spoils stockpile on the naturally vegetated late Pleistocene parabolic dunes										
Exposure of soil to wind erosion	Negative	Local	Medium	Short term	Definite	Medium	No	High	Medium	**Low**
With mitigation: reduce wind erosion	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Very low**
Damage of vegetation	Negative	Local	Medium	Short term	Definite	High	No	High	Medium	**Low**
With mitigation: careful rehabilitation	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Very low**
Potential impacts of climate change										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Creation of new active mobile dunefields due to sea-level rise	Neutral	Local	High	Permanent	Possible	High	No	Moderate	High	**High**
Mitigation: none										
Blowout increase due to rainfall decrease and temperature increase	Negative	Local	Low	Short term	Highly probable	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**

Table 9-17: Impacts on dune geomorphology at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Access road across mobile dunes and interdune wetlands of the Oyster Bay dunefield - routing										
High cuttings along the proposed western alignment of the northern access road	Negative	Local	High	Permanent	Highly probable	-	Yes	High	High	**High**
With mitigation: move the road eastward	Negative	Local	Low	Permanent	Definite	High	Yes	High	Medium	**Low**
Access road across mobile dunes and interdune wetlands of the Oyster Bay dunefield - construction phase										
Constructing infrastructure and access roads	Negative	Local	High	Short-term	Highly probable	High	Yes	High	High	**High**
With mitigation: avoid wetlands where possible, keep road narrow	Negative	Local	Low	Short-term	Definite	High	Yes	High	Medium	**Low**
With mitigation: culverts must be closely spaced so wetland functioning is not impaired	Negative	Local	Low	-	Definite	High	Yes	High	Medium	**Low**
With mitigation: repair of blowouts or water erosion	Negative	Local	Low	Short-term	Definite	High	-	High	Low	**Low**
With mitigation: ECO and special rehabilitation techniques	Negative	Local	Low	Short-term	Definite	High	Yes	High	Low	**Low**
Access road across mobile dunes and interdune wetlands of the Oyster Bay dunefield - operation phase										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Dune –groundwater -wetland dynamics	Negative	Local	Low	Permanent	Definite	High	Yes	**High**	Medium	**Medium**
Access road across vegetated dunefield – construction phase										
Formation of blowouts	Negative	Local	Medium	Short term	Probable	High	No	High	Low	**Low**
With mitigation: stabilise, rehabilitate	Negative	Local	Low	Medium term	Definite	High	No	High	Low	**Very low**
Access road across vegetated dunefield – operation phase										
Access roads	Negative	Local	Low	Permanent	Definite	High	No	**High**	Low	**Low**
Mitigation: none										
Transmission lines with 300 - 400 m span across mobile dunes and interdune wetlands of the Oyster Bay dunefield – construction phase										
Constructing infrastructure and access roads	Negative	Local	High	Permanent	Definite	High	Yes	High	Yes	**High**
With mitigation: position towers carefully with ECO	Negative	Local	Medium	Permanent	Definite	High	Yes	High	Yes	**High**
With mitigation: use helicopter for construction	Negative	Local	Low	Short term	Definite	High	Yes	High	Yes	**Very low**
Transmission lines with 300 - 400 m span across mobile dunes and interdune wetlands of the Oyster Bay dunefield – operation phase										
Infrastructure and access roads	Negative	Local	Low	Permanent	Definite	High	Yes	High	Low	**Medium**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
With mitigation: use light vehicle for maintenance	Neutral	Local	Low	Permanent	Definite	High	Yes	High	Low	**Very low**
Transmission lines with 300 - 400 m span across vegetated dunefield – construction phase										
Constructing infrastructure and access roads	Negative	Local	High	Short term	Definite	High	Yes	High	High	**High**
With mitigation: locate towers on broad ridges or wide inter-ridge valley	Negative	Local	Medium	Short term	Definite	High	Yes	High	Medium	**Medium**
With mitigation: use helicopter for construction	Negative	Local	Low	Short term	Definite	High	Yes	High	Low	**Very low**
Transmission lines with 300 - 400 m span across vegetated dunefield – operation phase										
Infrastructure and access roads	Negative	Local	Low	Permanent	Definite	High	Yes	High	Low	**Low**
With mitigation: use light vehicle for maintenance	Neutral	Local	Low	Permanent	Definite	High	Yes	High	Low	**Very low**
Topsoil stockpile on Oyster Bay mobile dunes										
Fatally flawed	Negative	Local	High	Medium	Definite	High	Yes	High	High	**High**
Topsoil stockpile on the naturally vegetated dunefield										
Destruction of dune vegetation	Negative	Local	High	Medium term	Definite	High	Yes	High	High	**High**
Mitigation: none										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Spoil stockpile on the mobile dunes of the oyster bay dunefield										
Fatally flawed	Negative	Local	High	Permanent	Definite	High	No	High	High	**High**
Spoils stockpile on the naturally vegetated dunefield[4]										
Temporary conveyor belt or haul road to panhandle across mobile dunes and interdune wetlands of the Oyster Bay dunefield - construction phase										
Constructing infrastructure and access road	Negative	Local	High	Short term	High	High	Yes	High	High	**High**
With mitigation: avoid wetlands wherever possible	Negative	Local	Medium	Short term	High	High	Yes	High	High	**High**
Temporary conveyor belt or haul road to panhandle across mobile dunes and interdune wetlands of the Oyster Bay dunefield - operation phase										
Dune –groundwater -wetland dynamics	Negative	Local	Medium	Short term	Definite	High	Yes	High	Low	**Low**
Mitigation: none										
Removing infrastructure and access road	Negative	Local	High	Short term	Definite	High	Yes	High	High	**High**
With mitigation: careful rehabilitation with ECO	Negative	Local	Low	Medium term	Definite	High	Yes	High	Low	**Low**

[4] Due to the potentially highly significant impacts associated with disposal of spoil on the dunefield, Eskom has indicated that it will not pursue such an action. Although this impact has been assessed in the specialist study, it is no longer relevant and has therefore not been reflected in this table..

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Temporary conveyor belt or haul road to panhandle across vegetated dunefield - construction phase										
Formation of blowouts	Negative	Local	Medium	Short term	Probable	High	No	High	Low	**Low**
With mitigation: stabilise, rehabilitate	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Low**
With mitigation: install the conveyor belt foundations using low-diameter piles instead of concrete foundations.	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Low**
Temporary conveyor belt or haul road to panhandle across vegetated dunefield - operation phase										
Constructing infrastructure and access roads	Negative	Local	Low	Short term	Definite	High	No	High	Low	**Low**
Mitigation: none										
Temporary conveyor belt or haul road to panhandle across vegetated dunefield – decommissioning phase										
Removing infrastructure and access road	Negative	Local	High	Permanent	Definite	High	Yes	High	High	**High**
With mitigation: careful rehabilitation with ECO	Negative	Local	Low	Medium term	Definite	High	Yes	High	Low	**Low**
Impacts of climate change										
Creation of new active mobile dunefields due to sea-level rise	Neutral	Local	High	Permanent	Possible	High	No	Moderate	High	**High**
Mitigation: none										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Blowout increase due to temperature increase	Negative	Local	Low	Short term	Highly probable	High	No	High	Medium	**Low**
With mitigation: stabilise with drift fences, brushwood and with pioneer indigenous dune vegetation	Neutral	Local	Low	Permanent	Definite	High	No	High	Low	**Low**

9.10 Impacts on wetlands

9.10.1 Duynefontein

The assessment[5] of potential impacts associated with the development of a nuclear power station at Duynefontein indicates that the proposed development is unlikely to result in any unmitigable impacts to wetland systems that would have high negative significance. Moreover, the recommended mitigation measures are not considered onerous, and revolve largely around best practice measures and excluding specified wetland areas from development.

While development of the proposed nuclear power station at the Duynefontein site would not be associated with any potential impacts of high negative significance, assuming implementation of mitigation measures, it must be noted that it does not present positive opportunities for conservation either, unlike the other two sites. Conservation of natural ecosystems has already been achieved through the past formation and management of the Koeberg Nature Reserve, the integrity of which is threatened by, rather than secured by, the proposed nuclear power station development.

9.10.2 Bantamsklip

Development of the proposed nuclear power station at Bantamsklip would not be associated with any potential impacts to wetland systems that are considered unmitigable or that would, once mitigated, result in a negative potential impact of higher than "low" significance level (**Table 6.2**). This is because the nuclear power station-associated activities would be concentrated in the area to the south of the R43. The potential impacts that have been assessed revolve around indirect potential impacts to the ecologically important Groot Hagelkraal wetlands, primarily associated with increased traffic through the area (e.g. affecting the use of the wetlands as a corridor between high lying areas, the estuary and the sea). Other potential impacts that have been identified include those associated with increased development in the presently small resort settlement of Pearly Beach, and the increase in sewage treatment and water demands, with their potential knock-on effects for wetland systems. Low confidence is attached to this assessment, given the low certainty that the impact could occur.

Mild concern raised by the geo-hydrological assessment regarding the extent of draw-down effects on the wetlands of the Groot Hagelkraal and Koks Rivers have been addressed through recommendations for accurate groundwater modelling, based on final proposed nuclear power station platforms and design, and the potential need (to be informed by the above) for implementation of a membrane or other device that will severely limit draw-down extent.

The recommended mitigation measures for the development at this site are not considered complex. Moreover, the possibilities to bring about positive impacts to wetland ecosystems through implementation of recommended mitigation activities have been assessed as of high positive significance, and thus of bearing in the decision making process for this site. It should be noted however that the actual achievement of these positive outcomes relies on a concerted effort to secure the Groot Hagelkraal wetlands, including their extensive hillslope seeps and adjacent terrestrial areas, and to put in place measures that will assure their management and conservation in the long term. The proposed nuclear power station site is

[5] For a detailed description of all identified potential impacts on wetlands on not only the Duynefontein site but also the Bantamsklip and Thyspunt sites, refer to the specialist report attached in **Appendix E12** and **Tables 9-20 to 9-22** below.

believed to be one of the most feasible vehicles for setting in place such management, based on the observed conservation management at the Duynefontein site, and visible present efforts at both the Thyspunt and Bantamsklip sites in terms of the control of alien vegetation.

9.10.3 Thyspunt

The length and detail of the assessment tables for the proposed nuclear power station development at Thyspunt highlight the complexity of issues to be considered in terms of potential impacts to wetland systems. It is suspected that there is a high degree of interaction between the dune systems and the wetlands. The dune systems act as filters for water and feed the wetland systems. Most of the potential impacts assessed are associated with a high level of negative significance in their unmitigated form. In some cases, this high rating is the result of uncertainty regarding present levels of understanding of system level drivers and responses, particularly with respect to the mobile dune system. This lack of certainty has led to a highly conservative approach to the assessment of any activity that could potentially impact on dune function. Mitigation measures against such proposals have thus taken the approach of impact avoidance, through the pursuit of other options.

The most significant sources of potential impact to wetland systems are associated with interferences in surface / groundwater interactions in the vicinity of the site. These could have serious implications for wetland function, resulting in permanent loss of important and presently virtually unimpacted coastal seep wetland ecosystems. Mitigation measures that seek to reduce these potential impacts increase the risk of draw-down related impacts to the adjacent Langefonteinvlei wetlands. These risks are heightened by uncertainty regarding the implications of an easterly nuclear power station footprint on groundwater draw-down extent, as well as uncertainty regarding the groundwater models, which have not been based on real proposed nuclear power station footprints.

Potential means for reducing draw-down potential impacts to the Langefonteinvlei do appear to be available, even though they have not as yet been developed to a high level of detail. The feasibility and likely efficacy of such measures has not however been tested, and it should be noted that mitigation against the identified drawdown effects requires that a high level of confidence should be attached to the efficacy of mitigation.

Impacts (outright loss and degradation) to a section of near-pristine coastal seep wetland are not however considered effectively mitigable, and this impact remains of high negative significance.

The assessment process also indicated ecologically preferred alternatives for a range of activities that would be associated with the proposed nuclear power station. The outcomes of the assessments are as follows:

- Preferred sewage treatment alternative: on-site treatment and recycling of effluent; and
- Preferred fresh water supply option: desalination, supplemented by treated effluent.

Other activities, such as the proposed routing of transmission lines across the mobile dunefields and wetland areas to the north, coupled with possible transport of sand across the dunefield, will result at best in a general degradation of what is at present a relatively undisturbed, one-in-a-kind habitat, and at worst, threaten the function and structure of the dune system which is a critical support system for the wetlands.

The assessment of different alignments for the access road, as shown in **Table 6.3** brings into play another set of complicating issues. The assessment process indicates that the proposed eastern access, with substantial mitigation measures focusing on avoidance of critical impacts, would be the preferred access option. If two access routes are required, specifically for construction, then the proposed western access route is greatly preferred to the northern route.

The eastern route carries with it a means to mitigate against the high cumulative significance of the proposed development. On the basis of full and effective implementation of all recommended mitigation measures, including recommendations around access routes to the site, the active conservation management in the long term (beyond the life time of the nuclear power station site) of the Eskom site, and the recommendation for application to be made for the Oyster Bay dunefield and its associated dune and wetland systems to be managed as a Ramsar wetland area, and on the assumption that Eskom will purchase all erven through which the proposed access road passes, and include this land in the conservation area, then the cumulative impact of the development would be assessed as of positive significance in terms of wetland systems. This implies that the inclusion of the full extent of remnant valley bottom wetland between Langefonteinvlei and The Links golf course near Cape St. Francis, and the inclusion of a substantial portion of the Oyster Bay dunefield system in this effective reserve, outweighs the definite impact of loss of and degradation to a section of presently unimpacted coastal seep wetland, of high conservation importance.

The above assessment is dependent on confirmation that the current geo-hydrological model regarding drawdown impacts is relevant to the actual size and location of the nuclear power station; the feasibility of the eastern portion of the site for the nuclear power station site and, critically, on the urgent implementation of the proposed surface / groundwater monitoring programme, which aims to address the present uncertainty regarding wetland / groundwater interactions.

9.10.4 Mitigation

(a) Duynefontein

Avoidance mitigation of potential impacts to wetlands is considered feasible at this site. Mitigation measures focus on effective management of dust, stormwater and road construction processes, and the location of the nuclear power station and its infrastructure in the least sensitive areas of the development envelopes. Within the EIA and HV Yard corridors, retention of the mobile dunes as a viable system is recommended, to ensure maintenance of wetland functions within and to the north of the dunes. Wetlands on the Duynefontein site that lie outside of the EIA and HV Yard corridors have, along with their terrestrial margins and interlinking corridors, been identified as “no development” areas.

(b) Bantamsklip

Essential mitigation measures for this site would require:

- Management of the site to the north of the R43 as a conservation area, with provision for the long-term conservation of the site (after the life span of the nuclear power station);
- Enlarging of the culverts at the Groot Hagelkraal crossing under the R43; and
- Adhering to certain development restrictions at Pearly Beach.

The potential cumulative impact of a nuclear power station at this site, with mitigation, would be a positive impact of high significance, based on the opportunity entailed in the development for securing the long-term conservation of the wetland systems to the north of the R43.

(c) Thyspunt

Mitigation measures at this site centre around both impact avoidance and increasing the confidence with which assessment of the implications of key potential impacts can be made, specifically with regard to the siting of the proposed nuclear power station. Essential mitigation measures comprise the following:

- Recognition of various “no go” development areas and ecological setbacks;

- Management of the whole site, apart from the nuclear power station footprint within the EIA corridor and the HV yard, as a formal conservation area;
- Purchase of all erven potentially crossed by the proposed eastern access road to the east of the Thyspunt site as far as the western boundary of The Links, and the management of the dunefields and wetlands thus acquired as a dedicated conservation area;
- Mitigation against the extent of loss and degradation of coastal seeps is complicated by issues of low confidence, including:

    - the implications for draw-down impacts of shifting the nuclear power station footprint to a location north of the Thysbaai beach;
    - the accuracy of the geo-hydrological model as a measure of drawdown radius for the actual size and location of a future NS footprint, given that it was not based on such accurate information; and
    - the links between the Langefonteinvlei and groundwater and its vulnerability to dewatering.
- Mitigation measures against impacts to the coastal seeps thus centre on improving the accuracy / confidence of the groundwater model, and would require the collection of additional (specified) surface and groundwater data, followed by:

    - inclusion of technology in the dewatering design to allow controlled dewatering, such that neither the present condition nor the resilience of upstream wetlands is affected by groundwater draw-down
    - inclusion in the dewatering design of mechanisms that will allow the redistribution and spread of diverted / dewatered groundwater back into the aquifer, such that it can feed the coastal seeps downstream, taking cognisance of projected increases in sea level that are likely to result in salinisation of groundwater levels just above present sea level.

Other mitigation measures at this site entail the following:

- The northern access road should not be used, and the western access road should be re-aligned northwards so as to avoid a number of coastal seeps;
- Access roads should allow for bridging of wetlands that are unavoidably crossed by the routes;
- Transmission lines should not include any maintenance / access roads across the mobile dunes, and provision should be made for access by helicopter or (potentially) quad bike only;
- Mitigation against the impacts associated with transport of excess sand to St. Francis Bay beach by pipeline; and
- Mitigation of impacts associated with the transport of sand across the mobile dunes is possible, with the conveyor system being the preferred approach considered, but with substantial restrictions being imposed on construction / maintenance roads and sediment control.

Implementation of mitigation measures outlined above would in theory result in a net positive impact to wetland systems. Such an assessment assumes that securing of all erven along the proposed access road takes place before these are developed, thus securing a large expanse of wetland and dune system, that would otherwise be permanently impacted (but not destroyed) by development. This does not mitigate against the loss of coastal seep wetlands, but the opportunity for large-scale active management and conservation of wetland ecosystems as a whole is believed to offset the loss of some of these important wetlands, provided that the extent of their loss, and the degree of degradation of remaining coastal seeps, can be effectively mitigated by shifting the nuclear power station footprint eastwards, without impacting on the Langefonteinvlei or other wetlands.

9.10.5 Conclusion

The development envelopes for both the EIA and the HV yard corridors at Duynefontein lie well away from the most sensitive wetlands on the site – that is, the duneslack depressional wetlands in the south western portion of the site. The main potential impacts associated with development of a single phase nuclear power station at Duynefontein relate to degradation of or disturbance to the artificial wetlands in the north west of the site, the transient duneslack wetlands of the mobile dune and an isolated seasonal wetland potentially in the vicinity of a proposed access road. Groundwater modelling associates a low level of draw-down risk to both these and other wetlands on the site, as a result of dewatering.

Without the implementation of mitigation measures, the potential impacts of development of an nuclear power station at Duynefontein are regarded of medium negative significance.

The envelopes for the proposed EIA and HV yard corridors at Bantamsklip lie to the south of the R43 road through the site and thus will not directly affect the critically important Groot Hagelkraal River and its associated hillslope seeps and valley bottom wetland tributaries. This means that impacts to wetland systems resulting from the proposed project would be largely avoided. The following are the main areas of concern:

- Increased traffic on the R43, leading to fragmentation of wetland corridors;
- Potential wetland degradation depending on the siting of nuclear power station administration buildings. These will however be sited South of the road therefore have no impact;
- Potential side-effects of increased development in the Pearly Beach area; and
- The geo-hydrological study also indicated that the radius of draw-down associated with dewatering of this site could extend close to the Groot Hagelkraal and Koks River systems but was however unlikely to affect either of them.

Without the implementation of any mitigation measures, the potential cumulative impacts of development of an nuclear power station at Bantamsklip was assessed as being of at least medium negative significance.

Potential impacts at Thyspunt would be associated with the greatest number, intensity and complexity of impacts to important wetland systems. The main impacts include:

- Permanent loss and degradation of coastal seep wetlands as a result of dewatering / groundwater diversion, concentration of groundwater flows and proposed new roads;
- Risks of impacts to the Langefonteinvlei and its associated hillslope seep to the south, as a result of possible draw-down effects;
- Fragmentation, infilling and physical disturbance to duneslack wetlands in the Oyster Bay mobile dune system as well as to wetlands immediately north of the Oyster Bay dunefield, as a result of impacts associated with the proposed passage of transmission lines, roads and potential options for sediment transport across the dunes;
- Potential infilling and fragmentation of important valley bottom wetlands to allow the construction of access routes to the site, as well as laying of sewage and water pipelines; and
- Degradation of depressional and other wetlands as a result of transporting excess spoil over the dunes to the HVY platform.

The above impacts are likely to result in profound degradation of a system that presently exists as a relatively unimpacted mosaic of terrestrial and wetland habitats, with high levels of interconnectivity and high overall biodiversity value, to which the wetland systems make a significant contribution. The potential cumulative impacts of the proposed development of a single nuclear power station at the Thyspunt site without implementation of mitigation measures has been assessed as of very high negative significance. It is important to keep in mind that additional research and monitoring will effectively increase the certainty of mitigation and the onus is on the applicant to ensure that mitigation measures are put in place to meet the requirements in terms of protecting the wetlands, reducing the potential significance of the impact.

Table 9-18: Assessment of impact on wetlands at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction Phase										
Loss or degradation of wetlands as a result of dewatering and seawater contamination	**No impact**									
Degradation of seasonal wetlands as a result of proximal location of spoil and laydown areas, and the deleterious placement of administration and other structures in the EIA corridors										
Without mitigation	Negative	Regional	Medium to high	Long	Probable	Medium to long	Yes	Low	High	**High**
With mitigation	Negative	Regional	Low	Long	Probable	Medium	Yes	Medium	Medium	**Low**
Loss or degradation of seasonal wetlands as a result of construction of internal access roads										
Without mitigation	Negative	Local	Medium	Long	Probable	Low	Yes	Medium	Medium	**Low**
With mitigation	Neutral	Local	Low	Long	Improbable	High	No	Medium	Low	**Very Low**
Loss of seasonal duneslack wetlands as a result of linking of transmission lines from the nuclear power station to the proposed HV yard and storage of spoil in the HVY corridor										
Without mitigation	Negative	Local	High	Long	Probable	Low	Yes	Medium	Medium	**Medium**
With mitigation	Neutral	Local	Low	Long	Improbable	High	No	Medium	Low	**Very Low**
Operational Phase										
Loss or degradation of seasonal wetlands as a result of operational phase use of internal access roads										
Without mitigation	Negative	Local	Low	Long	Probable	Medium	Yes	Medium	Low to medium	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
With mitigation	Neutral	Local	Low	Long	Probable	High	Yes	High	Low	**Very low**
Cumulative impacts associated with proposed development as a whole										
Without mitigation	Negative	National	High	Permanent	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Low	Permanent	Probable	Medium	Yes	Medium	Medium	**Medium**

Table 9-19: Assessment of impacts on wetlands at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction Phase										
Loss or degradation of wetlands as a result of dewatering	**No impact**									
Loss or degradation of wetlands as a result of other construction-related impacts on the site south of the R43	**No impact**									
Abstraction of surface or groundwater to supply fresh water to the nuclear power station	**No impact**									
Degradation of wetlands as a result of physical disturbance to wetlands north of the R43 during construction										
Without mitigation	Negative	National	Medium	Long	Probable	Yes	Yes	Medium	Medium	**Medium**
With mitigation	Positive	National	High	Permanent	Probable	Yes	Yes	Medium	High	**High**
Operational Phase										
Degradation of wetlands associated with the Groot Hagelkraal system through alien encroachment										
Without mitigation	Negative	National	High	Permanent	Improbable	High	Yes	Medium	High	**Medium**
With mitigation	Positive	National	High	Permanent	Highly probable	High	Yes	High		**Medium**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Increased fragmentation of wetlands up- and downstream of the Groot Hagelkraal system as a result of increased road use along the R43										
Without mitigation	Negative	National	Medium	Long Term	Probable	Yes	Yes	Medium	High	**Medium**
With mitigation	Positive	National	Medium	Long Term	Probable	Yes	Yes	Medium	High	**Medium**
Impacts to wetland systems associated with indirect impacts of the proposed nuclear power station development										
Without mitigation	Negative	National	High	Permanent	Probable	No	Yes	Low	High	**High**
With mitigation	Neutral	Local	Low	Nil	Probable	No	Yes	Medium	Low to negligible	**Low**
Cumulative impacts associated with proposed development as a whole										
Without mitigation	Negative	National	High	Permanent	Probable	Low	Yes	Medium	High	**High**
With mitigation	Positive	National	High	Permanent	Probable	Medium	Yes	Medium	High	**High**

Table 9-20: Assessment of impacts on wetlands at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss or degradation of dune slack and/or hillslope seep wetlands as a result of dewatering										
Without mitigation	Negative	National	High	Permanent	Possible	Low	Yes	Medium	High	**Medium**
With mitigation	Negative	National	Low	Short term	Improbable	Low	Yes	Low	Low	**Medium**
Loss or degradation of coastal seep wetlands as a result of interference with surface or groundwater flows										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
With mitigation	Negative	Local	High	Permanent	Probable	Low	Yes	Low	High	**High**
Degradation of coastal seep wetlands as a result of receipt of concentrated volumes of potentially sediment-rich water from dewatered areas										
Without mitigation	Negative	National	Medium	Long term	High	Low	Yes	Medium	High	**High to medium**
With mitigation	Negative	National	Medium to low	Short term	Probable	Low	Yes	Medium	Medium	**Medium**
Degradation of coastal seepage wetlands as a result of catchment hardening and runoff from laydown areas										
Without mitigation	Negative	National	Medium	Long term	Probable	Low	Yes	Medium	High	**Medium**
With mitigation	Negative	National	Low	Long term	Probable	Medium	Yes	High	Medium	**Medium**
Degradation of wetlands as a result of dust management approaches										
Without mitigation	Negative	National	Low to medium	Short term	Probable	Low	Yes	Medium	Low to medium	**Low to medium**
With mitigation	Negative	National	Low to negligible	Short term	Probable	Low	Yes	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Degradation / drainage / infilling of valley bottom and hillslope seep wetlands north of the high dune fields										
Without mitigation	Negative	Local	High	Permanent	Probable	Low	No	Medium	High	**High**
With mitigation	Negative	Local	Low	Permanent	Probable	High	No	Medium,	Local	**Low**
Impacts associated with catastrophic collapse of dune areas during construction										
Without mitigation	Negative	National	High	Long term	Possible	Low	Yes	Very Low	High	**High**
With mitigation	Negative	National	Low	Long term	Improbable	Low	Yes	Low	Low	**Medium**
Operational phase										
Loss or degradation of coastal seep wetlands as a result of interference with surface or groundwater flows										
Without mitigation	Negative	Regional	High	Long term	High	Low	Yes	High	High	**Very high**
With mitigation	Negative	Regional to local	Medium	Long term	Probable	Low	Yes	Medium	High	**High**
Salinisation of coastal seeps										
Without mitigation	Negative	Regional	High	Long term	High	Low	Yes	High	High	**High**
With mitigation	Negative	:Local	Low	Long term	Probable	Low	Yes	Medium	Medium	**Medium**
Degradation of remnant coastal seepage wetlands as a result of catchment hardening										
Without mitigation	Negative	Regional	Medium	Long tern	Probable	Low	Yes	Medium	High	**Medium to high**
With mitigation	Negative	Local	Low	Long term	Probable	Low	Yes	Medium	Medium	**Medium**
Degradation of valley bottom wetlands and hillslope seeps north of the high dune fields										
Without mitigation	Negative	Local	Medium	Long term	Probable	Low	No	Medium	High	**Medium to high**
With mitigation	Negative	Local	Low	Long term	Probable	Low	No	Medium	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Degradation of dune slack wetlands as a result of increased vehicle passage across the dunes										
Without mitigation	Negative	National	Medium	Long term	Probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	National	Low	Long term	Probable	Medium	Yes	Medium	Medium	**Low**
Contamination of wetlands as a result of leakage of hazardous waste (uranium) into groundwater and thence into groundwater-fed wetlands										
Without mitigation	Negative	National	Medium	Long term	Possible	Low	Yes	Very low	Medium	**Medium**
With mitigation	Negative	National	Low	Long Term	Improbable	Low	Yes	Medium	Medium	**Medium**
Conservation of remaining dune slack, coastal seep and valley bottom wetlands on the site										
Without mitigation										
With mitigation	Positive	National	Medium	Medium term	Probable	Medium	Yes	Medium	Medium to low	**Low**
Impacts associated with sewage management options										
Alternative 1: Treatment of sewage on site										
Without mitigation	Negative	National	Medium	Long term	Probable	Medium	Yes	Medium	Medium to low	**Low**
With mitigation	Negative	National	Low	Long term	Improbable	Medium	Yes	Medium	Medium	**Low**
Alternative 2: Pumping to Oyster Bay										
Without mitigation	Negative	National	Medium	Long term	Probable	Medium	Yes	Medium	High	**High**
With mitigation	Impact Avoidance –mitigation = Alternative 1 with mitigation									

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Impacts associated with different alternatives for fresh water supply on the site										
Alternative 1: abstraction from the Thyspunt aquifers										
Without mitigation	Negative	National	Medium	Long term	Probable	Medium	Yes	Medium	High	**High**
With mitigation	Impact avoidance – mitigation = Alternative 4									
Alternative 2: Piping municipal water from the St. Francis Bay feeder line										
Without mitigation	Negative	National	Medium	Long term	Probable	Medium	Yes	Medium	High	**High**
With mitigation	Impact avoidance – mitigation = Alternative 4									
Alternative 3: Piping water from the Orange River scheme										
Without mitigation	Negative	National	Medium	Long term	Probable	Medium	Yes	Medium	High	**High**
With mitigation	Impact avoidance – mitigation = Alternative 4									
Alternative 4: Desalination	**No impacts**									
Impacts of different options for linking transmission lines from the nuclear power station to the proposed HV yard										
Crossing of the dune using conventional transmission towers										
Without mitigation	Negative	National	Medium	Long term	Probable	Medium	Yes	Medium	High	**High**
With mitigation	Use dual circuit transmission system (see below) including full mitigation measures outlined									
Crossing of the dune, using a dual circuit transmission system										
Without mitigation	Negative	National	Medium to high	Long term	Probable	Medium	Yes	Medium	High	**High**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
With mitigation	Negative	Local	Medium	Long term	Probable	Medium	Yes	Medium	Medium	**Medium**
Impacts of different options for the removal of sand spoil from the nuclear power station site										
Alternative 1:Conveyance of sand to the disturbed agricultural land on the northern side of the dunes, across the sand dunes by road										
Without mitigation	Negative	National	High	Long term	Probable	Medium	Yes	Medium	Low	**Medium to low**
With mitigation	Impact avoidance – mitigation = Alternative 2 or 3 with mitigation									
Alternative 2:Conveyance of sand to the disturbed agricultural land on the northern side of the dunes, across the sand dunes by conveyor belt										
Without mitigation	Negative	National	High	Long term	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Medium	Short term	Probable	Medium	Yes	Medium	High	**High**
Alternative 3: Piping of sand to the St. Francis Bay / Cape St. Francis Beach										
Without mitigation	Negative	National	High	Long term	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Medium	Short term	Probable	Medium	Yes	Medium	Medium	**Medium**
Impacts associated with different access road alternatives										
Construction impacts – *all alternatives*										
Without mitigation	Negative	National	High	Long term	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Medium	Short term	Probable	Medium	Yes	Medium	Medium	**Medium**
Operation phase impacts – all alternatives										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Without mitigation	Negative	National	Medium	Short term	Probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	National	Low	Short term	Probable	Medium	Yes	Medium	Low	**Low**
Western Route										
Without mitigation	Negative	Regional	High	Long term	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	Local	Medium	Long term	Probable	Low	Yes	Medium	Medium	**Medium**
Northern Route										
Without mitigation	Negative	Regional to national	High	Long term	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	Regional	Medium	Long term	Probable	Medium	Yes	Medium	High	**High**
Eastern Access Road										
Without mitigation	Negative	National	High	Long term	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Low	Long term	Probable	Medium	Yes	Medium	Medium	**Medium**
Cumulative impacts associated with proposed development as a whole without positive impacts associated with incorporation of erven affected by road										
Without mitigation	Negative	National	Very high	Permanent	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Very high	Permanent	Probable	Low	Yes	Medium	High	**High**
Cumulative impacts associated with proposed development as a whole assuming positive impacts associated with incorporation of erven affected by road. Also assuming high confidence addressing of identified uncertainties										
Without mitigation	Negative	National	Very high	Permanent	Probable	Low	Yes	Medium	High	**Medium**
With mitigation	Positive	National	High	Permanent	Probable	Medium	Yes	Medium	High	**High**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Cumulative impacts associated with proposed development as a whole assuming positive impacts associated with incorporation of erven affected by road – but with high levels of uncertainty as at present										
Without mitigation	Negative	National	Very high	Permanent	Probable	Low	Yes	Medium	Medium	**High**
With mitigation	Negative	National	High	Permanent	Improbable	Low	Yes	Medium	Low	**High**

9.11 Impacts on terrestrial vertebrate fauna

The impacts of the proposed nuclear power station development, Nuclear-1, are identified separately for each of the three alternative sites, namely Duynefontein, Bantamsklip and Thyspunt (below). Note that most of the predicted impacts are common to all three sites, although the severity and significance of those impacts may differ between sites.

9.11.1 Duynefontein

(a) Destruction of natural habitats and populations

Wherever buildings and infrastructure are constructed, natural habitats will be destroyed. In addition, lay-down areas for machinery, materials and soil will be heavily impacted, albeit not permanently. Many of the animals associated with affected habitats will be killed at the time of site clearance. Some of those animals that are able to escape will establish themselves in similar habitats nearby, but their long-term prospects for survival will be poor because those habitats will most likely already be at carrying capacity for the relevant species. These potential impacts will be locally intense and mainly of a permanent nature. Lay-down areas can be rehabilitated over time. Mitigation should take the form of avoidance of the most sensitive areas.

(b) Reduction in populations of Threatened species

Species which have Threatened or Near Threatened status (see fauna specialist report) may experience a reduction of their national or global populations and an exacerbation of their poor conservation status. Species relevant to Duynefontein are: Gronovi's Dwarf Burrowing Skink *Scelotes gronovii* (Near Threatened), Southern Adder *Bitis armata* (Vulnerable), Blouberg Dwarf Burrowing Skink *Scelotes montispectus* (Near Threatened), Whitetailed Mouse *Mystromys albicaudatus* (Endangered), Honey Badger *Mellivora capensis* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened) and Black Harrier *Circus maurus* (Near Threatened). Other relevant bird species will be less directly impacted. The fact that habitats occupied by these species will be permanently destroyed means that the negative impacts on the species are likely also to be permanent.

(c) Fragmentation of natural habitats and patterns of animal movement

The construction of buildings and infrastructure, including fencing, will break up blocks of continuous or intergrading habitats into relatively isolated fragments. The impact of such fragmentation will vary from species to species, depending on the degree of mobility of the species and its tolerance of sub-optimal habitat types. Many species, with limited mobility and low tolerance of habitats other than their preferred habitat, will become isolated within fragments and thereby become more vulnerable to local extinction. This potential impact is likely to be permanent, but with the greatest impact on species with restricted movements, such as fossorial reptiles, and the least impact on birds. Ecological corridors are key to mitigate fragmentation.

(d) Road mortality

Local populations of animals will be negatively impacted by mortality on the roads. Areas close to roads are likely to become population “sinks” in which the rate of increase from reproduction and immigration is less than the rate of decrease owing to deaths on the road. For some species, especially nocturnal species, such impacts may be intense, especially if the road separates two different habitats which are both essential to the species, e.g. dryland and wetland habitats, or inland and coastal habitats.

(e) Mortality associated with overhead-transmission lines and substations

Overhead cables are obstacles to birds in flight and collisions can occur, especially under conditions of poor visibility. Such conditions frequently prevail on the west coast when fog rolls in from the sea. The danger applies particularly to larger birds, which are less manoeuvrable in flight. If transmission lines cross regularly used flight paths, the potential impact of the power lines on local or even regional populations can be severe. Large birds that perch on pylons can also be at risk of electrocution. Substations (e.g., the proposed HV yard) present what appear to be good nesting sites for some birds, but such nesting attempts are inherently dangerous. The interaction of birds and electrical installations is not only potentially deleterious to birds, but can also result in costly breaks in transmission. Eskom has extensive experience and technological expertise in mitigating problems of this kind. Note that the transmission lines are the subject of a separate EIA and these issues will presumably be highlighted in that process.

(f) Disturbance of sensitive breeding populations

Noise, visual disturbance, and especially an increased presence of human beings, all have the potential to disturb wild animals and possibly disrupt their normal behaviour patterns. This becomes particularly problematic when breeding of rare and sensitive species is disrupted. Impacts tend to be more intense during the construction phase when human activity is more intense and less routine. Extraordinary disturbances, such as blasting, are also associated with the construction phase. Depending on the nature and timing of disturbances, their impacts can vary from local and moderate to regional and intense. Species likely to be affected are, especially, seabirds roosting and breeding in the relatively protected environment in and around Koeberg harbour, including Swift Terns *Sterna bergii*, African Black Oystercatchers *Haematopus moquini* (Near Threatened), Cape Cormorants *Phalacrocorax capensis*, Crowned Cormorants *P. neglectus* (Vulnerable), and Bank Cormorants *P. coronatus* (Near Threatened). Nuclear-1 will not be using or affecting Koeberg harbour directly, but construction activities in the vicinity have the potential to cause damaging disturbance.

(g) Dust pollution beyond the building site

During the construction phase, dust generated by construction activities, especially trucks on dirt roads, will drift onto neighbouring vegetation and cause degradation of habitats with negative effects on the animals using those habitats. This potential impact is temporary and localised.

(h) Pollution of soil and water beyond the building site

The use of heavy machinery and vehicles will inevitably lead to fuel and chemical spills with some chemical pollution of soil and groundwater, especially during the construction phase when the use of machinery is more intense. The danger is that polluted water can move, either on the surface or underground, to areas beyond the building site and, in particular, may reach wetlands. Pollution of soil can also be damaging if such pollution occurs in areas that are intended for later rehabilitation to a natural state. Depending on the severity of the pollution, the resultant degradation of habitats can extend into the medium and long term, especially if polluting events continue during the operational phase. Pollution arising from the disposal of sewage is especially relevant in this regard. Some types of pollution can also be cumulative (e.g. heavy-metal pollution and organic eutrophication).

(i) Light pollution beyond the building site

Outdoor lighting, especially of the short-wavelength type (white and blue), attracts night-flying insects from considerable distances, and this leads to unacceptably high levels of mortality among these insects, many of which are critically important to normal ecosystem functioning. In addition, an abundance of insects under lights tends to attract predators such as owls, bats and toads, thus disrupting the normal behaviour patterns of these species. Long-term use of external lighting has a cumulative negative potential impact on ecosystems.

(j) Alteration of surface and groundwater levels and flows; knock-on effects on local wetlands

The fact that the nuclear reactor itself must be constructed on bedrock means that, of necessity, there will be local disruption of groundwater flow, and this is likely to lead to altered water supply and/or drainage at local wetlands. The hard surfaces of buildings and roads cause increased run-off, which is often contaminated with pollutants. Such potential impacts may be minor and negligible, or may be major with important ecological consequences for wetland-dependent fauna. The opinion of relevant specialists at the November 2009 specialist integration meeting was that such impacts will be insignificant at Duynefontein.

(k) Poaching of local wildlife

The area around the Duynefontein site comprises the Koeberg Private Nature Reserve, which is home to many antelope, game birds and other wildlife that is likely to tempt people who would like to hunt for sport or for the pot. With large numbers of workers temporarily on site during the construction phase, the negative potential impact of poaching could be locally intense. However, with the conservation personnel of Koeberg Private Nature Reserve already deployed on site, this impact will presumably be kept under reasonable control.

(l) Problem-animal scenarios

Of concern are animals that have the potential to become problematic, especially during the operational phase when some animals become accustomed to the presence and activities of humans. The Chacma Baboon *Papio ursinus* is often a good example, but this species does not occur at Duynefontein. However, even small and relatively harmless species, such as Small Grey Mongoose *Galerella pulverulenta*, Small-spotted Genet *Genetta genetta*, Cape Porcupine *Hystrix africaeaustralis,* and various rodents can become problem animals if they are tempted to exploit resources provided by humans. People, in their eagerness to interact with wildlife, will often try to feed mammals and birds. The feeding of birds, although traditional, can cause certain species to become a nuisance, and leftover food attracts other species, such as rodents. If rodent populations build up in an area as a result of artificially elevated food supplies, predators of rodents (including venomous snakes such as the Puff Adder *Bitis arietans* and Cape Cobra *Naja nivea*) will also be attracted. The development site is close enough to residential areas for domestic animals to also pose a potential problem. Stray animals have the potential to become feral and prey on wild fauna.

(m) Cumulative impacts

Several of the potential impacts listed above will potentially continue during the operational phase of the nuclear power station (e.g. road mortality, light pollution, disturbance of sensitive populations, etc.) and will thereby exert a cumulative impact over time. Given the fact that there is already one nuclear power station at Duynefontein, and that a Pebble-bed Modular Reactor (PBMR) is proposed for a site just to the south of Koeberg nuclear power station, the addition of another nuclear power station just to the north of Koeberg will clearly lead to cumulative impacts. Virtually all of the impacts listed above will be cumulative relative to similar impacts brought about by Koeberg and PBMR. One of the most serious potential cumulative impacts is the increasing isolation of coastal and inland habitats from each other. Many of the more mobile species, especially among mammals and birds, rely on a diversity of habitats to sustain them at different times and under varying conditions. For this reason it is ecologically important that animals be able to move freely and unhindered between coastal and inland habitat types. An increasingly long string of buildings and fences at the coast make such movements difficult or impossible and thereby have a cumulative negative impact on local populations. Another potentially serious cumulative impact is the disruption of dune systems. The mobile sands of the sand plume to the north of the site create a mosaic of habitat types with ecologically valuable edges. If the continuous addition of mobile sand from the south is further disrupted – it has already been partially disrupted by Koeberg – the existing dunes are likely to stabilize and become permanently vegetated, causing a cumulative negative impact on the diversity of the local ecology.

(o) Improvement of the conservation status of undeveloped land

Given that the site of the proposed new nuclear power station, and the land surrounding it, are currently managed by Eskom as an extension of the Koeberg Private Nature Reserve, it is clear that there will be no improvement of conservation status of Eskom-owned lands. On the contrary, the area under conservation management will shrink substantially. Nevertheless, conservation status can also be enhanced through elevation of the legal status of the reserve, and through improved conservation management, and there is potential to achieve these at Duynefontein.

9.11.2 Bantamsklip

(a) Destruction of natural habitats and populations

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(b) Reduction in populations of Threatened species

Species which have Threatened or Near Threatened status (see **Appendix E13**) may experience a reduction of their national or global populations and an exacerbation of their poor conservation status. Species relevant to the coastal portion of Bantamsklip are: Southern Adder *Bitis armata* (Vulnerable), Fynbos Golden Mole *Amblysomus corriae* (Near Threatened), Whitetailed Mouse *Mystromys albicaudatus* (Endangered), Honey Badger *Mellivora capensis* (Near Threatened), African Black Oystercatcher *Haematopus moquini* (Near Threatened), Black Harrier *Circus maurus* (Near Threatened), and Denham’s Bustard *Neotis denhami* (Vulnerable). The fact that habitats occupied by these species will be permanently destroyed means that the potential negative impacts on the species are likely also to be permanent. Other relevant bird species, i.e. various Threatened seabirds, would be less directly impacted, if at all because potential impacts on marine habitats would be minor. Roosting seabirds at the coast can be adequately protected by a wide coastal corridor, as recommended. The concerns, expressed by some I&APs about possible impacts on seabirds breeding on Dyer Island, are misplaced. The only manner in which these birds could be affected is if the nuclear power station somehow affected their food supply, namely the abundance of shoaling fish such as sardines, pilchards and anchovies. There is no danger of such a negative impact (Tamara Robinson, marine ecology specialist, *pers. comm*.).

(c) Fragmentation of natural habitats and patterns of animal movement

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(d) Road mortality

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(e) Mortality associated with overhead-transmission lines and substations

Overhead cables are obstacles to birds in flight and collisions can occur, especially under conditions of poor visibility, for example, when there is fog or mist. The danger applies particularly to larger birds which are less manoeuvrable in flight. If transmission lines cross regularly used flight paths, the impact of the lines on local or even regional populations can be severe. Large birds that perch on pylons can also be at risk of electrocution. Substations (e.g., the proposed HV yard) present what appear to be good nesting sites for some birds, but such nesting attempts are inherently dangerous. The interaction of birds and electrical installations is not only potentially deleterious to birds, but can also result in costly breaks in transmission. Happily, Eskom has extensive experience and technological expertise in mitigating problems of this kind. Threatened birds likely to be particularly affected at Bantamsklip are Blue Crane

(Vulnerable), Denham's Bustard (Vulnerable), and Secretarybird (Near Threatened). Note that the transmission lines are the subject of a separate EIA and these issues will presumably be highlighted in that process.

(f) Disturbance of sensitive breeding populations

Noise, visual disturbance, and especially an increased presence of human beings, all have the potential to disturb wild animals and possibly disrupt their normal behaviour patterns. This becomes particularly problematic when breeding of rare and sensitive species is disrupted. Impacts tend to be more intense during the construction phase when human activity is more intense and less routine. Extraordinary disturbances, such as blasting, are also associated with the construction phase. Depending on the nature and timing of disturbances, their impacts can vary from local and moderate to regional and intense. Species likely to be affected at Bantamsklip include, among others, Cape Cormorant (Near Threatened), Bank Cormorant (Endangered), Crowned Cormorant (Near Threatened), African Black Oystercatcher (Near Threatened), Damara Tern *Sterna balaenarum* (Endangered), Black Harrier (Near Threatened), Denham's Bustard (Vulnerable) and Blue Crane (Vulnerable).

(g) Dust pollution beyond the building site

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(h) Pollution of soil and water beyond the building site

The nature of this potential impact will be the similar to Duynefontein. However, the apparent absence of wetlands on or near to the proposed Bantamsklip footprint suggests that this impact is of relatively minor importance at this site.

(i) Light pollution beyond the building site

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(j) Alteration of surface and groundwater levels and flows; knock-on effects on local wetlands

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(k) Poaching of local wildlife

The area around the proposed Bantamsklip footprint is relatively wild and natural and home to antelope, game birds and other wildlife that is likely to tempt people who would like to hunt for sport or for the pot. With large numbers of workers temporarily on site during the construction phase, the negative impact of poaching could be locally intense. This negative scenario is exacerbated by the fact that abalone poachers are already active in the area. Numbers of antelope on site were noticeably low, which suggests that poaching of terrestrial fauna may already be happening in the area, adding to the need for strict control.

(l) Problem-animal scenarios

Of concern are animals that have the potential to become problematic. Chief among these is the Chacma Baboon *Papio ursinus*. As human habitation steadily encroaches on their territories, these primates become bolder in exploiting the opportunities presented. At such times, wild animals can become a threatening and hazardous presence. Other potentially problematic and dangerous species include Leopard *Panthera pardus* and Bushbuck *Tragelaphus scriptus*. Even small and relatively harmless species, such as Small Grey Mongoose *Galerella pulverulenta*, Small-spotted Genet *Genetta genetta*, Cape Porcupine

Hystrix africaeaustralis, Rock Hyrax *Procavia capensis* and various rodents can become problem animals if they are tempted to exploit resources provided by humans. People, in their eagerness to interact with wildlife, will often try to feed mammals and birds. The feeding of birds, although traditional, can cause certain species to become a nuisance, and leftover food attracts other species, such as rodents. If rodent populations build up in an area as a result of artificially elevated food supplies, predators of rodents (including venomous snakes such as the Puff Adder *Bitis arietans* and Cape Cobra *Naja nivea*) will also be attracted. The development site is close enough to residential areas for domestic animals to also pose a potential problem. Stray animals have the potential to become feral and prey on wild fauna.

(m) Cumulative impacts

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(n) Improvement of the conservation status of undeveloped land

Most of the development corridor, and the land surrounding it, are currently owned by Eskom but have no particular conservation status. If Eskom retains ownership of the land and manages the natural, undisturbed parts as a private nature reserve, as is presently the case with Koeberg Private Nature Reserve, it is clear that there will be a significant improvement in the conservation status of the undeveloped parts of the Bantamsklip site. This would be of special significance to the populations of Threatened frogs on the Hagelkraal farm, and other Threatened species. In addition, conservation status could be enhanced through improved conservation management, for example, removal of invasive alien vegetation. Such conservation actions would contribute to national conservation targets and could represent significant offsets for the loss of habitats and individuals at the development footprint.

9.11.3 Thyspunt

(a) Destruction of natural habitats and populations

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(b) Reduction in populations of Threatened species

Species which have Threatened or Near Threatened status (see fauna report) may experience a reduction of their national or global populations and an exacerbation of their poor conservation status. Species relevant to Thyspunt are: FitzSimons' Long-tailed Seps (Vulnerable) and Tasman's Girdled Lizard (Vulnerable), Elandsberg Dwarf Chameleon (Endangered), Fynbos Golden Mole (Near Threatened), Honey Badger (Near Threatened), Blue Duiker (Vulnerable), African Black Oystercatcher (Near Threatened), African Marsh Harrier (Vulnerable), Black Harrier (Near Threatened), White-bellied Korhaan (Vulnerable), Denham's Bustard (Vulnerable), Knysna Woodpecker (Near Threatened) and Knysna Warbler (Vulnerable). Other relevant bird species will be less directly impacted. The fact that habitats occupied by these species may be permanently destroyed means that the negative impacts on the species are likely also to be permanent.

(c) Fragmentation of natural habitats and patterns of animal movement

The nature of this impact will be the similar to that at Duynefontein and is therefore not repeated here in totality. At Thyspunt, however, the impact of roads is expected to be more intense than at Duynefontein and Bantamsklip. Although there are three alternatives, two major new roads are planned onto the site. The significance of the impact on the Thyspunt site differ as the lengths of the roads are greater in comparison to the other sites and because the roads cross environmentally more sensitive terrain including the Langefontein Wetland Complex located on the eastern portion of the site and the Dunefield located on the northern portion of the site.

(d) Road mortality

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(e) Mortality associated with overhead-transmission lines and substations

Overhead cables are obstacles to birds in flight and collisions can occur, especially under conditions of poor visibility, for example, when there is fog or mist. The danger applies particularly to larger birds which are less manoeuvrable in flight. If transmission lines cross regularly used flight paths, the impact of the lines on local or even regional populations can be severe. Large birds that perch on pylons can also be at risk of electrocution. Substations (e.g., the proposed HV yard) present what appear to be good nesting sites for some birds, but such nesting attempts are inherently dangerous. The interaction of birds and electrical installations is not only potentially deleterious to birds, but can also result in costly breaks in transmission. Happily, Eskom has extensive experience and technological expertise in mitigating problems of this kind. Threatened birds likely to be particularly affected at Thyspunt are Blue Crane (Vulnerable), Denham's Bustard (Vulnerable), White-bellied Korhaan (Vulnerable) and Secretarybird (Near Threatened). Note that the transmission lines are the subject of a separate EIA and these issues will presumably be highlighted in that process.

(f) Disturbance of sensitive breeding populations

Noise, visual disturbance, and especially an increased presence of human beings, all have the potential to disturb wild animals and possibly disrupt their normal behaviour patterns. This becomes particularly problematic when breeding of rare and sensitive species is disrupted. Impacts tend to be more intense during the construction phase when human activity is more intense and less routine. Extraordinary disturbances, such as blasting, are also associated with the construction phase. Depending on the nature and timing of disturbances, their impacts can vary from local and moderate to regional and intense. Threatened species likely to be affected include, among others, Blue Duiker (Vulnerable), African Black Oystercatcher (Near Threatened), African Marsh Harrier (Vulnerable), Black Harrier (Near Threatened), Black-winged Lapwing (Near Threatened), Denham's Bustard (Vulnerable), White-bellied Korhaan (Vulnerable), Blue Crane (Vulnerable); Knysna Woodpecker (Near Threatened) and Knysna Warbler (Vulnerable).

(g) Dust pollution beyond the building site

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(h) Pollution of soil and water beyond the building site

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here in totality. The presence of a large number of wetlands on or near to the proposed Thyspunt footprint suggests that this impact is of major importance at this site.

(i) Light pollution beyond the building site

The nature of this impact will be the similar to that at Duynefontein and is therefore not repeated here.

(j) Alteration of surface and groundwater levels and flows; knock-on effects on local wetlands

The fact that the nuclear reactor itself must be constructed on bedrock (Integration Meeting, pers. comm.) means that, of necessity, there will be local disruption of groundwater flow, and this is likely to lead to altered water supply and/or drainage at local wetlands. The hard surfaces of buildings and roads cause increased run-off which is often contaminated with pollutants. Such potential impacts may be minor and negligible, or may be major with important ecological consequences for wetland-dependent fauna. This specialist is not able to judge, in advance, the severity of such potential impacts, but the opinion of relevant specialists (Integration Meeting; pers. comm.) is that such impacts will be potentially major and highly significant at the Thyspunt site, however should these potential impacts be avoided or mitigated it the significance of the impact would lesson.

(k) Poaching of local wildlife

The area around the proposed Thyspunt footprint is relatively wild and natural and home to antelope, bushpigs, game birds and other wildlife that are likely to tempt people who would like to hunt for sport or for the pot. With large numbers of workers temporarily on site during the construction phase, the negative potential impact of poaching could be locally intense.

(l) Problem-animal scenarios

Of concern are animals that have the potential to become problematic. Chief among these are Chacma Baboon *Papio ursinus* and Vervet Monkey *Cercopithecus pygerythrus*. As human habitation steadily encroaches on their territories, these primates become bolder in exploiting the opportunities presented. At such times, wild animals can become a threatening and hazardous presence. Other potentially problematic and dangerous species include Leopard *Panthera pardus,* Bushpig *Potamochoerus larvatus* and Bushbuck *Tragelaphus scriptus*. Even small and relatively harmless species, such as Small Grey Mongoose *Galerella pulverulenta*, Small-spotted Genet *Genetta genetta*, Cape Porcupine *Hystrix africaeaustralis,* Rock Hyrax *Procavia capensis* and various rodents can become problem animals if they are tempted to exploit resources provided by humans. People, in their eagerness to interact with wildlife, will often try to feed mammals and birds. The feeding of birds, although traditional, can cause certain species to become a nuisance, and leftover food attracts other species, such as rodents. If rodent populations build up in an area as a result of artificially elevated food supplies, predators of rodents (including venomous snakes such as the Puff Adder *Bitis arietans* and Cape Cobra *Naja nivea*).will also be attracted, The development site is close enough to residential areas for domestic animals to also pose a potential problem. Stray animals can become feral and prey on wild fauna.

(m) Cumulative impacts

The nature of this potential impact will be the similar to that at Duynefontein and is therefore not repeated here.

(n) Improvement of the conservation status of undeveloped land

The site of the new nuclear power station, and the land surrounding it, are currently owned by Eskom but have no particular conservation status. If Eskom retains ownership of the land and manages the natural, undisturbed parts as a private nature reserve, as is presently the case at Koeberg Private Nature Reserve, there will be a significant improvement in the conservation status of the Thyspunt site. This would be of special significance to populations of various Threatened species. In addition, conservation status could be enhanced through improved conservation management, for example, removal of invasive alien vegetation. Such conservation actions would contribute to national conservation targets and could represent significant offsets for the loss of habitats and individuals at the development footprint.

9.11.4 Impact on decommissioning

Given the extensive and intensive nature of the decommissioning process, it is reasonable to assume that the range of impacts identified for construction and operation will also be relevant to the decommissioning process. These were:

- Destruction of natural habitats and populations;
- Reduction in populations of Threatened species;
- Fragmentation of natural habitats and patterns of animal movement;

- Road mortality;
- Mortality associated with overhead-transmission lines and substations;
- Disturbance of sensitive breeding populations;
- Dust pollution beyond the building site;
- Pollution of soil and water beyond the building site;
- Light pollution beyond the building site;
- Alteration of surface and groundwater levels and flows; knock-on effects;
- Poaching of local wildlife; and
- Problem-animal scenarios.

9.11.5 Mitigation

Mitigation at all sites measures must include the following categories of actions:

<u>Mitigation of destruction of natural habitats and populations</u>

- Restrict development to a recommended footprint.
- Restrict the footprint of the development to the smallest area possible.
- Dispose of spoil at sea.
- Create laydown areas in previously disturbed areas.
- Use natural topographical features as boundaries.
- Clear the site in a logical sequence.
- Mark off the affected area.
- Rehabilitate affected areas, where possible.
- Compensate for loss of habitats. (See below).

<u>Mitigation of reduction in populations of Threatened species</u>

- All of the mitigations listed under (i) (above).
- Facilitate search-and-rescue operations before and during site clearance.
- Facilitate collection of scientific material and information before and during site clearance.

<u>Mitigation of fragmentation of natural habitats and patterns of animal movement</u>

- Most of the mitigations listed under (i) (above).
- Make provision for ecological corridors.
- Construct under- and overpasses across roads.
- Keep roads as far away from wetlands as possible.
- Use recommended types of security fencing.
- Wherever possible, place pipelines and cables underground, and rehabilitate.
- Reduce the number of roads and tracks and place them carefully.
- Make roads off limits for fixed periods every day.

<u>Mitigation of road mortality</u>

- Reduce the number of roads and tracks and place them carefully.
- Keep roads as far away from wetlands as possible.
- Construct under- and overpasses across roads.
- Restrict speed on roads.
- Make roads off limits for fixed periods every day.
- Place warning signage in appropriate places.
- Use appropriate curb designs.

<u>Mitigation of mortality associated with overhead-transmission lines and substations</u>

- Fit standard devices on all new routes (e.g., “flappers” or reflectors or “balls”).
- Monitor routes and installations.

<u>Mitigation of disturbance of sensitive breeding populations</u>

- Determine location and extent of sensitive bird and other areas.
- Quarantine sensitive bird and other areas.
- Restrict the timing of blasting.

- Create wide buffer zones.
- Restrict air traffic.
- Restrict water traffic.
- Enforce all restrictions.
- Institute a programme of monitoring.

<u>Mitigation of dust pollution beyond the building site</u>

- Apply standard mitigation measures, e.g., damping down with freshwater, use of cloth or brush barrier fences, covering dumps with plastic sheeting, etc.
- Do not use seawater.

<u>Mitigation of pollution of soil and water beyond the building site</u>

- Apply standard mitigation measures.
- Remove all polluted soil and water from site.
- Dispose of brine from desalination into the sea.
- Dispose of sewage in a sustainable manner.

<u>Mitigation of light pollution beyond the building site</u>

- Reduce exterior lighting.
- Use only long-wavelength lights.
- Use directional fittings.
- Screen interior lighting.

<u>Mitigation of alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands</u>

- Avoid sites where major damage to wetlands is inevitable.
- Do not use wetlands or groundwater as sources of freshwater.
- Engineer solutions to the flow of groundwater.
- Carry out additional studies at Thyspunt.

<u>Mitigation of poaching of local wildlife</u>

- Educate workers.
- Patrol the area.
- Control materials.
- Control firearms.
- Control after-hours access.
- Control access to non-construction areas.

<u>Mitigation of problem-animal scenarios</u>

- Do not allow feeding of wild animals.
- Keep attractive resources out of reach.
- Exercise rigorous control of edible refuse.
- Eliminate feral cats and dogs.
- Do not allow pets on site.

<u>Mitigation of accumulation of radioisotopes in the environment and in bodies of wild animals</u>

- No mitigations, beyond those required by human health and safety regulations, are recommended.

<u>Mitigation of cumulative impacts</u>

- The recommended mitigations that will contribute most are:
- choice of a suitable development footprint
- rehabilitation of degraded areas, post construction
- use of a suitable design for boundary fences
- use of suitable exterior lighting
- avoidance and mitigation of impacts on groundwater
- enforcement of restrictions on disturbance and poaching of wildlife
- monitoring of sensitive populations to aid environmental management

- monitoring of radioisotope pollution to aid environmental management.

Mitigation/offset of impacts through improved conservation of undeveloped land

- Elevation of legal status of undeveloped portions to statutory nature reserves
- Replacement of unsuitable mesh fences with palisade fences
- Increased spending on the removal of invasive alien plants
- Installation of two or three strategically located underpasses to facilitate animal movements across busy roads
- Commissioning of detailed surveys of poorly surveyed animal groups, *viz.*, reptiles, amphibians and small mammals
- Commissioning of a programme to monitor the populations of sensitive species.

Recommended monitoring and evaluation programme

An appropriate monitoring and auditing programme should be put in place to track the efficacy of the mitigation measures. Most of this monitoring must be built into the auditing procedures of the EMPs for the construction, operational and decommissioning phases, but input during the design phase is also important for the demarcation of sensitive areas. The programme should include monitoring directed specifically at sensitive faunal populations.

9.11.6 Conclusions

At Duynefontein, the amount of land that is not of high faunal sensitivity between the coast and R43 available for development is more than sufficient to allow for the nuclear power station. The portion of the property inland of the R43 is highly sensitive and should not be developed at all.

At Bantamsklip the nuclear power station would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. However, highly significant potential offsets are possible at Bantamsklip if undeveloped land is declared a nature reserve and is effectively managed as such. This would depend especially on the protection and management of the inland portion, as well as an adequate coastal corridor. The no-development option at Bantamsklip is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a possible increase in intensity of agricultural exploitation on the inland portion.

At Thyspunt an nuclear power station would have significant negative impacts, mainly because of (a) the direct impacts on faunal habitats within the footprint areas, (b) the development of two major new access roads, and (c) the need for a development corridor across a large field of mobile dunes, making this site highly problematic with respect to fauna and faunal habitats. On the other hand, highly significant potential offsets are possible at Thyspunt if undeveloped land is declared a nature reserve and is effectively managed as such. Such offsets could be significantly strengthened by acquisition of additional land. The no-development option at Thyspunt is not positive because it can be assumed that it will lead to a change of land ownership and probable residential and/or resort development at the coast, and a probable increase in intensity of agricultural exploitation on the inland portion.

Table 9-21: Assessment of impacts on terrestrial vertebrate fauna at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Destruction of natural habitats and populations as a result of site clearance, buildings, laydown areas and infrastructure.										
Without mitigation	Negative	National	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	National	Medium	Permanent	Definite	Medium	Yes	High	High	**High**
Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.										
Without mitigation	Negative	National	Low	Permanent	Probable	Low	Yes	Medium	Medium	**Medium**
With mitigation	Negative	National	Low	Permanent	Probable	Medium	Yes	Medium	Medium	**Medium**
Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.										
Without mitigation	Negative	Local	Medium	Permanent	Highly probable	Low	Yes	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Highly probable	Medium	Yes	High	Low	**Low**
Road mortality (roadkills), resulting from traffic on roads through natural habitats.										
Without mitigation	Negative	Local	Medium	Permanent	Probable	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Probable	High	No	High	Low	**Low**
Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.										
Without mitigation	Negative	Local	Medium	Permanent	Medium	Low	No	High	Probable	**Medium**
With mitigation	Negative	Local	Low	Permanent	Low	High	No	High	Probable	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.										
Without mitigation	Negative	regional	Medium	Short term	Low	Medium	Yes	Medium	Probable	**Low**
With mitigation	Negative	regional	Low	Short term	Low	High	Yes	Medium	Probable	**Low**
Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.										
Without mitigation	Negative	Local	Medium	Short term	Low	High	Yes	High	Highly probable	**Low**
With mitigation	Negative	Local	Low	Short term	Low	High	Yes	High	Highly probable	**Low**
Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.										
Without mitigation	Negative	Local	Medium	Medium term	Medium	Low	Yes	Medium	Probable	**Medium**
With mitigation	Negative	Local	Low	Medium term	Low	High	Yes	Low	Probable	**Medium**
Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.										
Without mitigation	Negative	Local	High	Long term	High	Low	Yes	High	Highly probable	**High**
With mitigation	Negative	Local	Low	Long term	Low	High	Yes	High	Highly probable	**Low**
Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.										
Without mitigation	Negative	Local	Medium	Permanent	Medium	Low	No	Low	Possible	**Low**
With mitigation	Negative	Local	Low	Permanent	Low	Low	No	Low	Possible	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Poaching of local wildlife during construction phase, resulting from hunting and trapping by workers and employees, for sport and for the pot.										
Without mitigation	Negative	Local	High	Short term	Low	Medium	No	High	Probable	**Low**
With mitigation	Negative	Local	Low	Short term	Low	High	No	High	Probable	**Low**
Problem-animal scenarios, resulting mainly from human interaction with animals.										
Without mitigation	Negative	Local	Medium	Long term	Medium	Medium	No	Medium	Possible	**Low**
With mitigation	Negative	Local	Low	Long term	Low	High	No	Medium	Possible	**Low**
Accumulation of radioisotopes in the environment and in the bodies of wild animals, during operational phase, resulting from routine gaseous emissions from the reactors.										
Without mitigation	Neutral	Local	Negligible	Long term	Low	High	No	High	Highly probable	**Low**
With mitigation	Neutral	Local	Negligible	Long term	Low	High	No	High	Highly probable	**Low**
Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.										
Without mitigation	Negative	regional	High	Long term	High	Low	Yes	High	Highly probable	**High**
With mitigation	Negative	regional	Low	Long term	Medium	Medium	Yes	High	Highly probable	**Medium**
Improved conservation of undeveloped land, resulting from improved legal status and/or management.										
Without mitigation	Neutral	National	Not applicable	Long term	Low	High (bad)	Yes	High	Definite	**Low**
With mitigation	Positive	National	Potentially medium	Long term to permanent	Medium	Low (good)	Yes	High	Definite	**Medium**

Table 9-22: Assessment of impacts on terrestrial vertebrate fauna at Bantamsklip (coastal portion only)

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.										
Without mitigation	Negative	National	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	National	Medium	Permanent	Definite	Medium	Yes	High	High	**High**
Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.										
Without mitigation	Negative	National	Medium	Permanent	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Low	Permanent	Probable	Medium	Yes	Medium	High	**High**
Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.										
Without mitigation	Negative	Local	Medium	Permanent	Highly probable	Low	Yes	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Highly probable	Medium	Yes	High	Low	**Low**
Road mortality (roadkills), resulting from traffic on roads through natural habitats.										
Without mitigation	Negative	Local	Medium	Permanent	Highly probable	Medium	No	Medium	Medium	**High**
With mitigation	Negative	Local	Low	Permanent	Highly probable	High	No	Low	Low	**High**
Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Without mitigation	Negative	Local	Medium	Permanent	Probable	Low	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Probable	High	No	High	Low	**Low**
Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.										
Without mitigation	Negative	Regional	Medium	Short term	Probable	Medium	Yes	Medium	Low	**Low**
With mitigation	Negative	Regional	Low	Short term	Probable	High	Yes	Medium	Low	**Low**
Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.										
Without mitigation	Negative	Local	Medium	Short term	Highly probable	High	Yes	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Highly probable	High	Yes	High	Low	**Low**
Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.										
Without mitigation	Negative	Local	Medium	Medium term	Probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium term	Probable	High	Yes	Medium	Low	**Low**
Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.										
Without mitigation	Negative	Local	High	Long term	Highly probable	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Low	Long term	Highly probable	High	Yes	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.										
Without mitigation	Negative	Local	Low	Permanent	Possible	Low	No	Low	Medium	**Low**
With mitigation	Negative	Local	Low	Permanent	Possible	Low	No	Low	Low	**Low**
Poaching of local wildlife during construction phase, resulting from hunting and trapping by workers and employees, for sport and for the pot.										
Without mitigation	Negative	Local	High	Short term	Probable	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Problem-animal scenarios, resulting mainly from human interaction with animals.										
Without mitigation	Negative	Local	High	Long term	Probable	Medium	No	High	High	**High**
With mitigation	Negative	Local	Low	Long term	Probable	High	No	High	Low	**Low**
Accumulation of radioisotopes in the environment and in the bodies of wild animals, during operational phase, resulting from routine gaseous emissions from the reactors.										
Without mitigation	Neutral	Local	Negligible	Long term	Highly probable	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Negligible	Long term	Highly probable	High	No	High	Low	**Low**
Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Without mitigation	Negative	Regional	High	Long term	Highly probable	Low	Yes	High	High	**High**
With mitigation	Negative	Regional	Low	Long term	Highly probable	Medium	Yes	High	Medium	**Medium**
Improved conservation of undeveloped land, resulting from improved legal status and/or management.										
Without mitigation	Neutral	National	Not applicable	Long term	Definite	high (bad)	Yes	Low	Low	**Low**
With mitigation	Positive	National	High	Long term to permanent	Definite	low (good)	Yes	Low	High	**High**

Table 9-23: Assessment of on-site impacts on terrestrial vertebrate fauna at Thyspunt (coastal portion only)

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Destruction of natural habitats and populations, resulting from site clearance, buildings, laydown areas and infrastructure.										
Without mitigation	Negative	National	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	National	Medium	Permanent	Definite	Medium	Yes	High	High	**High**
Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality.										
Without mitigation	Negative	National	Medium	Permanent	Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National	Low	Permanent	Probable	Medium	Yes	Medium	High	**High**
Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences.									.	
Without mitigation	Negative	Local	High	Permanent	Highly probable	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	Highly probable	Medium	Yes	High	medium	**Medium**
Road mortality (roadkills), resulting from traffic on roads through natural habitats.										
Without mitigation	Negative	Local	High	Permanent	Probable	Medium	No	High	High	**High**
With mitigation	Negative	Local	Low	Permanent	Probable	High	No	High	Medium	**Low**
Mortality associated with overhead-transmission lines and substations, resulting from collisions and electrocutions.										
Without mitigation	Negative	Local	Medium	Permanent	Probable	Low	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Probable	High	No	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Disturbance of sensitive breeding populations, resulting from construction activities and direct human disturbance.										
Without mitigation	Negative	Regional	Medium	Short term	Probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	Regional	Low	Short term	Probable	High	Yes	Medium	Low	**Low**
Dust pollution beyond the building site, resulting from drifting, airborne dust from construction site and roads.										
Without mitigation	Negative	Local	Medium	Short term	Highly probable	High	Yes	High	Low	**Low**
With mitigation	Negative	Local	Low	Short term	Highly probable	High	Yes	High	Low	**Low**
Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage.										
Without mitigation	Negative	Local	High	Medium term	Probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium term	Probable	High	Yes	Medium	Low	**Low**
Light pollution beyond the building site, resulting from excessive outdoor lighting, and poor choice of lights and fittings.										
Without mitigation	Negative	Local	High	Long term	Highly probable	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Low	Long term	Highly probable	High	Yes	High	Low	**Low**
Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods.										
Without mitigation	Negative	Local	High	Permanent	Probable	Low	No	High	Low	**High**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
With mitigation	Negative	Local	Medium	Permanent	Probable	Low	No	Low	Medium	**Medium**
Poaching of local wildlife during construction phase, resulting from hunting and trapping by workers and employees, for sport and for the pot.										
Without mitigation	Negative	Local	High	Short term	Probable	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Short term	Probable	High	No	High	Low	**Low**
Problem-animal scenarios, resulting mainly from human interaction with animals.										
Without mitigation	Negative	Local	High	Long term	Probable	Medium	No	High	High	**High**
With mitigation	Negative	Local	Low	Long term	Probable	High	No	High	Low	**Low**
Accumulation of radioisotopes in the environment and in the bodies of wild animals, during operational phase, resulting from routine gaseous emissions from the reactors.										
Without mitigation	Neutral	Local	Negligible	Long term	Highly probable	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Negligible	Long term	Highly probable	High	No	High	Low	**Low**
Cumulative impacts, resulting from addition of impacts to existing impacts, and the operation of impacts over time.										
Without mitigation	Negative	Regional	High	Long term	Highly probable	Low	Yes	High	High	**High**
With mitigation	Negative	Regional	Low	Long term	Highly probable	Medium	Yes	High	Medium	**Medium**
Improved conservation of undeveloped land, resulting from improved legal status and/or management.										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Without mitigation	Neutral	National	Not applicable	Long term	Definite	high (bad)	Yes	High	Low	**Low**
With mitigation	Positive	National	High	Long term to permanent	Definite			High	High	**High**

9.12 Impacts on invertebrate fauna

The potential impacts of the proposed Nuclear 1 power station on the terrestrial invertebrate communities are described for the three sites below; most of the impacts are very similar for all three sites, therefore a separate list for each site is not provided, but site-specific differences in significance or type are emphasised where applicable.

9.12.1 Construction impacts

(a) Direct habitat destruction

The construction of the nuclear power station will result in significant loss of natural habitats. Rehabilitation of some areas is possible, but despite this there is likely to be at least some long-term damage. Dumping of construction rubble and waste material may also cause long-term habitat degradation.

(b) Indirect habitat alteration / degradation by changes in groundwater regime

While most obviously impacting on wetland ecosystems, the terrestrial / wetland interface is an important ecosystem component for many species, thus we would like to emphasise the significance of impacts resulting from changes to the groundwater regime; these are covered in more detail in the Wetland Ecosystems specialist report (Day 2009). This potential impact is most likely to be of significance to invertebrate populations at Thyspunt, followed by Duynefontein, while at Bantamsklip there is relatively little likelihood of it being significant

(c) Habitat fragmentation

The construction of buildings, fences and roads will inevitably result in natural movement patterns being disrupted and to a varying degree, depending on how different species react to these barriers, will result in the fragmentation of natural populations. Such potential impacts would be long-term or permanent, most likely the latter, depending on the procedure followed during eventual decommissioning.

(d) Reduction in populations of rare / threatened / protected species

This potential impact would be localised and mainly limited to the direct construction area, access roads and materials / soil lay-down areas during the construction period (but see also under light pollution for more extensive and long-term potential impacts). Populations of non-flying invertebrates on the construction site will largely be destroyed, although some may escape into the surrounding areas. Their chance of survival here may be low due to difficulties in establishing in an area that may already be at or near carrying capacity. Adult stages of species that are able to fly may be able to escape, but their immature stages, which are often confined to the vegetation or are underground, will also be destroyed. The potential impact will be permanent in the transformed areas, but may be partially reversible in rehabilitated portions of the project area.

While several previously undescribed invertebrate species were collected during the very brief initial survey of the Duynefontein, Bantamsklip and Thyspunt sites, and many more undescribed species would be expected to be found if more detailed surveys were carried out, the significance of impacts on these species is difficult to estimate as nothing is currently known about their potential distribution beyond the site boundaries. At least some of the species probably have much wider distributions, but given the coastal location of the three sites, it is possible that some may be specific to coastal habitats and hence have limited distributions. Given the high development pressures on South Africa’s coastline, species restricted to the coastal zone may be significantly threatened.

(e) Soil and water pollution

Construction work of the magnitude contemplated for the proposed nuclear power station will always carry a substantial risk of soil and water pollution, with large construction vehicles contributing substantially due to oil and fuel spillages. Building waste, batching plants, sewage and domestic waste are also potential contributors to this problem. If not promptly dealt with, spillages or accumulation of waste matter can contaminate the soil and surface or ground water, leading to potential medium/long-term impacts on invertebrates in the soil as well as aquatic species. Soil stockpiles may run off into streams and wetlands resulting in excessive sedimentation.

(f) Dust pollution

Excavation and movement of soil, as well as movement of heavy vehicles on dirt roads, has the potential to cause substantial dust pollution in the area surrounding the construction site and access roads. Accumulation of dust on plants can reduce their productivity, with knock-on effects on invertebrate herbivores and their predators as well as directly interfering with invertebrate species by *e.g*. physically impeding their movement on plants.

(g) Light pollution

After habitat destruction, light pollution is probably the single most significant potential impact of a development of this nature, but, in the operational phase at least, it is also one of the most easily manageable. The impacts of artificial lighting on insect populations can be very significant, resulting in the deaths of many thousands of individuals every night, and causing a very substantial drain effect ("population sink") on surrounding populations. Other impacts may include interference with normal foraging and mating behaviours, resulting in less immediate but equally significant reductions in natural population levels. The consequent knock-on effects, given the vital role that invertebrates play in ecosystem functioning, may affect virtually every component of the surrounding ecosystem.

Direct impacts of artificial lights such as high pressure mercury vapour streetlamps may extend up to 600 m or more from the source, and the drain effect resulting from continual depletion of the populations within this zone will probably cause a significant decline in population density of affected species up to at least several times this distance. High level unshielded lighting at the nuclear power station could thus extend the area of direct impact from the c. 80 ha of the construction footprint to over 360 ha, with lower intensity indirect impacts potentially being significant over an area of more than 3 000 ha (i.e. beyond the property boundary). These impacts would be continuous throughout the life of the project, and in our opinion, no justification can be made for allowing such easily controllable impacts to occur.

Due to the changing "landscape" within the development footprint as well as the need for strong lighting if construction continues at night, light pollution is often particularly difficult to control during the construction phase, and this is where the greatest potential impacts are to be expected.

(h) Increased risk of fire

The presence of a large number of construction workers on site over a protracted period will result in a greatly increased risk of uncontrolled fires arising from cooking fires, improperly disposed cigarettes etc. This risk may be somewhat higher at Koeberg and Bantamsklip due to the more strongly seasonal rainfall at these sites.

(i) Spread of invasive alien invertebrate species

Along with light pollution, this is probably one of the most significant potential impacts from a terrestrial invertebrate perspective, and also may have very significant knock-on effects that could impact of virtually every aspect of the surrounding ecosystem.

Two destructive invertebrate species which have already invaded the Western Cape and are considered the most likely to be of significance to this project are the Argentine ant, *Linepithema humile*, and the alien land snail, *Thisbe pisana*. An additional tramp ant species (*Hypoponera eduardi*) was confirmed only at Duynefontein during the course of this study, supporting the view that construction of the proposed nuclear power station would be likely to increase the risk of establishment of such species.

Invasive invertebrate species are commonly transported to new areas in construction materials and their establishment and spread is often enhanced by disturbance of natural ecosystems. The large volumes of materials that would be required to be transported to the site for construction of a nuclear power station carry a very high risk that invasive species will be carried to the site in this way. The large areas that will be disturbed, as well as the long duration of construction-related disturbance, will provide ideal conditions and ample opportunity for establishment and spread of invasive species on site.

The impact of an invasive species such as the Argentine ant can be very severe, as it displaces many of the indigenous ant species and competes very strongly for resources such as nectar, thus potentially impacting on honeybee populations as well as any other insect species that utilise nectar as a food source. Ant reproductives (“flying ants”) are an important food source for many organisms, particularly for birds, and since Argentine ant reproductives do not fly, this resource can be severely reduced if indigenous ant species are displaced by Argentine ants. Other impacts of this species include reduced pollination and seed set of indigenous plants, and interference with normal seed dispersal, which in the fynbos is carried out to a large extent by indigenous ant species. It is thus very important to prevent invasion by such species in sensitive habitats.

The construction phase almost certainly carries by far the greatest risk of alien invasive species being imported to the site, and the high levels of habitat disturbance also provide the greatest opportunities for such species to establish themselves, since most indigenous species are less tolerant of disturbance. The biggest risk is that colonies of species such as Argentine ants or individuals of exotic snails may be carried onto the site along with materials that have been stockpiled elsewhere at already invaded sites.

(j) Road mortality

Large numbers of invertebrates will be killed either by being crushed under the tyres of vehicles in the case of crawling species, or by colliding with the vehicle itself in the case of flying species. While extremely difficult to quantify, a study in Austria has estimated that approximately 116 insects were killed by the front of a car for every 1 km travelled. This apparently did not take into account individuals crushed under the wheels.

It is thus difficult to predict the extent of such mortality, or to suggest whether the impact would be greater during the construction/decommissioning phases (with larger numbers of heavy, but perhaps slower-moving, vehicles) than during the operational phase (with few large but many small and probably faster-moving vehicles), but for all phases it is obvious that mortality would be increased by higher vehicle speeds and numbers.

9.12.2 Operational impacts

(a) Habitat fragmentation

All barriers remaining after construction will continue to impact at least for the life of the project and possibly permanently, depending on the decommissioning process followed.

(b) Soil and water pollution

Sewage and domestic waste would be the main contributors to potential pollution problems during the operational phase, but this can very easily be managed effectively to avoid impacts.

(c) Light pollution

Any external lighting used will continue to have a potential impact throughout the life of the project.

(d) Increased risk of fire

The increased risk of fire would be expected to be smaller during the operational phase, but may still be significant due to the possibility of e.g. cigarette butts being thrown from vehicles transporting personnel to the site, or by accidental fires caused by visitors to the conservation area.

(e) Spread of invasive alien invertebrate species

Continued movement of personnel and vehicles on and off the site, as well as occasional delivery of materials required for maintenance, will result in a lower-level risk of importation of alien species throughout the life of the project.

9.12.3 Decommissioning impacts

(a) Direct habitat destruction

Direct habitat destruction would be mainly limited to the construction phase, but could also occur during decommissioning, depending on what procedure is followed. However, the decommissioning process will be carried out so far in the future (*c*. approximately 60 years) that technology and methods are likely to have altered radically from what is currently available; in the absence of plans now (even for Koeberg, we do not know precisely what is to be done and much of the current decommissioning plan relates to development and design of aspects of the plan), we cannot at this stage properly assess the potential impacts and a full EIA process will be required closer to the time of decommissioning.

Decommissioning by immediate decontamination and dismantlement (the “Decon” option), as currently planned for Koeberg, would have impacts similar to construction in that areas of habitat beyond the immediate footprint of the reactor site would be severely degraded when used for stockpiling of rubble and other waste. However, if effective rehabilitation of these areas as well as the previously developed area is achieved, these potential impacts could be substantially mitigated and a net positive impact could result.

Decommissioning by entombment would have the advantage of not significantly adding to the environmental degradation of the site (small areas might be affected e.g. by the need for concrete preparation), but this needs to be weighed against the lack of improvement in the environmental status of the reactor site itself, as this would not be returned to a natural state.

(b) Indirect habitat alteration / degradation by changes in groundwater regime

This cannot be properly assessed at this stage. If the Decon alternative option is followed, further changes (either improvement or further degradation) in the groundwater regime could result, while for the entombment alternative, no change from the operational phase would be expected.

(c) Habitat fragmentation

If decommissioning follows the Decon process, increased habitat fragmentation may occur during decommissioning, but following rehabilitation all barriers should be removed, resulting in a positive impact. If entombment is used for decommissioning, all barriers remaining during the operational phase would be expected to endure permanently.

(d) Soil and water pollution

The potential impacts during this phase cannot be properly assessed at this stage. If the Decon option is followed, soil and water pollution impacts could be similar to those experienced during construction, while for the entombment option, no further soil and water pollution would be expected.

(e) Dust pollution

The potential impacts cannot be properly assessed at this stage. If the Decon option is followed, dust pollution potential impacts could be similar to those experienced during construction, while for the entombment option, minimal dust pollution would be expected.

(f) Light pollution

Potential impacts of this phase will depend on the process followed and so this cannot be fully assessed at present. If the Decon option is followed, light pollution impacts could be similar to those experienced during construction, while for the entombment option, minimal light pollution in addition to that experienced during the operational phase would be expected.

Bantamsklip and Thyspunt are probably the most sensitive to this potential impact as their isolation means that at present there is very little impact of artificial lighting, while Duynefontein has probably already been significantly impact and thus cumulative effects would be greatest at Duynefontein. However, the potential impact at all sites is sufficiently severe that the assessment criteria used do not allow a fine enough distinction for these differences in sensitivity to be apparent in the relative significance ratings of the three sites.

(g) Increased risk of fire

Increased fire risk is possibly also important during the decommissioning phase, but the potential impact will be dependant on the means of decommissioning, which is so far in the future (approximately 60 years) that technology and methods may have altered radically from what is currently available, and thus no assessment can be made at present.

(h) Spread of invasive alien invertebrate species

Depending on the process followed, the decommissioning phase may carry risks of alien importation similar in level to those resulting from construction, so monitoring and control at this stage might be equally important as at any other stage; this cannot however be evaluated at this stage.

Bantamsklip is probably the most sensitive to this potential impact as its isolation renders it least likely to already have been invaded; in this respect it is followed by Thyspunt, and then Duynefontein, which may prove to have already been affected. However, the potential impact at all sites is sufficiently severe that the assessment criteria used do not allow a fine enough distinction for this to be apparent in the relative significance ratings of the three sites.

9.12.4 Cumulative impacts

All of the potential impacts identified above would be exacerbated by the construction of additional nuclear power stations at any one of the sites considered. In addition, existing (including Koeberg) and planned (PBMR) developments at and near the Duynefontein site would further increase the cumulative effect of many impacts. The implications of these on the invertebrate populations are briefly described below.

- If PBMR construction at Koeberg is approved and this occurs concurrently with Nuclear-1 construction, the magnitude of construction-related impacts at Duynefontein would be significantly increased and more difficult to contain.
- If Nuclear-2 and Nuclear-3 projects also go ahead at any one of the sites, potential impacts of the combined construction (and decommissioning) phases of the three (or

four in the case of Koeberg) projects would be similarly increased, and, depending on the degree of temporal overlap between projects, construction (and possibly decommissioning) impacts may occur over such a time period that they would need to be considered as long-term impacts (16 - 30 years), which would have a substantial effect on the consequence ratings of some construction-related impacts (*e.g.* dust pollution).

Cumulative impacts would be greatest at Duynefontein due to the presence of Koeberg and the PBMR, but may be most significant at Thyspunt due to the difficulties of avoiding impacts on wetlands; Bantamsklip would probably experience the lowest cumulative impact due to the relatively uniform mosaic of habitats.

9.12.5 Impacts of climate change

Probable impacts of climate change on invertebrate populations at the proposed Nuclear 1 sites may be divided into three main categories:

- **Reduction in available habitat due to sea level rise resulting from increased global temperatures.** Given the fairly small predicted sea level rise over the next century, this impact is unlikely to be very large over the lifespan of the proposed nuclear power station. It is likely however to be exacerbated by more frequent and severe storms and stronger average wind speed which would increase the amount of habitat lost by wave-mediated erosion, with the 100-year flood line predicted to extend as much as 100 m further inland by 2075 along parts of the shorelines of the proposed nuclear power station sites. This impact would be more severe if the nuclear power station was situated too close to the shoreline as this could interfere with natural movement of habitat boundaries as the mean sea level rises.
- **Indirect effects via change in distribution of vegetation types due to** a) localised microclimatic changes due to altered shoreline caused by sea level rise and b) broader climatic changes (at all three sites involving increased temperature, decreased rainfall, changes in mean wind speed and direction), influencing habitat suitability for and hence distribution of various host or food plant species.
- **Direct effects of** a) localised microclimatic changes due to altered shoreline caused by sea level rise and b) broader climatic changes (at all three sites involving increased temperature, decreased rainfall, changes in mean wind speed and direction), influencing habitat suitability for and hence distribution of various invertebrate species.

Precise impacts (especially for the latter two types of potential impacts) are very difficult to predict given uncertainty about the degree of climatic change that is likely during the lifetime of the nuclear power stations, as well as very limited knowledge of habitat and climatic requirements of the majority of invertebrate species. The only communities for which some predictions may be possible are those which are associated with particular plant communities for which predicted influences of climate change are better-understood.

Note that in assessing the significance of climate change, while this is clearly an influence of global extent, only the on-site impacts are here considered, so it is treated as local in extent.

9.12.6 Positive contribution to conservation by protection of owner-controlled property and prevention of further development within an exclusion zone

The positive impact of continued stewardship by Eskom of the sites on which construction of the nuclear power station is proposed must be emphasised. On all alternative sites a substantial, and in parts extremely effective, effort has been made to control and eradicate alien invasive plant species, with the result that (particularly at Bantamsklip) the Eskom-controlled areas appear in far better condition than their surroundings. Formal proclamation and management of the Bantamsklip or Thyspunt sites as conservation areas would be expected to further enhance these positive impacts, with controlled access hopefully leading to reduced poaching of marine resources and wildflowers. Continued and enhanced conservation-oriented management of these sites by Eskom must be seen as a significant positive impact of the proposed project.

However, it must also be borne in mind that:

- The potential positive impact may be significantly reduced during the construction and possibly decommissioning phases by increased unauthorised use of resources by the workforce;
- The area benefiting from the potential positive impact will be substantially reduced if Nuclear -1, -2 and -3 go ahead on one site; and
- Current progress in conservation of the Duynefontein site will be substantially reduced if any of Nuclear-1, -2, -3 or the PBMR proceeds at this location.

The potential positive impact could be substantially enhanced if a large exclusion zone around nuclear developments is gazetted, but only if prevention of development is not allowed to result in neglect and further degradation of the surrounding properties. The best approach to prevent such degradation would probably be for all land within the exclusion zone to fall under the stewardship of Eskom so that it could be managed in a coordinated manner along with the Eskom-owned lands on which the nuclear power station is situated.

9.12.7 Conclusion

From an invertebrate conservation perspective the most important potential negative impacts identified at all three sites are:

- the direct destruction of habitats and local populations of important invertebrates, including new and potentially new species, within the development footprint;
- the wider impact of artificial lighting on invertebrate populations in the surrounding ecosystems; and
- the potential for alien invasive species to become established as a result of site disturbance and importation of materials and equipment.

None of the butterflies likely to occur in the Cape Flats Dune Fynbos area around Duynefontein are endangered or endemic. The non-vegetated and partially vegetated portions of the site were ranked as of Very Low and Low sensitivity respectively. The parts of the site where development is planned have moderate – low butterfly conservation value. In combination with the low predicted butterfly diversity, Duynefontein has the lowest sensitivity of all three alternative sites. The portion of the EIA corridor immediately adjacent to Koeberg is already sufficiently altered from its natural state that development here could be considered.

Bantamsklip is ranked lower than Duynefontein in terms of overall species richness, but considered the high potential for rare, endemic and relictual species at Bantamsklip, its sensitivity ranking can be raised above Duynefontein. There are several other reasons, including the discovery of a probably new mygalomorph spider species and a potentially new specialised ant species, to consider Bantamsklip as highly sensitive. The Agulhas Limestone Fynbos area at Bantamsklip, including patches and elements found within the Overberg Dune Strandveld area, is likely to host at least one regional endemic butterfly and there is also a remote possibility that the Redlisted *Chrysoritis dicksoni* could occur in the area. The local abundance of a probably new trapdoor spider species and a potentially new ant species, combined with the likely presence of a number of rare and relictual taxa, indicate that construction impacts at Bantamsklip could be substantial.

Thyspunt has in all probability the highest butterfly diversity and conservation value of the three sites studied. From the point of view of other invertebrate groups no further evidence was found to suggest that the site was of high significance, but the combination of high butterfly and ant diversity and the Onchyophoran species indicate that Thyspunt has significant conservation value. Thyspunt is identified as higher sensitivity than Duynefontein, and only marginally lower than Bantamsklip. The description of the sites (in order of increasing sensitivity and suitability) is Duynefontein (most suitable), Thyspunt and Bantamsklip (least suitable).

From the viewpoint of potential positive impacts of the nuclear power station, the suitability of the sites is different. Duynefontein already enjoys substantial benefits under the management of Eskom, which means that of all the sites it would experience the least improvement in its status if the nuclear power station was sited there. Bantamsklip and Thyspunt on the other hand would benefit substantially from formalisation of their protected status It is probable that construction of the nuclear power station at either Bantamsklip or Thyspunt would have a potential net positive impact on invertebrate communities.

Table 9-24: Assessment of impacts on invertebrate fauna at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Direct habitat destruction										
Without mitigation	Negative	National *	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	National *	Medium	Permanent	Definite	Medium	Yes	High	High	**High**
Indirect habitat alteration by groundwater disturbance										
Without mitigation	Negative	Local	Medium	Permanent	Probable	Low	Yes	Low	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Probable	Low	Yes	Low	Low	**Low**
Habitat fragmentation										
Without mitigation	Negative	Local	Medium	Permanent	Highly Probable	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Highly Probable	Medium	No	High	Low	**Low**
Reduction in populations of rare/protected species										
Without mitigation	Negative	Regional *	Low	Permanent	Probable	Low	Yes	Medium	Medium	**Medium**
With mitigation	Negative	Regional *	Low	Permanent	Probable	Low	Yes	Medium	Medium	**Medium**
Soil and water pollution										
Without mitigation	Negative	Local	Medium	Medium-term	Highly probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium-term	Probable	High	Yes	Medium	Low	**Low**
Dust pollution										
Without mitigation	Negative	Local *	Medium	Short-term	Highly probable	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Low	Short-term	Probable	High	No	High	Low	**Low**
Light pollution - construction phase										
Without mitigation	Negative	Local *	High	Medium-term	Highly Probable	Medium	Yes	High	Medium	**Medium**
Partially mitigated	Negative	Local *	Medium	Medium-term	Highly Probable	Medium	Yes	High	Medium	**Medium**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Fully mitigated	Neutral	Local	Low	Short-term	Highly Probable	High	Yes	High	Low	**Low**
Light pollution - operational phase										
Without mitigation	Negative	Local *	High	Long-term	Highly Probable	Low	Yes	High	High	**High**
Partially mitigated	Negative	Local *	Medium	Long-term	Highly Probable	Medium	Yes	High	Medium	**Medium**
Fully mitigated	Neutral	Local	Low	Long-term	Highly Probable	High	Yes	High	Low	**Low**
Increased radiation levels										
Without mitigation	Negative	Local	Low	Long-term	Possible	High	No	Medium	Low	**Low**
With mitigation	Neutral	Local	Low	Long-term	Possible	High	No	Medium	Low	**Low**
Road mortality										
Without mitigation	Negative	Local	Medium	Long-term	Highly Probable	High	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Long-term	Highly Probable	High	No	High	Low	**Low**
Increased risk of fire										
Without mitigation	Negative	Local	High	Long-term	Highly Probable	High	No	High	High	**High**
With mitigation	Negative	Local	Medium	Long-term	Probable	High	No	Medium	Medium	**Medium**
Spread of alien invasive invertebrate species										
Without mitigation	Negative	Local *	High	Long-term	Highly Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	Local *	Medium	Long-term	Probable	Low	Yes	Medium	Medium	**Medium**
Land invasion by employment seekers										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Medium	Yes	Low	Medium	**Medium**
With mitigation	Negative	Local	Low	Short-term	Probable	High	Yes	Low	Low	**Low**
Cumulative impacts										
Without mitigation	Negative	Local	High	Long-term	Highly Probable	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Low	Long-term	Highly Probable	Medium	Yes	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Climate change										
Without mitigation	Negative	Local	Medium	Long-term/permanent	Highly Probable	Low	Yes	Medium	Medium	**Medium**
With mitigation	Neutral	Local	Low	Long-term/permanent	Highly Probable	Low	Yes	Medium	Low	**Low**
Positive contribution to conservation										
Without mitigation	Neutral	National	N/A	Long-term	Highly Probable	High	Yes	High	Low	**Low**
With mitigation	Positive	National	Medium	Permanent	Definite	Low	Yes	High	High	**High**

Table 9-25: Assessment of impacts on invertebrate fauna at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Direct habitat destruction										
Without mitigation	Negative	National *	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	National *	Medium	Permanent	Definite	Medium	Yes	High	High	**High**
Indirect habitat alteration by groundwater disturbance										
Without mitigation	Negative	Local	Medium	Permanent	Probable	Low	Yes	Low	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Probable	Low	Yes	Low	Low	**Low**
Habitat fragmentation										
Without mitigation	Negative	Local	Medium	Permanent	Highly Probable	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Highly Probable	Medium	No	High	Low	**Low**
Reduction in populations of rare/protected species										
Without mitigation	Negative	National *	Medium	Permanent	Highly Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	National*	Low	Permanent	Highly Probable	Low	Yes	Medium	High	**High**
Soil and water pollution										
Without mitigation	Negative	Local	Medium	Medium-term	Highly probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium-term	Probable	High	Yes	Medium	Low	**Low**
Dust pollution										
Without mitigation	Negative	Local *	Medium	Short-term	Highly probable	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Low	Short-term	Probable	High	No	High	Low	**Low**
Light pollution - construction phase										
Without mitigation	Negative	Local *	High	Medium-term	Highly Probable	Medium	Yes	High	Medium	**Medium**
Partially mitigated	Negative	Local *	Medium	Medium-term	Highly Probable	Medium	Yes	High	Medium	**Medium**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Fully mitigated	Neutral	Local	Low	Short-term	Highly Probable	High	Yes	High	Low	**Low**
Light pollution - operational phase										
Without mitigation	Negative	Local *	High	Long-term	Highly Probable	Low	Yes	High	High	**High**
Partially mitigated	Negative	Local *	Medium	Long-term	Highly Probable	Medium	Yes	High	Medium	**Medium**
Fully mitigated	Neutral	Local	Low	Long-term	Highly Probable	High	Yes	High	Low	**Low**
Increased radiation levels										
Without mitigation	Negative	Local	Low	Long-term	Possible	High	No	Medium	Low	**Low**
With mitigation	Neutral	Local	Low	Long-term	Possible	High	No	Medium	Low	**Low**
Road mortality										
Without mitigation	Negative	Local	Medium	Long-term	Highly Probable	High	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Long-term	Highly Probable	High	No	High	Low	**Low**
Increased risk of fire										
Without mitigation	Negative	Local	High	Long-term	Highly Probable	High	No	High	High	**High**
With mitigation	Negative	Local	Medium	Long-term	Probable	High	No	Medium	Medium	**Medium**
Spread of alien invasive invertebrate species										
Without mitigation	Negative	Local *	High	Long-term	Highly Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	Local *	Medium	Long-term	Probable	Low	Yes	Medium	Medium	**Medium**
Land invasion by employment seekers										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Medium	Yes	Low	Medium	**Medium**
With mitigation	Negative	Local	Low	Short-term	Probable	High	Yes	Low	Low	**Low**
Cumulative impacts										
Without mitigation	Negative	Local	High	Long-term	Highly Probable	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Low	Long-term	Highly Probable	Medium	Yes	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Climate change										
Without mitigation	Negative	Local	Medium	Long-term/permanent	Highly Probable	Low	Yes	Medium	Medium	**Medium**
With mitigation	Neutral	Local	Low	Long-term/permanent	Highly Probable	Low	Yes	Medium	Low	**Low**
Positive contribution to conservation										
Without mitigation	Neutral	National	N/A	Long-term	Highly Probable	High	Yes	High	Low	**Low**
With mitigation	Positive	National	Medium	Permanent	Definite	Low	Yes	High	High	**High**

Table 9-26: Assessment of impacts on invertebrate fauna at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Direct habitat destruction										
Without mitigation	Negative	National *	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	National *	Medium	Permanent	Definite	Medium	Yes	High	High	**High**
Indirect habitat alteration by groundwater disturbance										
Without mitigation	Negative	Local	Medium	Permanent	Probable	Low	Yes	Low	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Probable	Low	Yes	Low	Low	**Low**
Habitat fragmentation										
Without mitigation	Negative	Local	Medium	Permanent	Highly Probable	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Highly Probable	Medium	No	High	Low	**Low**
Reduction in populations of rare/protected species										
Without mitigation	Negative	National *	Medium	Permanent	Possible	Low	Yes	Medium	High	**High**
With mitigation	Negative	National *	Low	Permanent	Possible	Low	Yes	Medium	High	**High**
Soil and water pollution										
Without mitigation	Negative	Local	Medium	Medium-term	Highly probable	Medium	Yes	Medium	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium-term	Probable	High	Yes	Medium	Low	**Low**
Dust pollution										
Without mitigation	Negative	Local *	Medium	Short-term	Highly probable	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Low	Short-term	Probable	High	No	High	Low	**Low**
Light pollution - construction phase										
Without mitigation	Negative	Local *	High	Medium-term	Highly Probable	Medium	Yes	High	Medium	**Medium**
Partially mitigated	Negative	Local *	Medium	Medium-term	Highly Probable	Medium	Yes	High	Medium	**Medium**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Fully mitigated	Neutral	Local	Low	Short-term	Highly Probable	High	Yes	High	Low	**Low**
Light pollution - operational phase										
Without mitigation	Negative	Local *	High	Long-term	Highly Probable	Low	Yes	High	High	**High**
Partially mitigated	Negative	Local *	Medium	Long-term	Highly Probable	Medium	Yes	High	Medium	**Medium**
Fully mitigated	Neutral	Local	Low	Long-term	Highly Probable	High	Yes	High	Low	**Low**
Increased radiation levels										
Without mitigation	Negative	Local	Low	Long-term	Possible	High	No	Medium	Low	**Low**
With mitigation	Neutral	Local	Low	Long-term	Possible	High	No	Medium	Low	**Low**
Road mortality										
Without mitigation	Negative	Local	Medium	Long-term	Highly Probable	High	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Long-term	Highly Probable	High	No	High	Low	**Low**
Increased risk of fire										
Without mitigation	Negative	Local	High	Long-term	Highly Probable	High	No	High	High	**High**
With mitigation	Negative	Local	Medium	Long-term	Probable	High	No	Medium	Medium	**Medium**
Spread of alien invasive invertebrate species										
Without mitigation	Negative	Local *	High	Long-term	Highly Probable	Low	Yes	Medium	High	**High**
With mitigation	Negative	Local *	Medium	Long-term	Probable	Low	Yes	Medium	Medium	**Medium**
Land invasion by employment seekers										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Medium	Yes	Low	Medium	**Medium**
With mitigation	Negative	Local	Low	Short-term	Probable	High	Yes	Low	Low	**Low**
Cumulative impacts										
Without mitigation	Negative	Local	High	Long-term	Highly Probable	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Low	Long-term	Highly Probable	Medium	Yes	High	Low	**Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Climate change										
Without mitigation	Negative	Local	Medium	Long-term/permanent	Highly Probable	Low	Yes	Medium	Medium	**Medium**
With mitigation	Neutral	Local	Low	Long-term/permanent	Highly Probable	Low	Yes	Medium	Low	**Low**
Positive contribution to conservation										
Without mitigation	Neutral	National	N/A	Long-term	Highly Probable	High	Yes	High	Low	**Low**
With mitigation	Positive	National	Medium	Permanent	Definite	Low	Yes	High	High	**High**

9.13 Impacts on air quality

Owing to the uniformity of the nuclear power station power generation process at all sites, the nature of the emissions will be very similar for all sites. A short summary of the nature of the emissions is given below before the significance of the potential impacts at each of the sites is discussed individually.

9.13.1 Construction impacts

The air quality impacts of the proposed nuclear power station are expected to occur with construction, operation, and decommissioning phases. Only non-radioactive emissions would occur during the construction period. Air emissions during construction include airborne particulates (including inhalable particulate matter – PM10) and gaseous emissions. Airborne particulates are considered to result in significantly higher potential impact than the gaseous pollutants. Wheel entrainment on the construction site and on unpaved roads would be responsible for the majority of total airborne particulate emissions, and would contribute about 83 % of the total particulate emissions at Duynefontein, 90 % at Bantamsklip and 89 % at Thyspunt. Excavation will be the next largest source of particulate emissions, contributing about 13 % at Duynefontein and 7 % each at Bantamsklip and Thyspunt.

9.13.2 Operational impacts

(a) Non-radioactive emissions

Potential sources of non-radioactive air emissions during operation will include:

- Particulates, sulfur dioxide, oxides of nitrogen and carbon monoxide in the exhaust gases from engines of the backup electricity generators.
- Formaldehyde and carbon monoxide emitted by the insulation when installations go back into operation after servicing; and
- Ammonia discharged as the temperature rises in the steam generators during start-up.

Based on the US EPA's AERMOD dispersion model, the impacts of these pollutants was modelled over a 40 x 40 km area and with a resolution of 200 m. The emissions of formaldehyde and ammonia were found to be very infrequent and relatively low, and are not expected to exceed any guidelines. The highest hourly average formaldehyde concentrations predicted at Duynefontein, Bantamsklip and Thyspunt are 0.12 µg/m³, 0.30 µg/m³ and 0.19 µg/m³, respectively. This is very low when compared to the 1-hour exposure guideline of 94 µg/m³ (derived by the California Office of Environmental Health Hazard Assessment) for assessment of acute exposure of members of the public to formaldehyde.

The highest hourly average ammonia concentrations predicted at Duynefontein, Bantamsklip and Thyspunt are 14.3 µg/m³, 35.0 µg/m³ and 21.8 µg/m³, respectively. It is much lower than the US EPA's inhalation Reference Concentration of 100 µg/m³.

The predicted short-term ammonia and formaldehyde concentrations are also below the odour recognition concentrations of 200 µg/m³ (10% odour recognition level) and 70 µg/m³ (odour perception), respectively.

The predicted ground level concentrations of pollutants resulting from the operation of the two 25 MWe backup generators are low compared with the relevant air concentration guidelines. The highest hourly average predicted ground level nitrogen dioxide concentrations resulting from the operation of the two 25 MWe backup generators are shown in **Figure 9-2, Figure 9-3** and **Figure 9-4** for the Duynefontein, Bantamsklip and Thyspunt sites, respectively. The spatial distributions for the other pollutants (SO_2, CO and PM10) are similar and therefore not shown here.

(b) Radioactive emissions

Small amounts of radionuclides are released during normal operation of the nuclear power station. Most of these emissions are captured by High Efficiency Particulate Air (HEPA) filters. HEPA filters, by definition, remove at least 99.97% of airborne particles 0.3 µm in diameter. The radionuclide emissions that still manage to find their way to the atmosphere include tritium, carbon-14, iodine isotopes, noble gases and a small amount of other fission/activation products (mainly cobalt and caesium). Noble gases typically include krypton, xenon and argon. These emissions are continuously monitored and reported to the NNR for compliance proposes.

For calculation of the emissions of these gases from the Nuclear-1, a worst case (conservative) scenario was assumed. The main source of gaseous radioactive emissions during normal operation is the gaseous component arising within the coolant circuit. Gases from this system are not emitted continuously, and the gaseous radioactive waste system is used intermittently. Most of the time during normal operation of the nuclear power station, the gaseous radioactive waste system is inactive.

Similar to construction impacts, modelling was carried out for a 40 x 40 km area. For radionuclide emissions, the model was designed to estimate the maximum annual dose received during the period of the practice.

The model-wide maximum predictions for the three sites are summarised in **Table 9-27**

Table 9-27: Maximum inhalation and external effective dose predicted in the 40 km by 40 km study area for a 4000 MWe nuclear power station

Site	Effective Dose (µSv/annum)
Duynefontein	4.07
Bantamsklip	4.60
Thyspunt	11.31

The legal limit[6] for the annual effective dose limit for members of the public is 1 000 µSv, with an additional provision of an annual dose constraint of 250 µSv. The highest predicted inhalation and external effective dose of 11.3 µSv is therefore about 4.5 % of the dose constraint and about 1 % of the annual effective dose limit. Should additional units be added to eventually generate 10 000 MWe per site, the maximum external effective dose would be less than 30 µSv.

9.13.3 Impacts during decommissioning

Based on Eskom's decommissioning plan, limited release of radionuclides may occur during decommissioning. The decommissioning process is well controlled and designed to ensure that potentially radioactive materials are isolated and appropriately disposed. The exposure to radiation would be kept to a minimum and below the required dose stipulated by the NNR through continued measurement. Since these dose limits are based on safe exposure levels, it is expected that the radiation exposure during commissioning would be low.

Backup diesel will continue to be used during decommissioning and their imp[act will be the same as during the operational phase. The most significant potential impacts during construction would result from the demolition of buildings. The anticipated activities include blasting, coring, drilling, crushing, surface removal and trucking of rubble off-site for disposal as construction debris. The activities during this phase would generate airborne dust and

[6] Specified in Government Notice No. R 388 of 2009

unless proper management and emission control is applied could potentially generate fugitive dust impacts.

9.13.4 Duynefontein

(a) Impacts during the construction phase

Figure 9-5 and **Figure 9-6** summarise the maximum predicted inhalable particulate air concentration and deposition rate for the construction phase at Duynefontein. These predictions exclude any mitigation measures. The most significant potential impact is predicted to occur along the unpaved access road. The distance at which it is predicted that the 180 µg/m³ standard will be exceeded is about 1.4 km. The 75 µg/m³ limit is predicted to be exceeded up to 600 m from the road.

Fallout of larger particles normally occurs near the generating source, as shown in **Figure 9-7.** The fallout rate permissible for residential and light commercial land use is 600 mg/m² per day. The distance to this value is about 126 m. The distance to the SLIGHT fallout rate of 250 mg/m² per day is about 223 m.

(b) Impacts during the operational phase

The highest hourly average formaldehyde concentrations predicted at Duynefontein is 0.12 µg/m³, which is very low compared to the 1-hour exposure guideline of 94 µg/m³. The highest hourly average ammonia concentrations predicted at Duynefontein, is 14.3 µg/m³, which is significantly lower than the US EPA's inhalation Reference Concentration (RfC) of 100 µg/m³.

The highest hourly average predicted ground level nitrogen dioxide concentrations resulting from the operation of the two 25 MWe backup generators at Duynefontein is shown in **Figure 9-2** and are low compared with the relevant air concentration guidelines.

Figure 9-13 shows the maximum cumulative inhalation does at Duynefontein. The maximum effective dose of 4.07 µSv/annum is therefore about 1.6 % of the dose constraint and 0.4 % of the maximum annual average dose limit.

9.13.5 Bantamsklip

(a) Impacts during the construction phase

The predicted particulate unmitigated potential impact during the construction phase at Bantamsklip is given in **Figure 9-7** and **Figure 9-8** for the maximum air concentration and deposition rate, respectively. The distance at which it is predicted that the 180 µg/m³ standard will be exceeded is about 1.4 km (north of the site). Similarly, the 75 µg/m³ limit is predicted to be exceeded up to 3.0 km from the site.

As shown in **Figure 9-7**, the fallout is quite significant; with the rate permissible for residential and light commercial (600 mg/m² per day) predicted to be exceeded up to a distance of about 0.7 km. The distance to the SLIGHT fallout rate of 250 mg/m² per day is about 1.4 km.

(b) Impacts during the operational phase

The highest hourly average formaldehyde concentrations predicted at Bantamsklip is 0.30 µg/m³, which is very low when compared to the 1-hour exposure guideline of 94 µg/m³. The highest hourly average ammonia concentrations predicted at Bantamsklip and is 35.0 µg/m³, which is lower than the US EPA's inhalation Reference Concentration (RfC) of 100 µg/m³.

The highest hourly average predicted ground level nitrogen dioxide concentrations resulting from the operation of the two 25 MWe backup generators for Bantamsklip are shown in **Figure 9-4** and are low compared with the relevant air concentration guidelines.

Figure 9-14 shows the maximum cumulative inhalation doses at Bantamsklip. The maximum effective dose of 4.6 µSv/annum is therefore about 1.84 % of the dose constraint and 0.46 % of the maximum annual average dose limit.

9.13.6 Thyspunt

(a) Impacts during the construction phase

Three different access road options were considered for Thyspunt. With Option A the road enters the site from the north through the "panhandle". The road passes through Oyster Bay from the west in Option B. Option C is for the access to be from the eastern side of the site.

The predicted unmitigated PM10 concentrations for these three road options are given in **Figure 9-10** (Option A), **Figure 9-11** (Option B) and **Figure 9-12** (Option C). These figures include the envelope of the two possible construction locations, located on the eastern and western parts of the corridor. The simulations for the individual sites did not show any preference.

As with Duynefontein, the most significant impact is predicted to occur along the unpaved access road. The distance at which it is predicted that the 180 µg/m³ standard will be exceeded is about 1 km. The 75 µg/m³ limit is predicted to be exceeded up to 2.1 km from the road.

The fallout is quite significant; with the rate permissible for residential and light commercial (600 mg/m² per day) predicted to be exceeded up to a distance of about 0.6 km. The distance to the SLIGHT fallout rate of 250 mg/m² per day is about 1.1 km.

(b) Impacts during the operational phase

The highest hourly average formaldehyde concentrations predicted at Thyspunt is 0.19 µg/m³, which is very low when compared to the 1-hour exposure guideline of 94 µg/m³. The highest hourly average ammonia concentration predicted at Thyspunt is 21.8 µg/m³, respectively, which is lower than the US EPA's inhalation Reference Concentration (RfC) of 100 µg/m³.

The highest hourly average predicted ground level nitrogen dioxide concentrations resulting from the operation of the two 25 MWe backup generators for Thyspunt are low compared with the relevant air concentration guidelines.

Error! Reference source not found. shows the maximum cumulative inhalation does at Thyspunt. The maximum effective dose of 11.31 µSv/annum is therefore about 4.5% of the dose constraint and about 1% of the annual effective dose limit.

9.13.7 Mitigation

- An emission minimisation plan is regarded as essential in the situation where construction activities are conducted very close to residential and other sensitive receptors.
- Since the most significant source (between 80% and 90%) of fugitive dust emissions was shown to be wheel entrainment on unpaved roads, it is recommended to have the initial focus on the reduction of emissions from road surfaces. This can be achieved through regular watering of unpaved surfaces, applying chemical dust suppressants, or most preferably, tarring of roads.
- In areas were tarring is not a practical option the management plan should have, as a minimum, watering schedules of unpaved roads and other activities that could be mitigated with water sprays.
- In addition to road surface treatment, it is recommended to utilise the construction mitigation management checklist given in Appendix D of the air quality report, or a suitably modified version thereof.
- An air quality monitoring programme as provided in Section 5.2.1 of the air quality report must be initiated a year prior to construction. This would provide an adequate

baseline air concentration trend which would incorporate all seasons. This programme must include both non-radionuclide and radionuclide compounds.

- No additional mitigation measures are required for routine operational emissions of radionuclides. However, once the final reactor technology has been decided, Eskom need to confirm that the emissions from the selected technology confirm to the envelope used in this assessment and that such emissions can be maintained throughout the nuclear power station's lifecycle. This includes a thorough assessment of the reliability and maintenance of the high efficiency particulate air (HEPA) filters which would be used to control radiological air emissions from the nuclear power station.
- Similarly, the successful technology supplier must illustrate how incidental and accidental releases would conform to the NNR's requirements and how these would be kept As Low As Reasonably Achievable (ALARA).
- A site-specific decommissioning plan must be developed according to the most recent requirements stipulated by the NNR.
- It must be ensured that the emissions from the backup power generators perform according to the vendor specifications. Regular stack sampling must be conducted during operation. The first three isokinetic sampling campaigns should also include sulfur dioxide analysis.
- Air dispersion modelling must be repeated using the source terms for normal and upset emissions of the successful vendor and onsite meteorological data prior to construction of the nuclear power station. The simulations must be repeated for both non-nuclear and radionuclide air emissions. Furthermore, the methodology for calculating the dose must be done according to the latest international standards and NNR requirements.

9.13.8 Conclusion

The most significant potential air quality impacts would be felt during construction, due to fugitive dust emissions from general construction activities (clearance, excavation, scraping, road surfaces, etc.) and emissions emanating from vehicles and equipment. Construction phase impacts will have a HIGH *significance* if no or limited mitigation measures are applied. This impact can be reduced to LOW *significance* if unpaved roads are surfaced (i.e. tarred) and with implementation of an air quality management plan.

The operational phase impacts of non-radiological pollutants are predicted to be very low when compared to human health risk criteria. Furthermore, based on the predicted impacts of both non-radioactive and radionuclide air pollution, the assessment concludes that the operational impacts at all the sites would fall safely within legal limits and guidelines limits, and that the impacts at none of the are serious enough to discard them from consideration. During normal operation, trace quantities of radiological materials will be released to the environment. The predicted effective dose from these pathways indicates low *consequence*. However, since the emission is considered to be *definite*, the *significance* of the impact is rated medium. This rating applies to all three sites.

The predicted potential impacts are very similar at all three alternative sites and there is no preferable site as far as the impacts on air quality is concerned.

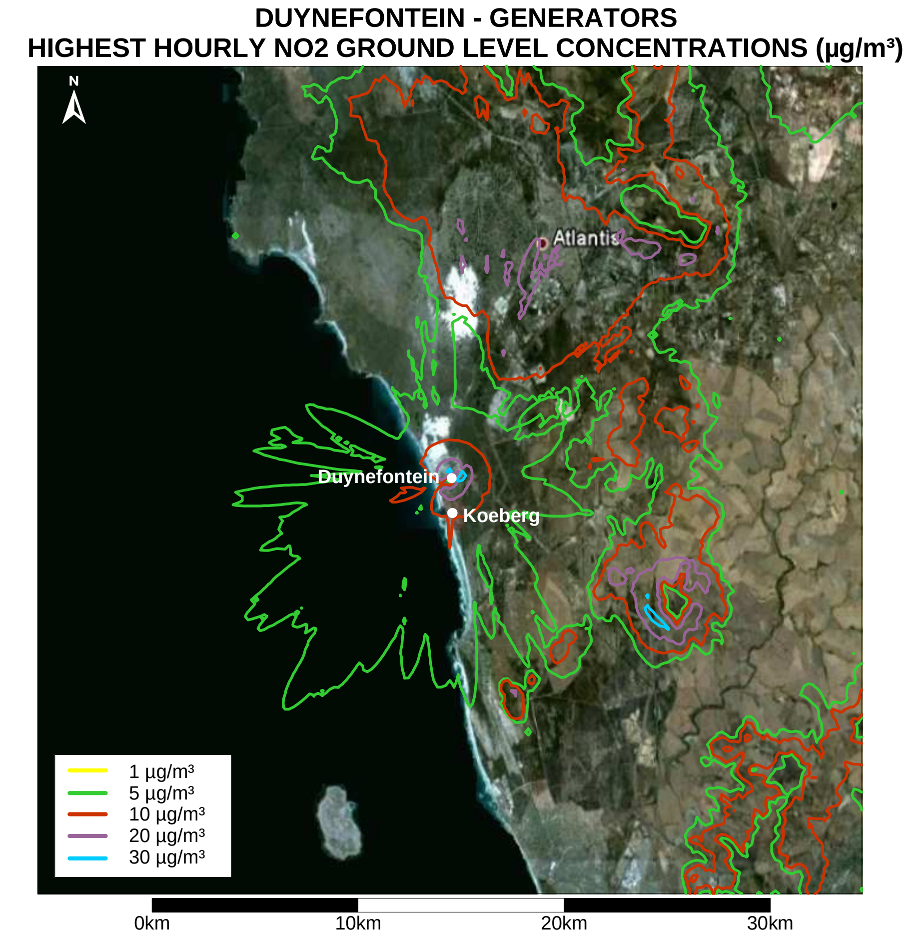


Figure 9-2: Predicted maximum hourly average nitrogen dioxide concentration from backup generators at Duynefontein

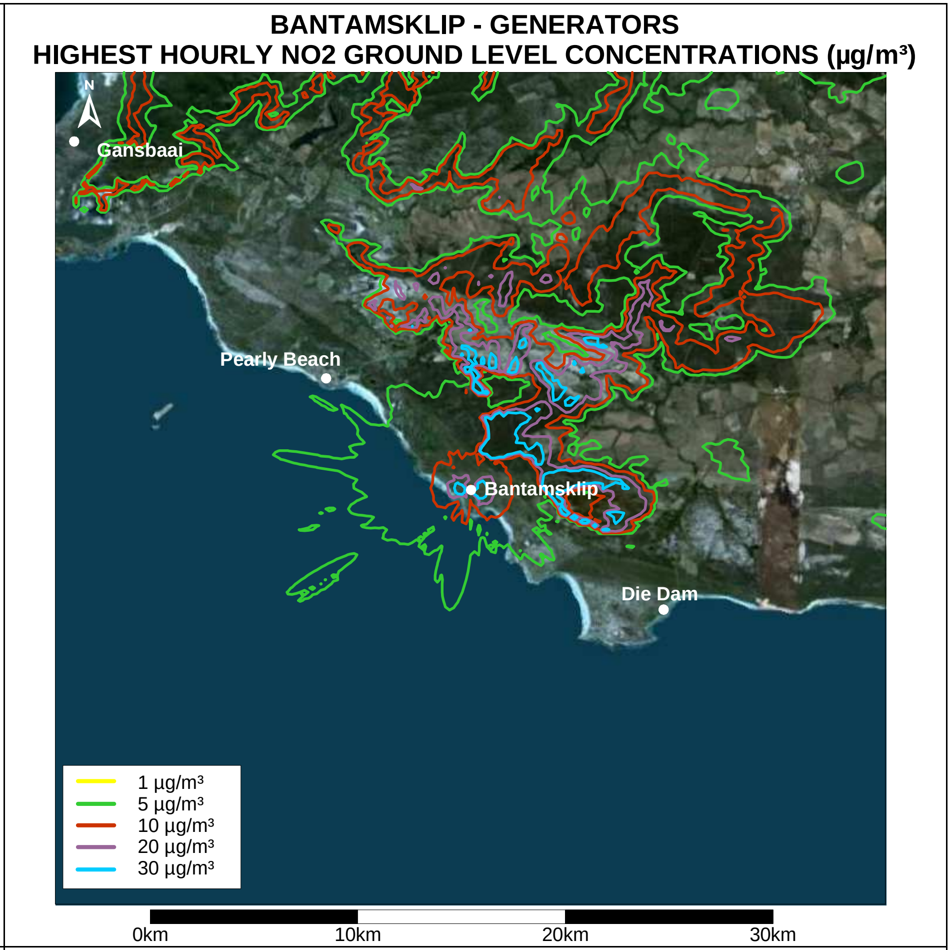


Figure 9-3: Predicted maximum hourly average nitrogen dioxide concentration from backup generators at Bantamsklip

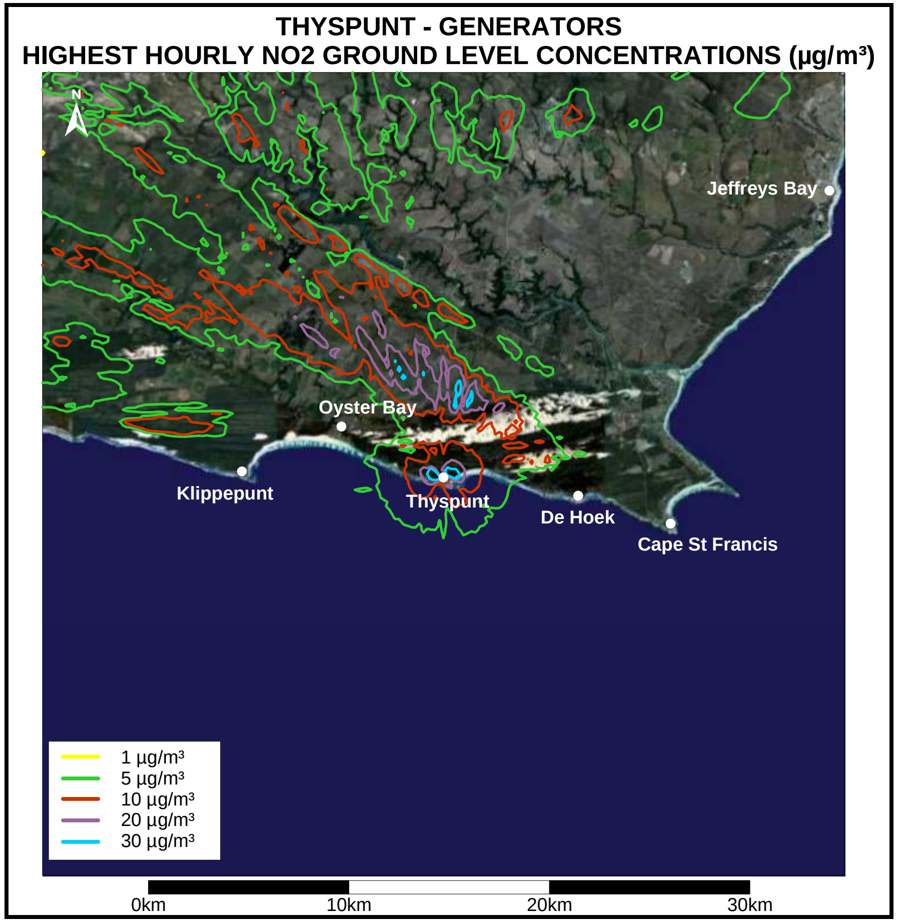


Figure 9-4: Predicted maximum hourly average nitrogen dioxide concentration from backup generators at Thyspunt

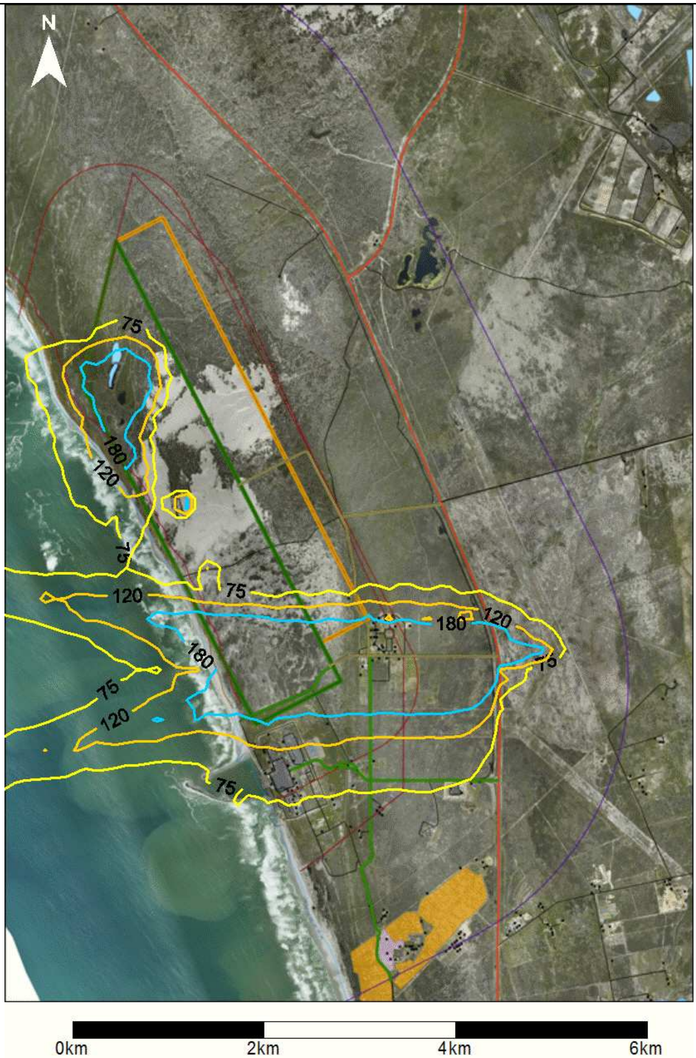


Figure 9-5: Predicted maximum daily average inhalable particle (PM10) concentration levels (µg/m³) during construction at Duynefontein (Unmitigated)

Figure 9-6: Predicted maximum daily average particle fallout rates (mg/m²/day) during construction at Duynefontein (Unmitigated)

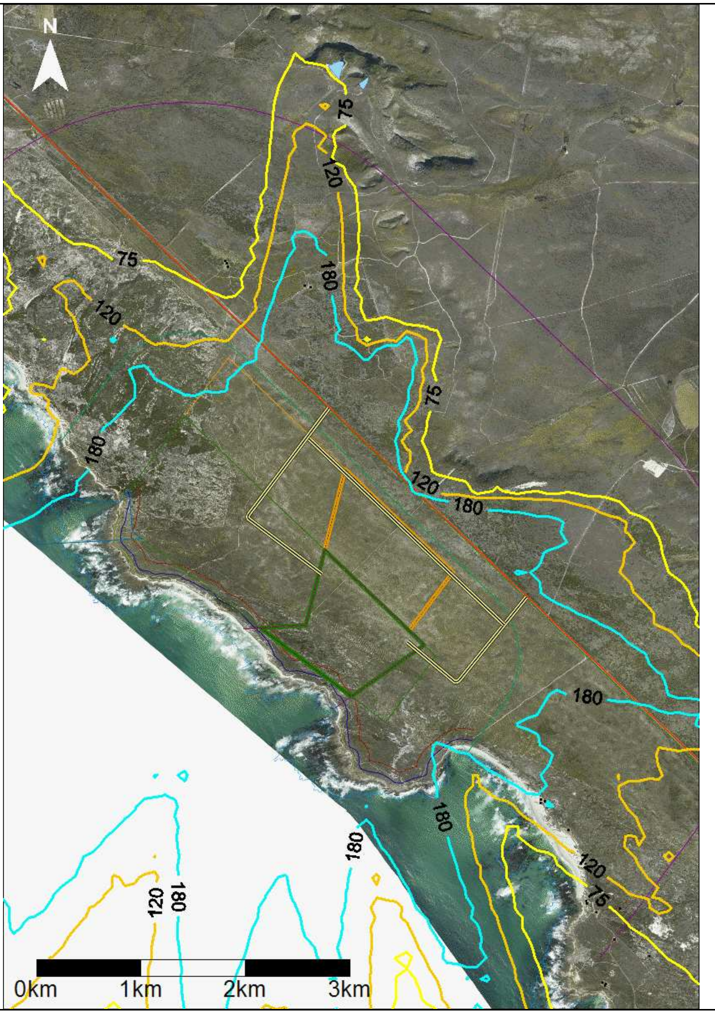


Figure 9-7: Predicted maximum daily PM10 concentration levels (µg/m³) during construction at Bantamsklip (Unmitigated)

Figure 9-8: Predicted maximum daily average particle fallout rates (mg/m²/day) during construction at Bantamsklip (Unmitigated)

Figure 9-9: Predicted maximum daily average PM10 concentration levels (µg/m³) during construction at Thyspunt with Road Option A and the envelope of the NPS on the east or west of the corridor (Unmitigated)

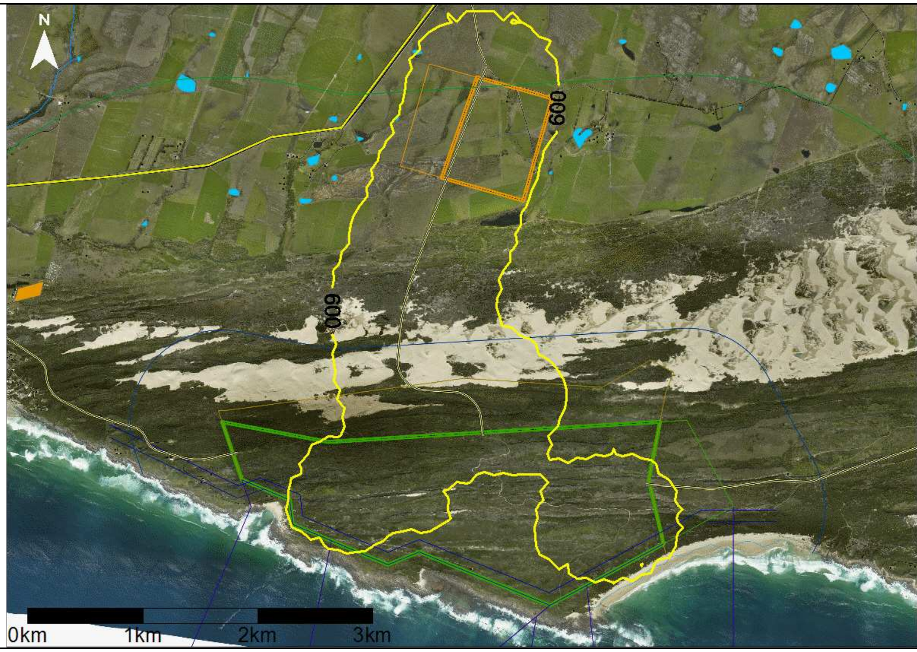


Figure 9-10: Predicted maximum daily average particle fallout rates (mg/m²/day) during construction at Thyspunt with Road Option A and the envelope of the NPS on the east or west of the corridor (Unmitigated)

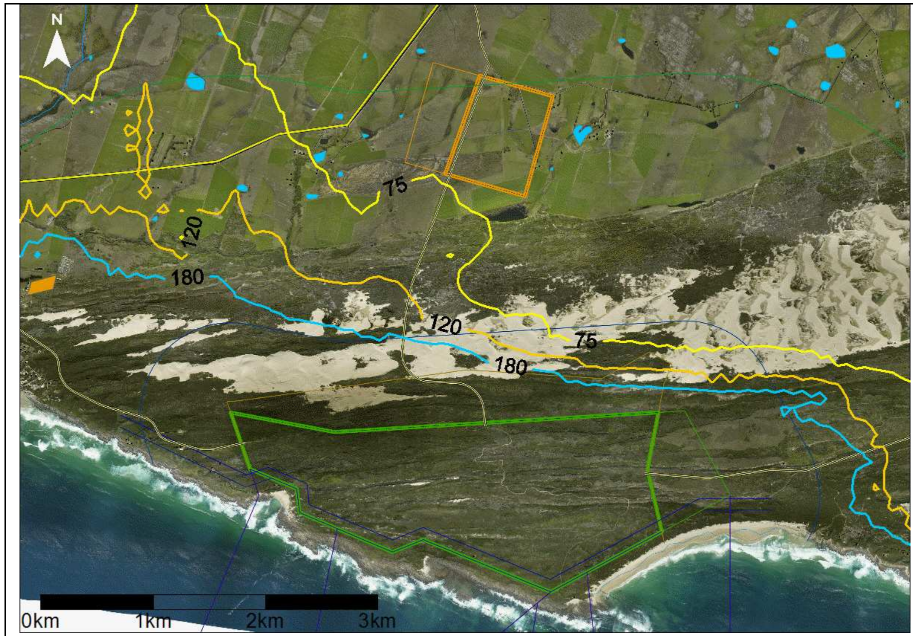
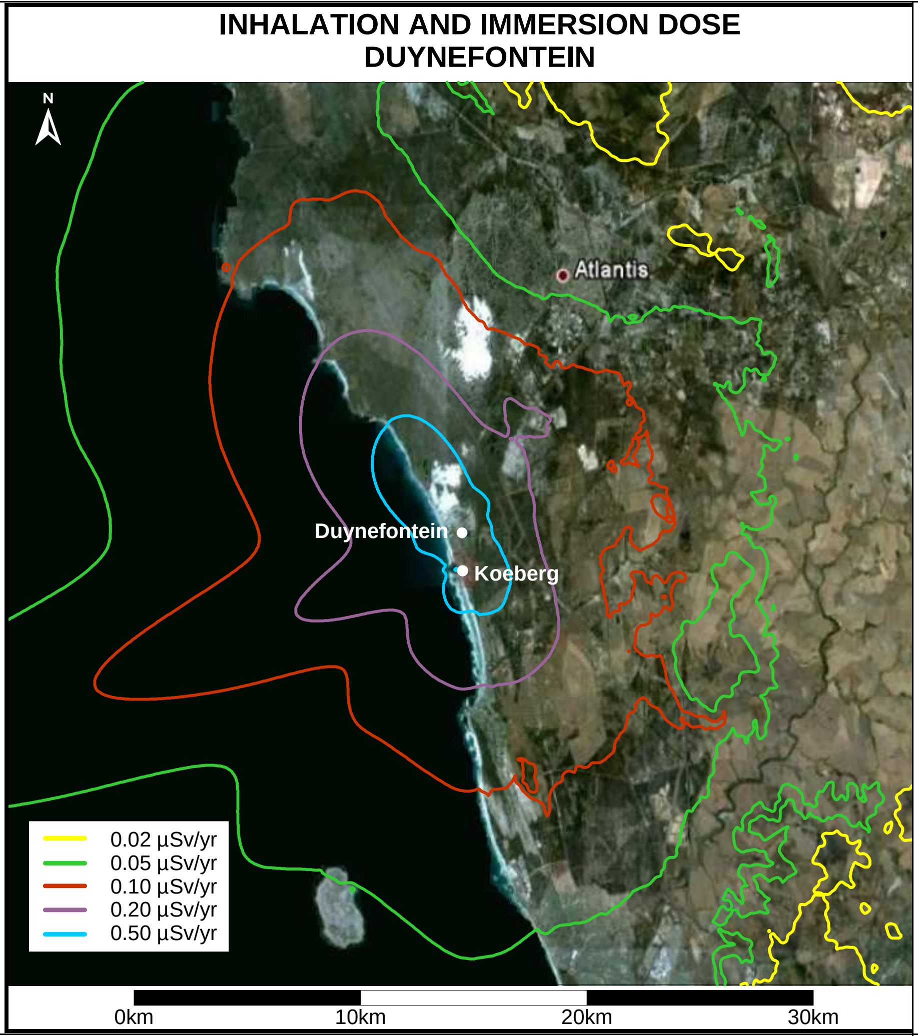


Figure 9-11: Predicted maximum daily average PM10 concentration levels (µg/m³) during construction at Thyspunt with Road Option B and the envelope of the NPS on the east or west of the corridor (Unmitigated)

Figure 9-12: Predicted maximum daily average PM10 concentration levels during construction at Thyspunt with Road Option C and the envelope of the NPS on the east or west of the corridor (Unmitigated)



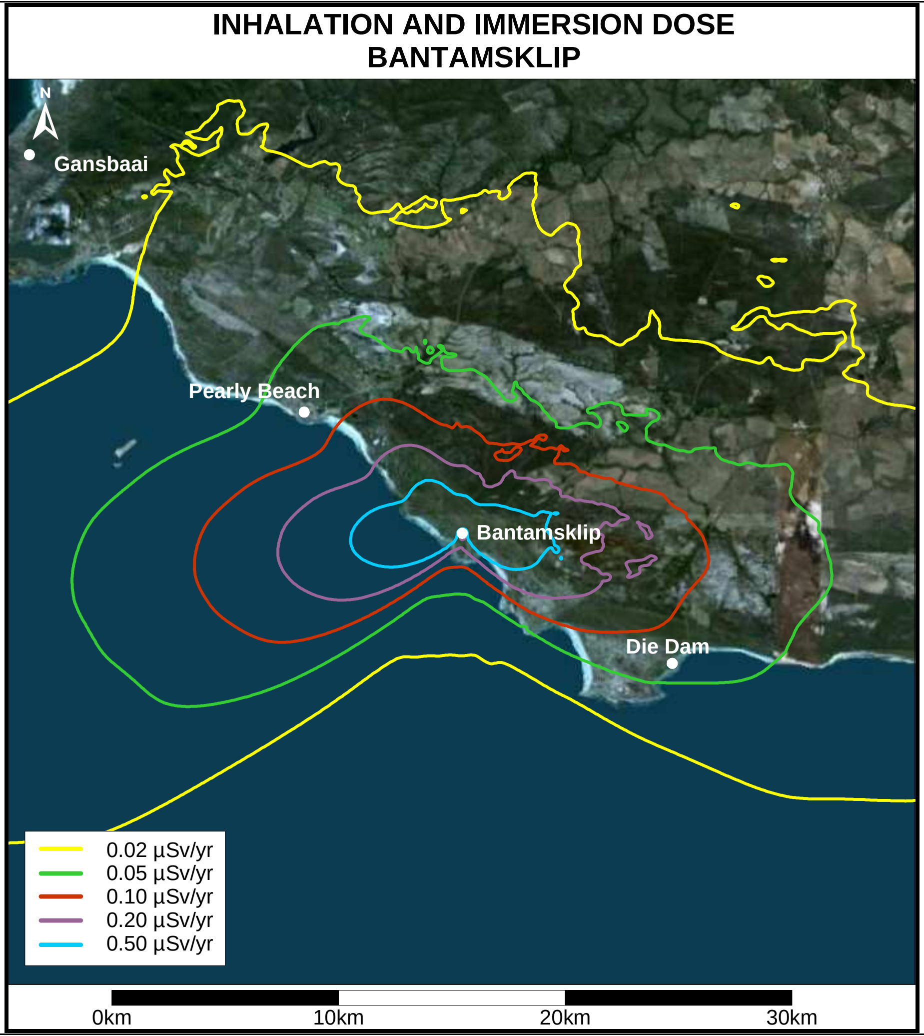


Figure 9-13: Predicted maximum cumulative annual inhalation and external radiation dose (µSv) for Duynefontein using 30 year equilibrium for deposition

Figure 9-14: Predicted maximum cumulative annual inhalation and external radiation dose (µSv) for Bantamsklip using 30 year equilibrium for deposition

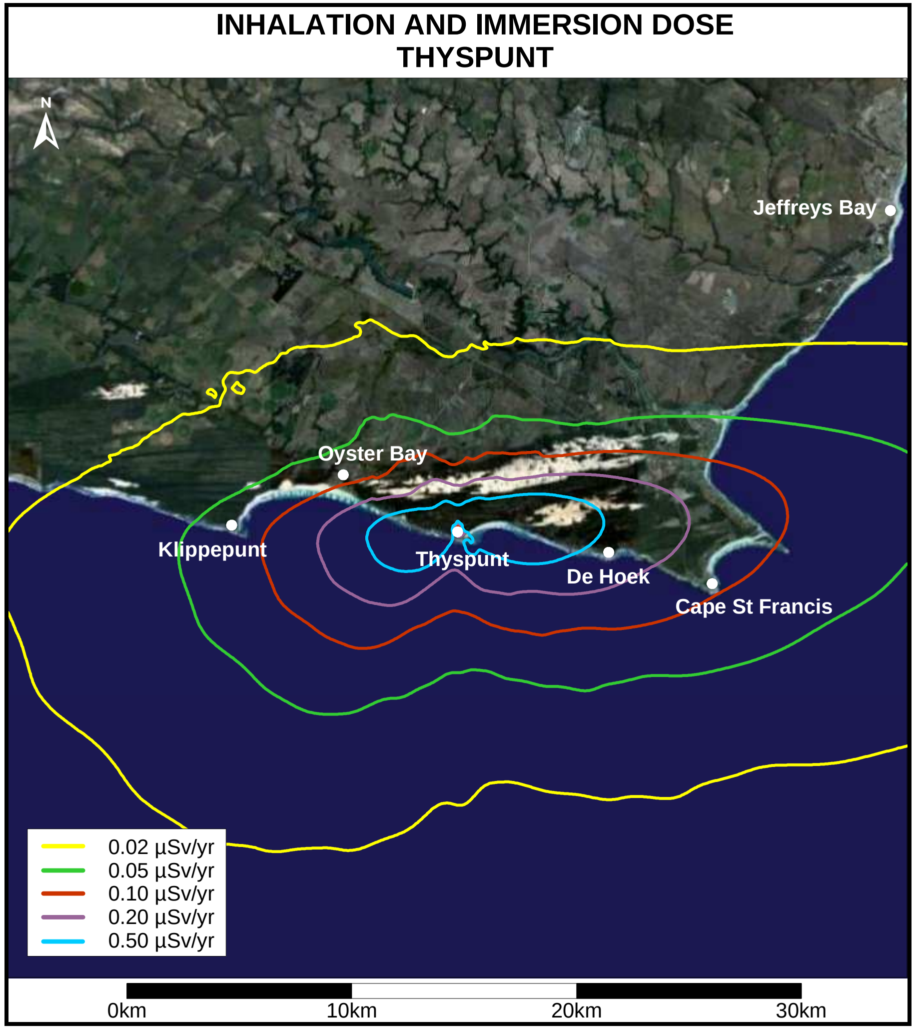


Figure 9-15: Predicted maximum cumulative annual inhalation and external radiation dose (µSv) for Thyspunt using 30 year equilibrium for deposition

Table 9-28: Assessment of air quality impacts at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction – Gaseous										
Without mitigation	Negative	Local	Low	Short-term	Probable	High	No	Medium	Low	Low
With mitigation	Negative	Local	Low	Short-term	Probable	High	No	Medium	Low	Low
Construction – PM10										
Without mitigation	Negative	Regional	High	Short-term	Definite	High	No	Medium	Medium	High
With mitigation	Negative	Local	Low	Short-term	Improbable	High	No	Medium	Low	Low
Construction – Fallout										
Without mitigation	Negative	Regional	High	Short-term	Definite	High	No	Medium	Medium	High
With mitigation	Negative	Local	Low	Short-term	Improbable	High	No	Medium	Low	Low
Operational – Non-Radionuclide										
Without mitigation	Negative	Local	Low	Long-term	Probable	High	No	High	Low	Low
With mitigation	Negative	Local	Low	Long-term	Probable	High	No	HIgh	Low	Low
Operational – Radionuclide										
Without mitigation	Negative	Local	Low	Long-term	Probable	High	No	Medium	Low	Medium
With mitigation	Negative	Local	Low	Long-term	Probable	High	No	Medium	Low	Medium
Cumulative Impacts										
Without mitigation	Negative	Local	Low	Long-term	Probable	High	No	Medium	Low	Low
With mitigation	Negative	Local	Low	Long-term	Probable	High	No	Medium	Low	Low

Table 9-29: Significance rating for air quality impacts at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction – Gaseous										
Without mitigation	Negative	Local	Low	Short-term	Definite	High	No	Medium	Low	**Low**
With mitigation	Negative	Local	Low	Short-term	Definite	High	No	Medium	Low	**Low**
Construction – PM10										
Without mitigation	Negative	Regional	High	Short-term	Definite	High	No	Medium	Medium	**High**
With mitigation	Negative	Local	Low	Short-term	Improbable	High	No	Medium	Low	**Low**
Construction – Fallout										
Without mitigation	Negative	Regional	High	Short-term	Definite	High	No	Medium	Medium	**High**
With mitigation	Negative	Local	Low	Short-term	Improbable	High	No	Medium	Low	**Low**
Operational – Non-Radionuclide										
Without mitigation	Negative	Local	Low	Long-term	Probable	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Long-term	Probable	High	No	High	Low	**Low**
Operational – Radionuclide										
Without mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Medium**
With mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Medium**
Cumulative Impacts										
Without mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Low**
With mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Low**

Table 9-30: Significance rating for air quality impacts at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction – Gaseous										
Without mitigation	Negative	Local	Low	Short-term	Definite	High	No	Medium	Low	**Low**
With mitigation	Negative	Local	Low	Short-term	Definite	High	No	Medium	Low	**Low**
Construction – PM10										
Without mitigation	Negative	Regional	High	Short-term	Definite	High	No	Medium	Medium	**High**
With mitigation	Negative	Local	Low	Short-term	Improbable	High	No	Medium	Low	**Low**
Construction – Fallout										
Without mitigation	Negative	Regional	High	Short-term	Definite	High	No	Medium	Medium	**High**
With mitigation	Negative	Local	Low	Short-term	Improbable	High	No	Medium	Low	**Low**
Operational – Non-Radionuclide										
Without mitigation	Negative	Local	Low	Long-term	Probable	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Long-term	Probable	High	No	High	Low	**Low**
Operational – Radionuclide										
Without mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Medium**
With mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Medium**
Cumulative Impacts										
Without mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Low**
With mitigation	Negative	Local	Low	Long-term	Definite	High	No	Medium	Low	**Low**

9.14 Impacts on oceanographic conditions

Although the major infrastructure for the nuclear power station will be built at least 10 m above sea level, associated infrastructure such as the intake and outflow channels for cooling water, as well as the possible disposal of spoil and sediment in the sea, may have an impact of physical oceanographic conditions. The oceanographic study involved modelling of the sea temperature and sediment movement patterns to predict the impacts. In turn, the changes to oceanographic conditions have influenced the prediction of impact on marine ecosystems.

9.14.1 Duynefontein

(a) Short term disruption of sediment transport during construction

The possible construction of the cofferdams at the Duynefontein site will influence sediment transport along the coast in the short term over the construction phase of the development.

Although the sediment transport varies along the beach due to the presence of rip cells, the net transport along the beach is low. The cofferdams are therefore expected to have a limited effect on the sediment transport and coastal erosion. Once construction has been completed the cofferdams will be removed. The overall significance of the impact is therefore considered to be low.

(b) Erosion due to brine discharge during construction

The discharge of brine from the Desalinisation Plant will result in the creation of an erosion channel across the beach. The extent of the channel is expected to be localised and will only impact the beach in the short term. Once construction is complete it is anticipated that the beach profile will quickly return to normal. The impact is therefore considered to have a low significance. Alternative methods of discharge have however been identified which will significantly reduce the erosion impact of the brine.

(c) Long term disruption of sediment transport – operational phase

The inlet pipes will be placed beneath the sea floor and will therefore not impact sediment transport along the coast, whilst the discharge point of the outlet pipes may form a minor barrier to sediment movement. Studies on the existing intake basin at Koeberg (a much larger structure) indicated minor coastal erosion in the first three years after construction but over the last ten years no erosion has taken place. The significance of the impact is therefore considered to be very low.

(d) Thermal plume dispersion – operational phase

The discharge of heated water and other co-discharges such as chlorine and nuclides has the potential to negatively impact upon the local marine ecology. This section will only consider physical factors such as the size, distribution and location of the mixing zone in quantifying potential impacts.

At the Duynefontein site it has been necessary to include the existing Koeberg intake and outfall within the base case model. This allows for an assessment of the potential cumulative impacts and also the potential for temperature increases at the Koeberg intake.

The intake and outfall configuration tested for the Duynefontein plant comprises two submarine intake tunnels extending to a depth of 20 m approximately 2.2 km offshore and two southerly outfall tunnels extending to a depth of 30 m approximately 3.5 km offshore.

Intake structures will be positioned at the end of each intake tunnel with the intake openings positioned 3 to 5 m above the sea bed to prevent the drawing in of large quantities of sediment. To reduce fish entrainment the intake openings should be designed to draw in water horizontally with a velocity of less than 0.3 m/s. The diffuser layout for the outfall was selected to achieve an initial dilution of at least 10 and to ensure that the plume surfaces under all current and ambient stratification conditions.

The modelling predicts no significant (> 1℃) increase in mean or maximum seawater temperature at the seabed as illustrated in **Figure 4-1** and **4-2 of the specialist report**, respectively. The discharge forms a discreet mixing zone at the surface with a 1-2 ℃ mean temperature increase contour extending a maximum of approximately 1.0 km from the outfall. The maximum increase in seawater temperature at the surface is shown by the 7 ℃ contour in the immediate vicinity of the outfall in **Figure 4-2 of the specialist report**.

Due to the buoyancy of the plume and the upward dispersion affected by the diffuser the plume will not impact to any great extent upon sensitive ecological receptors within the benthic environment.

Elevated water temperatures can deplete the dissolved oxygen in the water leading to unfavourable ecological conditions; however the ecological receptors within the water column, where the mixing zone is predicted to occur, are largely mobile and will avoid areas with unfavourable conditions. The significance of the impact of the thermal plume upon the marine environment is therefore considered to be low.

(e) Extreme Sea Levels – Operational Phase

The key potential impacts associated with extreme water levels are flooding of the nuclear facility or reduced water levels resulting in interruption of the cooling water supply. The theoretical extreme water levels are a function of a combination of (worst-case) hydrographic conditions.

The extreme high and low water levels are seen to occur during a meteo-tsunami event (i.e. extreme meteorological conditions in combination with maximum probable tsunami run-up and run-down values). Taking into account the effects of climate change upon sea level rise, the maximum water level under these conditions is predicted to be 10.54 m above MSL (at the upper 95 % confidence limit). Due to the site being constructed at 10 m above MSL there is the potential for the flooding. Flooding of the nuclear site is a potential major potential negative impact although the probability of such an occurrence is statistically very low. The potential impact of extreme water levels is therefore considered to be a negative potential impact of medium significance in lieu of appropriate mitigation. The cooling water intakes will be situated at -20 m MSL therefore there will be no potential for drying associated with the extreme low water level during a meteo-tsunami event (calculated to be -7.10 m MSL).

9.14.2 Bantamsklip

(a) Short term disruption of sediment transport during construction

The potential impacts upon short term sediment transport at the Bantamsklip can be considered to be the same as at the Duynefontein site (low significance).

(b) Erosion due to brine discharge during construction

The potential impact of the brine discharge at Bantamsklip can be considered to be the same as at the Duynefontein site (low significance).

(c) Disposal of spoil during construction

Dyer Island, situated approximately 15 km to the east of the nuclear installation corridor is a popular tourist destination with a number of operators offering shark cage diving adjacent to the island. An increase in suspended sediment in the vicinity of the island will reduce visibility and has the potential to impact on the tourism in the area.

Although many factors determine whether or not a sediment plume will be visible, available information suggests that the plume may be visible at suspended sediment concentrations as low as 10 mg/l. Since the maximum concentrations predicted by the model at Dyer Island generally exceed 10 mg/l, this suggests that the plume will occasionally be visible at Dyer Island during the sediment disposal operation.

(d) Long term disruption of sediment transport – operational phase

The potential impacts upon long term sediment transport at the Bantamsklip can be considered to be the same as at the Duynefontein site (low significance).

(e) Thermal plume dispersion – operational phase

The intake and outfall configuration tested for the Bantamsklip site comprises two submarine tunnel intakes extending approximately 3.5 km offshore (45 m depth) and two offshore tunnel outfalls extending approximately 2.5 km offshore (25 m depth). Other aspects of the intake and outfall design are the same as described above for Duynefontein.

A small mixing zone near the seafloor surrounds one of the tunnel outfalls indicating that a minor impact upon the benthic environment is to be expected in this area however the depth of the outfall, buoyancy of the plume and action of the diffusers insures that this impact is minimised as the plume is encouraged to move towards the surface.

The maximum increase in temperature near the seafloor is shown by the 3 – 4 ℃ contour which extends in a narrow band towards the shore. The 1 – 2 ℃ and 2 – 3 ℃ maximum temperature contours near the seafloor extends for a large area and impinges upon a significant extent of coastline.

The mean temperature increase in seawater temperature near the surface resulting from both outfalls is an area approximately 700 m in diameter 1 – 2 ℃ higher than ambient. The maximum temperature near the surface is shown by a very small 5 – 6 ℃ contour indicating that a high level of initial dilution is achieved at this site. However, as with the near seabed contour, the maximum temperature increase mixing zone appears to be forced towards the shallower nearshore waters where the impacts upon marine ecology are potentially greater.

Although the mixing zone has a relatively small extent the fact that it impinges upon the shallow near shore waters and shoreline results in a potential for low negative significance.

For a specific assessment of the potential impacts upon the ecological receptors present please refer to the EIA Marine Ecology Study.

(f) Extreme Water Levels – Operational Phase

The extreme high and low water levels predicted for the Bantamsklip site are seen to occur during a meteo-tsunami event (i.e. extreme meteorological conditions in combination with maximum probable tsunami run-up and run-down values). Taking into account the effects of climate change upon sea level rise, the maximum water level under these conditions is predicted to be 11.03 m MSL (at the upper 95 % confidence limit). Due to the site being constructed at 10 m MSL there is the potential for the flooding, although the probability of such an occurrence is statistically low.

The maximum meteorological extreme high water levels are 7.46 m over a 1:100 year return period. The cooling water intakes will be situated at -45 m MSL. Therefore, there will be no potential for drying associated with the extreme low water level during a meteo-tsunami event. Due potentially severe consequences but extremely low probability of a meteo-tsunami event occurring that may result in flooding of the proposed facility, the potential impact at the

Bantamsklip site associated with the predicted extreme high water levels has been assigned a medium negative significance.

9.14.3 Thyspunt

(a) Short term disruption of sediment transport during construction

The potential impacts upon long term sediment transport at the Thyspunt site can be considered to be the same as at the Duynefontein site (low significance).

(b) Erosion due to brine discharge during construction

The potential impact of the brine discharge at Thyspunt can be considered to be the same as at the Duynefontein site (low significance).

(c) Long term disruption of sediment transport –operational phase

The potential impacts upon long term sediment transport at the Thyspunt site can be considered to be the same as at the Duynefontein site (low significance).

(d) Extreme water levels – operational phase

The extreme high and low water levels predicted for the Thyspunt site are seen to occur during a meteo-tsunami event. Taking into account the effects of climate change upon sea level rise, the maximum water level under these conditions is predicted to be 14.77 m above MSL (at the upper 95% confidence limit). Due to the site being constructed at 10 m above MSL there is significant potential for the flooding.

The maximum meteorological extreme high water levels are 11.56 m (at the upper 95% confidence limit) over a 1:100 year return period.

The cooling water intakes will be situated at -45 m MSL therefore there will be no potential for drying associated with the extreme low water level during a meteo-tsunami event. Due to the potential for flooding during both a meteo-tsunami event and meteorological extreme high water levels the probability of such an occurrence at the Thyspunt site is relatively greater than the two other sites. The significance of the impact is therefore considered to be high.

(e) Extreme water levels – operational phase

The intake is a submarine tunnel extending to a depth of -29 m CD approximately 1000 m offshore. Either a single tunnel with an internal diameter of approximately 9 m, or two tunnels with diameters of approximately 6.4 m will be used. The outfall comprises six 3 m diameter pipes buried below the seabed in a 27.5 m wide trench and discharging approximately 250 m offshore in a water depth of approximately -5 m CD.

The mean increase in seawater temperature is seen to decrease rapidly from almost 8℃ above ambient immediately adjacent to the outfall to less than 2 ℃ within a discreet mixing zone only a few hundred metres in diameter indicating that good initial mixing is achieved despite the shallow depth. However, the 1 – 2 ℃ contour is seen to extend a significant distance and hug the coastline to the east of the outfall.

The mean increase in seawater temperature plume near the surface behaves similarly although is larger in its extent illustrating the buoyancy of the plume.

The maximum temperature increases with the proposed outfall layout are sub-optimal in terms of protecting the marine environment. Both the near seabed and near surface contour plots illustrate that the plume has a tendency to hug the shoreline and shallow nearshore area where the potential for impacts upon benthic ecology are greatest. Significant temperature increases (>2 ℃) are predicted to extend over a large area of coastline. It should however be noted that the maximum temperature increases may only be experienced for a short time over the typical 14 day tidal cycle.

The shallowness of the proposed outfall in this instance results in a relatively greater impact upon the benthic environment. The significance of the impact of the outfall upon the marine environment is considered to be of medium negative significance.

9.14.4 Mitigation

Mitigation measures applicable to all three sites are as follows:

(a) Erosion across the beach from brine discharge

Brine from the Desalinisation Plant will erode a channel from discharge point to the surf zone. The erosion will be quickly reversed once the discharge has ceased, however discharging the brine into a soakaway or infiltration gallery above the high water mark will result in minor impact to the beach profile. Furthermore discharging the brine to ground will increase dilution prior to mixing in the surf zone. Discharging brine into an infiltration gallery does however have the potential to negatively affect ground water resources on the site. The impact on local aquifers and groundwater fed surface water systems should be assessed at each site prior to considering discharging brine to ground.

(b) Disposal of spoil

The results of the marine sediment disposal modelling identifies three options for mitigating the potential impacts associated with the disposal of spoil; reducing the discharge rate, reducing the volume and / or disposing of the spoil in deeper water.

The modelling demonstrates that halving the sediment discharge rate significantly reduces the suspended sediment concentrations. However, halving the sediment discharge rate does not reduce the sediment thickness, since the transport of the coarser sediment away from the disposal mound occurs on a much longer time scale than the disposal operation.

Reducing the volume of sand disposed reduces the number of days that the threshold suspended sediment of 80 mg/l is exceeded, but has little influence on the maximum suspended sediment concentration.

Moving to deeper water reduces the suspended sediment concentrations (since there is more water depth available for mixing) and reduces the transport of the coarser sediment away from the disposal site (due the reduced orbital velocities of the waves).

Spoil disposal should cease during stormy conditions where sediments are less likely to settle upon the seafloor. The sediment plume should also be monitored visually and via water quality sampling frequently to ensure that the relevant water quality objectives established for the project are met.

(c) Extreme water levels

Flooding from sea will occur if the level of the sea rises due to climate change, storm events or a tsunami to a level above the footprint of the development. This can be mitigated during the design stage of the project by building the nuclear power station above the maximum predicted rise in sea level for each of the sites. At each of the three sites the highest predicted sea level rise is brought about by a tsunami combined with the effects of climate change. The IAEA (2003) does not state a level above the maximum run-up that the facility should be built. However, an elevation of at least 0.5 m above the maximum run-up is recommended. The maximum predicted rise in sea level for each site and the recommend elevation to prevent flooding is indicated in the table below.

Table 9-31: Recommended elevation of nuclear power station sites

Alternative	Meteo-tsunami Best estimate (m MSL)	Meteo-tsunami Upper 95% confidence level (m MSL)	Recommended elevation (m MSL)
Duynefontein	9.51	10.54	**>11.04**
Bantamsklip	9.98	11.03	**>11.53**
Thyspunt	13.61	14.77	**>14.27**

(c) Thermal Plume Dispersion

The key mitigation measures for minimising the potential impacts of a thermal plume are already in place. The outfalls will be placed a number of kilometres offshore at a depth of between 25 and 30 m. The mixing zones resulting from deep offshore outfalls are typically far smaller than nearshore channel outfalls. Moving the plume away from the shoreline and shallow nearshore area also ensures that the potential for ecological impacts is minimised.

Each outfall ends in a 200 m long diffuser with 5 ports at 50 m spacing. The ports have a diameter of 2 m and discharge vertically upwards from a height of 2 m above the seabed. The diffuser layout was selected to achieve an initial dilution of at least 10 and to ensure that the plume surfaces under all current and ambient stratification conditions. It is preferable that the plume is not trapped near the seabed as there is then an increased risk of ecological impacts at the seabed and also of recirculation back to the intakes, which in this case are located near the seabed in a depth of 20 m.

(d) Monitoring recommended by the IAEA

The International Atomic Energy Agency (IAEA, 2003) recommends that the following monitoring networks should be considered when constructing a nuclear power station:

- Monitoring of basic atmospheric conditions through a weather station; and
- A water level gauge system at Cape Town, Hermanus and Port Elizabeth for Duynefontein, Bantamsklip and Thyspunt respectively.

(e) Construction and Operational Environmental Monitoring

It is recommended that the construction and operation environmental management plans developed for the project include the methodology for monitoring key oceanographic parameters during construction and operation.

During construction this should include monitoring the levels of total suspended sediments within the water column during all marine works and spoil disposal operations. During operation ambient temperature and concentrations of co-discharges should be frequently measured.

9.14.5 Conclusion

All three of the sites are suitable for the construction of the nuclear power station. However, different impacts of varying significance are expected at each of the sites.

Construction related oceanographic impacts are likely to be similar at each of the project sites. However, the potential for suspended sediment plumes to impact upon tourism (in particular shark cage diving at Dyer Island) should be considered if Bantamsklip is selected. Analysis of the thermal plume dispersion at each of the sites indicates that relatively unfavourable dispersion takes place at Thyspunt, where the plume is seen to hug the coastline and shallow near shore areas. The most efficient dispersal of the thermal plume will occur at Duynefontein.

There is the potential for water levels to exceed the proposed elevation (+10 m MSL) of the nuclear power station at all three sites should a tsunami coincide with extreme meteorological conditions (a meteo-tsunami event). However, the occurrence of a tsunami is improbable, given the low risk of seismic activity in the surrounding ocean. Thyspunt is the only site where extreme high water levels resulting purely from meteorological factors are predicted to exceed + 10 m MSL during the expected lifetime of the installation. Consequently, the predicted water levels at Thyspunt during a meteo-tsunami are also significantly higher than at Bantamsklip and Duynefontein.

Table 9-32: Assessment of impacts on the oceanographic environment at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Short term disruption of sediment transport										
Without mitigation	Negative	Local	Low	Short –term	Low	Probable	Low	No	High	**Low**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Beach erosion due to brine discharge										
Without mitigation	Negative	Local	Medium	Short –term	Low	Definite	Low	No	High	**Low**
With mitigation	Negative	Local	Low	Short –term	Low	Improbable	Low	No	High	**Very low**
Long term disruption of sediment transport										
Without mitigation	Negative	Local	Low	Long term	Low	Highly-Probable	Medium	No	High	**Low**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Extreme sea levels										
Without mitigation	Negative	Local	Medium	Short-term	Medium	Probable	Not relevant	Not relevant	High	**Medium**
With mitigation	Negative	Local	Medium	Short -term	Medium	Improbable	Not relevant	Not relevant	High	**Very low**

Table 9-33: Assessment of impacts on the oceanographic environment at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Short term disruption of sediment transport										
Without mitigation	Negative	Local	Low	Short –term	Low	Probable	Low	No	High	**Low**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Disposal of spoil										
Without mitigation	Negative	Local	Medium	Short –term	Low	Highly Probable	Low	No	High	**Low**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Beach erosion due to brine discharge										
Without mitigation	Negative	Local	Medium	Short –term	Low	Highly Probable	Low	No	High	**Low**
With mitigation	Negative	Local	Low	Short –term	Low	Improbable	Low	No	High	**Very low**
Long term disruption of sediment transport										
Without mitigation	Negative	Local	Low	Long term	Low	Probable	Medium	No	High	**Low**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Extreme sea levels										
Without mitigation	Negative	Local	Medium	Short-term	Medium	Probable	Not relevant	Not relevant	High	**Medium**
With mitigation	Negative	Local	Medium	Short -term	Medium	Improbable	Not relevant	Not relevant	High	**Very low**

Table 9-34: Assessment of impacts on the oceanographic environment at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Short term disruption of sediment transport										
Without mitigation	Negative	Local	Low	Short –term	Low	Probable	Low	No	High	**Low**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Beach erosion due to brine discharge										
Without mitigation	Negative	Local	Medium	Short –term	Low	Highly Probable	Low	No	High	**Low**
With mitigation	Negative	Local	Low	Short –term	Low	Improbable	Low	No	High	**Very low**
Long term disruption of sediment transport										
Without mitigation	Negative	Local	Low	Long term	Low	Highly-Probable	Low	No	High	**Low**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Thermal plume dispersion										
Without mitigation	Negative	Local	Medium	Long-term	Low	Highly-Probable	High	No	High	**Medium**
With mitigation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**N/A**
Extreme sea levels										
Without mitigation	Negative	Local	High	Short-term	High	Probable	Not relevant	Not relevant	High	**High**
With mitigation	Negative	Local	Medium	Short -term	Medium	Improbable	Not relevant	Not relevant	High	**Very low**

9.15 Impacts on marine ecology

The development of a nuclear power station at any of the three alternative sites could have a combination of the following potential impacts during construction, operation and decommissioning:

- Disruption of surrounding marine habitats;
- The entrainment and death of organisms associated with the intake of cooling water;
- The release of warm water used for cooling purposes;
- The release of desalination effluent;
- The unintentional release of radiation emissions;
- The positive impacts of the protection of organisms from exploitation due to a safety exclusion zone; and
- Pollution of the marine environment by the discharge of groundwater polluted by organic, bacterial or hydrocarbon compounds.

9.15.1 Duynefontein

(a) Disruption of surrounding marine habitats

When associated with the construction of the cooling water uptake and release system, this effect will be focused within the construction phase and will be localised and of short duration. However, when associated with the potential discarding of spoil, disruption to the marine environment is significant and of high consequence. When mitigated by disposing spoil offshore, the impact is reduced to one of medium consequence, although the significance remains high.

(b) The entrainment and death of organisms

The entrainment and death of organisms associated with the intake of cooling water. At Duynefontein entrainment it is not anticipated to have significant ecological impacts.

(c) The release of warm water used for cooling purposes

A tunnelled design of the release system mitigates potential negative impacts through multiple points of release to aid dissipation of excess heat, by releasing cooling water above the sea bottom to minimise effects on the benthic environment and by utilising a very high flow rate at the point of release to maximise mixing with cool surrounding water. Comprehensive oceanographic modeling has demonstrated that the effects of elevated temperature are expected to be focused on the open water habitat.

(d) The release of desalination effluent

During construction small volumes of hypersaline effluent will be released directly into the surf zone where high energy water movement will result in adequate mixing with surrounding seawater to ensure minimal impact on the marine environment. During the operational phase the desalinisation effluent will be co-released with cooling water. As brine will be diluted to undetectable levels prior to release no impact on the marine environment is predicted during this phase of the development.

(e) The unintentional release of radiation emissions

Technical design of the cooling system has minimised this risk, so that this potential impact is rated as having low consequence and low significance.

(f) The positive impacts of the protection of organisms from exploitation due to a safety exclusion zone

There would be negligible positive impact at Duynefontein.

(g) Pollution of the marine environment by the discharge of groundwater polluted by organic, bacterial or hydrocarbon compounds

This impact is unlikely to occur and will be spatially and temporally restricted. It is therefore is considered to be of low consequence and significance at all three sites.

9.15.2 Bantamsklip

(a) Disruption of surrounding marine habitats

The nature of the impact will be similar to that at Duynefontein.

(b) The entrainment and death of organisms

The entrainment and death of organisms associated with the intake of cooling water. At Bantamsklip this is likely to have significant negative effects on stocks of the abalone *Haliotis midae*.

(c) The release of warm water used for cooling purposes

A tunnelled design of the release system mitigates potential negative impacts through multiple points of release to aid dissipation of excess heat, by releasing cooling water above the sea bottom to minimise effects on the benthic environment and by utilising a very high flow rate at the point of release to maximise mixing with cool surrounding water. Comprehensive oceanographic modeling has demonstrated that the effects of elevated temperature are expected to be focused on the open water habitat. This is of particular relevance at Bantamsklip, as it would help to mitigate impacts on abalone. It is strongly recommended that at Bantamsklip an offshore tunnel outfall be utilised for the release of warmed water in an effort to further mitigate impact on abalone. Importantly a channel release system at this site is considered to pose an unacceptable risk to abalone populations.

(d) The release of desalination effluent

The nature of the potential impacts will be the same as at Duynefontein.

(e) The unintentional release of radiation emissions

The nature of the potential impacts will be the same as at Duynefontein.

(f) The positive impacts of the protection of organisms from exploitation due to a safety exclusion zone

Bantamsklip is the only site that would benefit from such an exclusion zone, as this could be of great benefit to what are currently illegally harvested abalone populations. However, for such a benefit to be realised adequate and strict enforcement of the exclusion zone must be provided.

(g) Pollution of the marine environment by the discharge of groundwater polluted by organic, bacterial or hydrocarbon compounds

This impact is unlikely to occur and will be spatially and temporally restricted. It is therefore is considered to be of low consequence and significance at all three sites.

9.15.3 Thyspunt

(a) Disruption of surrounding marine habitats

The nature of the potential impact will be similar to that at Duynefontein. However, when mitigated by disposing spoil offshore, it will be important to use only a medium pumping rate at Thyspunt. Thereby the potential impact will be reduced to one of medium consequence, although the significance will remain high.

(b) The entrainment and death of organisms

The entrainment and death of organisms associated with the intake of cooling water. At Thyspunt entrainment it is not anticipated to have important ecological impacts.

(c) The release of warm water used for cooling purposes

The nature of the potential impacts would be similar to that at Duynefontein. Comprehensive oceanographic modelling has demonstrated that the effects of elevated temperature are expected to be focused on the open water habitat. As at the other sites, the construction of an intake and outflow system for cooling water will result in temporary disruption to the marine environment. Under such circumstances the benthic habitat and in particular egg beds of the chokka squid *Loligo vulgaris* are at risk of damage due to smothering, while turbidity may result in adults temporarily moving out of the area. This disturbance will be focussed within the construction phase and is likely to be localised and of short duration.

(d) The release of desalination effluent

The nature of the potential impacts will be the same as at Duynefontein.

(e) The unintentional release of radiation emissions

The nature of the potential impacts will be the same as at Duynefontein.

(f) The positive impacts of the protection of organisms from exploitation due to a safety exclusion zone

There would be negligible positive potential impact at Thyspunt.

(g) Pollution of the marine environment by the discharge of groundwater polluted by organic, bacterial or hydrocarbon compounds

This potential impact is unlikely to occur and will be spatially and temporally restricted. It is therefore is considered to be of low consequence and significance at all three sites.

9.15.4 The no-go alternative

While the no-go alternative will reduce the negative potential impact on the marine environment at Duynefontein and Thyspunt (although only from a low level), at Bantamsklip it may result in the loss of the potential positive impact associated with the exclusion of abalone poaching at this site. It is important to note, however, that there is uncertainty about how effective the policing of the exclusion zone will be and thus how much of a potential positive impact would be derived at Bantamsklip.

9.15.5 Mitigation

The majority of the potential impacts are inherently mitigated by the design of the nuclear power station facility and its associated infrastructure.

The following mitigation measure will be necessary:

(a) Disruption of the marine environment during construction

The potential impacts associated with tunnelling for intake pipes and laying of outlet pipes will occur only within the construction phase. No mitigation measures are possible but due to the localised and short-lived nature of this impact this is considered acceptable. Marine impacts will be mitigated by the placement of disposal sites offshore (and the use of a medium pumping velocity at Thyspunt).

(b) Abstraction of cooling water and the subsequent entrainment of organisms

The technical design of the intake system will result in water being drawn into the intake pipe at a rate of 1 $m.s^{-1}$. This very slow rate of intake means that large organisms, such as fish and marine mammals, will easily be able to swim against the flow and will avoid entrainment without difficulty. In addition, the use of screens will further help to prevent the intake of large organisms. Despite the above, eggs, sperm and larvae will be impossible to exclude, due to their small size. While this is of concern in the context of the abalone *Haliotis midae* at Bantamsklip, no measures can be applied to mitigate this potential impact without compromising the efficiency of the cooling system. Due to the sound design of the intake system no further mitigation measures are possible to further reduce entrainment of marine organisms.

(c) The release of warm cooling water

At Duynefontein and Thyspunt current design of the release system does in itself significantly mitigate negative potential impacts associated with the release of warmed cooling water. Due to the low consequence and medium significance of this impact at these sites, no further mitigation measures are recommended. However, due to the potential impacts on the abalone *H. midae*, it is recommended that at Bantamsklip an offshore tunnel outflow be used to prevent the thermal pollution of the nearshore benthic environment which would be associated with a nearshore channel outflow.

(d) Desalination

The effect of the release of hypersaline effluent will be avoided during the operational phase of the development as desalinisation effluent will be co-released with cooling water and adequate mixing will occur prior to release from the outflow pipe. During the construction phase brine will be released independently but into the surf zone to ensure mixing with surrounding seawater. Sufficient dilution will be achieved within 110 m from the point of release. Due to the effectiveness of this design in minimising impacts on the marine environment no additional mitigation measures are required.

(e) Radiation emissions

At a design level the risk of radiological releases into the marine environment has been minimised through the incorporation a 'double cooling system' whereby at no stage is there direct contact between the reactor and the coolant or between the coolant and the sea water. No further mitigation measures are necessary.

(f) Closure of site to exploitation

No additional benefit will be gained at the Duynefontein and Thyspunt sites, but a positive effect on the marine environment is possible at Bantamsklip. However, the level of organisation and the brazenness of poachers in this area will necessitate dedicated active policing of this exclusion zone for this benefit is to be realised.

(g) Release of sewage water

As the effluent to be released will meet the standards set out in the South African Water Quality Guidelines no further mitigation measures are necessary.

(h) Unintentional release of polluted groundwater

In order to reduce environmental risks it is recommended that mitigation measures prescribed in the geo-hydrological specialist study to minimise organic, bacterial and hydrocarbon pollution of groundwater (and subsequently the marine environment) should be applied.

9.15.6 Conclusion

The nature of the marine potential impacts is fairly similar at all the sites. Potentially the most significant impacts are the disruption of the marine environment through the offshore disposal of sediment, and the release of warmed cooling water. Secondly, disturbance will be associated with the potential discarding of spoil from excavation of the take tunnel, intake basin, nuclear island and turbine hall. This potential impact will have a highly significant and negative affect on the marine environment which will act in the long term. In an effort to minimise this potential impact, it is recommended that spoil only be discarded offshore and that at Thyspunt only a medium pumping rate be used. This would limit ecological impacts particularly on abalone at Bantamsklip and chokka squid at Thyspunt. Heating of seawater will be mitigated by a tunnelled design of the release system through multiple points of release to aid dissipation of excess heat. Water will be released above the sea bottom to minimise effects on the benthic environment and by utilising a very high flow rate at the point of release to maximise mixing with cool surrounding water.

From a marine biology perspective, there is no clear preferred site. All sites would have similar levels of negative impacts, and the impacts on all sites could be effectively mitigated if the proposed designs are implemented as planned. Thyspunt would require a medium pumping rate for offshore discard of spoil. **Bantamsklip would potentially gain the most from the declaration of a marine "no-go" security zone.** However, the real benefits of this positive impact are uncertain, as very strict policing of this zone would be required to prevent access by abalone poachers.

<u>NOTE</u>: All impacts have the same significance with and without mitigation, because mitigation is built into the design of the nuclear power station and associated infrastructure.

Table 9-35: Assessment of impacts on the marine environment at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Disruption during construction due to construction of the cooling water intake and outflow systems	Negative	Local	Low	Medium	Definite	High	No	High	Low	**Medium**
Disruption during construction due to discarding of spoil	Negative	Local	High	Long	Definite	Medium	No	High	High	**High**
Disruption during construction due to discarding of spoil offshore	Negative	Local	Medium	Long	Definite	Medium	No	High	Medium	**High**
Abstraction of cooling water and entrainment of organisms	Negative	Local	Low	Long	Definite	High	No	High	Low	**Medium**
Release of warmed cooling water	Negative	Local	Low	Long	Definite	High	No	Medium	Low	**Medium**
Desalination during the construction phase	Negative	Local	Low	Medium	Definite	High	No	High	Low	**Medium**
Radiation emissions	Negative	Local	Low	Long	Improbable	High	No	High	Low	**Low**
Unintentional discharge of polluted groundwater	Negative	Local	Low	Medium	Improbable	High	No	High	Low	**Low**

Table 9-36: Assessment of impacts on the marine environment at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Disruption during construction due to tunnelling for intake pipe and laying of outlet pipes	Negative	Local	Medium	Medium	Definite	Medium	No	High	Medium	**High**
Disruption during construction due to discarding of spoil	Negative	Local	High	Long	Definite	Medium	No	High	High	**High**
Disruption during construction due to discarding of spoil offshore	Negative	Local	Medium	Long	Definite	Medium	No	High	Medium	**High**
Abstraction of cooling water and entrainment of organisms	Negative	Local	Medium	Long	Definite	Medium	No	High	Medium	**High**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Release of warmed cooling water	Negative	Local	Medium	Long	Definite	Medium	No	Medium	Medium	**High**
Release of warmed cooling water with mitigation	Negative	Local	Low	Long	Definite	High	No	Medium	Low	**Medium**
Desalination during the construction phase	Negative	Local	Medium	Medium	Definite	High	No	High	Medium	**High**
Radiation emissions	Negative	Local	Low	Long	Improbable	High	No	High	Low	**Low**
Closure to exploitation	Positive	Local	Medium	Long	Possible	Not relevant	No	High	Medium	**Medium**
Unintentional discharge of polluted groundwater	Negative	Local	Low	Medium	Improbable	High	No	High	Low	**Low**

Table 9-37: Assessment of impacts on the marine environment at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Disruption during construction due to tunnelling for intake pipe and laying of outlet pipes	Negative	Local	Low	Medium	Definite	High	No	High	Low	**Medium**
Disruption during construction due to discarding of spoil	Negative	Local	High	Long	Definite	High	No	High	High	**High**
Disruption during construction due to discarding of spoil offshore at a medium velocity	Negative	Local	Medium	Long	Definite	Medium	No	High	Medium	**High**
Abstraction of cooling water and entrainment of organisms	Negative	Local	Low	Long	Definite	High	No	High	Low	**Medium**
Release of warmed cooling water	Negative	Local	Low	Long	Definite	High	No	Medium	Low	**Medium**
Desalination during the construction phase	Negative	Local	Low	Medium	Definite	High	No	High	Low	**Medium**
Radiation emissions	Negative	Local	Low	Long	Definite	High	No	High	Low	**Low**
Unintentional discharge of polluted groundwater	Negative	Local	Low	Medium	Improbable	High	No	High	Low	**Low**

9.16 Impacts on heritage resources

All three sites contain significant heritage resources, being situated in areas which are known to be archaeologically and palaeontologically sensitive and in scenic areas with strong wilderness qualities.

The fact that certain kinds of heritage are finite means that any form of impact assessment automatically invokes the maximum scores in terms of the criteria of replaceability, reversibility and duration. Tangible heritage resources such as protected structures, archaeological sites, palaeontological material is finite. Once they are damaged or destroyed, that state endures forever. It can never be replaced, or reversed. It is possible to mimic or reconstruct certain kinds of heritage such as buildings and individual objects, and to an extent it may be possible to reinstate a cultural landscape but with loss of authenticity. The main sources of potential impact to heritage fall into two broad categories – a) the destruction of the physical heritage object itself, b) the destruction or change of its context.

The nature and mechanisms of potential impact will be similar at all three sites – extensive excavation, landscape modification and disturbance.

(a) Construction phase impacts

Destruction of tangible heritage (structures, archaeological sites, fossils) almost always takes place during the construction process of development activities as the main source of potential impact to heritage is from the disturbance of ground or landscape and/or demolition of structures and places.

Archaeological sites, Pleistocene palaeontology, and graves are highly fragile and context sensitive, which means that their value is very easily destroyed when the landscape in which they are situated is disturbed by bulk excavation, installation of services and roads. Palaeontological material is destroyed by bulk earthmoving, cutting and mining operations, however palaeontological resources tend to be extensive (depending on the resource) and are rather more resistant to impact than archaeological material for the simple reason is that there is more of it. Because palaeontological material is often very deeply buried, scientists often rely on human intervention in the land surface to collect data. Provided that palaeontologists can use the opportunity arising from construction works to sample and record profiles and exposed material as part of the environmental management process, a potential negative impact can be transformed into a positive opportunity to increase the levels of knowledge about a locality and the species of fauna and flora that were present in the past.

Cultural landscapes are highly sensitive to accumulative impacts and large scale development activities that change the character and public memory of a place. In terms of the NHRA a cultural landscape may also include a natural landscape of high rarity value and scientific significance. Certainly the construction of a large facility such as a nuclear power station is likely to result in profound changes to the overall sense of place of a locality, if not a region. On a smaller scale comparatively minor factors such as ill-conceived and distasteful signage, “overpowering” entrance gates to sites or security fences adjacent to natural areas and scenic drives will constitute a bothersome aesthetic irritation than can cause serious cumulative damage to the “sense of place”. It may be argued that it is possible to a degree to rectify damage to a cultural landscape through demolition of intrusive elements, however this seldom ever happens – the impacts to all intents and purposes are permanent. Given the nature and scale of the proposed activity which will involve massive intrusive permanent bulk in what are considered significant natural heritage areas, mitigation is not feasible, however careful environmental planning may assist in lessening the effects of infrastructure “sprawl”.

(b) Operational phase impacts

During the operational phase of the plant, it is expected that impacts will be largely neutral provided that the applicant manages the heritage resources on the affected properties adequately. Impacts on a minor scale will occur when certain operational decisions are made in response to the needs of the facility – road construction, construction of peripheral buildings, pipelines etc. It is expected that significant changes will independently trigger EIAs or HIAs

(c) Decommissioning phase impacts

Heritage impacts can occur during the decommissioning phases of large operations. The process of rehabilitation will involve surface disturbance and earthmoving operations. The effect of this, like during the construction phase, will be the destruction of context in which archaeological heritage is situated, the demolition of buildings that are greater then 60 years old. In terms of the current protections of the NHRA, the Nuclear Infrastructure could be greater than 60 years old once demolition and rehabilitation is required. This would invoke the general protection of the NHRA in its present form.

9.16.1 Duynefontein

- Impacts to ephemeral Late Stone Age heritage will be minimal.
- Duynefontein is palaeontologically highly sensitive. Extensive mitigation will be required. If done appropriately, will benefit palaeontological research.
- In cultural landscape terms the nuclear industrial presence is already established and accepted as a landmark by most Capetonians. Any additions to this will be additions to an already established identity.
- No colonial period heritage is likely to be impacted.

9.16.2 Bantamsklip

- By Western Cape standards the preservation and volume of archaeological sites is exceptional. Extensive mitigation will be required.
- The natural heritage landscapes of the place are excellent and make a contribution to sense of place in the region. Given the mass and bulk of the proposed activity, un-mitigable cultural landscape impacts are expected.

9.16.3 Thyspunt

- The archaeological and palaeontological heritage is diverse and prolific. Mitigation without excessive impacts is going to be technically difficult to achieve due to the character of the site and difficulties with respect to accessibility, however the final location of the proposed facility will play a role in the degree of impact expected.
- The wilderness qualities of this portion of the coast are exceptional and make a substantial contribution to the character of the region. Given the mass and bulk of the proposed activity, un-mitigable cultural landscape impacts are expected, however the final location of the proposed facility will play a role in the degree of impact expected.

9.16.4 Cumulative impacts

Neither SAHRA nor Heritage Western Cape has conducted a systematic assessment of the potential population of archaeological sites on the south coast or the amount of undisturbed shoreline that survives. Given the extent of littoral sprawl of urban development from Hermanus to Gansbaai and the low proportion of coastal landscapes that are protected, a worst case scenario (i.e. destruction of a large proportion of archaeological sites in the study area) would make a significant impact on the 'regional estate' of archaeological sites. A concern is the loss of wilderness landscape and un-interrupted views, which gives the Overstrand region its particular character, and makes the R43 a scenic drive.

Indications are that the construction of transmission lines that will integrate the facility with the national grid will need to cross iconic Cape landscapes, resulting in significant impacts in terms of setting and scenery. Public response with respect to the scoping phase of the EIA has been vigorous with respect to these issues and therefore the cumulative impact of the transmission lines, in addition to the nuclear power station itself, can be expected to be high.

9.16.5 Impacts of the no-go alternative

The no-go alternative will result in retention of the *status quo* until such time that alternative land uses are found. In the medium to long term heritage impacts could be expected depending on future land use. Should any of the sites be used for property development, it is likely that heritage impacts in terms of archaeology and landscape will be severe. The westward expansion of Cape St. Francis and the development of associated golf estates is a case in point, as this has already resulted in highly significant impacts on heritage resources.

9.16.6 Mitigation

Mitigation can be achieved through scientific recording, sampling or excavation - however these are also destructive processes. In general, full rectification of heritage impacts is not normally possible in the case of archaeology unless the archaeological sites can be conserved in their entirety. The best that can be achieved is the sampling of the archaeological material so that a representative sample of the find is conserved in perpetuity. The process is slow, exacting and expensive. The end result is always the loss of the archaeological site as a permanent heritage resource; the gain is the rescue of knowledge provided that the archaeological sampling is done in according to suitable standards. Archaeologists prefer to conserve where ever possible in the interests of sustainable heritage management.

9.16.7 Conclusion

The amount of Late Stone Age heritage that will be impacted at Duynefontein will be substantially less than that of Bantamsklip and Thyspunt. However, Duynefontein is palaeontologically highly sensitive. If Eskom commits to a comprehensive mitigation programme there is real scientific benefit to be had from the opportunity to collect fossils, record their context and examining the profiles of deep excavations into caenozoic deposits. Thus, in spite of the high sensitivity of palaeontological resources, a comprehensive mitigation strategy may actually result in significant benefits by contributing to greater knowledge.

Bantamsklip is almost as sensitive as Thyspunt in terms of its heritage richness. However, mitigation measures will have a better chance of success at Bantamsklip, as heritage sites are more visible and accessible at Bantamsklip. Much of the necessary sampling can be done prior to commencement of construction work. The preservation and volume of archaeological sites is exceptional. Mitigation will be lengthy, expensive and resource intensive requiring up to a year's lead time.

Mitigation of impacts at Thyspunt is going to be the most difficult due to accessibility problems. This could result in localised delays during construction if mitigation excavations cannot be performed in time for the planned start of construction. Both the archaeological and palaeontological heritage is prolific, representing a very wide range of material, much of which is very well preserved. Without extremely lengthy mitigation, a great deal of Pleistocene palaeontological and archaeological material will be lost during construction. The wilderness qualities of this portion of the coast are exceptional and make a substantial contribution to the character of the region.

Table 9-38: Significance rating for heritage impacts at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Destruction of Miocene Palaeontology										
Without mitigation	Negative	Local	High	Permanent	Probable	Low	Yes	High	High	**High**
With mitigation	Positive	Local	High	Permanent	Probable	Low	Yes	High	Low	**Low**
Destruction of Pleistocene palaeontology and archaeology										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	Definite	Low	Yes	High	Medium	**Medium**
Destruction of Holocene archaeology										
Without mitigation	Negative	Local	Low	Permanent	Definite	Low	Yes	High	Low	**Low**
With mitigation	Negative	Local	Low	Permanent	Definite	Low	Yes	High	Low	**Low**
Destruction of colonial heritage										
Without mitigation	Negative	Local	Low	Permanent	Improbable	Low	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Improbable	Low	No	High	Low	**Low**
Destruction of landscape										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	Medium	**Medium**
With mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	Medium	**Medium**
Cumulative impacts										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	High	Low	Yes	High	Medium	**Medium**
Positive contribution to conservation										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	Low	**Low**
With mitigation	Neutral									

Table 9-39: Significance rating for heritage impacts at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Destruction of Miocene Palaeontology										
Without mitigation	Negative	Local	High	Permanent	Probable	Low	Yes	Low	Low	**Low**
With mitigation	Neutral	Local	High	Permanent	Probable	Low	Yes	Low	Low	**Low**
Destruction of Pleistocene palaeontology and archaeology										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	Medium	**Medium**
With mitigation	Negative	Local	Medium	Permanent	Definite	Low	Yes	High	Low	**Low**
Destruction of Holocene archaeology										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	Definite	Low	Yes	High	Medium	**Medium**
Destruction of Colonial heritage										
Without mitigation	Negative	Local	High	Permanent	Possible	Low	Yes	High	Medium	**Medium**
With mitigation	Positive	Local	Low	Permanent	Probable	Medium	Yes	Medium	Low	**Low**
Destruction of landscape										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
With mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
Cumulative impacts										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	High	Low	Yes	High	Medium	**Medium**
Positive contribution to conservation										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	Low	**Low**
With mitigation	Positive	Regional	Medium	Permanent	High	Low	Yes	High	Medium	**Medium**

Table 9-40: Significance rating for heritage impacts at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Destruction of Miocene Palaeontology										
Without mitigation	Negative	Local	High	Permanent	Probable	Low	Yes	Low	Low	**Low**
With mitigation	Neutral	Local	High	Permanent	Probable	Low	Yes	Low	Low	**Low**
Destruction of Pleistocene palaeontology and archaeology										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	Definite	Low	Yes	High	Medium	**Medium**
Destruction of Holocene archaeology										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	Definite	Low	Yes	High	Medium	**Medium**
Destruction of living heritage										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Permanent	Probable	Medium	Yes	Medium	Low	**Low**
Destruction of landscape										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
With mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
Cumulative impacts										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Permanent	High	Low	Yes	High	Medium	**Medium**
Positive contribution to conservation										
Without mitigation	Negative	Regional	High	Permanent	High	Low	Yes	High	Low	**Low**
With mitigation	Positive	Regional	Medium	Permanent	High	Low	Yes	High	Medium	**Medium**

9.17 Noise impacts

Described in simplest terms a nuclear power station consists of a source of heat provided by nuclear reaction to generate steam that causes the rotation of a steam turbine. The shaft of the steam turbine is coupled to an electrical generator that generates electrical power. Noise that might have a potential environmental impact is produced by the turbines, electrical generators and associated machinery/equipment. No audible noise emanates from the nuclear reactor itself.

The layout of the infrastructure of the nuclear power plant will have a significant influence on the propagation of sound emanating from the primary noise sources of the plant to the surrounding land areas. The dimensions of many of the buildings will be large, rendering them as effective sound barriers on the one hand as well as effective sound reflectors, depending on their location with respect to the primary sources of noise.

To simulate noise that would be produced by the proposed Nuclear-1 facilities, noise measurements were taken from Koeberg. From these measurements, it is evident that the oil cooler fans are the main sources of noise of the entire nuclear power station. However, at a distance of about 375 m from these fans, and within direct line of sight, no noise is perceptible from the cooler fans above the sound of the surf.

Apart from the potential operational impacts, noise will be caused by the construction of new roads and by transport of materials and people to the construction sites.

9.17.1 Duynefontein

(a) Construction noise impacts

No new construction roads would be constructed outside the site and therefore no construction phase impact associated with road construction would occur around Duynefontein.

The impacts of site works, construction and demolition are indicated in **Table 9-41**. This indicates that the noise impact of construction would have a very low insignificance at Duynefontein.

(b) Operational noise impacts

The most stringent outdoor noise rating level, according to SANS 10103, would be 45 dBA during daytime and 35 dBA during night-time in a rural residential district. Over unobstructed land the 45 dBA $L_{Aeq,T}$ contour is located approximately 400 m from the oil cooler fans, whereas the 35 dBA $L_{Aeq,T}$ noise contours occurs at approximately 750 m from a noise source. At both ranges noise from the source would be inaudible above the sound of the surf. These distances are well within the 2000 m distant boundary of the Duynefontein site with the R27 (the closest public road).

(c) Transporting of materials to site

With the addition of Eskom traffic the noise impact would remain the same as the current situation. The relative impact due to Eskom construction traffic throughout the first 8 years of the construction period would be low, reducing to negligible thereafter.

(d) Cumulative impacts

With regard to the potential cumulative effect of noise emanating from Nuclear-1 and from Koeberg, the separation distance between the two infrastructure sites would be such that the combined noise may, at most, increase the noise level midway along a line joining the noise sources between the two sites from 30 dBA to 35 dBA. Noise from the Koeberg plant would not influence the levels of noise northwest of Nuclear-1, nor would that from Nuclear-1 influence the levels of noise southeast of the Koeberg plant There would be no difference in noise levels at perpendicular distances, namely, in northeast and southwest directions.

9.17.2 Bantamsklip

(a) Construction noise impacts

The nearest noise sensitive land to the Bantamsklip site is a farm situated more than 2 000 m from the R43 and thus the distance to the nearest source of noise during construction of roads on site. No noise impact due to internal road construction is anticipated at Bantamsklip.

The potential impacts of site works, construction and demolition are indicated in **Table 9-42**. This indicates that the noise impact of construction would have a very low significance at Bantamsklip.

(b) Operational noise impacts

The most stringent outdoor noise rating level, according to SANS 10103, would be 45 dBA during daytime and 35 dBA during night-time in a rural residential district. The 45 dBA $L_{Aeq,T}$ contour is located approximately 220 m from each noise. This distance is shorter than at Duynefontein due to greater noise screening provided by the rugged coastline. The 35 dBA $L_{Aeq,T}$ noise contours occur at approximately 700 m from a noise source. At both ranges noise from the source would be inaudible above the surf noise.

The flatter inland terrain provides a similar unobstructed propagation path as the Duynefontein site and noise from the fans would reduce to 45 dBA at approximately the same distance as at Duynefontein, namely 400 m from the fans. It would further reduce to 35 dBA at an approximate distance of 750 m from a noise source. Both distances are well within the shortest distance to the property boundary of 1125 m.

(c) Transporting of materials to site

Existing hourly traffic flow on the R43 past Pearly Beach and the Bantamsklip site is low, with an average daytime flow of the order of 23 vehicles per hour. The distance between the R43 and the nearest Pearly Beach residence is more than 1100 m. The nearest distance to farm residences situated northeast of Pearly Beach is 580 m. In terms of SANS 10103 a "Rural" district would apply to these residences with a typical outdoor $L_{Req,d}$ of 45 dBA.

The calculated $L_{Req,d}$ due to existing, non-Eskom traffic is well below the typical outdoor $L_{Req,d}$ of 45 dBA for a "rural district" and is expected to remain so over the subsequent 9 years. Refer to row 1 of Table 17. The noise impact due to non-Eskom traffic would remain very low. With the addition of Eskom traffic the noise impact would be medium up to the peak construction period. It would reduce to low in the period following peak construction, where after it would become very low.

Because of the low volume of non-Eskom traffic flow, the <u>relative</u> impact due to Eskom construction traffic throughout the first 7 years of the construction period would be high reducing to medium in eighth and ninth year. It is anticipated that the high relative noise impact would elicit a strong response from the farm residents. The predicted $L_{Req,d}$ during all years of construction would comply with the NCR 65 dBA limit. No noise mitigation would be required in terms of the NCR.

(d) Cumulative impacts

The results indicate that there would be no potential impact of noise during daytime or night-time on land beyond the Bantamsklip property boundary during operation of Nuclear-1. Thus, whether or not Nuclear 1 was to be located at the Bantamsklip site, would not have any effect on the impact of noise beyond the Bantamsklip property boundary.

9.17.3 Thyspunt

(a) Construction noise impacts

For Thyspunt the nearest noise sensitive land to the proposed eastern access road off the R330 would be an informal settlement near Sea Vista, approximately 3 km from the noise source. No noise impact due to the construction of the eastern access road is anticipated.

Construction of northern and western access roads to the Thyspunt site is proposed initially to be used to transport construction equipment to the site and thereafter for light vehicle access. The northern route would be more than 1 000 m from farm residences along its route. No noise impact is anticipated during the construction of the northern route.

The western route would pass within 230 m of the Umzamowethu township. For continuous operation during 8 hours the $L_{Req,d}$ would be between 56 dBA and 53 dBA at the township boundary. The estimated maximum noise impact on the township for the duration of the construction of the road in the vicinity of the township would be medium. The Oyster Bay residential suburb would be screened from the western route by sand dunes and therefore no noise impact is anticipated during the construction of the western route at Oyster Bay.

The potential impacts of site works, construction and demolition are indicated in **Table 9-40.** This indicates that the noise impact of construction would have a very low significance at Thyspunt.

(b) Operational noise impacts

The most stringent outdoor noise rating level, according to SANS 10103, would be 45 dBA during daytime and 35 dBA during night-time in a rural residential district. The 45 dBA $L_{Aeq,T}$ contour would occur approximately 400 m from each noise source (oil cooler fans) with the 35 dBA $L_{Aeq,T}$ noise contours occurring at approximately 750 m from the noise source. The nearest eastern property boundary along Thyspunt Beach would be 700 m from the infrastructure site. With reference to Section 3.1.3, the noise emanating from Nuclear 1 would not be audible above surf noise at this distance. The nearest residential land would be Oyster Bay situated 4.2 km from the site. No noise from Nuclear 1 would be audible at that distance.

An additional source of noise at Thyspunt will be a proposed Open Cycle Gas Turbine (OCGT) Plant which in the case of the Thyspunt site will be located at the HV yard away from the plant area. Considering a worst-case scenario of all four 150 MW OCGT units operating continuously for 24 hours it was predicted that the LAeq,T would reduce to 45 dBA and 35 dBA at distances of 2 000 m and 5 000 m, respectively. For shorter operating periods the respective distances would be less. The OCGT will however only be operated in emergency situations - once or twice a year at most.

It is estimated that the $L_{Aeq,T}$ at the nearest farm residence, situated immediately east of the proposed HV yard, would be in excess of 55 dBA for 24-hour operation of the OCGT plant. The associated intensity of noise impact would be high.

The $L_{Aeq,T}$ at the residences of two farms situated approximately 1000 m west and northeast of the OCGT units would be approximately 35 dBA for 24-hour operation of the OCGT plant. The associated intensity of noise impact would be low at both farm residences.

(c) Transporting of materials to site

An estimate of the traffic to the Thyspunt site during a nine year construction period was made available by Eskom. It was construed that this traffic to the Thyspunt site would be via the R330 and the eastern site access. The R330 south of Humansdorp passes through mainly undeveloped land, excepting for a few residences on the south bank of Kromrivier, of which the nearest is located some 20 m from the R330 and a large informal settlement west of Sea Vista that extends to 10 m from the road edge. Other than a residence at 40 m, all other residences are located 70 m or more from the road edge.

The results of the calculations indicated that the existing, non-Eskom traffic causes and will continue to cause a medium potential noise impact with reference to an “urban district” during the following nine years. However, the existing and future $L_{Req,d}$ would comply with the 65 dBA limit. With the addition of Eskom traffic the cumulative noise impact would be high throughout the construction period. The combined road traffic would cause the noise level to exceed the 65 dBA limit contained in the NCR, necessitating noise mitigation procedures to be implemented. However, the situation has arisen due to the uncontrolled use of land typical of informal settlements. It may well be debated whether the onus for compliance with the NCR would rest with Eskom.

(d) Cumulative impacts

The results indicate that there would be no potential impact of noise during daytime or night-time on land beyond the Thyspunt property boundary during operation of Nuclear-1. Thus, whether or not Nuclear-1 was to be located at the Thyspunt site, would not have any effect on the impact of noise beyond the Thyspunt property boundary.

Operation of the proposed OCGT peaking power plant would probably have a cumulative noise impact of high intensity on occupants of a farm situated immediately to the east of the proposed HV yard. In the absence of the OCGT plant there would be no potential cumulative impact at this farm. However this OCGT is not predicted to operate regularly as it is part of the back up electricity supply required by the Nuclear Safety Regulations. The OCGT may undergo sporadic test start up, which will be for a very limited period of time.

The cumulative intensity of potential noise impact on occupants of farm residences situated 1000 m or more from the proposed OCGT plant would range between negligible and low.

9.17.4 Mitigation

The results of the noise study indicate that there would be no potential noise impact on land surrounding any of the three sites during construction and operation of Nuclear-1. No noise mitigation procedures would therefore be required.

It is probable that the OCGT peaking power plant proposed for the sites would at Thyspunt result in a noise impact on residences situated up to 1 000 m from the plant. It is recommended that this be confirmed once quantitative noise emission data of the actual plant to be installed is available. Should this be confirmed, it is recommended to locate the plant at a distance 1 000 m or more inside the property boundary, or such distance as determined by the detailed study.

Where road construction is to take place within approximately 500 m of residences, the intensity of noise impact can be reduced by selecting construction vehicles/machinery with low noise emission levels. The significance of the potential impact can be reduced by minimizing the total construction time.

9.17.5 Conclusion

The vast majority of the potential noise impacts are of low or very low significance. There would be no potential noise impact on land surrounding any of the three sites during construction and operation of Nuclear-1. No noise mitigation measures would therefore be required.

It is probable that the OCGT peaking power plant proposed for Thyspunt would result in a noise impact on residences situated within 1 000 m of the plant. It is recommended that this be confirmed by a noise prediction study once quantitative noise emission data of the actual plant to be installed is available. Any required noise mitigation procedures would flow from the results of that study.

No noise impact associated with the construction of new roads to the alternative sites is anticipated, excepting the western access road to the Thyspunt site that would pass within 230 m of the Umzamowethu township.

Table 9-41: Significance rating for noise impacts at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Noise impacts of oil cooler fans										
Without mitigation	Neutral	Local	Low	Long-term	Improbable	High	No	High	Low	**Very low**
Noise impacts of road construction										
Without mitigation	Neutral	Local	Low	Short-term	Improbable	High	No	High	Low	**Very low**
Noise impacts of site works and construction										
Without mitigation	Neutral	Local	Low	Short-term	Improbable	High	No	High	Low	**Very low**
Impact of transportation noise										
Without mitigation	Negative	Local	Low	Short-term	Probable	High	No	High	Low	**Low**

Table 9-42: Significance rating for noise impacts at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Noise impacts of oil cooler fans										
Without mitigation	Neutral	Local	Low	Long-term	Improbable	High	No	High	Low	**Very low**
Noise impacts of road construction										
Without mitigation	Neutral	Local	Low	Short-term	Improbable	High	No	High	Low	**Very low**
Noise impacts of site works and construction										
Without mitigation	Neutral	Local	Low	Short-term	Improbable	High	No	High	Low	**Very low**
Impact of transportation noise										
Without mitigation	Negative	Local	Low	Short-term	Probable	High	No	High	Low	**Low**

Table 9-43: Significance rating for noise impacts at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Noise impacts of oil cooler fans										
Without mitigation	Neutral	Local	Low	Long-term	Improbable	High	No	High	Low	**Very low**
With mitigation: No mitigation necessary										
Noise impacts of OCGT plant on adjacent farm										
Without mitigation	Negative	Local	High	Long-term	High	High	No	Low	High	**High**
Noise impacts of OCGT plant on farms at 1000 m										
Without mitigation	Negative	Local	Low	Long-term	Possible	High	No	Low	Low	**Low**
Noise impacts of OCGT plant on residences beyond 1000 m										
Without mitigation	Neutral	Local	Low	Long-term	Improbable	High	No	Medium	Low	**Very low**
Noise impacts of road construction										
Without mitigation	Negative	Local	Low	Short-term	Probable	High	No	High	Low	**Low**
Noise impacts of site works and construction										
Without mitigation	Neutral	Local	Low	Short-term	Improbable	High	No	High	Low	**Very low**
Impact of transportation noise										
On a residence 10m from the R 330	Negative	Local	Low	Short-term	Probable	High	No	High	Low	**Low**
On a residence 70m from the R 330	Negative	Local	Low	Short-term	Probable	High	No	High	Low	**Low**

9.18 Impacts on tourism

The following section describes the economic ramifications of the various identified potential impacts on the tourism industry at each site. The assessment is summarised in **Tables 9-43 to 9-45** below.

9.18.1 Duynefontein

The tourism industry around the Duynefontein site shows a dynamic and growing sector with most of this growth occurring since the opening of Koeberg in 1976. In other words, the tourism sector in the Koeberg-Duynefontein area has grown and has attracted a number of up-market developments such as golf estates, despite the presence of Koeberg.

The tourism industry in the area also did not express any particular concerns regarding the construction of a second nuclear power station or of the proposed Pebble Bed Modular Reactor (PBMR). This is indicative of the dynamic and adaptive nature of the tourism industry. The longer a community or tourism product is allowed to acclimatise to the proximity and function of a nuclear power station, the more integrated the tourism industry becomes with it.

As the greater Cape Town area is a large tourism base to start with, the positive impact of the influx of business tourists and the required extended stays of specialists, engineers and consultants during construction and operation of Nuclear-1 is relatively small as indicated in the hospitality systems row. This influx, along with significant presence of the extensive on-site labour force, will also initially change the social amenity of the area. Site works and traffic during construction, and the associated inaccessibility relating to safety and security, will result in a reduced terrestrial asset. However, as there are no viable commercial or tourism-orientated marine activities off the proposed site, there is no loss in marine asset. It is expected that, during normal operation, the social amenity of the area will return to the pre-construction equilibrium as the community adapts and acclimatises to a second nuclear power station. This has been demonstrated before through the Koeberg experience. Moreover, with the opening of further nature reserve areas to tourists, the terrestrial asset loss from the construction phase will also be mitigated.

It is unfortunate that data on the potential impact of construction at Koeberg on the local tourism industry, and especially on the effect of the influx of white-collar workers on bed-nights, were not recorded at the time. It is logical to assume that the effect must have been substantial, and also that business visitors from out of town during the operational period must have contributed to the increased sale of bed-nights in the area. This was certainly the impression gained during field interviews. It must again be stressed that the growth of Melkbosstrand and environs (including Atlantic Beach Golf Estate and other upmarket housing and leisure developments) has occurred subsequent to the construction of Koeberg.

Seasonality is of some concern as during peak periods of tourism activity in the greater Cape Town area (Christmas and New Year) and the West Coast (school holidays and the spring flower period), there is heavy congestion on major routes across the area. This is compounded by the fact that public transport in Cape Town and the province as a whole is minimal, thus forcing commercial travelers and tourists to hire vehicles.

Furthermore, as the Duynefontein area falls within the northern access and growth corridor of Cape Town, and forms part of the primary transport route to the West Coast (which is the third most popular region for domestic tourists after the Cape Peninsula and the Garden Route), congestion and road access need to be considered, particularly during nuclear power station construction.

A Nuclear-1 facility, together with the proposed PBMR and training centre, on the Duynefontein site is likely to have a negligible impact on tourism as the sensitivity levels of residents and visitors are tempered by the presence of the existing Koeberg nuclear power station which has not deterred the growth of upmarket residential areas and leisure resorts to the south and north of the site. The Visual Impact Assessment supports this by documenting a low impact of change in the sense of place as Koeberg has already changed the desolation and remoteness of the location. The majority of impacts will be absorbed into the Greater Cape Town tourism sector. However, as alluded to earlier in this sub-section, business tourism (in the form of visits by engineers, technicians and other specialists) in Duynefontein will increase during construction and, to a lesser extent, during operation. The enlarged exclusion zone will affect the amount of available land and the accessible sea area, but only to a small degree, and the enlarged reserve area will promote the environmental preservation ideals of the Integrated Development Plan and the Integrated Tourism Development Framework.

Of all the sites, though, the conceivable impact of the sea-level rise scenario and storm frequency will be most severely experienced at Duynefontein. The postulated effects are most prevalent at this site mainly due to its topographical character. A shallow seabed gradient and low coastal contour make the proposed nuclear power station platform site the most exposed in terms of potential sea-level rise. Consequently, not only would the proposed nuclear power station platform require considerable protective construction measures, but the severity of associated storm damage, flooding and land, property and tourism asset loss would be likely to be exacerbated more than at the other sites. Affected areas would include Blaauwbergstrand, Melkbosstrand, Milnerton, Sunset Beach and Table View. The impact of a nuclear power station on tourism in the sea-level rise scenario then becomes almost a moot discussion. However, it is conceivable that the impact would be even further reduced than at all the other sites as the extent of damage and loss to the local terrestrial tourism asset and the value thereof within the Greater Northern Cape Town tourism region would be of such magnitude that all reconstruction and tourism development efforts would incorporate the pre-existence of a nuclear power station, as has occurred already, for example, in Melkbosstrand in relation to Koeberg.

9.18.2 Bantamsklip

The community in the Bantamsklip area expressed concern with regard to adverse visual impacts of the nuclear power station and transmission lines. A nuclear power station at Bantamsklip would be visible from Pearly Beach and Dyer Island but not from Gansbaai. Concerns with regard to a perceived negative social impact of migrant construction workers were also mentioned. An additional concern was raised relating to the impact of heavy-vehicle traffic during the construction period on local roads. These roads are not built for such traffic, and it was felt that there would be a need for strict control both over the routes to be used and over noise pollution from heavy vehicles which could be a factor in Gansbaai with potential negative impacts on tourism.

The national, provincial and local tourism policy issues mentioned in Section 4.1 of the Tourism Impact Assessment apply here to the greater region in which Bantamsklip is situated. Of specific relevance to this site, the Integrated Development Plan for the local municipality, states that the district, with its largely rural character and high dependence on agriculture and tourism, is hugely reliant on the natural environment for its existence. Tourism is further emphasised as a priority building block for economic development in the area. In terms of the study area, the smaller holiday towns in the vicinity of Gansbaai are regarded by the IDP as having little or no potential for development outside of housing and recreation.

Due to the small-scale base of the industry, the relatively undeveloped infrastructure and the basic nature of tourism services, along with the current heavy reliance on shark and whale tourism, the Bantamsklip tourism economy is expected to experience a large expansion in facilities, from increases in restaurants to increases in the number of private houses being let out, as a result of the construction and operation of a nuclear power station. The immediate increase is expected to continue as the community services the influx of nuclear power station staff and their associated needs and spending. This also mitigates local concerns about seasonality: the local tourism service industry is dependent on holiday peaks around Christmas and Easter for its financial survival, but a higher local permanent population and influx of personnel from a nuclear power station could stabilise the industry. However, the influx of labour during construction and staff during operation will change the current social amenity of the area.

Road infrastructure is specifically identified by the Integrated Tourism Development Framework as an important element in realising the tourism potential of the Bantamsklip area. Most notably, to the west of Pearly Beach and Gansbaai, the traveller encounters gravel roads of varying quality. These roads are the “missing links” in tourism flows from the Cape

Metropole to Cape Agulhas, and act as a barrier to the development of tourism in the region and a deterrent to the average tourist. As a result of a nuclear power station, there will be considerable improvement of general road access in the area and an acceleration of the broader opening of the Agulhas and Bredasdorp corridors, further encouraging access and improving local tourism traffic.

However, as a result of the required exclusion zone that surrounds a nuclear power station, there will be a loss in the marine assets along the owner-controlled boundary. Of the three proposed alternative Nuclear-1 sites, Bantamsklip has the most locally significant marine tourism asset offshore of the site, and access to the whale-watching area will be reduced, especially during construction. Information from Eskom is that the exclusion zone will extend for 1 km along the shore and 1km out to sea. The shark-cage diving and whale-watching tourism industries in the Bantamsklip area are of such dominance and importance to local tourism and the local economy that they are worthy of specific attention.

The significance of 'Shark Alley', the open stretch of water between the mainland and Dyer Island off Gansbaai, is indicated by the fact that it is popularly referred to as the White Shark Diving capital of the world. There are currently two licensed whale-watching and eight licensed white shark cage-diving operators conducting tours within the sphere of direct nuclear power station influence. Shark-cage diving occurs mainly around Dyer Island while 80 % of whale-watching trips are undertaken to the west of the trawler wreck in the Bantamsklip exclusion zone. Thus, the impact will principally be on whale-watching but, as the marine exclusion zone is expected to be only 1km in extent, this will be not directly affect more than 10 % of current activities which would then have to move to the larger area. An even lesser potential impact is possible if Eskom is successful in applying (as it has indicated to the authors that it intends doing) for permission to allow access for whale-watching trips.

A concern for local holiday and residential communities (e.g., Pearly Beach) around Bantamsklip is that of the potential visual impact. The Visual Impact Assessment states that there will be a high level of visual intrusion and potential impact. The proposed Bantamsklip platform is a dominant feature on mostly flat landscape. The result is high visual intrusion in terms of visual contrast and direct line of sight for areas both east and west of the site. The high potential visual impact on high-quality scenic views emphasises the effect on the sense of place with the landscape setting being irrevocably changed. There is also a high level of light pollution because of the absence of other conspicuous light sources.

This could affect the immediately foreseeable demand for property and the decision to visit the area. Directly affected communities such as Pearly Beach consist predominantly of holiday-house owners, some of whom could perceive the effects of the nuclear station on their sense of place to be so adverse that they would in all likelihood attempt to sell their properties. However, they are likely to be replaced by new owners (including staff of Nuclear-1) who would be buying into the affected sense of place and environment, thereby adjusting the sense-of-place impact over the operational phase of the nuclear power station.

The Bantamsklip area is likely to experience an immediate and perceptible boost in tourism infrastructure and an increase in both the local resident population and business visitors. The resultant increase in bed-nights sold would have a stimulating effect on what is at present a relatively small albeit growing tourism market. In the long-term the wider effects of Nuclear-1 should also be positive. Although whale-watching might be restricted (unless permits are granted) in the zone adjoining the Nuclear-1 site, this appears to be mitigable by being moved to the larger area of the bay. Moreover, in that the natural resources and nature attractions of the site are currently inaccessible to tourists, the opening of the reserve areas that surround the proposed nuclear power station would result in an increased terrestrial asset to leverage wider tourism for the area as a whole. This would be important in the light of eco-tourism being identified in the local municipality’s IDP as one of the main economic and social development strategies for the future of the area.

In terms of the sea-level rise scenario potential impacts on the local Bantamsklip area, induced by climate change, there are a number of considerations for tourism. First, as in the case of the Thyspunt site, the sea-level rise scenario at Bantamsklip would cause considerable loss of property and coastal land along with infrastructure damage e.g., roads, utilities, etc. However, the topographical nature of the Bantamsklip coastline, with elevated rock contour at the location of the terrestrial tourism developments such as the residential areas and holiday villages (De Kelders, Gansbaai, Kleinbaai, Franskraal, Pearly Beach, Buffeljagsbaai and Die Dam) suggests a lesser impact than that postulated for the Thyspunt tourism industry. This is also supported by the fact that the Bantamsklip area has a less developed general tourism infrastructure, mitigating the extent and cost of comparative plausible damage.

Secondly, according to the Marine Biology Specialist study, the identified sea-level change possibilities and storm frequencies will not affect local marine wildlife, specifically whales and sharks. However, marine-based tourism is weather dependent as tourist charter boats and other recreational watercraft cannot safely operate in storm conditions, and this could affect these activities. So as far as Nuclear-1 is concerned, as with Thyspunt, the identified platform at Bantamsklip is outside a 2.5 m sea-level rise scenario. Thus, these two considerations outlined above are independent of whether there is a nuclear power station or not: Nuclear-1 would not affect climate change and climate change would not influence the impact of Nuclear-1 on tourism.

9.18.3 Thyspunt

Although the Economic Impact Specialist Report (**Appendix E17**) states that the business sector (including organised agriculture) is in favour of the construction of Nuclear-1 at Thyspunt, there is an active and organised lobby of residents who are strongly opposed to the idea. This group believes that the area's sense of place will be invaded and that lifestyles and tourism will be affected by the visual impact of the nuclear power station and the transmission lines which will need to be built. There is a wider concern within the community as a whole (including the business sector) about the possible negative social effects arising from the influx of relatively unskilled workers during the construction phase. The point was made that, in the recent past, the construction of the harbour at Port St. Francis was supposed have been undertaken by local labour but it was in fact undertaken by migrants from the Ciskei and Transkei who remained in the area afterwards, leading to a growth of informal housing, which has detracted from the up-market and affluent nature of the rest of the area.

With regard to tourism policies relevant to Thyspunt, the Eastern Cape Tourism Board (ECTB) has the stated priority of protecting and upgrading the diverse natural environment that serves as a core tourism attraction in the province. The primary identified method of achieving this priority is to expand the area with long-term conservation status. This would entail not only expanding the area under control of nature conservation bodies but also encouraging the expansion of conservation areas under private management. The ECTB further recognises that the need for land with conservation status should be balanced with the need for other land uses.

The associated nature reserve and marine exclusion zones of a nuclear power station could arguably fulfill the conservation priorities and strategies of the ECTB, However, according to the Visual Impact Assessment, the remote sense of place of the Thyspunt site, the high impact on the sense of place and high visual intrusion do undermine the positive impacts on potential tourism development (although in terms of light pollution at night, a nuclear power station would have a lower impact than the lights of the chokka boats). Nonetheless, the positive impact of environmental exclusion zones is lessened at the Thyspunt site as the area has been protected from all forms of utilisation for over a decade (Marine Environmental Specialist Report).

In terms of climate change considerations, the greater Thyspunt tourism product has already experienced storm damage in the form of beach erosion and extensive flooding, most significantly in St. Francis. However, the proposed nuclear power station construction site is located beyond the parameters of a 2.5 m sea-level rise scenario and will not be affected. But, if the wider coastal tourism asset of Thyspunt (including Oyster Bay, St Francis Bay, Cape St Francis and Port St Francis) is considered, the rise in sea-level could conceivably result in severe damage to the tourism attractions, facilities and general infrastructure, thereby resulting in extensive property, land and natural environment loss. The tourism asset and product of the area would then have to undergo massive reconstruction and rebranding which could incorporate the existence and operation of a nuclear power station, as is exemplified by current tourism initiatives surrounding Koeberg. The existence of a nuclear power station, though, would not affect climate change or its impact on tourism.

From a tourist perspective, the discerning visitor might choose not to visit the Thyspunt area and the eastern section of the Garden Route as a result of the construction and operation of a nuclear power station, as reflected through the loss in sense of place. However, any associated short-term reduction in the number of leisure tourists would be expected to be offset by the associated growth in the local population brought by Nuclear-1 that would increase the local demand for tourism-related services such as restaurants and accommodation. There would also be increased business tourism with specialists and consultants being brought in, especially during the construction phase, although an influx of construction labour and nuclear power station staff would alter the current social amenity of the area. Bed-nights sold to business visitors would help to offset the loss of traditional leisure tourists. However, the desertion of the area by leisure tourists is not likely to extend into the operational period of Nuclear-1 once its benign nature is realised. Road access would improve, particularly to Oyster Bay, and although a portion of natural assets would be lost to the station, overall access would be improved to more remote areas associated with the nuclear power station property.

The seasonal nature of tourism in the area could lead to congestion, crowding and limited access, particularly during the construction phase of a nuclear power station as tourists would be competing with construction staff and vehicles for local services and facilities. Eskom has advised the authors that construction would continue throughout this peak tourism period. However, these effects could be mitigated if construction is halted for the customary labour holiday period from 16 December until early January. Ultimately, the current marketed tourism brand and image of the area will change in nature, and an associated loss of sense of place will be experienced.

9.18.4 Mitigation

The main mitigation measure is a community-orientated and comprehensive public relations campaign to address popular misconceptions, specifically the impacts of nuclear power generation on the marine and immediate environment. An expressed and comprehensive integration of the relevant tourism agencies and organisations into Eskom’s nuclear intentions and activities at each site, will facilitate a timely adaptation of the destination marketing and tourism branding initiatives, thereby expediting the acclimatisation of each site’s tourism products and destination image toward the potential new nuclear environment; as emphasised by the commercial buy-in and stakeholder support experienced for Koeberg.

9.18.5 Conclusion

The Thyspunt and Bantamsklip communities have expressed the most adamant opposition to the proposed nuclear power station. The Thyspunt community has expressly highlighted the premium nature of the top-end coastal vacation destination, and the Bantamsklip community has emphasised the new and fragile nature of the developing tourism product and the local dependence thereon. While some Duynefontein tourism stakeholders have personal objections to the construction and operation of another nuclear power station, they recognise the potential for increased business and promote a generally positive outlook for tourism.

A weighted matrix of potential tourism impacts was set up and annual values of the indicative impacts on tourism were calculated using the bed-night figures. A summary is depicted in **Table 9-43**.

Table 9-44: Indicative tourism impacts in terms of bed nights[7]

Site	Current Tourism Value (Rands)	Construction Phase (yrs 1-6)		Operational Phase (yrs 7-20[8])	
		Annual Impact (Rands)	Impact (%)	Annual Impact (Rands)	Impact (%)
Duynefontein	497,827,951	0	0.00%	7,111,828	1.43%
Bantamsklip	62,247,100	3,112,355	5.00%	5,335,466	8.57%
Thyspunt	77,745,000	-6,108,536	-7.86%	0	0.00%

As can be seen from this table, it is predicted that there would be very little potential impact at Duynefontein during construction, Bantamsklip is predicted to experience a 5 % positive impact during construction and Thyspunt is predicted to experience a 7.86 % negative impact on tourism.

During operation, Duynefontein is predicted to experience a 1.43 % improvement in tourism, Bantamsklip is predicted to experience an 8.57 % improvement and Thyspunt is predicted to experience zero potential impact.

[7] These figures indicate the potential net effect, taking into account a potential decrease in nature-based tourism as well as an expected increase in business tourism.

[8] Although the operational life of the proposed power station is 60 years, the tourism impact assessment has predicted up to a 20 year margin. This is because prediction of predicting tourism trends and impacts in the decommissioning phase 60 plus years into the future is not feasible. Prediction more than 60 years into the future could result in misleading or inaccurate information.

Table 9-45: Summary of Tourism Impacts for the Duynefontein site

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Hospitality Systems										
Without mitigation	Positive	Local	Low	Permanent	High	High	No	High	Low	**Low**
With mitigation	Positive	Local	Low	Permanent	High	High	No	Medium	Low	**Low**
General Infrastructure										
Without mitigation	Neutral	Local	Low	Permanent	High	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Low	Permanent	High	High	No	Medium	Low	**Low**
Visual Amenity										
Without mitigation	Neutral	Local	Low	Permanent	High	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Low	Permanent	High	High	No	High	Low	**Low**
Sense of Place										
Without mitigation	Neutral	Local	Low	Permanent	High	High	No	High	Low	**Low**
With mitigation	Neutral	Local	Low	Permanent	High	High	No	High	Low	**Low**
Marine Assets										
Without mitigation	Negative	Local	Low	Permanent	High	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Permanent	High	High	No	High	Low	**Low**
Social Amenity										
Without mitigation	Negative	Local	Low	Permanent	High	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Permanent	High	High	No	High	Low	**Low**
Terrestrial Assets										
Without mitigation	Negative	Local	Low	Permanent	High	High	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Permanent	High	High	No	High	Low	**Low**

Table 9-46: Summary of Tourism Impacts for the Bantamsklip site

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Hospitality Systems										
Without mitigation	Positive	Local	High	Long	Highly Probable	Low	No	Medium	High	**High**
With mitigation	Positive	Local	High	Long	Highly Probable	Low	No	Medium	High	**High**
General Infrastructure										
Without mitigation	Positive	Local	Low	Long	Highly Probable	Low	No	Medium	Low	**Low**
With mitigation	Positive	Local	Low	Long	Highly Probable	Low	No	Medium	Low	**Low**
Visual Amenity										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
Sense of Place										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Long	Definite	Low	Yes	High	Medium	**High**
Marine Assets										
Without mitigation	Negative	Local	Medium	Permanent	Probable	Low	Yes	High	High	**Medium**
With mitigation	Negative	Local	Medium	Long	Probable	Low	Yes	High	Medium	**Medium**
Social Amenity										
Without mitigation	Negative	Local	High	Long	Probable	Medium	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Medium	Probable	Medium	Yes	High	Medium	**Medium**
Terrestrial Assets										
Without mitigation	Negative	Local	Low	Long	Probable	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Medium	Probable	Medium	No	High	Low	**Low**

Table 9-47: Summary of Tourism Impacts for the Thyspunt site

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Hospitality Systems										
Without mitigation	Neutral	Local	Low	Medium	Probable	Low	No	Medium	Low	**Low**
With mitigation	Neutral	Local	Low	Medium	Probable	Low	No	Medium	Low	**Low**
General Infrastructure										
Without mitigation	Neutral	Local	Low	Medium	Probable	Low	No	Medium	Low	**Low**
With mitigation	Neutral	Local	Low	Medium	Probable	Low	No	Medium	Low	**Low**
Visual Amenity										
Without mitigation	Negative	Local	Medium	Permanent	Definite	Low	Yes	High	Medium	**High**
With mitigation	Negative	Local	Medium	Permanent	Definite	Low	Yes	High	Medium	**High**
Sense of Place										
Without mitigation	Negative	Local	High	Permanent	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Medium	Long	Definite	Low	Yes	High	High	**High**
Marine Assets										
Without mitigation	Negative	Local	Low	Long	Definite	Low	Yes	High	High	**High**
With mitigation	Negative	Local	Low	Medium	Definite	Low	Yes	High	High	**High**
Social Amenity										
Without mitigation	Negative	Local	Medium	Long	Probable	Low	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium	Probable	Medium	No	High	Low	**Low**
Terrestrial Assets										
Without mitigation	Negative	Local	Low	Long	Probable	Medium	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Medium	Probable	Medium	No	High	Low	**Low**

9.19 Impacts on agriculture

There is existing agricultural production around all three sites. The types of agricultural production differ markedly, with the area around Duynefontein being characterised by mixed farming, although wheat and grape farming dominate. Milk farming dominates around Thyspunt and fynbos flower farming predominates around Bantamsklip. The latter is also characterised by some dairy farming, beef, sheep and game farming.

The impacts of a nuclear power station on farming activities at all three alternative sites can take several forms, as follows:

- Road congestion (negative);
- Dust deposition on crops (negative);
- Impacts on the job market (negative);
- Stimulation of the agricultural economy (positive); and
- Impacts of crop and livestock production in the event of a nuclear accident (negative).

(a) Road congestion

Construction of the nuclear power station may result is some congestion on local roads due to the large amount of building materials that will be brought into the site. This increased traffic is likely to have some impact on the local farmers because they transport produce to market on a daily basis. The impact on transport systems is assessed in Section 9.24 of this report and will not be discussed here.

(b) Dust deposition

Dust deposition on crops during construction, both in close proximity to the construction site the site and along dirt access roads. It is expected that, as a result of the large amount of transport involved in construction, there will be a certain amount of dust generated over an extended period. Dust in the air or deposited on plant foliage will reduce photosynthesis in the plants. Reduced photosynthesis will mean less energy for growth and lower crop yields.

The amount of dust will depend to a great degree on the surface of the roads[9]. If access roads are mainly dirt roads, a considerable amount of dust will be generated, which is not desirable in a farming operation. This is especially so where fresh produce like milk and vegetables are produced around the Thyspunt and Bantamsklip sites, but also around the Koeberg site where grapes are an important fresh product.

(c) Impacts on the job market

Impacts on the agricultural job market may occur through the influx of job seekers during the construction phase. Construction jobs generally pay higher wages than farm work, which results in demands for higher wages in farm communities and a move away from farm work to construction work and a shortage of labour in the agricultural sector. It must be noted that the Social Impact Assessment found that the personalities and lifestyle of farm workers very different to those of construction workers, to such an extent that competition is unlikely to occur on any significant scale. If this impact does occur, its duration would be of short-to medium-term as it would mainly be felt mainly during the construction phase of the development, and would only continue until labour from other areas moves into the affected areas to fill the vacuum left by labourers who move into construction.

[9] The air quality report recommends that construction roads must be tarred and that an air quality management plan must be implemented to mitigate dust emissions from roads.

(d) Stimulation of the agricultural economy

A nuclear power station will increase the market demand of local agricultural production in the area of the proposed sites, due to an influx of construction personnel, job seekers and operational personnel. This potential impact could be negated to some extent by the perceived consumer concern of produce grown in the proximity of a nuclear plant. During normal operation of the nuclear plant this perception has no scientific basis (**Table 9-46**) but could be a short-term impact until the consumer becomes more knowledgeable about the environmental impacts of a nuclear plant on agricultural production. It is important to note however that agricultural activity occurring in the proximity of Koeberg for many years has had no negative impacts on the environment.

Notwithstanding the above, an estimate has been made of the potential market increase for each site, given the potential to increase agricultural production in each area. This estimate is based on the potential of a region to increase its agricultural production as a result of increased demand within the region. If the region is not able to increase production then the increased production to meet the demand will come from another region.

(e) Impacts of crop and livestock production in the event of a nuclear accident

Radionuclides released from the nuclear power station may accumulate in crops and livestock, if emitted at high concentrations. The findings of the air quality assessment (reflected in **Section 9.13** of this report) found that the maximum predicted doses of µSv/ annum under normal operating conditions for the three sites and two different engineering designs for a nuclear power station will be as indicated in **Table 9-48**.

Table 9-48: Maximum Inhalation and External Effective Dose of radionuclides

Site	Effective Dose (µSv/annum)	
	EPR	AP1000
Duynefontein	4.07	2.56
Bantamsklip	4.60	2.19
Thyspunt	11.31	4.56

The annual effective dose limit for members of the public from all authorised actions is 1 000 µSv, with an additional provision of an annual dose constraint of 250 µSv. The highest predicted inhalation and external effective dose of 11.3 µSv is therefore about 4.5 % of the dose constraint and about 1 % of the annual effective dose limit. Accumulation of radionuclides during normal operation of the nuclear power station will therefore be negligible to non-existent. It is only in the event of a nuclear emergency that significant radionuclide accumulation would occur in livestock. Whilst this impact would have a high consequence in the event of an emergency, the probability of such an impact would be very low.

During the decommissioning phase, impacts on livestock and crops should be similarly low. Eskom has provided a decommissioning plan for the nuclear power station with Koeberg as the basis. The plan is based on the United States Nuclear Regulatory Commission (US NRC) “Decon” alternative.

Given this the exposure to radiation would therefore be kept to a minimum and below the required dose stipulated by the National Nuclear Regulator (NNR) through continued radiation measurement. Since these dose limits are based on safe exposure levels, it is expected that the radiation exposure during decommissioning would be low. Therefore decommissioning operation of the reactors should not affect livestock producers or their livestock or livestock produce in any substantial way.

Since this impact is predicted to be of no significance during construction, operation or decommissioning, it is not discussed further under the individual sites.

9.19.1 Duynefontein

(a) Dust deposition

The coastline at Koeberg lies north-west to south-east, and therefore dust from construction during summer will mainly affect beaches. The south-westerly winds are associated with rain which will settle the dust and therefore reduce dust depositions on farms inland of the coast.

(b) Impacts on the labour market

Labour-intensive farming activities such as grape harvesting (which occurs in the Duynefontein environment) may be negatively impacted during the construction phase when local labour costs, mainly for unskilled persons, will increase because of demand for labour. However, given the location of the site at the edge of a large urban area, it can be assumed that the impact on the agricultural labour market will be less serious than at the other two sites, due to the demands from other economic activities that have been active in this area for several decades. However, as apparent from the social impact assessment, this potential impact will be of low significance.

(c) Stimulation of the agricultural economy

It is estimated that there would be no stimulation of the agricultural sector around Duynefontein. The site is adjacent to an expanding urban area and any possible stimulation of agricultural production would probably be negated by urban expansion, which reduces the available agricultural land.

9.19.2 Bantamsklip

(a) Dust deposition

The risk of dust during construction will be highest at Bantamsklip, where farming mainly involves harvesting of flowers from fynbos grown under dryland conditions. Dust on leaves of perennial fynbos plants will result in some loss of photosynthetic activity and reduced flower yields, apart from the fact that dust-covered cut flowers will not be able to suitable to sell.

(b) Impacts on the labour market

Labour-intensive farming activities such as flower harvesting (which occurs in the Bantamsklip environment) may be negatively impacted during the construction phase when local labour costs, mainly for unskilled persons, will increase because of demand for labour. However, as apparent from the social impact assessment, this impact will be of low significance.

(c) Stimulation of the agricultural economy

The agricultural economy around Bantamsklip would not be significantly stimulated, since the main limiting factor for agricultural production in this region is the scarcity of irrigation water. In addition to this, the current agricultural production is heavily based on flower production, which is a form of production that will not necessarily be stimulated by a nuclear power station. The resultant predicted increase in agricultural production is estimated at less than 5 % (R29 million per annum).

9.19.3 Thyspunt

(a) Dust deposition

At Thyspunt the pastures of most farms used for dairy production are too far downwind of the proposed nuclear power station, and are therefore not likely to be impacted by dust. The farms Welgelegen, Penny Bee and Buffelsbosch may encounter some loss of fodder production due to dust. In summer the prevailing wind at Thyspunt (Cape St. Francis) is mainly off-shore, thus farms will be upwind from the construction dust generated at the coast.

(b) Impacts on the labour market

Potential impacts would be similar to Bantamsklip above and are therefore not repeated.

(c) Stimulation of the agricultural economy

It is estimated that the stimulation of the agricultural economy would be the greatest at Thyspunt. A 10 % to 15 % increase (with a value of R150 million per annum) is predicted around this site.

9.19.4 Mitigation

In order to minimise dust from construction the following measures should be implemented:

- Build the roads serving the nuclear power station as a first priority, and have these tarred or lined with concrete and implement an air quality management plan, as recommended by the air quality impact assessment; and
- Regular spraying of water on bare soil at site to reduce generation of dust.

In terms of negative market perspective of agricultural produce grown near a nuclear plant, an awareness programme showing the impacts of a nuclear plant on agricultural production needs to be implemented.

With regard to labour, an awareness campaign needs to be undertaken among existing farm labour highlighting the benefits of permanent work on farms as against the essentially short-term nature of construction work on a nuclear power station.

In the event of a nuclear emergency, appropriate mitigation measures need to be implemented to mitigate impacts on the food chain, as per Eskom's emergency response plan, as according to the Food and Agriculture Organisation and World Health Organisation's Codex Alimentarius.

9.19.5 Conclusions

Agriculture around Thyspunt is based substantially on milk production; fynbos prevails in the Bantamsklip area although there is some dairy as well as beef, sheep and game farming; while the Duynefontein area is based on mixed farming. It is estimated that the current annual value of farm production in 2008 was R150 million in the Thyspunt area, R29 million for Bantamsklip and R75 million for Duynefontein. The estimated changes in production as a result of the nuclear power station are reflected in **Table 9-49**. From this it can be seen that the greatest benefit would be at Thyspunt, followed by Bantamsklip and then Duynefontein (with zero increase in production).

Table 9-49: Estimated economic impact on the markets for agricultural produce

Site	Gross Value R (million)	Estimated impact
Bantamsklip	29	Increase by 0-5%
Duynefontein	75	No change
Thyspunt	150	Increase by 10-15%

The major impacts of a nuclear power station on agriculture would be the generation of dust during the construction phase, possible agricultural labour shortages and market effects. On the positive side, the presence of a nuclear power station will lead to an increased demand for agricultural goods, which will lead to a potential increase in agricultural production. This increase would be most significant at Thyspunt, less significant at Bantamsklip, but there would be a potential zero increase around Duynefontein.

From an agricultural production perspective Thyspunt is the preferred site as the area around this site would experience potentially the largest long-term benefit of increased agricultural production. Thyspunt is followed by Bantamsklip and then Duynefontein.

Table 9-50: Significance rating for agricultural impacts at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Dust Pollution										
Without mitigation	Negative	Local	Low	Shot term	High	High	No	High	Medium	**Medium**
With mitigation	Neutral	Local	Low	Short term	High	High	No	High	Low	**Medium**
Availability/Cost of Labour										
Without mitigation	Negative	Local	Low	Medium-term	Medium	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium-term	Medium	Medium	No	High	Low	**Low**
Change in Market Conditions										
Without mitigation	Positive	Local	Low	Medium-term	Medium	High	No	Medium	Low	**Low**
With mitigation	Positive	Local	Low	Medium-term	Medium	High	No	Medium	Low	**Low**

Table 9-51: Significance rating for agricultural impacts at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Dust Pollution										
Without mitigation	Negative	Local	Medium	Shot term	High	High	No	High	Medium	**Medium**
With mitigation	Neutral	Local	Low	Short term	High	High	No	High	Low	**Medium**
Availability/Cost of Labour										
Without mitigation	Negative	Local	Medium	Medium-term	Medium	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium-term	Medium	Medium	No	High	Low	**Low**
Change in Market Conditions										
Without mitigation	Positive	Local	Low	Medium-term	Medium	High	No	Medium	Low	**Medium**
With mitigation	Positive	Local	Low	Medium-term	Medium	High	No	Medium	Low	**Medium**

Table 9-52: Significance rating for agricultural impacts at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Dust Pollution										
Without mitigation	Negative	Local	Low	Shot term	High	High	No	High	Medium	**Medium**
With mitigation	Neutral	Local	Low	Short term	High	High	No	High	Low	**Medium**
Availability/Cost of Labour										
Without mitigation	Negative	Local	Low	Medium-term	Medium	Medium	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium-term	Medium	Medium	No	High	Low	**Low**
Change in Market Conditions										
Without mitigation	Positive	Local	Low	Medium-term	Medium	High	No	Medium	Low	**Medium**
With mitigation	Positive	Local	Low	Medium-term	Medium	High	No	Medium	Low	**Medium**

9.20 Economic impacts

The objective of the economic impact assessment was to analyse the economic cost-effectiveness of the three alternative sites from a broad community prospective. This includes the capital and operational costs of the service provider as well as the costs to the community, taking into account the positive and negative externalities on the economy and the environment. The study also considers the broader macroeconomic impacts of the three sites on their relevant provincial economies.

9.20.1 Cost-effectiveness comparison of the three sites

The detailed results, as obtained from the cost comparison model, for the three proposed nuclear sites are reflected in **Table 9-53**. In this table a negative value represents a relative benefit to a specific site.

Table 9-53: Comparison of Cost-effectiveness Values of three nuclear power station sites (2008 prices)

	Discount Rate: 8 %	Thyspunt	Bantamsklip	Duynefontein
	Cost Factors	Present Value[10] (Rand million)		
1	Land	5.92	3.38	0
2	Construction			
2.1	Site Preparation			
2.1.1	Sand removal and Disposal on site	95.28	150.63	96.89
2.1.2	Advantage for St Francis (Beach repair)	0.0	0.00	0
2.1.3	Water Removal	0.97	0.49	0.82
2.1.4	Bedrock removal and disposal	42.37	71.69	76.70
2.2	Reactor			
2.2.1	Reactor Constant Cost	101 902.31	101 902.31	101 902.31
2.2.2	Reactor Relative variable Cost Items			
2.2.2.1	Construction Support Services Transport	156.50	167.45	54.77
2.2.2.2	Construction Steel - transport	96.04	122.06	115.28
2.2.2.3	Construction Concrete and Bricks – transport	89.79	158.47	55.45
2.2.3	Foreign Import Material			
2.2.3.1	Import Material, Port to site (Abnormal load)	489.40	1 441.49	350.23
2.2.3.2	Import Material, Port to site (Normal load)	39.56	29.36	8.27
2.2.4	Construction Labour Cost			
2.2.4.1	Construction village Capital	1 969.58	1 969.58	1 792.48
2.2.4.2	Construction village Transport cost	314.83	125.93	198.69
2.2.4.3	Construction Camp Capital	227.35	227.35	227.35

[10] **Present Value** is the value on a given date of a future payment or series of future payments, discounted to reflect the time value of money.

	Discount Rate: 8 %	Thyspunt	Bantamsklip	Duynefontein
	Cost Factors	Present Value[10] (Rand million)		
2.2.4.4	Construction Camp Transport cost	123.96	49.58	84.29
2.2.4.5	Labour Difference in Numbers during Construction	0	0	0
2.3	Access Roads			
2.3.1	Capital Costs of access roads	539.39	122.59	204.31
2.4	Connection National Grid			
2.4.1	Capital Costs of Connection National Grid	3 778.63	9 068.71	3 636.04
2.4.2	Capital Cost – 132kV line – Duynefontein	119.07	0	0
2.5	Operational Externalities / Side effects			
2.5.1	Tourism Impacted construction phase	43.20	-81.85	24.99
2.5.2	Value of unskilled Job creation Construction Phase	-949.25	-444.19	0
3	Operational – Plant			
3.1	Electricity savings			
3.1.1	Power balancing	-1 339.99	-888.42	-833.84
3.1.2	Commencement delay	00	222.02	156.13
3.2	Operational Labour Cost			
3.2.1	Labour Difference in numbers	0	0	0
3.2.2	Labour Travel cost	229.60	91.84	156.13
3.3	Waste Removal			
3.3.1	Waste Removal Transport cost	6.83	6.91	5.31
3.4	Supporting Service Industries			
3.4.1	Supporting Service Transport Costs	2.15	2.66	0.28
3.5	Operational Externalities / Side effects			
3.5.1	Tourism Impacted operational phase	26.83	-332.01	0
3.5.2	Agriculture Normal	0	0	0
3.5.3	Aquaculture	0	0	0
3.5.4	Fishing	84.20	0	0
3.5.5	Value of unskilled Job creation	-263.62	-88.03	0
	Total	107 711.85	114 100.01	108 281.58

Table 9-54 shows the cost differences between the three sites.

Table 9-54: Cost Differences between the Proposed Nuclear-1 Sites

	Thyspunt	Bantamsklip	Duynefontein
Difference relative to Thyspunt (R million)	n/a	6 388	570
Difference relative to Thyspunt (%)	n/a%	5.93%	0.53%
Difference relative to Duynefontein (R million)	n/a	5 818	n/a
Difference relative to Duynefontein (%)	n/a	5.37%	n/a

It is evident that the three sites do not differ significantly. Thyspunt is about 6 % more cost-effective than Bantamsklip, and less than 1 % more cost-effective than Duynefontein. This constitutes a difference between Duynefontein and Bantamsklip of R6 388 million, and between Thyspunt and Duynefontein of R 570 million. It must be mentioned that although R6 388 million and R 570 million are large amounts, they are relatively small amounts in terms of the total estimated cost of a nuclear power station (R170 billion in 2008 prices).

To test the confidence level of the above-mentioned results, sensitivity analyses were performed with various real discount rates, i.e., 5 %, 8 % and 10 %. The 5 % is used as it is often the accepted discount rate for projects affecting the environment, while 10 % is the rate used by the World Bank to evaluate projects. The conclusion of these analyses is that there is no significant difference in the cost-effectiveness comparison between the three sites. Although there are noticeable differences in the magnitude of certain cost elements, the relative differences are minor.

9.20.2 Macro-economic analysis

(a) Methodology

In order to quantify the macroeconomic impact associated with the possible construction and operation of a new nuclear power station, a partial general macroeconomic equilibrium analysis was conducted. The nuclear power station is such a large capital investment (equivalent to that of six times the capital investment in Gautrain) that the economic ripple effects will go far beyond its direct boundaries. For this purpose the Eastern Cape was used as the economic service and support area for Thyspunt, and the Western Cape for the proposed nuclear facilities of Bantamsklip and Duynefontein. Potential macroeconomic impacts have been measured in terms of the following standard macroeconomic performance criteria:

- GDP (in order to assess the contribution to economic growth);
- capital formation (as an indicator of the demand for scarce production resources);
- employment creation (as an indicator of the impact on income distribution);
- low-income household income (as an indicator of the impact on poverty relief; and
- a series of social indicators.

Table 9-55 and **Table 9-56** below present a comparison of the various cost components that were used to generate the macroeconomic model for the construction and operation of a nuclear power station at each of the three alternative sites.

Table 9-55: Comparison of the construction costs of a nuclear power station (constant 2008 prices, R millions)

		Thyspunt	Bantamsklip	Duynefontein
1	Land	7	4	0
2	Sand removal and disposal on site	127	201	130
3	Advantage for St Francis (Beach Repair)	- 50	0	0
4	Water removal	1.3	0.9	1.1
5	Bedrock removal and disposal	57	96	5 103
6	Reactor – constant cost	160 275	160 275	160 275
7	Construction support services, transport	231	247	81
8	Construction steel – transport cost	142	180	170
9	Concrete and bricks – transport	133	234	82
10	Import material, port to site (abnormal loads)	793	2,339	R 567
11	Import material, port to site (normal	52	39	11

		Thyspunt	Bantamsklip	Duynefontein
	load)			
12	Construction village – capital	2 024	2 024	1 513
13	Construction village – transport cost	503	201	317
14	Construction camp – capital	265	265	R 265
15	Construction camp – transport cost	199	79	134
16	Labour – difference in numbers	0	0	- 173
17	Capital cost of access roads	660	150	250
18	Capital cost of connection – national grid	5 300	12 720	5 100
19	Tourism impact	65	- 124	38
20	Value of job creation	- 1 399	- 655	0
	Total	**169 535**	**178 277**	**R 168 863**

Table 9-56: Comparison of the operational cost of a nuclear power station (constant 2008 prices, R millions)

		Thyspunt	Bantamsklip	Duynefontein
1	Power balancing	0	0	0
2	Commencement date	0	22	12
3	Labour – difference in numbers	0	0	- 54
4	Labour – travel cost	45	18	26
5	Waste – removable – transport cost	1	1	1
6	Supporting services – transport cost	0.4	0.5	0.06
7	Tourism impact	7	0	0
8	Agriculture –normal	0	R0	0
9	Aquaculture	0	1	0
10	Fishing	17	0	0
11	Value of job creation	0	0	0
12	Selling of electricity	6 093	6 093	6 093
	Total	**6 163**	**6 135**	**6 078**

(b) Results of the macro-economic analysis

The results of the macroeconomic impact analysis indicate that the construction and operation of Nuclear-1 will have a significant impact on the economies of the Eastern and Western Cape provinces.

The predicted macro-economic impacts of the construction and operational phases of nuclear power station are indicated in **Table 9-57** and **Table 9-58** respectively.

Table 9-57: Comparison of the macroeconomic impact of the construction phase

Macroeconomic indicators	Thyspunt	Bantamsklip	Duynefontein
a. GDP (R millions)	5 527	6 961	6 546
b. Capital formation (R millions)	10 186	12 943	12 143
c. Employment (numbers)	67 673	94 906	91 194
d. Household income:			
• Low-income households (R millions)	352	109	104

• Medium and high-income households (R millions)	2 347	2 656	2 479
• Total household (R millions)	2 699	2 766	2 583

Table 9-58: Comparison of the macroeconomic impacts of the operational phase

Macroeconomic Indicators	Thyspunt	Bantamsklip	Duynefontein
a. GDP (R millions)	9 369	5 587	5 562
b. Capital formation (R millions)	172 066	178 198	172 572
c. Employment (numbers)	9 425	11 863	11 560
d. Household income:			
• Low-income household (R millions)	299	57	56
• Med and high-income household (R millions)	1 200	1 606	1 577
• Total household income (R millions)	1 499	1 664	1 633
Social indicators			
a. Additional number of educators	3 157	2 858	2 842
b. Additional number of hospital beds serviced	680	615	612
c. Additional number of doctors	71	64	64
d. Additional number of low-cost houses	2 968	2 687	2 672

9.20.3 No-go alternative

If no Nuclear-1 is built, the differential effects on the three alternative sites would be zero. However, based on the increasing electricity demands associated with increased economic growth in South Africa, the No-Go (no development) alternative is not considered to be a feasible alternative to the development of a nuclear power station or, for that matter, any other type of energy-generating facility.

The power outages experienced in 2008 affected all sectors of the economy, and illustrated that the provision of additional power is imperative if new large development projects (especially those that are energy-intensive, e.g., the proposed aluminium smelter at Coega) are to go ahead. Indeed, Eskom has a considerable programme for producing additional power: it has to provide additional large-scale, base-load power stations, either through nuclear power or through the development of additional coal-fired power stations. If it does not, the economic growth of the country will grind to a halt since a modern economy requires constant additions to its power supplies if it is to grow. It is clear, therefore, that the No-Go alternative is not a practical proposition for the South African economy.

9.20.4 Conclusion

The overall positive macro-economic impacts will be greater in the Western Cape (i.e., at Bantamsklip or Duynefontein) than in the Eastern Cape (Thyspunt) because the Western Cape has a larger, more diversified economy. More of the inputs required to construct and operate Nuclear-1 can be provided from within the Western Cape provincial economy, and more of the household income that flows from this project will be spent within the boundaries of the province. By contrast, the smaller, less-diversified Eastern Cape economy will not be able to supply as many of the inputs required, nor will it be able to retain as much of the household income, with the result that the macroeconomic impact of establishing a nuclear power station at Thyspunt produces less of a positive impact for this province's economy.

Thus, Nuclear-1 would result in less dislocation of economic activities if located at Duynefontein than at either of the other two sites.

Macroeconomic indicators favour the Western Cape sites of Duynefontein and Bantamsklip. However, the **cost-effectiveness analysis indicates that Thyspunt has a very slight edge over Duynefontein and a somewhat larger edge over Bantamsklip**. Thus, if one considers poverty alleviation as an important criterion in the location decision, then factors such as the impact on low-income households, the impact of the social indicators, and the opportunity to grow the economy of a province as reflected by the potential impact on GDP become much more significant. Giving greater weight to these social factors tends to suggest that locating a nuclear power station at Thyspunt would produce a larger positive impact than at the two Western Cape sites.

The differences between the alternative sites are slight, and all the sites would have large positive economic impacts both on the local area and the province in which they are situated.

The economic impact assessment gives greater weight to the cost-effectiveness analysis. This favours Thyspunt as the preferred site, followed by Duynefontein and Bantamsklip.

Perceptions regarding a nuclear power station are frequently based on a lack of scientific information about perceived impacts. The public’s level of concern is lower in the area around Duynefontein because of their experience with Koeberg. Public concern is also relatively low at Bantamsklip but is highest in the area around Thyspunt. In general, the business sectors around all three sites see opportunities arising from the establishment of a nuclear power station, quite apart from the importance of stabilising the electricity supply.

The two most sensitive industries in terms of their perceptions about the impacts of Nuclear-1 on their activities are fishing and tourism. However, the analysis shows that any negative impacts are likely to be slight and that in fact there would be overall positive impacts on tourism.

Table 9-27: Economics Impacts on the Duynefontein, Bantamsklip and Thyspunt Sites

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Loss of income arising from a loss of access to part of fishing grounds at Thyspunt										
Without mitigation	Negative	Local	Low	Permanent	Probable	Low	No	Medium	Low	**Low**
With mitigation	Neutral	Local	Low	Medium-term	Probable	High	No	Medium	Low	**Low**
Loss of income arising from a loss of access to part of whale-watching area at Bantamsklip										
Without mitigation	Negative	Local	Low	Permanent	Improbable	High	No	Medium	Low	**Low**
With mitigation	Neutral	Local	Low	Medium-term	Improbable	High	No	Medium	Low	**Low**
Construction phase macroeconomic impacts - local										
Without mitigation	Positive	Local	High	Short-term	Highly probable	Low	Yes	High	Low	**Low**
With mitigation	-	-	-	-	-	-	-	-	-	**-**
Construction phase macroeconomic impacts - regional										
Without mitigation	Positive	Regional	Medium	Short-term	Highly probable	Medium	Yes	High	Low	**Low**
With mitigation	-	-	-	-	-	-	-	-	-	**-**
Construction phase macroeconomic impacts - national										
Without mitigation	Positive	National	Low to medium	Short-term	Highly probable	Medium	Yes	High	Low	**Low**
With mitigation	-	-	-	-	-	-	-	-	-	**-**
Operational phase macroeconomic impacts - Local										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Without mitigation	Positive	Local	Medium	Long-term	Highly probable	n/a	No	High	Medium	**Medium**
With mitigation	-	-	-	-	-	-	-	-	-	**-**
Operational phase macroeconomic impacts - Regional										
Without mitigation	Positive	Regional	High	Long-term	Highly Probable	n/a	No	High	High	**High**
With mitigation	-	-	-	-	-	-	-	-	-	**-**
Operational phase macroeconomic impacts - National										
Without mitigation	Positive	National	High	Long-term	Highly Probable	n/a	No	High	High	**High**
With mitigation	-	-	-	-	-	-	-	-	-	**-**

9.21 Impacts on emergency response

The assessment of the impacts has been conducted according to a synthesis of criteria. The impacts are assessed with and without mitigation and the results presented in impact tables, which summarise the assessment. The significance of all potential impacts that would result from the proposed project are summarised in **Table 9-57** to **Table 9-59**.

9.21.1 Duynefontein

(a) Natural Disasters

Located on the coast approximately 30 km north of Cape Town, the Duynefontein site already contains the Koeberg and there is a maximum cumulative population of approximately 3.9 million people within 80 km of the nuclear power station site (estimated 2008).

The seismology and geology of the various regions and the engineering geology of the proposed sites, including Duynefontein, has been evaluated as part of the Site Safety Report process. If the sites fall within a zone of surface faulting that has a significant potential for relative displacement at or near the ground surface, the site should be deemed unsuitable.

The seismic hazard at the Duynefontein site is relatively high, much similar to Bantamsklip where low levels of tectonic activity have been recorded and several faults extend to within the site area. However, there is no evidence of recent activation of any faults (i.e. the faults are old structures).

(b) Extreme Weather Events

Extreme weather events affect the design of the planned plant. They depend on the local climatic conditions:

<u>High winds</u>
When considering the impact of high winds on the proposed developments, the maximum velocities, instantaneous peak velocities, and monthly maximum velocities are used to determine the normal and extreme basic dynamic pressures that are used in turn to determine the possible wind load on the buildings.

At the Duynefontein site the significance of possible wind load, with and without mitigation, on the buildings as a result of high winds is low and the likelihood of the impact occurring is improbable.

(c) Design Basis Accidents

Design-basis accidents are events that are taken into account in the design of the safety systems related to the nuclear power station. They include, for example:

- 100 % reactor outlet header break with failure of ventilation outlet dampers to close automatically;
- 100 % reactor outlet header break with partial failure of dousing; and
- 60 % reactor outlet header break with coincident loss of emergency core cooling.

Design Basis Releases, according to the Emergency Response Assessment, are *unlikely* as safety systems are designed to mitigate the consequences of such events and to prevent further degradation of the situation. The fission product mix, release fractions to the environment and release timing vary depending on the nature of the accident. The significance of the impact of Design Basis Accidents at the Duynefontein site with or without mitigation is very low and insignificant respectively, with the likelihood of the impact occurring, improbable.

(d) Severe Accident Releases (SAR)

Severe accidents occur when the safety systems are impaired and are unable to prevent significant core damage, with the greatest release fractions. Such events, according to the Emergency Response Assessment, are *extremely unlikely* because a large number of coincident failures of process and safety systems would need to occur. Furthermore, in some scenarios, the accident may threaten the integrity of the containment envelope. These are the worst case scenarios.

One such extremely rare postulated event is a power excursion with impairment and/or failure of the cooling systems leading to early core failure and disassembly. In this postulated event, the shutdown system fails to prevent a significant and prompt power increase.

At the Duynefontein site the significance of the potential impact, without mitigation is very low and with mitigation, insignificant.

(e) Mitigation

- Prompt removal of the population from the affected area as protective action against major airborne releases of radioactivity.
- Mass care facilities must be available for a substantial fraction of the evacuated population.
- The taking of stable iodine just before exposure to the release equal to the projected dose to the thyroid from inhalation.
- Temporary relocation when there is a need to keep the population out of the affected area for a period exceeding approximately seven days but not more than a few months. This measure requires that mass care facilities be provided to the affected population.
- An immediate ban on the consumption of locally grown food in the affected area.
- The protection of local food and water supplies by, for example, covering open wells and sheltering animals and animal feed.
- Long term sampling and control of locally grown food and feed.
- Control of milk production and distributors. This is generally considered particularly important because it is a significant part of children's diets.

9.21.2 Bantamsklip

(a) Natural Disasters

The Bantamsklip site is located in the Overberg Region of the Western Cape and numerous agricultural land units were identified within the 16 km radius of the site.

As previously mentioned low levels of tectonic activity have been recorded and several faults extend to within the Bantamsklip site area. However, there is no evidence of recent activation of any faults (i.e. the faults are old structures). The significance of the potential impact on the site is therefore low.

(b) Extreme Weather Events

<u>High winds</u>
At the Bantamsklip site the significance of possible wind load, with and without mitigation, on the buildings as a result of high winds is low and the likelihood of the potential impact occurring is improbable.

(c) Design Basis Accidents

The significance of the impact of Design Basis Accidents at the Bantamsklip site with or without mitigation is very low and insignificant respectively, with the likelihood of the potential impact occurring, improbable.

(d) Severe Accident Releases (SAR)

At the Duynefontein and Bantamsklip sites the significance of the potential impact, without mitigation is very low and with mitigation, insignificant.

(e) Mitigation

- Prompt removal of the population from the affected area as protective action against major airborne releases of radioactivity.
- Mass care facilities must be available for a substantial fraction of the evacuated population.
- The taking of stable iodine just before exposure to the release equal to the projected dose to the thyroid from inhalation.
- Temporary relocation when there is a need to keep the population out of the affected area for a period exceeding approximately seven days but not more than a few months. This measure requires that mass care facilities be provided to the affected population.
- An immediate ban on the consumption of locally grown food in the affected area.
- The protection of local food and water supplies by, for example, covering open wells and sheltering animals and animal feed.
- Long term sampling and control of locally grown food and feed.
- Control of milk production and distributors. This is generally considered particularly important because it is a significant part of children's diets.

9.21.3 Thyspunt

(a) Natural Disasters

The Thyspunt site is situated in a region of low seismicity and relatively low fault density. No faults extending into site area and the seismic hazard at the site is thus low.

(b) Extreme Weather Events

<u>High winds</u>
At the Thyspunt, as with the Duynefontein and Bantamsklip sites, the significance of possible wind load, with and without mitigation, on the buildings as a result of high winds is low.

(c) Design Basis Accidents

The significance of the potential impact of Design Basis Accidents at the Thyspunt site with or without mitigation is very low and insignificant respectively, with the likelihood of the potential impact occurring, improbable.

(d) Severe Accident Releases (SAR)

At the Thyspunt site the significance of the potential impact, without mitigation is very low and with mitigation, insignificant.

(e) Mitigation

- Prompt removal of the population from the affected area as protective action against major airborne releases of radioactivity.
- Mass care facilities must be available for a substantial fraction of the evacuated population.
- The taking of stable iodine just before exposure to the release equal to the projected dose to the thyroid from inhalation.
- Temporary relocation when there is a need to keep the population out of the affected area for a period exceeding approximately seven days but not more than a few months. This measure requires that mass care facilities be provided to the affected population.
- An immediate ban on the consumption of locally grown food in the affected area.
- The protection of local food and water supplies by, for example, covering open wells and sheltering animals and animal feed.
- Long term sampling and control of locally grown food and feed.
- Control of milk production and distributors. This is generally considered particularly important because it is a significant part of children's diets.

9.21.4 Conclusion

The acceptability of a site is closely related to the design of the proposed nuclear power plant. From the safety point of view, a site is acceptable if there are technical solutions to site problems which give assurance that the proposed plant can be built and operated with an acceptably low risk to the population of the region.

The rating of impacts significance indicates that all three sites will experience impacts of equal significance and all three sites are regarded as acceptable. In spite of this, Duynefontein site is considered marginally less suitable than the other two sites due to the large surrounding population. The presence of large populations in the region or proximity of a city to the nuclear power plant site may diminish the effectiveness and viability of an emergency plan. In the course of the "selection" phase, during which a regional analysis is performed, sites in zones having the highest population densities are eliminated from the search; it is in effect reasonable, all other things being equal, to prefer sparsely populated zones to highly urbanised zones.

Both Bantamsklip and Thyspunt are regarded as acceptable for emergency planning considerations since the newly adopted EUR approach followed by Eskom for emergency planning suggest that a proposed nuclear installation can be built in South Africa without the need for *off-site* short-term emergency interventions like sheltering, evacuation or iodine prophylaxis (i.e. no countermeasures). The EUR requirements prescribe that modern nuclear power plants should have no or only minimal need for emergency interventions (e.g., evacuation) beyond 800 m from the reactor, and provide a set of criteria which a reactor must meet in order to demonstrate that it can be built without such emergency planning requirements. The 800 m emergency planning zone would apply equally to Duynefontein and this entire zone could be accommodated within Eskom property at Duynefontein.

Table 9-59: Summary of Emergency Response Impacts at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction Phase										
Natural Disasters										
Without mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
With mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
Extreme Weather Conditions										
Without mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
With mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
Operational Phase										
Design Basis Accidents										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very low**
With mitigation	Negative	Regional	High	Short term	Improbable	Medium	No	High	Very Low	**Very low**
Beyond Design Basis Accidents										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very Low**
With mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Very Low	**Insignificant**
Severe Accident Releases										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very Low**
With mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Very Low	**Insignificant**

Table 9-60: Summary of Emergency Response Impacts at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction Phase										
Natural Disasters										
Without mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
With mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
Extreme Weather Conditions										
Without mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
With mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
Operational Phase										
Design Basis Accidents										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very low**
With mitigation	Negative	Regional	High	Short term	Improbable	Medium	No	High	Very Low	**Very low**
Beyond Design Basis Accidents										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very Low**
With mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Very Low	**Insignificant**
Severe Accident Releases										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very Low**
With mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Very Low	**Insignificant**

Table 9-61: Summary of Emergency Response Impacts at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Construction Phase										
Natural Disasters										
Without mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
With mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
Extreme Weather Conditions										
Without mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
With mitigation	Negative	Regional	High	Short term	Improbable	No	Medium	Medium	Medium	**Low**
Operational Phase										
Design Basis Accidents										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very low**
With mitigation	Negative	Regional	High	Short term	Improbable	Medium	No	High	Very Low	**Very low**
Beyond Design Basis Accidents										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very Low**
With mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Very Low	**Insignificant**
Severe Accident Releases										
Without mitigation	Negative	Regional	High	Short term	Improbable	Low	No	High	Low	**Very Low**
With mitigation	Negative	Local	Low	Short term	Improbable	Medium	No	High	Very Low	**Insignificant**

9.22 Visual impacts

Due to the sheer size of a nuclear power station their location in relative open, treeless landscapes along the coast, where there is limited to negligible visual screening by landforms, visual impacts at all three sites may be significant. Apart from the impacts on residents, potential visual impacts may also be experienced by visitors to the area. This is important at sites where tourism and recreational is one of the mainstays of the local economy. Apart from the turbine building itself, other ancillary structures that may have a significant impact include the meteorological mast (120 m tall), the radio mast (95 m), the transmission lines[11] within the EIA corridor, spoil and rock dumps and the access roads to the site from adjacent roads.

Visual risk sources for all three sites relate primarily to the increase in visual intrusion of the Nuclear Power Station as an entity and in combination with ancillary elements such as the construction offices, sheds, access roads, switch yards, transmission lines, masts and spoil dumps. At Duynefontein site the visual risk sources relate primarily to the increase in visual intrusion in combination with Koeberg Nuclear Power Station adjacent to the southern boundary of the site and the proposed Pebble Bed Modular Reactor Demonstration Power Plant (PBMR DPP) south of Koeberg. The additional risks for each site have been identified as the accommodation of the large volume of excavated material, the alteration of areas surrounding the site during construction and the new access road/s for the Thyspunt site specifically.

Spoil dumps especially have the potential to create a significant visual impact due to their large scale and artificial form (unless they are shaped to resemble natural landforms. Assuming a constant width of 480 m and a height of 40 m, the length of the spoil dumps will vary between 500 m and 780 m at the different sites. Even considering shaping to resemble natural landforms, the spoil dumps will look out of place as all the sites are situated on a gently sloping to flat coastal plain where hills are uncommon.

Table 9-62 indicates the approximate size of the spoil dumps, based on the assumption that all spoil has to be disposed of on land (i.e. no pumping of spoil out to sea). In reality, the spoil dumps may be smaller, but the assessment has been based on a worst case scenario.

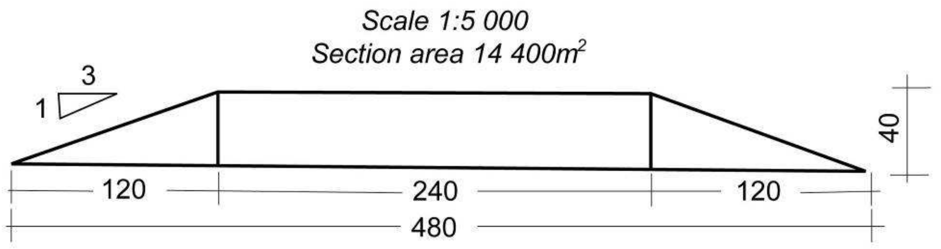
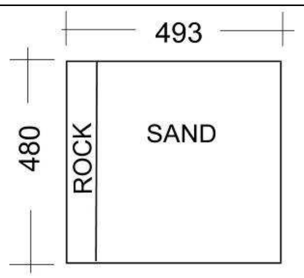
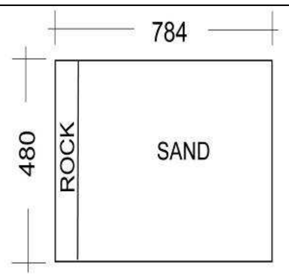
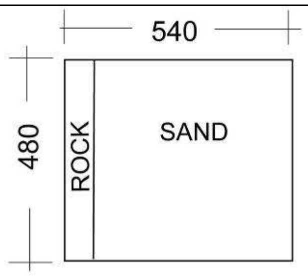
Significant potential visual impacts that will occur during the various phases of development are as follows:

(a) Construction

- Visible dust over extensive areas caused by earthmoving equipment and vehicles on dirt roads;
- Degradation of visual quality of local settings that result from landform change and vegetation removal;
- Visual clutter that will result from structures associated with the project such as site offices, on-site accommodation of personnel, lay-down areas, storage sheds and workshops, cement batching plants, temporary stockpiles of topsoil, rock and backfill material, vehicle and machine storage/parking and the maintenance and manufacturing of workshops;
- Visual change to local setting caused by
  - Large spoil dumps;
  - Alteration of visual quality of the local night scene from lighting required for safety and construction; and
  - Visual change to sense of place by the large level cleared areas.

[11] Subject to a separate EIA process outside the boundaries of the nuclear power station site

Table 9-62: Size of sand and rock spoil dumps at all three sites

CHARACTERISTICS	THYSPUNT m^3	BANTAMSKLIP m^3	DUYNEFONTEIN m^3
Height – 40 m Width – 480 m Side slope – 1:3			
<u>Volume</u> - m^3 Sand Rock <u>Length</u> (m) Sand dump Rock dump	 6 370 000 708 400 443 50	 10 100 000 1 198 600 701 83	 6 500 000 1 282 400 451 89
Area comparison			

(b) Operation

- There will be a visual change to the sense of place of coastal and inland areas experienced by visitors and local communities due to the large scale of new elements in the landscape, including the nuclear power station, the transmission lines within the site, new access roads, permanent spoil dumps and tall radio and meteorological masts;
- Changes in visual quality of the local landscape will be caused by new landforms arising from new access roads, platforms and spoil resulting from and required for the nuclear power station and ancillary buildings; and
- Changes in visual quality of the local night scene of the area will result from safety and security lighting of the nuclear power station, perimeter fence, access control buildings and roads.

(c) Decommissioning

- Visible dust will be caused by heavy machinery and on-site haulage;
- Visual clutter will result from structures associated with site offices and accommodation;
- Visual change to the landscape will result from new landforms that are created by removal or addition of soil or building rubble from temporary dumps to cover or screen areas;
- Visual intrusion will result from new fencing and lighting for safety and security; and
- Visual nuisance will result from heavy traffic on main roads.

9.22.1 Duynefontein

Figure 9-16 shows a viewshed analysis, indicating the areas from where the nuclear power station and 95m high stack will be visible. **Figure 9-17** shows an analysis of the intensity of visibility of these elements, based on distance from the site.

The viewshed analysis shows that the proposed Duynefontein nuclear power station and Koeberg nuclear power station to be located at the low point of half a shallow basin of radius approximately 8 - 10 km with a raised rim of low consolidated dunes. This topographical form effectively limits views of the site to those within a 10 km radius.

The actual visibility is further restricted by the gentle slope towards the site, because any structure or vegetation taller than 2 m that is near the observer will block any views of the Duynefontein nuclear power station. There will be no 120m meteorological mast, since the existing mast of Koeberg will be used.

(a) Access roads

Two existing roads will be upgraded for heavy and for light vehicles. The heavy vehicles access road is 1.2 km north and the light vehicle road is 2.7 km north of the existing entrance to Koeberg. The ground cover is low Strandveld type vegetation over a relatively flat sand terrace of low hummock type dunes. The visual impact in the context of the existing setting and access roads on the Koeberg site is not considered to be visually intrusive as minimal earthworks are required for the road. The visual intrusion of the road is limited, given the flat terrain and short distance and the use of existing road alignments.

9.22.2 Bantamsklip

Figure 9-18 shows a viewshed analysis, indicating the areas from where the nuclear power station and 95m high stack will be visible**. Figure 9-19** shows an analysis of the intensity of visibility of these elements, based on distance from the site.

Viewshed analysis shows that the proposed Bantamsklip nuclear power station is theoretically visible from most areas along the 30 km coastal strip and from the higher ground on the seaward side of the hills north of the site.

The actual visibility of the Bantamsklip nuclear power station is restricted by tall vegetation on the southern side of the R43 and the vegetated dunes to the north of the site

(a) Access road

Two access roads, approximately 2.6 km apart, from the coast road R43 are proposed. Both travel directly southwards to the nuclear power station and each will be approximately 1.5 km long.

The existing 2 to 3 m tall vegetation will screen the access road from the R43. However, for security reasons this vegetation may be removed. Much of the vegetation near the R43 is alien invader species such as Rooikrans and Port Jackson and this will be removed, leaving the Fynbos to regenerate. The access roads will be seen from the higher ground to the north, as will the entire nuclear power station and ancillary structures. The visibility of the road in the context of the overall change in the sense of place caused by the construction, power lines and spoil heaps, and the operation of the nuclear power station, will be negligible by comparison. The visual intrusion of the road will be limited, given the flat terrain and short distance.

9.22.3 Thyspunt

Figure 9-20 shows a viewshed analysis, indicating the areas from where the nuclear power station and 95m high stack will be visible. **Figure 9-21** shows an analysis of the intensity of visibility of these elements, based on distance from the site.

The viewshed analysis shows that the proposed Thyspunt nuclear power station to be located at the low point on the north-west to south-east orientated valley between Oyster Bay and Cape St. Francis. This valley extends inland to the north-west with the northern rim being the stabilised ancient dune ridge 5 km from the site. This topographical form effectively limits views southwards to the site from beyond the 10 km radius line.

The actual visibility is further restricted on the west as the dunes converge on the coast east of Oyster Bay. Existing vegetation on these dunes further screens views of the Thyspunt nuclear power station from Oyster Bay.

(a) Eastern Access Road

Because the topography is characterised by ridges and troughs orientated in a west to east direction due to the prevailing wind, there will need to be a substantial amount of cut and fill. The visual impact of new landforms and the removal of dune vegetation will change the present sense of place of relatively remote and scenic dune vegetation in various forms of development. Despite the mitigation and the fact that the road will not be seen, the visual integrity and sense of place will be degraded along the entire road corridor. The new access provided will most probably cause further degradation of the vegetation. Given the undulating terrain, the long distance and the wide reserve that will be cleared for road construction, the road will be visible from higher dunes in the area.

(b) Northern Access Road

Approximately one third of the route is through the sensitive dune vegetation on the northern and southern side. The other two thirds of the road are within old or fallow land and a short portion of coastal fynbos on thin soils over the sandstone. The road is approximately 4 km long.

The new road will be visible from the southbound traffic on the Oyster Bay Road because it will rise with the approach to the dunes. The cutting through the dunes will be highly visible until these slopes have been re-vegetated. The sense of place will be marginally altered because the area is an agricultural landscape with gravel roads. If this access route is selected, the road from Humansdorp will be upgraded in alignment and tarred.

(c) Western Access Road

This route leaves the Oyster Bay Road just north of the town and then alternately cuts through and along the vegetated dunes that lie to the north of the town. This road is approximately 3 km long. The cutting through the east-west dunes and then along the ‘slack’ (the depression between dune crests) will mean that the sand cut and fill slopes will require effective re-vegetation to prevent erosion and ‘blow outs’. This modification of the landscape will change its natural coastal vegetation character and significantly change the sense of place, which in this case is unique due to the presence of indigenous vegetation and wildlife. In fact that area is a nature conservancy. This road will not be seen from Oyster Bay, but the visual degradation of the sense of place and character of the natural area will be significant, as this is a place that the Oyster Bay residents frequently use for recreational pursuits such as walking and birding.

9.22.4 Cumulative impacts of wind farm sites

A number of wind farms are being planned for the region around Thyspunt. As can be seen from **Figure 9-22,** one of these sites is planned directly to the north of the proposed Thyspunt nuclear power station site. Another is planned north of St. Francis Bay and a 3rd one is planned west of Slangbaai, approximately 12km west of Thyspunt.

The visual combination of the central wind farm and the Thyspunt nuclear power station location will have a large potential cumulative visual impact on the region.

The reasons for this are as follows:

- Although the main nuclear power station structures are mostly screened by the east-west dune ridge, the transmission lines and the HV yard, haul road (visually preferred northern route) and possibly large spoil heaps all lie within the central wind farm's location and therefore this wind farms will add to the visual complexity.
- The central wind farm site will be experienced by communities nearby and by persons travelling to and from Oyster Bay along the district road that runs along the northern boundary of the wind farm site and through it on its western section.
- The wind turbines of the central wind farm will be experienced at close range (less than 1 km) by all who travel the district roads to Oyster Bay, Humansdorp and St Francis Bay.
- The visual perception of an energy generation node will be reinforced by the combined visibility of the two projects.
- The landscape character and sense of place of the setting will be altered over a large area within a 5 km radius of the Thyspunt nuclear power station.
- The viewshed for the central Wind Farm will be extended into the Krom River Valley both westwards and eastwards for a distance of at least 10 km from the Thyspunt nuclear power station.
- The potential cumulative visual impact of the Thyspunt HV yard and transmission lines and wind farm will be experienced by a large number of people who will be both transient and resident.

Although the potential cumulative visual impact will be high if the Central location is selected, it can be argued that it is preferable to contain the visual change to the landscape character and sense of place to one location, than to have two large facilities that change coastal character and sense of place in two locations within a popular residential and holiday / tourist region.

The western and the eastern proposed wind farm sites are too far to be visually associated with the Thyspunt nuclear power station.

9.22.5 The no-go option

(a) Duynefontein

Land to the north of the site is mostly owned by developers who intend to build housing estates. It is therefore probable that Eskom land sold will be included in this long term scenario because it will be unlikely that a developer will purchase the land to retain as a nature reserve. In this situation the scenic coast line that represents and retains particularly the character and sense of place of the desolate but unique elements of two dune types and threatened vegetation communities will be damaged by subdivision into erven crossed by roads and contained by fences.

An accessible and highly scenic public amenity will be lost by transformation into a housing estate or other urban type land use. The visual impact of the new land use will further degrade the visual quality of the extensive portion of the coastline currently under Eskom's management.

(b) Bantamsklip

The risk of the no-go alternative associated with this site is the systematic visual degradation of its features that may be caused by later developments in the form of residential estates and holiday resorts. This scenario can be expected given the adjacent Pearly Beach community and the holiday/residential towns of Gansbaai and Franskraal further west along the coast. Should an uncontrolled development scenario be realised, the long-term visual sense of place will be irreparably damaged. The visual impact on the existing setting can be greater and over a larger area than the visual impact of a large nuclear power station if housing is developed over the associated HV switchyard and transmission lines. The assumption is made that the property will not be bought by a private individual or company to primarily conserve the landscape. Alternatively if the area is managed solely for conservation purposes, the visual uniqueness and sense of place will be retained in its current condition.

(c) Thyspunt

The scenario of encroaching residential and commercial resort development can become a reality given that Oyster Bay and Cape St. Francis would consider expanding eastwards and westwards respectively. There are presently applications for residential developments on land west of Cape St Francis and along the landform between the dune filed and the coastline. On the other hand if the area is managed solely for conservation purposes the visual uniqueness and sense of place will be retained in its current condition.

9.22.6 Impacts on lighthouses

Potential impacts of the power station's lighting on lighthouses at Danger Point (near Thyspunt) and Gansbaai (near Bantamsklip) have also been raised as potential issues in the scoping phase of the public participation process.

A lighthouse is a rotating intense beam-seen as white light in a predetermined position (Red or green for instance) to orientate vessels of sea worthy bearings. Sector lights may additionally have a red or green filter on parts of the lantern house to distinguish safe water areas from dangerous shoals. The light cannot be confused with background lights at the nuclear power station for this reason.

At Bantamsklip (Quion Point) and Thyspunt (Danger Point) the lighting at the nuclear power station has been identified as being highly visually intrusive in that setting and mitigation measures that recommend detail design to limit light spill have been proposed. This includes using a special light source and fitting that directs the light downward and not outward. Flood lighting should only be used where absolutely necessary and be fixed in that condition.

9.22.7 Mitigation

The following generic mitigation measures are proposed at all three sites:

(a) Colour

It is recommended that a light blue-grey is used for the large structures (namely the Turbine-Generator Building), with the stack (chimney) a very light grey. The nuclear power station is a concrete structure, which will have a light grey colour. A darker band around the large structures will reduce their vertical scale. The masts should be a grey colour due to their galvanised finish. However this may be in conflict with the regulatory requirements that they are red and white bands.

(b) Alternative technology to monitor meteorological conditions

It is recommended that serious consideration should be given to replacing the proposed meteorological mast with a Doppler Sodar (SOnic Detection And Ranging) system[12], which is not dependent on a mast. Doppler Sodar is a meteorological technology, also known as a wind profiler, which measures the scattering of sound waves by atmospheric turbulence. Such technology has been used at other recently constructed nuclear facilities, e.g. in Finland.

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[12] SODAR systems are used to measure wind speed at various heights above the ground, and the thermodynamic structure of the lower layer of the atmosphere. Sodar systems are similar to radar (radio detection and ranging) systems, except that sound waves rather than radio waves are used for detection.

(c) Screens

It is recommended that temporary screens, in the form of shade cloth on fences around the construction site, working areas and lay-down areas must be used to obstruct views of most of the construction elements at the level of the fence.

Earth berms of significant proportions must be created along the site boundary nearest to sensitive land uses, e.g. residential areas and roads, to screen portions of the structures. However, consideration should be given to the associated impacts caused during their construction and stabilisation, such as dust, noise, rehabilitation and the destruction of existing coastal flora. A thorough assessment should be carried out on site before any decision is made regarding a screen berm. This is necessary in the context of possible residential land uses in the coastal area east of the Thyspunt site and west of Cape St. Francis, as well as east of Bantamsklip, which may result from the extension of the R43 to link with Bredasdorp.

(d) Lighting

The lighting of the structures and areas within the nuclear power station site should be designed by a suitably experienced person with the objective to reduce "light spill"[13]. Aspects to be incorporated will be down lighting, lighting colour, extent of necessary illumination, light fittings that direct the light and elimination of the visible light source.

(e) Spoil dumps

Large spoil dumps must be integrated into the selected setting by varying their form and side slopes to fit the scale of existing landforms. In addition their re-vegetation with typical indigenous species of the surrounding landscape is essential to create a visual fit of the dump's elements to the existing landscape character.

(f) Landscape Architect appointment

A Landscape Architect should be appointed to the design team to advise on the visual integration of the project on a detailed level during design and construction. The Landscape Architect's input must be obtained especially for the design of the spoil dumps and roads.

(g) Mitigation measures for roads

- The cut and fill sections need to be designed or shaped on site to blend with the adjacent landform and materials. A standard slope angle will not be appropriate.
- The rehabilitation of the road reserves (especially at Thyspunt) requires a detailed plan showing stabilisation methods and a specification of planting type and species together with maintenance requirements. A landscape architect and an experienced rehabilitation contractor should be engaged at the detailed design stage of the road.

(g) Mitigation measures for sand dumps

- The form of the spoil dump is most important because this will determine the primary impact. The form should therefore be considered in detail in the context of the surrounding scale and form of the dunes as well as the need to accommodate access roads and transmission lines and security patrolling of the secure areas.
- The side slopes should ideally be 1:3 but not steeper than 1:2. The landform on its long axis should be the same as that of the dune axis in the case of Thyspunt; for Bantamsklip the form is to be taken from the existing dune to the west and for Duynefontein the barchan dunes on the site. The direction of the prevailing wind and

[13] This concurs with the recommendation with respect to the impact on invertebrate fauna.

the way in which this has formed the dunes is an important consideration in order to reduce dust and fine sand from blowing into the works area.
- The top 300 mm of soil must be removed from the dump area and stockpiled nearby for later re-vegetation of the final dump.

9.22.8 Conclusions

The nuclear power station will exert a significant visual impact on the existing visual condition and character of the landscape at all three sites within a radius of 5 km. The meteorological and radio masts will be clearly visible on a cloudless day from at least 10 km away. The red light on top of the 120m high meteorological mast will be visible at night from beyond 10 km. The climatic conditions will influence the masts' visibility as cloudy or misty conditions can almost totally obscure these elements. This is due to the following:

- The scale and prominent position on the coast will make the nuclear power station a dominant feature in all three settings. The visibility from communities and residences within a 5 km radius is considered to be high. This includes the town of Pearly Beach for Bantamsklip, Oyster Bay and Cape St. Francis for Thyspunt and Duynefontein and Altantis for the Duynefontein site. Included are the various houses east and west of the first two sites.
- The landscape character and sense of place of the landscape setting will be irrevocably changed by the nuclear power station.
- The visual intrusion of the nuclear power station into views from the surrounding residential areas will be significant, because of the visual contrast and the direct line of sight.
- The general high quality scenic coastal views will be intruded upon by the large scale of the nuclear power station.
- The visual intrusion of the nuclear power station on the night scene is considered to be high, due to the concentration of light in an area that presently has no conspicuous lighting. The exception is the Duynefontein site where the illuminated area will increase northwards.

The large scale and prominent location of the nuclear power station on the coastline at all three sites allows little opportunity for effective visual mitigation. Particular visual aspects that relate to sites are as follows:

- Masts will be visible from further away than the nuclear power station, particularly at night, due to the flashing red light at the top. The mast will be slender, which will reduce its visual intrusion;
- Transmission lines within the EIA corridor will add to the visual intrusion of the project by their height and number;
- Access roads for Bantamsklip and Duynefontein will have negligible visual intrusion on the sense of place;
- Roads for Thyspunt will have the most negative impact on the sense of place, with the northern route identified as having the least negative impact as a result of it being visually integrated with the highly visible transmission lines, 2 x 400kV out and 1 x 132kV line in, as well as the HV Yard; and
- The spoil dumps are very large and have been considered to be placed within the EIA corridor. This position will result in the dumps being visually dominant and can serve as large screens of the nuclear power station in views from the provincial roads.

The potential cumulative impact of nuclear power station together with the proposed wind farm at Thyspunt directly to the north of the nuclear power station could be highly significant.

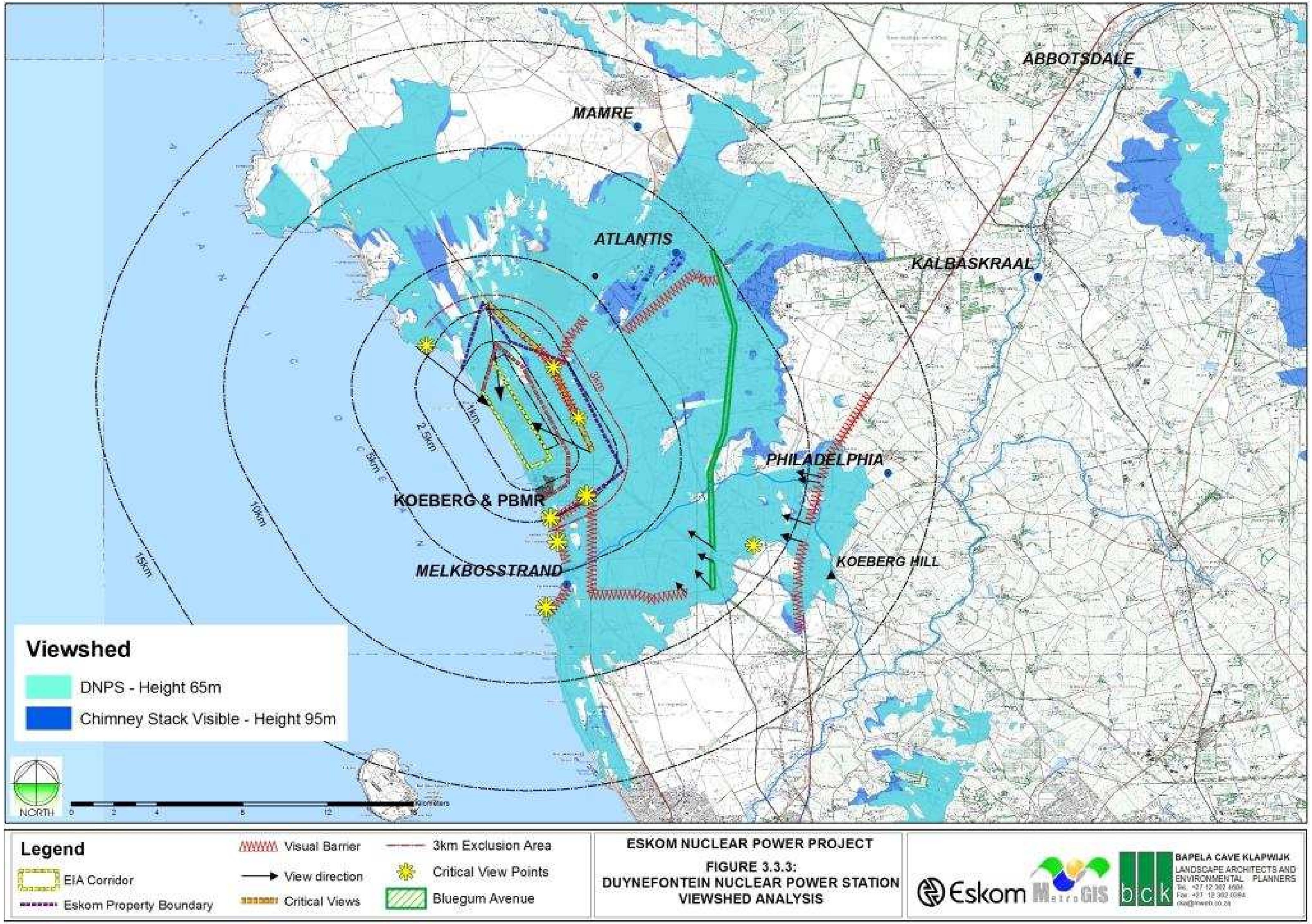

Figure 9-16: Duynefontein viewshed analysis

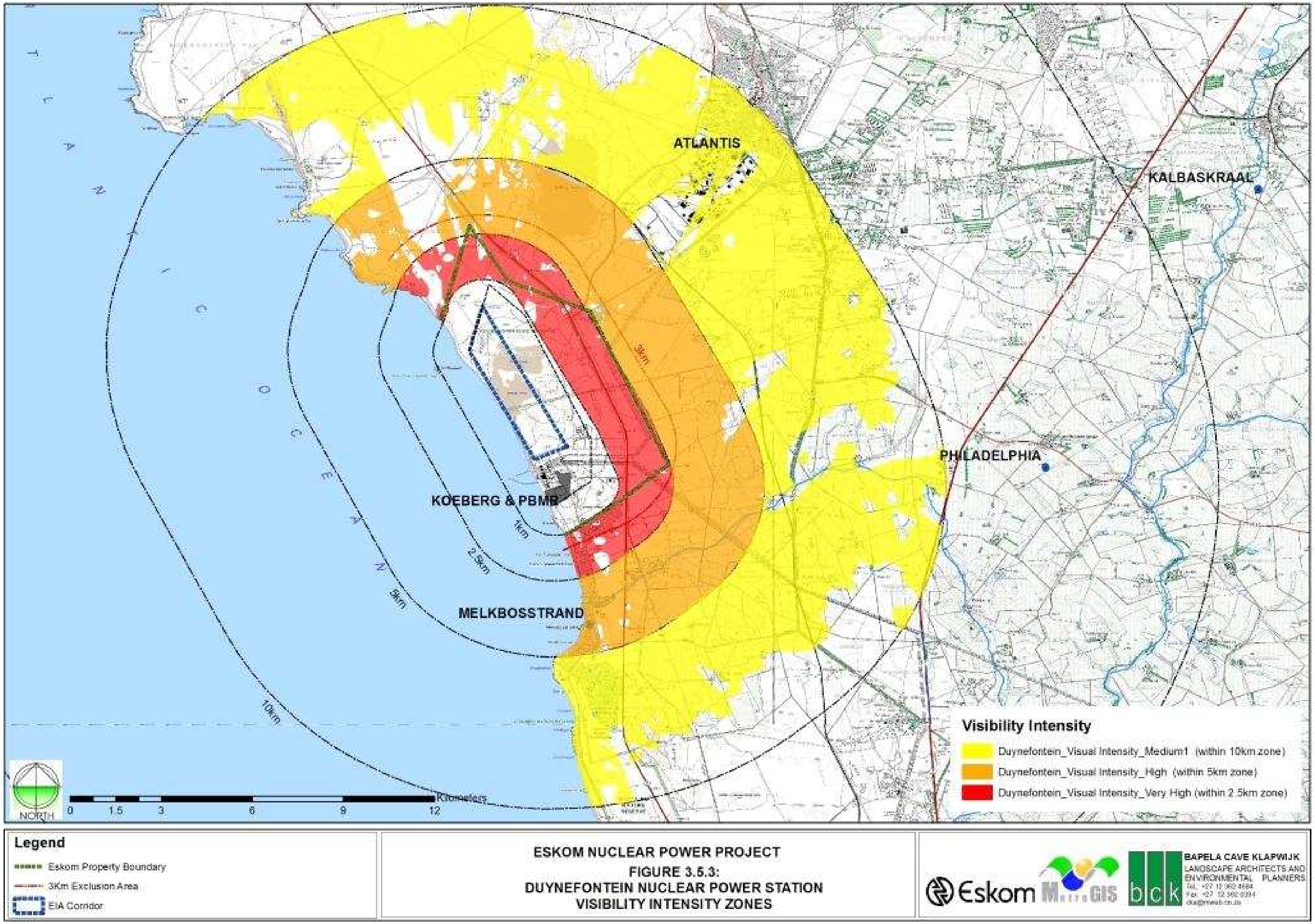

Figure 9-17: Duynefontein visibility intensity zones

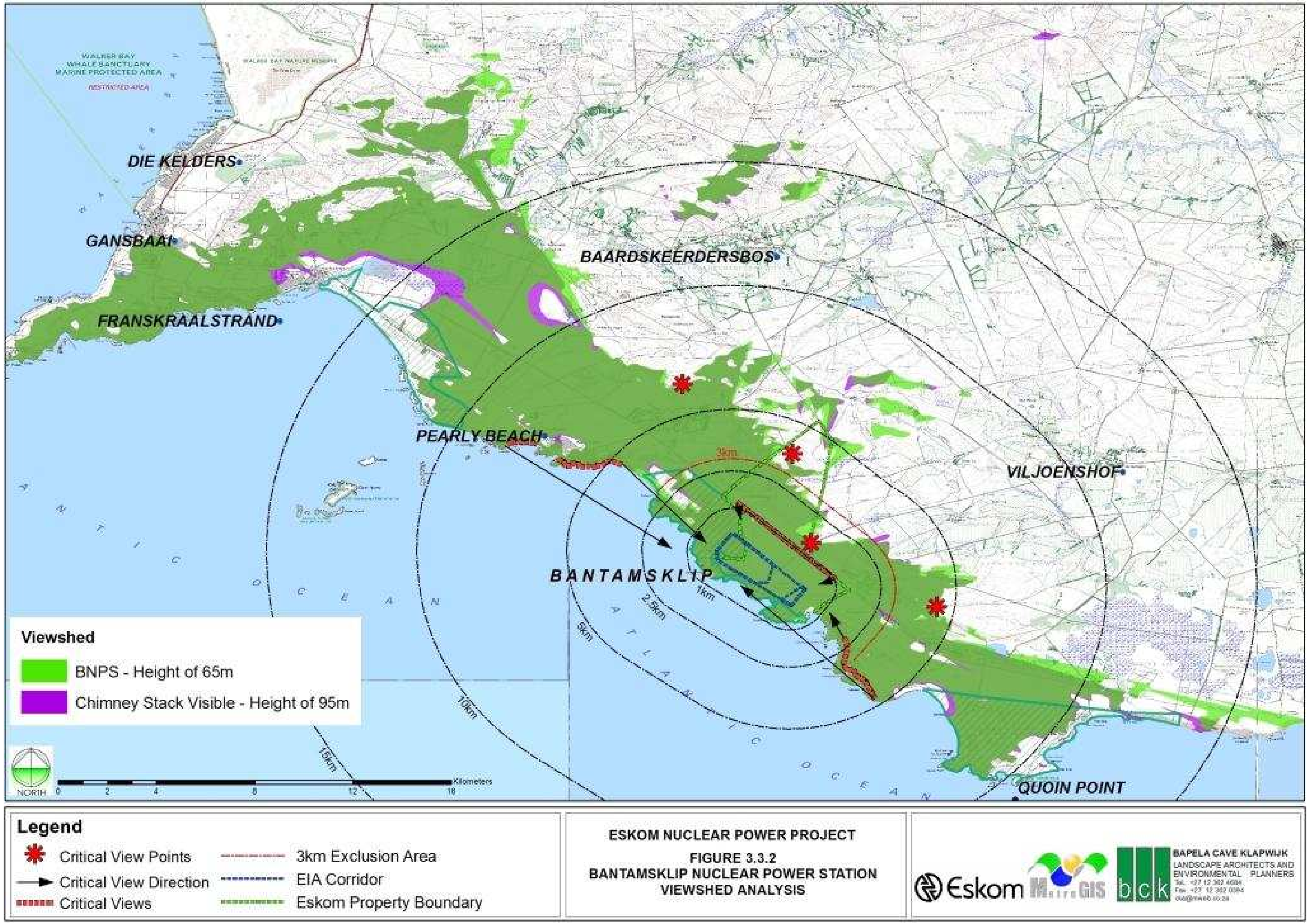

Figure 9-18: Bantamsklip viewshed analysis

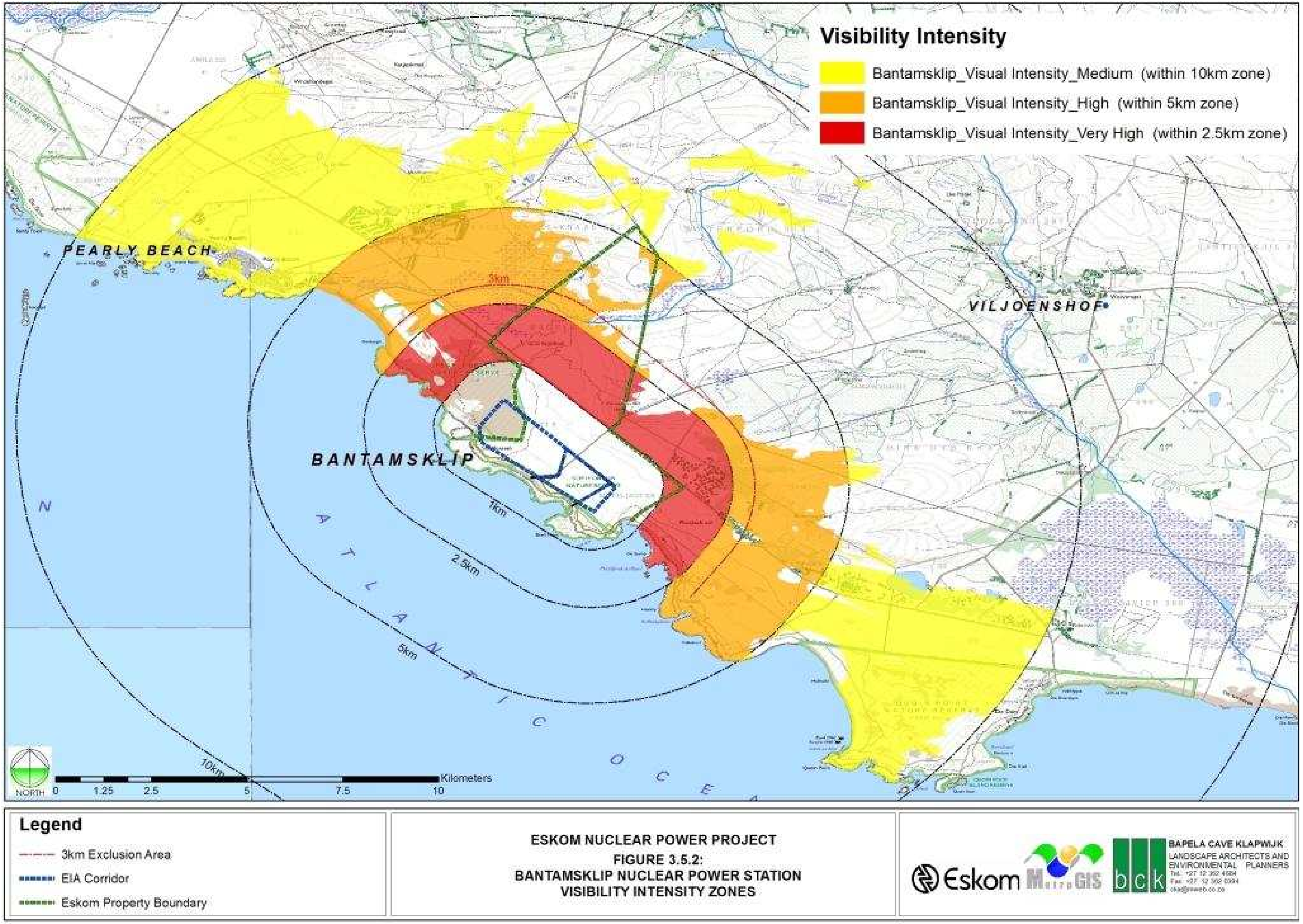

Figure 9-19: Bantamsklip visibility intensity zones

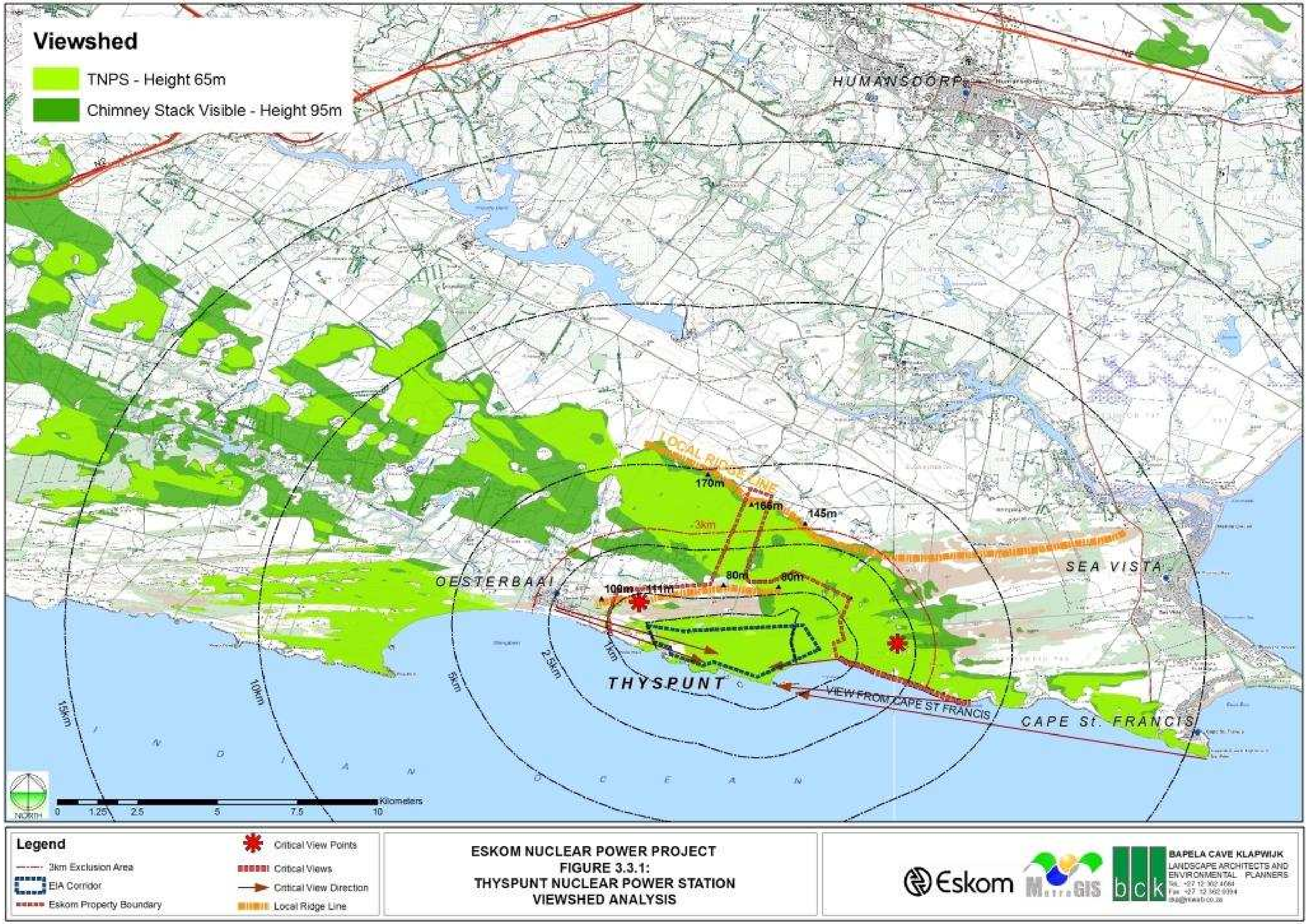

Figure 9-20: Thyspunt viewshed analysis

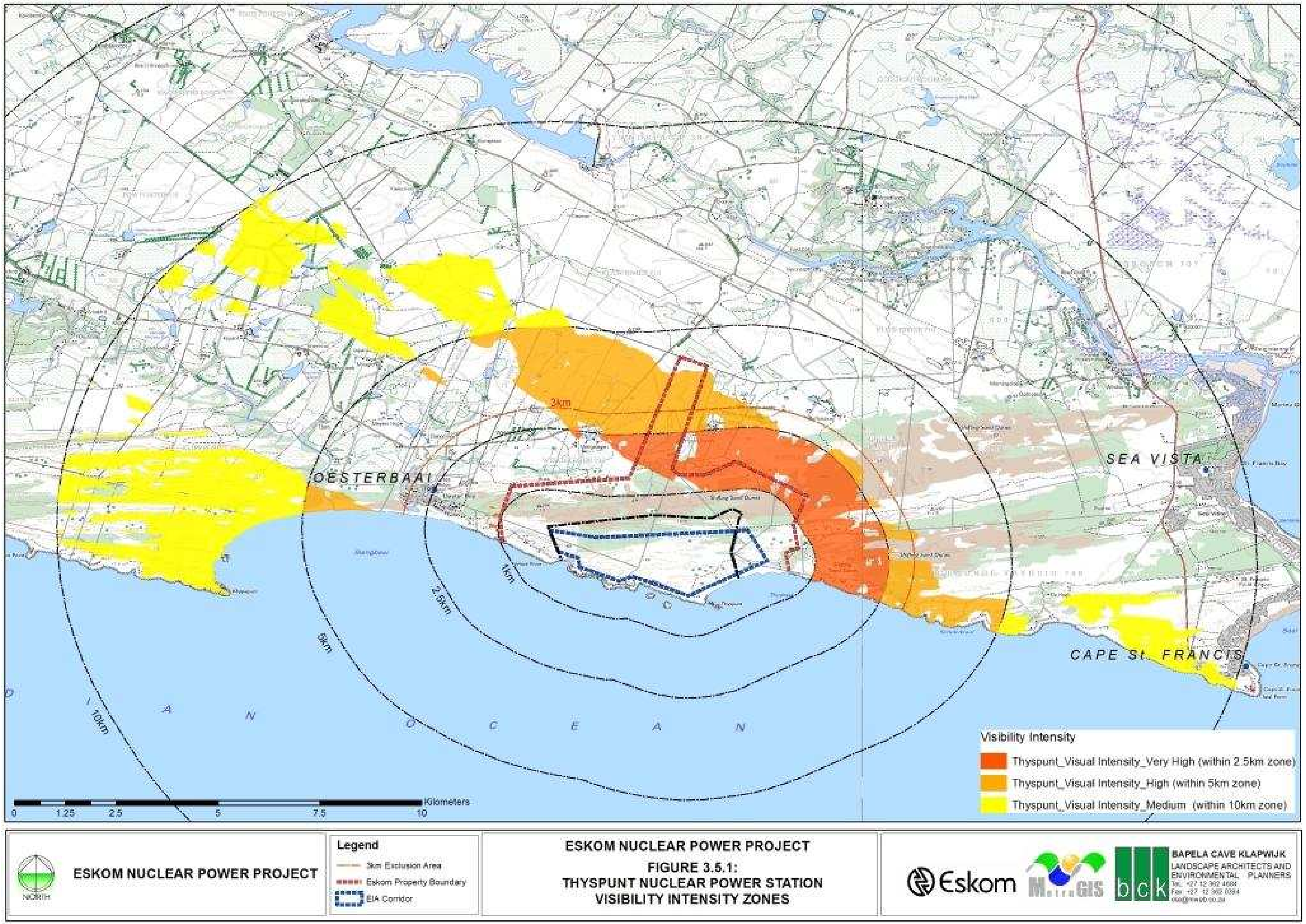

Figure 9-21: Duynefontein visibility intensity zones

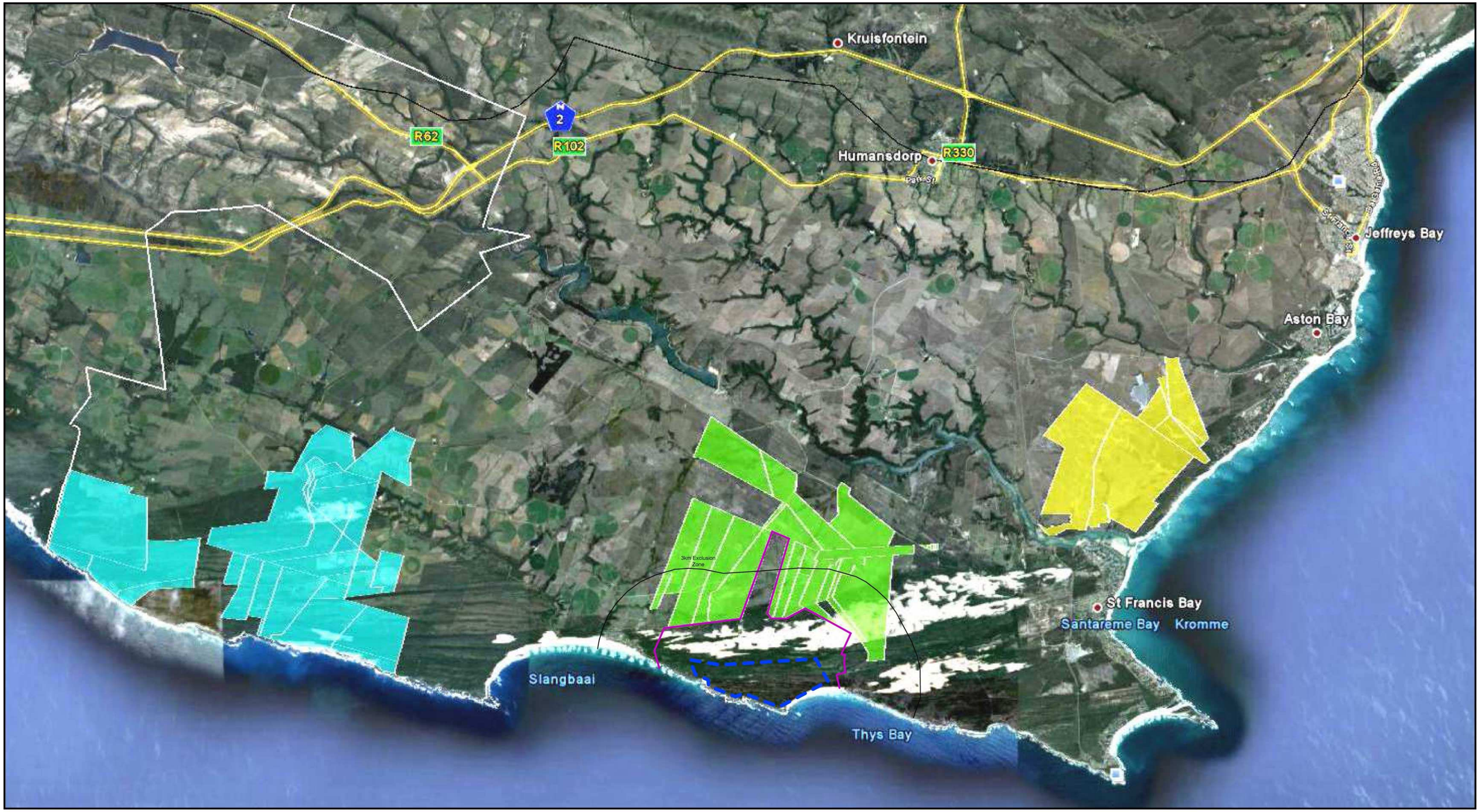

Figure 9-22: Proposed wind farm sites in proximity to Thyspunt (From BCK 2010)

Table 9-63: Visual impacts at all three alternative sites

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence level	Consequence	Significance
DESIGN PHASE										
Visual intrusion of drill rigs and ancillary equipment	Negative	Local	Low	Short	Probable	High	No	High	Low	**Low**
With mitigation										
Visual degradation of vegetation clearance, access roads and site camps	Negative	Local	Low	Short	Probable	High	Yes	High	Low	**Low**
With mitigation										
Degradation of Sense of Place	Negative	Local	Low	Short	Probable	Low	Yes	High	Low	**Low**
With mitigation										
CONSTRUCTION PHASE										
Visible dust	Negative	Local	Low	Medium	Probable	High	No	High	Low	**Low**
With mitigation										
Degradation of Visual Quality resulting from change to vegetation and landform	Negative	Local	Low	Medium	Probable	Low	Yes	High	Medium	**Medium**
With mitigation			Medium					Medium		
Visual clutter resulting from structures, site offices, laydown areas and site accommodation	Negative	Local	Low	Medium	Probable	Medium	No	High	Low	**Low**
With mitigation										
Visual quality change caused by large spoil dumps	Negative	Local	Low	Long	Probable	Low	No	Medium	Low	**Low**
With mitigation										
Visual alteration of night scene by lighting	Negative	Local	Low	Long	Probable	Low	Yes	High	Low	**Low**
With mitigation										
Visual change to Sense of Place	Negative	Local	Low	Long	Probable	Low	Yes	High	Low	**Low**
With mitigation										

OPERATIONAL PHASE										
Visual change to sense of place of local coastal and inland area due to large scale and extent of structures	Negative	Local	Medium	Long	Highly Probable	Low	Yes	High	Medium	**Medium**
With mitigation										
Change in visual quality of local area caused by new landforms and roads	Negative	Local	Medium	Long	Highly Probable	Low	Yes	High	Medium	**Medium**
With mitigation										
Change in visual quality of local night scene by lighting	Negative	Local	Medium	Long	Highly Probable	Low	Yes	High	Medium	**Medium**
With mitigation										
DECOMMISSIONING PHASE										
Visible dust	Negative	Local	Low	Medium	Probable	High	No	Medium	Low	**Low**
With mitigation										
Visual clutter resulting from structures, site offices and on site accommodation	Negative	Local	Low	Medium	Probable	Medium	Yes	Medium	Low	**Low**
With mitigation										
Visual change to local landscape due to earthworks and spoil dumps	Negative	Local	Medium	Low	Highly Probable	Low	Yes	High	Low	**Low**
With mitigation				Medium					Medium	
Visual nuisance of heavy traffic on local roads	Negative	Local	Low	Medium	Probable	Medium	No	Medium	Low	**Low**

9.23 Social impacts

The discussion below includes impacts identified and assessed in the social impact assessment. To some extent there is an overlap between the assessment of potential impacts in this specialist study (discussed in this section) and other specialist studies, like the agricultural impact assessment, noise impact assessment and visual impact assessment. Rather than being regarded as duplications, the assessments of similar issues from different points of view are regarded as important and complimentary, because the issues are assessed differently depending on the background of the particular specialist, and because it is important to understand how interested and affected parties perceive the possible potential impacts, whether on not these perceptions are based in fact. Where perceptions are not supported by objective and scientifically-based assessments, is pointed out.

The social impact assessment (SIA) assessed the following categories of potential impacts:

- Accommodation of staff and construction workers;
- Influx of job seekers;
- Increase in number of informal illegal dwellings;
- Creation of employment opportunities;
- Business opportunities;
- Impact on criminal activities;
- Risk of STDs, HIV and AIDS;
- Municipal services;
- Traffic impacts;
- Noise and dust impact;
- Loss of employment after construction;
- Visual impacts;
- Impact on social infrastructure and facilities;
- Impact on sense of place;
- Future land use; and
- Perceived risks associated with nuclear incidents.

The identification and assessment of these issues in the SIA was based on the following:

- Issues identified during the scoping process;
- Planning and policy documents pertaining to the area;
- Interviews with key interested and affected parties;
- The experience of the SIA specialist with social impacts in similar developments; and
- The experience of the author in the field of social assessment.

Owing to the fact that the nature of impacts is fairly similar across all three alternative sites, the potential impacts will not be discussed per site, as this would lead to unnecessary repetition. Instead, potential impacts will first be discussed generically, where after the difference in the consequence and significance of the impacts per site will be discussed.

9.23.1 Generic social impacts

(a) Accommodation of staff and construction workers

Large numbers of workers will place tremendous strain on the provision of temporary and permanent accommodation. The Vendor and Eskom staff requirements implicates an estimated influx of 3 837 workers (peak period) and their families to the nuclear power station project area. The total population influx is estimated at 10 500 people, to be accommodated on an area of approximately 167.2 ha.

A Construction Village will be required to accommodate approximately 3 750 people. The positioning of the Construction Village still needs to be determined, and is a sensitive issue with valuable opportunities and benefits, but also the potential for negative impacts on human well-being.

(b) Influx of job seekers

This potential impact deals with the influx of job seekers to the site during the construction phase. These job seekers, including those from areas outside the "local" area, enter the area with the hope of securing employment. When they do not secure employment, the potential exists that they will contribute to problems experienced with informal settlement, pressure on existing resources, services and infrastructure. The possibility further exists that they may contribute towards crime and other social problems such as alcohol abuse and prostitution.

(c) Informal developments and settlements

Related to the above–mentioned influx of people, there will be an increase in unplanned development and informal settlements surrounding the nuclear power station site. If not carefully managed, this type of uncontrolled development is also likely to result in an increase in an array of social pathologies such as crime, prostitution and alcohol and drug abuse.

(d) Creation of employment opportunities

The nuclear power station offers the potential for unemployed people to gain meaningful employment during the construction phase. It is estimated that the construction phase could take up to 9 years from the commencement of construction until commissioning of the nuclear power station. It is envisaged that at least 25 % of the construction workers will be sourced from the local labour force.

(e) Business opportunities

A significant number of business opportunities will be created for local companies / service providers and SMMEs. The utilisation of local suppliers and service providers can be promoted through local procurement and pro-active targeting processes via an open and transparent tender process for all construction related activities.

(f) Impact on criminal activities

The result of a large influx of people into the area as employees or in search of work could result in an increase in criminal activities. It is also possible that, during the construction phase of the project, an opportunistic criminal element may take advantage of increased activities in certain areas around construction sites.

(g) Increased risk of sexually-transmitted diseases

Due to the influx of construction workers and transport workers into the area, it is likely that there will be an increase in the prevalence of sexually-transmitted diseases (STDs), including HIV and AIDS. It is well documented that an increase in the risk of STDs is associated with an influx of workers, particularly migrant workers, and/or any increase in truck traffic into or through an area.

(h) Pressure on municipal services

The influx of construction personnel, operational personnel and others seeking economic opportunities will result in an increased demand for municipal services, including water, sanitation, roads, waste and waste removal. Increased vehicular movement during the construction phase may influence daily living and movement patterns of community members in the surrounding communities.

Provided that the tax base of local municipalities increases in parallel to the influx of people, the municipalities will be able to fund the increase in service provision, but inevitably there will be some people who will not enter the formal economy and will not pay rates and taxes. The limited availability of certain resources (e.g. water), also needs to be considered. According to the specialist report on water provision to the nuclear power station sites, there are severe limitations on the availability of fresh water, which is one of the prime reasons why Eskom has opted for desalination to provide fresh water for construction and operation.

(i) Noise and dust impacts

Increased levels of noise and dust may impact negatively on the quality of life of people living close to the proposed nuclear power station site and along transport routes close to the sites.

(i) Loss of employment after construction

Unskilled workers would lose their jobs once construction of the nuclear power station has been completed. Unless alternative employment is available, these workers will be left without income and may then become an additional burden on social services.

(i) Visual impact and change in the sense of place

The nuclear power station will change the visual character and quality of the local regions in which they are located. With the exception of Duynefontein, where there is already an adjacent nuclear power station, and which lies on the boundary of a metropolitan area, A nuclear power station at both other sites will result in a marked change in the sense of place, from primarily nature-based and agricultural to a noisy industrial environment, particularly during the construction phase. However, once construction has ceased, the planned maintenance of the Eskom property around the nuclear power station as a nature reserve (as evidenced at Koeberg), will to some extent (apart from the continued visual presence of the nuclear power station) return the natural sense of place to the area.

(j) Impact on land use

As indicated in Chapter 3 of this report, it is likely that, following final agreement from the NNR, that an Emergency Planning Zone of 800 m, within which no development may occur, will be established around the proposed power station. At all alternative sites, this zone will fall entirely within the Eskom owned property, and it would therefore have no direct impact on private development. At Duynefontein, the EPZ for the proposed Nuclear-1 nuclear power station will be substantially smaller than the current EPZ for Koeberg. The proposed power station would therefore not directly restrict future land use patterns outside the 800 m EPZ. The direct impact will relate to aspects such as ensuring proper and safe access to the power station and not to land use restrictions.

The proposed power station may lead to an indirect change in land use. It could well be that the presence of a power station will influence the nature of the land use in the vicinity in the same way as an industrial area influences its surroundings, however to a lesser extent than an industrial area, as there will be a distance of at least 800 m between the proposed power station and the closest development. It will thus be important that the development of the power station be planned for in a proper manner within the context of local and regional spatial development frameworks. At locations such as Thyspunt and Bantamsklip, where the power station is located in an undeveloped or remote area the change of land use might not occur at all, as there will be no .

It is therefore foreseen that the development of the power station is unlikely to result in the restriction of land uses, which cannot be appropriately dealt with through existing planning tools / legislation.

(k) Perceived risks of nuclear incidents

During the process of public consultation, it was stated clearly by various participants that they fear the impact of possible risks related to nuclear incidents. These risks are related to the following:

- Design safety;
- Nuclear accidents;
- Potential terrorist acts;
- Capacity and capability of people operating the nuclear power station;
- Strikes and labour unrest affecting daily management; and
- Reliability of communication flow, especially with reference to perception on potential risks and negative impacts on good health.

Given the generic impacts above that will apply to all three sites, the relative significance of the impacts at each site are discussed below.

9.23.2 Duynefontein

The area around the Duynefontein site may find it easier to accommodate large numbers of staff and construction workers than the other two sites, due to the development level of the area. A construction village will contribute positively to provide required accommodation for construction workers who do not have the option of alternative accommodation. Other developments in the area have the potential to absorb some of the influx of job seekers into the area. Municipal services and social infrastructure and facilities will experience additional strain. Implementation of mitigation measures is of high importance to cope with large numbers of people flowing into the area.

9.23.3 Bantamsklip

Accommodation for large numbers of staff and construction workers poses a serious problem, but can be mitigated. The erection of a construction village seems to be the preferred way to provide accommodation for construction workers, and should be done to enhance and support the building of sustainable human settlements. The exact location of the construction village, however, needs to be determined. The future of the construction village, after the construction phase has been completed, requires a proactive negotiated decision between Eskom and the local municipality. The influx of job seekers into the area will impact negatively on the rural character of the area, especially if an increase in the number of informal illegal dwellings is experienced. Municipal services and social infrastructure are inadequate to cope with the expected growth in the number of people working and living in the area. The implementation of mitigation measures is a pre-requisite to ensure proper provision of services and infrastructure.

9.23.4 Thyspunt

The situation in Thyspunt is very similar to that of Bantamsklip. However, the relative proximity of Humansdorp and Jeffreys Bay does offer some alternative options to address some of the impacts. Accommodation for large numbers of staff and construction workers poses a serious problem but can be mitigated. The erection of a construction village seems to be the preferred way to provide accommodation for construction workers, and should be done to enhance and support the building of sustainable human settlements. As in the case of Bantamsklip, the actual site for the village needs to be determined. The future of the construction village after the construction phase has been completed requires a proactive negotiated decision between Eskom and the local municipality. The influx of large numbers of job seekers into the area will impact negatively on the rural character of the area, especially if there is an increase in the number of informal illegal dwellings around the site and towards St. Francis Bay. Municipal services and social infrastructure are inadequate to cope with growth in the number of people working and living in the area. Implementation of mitigation measures is a pre-requisite to ensure proper provision of services and infrastructure.

9.23.5 Conclusion

All the identified potential impacts are relevant to all three proposed sites. However, the degree to which particular impacts will affect the social environment around the sites and the resultant rating of potential impact significance will differ between the sites due to the nature of the social environment at each site.

At a social level, a number of important issues associated with the responsibility of generating and supplying a secure source of electricity, is applicable. The first of these issues concerns the scarcity of suitable sites on which to place new infrastructure as, due to rapid development in the Western and Eastern Cape (including rapid tourism development in the St. Francis area), the requirement to upgrade existing infrastructure and the availability of suitable sites are in contradiction. This paradox begs for a need to attempt to balance the interests and welfare of neighbouring communities with the national interests of a secure electricity network. To this end, it is important to select a suitable site and to find compromises to maintain the sense of place of the affected area or at least ensure that the potential impacts on the sense of place are effectively mitigated to the lowest possible level.

The most significant potential negative impacts that may result from the nuclear power station relates to accommodation for temporary workers, particularly during the construction period. The possibility of an influx of job seekers is also a reality. Temporary workers, combined with influx of unsuccessful job seekers, can have a number of social impacts. This includes, *inter alia,* conflict with local communities, apparent competition for employment and the possibility of single men engaging in relations with local women (possibly increasing the risk of STDs, HIV and AIDS and unwanted pregnancies resulting in fatherless children). A potential increase in criminal and other illegal activities cannot be excluded.

The most significant potential positive social impact that may be associated with the proposed nuclear power station development is the provision of electricity and its related linkages to the broader national and regional economies. Additional potential positive impacts that can be optimised through appropriate mitigation include provision of temporary employment, local business opportunities (SMMEs) and possible skills development during construction. Limited employment opportunities for locals exist during the operational phase. The significance and consequence is high in the context of high levels of poverty and unemployment characterising the social environment around the three proposed sites. The extent to which local employment creation during construction can truly be considered positive, depends on the extent to which local labour is utilised and capacitated during the construction process, as well as on ensuring optimal working conditions for labourers.

The most controversial potential impact relates to the perceived risks associated with nuclear incidents. From a social point of view, risk is a “subjective experience” which is felt by, and is different, for everyone. Perceived risks could lead to a change in attitude which, in turn, could change behavior. It is therefore important to ensure a reliable flow of relevant and correct information in order for communities to differentiate between perceived and real risks.

Table 9-64: Social impacts at Duynefontein

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Accommodation during the construction phase										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Medium	No	Medium	Medium	**Medium**
Influx of job seekers										
Without mitigation	Negative	Local	Low	Medium-term	High	Low	No	High	Low	**Low**
Increase in informal illegal dwellings										
Without mitigation	Negative	Local	Low	Short-term	Possible	Low	No	Medium	Low	**Low**
Creation of employment opportunities										
Without optimisation	Positive	Local	High	Medium-term	Definite	Medium	No	High	High	**High**
Business opportunities										
Without optimisation	Positive	Local	Medium	Medium-term	Definite	Medium	No	High	Medium	**Medium**
Increase in criminal activities										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Low	No	Medium	Medium	**Low**
Increase in sexually transmitted diseases										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	High	No	Medium	Medium	**Medium**
Pressure on municipal services during the construction phase										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Low	No	Medium	Medium	**Medium**
Pressure on municipal services during the operational phase										
Without mitigation	Negative	Local	Low	Short-term	Possible	High	No	Medium	Medium	**Low**
Impact on roads and transport during construction										
Without mitigation	Negative	Local	Medium	Medium-term	High	Low	No	Medium	Medium	**Medium**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Impact on roads and transport during operation										
Without mitigation	Negative	Local	Low	Long-term	Probable	Low	No	High	Low	**Low**
Impacts on land use										
Without mitigation	Negative	Local	Low	Long-term	Improbable	Low	No	High	Low	**Very low**
With mitigation	Negligible	-	-	-	-	-	-	-	-	**-**

Table 9-65: Social impacts at Bantamsklip

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Accommodation during the construction phase										
Without mitigation	Negative	Local	High	Medium-term	Definite	Medium	No	High	High	**High**
Influx of job seekers										
Without mitigation	Negative	Local	Medium	Medium-term	High	Medium	No	High	Low	**Medium**
Increase in informal illegal dwellings										
Without mitigation	Negative	Local	Medium	Medium-term	Possible	Medium	No	Medium	Medium	**Medium**
Creation of employment opportunities										
Without optimisation	Positive	Local	High	Medium-term	Definite	Medium	No	High	High	**High**
Business opportunities										
Without optimisation	Positive	Local	Medium	Medium-term	Definite	Medium	No	High	Medium	**Medium**
Impact on criminal activities										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Low	No	Medium	Medium	**Low**
Increase in sexually transmitted diseases										
Without mitigation	Negative	Local	Medium	Medium-term	High	High	No	Medium	Medium	**Medium**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Pressure on municipal services during the construction phase										
Without mitigation	Negative	Local	Medium	Medium-term	Definite	Low	No	High	Medium	**Medium**
Pressure on municipal services during the operational phase										
Without mitigation	Negative	Local	Low	Short-term	Possible	High	No	High	Medium	**Low**
Impact on roads and transport during construction										
Without mitigation	Negative	Local	Medium	Medium-term	High	Low	No	High	Medium	**Medium**
Impact on roads and transport during operation										
Without mitigation	Negative	Local	Medium	Long-term	Probable	Low	No	High	Low	**Low**
Impacts on land use										
Without mitigation	Negative	Local	Low	Long-term	Improbable	Low	No	High	Low	**Very low**
With mitigation	Negligible	-	-	-	-	-	-	-	-	**-**

Table 9-66: Social impacts at Thyspunt

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Accommodation during the construction phase										
Without mitigation	Negative	Local	High	Medium-term	Definite	Medium	No	High	High	**High**
Influx of job seekers										
Without mitigation	Negative	Local	Medium	Medium-term	High	Medium	No	High	Low	**Medium**
Increase in informal illegal dwellings										
Without mitigation	Negative	Local	Medium	Medium-term	Possible	Medium	No	Medium	Medium	**Medium**
Creation of employment opportunities										

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Without optimisation	Positive	Local	High	Medium-term	Definite	Medium	No	High	High	**High**
Business opportunities										
Without optimisation	Positive	Local	Medium	Medium-term	Definite	Medium	No	High	Medium	**Medium**
Impact on criminal activities										
Without mitigation	Negative	Local	Medium	Medium-term	Probable	Low	No	Medium	Medium	**Low**
Increase in sexually transmitted diseases										
Without mitigation	Negative	Local	Medium	Medium-term	High	High	No	Medium	Medium	**Medium**
Pressure on municipal services during the construction phase										
Without mitigation	Negative	Local	Medium	Medium-term	Definite	Low	No	High	Medium	**Medium**
Pressure on municipal services during the operational phase										
Without mitigation	Negative	Local	Low	Short-term	Possible	High	No	High	Medium	**Low**
Impact on roads and transport during construction										
Without mitigation	Negative	Local	Medium	Medium-term	High	Low	No	High	Medium	**Medium**
Impact on roads and transport during operation										
Without mitigation	Negative	Local	Medium	Long-term	Probable	Low	No	High	Low	**Low**
Impacts on land use										
Without mitigation	Negative	Local	Low	Long-term	Improbable	Low	No	High	Low	**Very low**
With mitigation	Negligible	-	-	-	-	-	-	-	-	**-**

9.24 Suitability of transport systems

The construction phase of a nuclear power station at any location will require the transportation of equipment, people and materials to and from site. Transportation for a nuclear power station construction project, other than normal construction projects, requires the transport of exceptionally heavy loads to the sites. The heaviest load to be transported to the sites will be a “Self Propelled Modular Transporter” (SPMT) as indicated in **Figure 9-23** and **Figure 9-24**. An SPMT’s dimensions are approximately 42 m in length and can be either 5.33 m (two trailers wide) or 8.23 m (three trailers wide) in width.

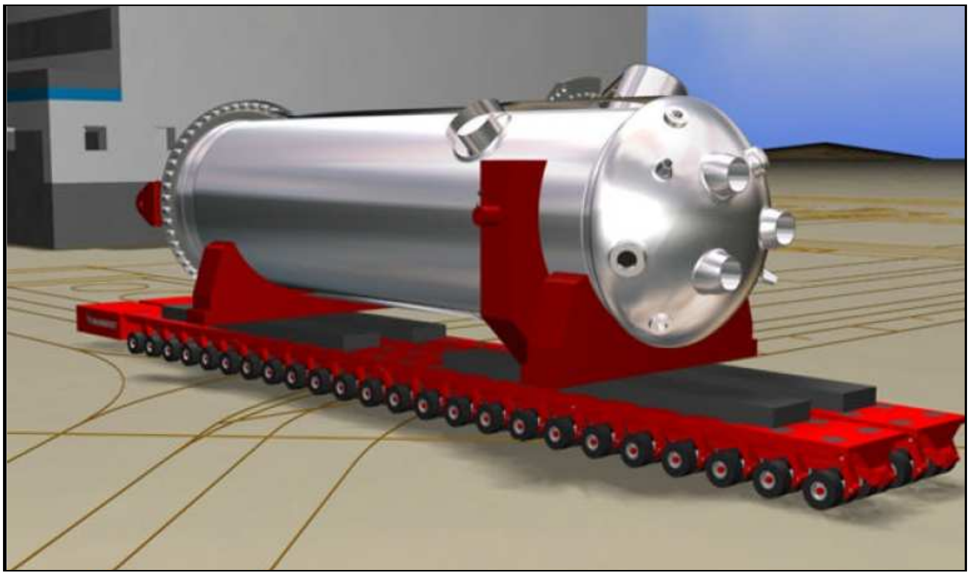

Figure 9-23: Graphic representation of an SPMT

Figure 9-24: A SPMT utilising the entire width of a road

The transportation impact assessment assessed the ability of the current transport systems, including roads and harbours, to accommodate the expected construction and operational traffic to and from the nuclear power station sites and recommends upgrades that need to be made in order to cater for the expected increase in the volume and nature of traffic.

The following construction phase impacts were identified:

- Daily construction related transport impacts:
  - Access;
  - Traffic analysis;
  - Parking;
  - Public transport; and
  - Non-motorised transport.
- Impacts of heavy load transport to the Nuclear-1 site; and
- Emergency evacuation impacts (Duynefontein only).

The following operational phase impacts were identified:

- Normal daily transport impacts
  - Access;
  - Traffic analysis;
  - Parking;
  - Public transport; and
  - Non-motorised transport.
- Low to medium nuclear waste transport;
- Emergency evacuation impacts; and
- Air and shipping route impacts

In traffic engineering terms, Level of Service (LOS) is used determine the effectiveness of elements of transportation infrastructure. This defines the degree to which traffic flows uninterrupted. LOS A indicates best effectiveness (i.e. freest flow of traffic) and LOS F indicates the least effective traffic flow, associated with significant delays and congestion. LOS A describes conditions where traffic flows at or above the posted speed limit and all motorists have complete mobility between lanes. This occurs late at night in urban areas and frequently in rural areas. LOS D is acceptable within an urban environment. LOS F is the lowest measurement of efficiency for a road's performance. This indicates that flow is forced, every vehicle moves in lockstep with the vehicle in front of it and there frequent slowing is required. Technically a road in a constant traffic jam would be at LOS F. LOS F describes a road for which the travel time cannot be predicted demand outstrips the road’s capacity.

9.24.1 Duynefontein

(a) Proposed access

Construction vehicle access is proposed to be via the existing R27 / Emergency Access Road intersection (Access 2) to isolate the Nuclear-1 construction vehicle impact on the normal traffic operations of the Koeberg nuclear power station as well as from the possible PBMR construction traffic. The eastern leg of the R27 / Main Access Road intersection is proposed to be constructed by 2013 to give access to the PBMR construction area.

Table 9-67 indicates the LOS for relevant intersections and the recommended interventions to ensure an acceptable LOS for the Duynefontein road routes.

(b) Heavy and exceptionally heavy loads

According to the Nuclear Siting Investigation Programme (NSIP) report (Eskom, 1994), several bridges between Cape Town Harbour and Duynefontein cannot accommodate exceptionally heavy loads. Therefore utilising Cape Town Harbour for exceptionally heavy loads was dismissed as an option.

Route

- Due to the low speed (5 km/hr) at which the SPMT travels, approximately two stops would have to be constructed along the R27, the first could possibly be at or near the Engen One Stop approximately 10 km from the R79 / R27 intersection. Approximately six picnic spots as, spaced approximately 15 km apart, could be used as traffic lay byes during heavy load transport. These aspects should be investigated in more detail in a Heavy Load Traffic Management Plan.
- The Modder River Bridge located approximately 27 km from the R27 / Koeberg Main Access intersection, has been preliminarily assessed as part of the investigation "Transport Study from Saldanha Harbour to Koeberg Power Station for the Exceptionally Heavy SSC, and is seen to be structurally inadequate to accommodate the exceptionally heavy load being transported by the SPMT.
- The construction of a bypass upstream of the bridge should be undertaken to traverse the Modder River. The SPMT is expected to gain access to the site via the main access on the R27.
- It is recommended that exceptionally heavy loads should be transported during the dry season, on weekdays and during non-peak periods.

(c) Transport of radioactive waste

As indicated in **Chapter 3**, low to medium-level radioactive waste produced by Nuclear-1 will be stored at Vaalputs in the Northern Cape. Two to four shipments of low to medium-level radio active waste will be made each week. It is proposed that the waste is transported using the current route to Vaalputs via the N7. Currently approximately 48 low to medium radioactive waste consignments are transported from Koeberg to Vaalputs annually as part of the normal operations. If Nuclear-1's waste transport consignments coincide with Koeberg's consignments, the potential impacts on the transportation network will be minimal.

(d) Emergency evacuation

Koeberg's 2005 Emergency Plan currently in place will be required to be updated to include the evacuation of the Nuclear-1 (6 000 persons) construction workers. If an emergency evacuation is required it is expected that a total of 8 500 construction workers would have to be evacuated, utilising approximately 130 x 65 seater buses, within four hours.

The transport network road capacity currently available (2005) to accommodate the planned evacuation is approximately 4500 vehicles.

(e) Impact on air routes

A Site Safety Report addresses all airports and air routes and Nuclear-1's impacts on those routes, was completed for the Koeberg in 2006. Due to the Nuclear-1 falling within Koeberg's safety zones (5 km UPZ and 16 km EPZ) the potential impacts of Nuclear-1 on air routes will be the same as Koeberg.

(f) Impact on shipping

Due to the Nuclear-1 falling with the Koeberg's safety zones (5 km UPZ and 16 km EPZ) the impacts of Nuclear-1 on shipping lanes will be the same as Koeberg.

9.24.2 Bantamsklip

(a) Proposed access

Access to the Nuclear-1 construction site is expected to be directly off the R43 with two new access roads proposed.

Table 9-68 indicates the LOS for relevant intersections and the recommended interventions to ensure an acceptable LOS for the Bantamsklip road routes.

(b) Heavy and exceptionally heavy loads

According to the NSIP Southern Cape Summary Report (Eskom 1994) the feasibility of transporting heavy loads from Table Bay Harbour in Cape Town to the Bantamsklip site was investigated by Drennan, Maud and Partners in 1988. According to this study Cape Town Harbour (Table Bay Harbour) is ideally situated and has the infrastructure capabilities for loading and offloading heavy loads.

In terms of normal heavy vehicle routes, the main section of the heavy vehicle route from Bantamsklip is along the R43 to the N2 via Sir Lowry's pass into Cape Town. However, route studies have shown that there are several bridges along this route that cannot accommodate exceptionally heavy loads. Therefore transporting exceptionally heavy loads from the Table Bay harbour to Bantamsklip via the preferred road option would require major upgrades. The cost of these upgrades has been investigated in the economic impact assessment, and the findings thereof are reflected in **Section 9-21** of this report.

Transport of the exceptionally heavy loads via a barge from Table Bay Harbour to a suitable area on the beach close to Bantamsklip was therefore considered. However, this option was rejected on the basis of the construction impacts on the coastline.

(c) Transport of radioactive waste

Two to four shipments of low to medium-level radio active waste to Vaalputs will be made from Bantamsklip each week. It is proposed that the waste be transported via the N2 and N7 to Vaalputs**.** Maud, Drennan and Partners conducted a preliminary investigation in 1988 with regard to the transport of nuclear waste from the Bantamsklip site to Vaalputs. The results of this study indicates that road transport is the most viable option.

At Koeberg, shipments of radioactive waste over a 3 years period, 2007 – 2009 resulted in:

- Steel drums - 8 shipments/year (ave) therefore +/- 1 shipment/month (120 drums per shipment); and
- Concrete drums - 39 shipments/year (ave) therefore +/- 3 shipments/month (5 drums per shipment)

Maximum shipments per week came to two shipments (either metal or concrete) i.e. 3 days for one shipment Koeberg-Vaalputs-Koeberg and one day rest between the two shipments.

(d) Emergency evacuation

An Emergency Plan for an nuclear power station at Bantamsklip must be compiled to include non-nuclear and nuclear accidents. During the operational phase, the 1 300 staff would be evacuated using approximately 434 vehicles.

A single lane road capacity is approximately 1 500 vehicles per hour. This initial assessment indicates that the road capacity is sufficient to evacuate 434 vehicles an hour. From a contingency plan point of view the upgrading of the DR 1206 gravel road, which links the R43 to Bredasdorp, should be considered, since the R43 heading west towards Pearly beach is the only current exit route. Should this site be chosen, a detailed Emergency Plan (including a Transport Model and an Evacuation Management Plan), should be compiled to enable testing of different scenarios.

(e) Impact on air routes

Bantamsklip is situated on a heading of 257° T and 35.758 NM (66.223 km) from Air Force Base (AFB) Overberg. AFB Overberg is the SA Air Force's Testing and Development centre.

It is also situated under the AFB Overberg Terminal Control Area (TCA) which extends from 6 500 to 14 500 ft above mean sea level.

One of each aircraft type in use by the SA Air Force is stationed as this base. These include fighter aircraft and helicopters. Live missile firing and bomb testing from fully weapon loaded aircraft are conducted at this facility. This facility is also used by foreign countries for aircraft and weapons testing. Exercises by local and foreign Air Forces and Navies are conducted in this area as well. A restricted area (FAR 147 - Ground level to 19 500 ft above mean sea level) has been declared for this reason. Bantamsklip is situated 13.4 NM (24.816 km) within this restricted area.

Bantamsklip is also situated 15.508 NM (27.720 km) to the east of a Danger Area, FAD 143, which extends from Ground Level to 19 500 ft. above mean sea level. This is used by the Navy as a training area, which includes the firing of live missiles and guns as well as the demolition of ammunitions.

General aviation aircraft as well as helicopters also operate along the coast at low levels. A total of 8 known aerodromes/airstrips lie within a 30NM (55.56 km) radius of Bantamsklip. The closest aerodrome is Pearly Beach which is situated 4.763NM (8.821 km) to the North-West of Bantamsklip. The runway direction is in a North-West/South-East direction. The closest air routes pass 26.597NM (49.257 km) to the north of Bantamsklip.

The Bantamsklip site would require the promulgation of new Restricted / Danger / Prohibited areas.

(f) Impact on shipping

In terms of the Sea-Shore Act (No 21 of 1935), a safety exclusion zone must be identified if a nuclear power station is built on the Bantamsklip site. The proposed exclusion zone for the Bantamsklip site is situated in domestic waters. An application to SAMSA will therefore have to be put forward to create an exclusion zone for Bantamsklip.

As indicated in the marine ecology report, if an nuclear power station is located at this site and an exclusion zone is declared, this will have a significant positive impact on the conservation of abalone, which is under threat along the South African coastline due to poaching.

9.24.3 Bantamsklip

(a) Proposed access

The NSIP Eastern Cape Summary Report (Eskom, 1994) identified two access routing options from Humansdorp to Thyspunt. One of the access route options identified is via the untarred Oyster Bay Road from Humansdorp towards Oyster Bay (Route 1). A new road will then have to be constructed from the Oyster Bay Road, approximately 5 km from Oyster Bay, crossing the mobile dune system towards the site.

The second access route option is via the R330 towards St. Francis Bay, with new surfaced road being constructed from the R330 after the Krom River crossing towards the site, crossing the mobile dune system (Route 2).

It has been proposed by Eskom that both routes be utilised during the construction period, with route 2 being mainly used by heavy and exceptionally heavy vehicles and route 1 and 2 being utilised for commuter construction traffic.

Table 9-69 indicates the LOS for relevant intersections and the recommended interventions to ensure an acceptable LOS for the Bantamsklip road routes.

(b) Heavy and exceptionally heavy loads

Revision 1 of the NSIP Eastern Cape Summary Report (Drennan *et al*. 1988) investigated the feasibility of transporting heavy loads from Port Elizabeth Harbour to the Thyspunt site.

According to this study, no off-loading crane facility exists at Port Elizabeth harbour and either Roll-on-Roll-off vessels or vessels with high capacity ship's derricks would have to be used. Port Elizabeth Harbour is the closest harbour with the infrastructure capabilities to load and offload heavy loads and should be used to transport exceptionally heavy loads to Nuclear-1. The main section of the exceptionally heavy vehicle route will be from Port Elizabeth Harbour, via the N2 and through Humansdorp via the R330 to the site.

A comprehensive traffic management plan will be required to minimise the impacts on normal daily traffic.

(c) Transport of radioactive waste

Two to four shipments of low to medium-level radioactive waste will be made from Thyspunt each week.

Maud, Drennan and Partners conducted a preliminary investigation between 1984 and 1987 with regard to the transport of nuclear waste from Thyspunt to Vaalputs. The results of this study indicates that road transport is the most viable option. It is proposed that the waste be transported by road via the N2 and N7 to Vaalputs.

(d) Emergency evacuation

The Nuclear-1's Emergency Plan must be compiled to include non-nuclear and nuclear accidents occurring at the Nuclear-1. During the operational phase, the 1 300 staff would be evacuated using approximately 434 vehicles.

A single lane road capacity is approximately 1 500 vehicles per hour. This initial assessment indicates that the road capacity is sufficient to evacuate 434 vehicles an hour. However, a detailed Emergency Evacuation Plan must be compiled to include a Transport Model to test the different scenarios and there effects on critical intersection capacities during the evacuation period.

(e) Impact on air routes

Thyspunt is situated 87 km from Port Elizabeth International Airport. It is also situated under the Terminal Control Area (TMA) of Port Elizabeth International Airport, which extends from 6500 to 14 500 ft above mean sea level. Thyspunt is situated 3.986NM (7.382 km) to the North-East of the OKSET, a Standard Instrument Departure (SID) route termination point for Port Elizabeth International Airport as well as the starting and termination point of the UQ49 Air Route. It is also 10.299NM (19073 km) to the South-South-West of EVISO, a Standard Instrument Arrival (STAR) route starting point for Port Elizabeth International Airport as well as the starting and termination point of the A402, UA402 and UZ14 Air Routes. Siting of the nuclear power station at Thyspunt may require the redesign of these procedures as well as re-routing of the Air Routes.

A total of 7 known aerodromes/airstrips lie within a 30NM (55.56 km) radius of Thyspunt. It is also situated 6.585NM (12.195 km) to the West of St. Francis Field (FACF) and 10.618NM (19.664 km) to the South-West of Paradise Beach (FAPX) aerodromes, which are both licensed aerodromes. The Thyspunt site would require the promulgation of new Restricted / Danger / Prohibited areas.

(f) Impact on shipping

In terms of the Sea-Shore Act (No 21 of 1935), a security exclusion zone must be identified if a nuclear power station is built on the Thyspunt site. However, the proposed exclusion zone for the Thyspunt site is not fully located in domestic waters and the area is therefore semi-uncontrolled.

This could result in security issues for the nuclear power station. An application will therefore have to be put forward to create an exclusion zone for Thyspunt. It should be noted that there are fishing sites along the coast of Port Elizabeth, close to Thyspunt, that will be greatly affected by the implementation of an exclusion zone.

9.24.4 Conclusion

The Duynefontein site does not require significant upgrades during the construction and operational phases of Nuclear-1 with regard to intersection upgrades and heavy load transport road upgrades. It does, however, require a significant number of stand-by evacuation vehicles to ensure safe evacuation of construction workers if an accident does occur at Koeberg during the construction period. These vehicles can be used to shuttle the construction workers to and from the site during the AM and PM peak periods.

Bantamsklip has a significant impact on the transport network with upgrades required to the public transport system, heavy load routes and road upgrades required for emergency evacuation purposes. Due to the Bantamsklip site’s isolated location, transporting heavy loads by road will require significant upgrades, which will have a high financial cost. However, from a biophysical perspective, the construction of landing facilities for barging heavy loads to site is dismissed as an option.

Thyspunt requires significant transport upgrades with regard to public transport and access during the construction phase. The R330 is proposed to be used for heavy load transport and may require pavement structure upgrades to cope with the increased heavy loads. The Oyster Bay road is proposed to be upgraded to a surfaced road to be used during the operational phase for surrounding staff access and as a required emergency evacuation route for areas such as Oyster Bay.

Table 9-67: Summary of LOS for intersections and recommended upgrades for Duynefontein

2013 construction traffic	Upgrades required	2018 operational traffic
R27 / Main Access Road		
The through movements of the R27 will operate acceptably at LOS A to LOS C during the AM and PM peak hours with no significant vehicle queues	Should the nuclear power station be constructed, signalisation of intersections along the R27 north of the Melkbosstrand Road will have to be discussed with the PGWC. The PGWC has proposed the construction of a grade separated structure at the R27 / Main Access Road intersection. This proposal is still under investigation and should be considered once the investigation is complete. An additional lane on R27 southbound and northbound approaches are proposed to constructed between the R27 / Main Access Road and R27 / Napoleon Street intersections to accommodate the additional construction-related traffic volumes. If upgraded, the critical right turn from the Main Access Road will improve from LOS F to LOS D during the PM peak hours	The intersection will operate acceptably at intersection LOS B for the AM and PM peak hours. No further upgrades are therefore required
R27 / Napoleon Street		
The south approach of the R27 will operate acceptably at LOS A during the AM and PM peak hours with non-significant vehicle queues. The west approach of Napoleon however, will operate at LOS F with a 46 vehicle queue length during the AM peak hour. An upgrade is therefore required.	This intersection may have to be upgraded to a signalised intersection or a grade separated intersection. However, if Access 1 is upgraded to a grade separated intersection, all adjacent accesses upgrades off the R27 will have to be investigated. These options are to be discussed with the PGWC. The R27 North approach between the R27 / Main Access Rd and this R27 / Napoleon intersections should be upgraded to two. The operation of the west approach of Napoleon will improve from LOS F with a 46 vehicle queue length to LOS D with a four vehicle queue length	The intersection will operate acceptably at intersection LOS A for the AM and PM peak hours with no significant vehicle queues. No further upgrades are therefore required
Ou Skip Road / Narcissus Avenue (Access 3)		
		All intersection approaches will operate acceptably with LOS A and LOS B during the AM and PM hours, with no significant vehicle queue lengths
Ou Skip Road / Main Access Road		
All approaches will operate acceptably from LOS A to LOS D during the AM and PM peak hours. The west approach of the Main Access Road will operate at LOS D with a 29 second delay during the AM peak hour		All intersection approaches will operate acceptably at LOS B during the AM and PM peak hours with no significant vehicle queues. No upgrades are therefore required
R27 / Access 2		

2013 construction traffic	Upgrades required	2018 operational traffic
The west approach of Access 2 is expected to operate at LOS F, with a 301 vehicle queue length during the AM peak hour. An upgrade is therefore required to improve the intersection capacity, as well as to ensure safety, as it is expected that a high volume of construction vehicles will utilise this access on a daily basis for the duration of the six year construction period	This intersection may have to be upgraded to a temporary signalised intersection for the duration of the construction period. However if Access 1 is grade separated, the upgrade / operation of this intersection should be investigated further. These options are to be discussed with the PGWC.	The intersection will operate acceptably at intersection LOS B for the AM and PM peak hours. No further upgrades are therefore required.
Ou Skip / Access 2		
All intersection approaches will operate acceptably with LOS A to LOS C during the AM and PM hours with no significant vehicle queue lengths		All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with no significant vehicle queues. No further upgrades are therefore required

Table 9-68: Summary of LOS for intersections and recommended upgrades for Bantamsklip

2013 construction traffic	Upgrades required	2018 operational traffic
R43 / DR01211		
All approaches will operate acceptably at LOS A to LOS E with minimal vehicle queue lengths during the AM and PM peak hours. No upgrades are therefore required.		All intersection approaches will operate acceptably at LOS A to LOS C during the AM and PM peak hours with minimal vehicle queues. No upgrades are therefore required
R43 / DR01206		
All approaches will operate acceptably at LOS A with minimal vehicle queue lengths during the AM and PM peak hours. No upgrades are therefore required.		All intersection approaches will operate acceptably at LOS A during the AM and PM peak hours with minimal vehicle queues. No upgrades are therefore required
R43 / Main Access Road		
The through movements on the R43 will operate at LOS A during the AM and PM peak hours with minimal queues. The left and right turns from the Main Access Road will operate at LOS B and LOS F during the AM and PM peak periods.	Due to the low volumes of traffic turning right heading east, no upgrades are recommended.	All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with minimal vehicle queues.

Table 9-69: Summary of LOS for intersections and recommended upgrades for Thyspunt

2013 construction traffic	Upgrades required	2018 operational traffic
R330 / Main Access Road		
The western approach of the Main Access Road is expected to operate acceptably during the AM peak however during the PM peak, the Main Access Road approach will operate at a LOS F with a 42 vehicle queue length. An upgrade is required to improve the operation of this intersection.	This intersection is proposed to be upgraded by constructing a left slip lane from the Main Access Road to the R330 .The operation of the west approach of Main Access Road will improve from LOS F with a 46 vehicle queue length to LOS C with a 16 vehicle queue length.	All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with minimal vehicle queues. No further upgrades are therefore required.
R330 / St Francis Bay Access Road		
The eastern approach of the St. Francis Bay Access Road is expected to operate at LOS F with a 13 vehicle queue length and the Golf Estate Access will operate at LOS E during the PM peak. To maintain the 2018 background traffic operation levels of this intersection, an upgrade is required	This intersection is proposed to be upgraded to a traffic circle. All approaches are expected to operate at LOS A to LOS C with no significant vehicle queue lengths.	All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with minimal vehicle queues. No further upgrades are therefore required.
R330 / Gravel Road		
All approaches will operate acceptably from LOS A to LOS D with no significant vehicle queue lengths. No upgrades are therefore required.		All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with minimal vehicle queues. No upgrades are therefore required.
Park Road / Main Street		
All approaches will operate acceptably from LOS A to LOS C with no significant vehicle queue lengths. No upgrades are therefore required		All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with minimal vehicle queues. No further upgrades are therefore required.
Main Street / Jeffrey's Bay Access Road		
The critical right turn from Park Road will operate at LOS F with a 453 second delay during the PM peak hours. To maintain the 2018 background traffic operation levels of this intersection, an upgrade is required	This intersection is proposed to be upgraded to a traffic circle. lengths with this upgrade	All intersection approaches will operate acceptably from LOS A to LOS C during the AM and PM peaks
Main Street / N2 South Off-Ramp		
All approaches will operate acceptably from LOS A to LOS D. The Main Street south approach will operate at LOS C with a 19 vehicle queue length. No upgrades are therefore required		All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with minimal vehicle queues. No upgrades are therefore required
Main Street / N2 North Off-Ramp		

2013 construction traffic	Upgrades required	2018 operational traffic
All approaches will operate acceptably from LOS A and LOS B with no significant vehicle queue lengths during the AM and PM peak hours. No upgrades are therefore required		All intersection approaches will operate acceptably at LOS A and LOS B during the AM and PM peak hours with minimal vehicle queues. No upgrades are therefore required.

9.25 Risks to human health

9.25.1 Construction phase

The construction phase is expected to have a short time span relative to the operational phase and would therefore exclude chronic health effects such as cancer. The impact of non-radioactive substances (welding fumes, paint etc.) is expected to be localised to the construction site and it is assumed that members of the public will not be allowed in this area. These exposures should be assessed and managed in accordance with occupational exposure limits. Environmental dust generation from the site will be controlled in accordance with a health risk management plan, based on ambient air quality guidelines and standards.

There will be no nuclear fuel on site during the construction phase and the only radiological impact would be due to natural background levels. These levels may increase slightly due to natural radioactivity in construction materials, but impacts associated with naturally occurring radioactive material (NORM) during construction of a nuclear power station would not be significantly different from other construction projects that use natural materials. Impacts associated with radiation exposure during the construction phase are thus not regarded as significant.

9.25.2 Operational phase

There is no direct evidence of increased risk of non-cancer diseases at doses below about 100 mSv and such health outcomes are not regarded as significant in the impact identification. The NNR dose limits are much lower than 100 mSv. The primary concern about exposure to ionising radiation in the low dose region is the potential for development of radiogenic cancers and heritable disease. These effects are interpreted as stochastic in nature, with no threshold, and they increase in frequency in proportion to the radiation dose. Potential impacts must therefore be assessed in terms of the interpretation of the non-threshold nature of stochastic effects. All exposures must be assessed, even cases where exposures may be very low.

The dose assessment methodology will be applied for quantification of radiological dose to the critical group for each candidate site. The quantified doses for the site-specific exposure scenarios are compared with the NNR dose limits and dose constraints considering also the rigorous application of the As Low As Reasonably Acceptable (ALARA) principle.

9.25.3 Decommissioning

In accordance with Regulation No. R. 388 promulgated by the NNR, a decommissioning strategy must be submitted to the NNR as part of the prior safety assessment that is to be conducted prior to commencement of operations. This decommissioning strategy has to be updated throughout the operation of the nuclear power station as a basis for detailed decommissioning planning and for authorisation of specific actions or phases of decommissioning, with due regard to dose limits and probabilistic risk limits as stipulated in Regulation No. R. 388 and its Annexures 2 and 3. Decommissioning will thus be under rigorous regulatory control, ensuring health risks ALARA. Assessment of radiological impacts during decommissioning should thus be within the same framework as the assessment of the operational phase.

9.25.4 The no-go scenario

Because of the insignificant impacts of an nuclear power station on public health due to regulatory control through dose limits and dose constraints, as well as through the rigorous application of the ALARA principle, there would be no measurable difference at any of the proposed sites in the frequency of cancer, hereditary effects and other diseases that may be associated with exposure to ionising radiation whether an nuclear power station is constructed or not.

9.25.5 Impact Assessment

The NNR will issue a license for a site for construction of an nuclear power station only if full compliance with the dose limits and dose constraints is demonstrated. The dose limits and dose constraints apply to the concept of a technology envelope, within which any reactor technologies can be accommodated for the required generation capacity at a particular site.

Submissions to the NNR will demonstrate that the combined impact of gaseous and liquid discharges of radioactive substances will be below regulatory public dose limits, dose constraints and in accordance with the ALARA objective. The primary concern is the risk of developing radiogenic cancer.

The cancer risk range that is deemed acceptable in various parts of the world is from 1 case in a million to 1 case in ten thousand. This risk range reflects a *de minimis* lifetime risk that is so trivial that any action to reduce risk is not warranted.

The NNR regulatory dose limit of 1 mSv/year is an upper limit of exposure, representing a level of *de manifestis* risk, above which regulatory action would be taken to reduce risks.

The importance of the ALARA objective in controlling exposures of the public is demonstrated by the fact that for nuclear facilities in the USA, the average annual individual dose is only 0.05 per cent of the annual dose limit of 1 mSv for all controlled sources combined. Individuals who receive the highest dose (the critical group) normally do not receive more than about 10 per cent of the dose limit and often substantially less. This is achieved through rigorous application of the ALARA objective. The NNR follows similar rigorous application of the ALARA objective and doses to members of the public will be controlled with similar effectiveness.

Application of this nominal cancer risk coefficient produces cancer risk estimates that in practice would not be higher than the calculated value, but most likely would be lower. For exposures below the annual dose limit of 1 mSv, as required by the ALARA principle, the upper limit of cancer risk would be in the *de minimis* lifetime risk range. This conservative approach confirms that cancer risks to members of the community would be trivial under the application of the rigorous regulatory control of the NNR. Protection against the development of radiogenic cancer is considered to be adequate for protection against hereditary effects and other radiation-associated diseases. The potential impact on human health due to exposure to ionising radiation from an nuclear power station during normal operation under these conditions is therefore assessed as of low significance.

The assessment of design Basis Accidents (DBAs) has indicated that the probability of occurrence of such events is very small during the operational lifetime of an nuclear power station. However, it will be demonstrated in the submission to the NNR that the dose to the critical group during such an event would be within the dose limit of 50 mSv and ALARA. The potential impact due to DBAs is therefore assessed as of low significance over the lifetime of a nuclear power station.

Dose compliance assessments are conducted on the side of caution, because the dose limits apply to members of the so-called critical group, which represents the highest exposed individuals. Other members of the community would receive even lower doses.

9.25.6 Mitigation

The likelihood of adverse health impacts associated with radiological exposure due to a nuclear power station is regarded as remote. A key focus of accident prevention has long been the use of multiple precautionary defences against the consequences of failures. This approach of *'defence in depth'* is aimed at preventing equipment failures and human errors and mitigating their consequences, should any of these happen. Comprehensive assessment methodologies are applied in the design phase of nuclear installations by applying such methods as failure-mode and effects analysis, cause-consequence analysis and fault tree analysis, to select components and materials that have an extremely low probability of failing during operation. Furthermore, should components or materials fail, or should human errors lead to consequences that may have adverse effects on human health and the environment, several layers of backup systems and other controls are automatically introduced to stop the propagation of the IE or to mitigate its consequences.

In addition to regulatory dose constraints and dose limits set to protect human health, the NNR also applies the ALARA principle, thereby assuring by a large margin of safety that radiological doses to members of the community would be in the *de minimis* lifetime risk range. Furthermore, should radiological doses approach the *de manifestis* level of risk, the NNR would intervene by taking regulatory action to reduce the risk. There are thus several layers of mitigation to protect human health against the consequences of radiological exposure.

9.25.7 Conclusion

Provided that the NNR's statutory limits are adhered to, and that Eskom can demonstrate to the NNR that the design of the proposed Nuclear-1 will not exceed these statutory constraints, then there should be no impact on human health during normal operations. This finding is supported by the air quality assessment, which found that airborne radionuclide levels would be so low that there would be no effect on human health.

9.26 Impacts of waste

9.26.1 Impacts of construction phase waste

The nature of the impacts of this waste is unlikely to have far-reaching effects, is not typically life threatening and is largely a threat to the environment. Unmanaged waste, nonetheless, represents a pollution risk to the environment, will be aesthetically unattractive and generally, will not conform to norms for responsible environmental management. Potential impacts will be felt by flora and fauna and by the surrounding human population in terms of aesthetic degradation.

9.26.2 Impacts of non-radioactive construction waste

Unmanaged waste of this type does represent a threat to human and natural environments. The most significant potential impacts include:

- Potential contamination of surface and groundwater due to poorly managed concrete batching operations and materials handling;
- Potential damage to flora and contamination of surface and groundwater due to poorly managed excavation operations and stockpile management; and
- Air pollution due to excavation and haulage activities, as well as concrete batching (cement and sand dust).

9.26.3 Management of General and Hazardous, non-radioactive, construction waste

The Duynefontein site is favourably located with regard to the availability and proximity of disposal sites licensed to accept both General and Hazardous (non-radioactive) wastes. The municipal Vissershok waste disposal site and the adjacent privately managed Vissershok Waste Management Facility are licensed to handle General and low-hazard waste (**G and H:h**) and General and high–hazard waste (**G and H:H**) respectively. These sites are some 25 km from Duynefontein. With regard to the lifespan of these disposal sites, the City of Cape Town site has a projected life of some 20 years, but a regional facility in the Atlantis area is in an advanced stage of planning.

If a power station is constructed at Thyspunt, Eskom would need to make use of the Aloes waste site, about 20km from Port Elizabeth in the direction of Grahamstown. This site has an **H:H** rating and is estimated to have a remaining lifespan of only approximately 5 years. This site in its current design would therefore run out of capacity prior to completion of construction at Thyspunt. However, expansion of the site is currently being planned. General waste would also have to be disposed at this site.

If a power station is constructed at Bantamsklip, Eskom would need to make use of the Karwyderskraal Regional landfill site, approximately 15 to 20 km from Hermanus. This site has a GMB+ rating and has remaining capacity for more than 20 years. There is also a small disposal site at Gansbaai (30 km east of Hermanus) that could accept general waste. Hazardous waste would need to be transported to the Vissershok facility.

Accordingly, there appears to be sufficient disposal capacity, although long-term agreements should be entered into with the managers of these sites to secure disposal space.

Although the management of wastes generated at the power stations must follow standard procedures, the overall structure will have to ensure that radioactive and non-radioactive wastes are kept separate – both in their generation phase, as well as for transport and disposal. Thus, the potential for recycling will have to be closely examined. The separation of the radioactive fraction is a challenge and may make recycling inefficient and difficult.

9.26.4 Management of radio active (nuclear) waste

As indicated in **Chapter 3** of the Draft EIR, three types of waste will be generated at the proposed Nuclear-1, irrespective of the location of the plant and its associated infrastructure. These are:

- High level waste (HLW)
- Intermediate-level waste (ILW);
- Low-level waste (LLW[14]).

9.26.5 (a) Management of Low-Level and Intermediate-Level Radioactive Waste

Low-Level Waste (LLW) and Intermediate-Level Waste (ILW) will be controlled within the radiological zones of the power plant and will be transported by road to Vaalputs for long-term storage, as prescribed by the Eskom operating procedures.

Using the data obtained from Eskom for the Koeberg Nuclear Power Station over the 2007 to 2009 period as an example, it is anticipated that the following shipments of ILW will be made to Vaalputs:

- Steel drums – average of 8 shipments of 120 drums per shipment/ annum i.e. approximately 1 shipment per month
- Concrete drums – average of 39 shipments of 5 drums per shipment / annum and therefore approximately 3 shipments per month. The ILW is mixed in a very specific way with concrete and sealed into appropriately marked concrete drums. Therefore, even in the event of a spillage of ILW, there is no risk of contamination.

It is expected that there will be a maximum of two shipments of waste per week (either in metal or concrete drums) i.e. three days for one shipment and one day rest between shipments.

Vaalputs has been designed and permitted with sufficient capacity for handling the LILW of Koeberg plus three additional conventional nuclear power stations. The currently active area used for waste disposal at Vaalputs is 1 km^2, of which only 5% is has been used after the more than 20 years of Koeberg's operation. The total area of the property is 10 000ha (Beyleveldt, pers. comm. 2010).

The concept for the disposal of solid waste at Vaalputs consists of near-surface trenches using metal containers for low-level waste, and concrete containers for intermediate level waste. The long-term safety of the facility, which complies with international best practices for the disposal of low and intermediate level waste, has been demonstrated for a national inventory of radioactive waste.

Provided that the transport of LILW to Vaalputs is carried out strictly according to the IAEA transport regulations, the potential environmental impact are considered to be of low significance, as the transport operations will be well controlled.

9.26.6 (b) Management of High-Level Radioactive Waste

Internationally, spent fuel is sent for reprocessing (for re-use as nuclear fuel) or it is sent to a national repository for HLW. In South Africa, neither of these options currently exists, and HLW is kept in contained storage at the nuclear power station. At Koeberg, spent fuel is stored under water in storage racks with sufficient capacity to contain these assemblies for the life of the station. Water cools the fuel rods and serves as an effective shield to protect workers in the fuel storage building from radiation. The storage ponds are steel-lined concrete tanks, approximately eight metres deep and filled with water.

[14] Low-Level and Intermediate-Level Waste are collectively referred to as LILW.

Alternatives to on-site storage of HLW will depend on the legislative provisions that are put in place to manage HLW. The South African Cabinet has approved a National Radioactive Management Policy and Strategy in 2005. The purpose of the policy and strategy document is to ensure the establishment of a comprehensive radioactive waste governance framework. In response to that, the National Radioactive Waste Disposal Institute Act, 2008 (Act No. 53 of 2008) was promulgated in January 2009 and came into effect in December 2009. The purpose of this Act is to ensure that the capability and capacity of the institutions to manage radiological waste is addressed. This Act provides for the establishment of a National Radioactive Waste Disposal Agency in order to manage radioactive waste (a function currently managed by NECSA). Although the Act has come into effect, it will still be some time before the Agency is formally constituted.

At present, South Africa does not have an authorised facility for the disposal of HLW. However, Vaalputs is being considered as a site for the disposal of HLW (http://www.engineeringnews.co.za/article/high-level-nuclear-waste-may-be-disposed-at-vaalputs-in-future-2009-03-25 - accessed on 16 February 2010 and Beyleveldt, pers. comm. - 24 February 2010). Before use as a HLW facility, the necessary environmental and NNR licensing processes would need to be followed. Thus, the only currently feasible alternative is for Eskom to store HLW in the Nuclear-1 generator building, as is the case at Koeberg. The proposed Nuclear-1 facility must be designed in such a way that such long-term storage within the generator building is possible.

The generators of radioactive waste remain responsible for all liabilities in connection with such radioactive waste under their control until such time as the National Radioactive Waste Disposal Agency is able to take responsibility for this waste.

9.26.7 Mitigation

The following mitigation measures must be adhered to:

- An emergency response plan for road transport of LLW and ILW must be in place to swiftly deal with any accidental spillages of these wastes during transport to Vaalputs.
- The fuel assembly must be designed to safely hold all HLW spent fuel for the duration of the life span of the nuclear power station.
- The Construction EMP must contain measures to prevent poor waste disposal practices and to mitigate against the irresponsible handling and disposal practices.
- Strict control must be exercised over the transport of non-radioactive waste from the Nuclear-1 site to the appropriate regional waste disposal site. Waste transport contractors must be subjected to regular audits to ensure that waste is disposed at its intended destination.
- Disposal sites at which waste from Nuclear-1 is disposed must be audited on a periodic basis to ensure that they comply with legal requirements.

9.26.8 Conclusion

The management of construction waste (General and Hazardous but non radio-active) and the mitigation of impacts will follow standard practices. This process must be adequately described in the Construction Environmental Management Plan

The management of radioactive waste is conducted according to standards as laid down by the International Atomic Energy Agency as follows international best practice. The Vaalputs nuclear waste site has the capacity to handle the additional waste that will be produced by Nuclear-1 and is regarded as a safe and well-managed site. The storage of high-level waste (as has been the practice at Koeberg) on site holds no significant risks, provided that the spent fuel waste is contained within a protected and shielded facility with the same degree of care as the active nuclear fuel.

Table 9-70: Impacts associated with radioactive waste

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Radioactive contamination of groundwater due to unintended release of Low and Intermediate Level Waste (Commissioning, Operational and Decommissioning Phase)										
Without mitigation	Negative	Local	Medium	Medium-term	Low	Reversible	No	High	Medium	**Medium**
With mitigation	Negative	Local	Low	Medium-term	Improbable	Reversible	No	High	Medium	**Low**
Radioactive contamination of groundwater due to unintended release of High Level Waste (Operational Phase)										
Without mitigation	Negative	Local	Medium	Long-term	Very low	Reversible	No	High	High	**High**
With mitigation	Negative	Local	Low	Medium-term	Very low	Reversible	No	High	Low	**Low**
Groundwater impacts of radioactive waste disposal at Vaalputs (Operational Phase)										
Without mitigation	Negative	Local	Medium	Medium-term	Low	Reversible	No	High	Low	**Low**
With mitigation	Negative	Local	Low	Medium-term	Improbable	Reversible	No	High	Low	**Very Low**

Impact	Nature	Extent	Intensity	Duration	Probability	Reversibility	Irreplaceable resources	Confidence	Consequence	Significance
Spillage of radioactive waste during transport (Operational Phase)										
Without mitigation	Negative	Local	Low to High[15]	Short-term	Low	Reversible	No	High	Low	**Low to High**
With mitigation	Negative	Local	Low	Short-term	Improbable	Reversible	No	High	Low	**Very Low**

[15] Intensity of a spillage is entirely dependent on where the spillage occurs i.e. within a sensitive environment or not.

FACTORS INFLUENCING TRANSMISSION INTEGRATION

9.27 Transmission integration factors

For the electricity generated by the proposed nuclear power station to be made available to end-use customers, it needs to be transmitted from the high voltage yard at the power station through a complex network of high voltage transmission lines and then through a series of distribution lines of ever decreasing voltage, until it reaches to end user. The ease with which electricity produced at the power station can be “integrated” with the rest of the transmission system is dependent on a number of technical factors that Eskom needs to consider. However the Eskom transmission system design philosophy is to connect new base load generation to the closest load wherever possible. These considerations have been presented in an Eskom publication (Eskom 2008) that compares the relative ease of integration in the Eastern and Western Cape Provinces and at all three alternative sites.

Broadly speaking, the transmission integration requirements are categorised as follows:

- System reliability and quality of supply;
- Integration considerations;
- Future potential for generation in each of the provinces.

Considerations of system reliability and quality of supply are indicated in **Table 9-71**. Transmission integration considerations are indicated in **Table 9-72.**

Table 9-71: Factors relating to system reliability, security and quality of supply

Factor	Western Cape (Duynefontein and Bantamsklip)	Eastern Cape (Thyspunt)
Generation versus load balance and system adequacy	• Substantial generation capacity already installed • 80 % of Western Cape can be supplied from existing local generation during peak generation • Nuclear-1 would result in excess generation capacity during peak generation	• Existing Open Cycle Gas Turbine in East London provides only 4 % of the Eastern Cape load. OCGT is only utilised during peak periods to avoid load shedding. • There is no base load supply in the Eastern Cape
Quality of supply impact	Limited improvement in quality of supply	Would result in significant improvement of quality of supply
Islanding capability[16]	Already exists	Would be introduced in the network
Diversity of sources of power	• Able to receive power from local generation pool and the transmission system • Nuclear-1 will increase capacity of the generation pool and will have to export the excess.	• Entirely dependant on the transmission system for power • Nuclear-1 will create a new local generation pool which will supply the local load centres and export the excess..

[16] Islanding refers to the ability to isolate a portion of the network from the remainder of the system. This is particularly helpful during technical problems, because it allows a part of the system to remain stable while other parts of the system are being restored.

Table 9-72: Transmission integration factors

Factor	Duynefontein	Bantamsklip	Thyspunt
Line length required	190 km of 400 kV lines combined with cables	990 km of lines (400kV and 765 kV lines combined)	500 km of 400 kV lines
Infrastructure cost (R billion)	5.1	12.72	5.3
EIA and servitude difficulty	Medium (high between Acacia and Philippi)	Difficult due to extensive 765 kV network	Medium
Implementation time frame	Achievable	Achievable with difficulty due to long network required	Achievable
System transient performance	Good (400 kV network)	Good (with extensive 765 kV network required	Good (400 kV network)
Impact on grid transfer capacity	Defers 3rd Gamma-Omega 765 kV line indefinitely	Defers 3rd Gamma-Omega[17] 765 kV line indefinitely	Defers 3rd Gamma-Grassridge[18] 765 kV line indefinitely
Overall[19]	**2nd best alternative**	**Least preferred alternative**	**Preferred alternative**

In summary, development of a power station in the Eastern Cape would result in substantial improvement in system adequacy and supply security due to a better "generation to load balance" in the local area, as it has no base-load generating capacity.

A power station at Bantamsklip would be less advantageous, as 765 kV transmission lines would be required through difficult terrain, which would result in substantial additional cost at the Bantamsklip site.

Development of the Duynefontein site will result in an increased capacity of the generation pool in the Western Cape, which means a concentration of generation in one area at the expense of another. Strategically this exposes the transmission system to more risk as opposed to diversifying the generation closer to major load centres. This is the overriding strategic transmission advantage of the Thyspunt site, which will provide a new base load generation pool in a weak part of the Eskom network and enable future potential load growth for the Eastern Cape.

From a technical point of view, therefore, the most preferred site alternative is Thyspunt. Strengthening of the Western Cape network is still required, but technically Eskom will be able to delay this until after the construction of a power station in the Eastern Cape.

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17 Eastern Cape substations
18 Eastern Cape substations
19 Preferences in this row indicate Eskom preferences

9.28 Evaluation of alternatives

Given the assessment of impacts in the sections above, an evaluation of the alternatives presented in **Chapter 5** can be made. The evaluation is based on a combination of the documented specialist assessments (as contained in the specialist reports in **Appendix E**), and the results of the specialist integration workshop held in November 2009, as well as Arcus GIBB's integration of the findings of all the studies undertaken for this EIA.

9.28.1 Selection of the preferred site

The ranking of the three alternative sites relative to one another was based on the following:

- Results of the specialist studies: specialists have indicated the relative significance of potential impacts with mitigation at each of the three alternative sites.
- An integration workshop, involving all specialists, on 24 and 25 November 2009, where potential impacts and ranking of the sites was discussed;
- Costs; and
- Transmission integration requirements.

The purposes of the integration workshop included the following:

- Facilitating understanding of the key specialist findings by Arcus GIBB;
- Ensuring that all specialists understand the key findings of all other specialist studies as it may apply to their fields of specialisation;
- Where appropriate, to ensure that conflicts between specialist studies are eliminated and to align specialist studies with each other;
- Agreeing with Eskom and all specialists on appropriate modifications to the proposed designs of the plant and associated infrastructure in order to mitigate impacts; and
- Agreeing on ranking and rating criteria to choose the most suitable alternative site for the nuclear power station and associated infrastructure.

In preparation for the integration meeting, specialists were divided into four teams as follows. These teams met before the integration meeting to discuss their findings with each other and agree on relative impact significance for the three alternative sites:

- **Technical factors** (geological and geotechnical suitability and seismological risk);
- **Water-related factors** (fresh water supply, geo-hydrology and surface water hydrology);
- **Social factors** (traffic and transportation, noise, social impacts, economic impact, agriculture, tourism, human health risk, emergency response and site control, and safety and visual impact); and
- **Biophysical factors** (heritage and / archaeology, air quality, freshwater ecology, vertebrate fauna, invertebrate fauna, oceanography, marine biology, botanical and dune geomorphology).

Technical factors regarding the ease with which electricity from the power station can be integrated with Eskom's transmission network, as well as the importance of having generating capacity in close proximity to specific load centres, were added to **Table 9-73** after the integration meeting. A description of the transmission integration factors is contained in **Section 9.27**.

Although there are obvious differences between the significance of the impacts at the three alternative sites, all specialists agreed that there are no fatal flaws at any of the sites (provided appropriate mitigation is implemented) and that all three alternative sites are suitable for development of a nuclear power station, given sufficient mitigation of impacts.

(a) Summary of impacts

Table 9-73 provides a summary of only the potential impacts of high and medium significance (after mitigation) at all the alternative sites. Thus, each impact in this table has a significance of medium or high at one or more of the alternative sites. Impacts of medium and high significance are, by definition, the impacts that should have the greatest influence on decision-making. Secondly, impacts that have the same significance at all the sites have been filtered out, as they provide no basis for choice amongst sites[20]. The impacts that are reflected in this table are therefore those that provide the most important information for choice of the preferred site alternative.

It is important to note that the impacts in **Table 9-73** have not been weighted, i.e. it has not yet been decided which impact categories should play a greater influence in decision-making than others. Weighting is undertaken in **Section 9.28.1 (b)** below.

The following conclusions can be drawn from **Table 9-73**:

Technical factors:

With respect to technical considerations, the only **geo-hydrological impact** of any significance is the disturbance of the site adjacent to excavations, due to the loose soil conditions resulting in a high potential for collapse of cuttings. This can, however, be mitigated by putting in appropriate support of excavations.

Seismic risk is considered to be a key determining criterion that needs to be considered when considering the preferred site for Nuclear-1. Seismic values vary significantly between the alternative sites. Based on work completed to date, none of the sites are considered to have any seismic disqualifiers. The Senior Seismic Hazard Analysis Committee (SSHAC) process, will be completed within the next 2 to 3 years. The information emerging from this process could result in the seismic risk rating of the sites either increasing or decreasing.

The design basis for standard nuclear power stations is based on a peak ground acceleration (PGA) value of 0.3 g. A rating beyond this value would necessitate the re-evaluation and design of the standard nuclear power station, resulting in potentially significant financial additions to the overall construction and operational cost of the plant. No detailed cost assessment of such additions has been undertaken (since it requires detailed design work and since it will only be undertaken if it is confirmed that the seismic risk exceeds the design basis of 0.30 g), but indications from the Koeberg experience are that it would add approximately 1.5 % to the total construction cost (i.e. approximately an additional R 2.25 billion based on the 2008 estimate of R 150 billion per nuclear power station).

The PGA values at the alternative sites vary as follows:

- Duynefontein: ~0.30 g;
- Bantamsklip: ~0.23 g; and
- Thyspunt: ~0.16 g.

In light of the above differences in the PGA values, Thyspunt demonstrates considerably lower risk with respect to any future variations between the 0.3 g design basis of a standard nuclear power station and the eventual value arising from the SSHAC process. This process is being initiated for all sites, and any possible

[20] Whilst it remains important to understand the nature of these impacts and to apply effective mitigation to prevent and reduce them, the purpose of this section of the report is focused on the choice of a preferred site alternative. Impacts that have the same significance at all three alternative sites provide no basis for comparison between the sites.

subsequent deviations from the standard export design could result in significant cost and time delays to Nuclear-1.

In light of the above, the Thyspunt site is favoured in terms of seismic risk, followed by Bantamsklip and Duynefontein.

Water-related factors:

There are no factors related to the availability of water or the potential impacts on surface water flow that are of high or medium significance at any of the alternative sites, due to the fact that all sites will make use of a desalination plant during both construction and operational phases. Favourable groundwater conditions at Thyspunt may allow for groundwater to be utilised during construction, in addition to desalinated water. Water-related factors can therefore be disregarded as far as the choice of site alternative is concerned.

Biophysical factors:

- **Impacts on flora:** These potential impacts are of medium to low significance after mitigation. The only exception is the potential loss of highly important wetland habitat at Thyspunt - this impact cannot be mitigated. However, provided that impacts on this habitat can be avoided, the flora specialist also indicated that Thyspunt would have the highest potential positive impacts to conservation if the remainder of the site, outside the immediate power station footprint, could be conserved.
- **The impacts on dune geomorphology:** These potential impacts are highest at Thyspunt, due to the presence of the unique Oyster Bay headland dune bypass system. These impacts are primarily related to the proposed northern access route alternative between the HV yard in the northern “panhandle” portion of the site and the power station in the south. By contrast potential impacts on dune geomorphology are insignificant at Duynefontein and Bantamsklip.
- **Impact on wetlands:** These potential impacts are of low to negligible significance at Duynefontein and Bantamsklip, provided that the northern portion of the Bantamsklip (north of the R43) is not developed. The potential impacts of highest significance will occur at Thyspunt due to the extensive distribution of wetlands across the site and the linkage between the dune system and the wetlands. If these impacts occur they would be related to dewatering during construction and possibly operation, possible disruption of groundwater flows to the coastal seeps as well as the surface impacts of the road construction. It is however important to note that such impacts are based on the current understanding of the wetland systems at Thyspunt. Additional monitoring and modelling currently being undertaken by independent specialists would provide greater certainty as to the groundwater regime at the site and allow for improved mitigation measures to be designed. Therefore despite impacts being considered as high, without mitigation. The implementation of appropriate mitigation, based on current and future monitoring results at Thyspunt would potentially result in a net positive impact on wetland systems. Such an assumption, in addition to all technical mitigation options, would assume the management of the site and all surrounding land crossed by the access roads as conservation areas, thus securing a large expanse of wetland and dune system that would otherwise be permanently impacted by development. The opportunity for large-scale active management and conservation of wetland ecosystems as a whole will offset potential negative impacts.
- **Impacts on vertebrate fauna:** The potential impact of highest significance at all three sites is the destruction of habitat within the footprint of the proposed power station (31 ha) and direct mortality of these animals. On the other hand, at Thyspunt and Bantamsklip the potential positive impacts of conserving the undeveloped land around the power station is also of high significance.

- **Impacts on invertebrate fauna:** The significance of the potential impacts is generally of similar significance across all three alternative sites. A reduction in rare and/or endangered species is of high significance at Thyspunt and Bantamsklip. However, according (Low *pers. comm.* 2010), the particular habitat where these invertebrate species occur is widespread across the site (i.e. not limited to the nuclear plant footprint) as well as outside the site. Therefore it is possible to relocate or alternatively identify the same species elsewhere on the site. The potential positive impacts of conservation of the remainder of the site that will not be affected by the power station footprint is of high significance particularly at Thyspunt and Bantamsklip, as such protection does not currently exist at these sites.
- **Impacts on marine ecology:** The potential impacts on marine ecology are generally highest at Bantamsklip. The potential positive impacts are also highest at Bantamsklip, as the declaration of a marine exclusion zone would afford protection to the heavily poached populations of abalone at this site.

Social factors:

- **Impacts on heritage resources:** These potential impacts are of medium significance with mitigation at all the alternative sites, with the exception of the destruction of landscape properties at Bantamsklip, where this potential impact has a high significance. If the remainder of the site is conserved and an intensive excavation and conservation of palaeontological and archaeological remains is carried out, the potential positive impact is of medium significance at the Bantamsklip and Thyspunt sites.
- **Noise impacts:** The only site where a potential noise impact of significance could take place is Thyspunt, due to an Open Cycle Gas Turbine (OCGT) plant that will be used infrequently to provide emergency power. Due to the infrequent use of this noise source, it does not add substantially to the significance of the overall noise impact at Thyspunt.
- **Tourism impacts:** The Bantamsklip and Thyspunt sites will experience potentially the highest significance negative impacts. Negative impacts on tourism at Duynefontein will be low.
- **Agricultural impacts:** The negative potential impacts will be of medium significance at all alternative sites. On the positive side, Thyspunt will experience a potentially significant increase of 15 % in agricultural production, while Bantamsklip will experience a potential low increase and Duynefontein will not experience any increase.
- **Economic impacts**: All three sites will experience potential positive economic impacts of high significance during operation and low significance during construction[21]. The greatest macroeconomic benefits would be experienced at Duynefontein and Bantamsklip due to the stronger provincial economy in the Western Cape: this province's economy would be in a better position to provide goods and services to the power station. The costs of the Bantamsklip alternative would be highest due to significant transport system upgrading and high voltage transmission lines that would be required for this alternative. Considering poverty alleviation, then factors such as the positive impact on low-income households, the impact of the social indicators, and the opportunity to grow the economy of a province as reflected by the potential impact on GDP favour Thyspunt.
- **Social impacts:** Impacts on accommodation and the influx of job seekers would be potentially of medium significance at all three alternative sites. All other negative impacts would be of low significance with mitigation. Positive potential impacts (creation of employment opportunities and business opportunities) would be of high and medium significance respectively at all three sites.

[21] Not reflected in the table below because these impacts are of equal significance at all sites.

Table 9-73: Potential impacts of high to medium significance for all sites (after mitigation)

Key:

(red)	Negative impact of high significance
(orange)	Negative impact of medium significance
(amber)	Negative impact of medium to low significance
(yellow)	Negative impact of low significance
(dark green)	Positive impact of high significance
(green)	Positive impact of medium significance
(light green)	Positive impact of low significance

Impact (after mitigation)	Duynefontein	Bantamsklip	Thyspunt
	Impact significance		
FACTORS INFLUENCING SITE SUITABILITY			
Geo-hydrology			
Excessive site disturbance resulting in environmental damage	Medium	Low	Medium
Seismic suitability			
Seismic suitability	Highest risk that standard nuclear power station design may not be able to meet seismic site characteristics	Intermediate risk that standard nuclear power station may not be able to meet seismic site characteristics	Lowest risk that standard nuclear power station may not be able to meet seismic site characteristics
BIOPHYSICAL IMPACTS			
Botanical impacts			
Loss of habitat - Mitigation: no mitigation for habitat loss.	Medium to low	Medium to low	High
Loss of ecosystem function - Mitigation: locate footprint away from affected area.	Medium	Low	Low
Loss of Red Data species - Mitigation: translocate or grow on affected species.	Low	Medium	Medium
Climate change (rise in sea level) - Mitigation: coastal corridor and nuclear power station setback from coast.	Medium	Medium to low	Medium to low
Cumulative impacts - Mitigation: locate footprint away from affected area.	Medium to low	Medium	Medium

Impact (after mitigation)	Duynefontein	Bantamsklip	Thyspunt
	Impact significance		
Loss of habitat due to power lines - Mitigation: align power lines to avoid rare and sensitive habitat.	Medium	N/A	Medium
Dune geomorphology			
Access road across mobile dunes and inter-dune wetlands of the Oyster Bay dunefield - operation phase. Dune – groundwater -wetland dynamics.	N/A	N/A	Medium
Transmission lines with 300 - 400 m span across mobile dunes and inter-dune wetlands of the Oyster Bay dunefield – construction phase[22]. Constructing infrastructure and access roads. With mitigation: position towers by helicopter	N/A	N/A	Low
Temporary conveyor belt or haul road to panhandle across mobile dunes and inter-dune wetlands of the Oyster Bay dunefield - construction phase. Constructing infrastructure and access road. With mitigation: avoid wetlands wherever possible	N/A	N/A	High
Wetlands (Construction Phase)			
Degradation of wetlands as a result of physical disturbance to wetlands north of the R43 during construction	N/A	High	N/A
Loss or degradation of dune slack and/or hillslope seep wetlands as a result of dewatering	N/A	N/A	Medium
Loss or degradation of coastal seep wetlands as a result of interference with surface or groundwater flows	N/A	N/A	High
Degradation of coastal seep wetlands as a result of receipt of concentrated volumes of potentially sediment-rich water from dewatered areas	N/A	N/A	Medium

[22] This impact will be of high significance if a road is constructed to place the pylons in the middle of the dune field.

Impact (after mitigation)	Duynefontein	Bantamsklip	Thyspunt
	Impact significance		
Degradation of coastal seepage wetlands as a result of catchment hardening and runoff from laydown areas	N/A	N/A	Medium
Wetlands (Operational Phase)			
Degradation of wetlands associated with the Groot Hagelkraal system through alien encroachment	N/A	Medium	N/A
Increased fragmentation of wetlands up- and downstream of the Groot Hagelkraal system as a result of increased road use along the R43	N/A	Medium	N/A
Loss or degradation of coastal seep wetlands as a result of interference with surface or groundwater flows	N/A	N/A	High
Salinisation of coastal seeps	N/A	N/A	Medium
Degradation of remnant coastal seepage wetlands as a result of catchment hardening	N/A	N/A	Medium
Contamination of wetlands as a result of leakage of hazardous waste (uranium) into groundwater and thence into groundwater-fed wetlands	N/A	N/A	Medium
Wetlands: Impacts of transmission lines from the nuclear power station to the HV yard			
Crossing of the dune using conventional transmission towers	N/A	N/A	Medium
Crossing of the dune, using a dual circuit transmission system	N/A	N/A	Medium
Wetlands: Impacts of different options for the removal of sand spoil from the nuclear power station site			
Alternative 1:Conveyance of sand to the disturbed agricultural land on the northern side of the dunes, across the sand dunes by road	N/A	N/A	Medium to High
Alternative 2:Conveyance of sand to the disturbed agricultural land on the northern side of the dunes, across the sand dunes by conveyor belt	N/A	N/A	High
Alternative 3: Piping of sand to the St. Francis Bay / Cape St. Francis Beach	N/A	N/A	Medium

Wetlands: Impacts associated with different access road alternatives at Thyspunt			
Construction impacts – *all alternatives*	N/A	N/A	Medium
Western Route	N/A	N/A	Medium
Northern Route	N/A	N/A	High
Eastern Access Road	N/A	N/A	Medium
Cumulative impacts associated with proposed development as a whole assuming positive impacts associated with incorporation of erven affected by road. Also assuming high confidence addressing of identified uncertainties	N/A	N/A	Medium
Cumulative impacts associated with proposed development as a whole	Medium[23]	High	Medium[24]
Conservation of remaining dune slack, coastal seep and valley bottom wetlands	N/A	N/A	Low
Vertebrate Fauna			
Reduction in populations of Threatened species, resulting from habitat destruction and direct mortality	Medium	High	High
Fragmentation of natural habitats and patterns of animal movement, resulting from buildings, infrastructure and fences	Low	Low	Medium
Road mortality (road kills), resulting from traffic on roads through natural habitats	Low	High	Low
Pollution of soil and water beyond the building site, resulting from spills of chemicals, fuel and sewage	Medium	Low	Low
Alteration of surface and groundwater levels and flows, and knock-on effects on local wetlands, resulting from underground foundation structures and construction methods	Low	Low	Medium

[23] This is in contrast to the medium to high significance positive impacts at Bantamsklip and Thyspunt because the wetlands at Duynefontein are of low conservation value in comparison and are already conserved in the Koeberg Nature Reserve.
[24] This assumes positive impacts associated with acquisition of properties affected by the eastern access road. It also assumes high confidence in addressing of identified uncertainties.

Improved conservation of undeveloped land, resulting from improved legal status and/or management.	Medium	High	High
Invertebrate Fauna			
Reduction in populations of rare/protected species[25]	Medium	High	High
Positive contribution to conservation	High	High	High
Impacts on marine ecology			
Disruption during construction Duynefontein - Due to construction of the cooling water intake and outflow systems. Bantamsklip and Thyspunt - Due to tunneling for intake pipe and laying of outlet pipes	Medium	High	Medium
Abstraction of cooling water and entrainment of organisms	Medium	High	Medium
Desalination during the construction phase	Medium	High	Medium
Closure to exploitation of marine organisms (abalone)	N/A	Medium	N/A
IMPACT ON SOCIAL AND ECONOMIC CONDITIONS			
Heritage			
Impact on Miocene palaeontology	Low	Low	Low
Destruction of Pleistocene palaeontology and archaeology	Medium	Low	Medium
Destruction of Holocene archaeology	Low	Medium	Medium
Destruction of landscape	Medium	High	High
Positive contribution to conservation		Medium	Medium
Noise			
Noise impacts of OCGT plant on adjacent farm - Without mitigation	N/A	N/A	High[26]

[25] This impact can be reduced by search and rescue operations and re-establishment of populations in similar habitats on the site and in surrounding areas.

[26] This impact will occur infrequently and is not a normal operational impact, as the OCGT plant will be used only to provide emergency backup power.

Tourism			
Hospitality Systems	Low	High	Low
Visual Amenity	Low	High	High
Sense of Place	Low	High	High
Marine Assets	Low	Medium	High
Social Amenity	Low	Medium	Low
Agriculture			
Change in market conditions (Increased agricultural production)	Low	Medium	Medium
Social impacts			
Influx of job seekers	Low	Medium	Medium
FACTORS INFLUENCING TRANSMISSION INTEGRATION			
Transmission integration considerations	Suitable but not ideal as there is already significant generation capacity in the Western Cape	Suitable but difficult due to long transmission lines required	Positive impact on transmission system as it would greatly assist the Eastern Cape transmission network

(b) Selection of key decision factors for ranking of site alternatives

From the above table, it is clear that even after all potential impacts that have similar significance at all alternative sites are removed from consideration, the number of impacts to be considered remains numerous and it is difficult to come to a conclusion based on such a large number of decision factors.

Although consensus was sought at the integration meeting as far as possible, and where possible specialists tried to align their recommendations with each other, this was not always possible. In many cases recommendations of particular specialists with regards to site preference differ from those of other specialists. Therefore, both to reduce the number of decision factors to a manageable number and to ensure that responsible trade-offs can be made between impact categories that give contrasting recommendations regarding the preferred site, the categories of potential impacts need to be weighted in order to select a recommended site. The integration meeting therefore included the development of weightings (indications of importance) for the different decision factors (specialist disciplines). The weightings reflected in **Table 9-74** below are the results of the weighting developed at the integration meeting, as well as the Arcus GIBB team's consideration of all specialist studies after the integration meeting.

Table 9-74: Conclusions of the specialist integration meeting regarding key decision-factors for selection of the preferred site alternative

Key

xxx (black)	Key decision factor
xxx (white)	Not a key decision factor

Specialist discipline	Discussion	Weighted value[27]
Transmission integration factors	Transmission integration factors have a critical influence on the decision, as there are large technical differences between the sites with respect to the need for additional generation capacity in the Eastern and Western Cape provinces and the ease with which electricity produced at the sites can be conveyed into the transmission system.	4
Geo-hydrology	There is evidence of a strong link between geo-hydrological conditions and wetlands, particularly at Thyspunt. However, impacts on wetlands are considered separately and to avoid double counting, geo-hydrology cannot be considered to impacts on wetlands.	1
Seismic suitability	This is an important factor in site selection for a nuclear power station. The seismic values at sites will determine the ability to use a standard nuclear power station design, or whether any additional design work will be required for a non standard plant, which will impact on timelines and costs. Additional time may also imply an inability to meet the increasing demand for electricity over the next two to three years, with potential load shedding as a result.	4
Impacts on flora	Potential impacts on flora can be mitigated if the specialist's recommendations regarding placement of the power station and associated infrastructure on the sites are followed.	1
Impacts on dune geomorphology	Major sensitive dune systems at one of the sites result in large differences in significance of impacts between the alternative sites. Moving dune systems are rare features along South Africa's coastline and relatively unimpacted dune systems, such as found at one site, even more rare. Dune geomorphology influences habitats and communities and therefore indirectly influences species diversity.	3
Impacts on wetlands	Wetlands are threatened ecosystems in South Africa and are important life-support systems. Protecting wetlands is regarded as a national priority.	3
Vertebrate fauna	There are no highly threatened vertebrate species at any of the three siites. The areas of vertebrate sensitivity largely correspond to the wetlands and areas that have been identified as being important from the perspective of other biophysical specialist studies.	2
Invertebrate fauna	There are significant differences in the sensitivity of the sites from an invertebrate perspective. All alternative sites contain potentially new (undescribed) species and/or varieties.	3
Marine ecology	Marine impacts are similar at all sites, although higher at Bantamsklip, but there are no impacts of critical nature. The marine specialist indicated that the area that will be affected by the disposal of spoil in the sea can be justifiably sacrificed.	1

[27] Scored on a scale of 0 to 5, with **5** being most important for decision-making and **0** being of no importance for decision-making.

Specialist discipline	Discussion	Weighted value[27]
Heritage impact	Although the nature and significance of heritage impacts differ between sites, they can be mitigated through excavation prior to the commencement of construction.	1
Noise impacts	Potential noise impacts are similarly insignificant at all alternative sites and no mitigation is required.	1
Tourism impact	Potential impacts on tourism are mostly negative in the short term but positive over the longer term during the operational phase.	1
Agricultural impact	Agricultural impacts were agreed to be of low importance. None of the sites will have significant negative impacts as no high potential agricultural land will be directly affected.	1
Social impact	Social impacts are not seen as a critical decision factor because they can be relatively easily mitigated, compared to other impacts.	1
Economic impact	The potential magnitude of the economic impacts is important due to the high costs of a nuclear power station and the potential for significant costs differences and impacts on the provincial economies. Major upgrades to heavy vehicle routes may result in significant cost differences between sites. Given South Africa's status as an emerging economy, this is an important decision factor to distinguish between the sites.	3

Based on the above analysis, the following decision factors emerge as most important for decision-making and have been carried forward to the next step in the comparison of alternatives:

- Transmission integration factors;
- Seismic suitability of the sites;
- Impacts on dune geomorphology;
- Impacts on wetlands;
- Impacts on vertebrate fauna;
- Impacts on invertebrate fauna; and
- Economic impacts.

Two of these factors indicate that Bantamsklip cannot be regarded as a preferred alternative for Nuclear-1, when compared with the other two alternative sites. Firstly, the Bantamsklip site would result in higher costs due to its location, resulting in longer and larger transmission lines than either of the other two sites (900 km of combined 765kV and 400kV transmission lines at Bantamsklip vs. 500 km and 190 km of 400 kV lines at Thyspunt and Duynefontein respectively). The road and bridge upgrades that would have to take place to transport extra heavy loads from Cape Town harbour also contribute to the high costs of the Bantamsklip site. The difference in cost effectiveness between Bantamsklip on the one hand and Thyspunt or Duynefontein on the other hand (since the cost effectiveness of the latter two are practically equal) would be approximately R 8 billion. The economic specialist report views this cost difference as significant.

Apart from cost, if the cumulative environmental impacts of the transmission corridors are considered, the potential impacts of construction of a nuclear power station at Bantamsklip would likely be much more significant than the other two site alternatives, considering the length of the transmission lines and the difficult mountainous terrain through which the Bantamsklip transmission lines would have to pass. This would, however, need to be confirmed by the EIAs being undertaken for the transmission lines from the three alternative sites. Furthermore, potential impacts on invertebrate fauna are of significantly higher significance at Bantamsklip than at either of the other site alternatives, due to the confirmed presence of two undescribed species at Bantamsklip. These aspects are not considered fatal flaws and do not disqualify Bantamsklip as an alternative site for a nuclear power station in the future. Thus, in spite of the potential positive impacts that would be realised by the effective conservation of the Bantamsklip site by the development of Nuclear-1, **bearing the above-mentioned factors in mind, the Bantamsklip site can be regarded as the least preferred site alternative and is removed from further consideration[28].** This leaves Thyspunt and Duynefontein for further comparison.

Thyspunt and Duynefontein have been compared using a numerical ranking model that takes only the weighted (important) decision factors into account. Each criterion (decision factor) has been scored on a scale of 0 to 5, with zero indicating the greatest negative impact (or least benefit) and 5 indicating the least negative impacts (or greatest positive impact) (**Table 9-76**).

Table 9-75: Values allocated to site selection for Duynefontein and Thyspunt

0	Highest negative impact or lowest positive impact
1	High negative impact or low positive impact
2	Medium to high negative impact or medium to low positive impact
3	Low to medium negative impact or medium to high positive impact
4	Low negative impact or high positive impact
5	Lowest negative impact or highest positive impact

Values given to the sites were allocated by the Arcus GIBB EIA team. Scores for all criteria in each category were totalled to provide an indication of the ranking of the alternative sites. The highest numerical ranking indicates the preferred alternative site.

It is important to note that both potential positive and negative impacts have been considered in this table. Specialists stressed that, in spite of the highly significant negative biophysical impacts at Thyspunt, the conservation benefits of the development of a nuclear power station would also be significant, particularly for Thyspunt. Given the fact that the nuclear power station and its associated infrastructure would only occupy around 31 ha of each site, the establishment of a nuclear power station at Thyspunt would provide a mechanism whereby a large portion of the property would effectively remain conserved for at least the 60 year lifetime of the proposed nuclear power station. This was regarded as an important potential conservation benefit by the botanical, vertebrate fauna, invertebrate fauna and wetland specialists.

[28] This does not rule out Bantamsklip completely as a site for a nuclear power station, but indicates that it is least preferred compared to the Thyspunt and Duynefontein sites for Nuclear-1.

Table 9-76: Comparison of Duynefontein and Thyspunt sites

Impact category	Weighting	Duynefontein Discussion	Value	Weighted value	Thyspunt Discussion	Value	Weighted value
Transmission integration factors	**4**	The Western Cape network is already relatively stable. Addition of a power station in this province would add little value to the transmission system.	1	**4**	Thyspunt site provides opportunity to strengthen the Eastern Cape network, where there is currently insignificant generation capacity.	4	**16**
Seismic suitability	**4**	Although there are no factors that disqualify Duynefontein from a seismic point of view, its PGA value of 0.3 g is equal to the 0.3 g design basis of a standard nuclear power station. Further detailed seismic studies are likely to increase it beyond 0.3 g, which would necessitate additional design work, resulting in delays and extra construction costs.	1	**4**	The margin between the PGA value of 0.3 g design basis of a standard nuclear power station and the 0.16 g value at Thyspunt provides a high level of certainty that a standard nuclear power station could be used without any additional design to that of a standard nuclear power station. There is little potential for delays or additional costs due to a non-standard design being used.	4	**16**
Negative impacts on dune geomorphology	**3**	The power station would impact the southern extremity of the Atlantis mobile dune system. This system has already been impacted by the development of Koeberg Nuclear Power Station and portions have been artificially stabilised with vegetation. Therefore potential impacts at this site would not be highly significant.	4	**12**	Possible development of transmission lines, roads and conveyor belts across the highly sensitive Oyster Bay dune fields are of high significance, due to their uniqueness and associated sensitive habitats.	2	**6**
Negative impacts on wetlands	**3**	Extent of wetlands at Duynefontein is limited. Very limited potential negative impacts are anticipated.	4	**12**	Extent of wetlands is extensive and correlates with the headland dune bypass system which stretches from east to west across the site. The very sensitive Langefontein wetlands are located in the east of the site. The northern access route may have significant potential impact on wetlands. Drawdown of groundwater during construction may impact wetlands – there is uncertainty about the degree of linkage between geo-hydrological conditions and water levels in the wetlands.	1	**3**

Impact category	Weighting	Duynefontein Discussion	Value	Weighted value	Thyspunt Discussion	Value	Weighted value
Negative impacts on vertebrate fauna	**2**	Sufficient low sensitivity land is available for development on this site, so potential negative impacts are not considered to be highly significant.	3	**6**	Significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas, the development of two major new access roads that may have significant impacts on their own and the need for a development corridor across a large field of mobile dunes between the power station and the HV yard. . Effective mitigation can, however, reduce potential impacts.	2	**4**
Negative impacts on invertebrate fauna	**3**	An undescribed ant species has been found in EIA corridor in the artificially vegetated dunes. However, this is a generalist species that occurs in a number of habitats and it occurs in artificially vegetated dunes, which indicates it has colonised the site from adjacent areas and should therefore be found on the remainder of the site.	3	**9**	The combination of high butterfly and ant diversity and the Onchyophoran species indicate that the Thyspunt site has significant conservation value.	2	**6**
Economic impacts	**3**	Cost not significantly different to Thyspunt. The overall positive macro-economic impacts will be greater at Duynefontein than at Thyspunt due to the Western Cape having a larger, more diversified economy. However, there will be less positive impact on poverty alleviation at Duynefontein than at Thyspunt.	2	**6**	Cost efficiency not significantly different to Duynefontein. Cost-effectiveness analysis indicates that Thyspunt has a very slight edge over Duynefontein. When considering poverty alleviation, then factors such as the impact on low-income households, the impact of the social indicators, and the opportunity to grow the economy of a province as reflected by the potential impact on GDP favour Thyspunt.	3	**9**
Positive impacts on conservation	**4**	The Duynefontein site is already conserved as part of the Koeberg Nature Reserve. Thus, there would be limited additional conservation benefit to establishment of a nuclear power station.	1	**4**	The Thyspunt site has significant conservation value for invertebrates, flora, wetlands and the Oyster Bay headland bypass dune system. There is also a number of other small nearby conservation areas / nature reserves with which the site could be linked to form a larger effective conservation area, together with the area of the site outside the 31 ha footprint assessed in this EIA. Furthermore with the purchase of the recommended sites outside the EIA corridor, the large conserved area will be an important conservation asset.	4	**16**
Overall value				**57**			**76**

(c) Conclusion based on key decision factors

An assessment of the above key criteria indicates **that Thyspunt is preferred (with a weighted score of 76, as opposed to Duynefontein's weighted score of 57),** primarily due to the lower seismic risk (thereby avoiding the potential time delays and additional costs for redesign), ease of transmission integration and the site's locality relative to the Port Elizabeth load centre, which currently does not have any power generation in close proximity, as well as the potential overall conservation benefits of a large portion of the site being managed for conservation purposes. The most important argument in favour of Thyspunt with regards to biophysical impacts is the conservation benefits that would be realised through access control and active management of the site, should a nuclear power station be constructed here. This benefit would not be realised at Duynefontein, as the Koeberg Private Nature Reserve already includes the Duynefontein site.

9.28.2 Access roads to the Thyspunt site

The Thyspunt site will require the construction of two new access road(s). The Eastern Access Road will carry heavy and extra heavy loads, and is therefore essential. There are, therefore, no alternatives to this access road.

The Northern and Western routes for the access roads will carry lighter traffic, and are regarded as alternatives to each other. All these routes are 'greenfields' alignments (through natural landscape).

The access roads alternatives have been assessed against the following key impact categories, as the findings of these studies have a specific influence on the choice of access road alignments:

- Visual impacts;
- Impacts on agriculture;
- Impacts on flora;
- Impacts on dune geomorphology;
- Impacts on terrestrial vertebrate fauna;
- Impacts on invertebrate fauna;
- Impacts on wetlands;
- Noise impacts; and
- Impacts on heritage resources.

(a) Visual impacts

<u>The Eastern Access Road</u>[29]
The topography in the vicinity of the proposed eastern access road is undulating, with the ridges and troughs orientated in the west to east direction. Due to the prevailing wind, there will be a need for a substantial amount of cut and fill during road construction.

The visual impact of new landforms and the removal of dune vegetation will change the present sense of place of relatively remote and scenic dune vegetation. This is despite much of the present vegetation being alien invasive species planted to stabilise the sand dunes. The effective stabilisation of the new sand surfaces exposed and created will be a requirement. Despite the proposed mitigation and the fact that the road will not be seen, the visual integrity and sense of place will be degraded along the entire road corridor.

<u>The Northern Access Road</u>
The new road will be visible from the southbound traffic on the Oyster Bay Road because it will rise with the approach to the dunes. The cutting through the dunes will be highly visible until these slopes

[29] As indicated in Section 5, the Eastern Access Road is essential as a heavy vehicle route and there are no alternative to it. The impacts of this route are given her only to provide an indication of overall impacts of this route.

have been re-vegetated. The sense of place will be marginally altered because the area is an agricultural landscape with gravel roads. If this alternative access route is selected, the road from Humansdorp will be upgraded in alignment and tarred.

The Western Access Road
The cutting through the east-west dunes and then along the 'slack' (the depression between dune crests) will mean that the sand cut and fill slopes will require effective re-vegetation to prevent erosion and 'blow outs'. This modification of the landscape will change its natural coastal vegetation character and significantly change the sense of place, which in this case is unique due to the presence of indigenous vegetation and wildlife. In fact that area is a nature conservancy.

(b) Impacts on agriculture

The proposed northern access road will pass through cultivated pasture land used for dairy production. The exact extent of the amount of pasture land taken out of production as a result of the road will depend on the final route of the road. This area is considered to be a prime dairy production area, and the estimated value of pasture land is in the region of R 20 000 – R 25 000 per hectare. It should also be noted that dust from the northern access road will have a potential negative impact on surrounding pastures, i.e. dust settling on the leaves and reducing photosynthesis of the pasture[30]. The proposed western and eastern access roads will have no significant potential impact on agricultural production.

(c) Impacts on flora

Negative impacts at the proposed EIA corridor for the nuclear facility would be chiefly on the partially mobile dunes. However, potential impacts on the wetlands on the coast, as well as the Langefontein wetland, would be of the most concern. Crossing of the transverse dunes by the construction of a road linking the power station with the HV yard would also be a potential and major negative impact. Two other access roads, from the east and west, would potentially impact both the transverse dunes and associated inland wetlands.

Alignments of access road routes would therefore need to be fine-tuned so as to avoid sensitive and rare habitats. The eastern approach, in particular, must show sensitive alignment given the importance and endemism of the longitudinal wetlands draining towards Cape St. Francis. The western alignment poses problems for the maintenance of the western extremity of the northern transverse dune system, as well as potentially impacts on mobile parabolic dunes. Astute mitigation is required to avoid mobile dunes and wetlands. The northern access road is viewed as too difficult to mitigate and should not be constructed.

The location of the HV yard in degraded sandstone fynbos is considered acceptable, providing the footprint is realigned to occupy previously farmed land. The powerline servitude between the coast and the HV yard is not supported. A key aspect is the crossing of the mobile and semi-mobile transverse dunes by the powerline, and this will need careful consideration, and preferably avoidance. In tandem with this is a service road linking the NPS with the HV yard; as this is likely to compromise the functioning of the northern transverse dune system, this route is not supported at all.

(d) Impacts on dune geomorphology

An access road, transmission lines and a temporary conveyor belt or haul road could probably be built across the mobile dunes of the Oyster Bay dunefield at Thyspunt. When this option was first investigated, it was for a route along the eastern side of the "panhandle", where dunes are lower: maximum height about 10 metres. The route currently under consideration runs along the western side of the "panhandle", where transverse dunes are about 30 m high; dune height increases westward. There is a maximum dune height that this option could handle, probably about 10 m. This option is thus not viable for the route along the western side of the "panhandle". In addition, large cut

[30] Assuming that Eskom tars this road and puts in place an air quality management plan, as recommended in the air quality report, this impact will not be realised.

and fill will be required as two large vegetated dune ridges would have to be crossed, which again makes this route unviable.

The access road can be built either using an aerodynamically smooth road slightly raised above the inter-dune surface with frequent culverts, or with an aerodynamically shaped bridge that crosses the mobile dunes and inter-dune wetlands to allow sand to be transported below the road without causing sand build-up.

The smooth hard-surfaced road and the aerodynamically shaped bridge would both have high impacts during the construction phase. The smooth hard-surfaced road would have a low operational impact. The aerodynamically shaped bridge would have a somewhat lower operational impact. The aerodynamically shaped bridge would have a lower operational impact.

A temporary conveyor belt or haul road can be built across the mobile Oyster Bay dunefield to carry spoils to the "panhandle". The environmental impact after the conveyor belt or haul road is removed and rehabilitation is completed would be low.

<u>Access roads across the fixed, vegetated dunes: north route and west route</u>

Access roads, transmission lines and a temporary conveyor belt or haul road could be built across the vegetated dunefield with low operational impacts. Installing the conveyor belt foundations using low-diameter piles instead of concrete foundations will reduce impacts further. Terraforce or similar blocks must be used to stabilise the sides of the cut and fill, as rehabilitation by vegetating the slopes will be difficult and slow.

(e) Impacts on terrestrial vertebrate fauna

Wherever buildings and infrastructure are constructed, natural habitats will be destroyed. The construction of buildings and infrastructure, including roads and fencing, will break up blocks of continuous or intergrading habitats into relatively isolated fragments. Roads have an especially damaging impact because they encourage further developments and human activity adjacent to the road; in other words, they begin an ongoing process of human encroachment. The disturbance associated with roads causes some animals to avoid roads, thus inhibiting their ecological need to move across the landscape. The impact of such fragmentation will vary from species to species, depending on the degree of mobility of the species and its tolerance of sub-optimal habitat types. Many species, with limited mobility and low tolerance of habitats other than their preferred habitat, will become ecologically isolated within fragments and thereby become more vulnerable to local extinction. This impact is likely to be permanent, but with the greatest impact on species with restricted movements, such as fossorial reptiles, and the least impact on flying species, such as birds.

In addition to the fragmentation effect of roads (above), local populations of animals will be negatively impacted by mortality on the roads. Areas close to roads are likely to become population "sinks" in which the rate of increase from reproduction and immigration is less than the rate of decrease owing to deaths on the road. For some species, especially nocturnal species, such impacts may be intense, especially if the road separates two different habitats which are both essential to the species, e.g., dryland and wetland habitats, or inland and coastal habitats.

At Thyspunt, the potential impact of roads is expected to be intense because three major new roads onto the site are planned, from the east, west and north.

(f) Impacts on invertebrate fauna

The road approach from the east passes through the least highly sensitivity area of the three alternatives, but passes close to the wetlands situated on the eastern part of the site. While these wetlands were not considered of high sensitivity for butterflies, they may be important habitat for many other invertebrate species and are likely to be considered highly sensitive for other reasons. Use of this approach should thus be avoided.

The approach from the west passes through the largest amount of highly sensitivity butterfly habitat, but does so along an existing road route which could be upgraded with relatively little further disruption of natural ecosystems. This is the recommended route for light traffic.

The approach from the north via the HV yard passes through a significant amount of high sensitivity butterfly habitat. As this route would presumably need to be suited to heavy traffic at least up to the HV yard, it is recommended that (subject to approval by the flora and dune geomorphology specialists) it be used in preference to the western access road . The access route could in part it could also be used as access for installation of the 132 kV transmission line, depending on the precise route chosen for the latter.

(g) Impacts on wetlands

In terms of the generic impacts of all three alternative access road alternatives on wetlands on site both the generic construction phase and operational phase impacts would be associated with at least a medium level of negative significance.
.
Infilling of the ecologically important, largely unimpacted wetlands that occur on and near to the Thyspunt site and the impacts on wetland function and habitat quality that would be associated with this infilling, has been assessed as a potential negative impact of high ecological significance. This assessment applies to all of the road alternatives.

When considering impacts on wetlands associated with the mobile dunes, construction of a road across the mobile dune would potentially interfere with the dynamics of this system. Any activities that might result in interference with dune dynamics have been assessed as of high negative significance, taking into account the importance of the dune / dune slack wetland system, which is considered a unique natural ecosystem). Activities that interfere with the dune system are considered likely to have knock-on impacts on the associated dune slack wetlands. The above comment applies to both the northern and the western access routes, although it is presently most pertinent with regard to the northern route.

The assessment of different alignments for the access road indicates that the proposed eastern access, with substantial mitigation measures focusing on avoidance of critical impacts, would be the preferred access option. If two access routes are required, specifically for construction, then the proposed western access route is greatly preferred to the northern route. The eastern route carries with it a means to mitigating against the high cumulative significance of the proposed development.

(h) Impact on heritage resources

There are three proposed access roads from Cape St. Francis and Oyster Bay areas to the site. One of these will be used by heavy vehicles.

<u>The western access road (light vehicles)</u>
Indications are that the distribution of archaeological sites along the alignment is lower than would be expected for a coastal alternative. While it is expected that some impacts will occur, it is expected that these will be controllable through mitigation as long as site inspection during bush clearing can take place. The proposed route is acceptable.

<u>The northern access road (light vehicles)</u>
Although archaeological sites have been observed in the dune field, the alignment as it is will not result in any impacts to these. However, it is possible that buried sites may be impacted during earthmoving operations. Mitigation should be achievable, provided that sites can be identified during and after bush clearing and then adequately sampled. The practicalities of constructing a road over a mobile dune field are a cause for concern, along with the possible damage to the functioning of the dune system.

<u>The eastern access road (heavy vehicles)</u>

Archaeological sites have been identified in road cuttings in the existing property development areas west of Cape St. Francis Bay, indicating that there is a strong likelihood that archaeological sites may be impacted. Mitigation should be achievable, provided that sites can be identified during and after bush clearing, and then adequately sampled.

(h) Conclusion with regards to Thyspunt access roads

A summary of the specialist findings is indicated in **Table 9-77**. From this summary it appears that the Northern Access Route is clearly less favoured than the Western Access Route, with respect to the impacts on agriculture, impacts on flora, impacts on wetlands and impacts on heritage resources. The Northern Access Route is favoured only in terms of visual impacts. None of the other specialist studies indicate a clear preference. The visual impacts associated with the Western Access Road (mostly related to a change in the sense of place) are minimal when compared to the overall change in the sense of place caused by the presence of a nuclear power station. **Therefore, taking all relevant impacts into account, the Western Access Road is the preferred access road for the Thyspunt site.**

It must be noted that, with respect to the Eastern Access Road, for which there are no alternatives, there are a number of potentially significant impacts. Should a nuclear power station be constructed at Thyspunt, a rigorous process of refining the routing must be followed. This process must include the relevant specialist who took part in this study, to enable the identification of a route that avoids impacting the sensitive features. Particularly, a rigorous and timeous mitigation plan for heritage resources would have to be implemented for this route. It would also be important to implement the recommendations of the wetland specialist report with regards to the purchase of additional parcels of land where wetlands (currently outside Eskom property) are located, to secure these wetlands for conservation.

Table 9-77: Comparison of Northern and Western Access Roads at Thyspunt

Key

(shaded)	Most preferred alternative
(unshaded)	Least preferred alternative

No shading indicates no preferred alternative

Impact category	Western Access Road	Northern Access Road
Visual Character	This modification of the landscape will change its natural coastal vegetation character and significantly change the sense of place.	The sense of place will be marginally altered because the area is an agricultural landscape with gravel roads. If the Northern Access Road is selected, the road from Humansdorp will be upgraded in alignment and tarred.
Impact on agricultural production	The proposed western and eastern access roads will have no significant impact on agricultural production.	The proposed northern access road will pass through cultivated pasture land used for dairy production and dust from the northern access road will have a negative impact on surrounding pastures[31].

[31] The recommendation of the air quality assessment is that this road must be tarred. If this is the case, then the impacts of dust deposition will not be realised.

Impact category	Western Access Road	Northern Access Road
Flora	Access roads from the west would potentially impact both the transverse dunes and associated inland wetlands. The western alignment poses problems for the maintenance of the western extremity of the northern transverse dune system, as well as impacts on mobile parabolic dunes; here astute mitigation is required to avoid mobile dunes and wetlands.	The northern access road is viewed as too difficult to mitigate and should not be constructed. A proposed service road linking the power station with the HV yard is not supported at all.
Dune Geomorphology	Vegetated Dunes: The smooth hard-surfaced road and the aerodynamically shaped bridge would both have high impacts during the construction phase. The smooth hard-surfaced road would have a low operational impact. The aerodynamically shaped bridge would have a somewhat lower operational impact. The aerodynamically shaped bridge would have a lower operational impact.	Mobile Dunes: An access road, transmission lines and a temporary conveyor belt or haul road could probably be built across the mobile dunes of the Oyster Bay dunefield at Thyspunt. Vegetated Dunes: The smooth hard-surfaced road and the aerodynamically shaped bridge would both have high impacts during the construction phase. The smooth hard-surfaced road would have a low operational impact. The aerodynamically shaped bridge would have a somewhat lower operational impact. The aerodynamically shaped bridge would have a lower operational impact.
Vertebrate Fauna	At Thyspunt, the impact of roads is expected to be intense in terms of fragmentation effects as well as mortality on the roads.	At Thyspunt, the impact of roads is expected to be intense in terms of fragmentation effects as well as mortality on the roads.
Invertebrate Fauna	The approach from the west passes through the largest amount of high sensitivity butterfly habitat, but does so along an existing road route, which could be upgraded with relatively little further disruption of natural ecosystems; this would be the recommended route for light traffic.	The approach from the north via the HV yard also passes through a significant amount of high sensitivity butterfly habitat. As this route would presumably need to be suited to heavy traffic at least up to the HV yard, it is recommended that (subject to approval by the botany and dune geomorphology specialists) it be used in preference to the western approach as the heavy traffic route; in part it could also be used as access for installation of the 132 kV transmission line, depending on the precise route chosen for the latter.

Impact category	Western Access Road	Northern Access Road
Wetlands	Fragmentation, infilling and physical disturbance to duneslack wetlands in the Oyster Bay mobile dune system as well as to wetlands immediately north of the Oyster Bay dunefield, as a result of impacts associated with the proposed passage of transmission lines, roads and potential options for sediment transport across the dunes If two access routes are required, specifically for construction, then the proposed western access route is greatly preferred to the northern route.	Fragmentation, infilling and physical disturbance to duneslack wetlands in the Oyster Bay mobile dune system as well as to wetlands immediately north of the Oyster Bay dunefield, as a result of impacts associated with the proposed passage of transmission lines, roads and potential options for sediment transport across the dunes.
Heritage Resources	While it is expected that some impacts will occur, it is expected that these will be controllable through mitigation as long as site inspection during bush clearing can take place. The proposed route is acceptable.	Although archaeological sites have been observed in the dune field, the alignment as it is will not result in any impacts to these. However, it is possible that buried sites may be impacted during earthmoving operations. Mitigation should be achievable, provided that sites can be identified during and after bush clearing and then adequately sampled. The practicalities of constructing a road over a mobile dune field are a cause for concern, along with the possible damage to the functioning of the dune system.

9.28.3 Forms of power generation

The comparative assessment of energy generation technologies undertaken as part of the Scoping Phase gave rise to the following conclusions:

- Technological alternatives for power generation involving coal as a resource are not viable alternatives for power stations located in coastal areas as coal resources are concentrated in the Mpumalanga and Limpopo Provinces. Transmitting electricity from this region to the Eastern and Western Cape provinces results in significant losses due to the distance.
- Although Eskom remains committed to identifying ways in which renewable energy (e.g. wind and solar power) may be utilised to assist in the supply side of its operations, such technologies currently do not provide the capacity to provide the large scale power generation facilities needed to supply a reliable base load and easily integrate into the existing power network in South Africa.
- At present the only viable technology for large scale base load electricity production within the borders of South Africa, other than coal, is nuclear power.
- Hydro-electric power is not considered a feasible alternative due to the scarcity of water in South Africa. Furthermore, the importation of hydro-electrical energy would be expensive due to the long distances over which transmission lines would need to be built, and politically complicated due to the transmission corridors having to cross the borders of a number of politically unstable African countries from the Congo River.

In terms of South Africa's climate change commitments of reducing CO_2 by 34 percent, the country is required to diversify its energy mix. Nuclear as a base load alternative provides a means for a significant reduction in CO_2 emissions.

Thus, as far as power generation technologies are concerned, nuclear generation and coal-fired power generation are the only proven base-load technologies. Of these two, coal-fired

generation is not viable in the coastal regions of the Western Cape and Eastern Cape. Apart from these factors, South Africa must make increasing use of nuclear power generation in future to reduce its greenhouse gas emissions in order to comply with its commitments made at the Copenhagen Climate Change Summit in December 2009. The life cycle contributions of nuclear electricity generation to greenhouse gas emissions is small compared to coal-fired electricity generation. This points to Nuclear generated electricity being a necessary part of South Africa's strategy to generate an additional 40 000 MW of electricity by 2025.

9.28.4 Modes of transport (Bantamsklip site only)

Road transport is accepted as the only solution for the transports of heavy loads from the harbours for Duynefontein and Thyspunt. However, at Bantamsklip, due to the extensive road and bridge upgrades that will be required for the transport of heavy equipment from Cape Town harbour, transport by barge from Cape Town harbour has been suggested as an alternative to road transport.

Clearly the social impacts associated with transport by barge would be significantly less than road transport, since road transport would result in significant delays along the route, particularly when extra heavy loads are transported by a Self Propelled Modular Transporter. There are several mountain passes along the route between Cape Town and Bantamsklip that would be very difficult and time-consuming to negotiate by a vehicle of this nature.

If a barge were to be used, it would have to cover a distance of approximately 150 km from Cape Town Harbour to Bantamsklip. Suitable landing and loading / off-loading facilities appropriate for a barge would have to be constructed along the beach close to the Bantamsklip site. The exceptionally heavy load would then have to be transported via road from the landing point of the barge to the Bantamsklip site. This option requires the heavy load to change modes of transport more often than if the load was transported directly via road and is therefore only considered as a last resort.

From an environmental point of view, this option is regarded as unacceptable, due to the expected significant impacts that would result from the construction of landing facilities for the barge. Although no specific assessment of potential landing points has been conducted, the vertebrate fauna and heritage assessments both identified the coastal strip along the Bantamsklip site as being highly sensitive to disturbance. In any event, the construction of a landing facility for a barge would require a separate EIA process.

Barging of exceptionally heavy loads to Bantamsklip is therefore rejected as an alternative in this EIR. Should Eskom wish to pursue this alternative, a separate EIA process would have to be commissioned as landing facilities have not been considered in this EIR.

9.28.5 Fresh water supply

(a) Duynefontein

The Site falls within the Berg Water Management Area (WMA). According to the water requirement projections in Appendix D of the DWA's National Water Resource Strategy (DWAF 2004), there is no allowance for water requirements for power generation in this Water Management Area. Potential sources of freshwater, as discussed below, were considered.

<u>Aquifer</u>
The Aquarius Wellfield is located approximately 6 km north-east of Duynefontein. Water was previously abstracted from this well field and used as a source at Koeberg, but it is no longer being used as a result of the poor water quality. On-site use of groundwater is therefore not an option at Duynefontein.

<u>Cape Town metropolitan water supply system</u>
Koeberg currently receives water through the municipal supply line along Otto du Plessis Drive through Van Riebeeckstrand. The site receives the bulk of its water from one source via the local authority. Water to the Duynefontein nuclear power station can be supplied from the 500 mm

diameter bulk feeder main along the West Coast Road (R27). However, based on the DWA's National Water Resource Strategy, it is unlikely that this water supply will be allocated to a nuclear power station and it is unlikely that it will sustain the nuclear power station for the duration of its lifetime.

Desalinisation
This alternative presents a guaranteed source of fresh water supply for the lifespan of the proposed nuclear power station without jeopardising the availability of freshwater to other users. **A desalinisation plant is therefore the preferred alternative for the provision of fresh water at Duynefontein.**

(b) Bantamsklip

According to water requirement projections in Appendix D of the DWAF's National Water Resource Strategy (2004), there is no allowance for water requirements for power generation in this WMA. Potential sources of freshwater, as discussed below, were considered.

Aquifer
According to Eskom (Services Report), Bantamsklip is not associated with an exploitable groundwater source. This alternative is therefore not feasible.

Local Municipality water supply system
Pearly Beach and Buffelsjag obtain their water supply from boreholes while Gansbaai and Franskraal obtain their water supply from the Kraaibos Dam water treatment works. According to Eskom (Services Report), the current water sources cannot accommodate the water requirements associated with the proposed nuclear power station.

Breede River
Any major industrial undertaking in the Bantamsklip area would entail the acquisition of piped fresh water from a water source located outside the immediate region. The nearest such system is the Breede River. Acquiring water from this source necessitates an application to the DWA for approval and therefore cannot be guaranteed.

Desalinisation
This alternative presents a guaranteed source of fresh water supply for the lifespan of the proposed nuclear power station without jeopardising the availability of freshwater to other users. **A desalinisation plant is therefore the preferred alternative for the provision of fresh water at the Duynefontein site.**

(c) Thyspunt

The site falls within the Fish-Tsitsikamma Water Management Area, but large quantities of water are imported from the Upper Orange River Water Management Area. According to water requirement projections in Appendix D of the DWA's National Water Resource Strategy, DWAF (2004), there is no allowance for water requirements for power generation for this WMA. Potential alternative sources of freshwater, as discussed below, were considered.

Aquifer
According to Eskom (Services Report), large quantities of ground water are available in aquifers underlying the Thyspunt region. Existing boreholes are currently used as a source of potable water for the residential areas of Humansdorp, St. Francis Bay and Oyster Bay. Oyster Bay is totally reliant on groundwater as a source of freshwater. There are a number of existing licensed boreholes that could be used for water supply during the initial construction stages.

Kouga Local Municipal water supply system
Water for the Thyspunt site can be drawn off the municipal feeder main at St Francis Bay, which will require the installation of a pipeline along the proposed access road to the Thyspunt site. There is a spare capacity of 79 l/s available on this line, and the portion of this capacity for use at the nuclear power station is still to be determined by the Kouga Municipality.

Orange River scheme
Another alternative is to source fresh water from the Orange River scheme via Port Elizabeth. However, the total capacity available for use for the proposed nuclear power station is currently unknown. In the event that this source is used for the proposed nuclear power station, it may be possible to place the reservoir at the existing St Francis reservoir rather than on the site.

Desalinisation
This alternative presents a guaranteed source of fresh water supply for the lifespan of the proposed nuclear power station without jeopardising the availability of freshwater to other users. **A desalinisation plant is the preferred alternative for the provision of fresh water at the Thyspunt site.**

9.28.6 Utilisation of abstracted groundwater

Groundwater will have to be abstracted at all three alternative sites in order to allow the excavation for the construction of a platform for the Nuclear Island.

(a) Transfer to the municipal sewage system

Given that the abstraction of water will occur over a relatively short period of time, it is not feasible to construct pipelines to transfer the water to the local municipality. This alternative is neither sustainable, nor cost effective and is therefore not recommended.

(b) Storage and utilisation

The abstracted water can be stored in dams/ ponds on site and utilised during the construction phase of the nuclear power station for example, dust suppression. It should be noted that storage dams/ ponds exceeding 10 000 m^3 will require authorisation from the DWA. **This is the preferred alternative, as it is allows for the effective utilisation of resources.**

(c) Discharge to sea

Should Eskom not be able to use the full volume of abstracted groundwater for human consumption or for construction, it will be discharged into the sea.

In conclusion, the preferred alternative with regards to abstraction of groundwater is the storage and utilisation of the water on site. However, due to the volume of water likely to be abstracted, particularly at Thyspunt (the only site with appreciable volumes of groundwater), some water may also have to be discharged into the sea. Transfer to the municipal water is not regarded as feasible at any of the sites, due to distance from the nearest serviced urban area. **Therefore, a combination of storage and discharge to the sea is recommended. Given the findings of the oceanographic assessment (Appendix E16) and marine biology assessment (Appendix E15) that discharge of spoil into the sea will not result in significant negative impacts, this combination of alternatives is regarded as environmentally acceptable.**

9.28.7 Disposal of brine

(a) Disposal of brine directly into the sea

During the construction phase, the brine will be released into the surf zone. The physical mixing with surrounding sea water will result in dilution to 1 g/L above ambient salinity within 110 m from the point of release. According to the marine biological assessment (**Appendix E15**), any ecological impacts will be focused within the water column due to the high energy of the surf zone. However, the long-term direct disposal of the brine into the ocean, without prior dilution, will induce a significant impact on the marine environment. Thus, this alternative is acceptable for the construction phase only.

(b) Co-disposal of brine and cooling water into the sea

During the operational phase, the brine is mixed with the sea water that is used to cool and condense the steam that drives the turbines. The brine and cooling sea water are subsequently co-disposed into the ocean at the outfall structure. The brine is expected to have a salinity of 58 ppt (in comparison with seawater, which has a salinity of 35 ppt). This effluent will account for less than 1% of the water released. Thus, the brine will be diluted to undetectable levels within the outflow pipes prior to release (Prestige *et al.* 2008b). Thus, the co-disposal of the cooling water and the brine would result in significant dilution of the brine, thereby inducing a negligible impact on the marine environment.

In conclusion, either alternative is environmentally acceptable. Disposal of brine directly into the sea should be utilised only during construction, and brine should be mixed with cooling water that is discharged into the sea during the operational phase.

9.28.8 Intake of seawater

(a) Utilise the existing intake structures located at Koeberg

This alternative is applicable to the Duynefontein site only. It is proposed that the new nuclear power station will be located adjacent and to the north of the existing nuclear power station, which obtains water from an existing harbour. The utilisation of the harbour at Koeberg is not considered feasible because the current Koeberg intake structure is sized for three 1 000 MW units and therefore does not have the capacity to support the proposed Nuclear-1. In addition, the active cooling safety systems of some proposed Nuclear-1 technology would not have adequate protection for the ultimate heat sink.

(b) Installation of intake tunnels and inlet structure

Intake tunnels entail the installation of undersea pipelines, which obtain water from the ocean and feed cooling water into a storage area (intake basin) located adjacent to the cooling water pump houses. According to the marine biologist, this alternative is preferred, as the impacts are minimised in comparison with the development of a new harbour and is therefore the preferred alternative.

According to the marine biologist, the specifications of the tunnel and the inlet structures will not influence the impacts on the marine environment and alternative specifications were therefore not discussed. However, the mitigation measures as provided in the EMP must be adhered to.

In conclusion therefore, the installation of intake and outlet tunnels is the only feasible alternative for all three alternative sites.

9.28.9 Outlet of water and chemical effluent

(a) Near shore outfall structure

Nearshore release does not facilitate mixing of the water, while release outside of the surf zone allows the heated water to rise to the surface layer and spread laterally. Thus, near shore release is not recommended.

(b) Offshore outfall tunnels

This design prevents warmed water being released at a single point source (the more release points, i.e. the more outlet pipes, the better) and releases the cooling water above the sea bottom. This minimises thermal pollution of the benthic environment. Mixing is further enhanced by the buoyancy of the warm water, which causes the water to rise. This design will have less potential impact on the benthic environment than a channel release and is therefore the preferred alternative.

On offshore outlet tunnel prevents warmed water being released at a single point source (the more release points, i.e. the more outlet pipes, the better) and releases the cooling water above the sea bottom, which minimises thermal pollution of the benthic environment. Mixing of further enhanced by the buoyancy of the warm water, which cause the water to rise. This design will have less impact on the benthic environment than a channel release and is therefore the preferred alternative.

In conclusion, outlet structures for cooling water and chemical effluent must be offshore. All releases need to occur at the appropriate distances as described by the relevant specialists. Provided that the specific mitigation measures identified in the marine biology report are adhered to, offshore effluent release is therefore the recommended alternative.

9.28.10 Management of spoil material

(a) Discard in the sea

The spoil can be hydraulically pumped offshore, where it will be discarded into the sea. According to the marine biologist, discarding of a small portion of spoil that would affect only 3 km^2 is permissible at all three sites, since movement patterns in the sea would allow for sufficient dilution of the spoil (**Appendix E16**).

(b) Discard on land

The spoil will be discarded in a designated off site spoil dump. The EIA corridors assessed by specialists included an area for a spoil dump. At Thyspunt, there is also the alternative of transporting the spoil to via a conveyor belt to the northern “panhandle” portion of the site. Given that the spoil is not actually a waste product, it can be regarded and utilised as a valuable resource.

(c) Development of rock retaining walls

The rock spoil can be used to construct rock retaining walls, which will serve to stabilise landforms. However, the quantity of spoil required to construct the rock retaining walls may be insignificant in comparison to the amount of spoil available for use. Thus, there will be an excess of spoil, which means that this alternative should be pursued in conjunction with other suitable alternatives.

(d) Development of terraces

The spoil can be used to construct the terraces of the nuclear plant. The terraces require engineered fills in order to create a stable platform that is not subject to wind erosion.

(e) Building of dunes

It may be possible to utilise the spoil to recreate specific components of the dune system. Further assessments are, however, required to determine the feasibility of this alternative. It is recommended that a terrestrial ecologist and geomorphologist play an integral role in the feasibility of using the spoil to develop the dunes.

(f) Levelling of the HV yard (only applicable to Thyspunt)

Some of the sand and rock spoil may be used to level the proposed HV yard in the panhandle of the Thyspunt site. The spoil will be transported via conveyor belts and/or hydraulic pumping across the moving dunes to the HV yard.

(g) Commercial uses for the spoil

In accordance with the principle of optimal utilisation of resources, it may be possible to sell the spoil to landscapers or other potential buyers. However, due to the infestation of portions of the Nuclear-1 properties by invasive alien species such as *Acacia cyclops* (Rooikrans), this alternative may result in the exportation of propagules of these species to other areas.

In conclusion, based on the findings of the oceanographic modelling (Prestedge *at al.* 2009) and the marine impact assessment (Appendix E15), it is proposed that as much as possible fine spoil must be disposed of in the marine environment, according to the recommendations of the marine sediment study and the marine biology study. The remainder, which cannot be pumped to sea, must be disposed of on land and used for activities like levelling of the HV yard to the greatest extent possible, to minimise the footprint on the terrestrial environment. The spoil dumps that need to be placed on land must be placed and shaped so that they fulfil a visual screening role as well and should be designed to minimise their visual impact. A Landscape Architect should be engaged to assist in the appropriate design of the spoil dumps, for this purpose.

9.28.11 Nuclear plant types

Pressurised Water Reactors are the most commonly used nuclear reactors both nationally and globally. The existing Koeberg uses PWR technology and it is therefore a tested form of power generation that has been operating safely for the past 24 years. Eskom is familiar with the technology from a health and safety, as well as from an operational perspective.

9.28.12 'No go' (No development alternative)

Given the urgent power demand based on economic growth in South Africa, the No-Go alternative is not considered to be a logical alternative, as Eskom's mandate is to provide power. Eskom, would in all likelihood, apply to develop more coal-fired power stations if the No-Go alternative for the proposed nuclear power station is adopted. It would not be economically viable (and difficult to finance these projects as banks are becoming reluctant to finance such projects) to develop more coal-fired power stations in the future, due to carbon tax that would be imposed on countries that continue to emit greenhouse gases.

The No-Go alternative would imply that potential benefits, as listed below, that emanate from the proposed project would not be realised:

- The supply of base load power from diverse, secure, sustainable energy sources, which have relatively low greenhouse gas emissions;
- Increased difficulty in achieving the energy requirements of economic growth targets set by government within the Accelerated and Shared Growth Initiative for South Africa (AsgiSA)[32], which requires that more than 40 000 MW of new electricity generating capacity be provided within the next twenty years;
- The reduction of coal fired contributions to power generation that would be in line with Eskom's long-term strategy to diversify its primary energy requirements, and reduce GHG emissions. Without the proposed project, given the economic growth rates and existing power generation capacities, Eskom is likely to be compelled to construct more Coal Fired Power Stations to meet the demand;
- Reduction in transmission line losses; and
- The use of uranium, which apart from coal is the only primary energy source in South Africa that is suitable and commercially available in sufficient quantities for base load power generation.

In addition to potential benefits that would not be realised, potential negative impacts that could occur through the proposed project would also be avoided with the No-Go alternative. The potential

[32] http://www.info.gov.za/asgisa/asgisa.htm

negative impacts that may occur as a result of the development of a nuclear power station are discussed and mitigated in this Draft EIR.

It should further be noted that should Eskom not utilise the sites for nuclear development, it is likely to sell the properties, pending a decision by the Eskom Board. The sale of the properties will be to a willing buyer at the market-related price, which would probably result in an alternative form of land use that may be more damaging than a nuclear power station.

The no-go alternative is therefore not recommended.

9.28.13 Position of the nuclear power station on the sites

Preliminary envelopes, within which the power station footprints could be located, were developed for each site. These envelopes were provided to the specialists and were subsequently refined to address some of the issues and concerns that the specialist raised during the specialist integration workshop held on the 25 August 2008 and at a second integration meeting with a smaller group of specialists held on 26 September 2008. Areas of highest sensitivity were discussed with the specialists during the November 2009 integration meeting. Their sensitivity maps (refer to the individual specialist reports **Appendices E2 to E27**) were overlaid to produce composite sensitivity maps for the sites, shown below. The least sensitive areas of each of the alternative sites are indicated on these maps.

For all three alternative sites, the area within 800 m from a public road was excluded from consideration in the EIA and HV yard corridors as no public access is allowed within the Emergency Planning Zone (EPZ), which is expected to be at least 800 m from the proposed nuclear power station (refer to **Section 5.5** and **Figures 5- 5 to 5-7**).

From an environmental perspective the specialists collectively recommended that the following areas <u>not be considered as suitable</u> for the construction of a nuclear power station:

1. The area between the low and high water mark and then 200 m inland from the high water mark to allow for the maintenance of ecological corridors, whilst also limiting the potential impact on the sensitive mobile dunes and heritage features along the shoreline of all sites (refer to **Section 5.5** and **Figures 5-5 to 5-7**);
2. At the Bantamsklip site, the area north of the R43 due to its conservation significance (**Figure 5-6**); and
3. The area within 100 m from the high water's edge of any wetland.

Figures for the combined overlaid sensitivity maps for all three sites are contained on the last four pages on this Chapter.

At the Bantamsklip site the area considered to be suitable for the construction, operation and decommissioning of a nuclear power station is a 172.06 ha area on the north-eastern side of the EIA corridor and the south-eastern side of the HV yard corridor. None of the specialists indicated the area as environmentally sensitive.

At the Duynefontein site the area considered to be suitable for the construction, operation and decommissioning of a nuclear power station is a 156.51 ha area on the eastern side of the EIA and HV yard corridor, adjacent to the existing Koeberg Nuclear Power Station. Only the flora and invertebrate specialists have indicated that this area is environmentally sensitive. From an invertebrate perspective the specialist has indicated that there is a high level of confidence that, while similar habitat outside the area is limited, the species present (including the undescribed ant species), are adequately represented in other habitats on the site. From a flora perspective the specialist has indicated that habitat rarity is moderate, with highest species endemism being localised in the Sand Plain Fynbos. Sensitivity is also locally high due to the presence of the mobile dunes. The botanical specialist's opinion that the transverse dune system at Duynefontein is endemic is not supported by the dune geomorphology specialist. Nevertheless, appropriate placement of the nuclear power station footprint would have to be carefully determined with the assistance of a suitably qualified and experienced botanist, so that the above potential impacts on the flora are mitigated.

At the Thyspunt site the area considered to be suitable for the construction, operation and decommissioning of a nuclear power station is a 125.11 ha (73.79 ha for the main plant and 51.32 ha for the HV yard) on the southern central portion of the EIA corridor and the centre portion of the HV yard corridor. The area straddles two ‘no-go’ zone of seismic hazards (i.e. the Goudini/Cedarberg Transition and the Skurweberg/Goudini Transition). Only the invertebrate specialist has indicated that this area is environmentally sensitive. The invertebrate specialist has indicated that whatever the sensitivity of the habitat types within the proposed nuclear power station footprint, there is sufficient scope for protecting adequate amounts of similar habitat elsewhere on the site.

It must be noted that the above are only recommendations regarding the areas suitable for the construction of a nuclear power station at any one of the alternative sites and that the final positioning will be determined taking the following aspects into consideration:

1. The DEA’s decision regarding authorisation of the proposed activity has been announced at the recommended alternative site, or any of the other alternative sites.
2. Should the DEA authorise the construction of a nuclear power station at any one of the alternative sites, \associated conditions of authorisation would need to be taken into account.
3. Appointment of the vendor and results of the inter-site geological conditions.
4. Detailed studies are undertaken for the disciplines that have indicated medium to high sensitivity within the area proposed, to confirm that no unique species or communities will be threatened, and to carry out the effective mitigation where appropriate e.g. search and rescue operations to relocate any rare and/or useful plant species to areas which enjoy long-term protection, rehabilitation of disturbed areas, etc.

Based on the sizes of the above-mentioned areas that are suitable for a nuclear power station, (between 73.79 ha and 172 ha), and the proposed size of the Nuclear-1 footprint (31 ha), it will be possible to construct additional power stations, beyond Nuclear-1, on all the alternative sites.

In spite of the above-mentioned broad recommendations regarding the number of power stations at each site, it must be emphasized that the current application is for a single nuclear power station. The cumulative impacts of any additional nuclear power stations would have to be confirmed in a new EIA process and authorisation would have to be obtained prior to development.