1 SPECIALIST REPORTS

1.1 Dune Geomorphology (Appendix E2)

This specialist study investigates environmental impacts related to dune dynamics for the nuclear power station (‘Nuclear-1’) that Eskom proposes to build. There are three sites under consideration: Duynefontein, Bantamsklip and Thyspunt. Aerial photographs from 1942 to 2007 were analysed to assess the dune morphology and dynamics of the mobile dunefields and vegetated dunefields at the three sites. Available literature on the subject was perused, including diverse reports prepared for Eskom, and various environmental specialists were consulted. Site visits were made, including visits with the wetlands and botany specialists.

Duynefontein

The dunes at Duynefontein form part of the Atlantis corridor dunefield. The dune varieties found are mobile transverse dunes, transverse dunes artificially stabilised with alien vegetation such as Rooikrans, and naturally vegetated parabolic dunes. Groundwater only “daylights” at Duynefontein in one or two small ephemeral interdune hollows, so there are no significant impacts related to the interaction between groundwater and dune dynamics at this site.

Access roads and transmission lines can be built across the mobile dunes with operational impacts ranging from medium to low. Access roads and transmission lines can be built across the vegetated dunefields with operational impacts ranging from low to insignificant.

Topsoil and spoils stockpiles located on the mobile dunes will have medium operational impacts. Topsoil and spoils stockpiles located on the vegetated dunefields will have low operational impacts.

At Duynefontein, 25% of the specific variety of mobile dunes will be lost if the proposed NPS site is used, and although it would be preferable not to lose these mobile dunes, this is not a fatal flaw in terms of their geomorphologic conservation value. The artificially vegetated dunes have no conservation value. A small proportion of the Late Holocene parabolic dunes will be lost; this is of low conservation significance.

Bantamsklip

Transgressive dunefields occur along the coast in the Bantamsklip area. They consist mainly of transverse dunes, which are mostly artificially stabilised with alien vegetation such as Rooikrans and some indigenous species. There are no currently mobile dunes on the site itself. There are some much older naturally vegetated fossil parabolic dunes formed during the previous interglacial (~ 120 000 years ago). Groundwater does not “daylight” at the site and so there are no impacts related to the interaction between groundwater and dune dynamics at the site.

Access roads and transmission lines can be built across the artificially vegetated dunefields with low operational impacts. Access roads and transmission lines can be built across the older naturally vegetated parabolic dunes with low operational impacts after careful rehabilitation.

Topsoil and spoils stockpiles located on the artificially vegetated dunefields or on the older naturally vegetated parabolic dunes will have low operational impacts. The geomorphologic conservation value of the dunefields at the Bantamsklip site is low, considering that other examples of dunefields of their type are hardly impacted.

Thyspunt

The dune varieties found at Thyspunt are mobile dunefields of the headland-bypass dunefield variety (the Oyster Bay dunefield), and vegetated parabolic dunes and hairpin parabolic dunes. In addition, sidewalls of previously mobile dunefields form long, vegetated dune ridges.

Parts of the mobile dunefields have been artificially stabilised with alien vegetation such as Rooikrans. The mobile dunefields are very dynamic.

At Thyspunt groundwater "daylights" in many interdune areas within the Oyster Bay dunefield to form ponds in the interdune areas (also known as dune slacks), where wetlands are often found. The behaviour and flow characteristics of groundwater and surface water were investigated to help determine the viability, in respect of dune dynamics, of building transmission lines and an access road to Thyspunt from the north, across the Oyster Bay dunefield.

Mobile dune dynamics at Thyspunt were investigated in detail. An access road, transmission lines and a temporary conveyor belt or haul road could potentially be built across the mobile dunes of the Oyster Bay dunefield at Thyspunt. ***Further groundwater monitoring work on surface water and shallow groundwater flow as required was completed at the end of 2010 and the results thereof have been incorporated in the revised Freshwater Ecology (Wetlands) Report.***

The access road can be built either using an aerodynamically smooth road slightly raised above the interdune surface with frequent culverts, or with an aerodynamically shaped bridge that crosses the mobile dunes and interdune wetlands to allow sand to be transported below the road without causing sand build-up. The aerodynamically shaped bridge design would have a lower operational impact.

Transmission lines can be built across the mobile Oyster Bay dunefield. The operational impacts of towers spaced at 300 - 400 m intervals 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, the whole mobile dunefield could be crossed with no activities or structures being located within the mobile dunes, and thus without any impacts whatsoever.

A temporary conveyor belt or haul road can be built across the mobile Oyster Bay dunefield to carry spoils to the "panhandle" in the north of the site. The environmental impact would be low after the conveyor belt or haul road is removed and rehabilitation is completed. However, rehabilitation would be slow.

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.

Topsoil and spoils stockpiles cannot be located on the mobile Oyster Bay dunefield at Thyspunt. Topsoil and spoils stockpiles can be located on the vegetated dunefield at Thyspunt with medium operational impacts.

The geomorphologic conservation value of the headland-bypass dunefields at Thyspunt is high, as they are the only remaining large dunefields of this type that are still active in South Africa. The headland-bypass dunefields at Cape St. Francis are unique on a local, regional and probably global scale. The vegetated dunefield is a classic, almost pristine example of a suite of Holocene and Pleistocene dune ridges with a variety of origins: parabolic dunes, hairpin parabolic dunes, and sidewalls of previously mobile headland-bypass dunefields, including fairly unique examples of such sidewalls. Overall, the dunefields at Thyspunt has high interpretive value for elucidating coastal dune dynamics.

Climate change

The possible effects of climate change on dune dynamics are:

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.

Rainfall decrease and temperature increase at Duynefontein and Bantamsklip will stress vegetated dunes, so it will be easier for blowouts to form. At Thyspunt, rainfall is not expected to change, but temperature will increase, so it will be somewhat easier for blowouts to form, but not as much as at the other sites.

Wind speed increase is not expected to have any significant environmental impact.

1.2 Geological Hazard Assessment (Appendix E3)

In general the impact of a Nuclear Power Station on the geological environment is smaller compared to the potential impact that the geological environment may have on the proposed ***Nuclear Power Station***. Geological investigations are guided by Nuclear Regulatory Codes, especially U.S. Nuclear Regulations, which are regarded as the ***leading*** international regulatory framework, and geoscientific investigations which are guided by the increasing resolution in consecutive regulatory radii of 1, 8, 40 and 320 km around each proposed site.

A number of different geological factors are considered here, including:

- Locally induced (by the steam turbines) vibratory ground motion at the site;
- Surface rupture;
- Subsurface stability; and
- Volcanic risk.

Available geological data on the three sites being considered for installation of a nuclear power plant, Thyspunt, Bantamsklip and Duynefontein, has been reviewed regarding the above-mentioned risk factors. This showed that the geological risk regarding the abovementioned risk factors is low at all three proposed sites. However, additional neotectonic studies still need to be completed and the results submitted to the National Nuclear Regulator as part of the Site Safety Report submissions. These studies, which will be done separately from the EIA process, may impact and even change conclusions reached to date, and therefore no final conclusions can be made about site suitability.

Geologically, there are no sensitive areas that need to be avoided at the Bantamsklip and Duynefontein Sites. At the Thyspunt site the foundation of critical structures should not cross the contact between the Goudini and Skurweberg Formations.

A decision not to proceed with a Nuclear Power Station will have no impact on the geology at the Thyspunt, Bantamsklip or Duynefontein sites. A minor risk to subsurface stability exists at the proposed Duynefontein site.

1.3 Seismic Risk Assessment (Appendix E4)

In general the impact of a Nuclear Power Station on the geo-scientific environment is insignificant compared to the potential impact that the geo-scientific environment may have on the proposed Nuclear Power Station. Geo-scientific investigations for nuclear sites are guided by Nuclear Regulatory Codes, especially U.S. Nuclear Regulations, which are regarded as the most comprehensive international regulatory framework, and requires geological and geophysical investigations of increasing resolution in concentric regulatory radii of 320, 40 and 8 km around each proposed site.

Seismic Hazard Analysis (SHA) entails estimating the expected level of ground motion at the site during the active and decommissioned life of the plant, based on a model of the regional and local seismicity (size and locations of earthquakes). All seismic hazard analyses require the same fundamental input data; a model for the occurrence of earthquakes (seismic *source* model) and a model for the estimation of the ground motions at a given location as a result of each earthquake scenario (ground-motion model). The seismic source and ground-motion models are combined, either probabilistically or deterministically, to obtain the ground motions to be considered for design. Probabilistic Seismic Hazard Analysis (PSHA) uses advanced statistical methodologies which enable the consideration of uncertainties.

Site specific SHA were previously undertaken for the three sites by the Council for Geoscience (CGS), employing a methodology called the Parametric-Historic SHA.

Using this methodology, median PGA values of 0.16 g, 0.23 g and 0.30 g were calculated for the Thyspunt, Bantamsklip and Duynefontein sites, respectively and these values constitute the current seismic hazard levels for the sites.

These results were accepted by the National Nuclear Regulator (NNR). The NNR however, imposed the condition that current state of the art for SHA should be used in the evaluation of the sites when formal applications are made for a construction and operating licence. In order to meet this requirement, Eskom has decided to follow the regulations of the United States Nuclear Regulatory Commission (or US NRC), which is considered to be the most stringent, detailed, tried and tested set of regulations in the world, and therefore describes international best practice for the SHA and the proposed licensing process with the NNR. Additionally, the United States, like South Africa, is a member state of the International Atomic Energy Association (IAEA), and as such their national legislation is compatible with the IAEA regulations.

The present Chapter of the EIR describes the work carried out to date on the seismic hazard assessment of the three sites, and provides the current positions regarding their suitability for locating nuclear power plant installations.

1.4 Geotechnical Suitability Assessment (Appendix E5)

Eskom Holdings Limited (Eskom) proposes to construct Nuclear Power Stations and associated infrastructure, either in the Eastern or Western Cape Province. Three site alternatives are considered:

- Thyspunt (Eastern Cape – West of Port Elizabeth near Oyster Bay)
- Bantamsklip (Western Cape – 5 km south-east of Pearly Beach)
- Duynefontein (Western Cape – adjacent to the existing Koeberg Power Station, CapeTown)

The choice of suitable sites will be influenced by the Environmental Impact Assessment (EIA) process, in terms of which numerous physical, biophysical, oceanographical and engineering aspects are being investigated. This report considers the Geotechnical Engineering aspects of the sites.

The report is based on a desk study of historical information as well as on extensive data gathered through intrusive field investigations. These data sources have identified the following fundamental geotechnical characteristics at the sites:

Thyspunt

- The site soil profile varies considerably in thickness as one moves inland, ranging from 0m 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;
- An historical erosion depression containing cobbles exists in the Goudini Formation and this cobble layer influences groundwater flow direction in a South Easterly direction.

Bantamsklip

- 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;
- These quartzitic sandstones are highly jointed, but competent and present a more competent wave cut platform than at Thyspunt;

Duynefontein

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

No-go option

Should it be decided to not construct a nuclear power station none of the above impacts associated with construction of a nuclear power station will be introduced. All associated negative impacts will therefore be removed. However, Eskom could sell the Thyspunt and Bantamsklip sites, and possibly parts of the Duynefontein site under this scenario and there could therefore be other unforeseen negative impacts arising from different property development scenarios.

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);
  - The disposal of excavation spoil.

The impacts related to slope stability imposing safety risks without mitigation measures have low significance 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 rexcavation footprint disturbances and a need for disposal of greater volumes of spoil. The impacts associated with this ***(without mitigation)*** are of ***medium*** significance at ***Duynefontein and Thyspunt and low significance at Bantamsklip. With mitigation, which essentially involves locating the excavations near the sea at Bantamsklip and Thyspunt, the significance of associated impacts are reduced to low and low – medium at Duynefontein and Thyspunt respectively. At Bantamsklip, the significance of these impacts are low – corresponding to less overburden on this site.*** Site sensitivity maps depicting ***the significance of these excavation-related impacts*** are presented in this report.

1.5 Hydrological Assessment (Appendix E6)

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a proposed conventional Nuclear Power Station (NPS) and associated infrastructure at one site in the Eastern Cape and two in the Western Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Hydrology and was carried out by SRK Consulting.

Eskom proposes to construct a NPS of the Pressurised Water Reactor type technology, with a capacity of ~4 000 MWe. The proposed NPS will include nuclear reactor, turbine complex, spent fuel, nuclear fuel storage facilities, waste handling facilities, intake and outfall basin and various auxiliary services infrastructure.

All three proposed sites at Thyspunt, Bantamsklip and Duynefontein are located on the coast.

The study has covered regional aspects based on the surrounding quaternary catchments and a study area of 20 km radius. From the regional assessment it was determined that no potable surface water resources are available at any of the sites. Alternative water supply sources or treatment of sea water must therefore be considered. Desalination is discussed in the Fresh Water Supply specialist study report.

For the currently proposed 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 NPS and climate change should also have a minor effect on ***the hydrology of the surface water bodies*** 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 predevelopment conditions. All impacts can, however, be reduced with the implementation of mitigatory 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 sensitive environmental features or any ecologically sensitive wetlands. The direct hydrological impacts at all three sites are *low* in significance rating with a *low* consequence.

Should no Nuclear Power Station be built (no-go option) at any of the sites, Eskom would sell the Bantamsklip and Thyspunt properties and possibly ***also*** superfluous land ***at*** Duynefontein. The sites may then be developed for other purposes with less strict controls and regulation than those for Nuclear Installations. This may lead to increased runoff from the developments.

If the impacts are then not well managed they may have negative consequences. However, the impact on the Duynefonetin site would be positive.

The Best Management Practices approach is adopted for the identification of structural and non-structural mitigation measures.

The structural mitigation measures include:

- Diversion berms;
- Silt traps;
- Energy dissipation structures; and
- Dirty water containment dams.

The non-structural measures include:

- Drawing-up stormwater control measures maintenance programmes; and
- Production of control measures operational manuals.

There are no fatal flaws at any of the sites regarding surface water impacts.

Existing information should be supplemented on the following aspects:

Detailed footprint and layout of plant area and ancillary works;
Locality and extent of possible future residential / commercial developments; and
Quantification of the rainfall difference due to climate change at each of the sites.

1.6 Geohydrological Assessment (Appendix E7)

This assessment covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites, in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from this EIA Scoping Study. This specialist study covers Geohydrology and was carried out by SRK Consulting, with assistance from the Institute for Groundwater Studies at the University of the Free State and North-West University on the numerical modelling.

This impact study comprises the baseline information and an impact assessment for the following sites:

1. Duynefontein;
2. Bantamsklip; and
3. Thyspunt.

The study provides an overall assessment of the impact of a nuclear facility on the aquifer hydrodynamics and vice versa. The Terms of Reference for the specialist Geohydrological Assessment are to investigate:

- The existence and location of regional / local aquifers and other relevant geohydrological units relative to the sites, e.g. aquitards, fractures, boundaries;
- Groundwater observations including information about hydraulic conductivity / transmissivity, groundwater levels and their fluctuations, monitoring of groundwater chemistry and resistance of soil-cement foundations to chemical attack;
- The possibility of groundwater contamination, flooding by groundwater and material degradation due to groundwater attack;
- The effect of withdrawal of groundwater from neighbouring areas on flow of groundwater at the sites;

- A 3D conceptual geohydrological model showing aquifers, groundwater levels, aquifer boundaries, and groundwater flow directions;
- A 3D numerical flow model to simulate regional, local and site specific response of the groundwater system to natural and manmade influences, e.g. seasonality, dewatering during construction, abstraction from wellfields;
- A contaminant transport model to simulate the fate of any contaminants introduced into groundwater systems from operation of the sites; and
- A risk assessment of the impacts of the NPSs on the receiving environment.

Extensive and detailed work has been carried out at all three sites as part of this assessment, including a hydrocensus, surface geophysics, drilling, test pumping, packer tests, chemical analysis, numerical flow and transport modelling and monitoring.

Four potential environmental impacts involving groundwater have been identified, *viz.*:

- Depletion of local aquifers;
- Degradation of wetlands / phreatophytes/ seeps / springs[1];
- Contamination of groundwater; and
- Contamination of the shore zone by seawater intrusion.

Two potential impacts of the environment on the NPS have been identified, *viz*:

- Degradation of infrastructure; and
- Flooding by groundwater.

The three sites are all located in coastal environments with so-called EIA Corridors within which the NPS and related infrastructure will be located. There are, therefore, certain key geohydrological characteristics that are likely to govern groundwater occurrence and behaviour at the sites. These are:

- There is unlikely to be any downstream groundwater use;
- Groundwater at the site will be near / at the end of its flow path;
- There will be a component of groundwater flow towards the water table (i.e. upwards);
- Groundwater levels will be near the ground surface;
- The bedrock may comprise a wave-cut platform;
- The receiving environment / downstream receptor of any contamination will be the shore zone / sea;
- There is likely to be a two aquifer system at the site, with an upper intergranular and a lower fractured rock aquifer;
- These two aquifers are likely to be in hydraulic connection but may be separated by a weathered zone in the bedrock possibly constituting an aquitard;
- Local recharge may only affect the upper aquifer. Deeper aquifers may be recharged further inland, possibly many kilometres from each site;
- Groundwater quality may be relatively poor because of a combination of the length of the flow path, time for interaction with aquifer materials and proximity to the sea (sea-water intrusion, wind-blown salts);
- Groundwater flow rates are likely to be relatively slow because of low hydraulic gradients;
- There will be an interface between ‘fresh’ groundwater from inland and saline groundwater in the shore-zone;
- Groundwater may feed wetlands and coastal springs / seeps which support sensitive ecosystems; and
- Liquid radioactive emissions will not affect existing groundwater users directly. However, any air emissions could be transported inland by prevailing winds and contaminate the groundwater by being incorporated into rainfall recharge.

[1] Please note that although the activities and geohydrological processes leading to impacts on wetlands are discussed this report, the impacts on wetlands are assessed in the Freshwater Ecology Assessment (a separate but related Appendix to the Environmental Impact Report). The assessment of impacts in the Freshwater Ecology Report is based on the sources of impact discussed in the geo-hydrological assessment.

These characteristics have been taken into account in the approach and execution of this study and played a major role in the impact assessment ratings. At the Bantamsklip site it has been established that no viable aquifers are present, whereas viable aquifers are present at Thyspunt (primary and secondary) and Duynefontein (secondary and primary further inland).

The impact rating of the potential environmental impacts is summarised as follows for the construction and operational phases:

- Flooding by groundwater: ***Medium*** at all three sites without mitigation and ***Low*** with mitigation;
- Depletion of local aquifers: ***Medium*** at Thyspunt and ***Low-Medium*** at Bantamsklip and Duynefontein without mitigation and ***Low*** at all three sites with mitigation;
- Non-radioactive contamination: ***Medium*** at all three sites without mitigation and ***Low*** with mitigation;
- Degradation of infrastructure: Duynefontein overall index slight to serious corrosion and minor scaling. Bantamsklip overall index slight to serious corrosion and minor scaling. Thyspunt overall index non-corrosive to corrosive and scaling.
- Contamination with radioactive material under normal reactor operation: ***Low-Medium*** at all three sites without mitigation and ***Low*** with mitigation;
- No go option: ***Low*** impact at Bantamsklip and ***High*** at Thyspunt and Duynefontein without mitigation, and ***Low*** at Bantamsklip and ***Medium*** at Thyspunt and Duynefontein with mitigation.

The low ratings are largely a function of the sites being situated in coastal zones with groundwater being at/near the end of its flow path, minimal downstream groundwater receptors and application of tried and tested mitigation measures. Site sensitivity (<u>excluding wetlands</u>, which are dealt with in a separate report) is rated as follows:

- Bantamsklip: Low;
- Duynefontein: Low along the coast increasing in sensitivity inland;
- Thyspunt: Mostly Medium.

Essential mitigation measures include the following:

- On-going operation of suitably designed groundwater monitoring networks to cover water levels and quality in all aquifers/wetlands;
- Use of cut-off walls around excavations to a) limit the spread of drawdown during construction and b) maintain stable excavation walls and safe working conditions;
- Use of managed artificial recharge of groundwater pumped from excavations during dewatering to maintain wetlands/springs/seeps and phreatophytes;
- Siting of the NPS excavation on the site within the EIA Corridor such that the impacts identified can be reduced in significance, e.g. avoiding seismically capable faults, fracture zones, wetlands and coastal seeps (assumes groundwater control mitigation measures in place);
- Use of corrosion-resistant foundations, pipes and fittings where infrastructure will be located below the water table;
- The potential for scale formation must be taken into account in the design and maintenance of appropriate structures at the Thyspunt site;
- Development of a remediation/mitigation protocol prior to construction so that measures are documented and in place to deal rapidly with any on-site pollution incidents or signs that predicted drawdown levels have been exceeded during construction.

Based on the geohydrological assessment presented in this specialist report, all three sites are environmentally acceptable, in terms of groundwater, for the development of an NPS.

The confidence level of all information presented in this specialist report is high.

1.7 Fresh Water Supply Assessment (Appendix E8)

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Fresh Water Supply and was carried out by SRK Consulting.

Water requirements for a 4 000 MWe NPS are the following:

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

Water supply is required for potable and construction purposes during NPS construction and for potable, demineralised and fire protection purposes during NPS operation.

This EIR is based on a desk study and site investigation involving the following:

- Department of Water Affairs and Forestry (DWAF) reports;
- Review of Atomic Energy Corporation/Eskom reports on the three sites from the 1980s and 1990s;
- Review of relevant legislation;
- Detailed site investigations for this EIR, including a census of existing water users/sources, drilling and testing of boreholes, water sample chemical analyses;
- Information supplied by various local authorities.

Water supply options for all three sites are as follows:

- Municipal or DWAF supply from existing local or regional schemes, mainly sourced from surface water/dams but also possibly from groundwater;
- Development of new dams by Eskom or local authorities;
- Development of groundwater resources; and
- Desalination of sea water (Eskom preferred option).

Conclusions from this specialist study

Thyspunt

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

Bantamsklip

- There are no viable aquifers in the area;
- Local and regional surface water sources are fully utilized;
- The surrounding towns are supplied with surface water from Kraaibosch Dam and groundwater from springs and boreholes;
- Local and regional surface water resources are under stress and additional draw-off to supply a NPS would exacerbate this situation;
- The only option for surface water supply is import of water from the Riviersonderend-Bree scheme;
- Surface water and to a lesser extent groundwater is likely to be adversely affected by climate change; and
- Desalination of sea water is the most viable option for an assured water supply with least environmental impact and would not be affected by climate change. This option would have the least environmental impact and is Eskom's preferred option for fresh water supply.

Duynefontein

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

No-go option

- In the event that the sites are not developed for NPSs, Eskom will sell the Bantamsklip and Thyspunt properties and non-essential parts of Duynefontein could also be sold. In this scenario the impact is seen to be low intensity, neutral consequence and low significance for the Bantamsklip site (no aquifers) but of medium intensity, negative consequence and high significance for the Thyspunt and Duynefontein sites as local groundwater resources could be exploited by private land owners/developers. The main mitigation measure for this scenario would be strict enforcement of conditions applicable to any approved future development of the sites.
- It is recommended that desalination of sea water is implemented at the chosen site for fresh water supply. The main mitigation measures required for this supply option are:
- Brine produced as a by-product of the desalination process must be discharged in the surf zone during the construction phase (up to 156 L/s) to facilitate mixing;
- Brine produced as a by-product of the desalination process must be mixed with the cooling water discharge from the NPS during operation;
- A marine ecologist must monitor the discharge areas to assess impacts on marine ecology.

1.8 Position of the 1 in 100 Floodline (Appendix E9)

A number of specialists working on the Nuclear-1 EIA have requested that the 1:100 year flood line due to flooding from the sea be estimated. This relates to the width of the coastal corridor and the siting of the nuclear terrace within the defined Nuclear Installation Corridor.

The 1:100 year flood line is a combination of surface elevations caused by a number of coastal processes. Specifically the elevations due to:

- Tides
- Sea level rise (where applicable)
- Storm surge
- Wave run-up

The dominant process is seen to be the maximum elevation calculated for the wave run-up. As the run-up is highly dependent on the slope of the coastal feature, the wave height and water depth, it is necessary to discretize the area under study into a number of regularly spaced beach normal profiles.

The total flood elevation is calculated by summation of the tide, storm surge and wave run-up for each of the profiles and then interpolated onto a digital elevation map of the site topography. The 1:100 year flood line is then the intersection of the calculated surface elevation and the surfaced topography.

For the evaluation of the 1:100 year flood line for 2075 the influence of climate change is calculated on both the hydrographic parameters and the local topography.

The shoreline also undergoes an adjustment based on the increase in sea level. Erosion occurs at progressively higher levels up the beach. The beach, in profile, is expected to translate vertically, an amount equal to the sea level rise and erode into the hinterland a distance proportional to the local beach slope.

In order to calculate a flood line for a future period, it is necessary to apply the above mentioned shoreline changes to the topography before the interpolation of the increased calculated surface elevation onto the modified surface.

The 1:100 year flood lines have been calculated for each site for the present day and 2075. These may be used by other specialists working on the coastal corridor and the siting of the nuclear terrace within the defined Nuclear Installation Corridor.

1.9 Air Quality Assessment *(Appendix E10)

Eskom proposes to construct a nuclear power station in South Africa with a power generation capacity of up to 4 000 MWe. In this EIA, the project is known as Nuclear-1, which includes the assessment of three sites. As a preliminary indication of the schedule, it was given that site access and terrace preparation for Nuclear-1 is proposed for January 2013, and would continue for 6-12 months. Construction of the nuclear power station would last for 7-9 years

The proposed sites for these power stations include:

- Duynefontein (Western Cape) located adjacent to the existing Koeberg Power Station, Cape Town;
- Bantamsklip (Western Cape) located 10 km south-east of Pearly Beach; and
- Thyspunt (Eastern Cape) located west of Port Elizabeth and approximately 15 km west of Cape St. Francis.

The Scoping Phase of this Environmental Impact Assessment (EIA) process has recommended that the two sites in the Northern Cape (Brazil and Schulpfontein) be excluded from further investigation during the EIA phase.

Eskom proposes to utilise Pressurised Water Reactor (PWR) technology. However, a final vendor specific plant design has not been decided on as yet. This assessment was therefore based on a generic nuclear power station, with atmospheric release information that provided an envelope of different reactor designs. In all cases, the worst-case impacts were assessed. The assessment therefore includes the maximum radionuclide emission from the nuclear power station during routine operation for its entire lifetime and design basis accident (DBA[2]) scenarios based on different reactor design technologies, which are being considered by Eskom.

AIRSHED PLANNING PROFESSIONALS (Pty) Ltd was appointed by ARCUS GIBB (Pty) Ltd to undertake an Air Quality Impact and Climatology Assessment for the proposed construction, operation and decommissioning of the nuclear power station and associated infrastructure.

METHODOLOGY

The main objective of the study was to determine the potential air pollution impacts associated with the construction, operation and decommission of the proposed nuclear power station on the surrounding environment. To accomplish this, the first step was to establish the baseline conditions of the proposed three sites through measurement of local meteorology. The next step was to determine all air emissions which are expected to result during the different phases. Whilst great care was taken to estimate emissions expected during the construction phase, it is anticipated that some minor differences may eventually exist with the final construction plan. The impact during the decommissioning phase was qualitatively evaluated using a pro-forma decommissioning plan. The atmospheric dispersion of emissions of all potential air pollutants during the operational phase was included in the assessment. These included non-radionuclides and radioactive emissions. Air concentrations and fallout rates were simulated using meteorological data recorded on site[3] and from the closest South African Weather Services (SAWS) meteorological stations with adequate historical data. For non-radioactive air releases, ambient air quality guidelines were used to compare against predicted concentrations, which serve to provide a screening health risk[4]. The impact of radionuclides was assessed in a similar fashion as non-radioactive substances, i.e. comparison to a “dose limit”. However, the predicted nuclide activities (“concentrations”) and surface deposition rates were first converted to an effective dose[5]. The study focused only on inhalation, immersion in a cloud and irradiation from surface soils. The ingestion pathway (water and food) is dealt with in the overall health risk study using the air concentration and deposition rates results derived from this study.

For the purposes of this assessment, a 40 km by 40 km study area was defined for the local dispersion calculations. No specific study area was defined for long-range transport since these were based on the distances typically travelled by the pollutants over a three-day period.

ASSUMPTIONS AND LIMITATIONS

The lack of knowing the specific vendor for the nuclear power station is considered to be a gap. This is specifically important with regards to the radionuclide emission source term. However, in order to account for the possible radionuclide emissions from the proposed nuclear power station, the source terms from two candidate vendors were included in the assessment. These source terms provides an envelope of different reactor designs. These

[2] A postulated accident that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to assure public health and safety. Design Basis Accidents, which could include pipe ruptures, component failure, etc. must be controlled by the safety facilities in such a way that effects on the environment are kept below the specified planning values of the NNR, i.e. the effective dose to a worker or members of the public is less than 50 mSv.

[3] Onsite meteorological data at Thyspunt and Bantamsklip was only available for a few months at the outset of the impact assessment. On subsequent review of the assessment, more than a year’s onsite meteorological data became available and a comparison to the SAWS data revealed small differences, which would not change the conclusions of the assessment.

[4] The air concentrations and deposition of non-radionuclide pollutants were compared to health risk limits developed by international institutions, such as the World Health Organisation (WHO), to represent safe levels below which no health risk effects are observed. Exceedances of a limit would flag for additional mitigation of emissions.

[5] Effective dose is an estimate of the effect that a non-uniform radiation dose has on a human. (The unit for effective dose is the Sievert (Sv)). Dose conversion coefficients (Sv/(Bq/m³)) obtained from the International Commission on Radiological Protection (ICRP), as contained in ICPR Publication 72 were used. The ICRP 72 is the latest revision. These dose conversion coefficients allow the calculation of age-dependent doses to the members of the public from the intake of and exposure to radionuclides. Dose conversion coefficients are available for all radionuclides.

emissions included both normal and upset conditions. The assessment was therefore based on the most conservative results from these two vendors. It should be noted that in order to comply with NNR requirements, the proposed nuclear power station will have to remain within the emission levels stipulated in its licence.

Catastrophic incidents were not part of the plan of study for the assessment since these incidents are within the jurisdiction and mandate of the NNR. The NNR will evaluate the safety case for the proposed nuclear power station to determine compliance with the requirements contained in Government Notice R388 of 28 April 2006, “Safety Standards and Regulatory Practices”. The NNR process has not start yet, but will follow after the specific PWR vendor has been selected as part of the procurement process. Thus accident scenarios have not been expressly dealt with in this assessment.

Although the relatively short, one-year period of meteorological data recorded at Thyspunt and Bantamsklip may also be regarded as a limitation to the dispersion modelling results, a comparison of the onsite data with the longer records at Cape St. Francis and Hermanus, respectively, indicate that the prevailing meteorological parameters (i.e. wind speed, wind direction, rainfall and ambient air temperatures) are comparable and result in similar conclusions. Although a more extended onsite monitoring period would provide slight adjustments to the results, it is not anticipated that the conclusions, given below, would change with any significance.

Decommissioning plans for PWRs are similar and consequently the decommissioning plan of Koeberg was use in this assessment. Furthermore, the impact would have to comply with the dose limits stipulated by the National Nuclear Regulator (NNR).

Whilst the study included baseline air quality monitoring for non-radionuclides, a radiological baseline study was not included. The NNR requires that a baseline monitoring campaign of radionuclides be conducted prior to construction. Furthermore, the dose limits stipulated by the NNR applies to the incremental dose calculated for the proposed nuclear power station. The conclusions would therefore not change, even once the natural radioactivity has been established at the three sites.

This assessment utilised air quality limits which have been given by the Department of Environmental Affairs (DEA) for non-radionuclide emissions and by the NNR for radionuclide emissions, respectively. The assessment of health risks is therefore considered to be at a screening level. The results from this assessment will be used as input into the Health Risk Assessment for this EIA which will be a qualitative assessment of the impact of radionuclides on human health and ecology.

Although a comprehensive sensitivity analysis of the dispersion model was not completed, the most important features were tested, which included the treatment of land-sea interaction and topography. In all cases, the most conservative option was selected to complete the assessment. A more detailed comprehensive evaluation of the quality of data and model sensitivities will be part of the application for a licence from the NNR.

CONCLUSIONS

The predicted impacts would be similar at all three sites. Furthermore, based on the predicted impacts of both non-radioactive and radionuclide air pollution, the assessment concludes that none of the sites need to be discarded for the proposed nuclear power station.

Specific mitigation is recommended during the construction phase only. Due to the predicted low impact of radionuclide emissions under normal operation, no additional mitigation would be required for radionuclide emissions.

Construction Phase

The sources of impacts during construction would be 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.

Operational Phase

Potential sources of non-radioactive air emissions during the operational phase include:

- Carbon, sulphur and nitrogen oxides 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.

The predicted impacts of these non-radiological pollutants were predicted to be very low when compared to human health risk and vegetation impact criteria.

During normal operation, trace quantities of radiological materials will be released to the environment. Ignoring the ingestion pathway, the predicted effective dose from these pathways indicates LOW *significance*. This rating applies to all three sites.

The predicted impacts of non-radioactive emissions during the operational phase at Bantamsklip and Thyspunt were shown to have a LOW *significance*. Currently, no industrial, commercial or significant residential developments exist in these two areas. This was confirmed through a three-month sampling campaign during which ambient air sulphur dioxide and nitrogen dioxide concentration levels were measured. The cumulative air pollution impact would therefore essentially only be that of the proposed nuclear power station.

In contrast, Duynefontein is located in an area where there is the potential for slightly elevated air pollution levels due to the proximity to Cape Town. However, based on background measurements, the impact of other air pollution sources[6] in the vicinity of Duynefontein was shown to be limited. The predicted cumulative impact of air pollution at the Duynefontein site is considered to be of LOW *significance*.

The dispersion simulations included a number of identified DBA. The predicted highest whole body dose at 1 km downwind from the nuclear power station following such accidental releases was shown to be below the maximum acceptable limit of 50 mSv for a single event, as stipulated by the NNR.

Decommissioning Phase

The exposure to radiation, based on the decommissioning plan developed for Koeberg, be kept to a minimum and below the required dose stipulated by the National Nuclear Regulator (NNR). Since these dose limits are based on safe exposure levels, it is expected that the radiation exposure during commissioning would be low. The plan consists of six phases. At the end of the last phase (*Phase 6*), the sub-surface radionuclide concentrations would again be verified to meet site release requirements.

"No-Go" Option

Duynefontein Site

[6] No industrial air pollution sources other than the Koeberg Nuclear Power Station exist in the immediate Duynefontein area. Industrial processes are present at Atlantis (Open Cycle Gas Turbine Power Station, brickworks and other smaller commercial activities) about 9 km northeast, landfill operations at Vissershok (5 km southeast) and a petroleum refinery (approximately 21 km south-southeast). Vehicles along the main roads (e.g. R27) and nearby residential areas also contribute to the airshed, especially oxides of nitrogen. Unfortunately, no historical air quality monitoring data is available for Duynefontein. However a relatively short, three-monthly sulfur dioxide and nitrogen dioxide air sampling campaign was conducted from March to May 2009. These data indicated low sulfur dioxide and nitrogen dioxide concentrations.

Without the proposed nuclear power station at the Duynefontein site, the “no-go” option would be the same as the current air quality impact, which is considered to be of LOW significance for non-radioactive compounds and MEDIUM significance for radionuclide emissions.

Bantamsklip and Thyspunt Sites

The current air quality at the Bantamsklip site is regarded very clean with regards to non-radioactive criteria pollutants, such as oxides of nitrogen, sulphur dioxide and carbon monoxide. Any alternative developments on the site which would increase vehicle numbers, introduce combustion sources (ovens, boilers, heaters, etc.) or human population could have the potential of increasing the levels of these criteria pollutants. The significance depends on the alternative options, and could result in a HIGH significance.

Since the current baseline dose at these two sites are not known, it is not quantitatively possible to provide an accurate “no-go” impact rating for radioactivity. Given the low dose limits set by the NNR, normal emission would result in dose levels within naturally occurring radiation levels. However, in the event of an accidental release, it is expected that the dose would be above the naturally occurring radioactivity at the site and as such, unless radioactive material is used in any alternative developments, the radio nuclear impact of the “no-go” option would be rated lower.

RECOMMENDATIONS

- The predicted impacts of unmitigated emissions during the construction phase were shown to have a HIGH significance.
    - A comprehensive list of recommendations has been provided in Section 5.2.1.
    - This impact can be reduced to LOW significance with management plans and emission controls in place.
    - An emission minimisation plan is regarded essential in the situation where construction activities are conducted very close to residential and other sensitive receptors.
    - The most significant source (between 80% and 90%) of fugitive dust emissions was shown to be wheel entrainment on unpaved roads. It is, therefore, 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 road surfaces.
    - In areas where 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, or a suitably modified version thereof.
- The recommended air quality monitoring programme provided in Section 4.2.1 should preferably 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 (as stipulated by the NNR);
- No additional mitigation measures are required for routine operational emissions of radionuclides. However, once the final reactor technology has been decided, Eskom needs to confirm that the emissions from the selected technology conforms 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);

- The impact during the decommissioning phase was qualitatively assessed based on the assumption that the decommissioning plan would be the same as that developed for the Koeberg nuclear power station. A site-specific decommissioning plan must be developed according to the most recent requirements stipulated by the NNR.
- It is recommended to ensure that the emissions from the backup power generators perform according to the vendor specifications, which the assessment was based on. Although continuous emissions monitoring (CEM) would be preferred for particulates and oxides of nitrogen, regular stack sampling campaigns would be adequate given the intermittent nature of operation. It is recommended that the first three isokinetic sampling campaigns should also include sulphur 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.

1.10 Botany and Dune Ecology Assessment (Appendix E11)

Findings

Initial assessment of the mobile dune systems at Koeberg (Low, 2011) found that impacts associated with a NPS would be too severe. He recommended that any footprint be located some 1.5 km inland of the coast in order to avoid the sensitive transverse dunes.

In the ensuing seven or so years since this study (field work initially conducted in 2007/8) the transverse dunes have stabilised themselves to such an extent, suggesting they might be amenable to development.

An assessment of the soils, flora and vegetation along a gradient from bare sand through pioneer and successional (fynbos) communities, to climax thicket, showed that increase in plant species, cover and height. Soils under mature thicket displayed greater levels of nutrients and cation exchange capacity, much of this correlated with higher levels of organic carbon which acts as a colloid in sandy soils.

Mapping of a sequence of aerial photographs from 1938 to 2014, indicated the transverse dunes were vegetating at a fair pace. Bare sand showed a loss in extent of 637 ha over this period with a concomitant rise if thicket cover (401 ha). Development accounted for some 265 ha. Not only is the dune system “slowing down” but auto-vegetating of this system has been aided by the decline in sand inputs into the mobile dunes, through the location of Koeberg in the middle of the sand sea supplying the mobile dunes, as well as Melkbosstrand in the main channel of sand supply.

Recommendations

Low (2011) in his report on the dunes and botany of the Koeberg site, recommended a set back line which would place any proposed power station beyond the mobile dune field, i.e. over 1.5 km km inland of the coast. That recommendation stands for areas which still contain mobile dunes, but the more recent information entertained in this study suggests a reappraisal of the situation, particularly given the stabilisation of the mobile dunes just north of the existing Power Station.

Two factors are paramount to this debate: (i) the substantial loss in dune mobility due to development in the south, coupled with increases in vegetal cover have meant the dune can no longer function in its pristine state and (ii) development would be localised to vegetated parts of the dune system, permitting the remaining small mobile system in the north to function in the long term, albeit artificially restricted.

Low (2011) comments: “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. This system is poorly represented in the region, although there is a large transverse dunefield to the north-east at Witzand and a similar, but larger, more intact system north of Yzerfontein. The Duynefontein system is remarkable for its size (nearly 1 000 ha) and location at the coast, just above the primary dunes. Despite the present position of the Koeberg Power Station to the south, and at the start of this system, thereby somewhat compromising the supply of sand to the north (the general direction of sand movement), field observations, together with those of the dune geomorphologist, confirm that there is fairly substantial inland sand movement from the south-west, suggesting there has either been somewhat of a “correction” in the system, or the south-western source has been present for some length of time”.

In the seven or so years since the first study, it is clear that both development and active planting of the mobile transverse dunes has hampered dune mobility and has led to a "slowing down" of the system. The prognosis for dune stabilisation is that this will continue into the foreseeable future, as sand supply literally dries up, and auto-vegetation accelerates.

It is therefore the recommendation of this report, that location of the proposed Nuclear footprint be considered for the southern VEGETATED and STABILISED part of the transverse dunes, but with the provisos dealt with under the next section.

Any losses of the transverse dune should be offset by addition of dune vegetation to the north of the Koeberg Nature Reserve boundary (i.e. Groot Springfontein Farm).

<u>Response of the stabilising transverse dunes to impact</u>

Construction phase of Nuclear facility

Soils

As plant cover increases, so does the level of organic carbon and most nutrients (see above). Soils under climax dune thicket show disproportionately higher amounts of carbon and nutrients than bare sand and pioneering communities. Of note is the greater cation exchange capacity and nutrient availability which ensures a greater diversity of species and and a plant community far more resilient to disturbance. Soil stability is ensured through a) higher amounts of organic matter and therefore soil binding and b) dense canopies which afford sand protection from the wind. Correspondingly, natural transverse dunes are far less vegetated and mobile, being blown in perpendicular waves in the direction of the wind (see below and refer to Illenberger, 2013).

Flora

Some 87 species were encountered on the transverse dunes in this study, 10 more than in Low’s (2011) work (see SaSFlora, 1998 – 2015). Both this and Low’s (2011) study report five Red List species, all of which are well-distributed in the dunes of the West Coast and elsewhere (*sensu* SaSFlora, 1998 – 2015). Losses to a NPS footprint are thus considered minor.

Vegetation and dune stability

The vegetation of the site is well-represented elsewhere on the West Coast and Cape Flats. However, it is a dynamic system, with an unnatural succession (owing to artificial stabilisation) moving these dunes towards mature thicket. This is the climax vegetation of the adjacent parabolic dunes (Low, 2011), where dense thicket provides far greater stability than the transverse dunes.

Reversal of this process would require removal of vegetation from the dune and even then it would not return to its natural state as the main supply of sand from the south is blocked by Koeberg itself, and to a certain extent, Melkbosstrand. This echoes the situation for the Oyster

Bay-Cape St Francis headland bypass system, where development in the former town is preventing sand from feeding this massive dune system (Illenberger, 2010; Low, 2011).

The impacts associated with building a Nuclear facility on dunes which were previously mobile has been dealt with in the main impact assessment (Low, 2011). In this report Low (2011) recommends that there be no development on mobile dunes, in particular the transverse system north of Koeberg, and that such development is shitted inland onto stable parabolic dunes. Clearly the transverse dunes just to the north of the existing power station are now well-stabilised (Figures 23 & 24) and the trajectory of vegetation cover is towards climax dense thicket, now occurring patchily throughout the area (see Low, 2011 for distribution of plant communities).

With the vegetating of the once-mobile transverse dunes, this new stability would imply that development could be considered, but with the migratory measures for parabolic dunes (Low, 2011).

Fine-tuning of footprint

It is vital that no footprint is permitted in the mobile transverse dune system. Rather care must be taken to ensure that the boundary of the footprint is well within stabilised dunes. In addition, there should be at least a 100 m wide buffer between the boundary and any mobile dune.

Operational phase of nuclear facility

Coastal set back and buffers

A key agreement reached between Eskom management and the consulting team was provision of a coastal corridor of 200 m minimum width (see Low, 2011). This should also be applied here and will also ensure that the more sensitive and mobile primary dunes at the coast are avoided.

Low (2011) produced a series of management and rehabilitation guidelines for the operational phase of the project and which have been included here. These are to be adhered to and included as part of the record of decision should permission be granted for another Nuclear facility at Koeberg.

Conservation

In short, the transverse dunes are part of the Cape Flats Dune Strandveld vegetation type which is rated as Endangered (Rouget et al., 2004). This system is well-protected in the 3 000 ha Koeberg Nature Reserve and in various parts of the Cape Flats and West Coast. Low (2011) recognises this as a positive impact in the development of a new nuclear facility: “The continued management of the Koeberg Nature Reserve, which entails the whole of the site outside the present NPS, is considered a positive impact. Current multiple-use of the reserve is extensive and management would continue with the new NPS. Extension of the reserve into good quality dune veld of the Groot Springfontein Farm to the north is also highly desirable, and could be effected by a cooperative conservation agreement. All in all the use of some 200 to 280 ha for a NPS is far outweighed by the 3 000 ha currently under conservation within the Koeberg Nature Reserve”. I would add here that a biodiversity offset should be sought for the potential loss of transverse dunes in the south of the site, and that the Groot Springfontein Farm on the northern boundary of the KNR would be a worthy addition, particularly as it lies to the west of the R27, encompasses a relatively pristine coastline and would be directly connected to the Koeberg Nature Reserve.

<u>Key interventions during construction and/ or operational phases (largely from Low, 2011)</u>

Search & rescue

For each phase of construction within natural veld, a search and rescue operation is required which would identify all plants which were either extremely rare (i.e. Endangered or Critically Endangered) or which could be used in site rehabilitation. Red List species likely to be affected if development is carried out on the transverse dunes, are the annual *Capnophyllum africanum, Helichrysum cochleariforme* duineteebossie (Near Threatened - NT), *Psoralea repens* duine-ertjie (NT), the succulent vygie *Ruschia indecora* (Endangered - EN), and *Passerina ericoides* kusgonnabas (Vulnerable - VU) (Red List status in brackets) (see Appendix 2). Such RL species would require to be identified by a specialist botanist who would ensure a plan was in place to remove said plants **prior** to construction's commencing. Plants with a bulb or rootstock have the greatest chance of surviving translocation, whereas most shrubs and many of the graminoids (grasses, sedges, restios), particularly the obligate reseeders, would not translocate successfully. Seed and/or cuttings should be removed from species which will not translocate easily and grown on in the on-site nursery (see below).

Rehabilitation plan

Linked with Search and Rescue above should be a rehabilitation plan which would see that all areas disturbed in the development of the proposed facility are satisfactorily rehabilitated with locally occurring indigenous species. This would 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 NPS plant. A nursery which would accommodate stored and grown on plants would be an absolutely essential requirement for satisfactory rehabilitation. For this purpose a rehabilitation plan needs to be drawn up which will identify suitable species, method of storage and/or propagation, method of planting and maintenance, and monitoring of rehabilitation success (see below). This can be included as a part of the construction and operational EMP.

A comprehensive rehabilitation plan will require the services of a rehabilitation specialist together with a specialist botanist who would identify and locate suitable species; measures must be in place to ensure removal of said plants **prior** to construction's commencing. Seed and/or cuttings should be removed from species which will not translocate easily and grown on in the on-site nursery.

The plan should include the following key elements:

Preparation phase
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. This would provide material ready for planting as areas are required to be rehabilitated. In addition certain species could also be translocated into the nursery. The amount of plant material required would be guided by the extent of construction and areas to be disturbed. Both terrestrial and wetland habitats need to be considered.
A list of selected species suitable for rehabilitation is provided.

Topsoil

This is perhaps the most critical part of rehabilitation and would determine to a great extent the ultimate success of any rehabilitation work.

- Topsoil (0 – 300 mm depth) should 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

- 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.

Mulching

- Mulch should be strewn over the planted areas and this should shade the soil, and provide a source of organic matter and some nutrients, as well as retention of moisture for new plants. The best source for mulch is locally occurring introduced acacias and these can be mulched on site after cutting. Care should be taken not to clear these woody aliens when they are setting seed (October-November for *Acacia saligna* Port Jackson willow).

Maintenance

- Newly planted areas should be regularly weeded. Where plant death occurs, dead specimens should be replaced with material from the nursery. Plants should also be irrigated during the first summer season. For this purpose a simple above ground irrigation system would prove useful if not essential.
- All woody aliens should be removed once they reach knee height (for ease of pulling).

Coastal corridor and buffers

The negative aspects of locating a nuclear facility at the coast (i.e. on the high water mark) have been discussed by Low (2008) for the proposed PBMR plant (since discounted as an option) and historically have existed for the Koeberg Nuclear Power Station. “These habitats are extremely sensitive and fragile and demand great circumspect if both the habitat as well as issues such as maintenance of structures are to be satisfactorily dealt with. A setback line should be implemented ......”

The EIA corridor should be separated from the high-water mark by a coastal corridor and adequate buffer to the sensitive mobile dunes, whichever is the greater. Such a corridor should be underpinned by the following ecological rules or criteria:

- 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 and pollination, and preservation of major communities. At Koeberg this will be far wider if recommendations for avoiding the sensitive, rare and endemic transverse dune system are upheld;
- Avoidance of the sensitive primary dunes at the coast;
- Avoidance of the sensitive limestone cliffs, in the north of the area;
- Whichever setback line is the furthest from the HWM, an additional buffer of 100 m should be set to protect the sensitive systems discussed above from any long-term impacts the development could have on such systems; and
- All setback lines would need to be accurately surveyed before the footprint was fine-tuned.

Impact of development on the coast could compromise the existing, albeit *de facto,* corridor along the Cape West Coast, which locally stretches several kilometres inland. The recommended 200 m setback maintains such a West Coast coastal corridor (Low, 2011).

Monitoring

Rehabilitation

Goal: to ensure that rehabilitation with indigenous species is carried out effectively and has long-term sustainability

a Uninvaded areas

Where habitats have been unnaturally disturbed but are not invaded by *Acacia cyclops* rooikrans, rehabilitation with indigenous species is to be implemented. Such rehabilitation must follow a plan put together by a rehabilitation specialist, assisted by a specialist botanist with a good working knowledge of the local flora, and using locally occurring indigenous species. Details of the plan are presented in section (v) above. Rehabilitation success must be monitored on a three monthly basis for the first year, and then six monthly until acceptable species densities and cover are achieved.

b Invaded areas

Areas invaded by *Acacia cyclops* rooikrans or *Acacia saligna* Port Jackson willow should be cleared and rehabilitated as per the recommendations in (v) above. Rehabilitation should only be implemented if thicket species do not naturally return to a desired cover and species complement. The latter two factors should be monitored by a specialist botanist and targets set for both these two criteria; this should be included in the rehabilitation plan.

Whilst it is strongly recommended that rooikrans be cleared manually – for both social as well as ecological reasons – individuals removing acacias should be subject to a code of conduct which would govern behaviour on site. Key issues would include damage to plants and animals, toilets, fire, and general behaviour to be consistent with that of a nature reserve. Activities of these individuals need to be monitored by the on-site supervisor or conservation manager (see below).

(ii) Coastal corridor

Goal: to ensure a coastal corridor is created in an appropriate manner and is maintained in the long-term

Implementation of a coastal corridor must be a key goal of the development of the nuclear facility. Monitoring must be implemented to ensure that the coastal corridor is maintained in as natural a state as possible. This would include monitoring the rehabilitation of areas which have been excavated for the inlet and outlet pipes and the area immediately alongside the nuclear structure. Rehabilitation with indigenous species should be undertaken following the rehabilitation plan discussed above.

Relocation and/or growing on of Red List species

Goal: to ensure that where possible all Red List species in particular those on the Vulnerable and Endangered categories affected by development are relocated or successfully grown on in a nursery and returned to the wild.

Relocation and/or growing on of Red List species should be included in the site's rehabilitation plan. Key performance criteria include the reintroduction of RL species into protected areas, either on the site or in nearby nature reserves, or the growing on of such species for introduction into natural habitats through the rehabilitation plan. The bottom line would be to ensure there would not be a reduction in the natural densities and populations in each RL species.

State of conservation area

Goal: to ensure that the natural areas of Duynefontein/Koeberg Private Nature Reserve are maintained in a state consistent with that of a well-managed nature reserve

Koeberg should continue with its present management programme and ensure that that a management plan for the area is implemented. Key performance areas would be: woody alien eradication, rehabilitation, creation of a trail system for the public, control of access and use of the area, control of vehicles entering the area.

Conclusions

From this study, major changes were recorded in the transverse dune system to the north of the existing Koeberg Nuclear facility.

Mapping of aerial photographs over a 76 year period showed conclusively the once-mobile transverse dunes are vegetating at a fairly rapid rate and have lost their mobility in the south.

This was demonstrated through a decline in bare sand (mobility) and increases in the cover of thicket and other plant communities (loss of mobility).

Accompanying the above, was an increase in species number and vegetation cover, as one moved along a succession from pioneer to mature, climax thicket.

Soils showed concomitant changes along the gradient, with appreciable increases in organic carbon, total nitrogen and several cations, as well as cation exchange capacity. The latter was closely correlated with organic carbon, which in these sandy soils acts as a colloid in the place of clay.

Recommendations

Given the rapidly stabilising transverse dune system at Koeberg, it is recommended that consideration be afforded the location of a new Nuclear facility within the transverse dune directly north of the existing NPS. However, this should be accompanied by strict measures which ensure proper fine-tuning of the footprint, creation of a buffer between development and presently mobile dunes, and implementation of an effective management plan during both the construction and operational phases. This plan would include, among other, effective rehabilitation and monitoring, and the enhancement of the Koeberg Nature Reserve through addition of land in the north.

1.11 Freshwater Ecology (Wetland) Assessment (Appendix E12)

Introduction

This section is intended to provide a short summary of the major implications of the proposed Nuclear Power Station (NPS) development for wetlands at three alternative sites – Duynefontein, Bantamsklip and Thyspunt. All of the site alternatives include in their boundaries and immediate surroundings wetland systems that are of high ecological importance, relatively unimpacted and considered to be either among the last (in the case of Duynefontein) remnants of particular wetland habitats that have been lost from large areas or, in the case of Bantamsklip and particularly Thyspunt, they are considered unique systems that are unlikely to be represented in their present form and complexity elsewhere in the world. The conservation status of all three sites, from a wetlands perspective, is extremely high and any threats to their integrity are viewed as of high negative significance.

The report on which this summary is based has taken cognizance of the outcomes of a year of intensive groundwater and surface water monitoring and analysis (Visser *et al*. 2011) which have resulted in higher levels of confidence being accorded to predictions of the impacts of proposed activities associated with the development of a NPS, on wetlands at each of the three potential sites. Some of the conclusions of this report have thus changed substantially from those reflected in previous versions (e.g. Day 2009 and 2010).

Impacts associated with the proposed NPS

Duynefontein

The main impacts associated with development of a single phase NPS at this site comprise a low likelihood of potential 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. The “recommended” (or least sensitive) development area for the proposed plant lies well away from the most sensitive wetlands on the site – that is, the duneslack depressional wetlands in the south western portion of the site. 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 implications of development of a single NPS at Duynefontein have been assessed as of medium negative significance from a wetland perspective.

Bantamsklip

The “recommended” (or least sensitive) development area for the proposed EIA and HV corridors at this site lie to the south of the R43 road through the site. The road itself acts as a barrier to the northern portion of the site, within which the critically important Groot Hagelkraal River and its associated hillslope seeps and valley bottom wetland tributaries occur. A major assumption of the EIA assessment of this site is that activities associated with the construction and operational phases of a NPS would be confined to the area south of the R43. 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 NPS administration buildings
- Potential side-effects of increased development in the Pearly Beach area.

Of these, assessment of the latter falls outside of the scope of this study. The issue is nevertheless redflagged.

The geohydrological study (Visser et al. 2011) indicated that although the radius of draw-down associated with dewatering of this site could extend close to the Groot Hagelkraal and Koks River systems it was however unlikely to affect either of them.

Without the implementation of any mitigation measures, the cumulative implications of development of a single NPS at Bantamsklip were assessed as of at least medium negative significance from a wetland perspective.

Thyspunt

Development at this site would, in the absence of mitigation measures, be associated with the greatest number, intensity and complexity of impacts to important wetland systems. The main impacts assessed include:

- Permanent loss and degradation of coastal seep wetlands as a result of dewatering / groundwater diversion, concentration of groundwater flows and proposed new roads;
- Some risks of impacts to the Langefonteinvlei as a result of possible draw-down effects: the likelihood of risk was however considered low, given the findings of Visser *et al*. (2011), namely that the Langefonteinvlei is perched above the groundwater table in its southern and western extents. Hence draw-down impacts would need to extend to the northern and eastern portions before they had an effect on wetland hydrology;
- 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 water pipelines;
- 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 significant 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 cumulative impacts of the proposed development of a single NPS at the Thyspunt site without implementation of mitigation measures have been assessed as of high negative significance.

Key mitigation measures proposed for each site

Duynefontein

Avoidance mitigation of 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 NPS and its infrastructure in the least sensitive areas of the development envelopes. Within the EIA and HV 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 "recommended development area" have, along with their terrestrial margins and interlinking corridors, been identified as "no development" areas.

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 NPS)

In addition, the report noted the desirability of:

- Enlarging of the culverts at the Groot Hagelkraal crossing under the R43
- Adhering to certain development restrictions at Pearly Beach.

These recommendations affect areas outside of the direct control of Eskom and thus cannot be conditions of authorisation.

The cumulative impact of a NPS 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.

Thyspunt

Essential mitigation measures at this site would comprise the following:

- Recognition of various "no-go" development areas and ecological setbacks – implementation of the latter would require that the proposed "recommended development area" on the site should be drawn towards the west, to accommodate the recommended (surface) Langefonteinvlei buffer;
-
- Management of the whole site, apart from the NPS footprint within the "recommended" development area 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 risk of draw-down related impacts to the Langefonteinvlei include the incorporation of cutoff walls, semi-permeable membranes or other appropriate devices into dewatering design such that they effectively limit the radius of drawdown to the NPS excavation site itself, and prevent any risk of drawdown impacts affecting the Langefonteinvlei.

Mitigation measures against impacts to the coastal seeps centre on inclusion in the dewatering design of mechanisms that will allow the long-term 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 recommended mitigation measures at this site would entail:

- 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 of impacts associated with the transport of sand across the mobile dunes is possible, if a conveyor system is utilised, but with substantial restrictions being imposed on construction / maintenance roads and sediment control.

Even with implementation of all of the mitigation measures outlined above, the cumulative outcome is still considered of net high negative significance, as a result of the residual impact to presently largely unimpacted wetlands across a large area, and the definite and unmitigable degradation of a limited area of unimpacted coastal seep wetlands.

Offset mitigation is however possible, and would involve conservation of areas that include both the Eastern Valley Bottom wetlands and the Oyster Bay dunefield itself, as far as the impacted area at the upstream boundary of The Links golf course. The required measure assumes that securing of all erven along the proposed eastern 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, while retaining the Langefonteinvlei and duneslack wetlands in an unimpacted condition. In the event that full mitigation as well as offset measures were implemented, the net impact to wetlands on the Thyspunt site is likely to be one of positive significance, and a preferable scenario to the assessed no development alternative.

This said, however, it is acknowledged that ideally, none of the wetlands within and associated with the Oyster Bay dunefield should form part of any development offset. In the event that a no development alternative was available that provided adequate funding opportunities for alien control, and did not include piecemeal fragmentation of the area into multiple small developments, then such an option would clearly be preferred from an ecological perspective, to any development of a nuclear power facility at this site.

1.12 Vertebrate Faunal Assessment (Appendix E13)

At Duynefontein, the amount of land that is available for development, and that is not of high faunal sensitivity, is limited but sufficient to allow for Nuclear-1. However, further future expansion of power-generating facilities within the present Eskom property, to the north of KNPS, should not be considered.

Development of Nuclear-1 at Duynefontein would have significant negative impacts, mainly because of the direct impacts on faunal habitats within the footprint areas. Duynefontein would benefit from the no-development option because the land is already managed as part of a private nature reserve. Opportunities for on-site conservation offsets are limited.

At Bantamsklip, the amount of land on the coastal side of the R43, available for development and that is not of high faunal sensitivity, is more than sufficient to allow for Nuclear-1. The portion of the property inland of the R43 is highly sensitive and should not be developed at all.

Development of Nuclear-1 at Bantamsklip 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.

The amount of land that is available for development, and that is not of high faunal sensitivity, is severely constrained and not sufficient to allow for Nuclear-1. However, if additional land were purchased adjacent to the pan-handle portion of the property, this deficit could be overcome.

Development of Nuclear-1 at Thyspunt would have significant negative impacts, mainly because of (a) the direct impacts on faunal habitats within the footprint areas, (b) the development of three 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.

An important negative factor is the lack of definitive information on whether adequate engineering solutions are available to avoid serious negative impacts on groundwater flows and sensitive wetlands at Thyspunt. There are similar needs for more information on the dynamics of the mobile-dune field, and better mapping of dune forests and thickets of alien vegetation. It is essential that the necessary studies be carried out as a matter of urgency to inform the EIA process.

From the perspective of faunal conservation, the following overall conclusions are reached:

- Given the present uncertainty around groundwater and wetlands as well as other aspects of the biophysical environment, and the inadequate amount of suitable land for development, the proposal for development at Thyspunt is currently flawed. This situation must be improved by completion of relevant studies, and acquisition of additional land, if necessary.
- Outstanding issues at Thyspunt should be satisfactorily resolved before final decisions are made and in time for full specification of necessary mitigation measures. This may have the effect of postponement of development at Thyspunt.
- Nuclear-1 could be developed at either Duynefontein or Bantamsklip, without further faunal EIA investigations.

Impacts

The identified impacts are similar for the three site alternatives, Duynefontein, Bantamsklip and Thyspunt, although the severity of the impacts varies from site to site. The identified impacts are:

i. Destruction of natural habitats and populations
ii. Reduction in populations of Threatened species
iii. Fragmentation of natural habitats and patterns of animal movement
iv. Road mortality
v. Mortality associated with overhead-transmission lines and substations
vi. Disturbance of sensitive breeding populations
vii. Dust pollution beyond the building site

viii. Pollution of soil and water beyond the building site
ix. Light pollution beyond the building site
x. Alteration of surface and groundwater levels and flows, effects on local wetlands
xi. Poaching of local wildlife
xii. Problem-animal scenarios
xiii. Accumulation of radioisotopes in the environment and in the bodies of wild animals
xiv. Cumulative impacts
xv. Improved conservation status of undeveloped land (positive impact).

Mitigation Measures

Recommended mitigation measures are similar for the three site alternatives, Duynefontein, Bantamsklip and Thyspunt, although the details vary from site to site.

i. Mitigation of destruction of natural habitats and populations

- 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.)

ii. Mitigation of reduction in populations of Threatened species

- 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.

iii. Mitigation of fragmentation of natural habitats and patterns of animal movement

- 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.

iv. Mitigation of road mortality

- 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.

v. Mitigation of mortality associated with overhead-transmission lines and substations

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

vi. Mitigation of disturbance of sensitive breeding populations

- 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.

vii. Mitigation of dust pollution beyond the building site

- 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.

viii. **Mitigation of pollution of soil and water beyond the building site**

- 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.

ix. **Mitigation of light pollution beyond the building site**

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

x. Mitigation of alteration of surface and groundwater levels and flows, and knock on effects on local wetlands

- 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.

xi. Mitigation of poaching of local wildlife

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

xii. Mitigation of problem-animal scenarios

- 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.

xiii. Mitigation of accumulation of radioisotopes in the environment and in bodies of wild animals

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

xiv. Mitigation of cumulative impacts

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.

xv. 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.

1.13 A Invertebrate Faunal Assessment (Appendix E14)

During the two field surveys of August – September 2012 and December 2013, 605 invertebrate species were collected at the 51 sample points at Duynefontein, Bantamsklip and Thyspunt. Of the 605 species, 138 species were only found at Duynefontein, 205 species only at Bantamsklip and 166 species were only sampled at Thyspunt. Twenty-seven species were only found within the Western Strandveld area (including Duynefontein and Bantamsklip only), and 69 eurytopic species (wide geographic distribution) were sampled. The invertebrates found during the two field investigations included snails, centipedes, millipedes, amphipods, ticks, scorpions, spiders and insects. Most of the species were identified to family level; 133 species were identified to genus or species level.

A Wishbone Trapdoor Spider of the genus *Spiroctenus* Simon, 1889 was collected at the Bantamsklip site during the December 2013 field investigation. A very good series of live specimens were sent to specialist Ian Engelbrecht, including several sub-adult males. The species is likely to be an undescribed species of *Spiroctenus* Simon, 1889 (it is impossible to be certain until the sub-adult males have reached maturity); the same species was misidentified during the first survey as a species of *Ancylotrypa* Simon, 1889 (Wafer-lid Trapdoor Spider).

A species of Common Baboon Spider of the genus *Harpactira* Ausserer, 1871 was also collected at the Bantamsklip site. The specimen collected is designated as *Harpactira* cf. *cafreriana* (Walckenaer, 1837), the Cape Orange Baboon Spider, but positive identification is not possible until adult males of the population at Bantamsklip are collected (only a female was collected during the December 2013 field investigation). The specimen collected looks quite different to typical *H. cafreriana*.

In order to be able to compare the three sites in terms of Red Data species, all species listed for the Western and Eastern Cape Provinces of South Africa are included in this assessment.

A total of 47 threatened (VU, EN and CR listed) invertebrate species are listed for the two provinces (Onychophora, Gastropoda, Diplopoda, Odonata and Lepidoptera). The following conservation categories are included:

- Nineteen species are listed as Vulnerable;
- Fourteen species are listed as Endangered; and
- Fourteen species are listed as Critically Endangered

Forty-one of the forty-seven species have not been recorded from the regions in which the study sites are located (they are known from elsewhere within the Eastern and Western Cape provinces) and six of the species are known from the regions in which the study area is located. None of the these six species are considered likely to occur within any of the study sites – a combination of known local distribution and specific habitat requirements of these species are not met within the study sites.

Based on the results obtained during this study it is evident that the Bantamsklip study site has a high invertebrate sensitivity and is deemed unsuitable for the proposed Nuclear Power Station. None of the results indicate the unsuitability of the Duynefontein and Thyspunt study sites regarding the proposed Nuclear Power Station.

It is recommended that the Bantamsklip study site is excluded a potential site for the proposed Nuclear Power Station.

1.14 Marine Ecology Assessment (Appendix E15)

This specialist study was undertaken to assess the possible impacts of a 4 000 MW capacity power station on the marine environment at one of three potential sites along the Eastern and Western Cape coasts. Such a development at Duynefontein, Bantamsklip or Thyspunt will have a variety of potential impacts.

Impacts

- Disruption of surrounding marine habitats. When associated with the construction of the cooling water intake and outfall system, this effect will be focused within the construction phase and will be localised, of medium duration and significance. When associated with the discarding of spoil, disruption to the marine environment is significant. When mitigated by disposing spoil offshore (and by using only a medium pumping rate at Thyspunt), the impact is reduced to one of medium consequence and medium significance The temporal and spatial limitations of the impacts associated with the disposal of spoil on chokka squid at Thyspunt will have limited impact on the overall squid stock, when taken within the context of the extensive area over which this species spawns.
- The entrainment and death of organisms associated with the intake of cooling water. At Duynefontein and Thyspunt entrainment it is not anticipated to have important ecological impacts. However, at Bantamsklip larval entrainment may have significant negative effects on local stocks of the abalone *Haliotis midae*.
- 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 modelling 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 and to a lesser degree at Thyspunt, as it would help to mitigate impacts on abalone and chokka squid egg capsules respectively. While chokka squid at the Thyspunt site are expected to avoid water temperatures elevated above their thermal tolerance range, the area predicted to be affected represents less than one percent of the coastal spawning ground. It is strongly recommended that at Bantamsklip an offshore tunnel outfall be utilised for the release of warmed water in an effort to mitigate impacts on abalone. Importantly a nearshore release system at this site is considered to pose an unacceptable risk to abalone populations.

- The release of desalination effluent. During construction limited 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 from this effluent during this phase of the development.
- The unintentional release of radiation emissions. Technical design of the cooling system has minimised this risk, so that this impact is rated as having low consequence and low significance.
- The additional protection of marine organisms from exploitation due to a safety exclusion zone. The only site which would benefit from such an exclusion zone would be Bantamsklip, as this could be of great benefit to what are currently illegally harvested abalone populations. However, for such a benefit to be realised adequate enforcement of the exclusion zone should be provided.
- The release of treated sewage effluent. This effluent will meet the standards set by the Department of Water Affairs and Forestry and, as such, no significant impact on the marine environment is expected.
- Pollution of the marine environment by the discharge of groundwater polluted by organic, bacterial or hydrocarbon compounds. As this impact is unlikely to occur and will be spatially and temporally restricted, it is considered to be of low consequence and significance.

Besides the impacts of the proposed development on marine habitats, organisms in the marine environment may also impact on the development. This would take the form of fouling of cooling water pipes. This impact is anticipated to be most significant at Duynefontein, due to its location along the west coast, where jellyfish blooms appear to be increasing in frequency.

1.15 Oceanography Assessment (Appendix E16)

In South Africa economic growth and social needs are resulting in substantially greater energy demand to meet the power generation requirements. Eskom therefore proposes to construct a Nuclear Power Station (NPS) with a power generation capacity of up to 4000 MW using Pressurised Water Reactor (PWR) technology.

This report examines the impacts on the physical marine environment brought about by the construction and operation of the NPS at the three possible sites, namely; Duynefontein, Bantamsklip and Thyspunt. In addition to the impacts of the NPS on the physical marine environment, impacts of storm events, global warming and natural disasters such as tsunamis affecting the operation and safety of the NPS were considered.

Oceanographic impacts related to the construction phase are considered to be of low significance and relatively uniform across each of the three potential sites.

The extent of the thermal plume at each of the sites is highly variable and dependent on the wind and wave conditions at any particular time. 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 is seen at Duynefontein.

Impacts to the NPS caused by the physical marine environment will arise from flooding from the sea and the interruption of the cooling water supply. Interruption of the cooling water was considered to be of low significance at each of the alternative sites due to the depth of the intake and the mitigation measures incorporated in the design of the cooling water intake system.

There is the potential for water levels to exceed the proposed elevation of the NPS at all three sites should a tsunami coincide with extreme meteorological conditions (a meteo-tsunami event). The occurrence of a tsunami is, however, 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.

Appropriate mitigation measures are recommended for each of the potentially significant oceanographic issues that have been identified.

1.16 Economic Assessment (Appendix E17)

Eskom proposes to construct a nuclear power station with a power generation capacity of up to 4,000 MW on each of three sites, namely Thyspunt in the Eastern Cape, Bantamsklip in the Western Cape and Duynefontein in the Western Cape. The objective of the study is to analyse the economic cost-effectiveness of the three sites from a broader 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 impact of the three sites on their relevant provincial economies.

The study approach consisted of a combination of desk research, field interviews and the application of data collected to macroeconomic modeling.

The Duynefontein site is located in a far more developed and sophisticated area than are the other two sites (Bantamsklip and Thyspunt). The Cape Town metropolitan economy would find it far easier to absorb and service a nuclear power station and its staff than would be the case at Thyspunt or Bantamsklip.

Perceptions regarding a nuclear power station are frequently based on a lack of scientific information about perceived impacts. Our field interviews revealed that the public’s level of concern is lower in the area around Duynefontein because of their experience with Koeberg; by contrast, there is significant opposition to a nuclear power station at the other two sites. 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.

The macroeconomic impact analysis gives mixed results for the construction and operational phases at the three sites. Macroeconomic indicators favour the Western Cape sites but household and social indicators favour Thyspunt. The cost-effectiveness analysis indicates that Thyspunt has a very slight edge over Duynefontein and a somewhat larger edge over Bantamsklip. ***The difference between Thyspunt and Bantamsklip is R6.388 billion, and expressed as a percentage the difference is 5.93% in favour of Thyspunt. Between***

Thyspunt and Duynefontein the difference is R570 million, or 0.53% in favour of Thyspunt. Thus, the order of preference (from most to least preferred) is Thyspunt, Duynefontein and Bantamsklip. However, the differences 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.

Mitigation measures proposed relate to operation and maintenance (particularly the skills issues), public perceptions and concerns, and compensation.

1.17 Social Impact Assessment (Appendix E18)

Background

Octagonal Development cc (Alewijn Dippenaar) has been appointed to conduct a Social Impact Assessment (SIA) for the proposed construction of a nuclear power station and associated infrastructure, on three sites with one being located in the Eastern Cape and a further two in the Western Cape Provinces. The three alternative sites identified are referred to as:

- Thyspunt;
- Bantamsklip and
- Duynefontein.

The report related to the SIA is divided into four chapters, viz.:

- Section 1: Introduction;
- Section 2: Description of the affected environment;
- Section 3: Impact identification, assessment and mitigation/ optimisation measures; and
- Section 4: Conclusions and recommendations

The Project (Nuclear Power Station)

Eskom proposes to construct a Nuclear Power Station, referred to as Nuclear-1, with a power generation capacity of up to 4 000 MW, using the Pressurised Water Reactor technology (PWR). In many ways the structure of the nuclear plant resembles that of a conventional thermal power plant. The difference between nuclear and conventional fossil fired power plants is the fuel source and the manner in which heat is produced. In a fossil plant oil, gas or coal is fired in the boiler, which means that the chemical energy of the fuel is converted into heat. In a nuclear power station the fuel source is enriched uranium and energy from the nuclear fission chain reaction is utilised.

A typical construction programme for Nuclear-1 could take up to 9 years to complete and includes aspects regarding site establishment, bulk excavation, civil works, access roads and construction of the reactor.

Information provided by Eskom (September, 2008) details the proposed accommodation required for the Nuclear-1 nuclear power station. It must be emphasised that the detail of accommodation requirements, and the integration into existing communities and towns, still need to be negotiated with respective municipalities and other role-players where relevant. The exact location of a possible construction village still needs to be determined after the preferred site has been identified.

The areas of the land will be finalised in terms of the residential densities prescribed by the Spatial Development Plan for the properties that are available. Eskom must provide rezoned land for the Vendor to build a Construction Village for migrant workers. It is Eskom’s responsibility to facilitate the EIA process.

In addition, Eskom may provide serviced residential stands for the Vendor to build staff accommodation (Staff Village). The accommodation will be finalised once the Vendor is appointed, and the development of the land will be included in the overall community integration strategy for the Eskom residential developments.

Purpose of the report

The purpose of this report is to provide the findings of the SIA, specifically as it relates to the three sites, viz. Thyspunt, Bantamsklip and Duynefontein. It represents an in-depth assessment of the possible social impacts, including a rating of impacts as required by the EIA Regulations, the significance thereof and measures for mitigation through the enhancement of positive impacts and the mitigation of negative impacts.

Assumptions and Limitations

The following assumptions and limitations are taken into account in this report:

- The South African Government will continue with their intention to actively pursue nuclear energy over the next two decades as indicated in The Nuclear Energy Policy and Strategy for the Republic of South Africa (DME, 2007);
- Different people tend to view the realities of life differently and therefore the impact that may be perceived negatively by one individual or community could be perceived as the best and most positive impact by the next individual;
- Consultation with people, in order to gain an understanding of the issues, does have limitations, primarily due to the fact that individuals/parties are not always willing to attend and participate in discussions and consultation sessions. Often people are hesitant to contribute openly in group meetings and the conducting of individual interviews are not always possible or feasible;
- Although Statistics SA provides certain statistical updates on a regular basis, gaps do exist in the official data obtainable from this institution. Although this lack of more recent area-specific data has been a limiting factor, these limitations have not been insurmountable as a fair, if not relatively accurate, estimate, can be obtained by plotting the available data against updated Provincial and National trends;
- While every attempt was made to provide an opportunity for all affected and interested parties to participate in this study, the results of the study cannot be generalised to the entire research population. Therefore, in analysing the results, conclusions are drawn with regard to the characteristics and views of those interested and affected parties (I&APs) who participated in the study;
- The impact assessment tables pose a limitation for the social impacts in the sense that the tables do not allow for a comparison between the impacts with a weight attached and those without. Not all impacts have the same value and it is not part of the impact tables to assess the relative value of each impact towards an index figure.

Methodology and Study Approach

A recognised methodology in the form of triangularisation, was applied in gathering and analysing data during this study, as was an accepted impact assessment technique.

The methodology employed for the SIA is in accordance with the International Association for Impact Assessment (IAIA) and guidelines outlined in the Western Cape Department of Environmental Affairs and Development Planning's Guidelines for involving Social Specialists in an EIA.

A mixed quantitative and qualitative methodological approach is employed and, in line with this methodology.

For each of the two primary project phases, viz. construction and operation, the existing and potential future impacts and benefits, associated only with the proposed development, were described and assessed, both prior to and after mitigation/ optimisation, according to prescribed assessment criteria.

Impact identification and assessment for construction and operational phase

The following social impacts were identified and assessed:

- 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 planning;
- Perceived risks associated with nuclear incidents;
- Assessment of no development option.

The assessment was based on a review of:

- Issues identified during the Scoping Process;
- Planning and policy documents pertaining to the area;
- Interviews with key interested and affected parties;
- Social issues associated with similar developments; and
- The experience of the author in the field of SIAs.

Each of these impacts is now briefly discussed.

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 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.

The 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.

Mitigation measures for the provisioning of sufficient accommodation should be implemented.

Influx of job seekers

This 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.

Mitigation measures are aimed at minimising the number of job seekers staying in the area.

Informal Development and Settlements

An increase in unplanned development and informal settlements surrounding the nuclear power station site is associated with perceived economic opportunities. 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.

Mitigation measures are aimed at controlling the threat of an increase in unplanned development and the rise of informal settlements.

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. During this period it is foreseen that an estimated 8 737 staff, including construction workers, will be employed on site. It is envisaged that at least 25% of the construction workers will be sourced from the local labour force.

Optimisation measures are aimed at enhancing the benefits of employment creation.

Business Opportunities

A significant number of business opportunities will be created for local companies / service providers and SMME’s.

The utilisation of local suppliers and service providers must be promoted through local procurement and pro-active targeting processes via an open and transparent tender process for all construction related activities.

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.

Mitigation measures are aimed at reducing the risk of crime.

Risk of STDs, HIV and AIDS

This impact refers to an increase in the risk of STDs and HIV and AIDS. It is well documented that an increase in the risk of STDs, HIV and AIDS is associated with an influx of workers, particularly migrant workers, and/or any increase in truck traffic into or through an area.

Mitigation measures are aimed at managing the risks associated with STDs, HIV and AIDS.

Municipal Services

This impact deals with the probability of the new nuclear power station placing strain on municipal services such as water, sanitation, roads, waste and refuse removal.

Mitigation measures are aimed at provision of required services.

Roads and Transport

The concern is the capacity of roads and transportation infrastructure required for the construction and operations of the nuclear power station.

Mitigation measures are aimed at planning, funding and developing roads and transportation infrastructure as required for the construction and operations of the nuclear power station, in addition to roads and transportation infrastructure to the residential areas to be developed to accommodate the staff and construction workers.

Waste and Refuse Removal

This concerns the capacity of Land Fill Sites and Waste Transportation required for the construction and operations of the nuclear power station, as well as the services and infrastructure to the residential areas to be developed to accommodate the staff and construction workers.

Mitigation measures are aimed at providing sufficient Land Fill Sites and Waste Transportation for the construction and operations of the nuclear power station, as well as refuse removal services to the residential areas to be developed to accommodate the staff and construction workers

Traffic impacts

Increased vehicular movement during the construction phase may influence daily living and movement patterns of community members in the surrounding communities.

Mitigation measures are aimed at optimising vehicular movement during the construction phase to minimize traffic congestion problems in the area, which in turn influences daily living and movement patterns of community members in the surrounding communities who make use of these roads.

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.

Mitigation measures are aimed at limiting disturbance and the psychological effects of noise and dust pollution.

Loss of Employment after Construction

A number of jobs will be lost once construction of the nuclear power station has been completed.

Mitigation measures are aimed at minimising the extent of jobs lost after construction

Visual impacts

The nuclear power station will change the visual character and quality of the setting according to the Visual Specialist Study (September 2009).

Mitigation measures are aimed at limiting the negative effects and the disturbance on the sense of place that the nuclear power station may impose. The solution would be the implementation of the mitigation measures suggested by the visual impact study.

Impact on Social Infrastructure / Facilities

This impact refers to the likelihood of the proposed nuclear power station placing strain on existing infrastructure such as medical facilities, police, schools and sport facilities.

Mitigation measures are aimed at making provision for adequate social infrastructure and facilities for growth in number people.

Impact on sense of place

The proposed nuclear power station will possibly result in a change to the local sense of place.

This concern relates to the possibility that the nuclear power station may contribute negatively to the current characteristics, or feeling / perception held by people. Communities experience that their place have a special and unique character.

Mitigation measures are aimed at limiting the negative effects and the disturbance on the sense of place that the project may have on the environment.

Future Land Use (Planning)

The proposed nuclear power station will impact on future land use and planning in the area. Mitigation measures are aimed at minimising the impact of the proposed nuclear power station on future land use and planning.

Perceived Risks Associated with 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.

Mitigation measures are aimed at ensuring that communities receive correct and reliable information regarding the real and perceived risks of nuclear power.

1.18 Visual Impact Assessment (Appendix E19)

Eskom intends building new nuclear power stations on all three sites. One site is located on a coastal promontory known as Thyspunt between Oyster Bay and Cape St. Francis, approximately 70 km south-east of Port Elizabeth. The second site is located near Bantamsklip between Pearly Beach and Quoin Point on the southern western Cape coast east of Gansbaai and the third is Duynefontein located north and adjacent to the Koeberg Nuclear Power Station (NPS), due west of the Town of Atlantis on the Western Cape Coast.

This report evaluates the potential visual impact of the Nuclear Power Station on the surrounding natural and human-modified environment of each site.

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 adjacent on the southern side 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 roads for the Thyspunt site specifically.

Each site is discussed and rated according to the visual criteria of visibility from roads and the general surrounding landscape, the possible visual intrusion on landscape character and sense of place and the visual association with the new transmission lines. The visual impact of the transmission lines are the subject of a separate EIA; viz. the Transmission EIA.

Each site is assessed according to a set of rating criteria set for visual intrusion and visibility impact. The finding is that the Thyspunt NPS, Bantamsklip NPS and Duynefontein NPS have an intensity of visual intrusion that is rated as significant, particularly the night scene.

Using set criteria the visual impact is assessed for each of the NPS sites.

Impacts

The conclusion drawn is that the Thyspunt Nuclear Power Station, Bantamsklip Nuclear Power Station and Duynefontein Nuclear Power Station will exert a significant visual impact on the existing visual condition and character of the local setting 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. Particular visual aspects that relate to site are as follows:

Thyspunt

The visibility is contained along the coast by east-west orientated dune fields. This limits the visual exposure of the Thyspunt NPS to the towns of Oyster Bay and Cape St. Francis.

The main aspect that influenced the above conclusion is the presence of the visually dominant Thyspunt NPS and the associated transmission lines and buildings, all of which are visible to some degree from within a 10 km radius of the site, but mainly along the coastal edge. This is due to the landform that includes vegetated and moving dunes that trend east-west, almost parallel to the coastline and the extended visibility at night due to intense illumination of that site. However the general existing coastal night scene is disturbed by the intense incandescent lights on the 'chokka' boats as they fish for squid near the shore. The light intensity varies according to the season for chokka fishing. The visual intrusion on the landscape character will be increased by the HV Yard, the transmission lines and proposed northern access road that all become visually prominent in the panhandle of the property north of the high sand dune.

Bantamsklip

The main aspect that influenced the above conclusion is the presence of the visually dominant Bantamsklip NPS and the associated transmission lines and buildings, all of which are visible to some degree from within a 10 km radius of the site. This is due to the landform that slopes towards the coastline and the prominent seaward location of the site on a coastal terrace. This visibility will be extended at night by the illumination of the plant.

Duynefontein

The finding is that the Duynefontein NPS has an intensity of visual intrusion that is rated as significant, particularly at night. This in association with the scale and proximity of the Koeberg NPS and possible future Pebble Bed Modular Reactor Demonstration Power Plant (PBMR DPP) will as a group extend the existing visual impact of Koeberg NPS on the surrounding landscape and communities.

The visually dominant Duynefontein NPS and the associated infrastructure will be visible to some degree from within a 10 km radius of the site. This is due to the landform that slopes gently towards the coastline and the extended visibility at night due to illumination of that site.

The cumulative visual impact of three large power generating facilities within 3 km of the coast will have a high visual intrusion on views, visual character and visual quality.

The new Opened Cycle Gas Turbine Power Station is completed in Atlantis, approximately 10 km inland from the proposed site. This add another large scale structure to the regional landscape.

Ancillary structures and features were also assessed for their influence on the visual sense of place and their visual intrusion. These elements are the meteorological mast (120m) and the radio mast (95m), the transmission lines within the EIA corridor, the spoil and rock dumps and the access roads to the site from the provincial road.

Findings

- The masts will be visible from further away than for the NPS, particularly at night, due to the flashing red light at the top. The mast will be slender, which will reduce its visual intrusion;
- The transmission lines within the EIA corridor will add to the visual intrusion of the project by their height and number;
- The access roads for Bantamsklip and Duynefontein will have negligible visual intrusion on the sense of place;
- The 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;
- 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 dominant visually within this area and can serve as large screens of the NPS in views from the provincial roads.

Mitigation Measures

The following Generic Mitigation measures are proposed to reduce the visual impact of the NPS.

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 NPS 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 which will be the result of their galvanised finish. However this may be in conflict with the regulatory requirements that they are red and white bands.

Screens

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 NPS site and west of Cape St. Francis, as well as east of Bantamsklip NPS, which may result from the extension of the R43 to link with Bredasdorp.

Lighting

The lighting of the structures and areas within the NPS site should be designed by a suitably experienced person with the objective to reduce “light spill”. 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.

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.

A Landscape Architect should be appointed to the design team to advise on the visual integration of the project on a detailed level during the phases of design and construction and operation.

The dilemma of placing a new large scale facility in an area that is relatively undisturbed and remote or near build-up areas to reduce the visual intrusion intensity remains. The question is whether to increase, but contain the visual impact locally or to visually impact another (already impacted) location, but not to the same degree.

The conclusion is that the NPS on any of the three sites will have a high visual impact on the character and sense of place of the existing setting. However, with attention to detailed aspects of all mitigation measures proposed, the visual impacts can be reduced. To achieve this considerable effort will need to be spent on this aspect during the site design and construction stage of the project.

1.19 Heritage Impact Assessment (Appendix E20)

The Archaeology Contracts Office of the University of Cape Town was appointed by Arcus Gibb (Pty) Ltd on behalf of Eskom Holdings to undertake the heritage component of an environmental impact assessment of three proposed sites for a 4000 MW nuclear power station and associated infrastructure. Authorisation is sought for one of the three sites. The sites are situated in the Western and Eastern Cape, Dynefontein close to the existing nuclear power station (Western Cape), a second at Bantamsklip between Pearly Beach and Die Dam (Western Cape) and a third at Thyspunt between Cape St. Francis and Oyster Bay in the Eastern Cape. This study, which has involved extensive background and primary research followed by field assessment, has identified heritage sensitivities at all three sites.

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 findings of the study are summarised thus:

Duynefontein:

- Impacts to ephemeral Late Stone Age heritage will be minimal.
- Duynefontein is palaeontologically highly sensitive. Extensive mitigation will be required which, 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.

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. Together with the archaeological material they represent a largely intact pre-colonial cultural landscape. Given the mass and bulk of the proposed activity, un-mitigatable cultural landscape impacts are expected.

Thyspunt:

- The archaeological and palaeontological heritage is diverse and prolific but pertinent to certain geographical areas – in particular the Oyster Bay Dune Field and within 300 m of the high water mark. The increase in the coastal set back zone from 60 m from the high water mark to 200 m has substantially reduced the impacts on archaeological sites. As a result of findings of extensive surveys, including a trial excavation program, it is possible to position the proposed nuclear power station in such a way that physical impacts to heritage sites of an archaeological nature are minimised. Mitigation of any heritage material through sampling by controlled excavation, or creation of local exclusion areas is considered feasible with resources currently available. Some on site storage (a small museum) may be necessary. The wilderness qualities of this portion of the coast in contiguity with the archaeological heritage are exceptional and make a substantial contribution to the character of the region. Given the mass and bulk of the proposed activity, un-mitigatable cultural landscape impacts are expected.

1.20 Agricultural Assessment (Appendix E21)

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.

Given the information gathered in the agricultural study, it was 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 major impacts of a nuclear power station on agriculture would be the generation of dust during the construction phase, labour shortages and wage increases, and market effects. The estimated impact on produce markets showed that the gross value of production in the Bantamsklip area ***could potentially*** increase by up to 5% and in the Thyspunt area by 10 to 15%, while no change is anticipated in the Duynefontein area.

From an agricultural production perspective Duynefontein is a mature site because grape and wheat production in the area has progressed alongside the construction and operational phases of the existing Koeberg Nuclear Power Station. Dust during construction of the new plant will have little effect on farm lands because the prevailing winds during the dry summer months are in line with the coastal strip.

Impacts

In summary, the impacts on agriculture at the three sites are as follows:

Duynefontein

- No significant impact on agriculture during construction and normal operations. No increase in agricultural production during operation.

Thyspunt

- ***short term*** negative impact on agriculture in terms of dust during the construction phase. However, there is potential for a positive impact on production by increasing the size of the local market for fresh produce as a result of the influx of population (Nuclear-1 employees and their families as well as construction workers) to the area.

Bantamsklip

- ***short term*** negative impact on agricultural production with regard to dust during the construction phase. There is an estimated potential of less than 5% to increase the market for local agricultural produce because of water limitations that restrict expansion.

In terms of the impact on agriculture, there are no fatal flaws in respect of any of the three sites, and all of them would be suitable to accommodate Nuclear-1.

1.21 Tourism Assessment (Appendix E22)

This study evaluates the tourism industry at each of the three sites defined in Eskom's Nuclear-1 programme, namely, Thyspunt, Bantamsklip and Duynefontein. The tourism market at each site is described and assessed in the following terms:

- A description of the status quo in terms of the current tourism industry and an outline of current proposed developments in each area
- A definition and value of the change in the tourism asset that would occur as a result of the construction and operation of a nuclear power station in each area
- The identification and recommendation of mitigation measures to reduce or offset the perceived negative impacts on the tourism asset

Each site was investigated with a thorough desktop study followed by a field visit. Various prominent tourism stakeholders and authorities were identified, contacted and interviewed. The complex nature of the tourism industry as a whole and the variable influence of perception and image in tourism marketing, destination branding and decision-making, makes averaging the value of tourism difficult. It was therefore decided that the best indication of tourism performance and the most comparable rand figure for each area would be the value of bed nights spent there. This is calculated for each research area by the approximate number of beds multiplied by the average annual occupancy rate multiplied by the average cost per night.

The tourism asset at each area was then described according to specialist observation and the perceptions of the consulted stakeholders. Following a specialist review of the field data, a weighted matrix of 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 the table below.

		Construction Phase (yrs 1-6)		Operational Phase (yrs 7-20)	
	Current Tourism Value (Rands)	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%

The Thyspunt and Bantamsklip communities have expressed the most adamant opposition to the proposed nuclear power station. Thyspunt has expressly highlighted the premium nature of the top-end coastal vacation destination, and Bantamsklip has emphasised the new and fragile nature of the developing tourism product and the local dependence thereon. The difference in size and type of tourism at these two sites explains why the short-term impact at

Thyspunt is shown to be negative; a loss of some of the current holiday market might not be entirely offset by the growth of business tourism at Thyspunt, whereas business tourism is likely to significantly increase the size of the smaller market at Bantamsklip. 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.

The main mitigation measure is an aggressive 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 the Koeberg NPS.

Impacts

In summary, the impacts on tourism at the three sites are as follows:

- Duynefontein – most easily absorbed into the local economy; no short-term discernible impact on tourism; small-scale, long-term discernible positive impact on tourism;
- Bantamsklip – small-scale, short-term and long-term positive discernible impact on tourism;
- Thyspunt – small-scale, short-term, negative discernible impact on tourism; no overall discernible long-term impact on tourism.

In terms of the impact on tourism, there are no fatal flaws in respect of any of the three sites, and all of them would be suitable to accommodate Nuclear-1.

1.22 Noise Impact Assessment (Appendix E23)

A specialist study was conducted into the potential impact of noise emanating from the proposed establishment of a Nuclear Power Station (Nuclear-1), with a maximum electrical generation capacity of 4 000 MW, at three different locations. The three locations are on the Koeberg (Duynefontein) site immediately north of the existing Koeberg Nuclear Power Station (KNPS), Western Cape; at Bantamsklip approximately 5 km east of Pearly Beach, Western Cape; and Thyspunt, east of Oyster Bay, Eastern Cape.

No quantitative noise emission data of machinery and equipment to be installed on site was available. This data, provided by the manufacturers of the respective machines/equipment, is usually only available at the tender and detail design stage once the manufacturers and specific machinery/equipment have been selected.

The maximum 4 000 MW electrical power capacity of Nuclear-1 would be 2,2 times greater than the 1 800 MW of the existing KNPS. It is clarified in this report that if there were to be an associated 2,2 times increase in sound power emitted (in watts) this would not be audible to humans. Such differences are considered insignificant in national and international standards relating to the assessment of environmental noise. It was thus considered justified to use the results of detailed sound measurements conducted at the KNPS to calculate the approximate noise levels on land surrounding the proposed Nuclear-1 at the three alternative sites. This provided the best available data for predicting the potential impact of noise from the proposed Nuclear-1 nuclear power station.

The results of the study indicated that there would be no noise impact on land surrounding any of the three properties during construction and operation of the proposed nuclear power station. No noise mitigation procedures would therefore be required. Noise during the operational phase would thus not have a bearing on the selection of any of the three alternative sites.

No noise impact associated with the construction of new roads to the alternative sites was anticipated, excepting the western access road to the Thyspunt site that would pass within 230m of the Umzamowethu township. In the latter instance the following recommendations are made:

- Construction processes and machinery/vehicles with the lowest noise emission levels available are utilised;
- A well planned and co-ordinated “fast track” procedure is implemented to complete the total construction process in the shortest possible time; and
- Construction work near residences only takes place during normal daytime working hours.

The impact of noise associated with transportation of materials & equipment to site would have a low impact on the nearest residences located along the R27 leading to the Duynefontein site. The noise impact on the nearest residences along the R43 to the Bantamsklip site would be medium. The noise impact on a small number of residences in the nearest informal settlements along the R330 at sea Vista near the Thyspunt site would be medium. In all instances no noise mitigation would be required in terms of the Noise Control Regulations (NCR).

The transportation of heavy machinery on extra-heavy-duty vehicles traveling very slowly on roads within 1000 m of residences is likely to result in a noise impact of medium intensity but of very short duration. Little can be done to reduce the levels of noise emitted by extra-heavy duty vehicles. In order to minimize the noise impact on affected communities it is recommended that they be informed prior to any such transportation taking place.

1.23 Human Health Risk Assessment (Appendix E24)

The Eskom Nuclear-1 project involves the licensing of three candidate sites along the west and south coasts of South Africa for the establishment of nuclear power stations. The sites are:

- The Thyspunt site, situated in the Eastern Cape Province in the region west of Port Elizabeth between Cape St Francis and Oyster Bay;
- The Bantamsklip site, located in the Western Cape in the area between Danger Point and Quoin Point;
- The Duynefontein site, situated on the Cape West Coast, approximately 30 km north of Cape Town, adjacent to the current Koeberg Nuclear Power Station.

The establishment of a nuclear power station includes a number of activities, which require authorisation in terms of the Environmental Impact Assessment (EIA) Regulations promulgated under the National Environmental Management Act (No. 107 of 1998), as amended. The EIA process is administrated by the Department of Environmental Affairs (DEA). However, following a co-operative agreement between the DEA and the National Nuclear Regulator (NNR), it was agreed that the NNR will be the responsible authority regarding the assessment of all matters relating to impacts of ionising radiation on human health. This environmental impact report on the assessment of potential health risks associated with nuclear power stations at the candidate sites will thus be submitted to the NNR for approval. The report has been prepared by INFOTOX (Pty) Ltd in conjunction with SRK Consulting.

Radiological protection in the low dose range is concerned primarily with protection against radiation-induced cancer and heritable disease. These effects are interpreted as stochastic, with no threshold, and they increase in frequency in proportion to the radiation dose. Radiation exposure has been demonstrated to increase the risk of other diseases, particularly cardiovascular disease, in persons exposed to high ***radiological doses, such as in radiotherapy*** and also in atomic-bomb survivors exposed to high radiation doses. However, there is no direct evidence of increased risk of non-cancer diseases at doses below about 100 millisieverts (mSv). This dose level is two orders of magnitude higher than the NNR dose limit for public exposure. Protection against the development of radiogenic cancer is considered to be adequate for protection against hereditary effects and any other radiation-associated diseases.

Human beings are exposed daily to natural background radiation from environmental soil, building materials, air, food, cosmic rays, and even from radioactive elements within the human body. There is no general property that makes the effects of manmade radiation different from those of naturally-occurring radiation.

In Government Notice No. R. 388, the Department of Minerals and Energy specifies an annual effective dose limit of 1 mSv for members of the public from all authorised actions. ***Dose limit means "the value of effective dose or equivalent dose to individuals from actions authorised by a nuclear installation license, nuclear vessel license or certificate of registration, that must not be exceeded".***

In addition, the NNR stipulates a dose constraint of 0.25 mSv specific to an authorised action, to ensure that the sum of the doses received by the average member of the critical group from all controlled sources would be smaller than the dose limit. A dose constraint is "a prospective and *source*-related restriction on the individual *dose* arising from ***the predicted operation of the authorised action which serves exclusively as a bound on the optimisation of radiation protection and nuclear safety".***

The NNR requires that any exposure above the natural background radiation should be kept as low as reasonably achievable (the ALARA principle). Dose limits and dose constraints must always be interpreted as upper bound limits in conjunction with the ALARA principle, inferring that exposures from authorised activities in practice would be lower than the dose limits and dose constraints.

Reactor technologies have not been selected for the Nuclear-1 project at this time and the current assessment is based on the concept of a technology envelope (TE), which sets an upper limit on radiological discharges, requiring that radiological doses to the average member of the critical group at any of the sites under consideration would not exceed the NNR regulatory requirements. For a selected power generation capacity at a site, combinations of reactors may be considered, as long as radiological discharges would not exceed the TE. The health impact assessment presented in this report has been based on the premise that the NNR will issue a license for a site only if full compliance with regulatory requirements is demonstrated. This would take into account not only the radiological dose assessment for normal operation of the nuclear power station, which will be submitted to the NNR in the form of a site safety report (SSR), but all the other studies that are required for the assessment of the overall safety case.

This environmental impact report outlines the methodologies for quantification of radiological exposure and places the NNR regulatory requirements in context with potential risks to human health. The approach considers site-specific scenarios for multiple pathways of exposure. The quantified radiological doses determined for the SSR will be assessed in terms of regulatory requirements of the NNR. The assessments for the candidate sites must not only demonstrate compliance with the NNR dose limits and dose constraints, but must also take into consideration the principles of ALARA. Should a calculated dose be within the acceptable NNR requirements, it can be concluded that the cancer risk would be within the *de minimis* lifetime risk range, which represents a level of health risk that is regarded as insignificant or trivial. Protection against the development of radiogenic cancer is considered to be adequate for protection against hereditary effects and other radiation-associated diseases.

The impact assessment has highlighted that there is extensive mitigation built into reactor design for safety and that there are multiple precautionary defenses against the consequences of failures in materials and equipment and human error.

For purposes of the EIA, it is acknowledged that the NNR will issue a license for the establishment of a nuclear power station at any particular site only if full compliance with the radiological dose limits and dose constraints is demonstrated, taking into account the principles of ALARA and all other matters relating to the overall safety case. Considering the methodologies for dose assessment that are presented in this report, it is recommended that the approach be accepted as adequately protective against adverse health effects to members of the community.

1.24 Transportation Assessment (Appendix E25)

Arcus GIBB (Pty) Ltd (Arcus GIBB) was appointed by Eskom Holdings SoC (Eskom) to undertake an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed construction of a nuclear power station and associated infrastructure on one of three selected sites that are located in the Eastern and Western Cape Provinces, namely:

- Duynefontein (Existing Koeberg Nuclear Power Station Site) – Western Cape;
- Bantamsklip – Western Cape;
- Thyspunt – Eastern Cape

Two other sites in the Northern Cape, namely Brazil and Schulpfontein, were excluded from further study, in the Scoping Phase of the EIA process. The three sites were accepted by the Department of Environmental Affairs (DEA) in the Scoping phase.

This Traffic Impact Assessment Report details the Impact Assessment Phase of Nuclear-1's Transport Specialist Study.

The **Duynefontein** site requires no significant upgrades during the construction and operational phases of Nuclear-1 with regard to intersection upgrades, heavy load transport road upgrades and emergency evacuation upgrades. Duynefontein, however, requires a significant number of stand-by evacuation vehicles to ensure safe evacuation of construction workers if an accident does occur at the adjacent Koeberg Nuclear Power Station during the construction period. These vehicles can also be used to shuttle the construction workers to and from the site during the AM and PM peak periods.

The **Bantamsklip** site will have 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 and bypassing Gansbaai. Due to the Bantamsklip site's isolated location, transporting heavy loads by road will require significant upgrades and the alternative transport by sea should be considered. A suitable site on the beach near to Bantamsklip will have to be identified and a landing with loading / off-loading facilities will have to be constructed.

The **Thyspunt** site requires significant transport upgrades with regard to public transport, access and emergency evacuation, during the construction phases. The recommended routes in Version 9 of this Report were revised as a result of public input and recommendations received between 29 May 2011 and 2 June 2011. Based on the feedback received, the R330 is now proposed to be used for light vehicle traffic and abnormal load transport, and sections will require upgrading for this purpose. The Oyster Bay Road is now proposed to be upgraded to a surfaced road to be used during the construction and operations phases for staff access, light vehicle traffic, heavy vehicle traffic and as an emergency evacuation route for areas such as Oyster Bay. DR1762, which links the R330 and Oyster Bay Road is now proposed to be surfaced to provide improved east-west connectivity. Bypass roads to the east and west of Humansdorp are also now proposed to be constructed to reduce the traffic impact on central Humansdorp.

1.25 Emergency Response Assessment (Appendix E26)

This Environmental Impact Report (EIR) covers the impacts and mitigation measures associated with the construction and operation of a conventional Nuclear Power Station (NPS) and associated infrastructure at three sites in the Eastern (1) and Western (2) Cape. The sites were originally identified as a result of site investigations undertaken since the 1980s and from the EIA Scoping Study. This specialist study covers Emergency Response and was carried out by Mogwera Khoathane/SRK Consulting.

This assessment aims to demonstrate the emergency planning feasibility ***(nuclear related)*** within the study area. Emergency Planning Assessments provide decision makers with information that will guide their decision on final site choice.

Emergency preparedness in the context of an NPS can be defined as the measures that enable individuals and organisations to stage a rapid and effective emergency response in the context of nuclear emergencies. Protective actions include measures to limit the exposure of the public to radioactive contamination through external exposure, inhalation and ingestion. The objectives of these actions are to prevent deterministic effects (early mortality) and to reduce stochastic effects (principally cancer).

For nuclear emergencies, two sets of requirements have to be fulfilled.

Functional (response) requirements; and Infrastructure (preparedness) requirements functional response requirements refer to the “capability” to perform an activity. The “capability” includes having in place the necessary authority and responsibility, organisation, personnel, procedures, facilities, equipment and training to effectively perform the task or function when needed during an emergency.

The “capability” includes having in place the necessary authority and responsibility, organization, personnel, procedures, facilities, equipment and training to perform the task or function when needed during an emergency. In this context, infrastructure means transport and communications networks, industrial activities and, in general, anything that may influence the rapid and free movement of people and vehicles in the region of the site.

In demonstrating the feasibility of the emergency plan, many site related factors should be taken into account. The most important factors are:

Population density and distribution, distances from population centres, groups of population difficult to shelter or to evacuate in the event of an emergency;
Special geographical features, such as islands, mountains terrains, rivers, capabilities of local transport and communication network;
Agricultural activities that are sensitive to possible discharges of radionuclides; and
Disastrous external events or foreseeable natural phenomena.

Findings

The key findings and recommendations of this Emergency Response study can be summarised as follows:

Infrastructure Considerations

The Duynefontein Site includes the existing Koeberg Nuclear Power Station, therefore the emergency response infrastructure and systems are in place. However, the outcomes of the Safety Analyses, done prior to commissioning as part of the Safety Analysis Report will determine if the current infrastructure would be adequate to cope with the demands of the additional and proposed Nuclear-1 Power Station.

The Bantamsklip and Thyspunt sites will require upgrading of infrastructure since they are in remote areas as indicated by the land use studies done by Eskom.

Population Distribution

The siting process for a NPS generally consists of a study and investigation of a large area to select one or more candidate sites (see IAEA Safety Guide 50-SG-S9 on Site Survey) followed by a detailed evaluation of those sites.

Major factors considered are:

- Effect of the region of the site on the plant
- Effect of the plant on the region
- Population

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. The Thyspunt and Bantamsklip sites are satisfactory in this respect.

The Thyspunt and Bantamsklip sites are acceptable for emergency planning considerations since the newly adopted EUR approach followed by Eskom for emergency planning suggests that an NPS 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 urgent 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.

1.26 Site Control Assessment (Appendix E27)

This report investigates the impacts and required mitigation measures associated with the construction and operation of a Conventional Nuclear Power Station (NPS) and associated infrastructure at one site in the Eastern Cape and two sites in the Western Cape. The sites have been identified based on site investigations undertaken since the 1980s. This EIR covers Site Control and was carried out by SRK Consulting.

Eskom proposes to construct an NPS of the Pressurised Water Reactor type technology, with a capacity of ~ 4 000 MWe. The proposed NPS will include nuclear reactor, turbine complex, spent fuel, nuclear fuel storage facilities, waste handling facilities, intake and outfall structures and various auxiliary services infrastructure. The plant will have a commercial lifespan of ~60 years.

All three proposed sites, at Thyspunt (Eastern Cape), Bantamsklip and Duynefontein (Western Cape), are located on the coast. The first two are greenfield sites while the existing Koeberg Nuclear Power Station (KNPS) is located on the latter site.

The Terms of Reference (ToR) for the specialist Site Control study is to assess various aspects with respect to site control, including the following:

- Site security;
- Access control (entry and exit of, both during the construction and operational stages); and
- Owner-controlled areas.

The methodology followed for the Site Control EIR has entailed a desk study and site reconnaissance based on:

- Relevant Sections of Eskom's Technical Specifications for Nuclear Sites Investigations (Eskom 2006, 2009);
- Relevant legislation;
- Relevant chapters of the Koeberg Site Safety Report (Eskom 2006, 2009);
- Site control measures at the KNPS (Eskom 2006);
- Site investigations; and
- Pebble Bed Modular Reactor Demonstration Power Plant (on the Duynefontein site).
- Environmental Impact Assessment Specialist Study: Site Security (Malepa Holdings 2007).

Findings

Based on the above information and impact assessment, the following conclusions can be drawn:

Duynefontein

- The site is already developed as a NPS with full access and site control, which has been in place since commissioning in 1979 and prior to this during construction;
- It has full visitor facilities with a Visitor's Centre;
- Koeberg Nature Reserve has been developed on the site;
- Walking and mountain bike trails exist;
- Access will be via new access control points and upgraded existing roads leading off the R27;
- There will be minimal additional or cumulative impacts with development of Nuclear-1; and
- The impact rating is low for intensity, consequence and significance, at a mostly high level of confidence and there will be no impact on irreplaceable resources. There are no fatal flaws.

Thyspunt

- It is a greenfield site;
- Sensitive wetland ecosystems and heritage features present will be preserved by the implementation of site control measures;
- Access to the site is currently limited and controlled by fencing and electronic/locked gates;
- A new access control point will be developed on the western or eastern owner controlled boundary and at the outer and inner security fence; and
- The impact rating is low for intensity, consequence and significance, at a mostly high level of confidence and there will be no impact on irreplaceable resources. There are no fatal flaws.

Bantamsklip

- It is a greenfield site;
- Access to the site is currently limited and controlled by fencing and gates. However, the R43 tarred road passes through the site;
- Access will be via an access control point/roads from the R43 and access control points at the outer and inner security fence; and
- The impact rating is low for intensity, consequence and significance, at a mostly high level of confidence and there will be no impact on irreplaceable resources. There are no fatal flaws.

No-go Option

- Eskom will sell the Thyspunt and Bantamsklip sites;
- The impact rating is low for intensity with neutral consequence and low significance for Duynefontein and medium for intensity, negative consequence and high significance for the Thyspunt and Bantamsklip sites.

Climate change and a desalination plant will not have any bearing on this Site Control impact assessment.

Mitigation Measures

- The following mitigation measures are proposed:
- Clearly communicate access policy for the properties to the public, using notice boards on access gates and by directly communicating with the communities nearby;
- Consider providing permits to allow access for fishing activities and whale watching in any coastal exclusion zone;
- Maintain public access to the R43 where it traverses the Bantamsklip site;
- Implement mitigation measures recommended in the visual impact assessment report;
- Establish a nature reserve within the owner-controlled area and provide access for scientific research;
- Maintain or re-establish indigenous vegetation;
- Retain and maintain environmental features on sites such as wetlands;
- Preserve heritage features;
- Facilitate a review of site control issues raised in this EIR on National Key Points via the Minister of Police;
- Confirm the availability of any required support for site control from the relevant police, military, naval and coastal management agencies;
- Integrate the site specific control measures with existing local and regional security measures;
- Develop an Environmental Management Plan prior to construction. Define mitigation measures, monitoring parameters, target ‘goals’ and responsibilities in the EMP; and
- Appoint an Environmental Control Officer.

An Environmental Management Plan must be drawn-up prior to construction in consultation with Eskom. Responsibilities, mitigation measures and monitoring of the effectiveness thereof must be clearly defined.

1.27 Eskom Grid Planning / Transmission Integration (Appendix E28)

Eskom is considering building a new fleet of nuclear power stations to meet the national demand for electricity and diversify the source of base load generation away from predominantly coal fired generation. The first phase of this nuclear programme is referred to as Nuclear 1 which will consist of either three 1100MW units or two 1600MW units, giving a total of between 3200MW to 3300MW. Eskom had already identified five potential sites on the Cape coast and the Environmental Impact Assessment (EIA) study has been undertaken to determine the potential impact of a 3300MW nuclear power station at the five sites.

To give an overall view of the power transfers that will occur as nuclear generation is integrated into the Cape transmission network can be simplified into a number of main transmission power corridors. This is illustrated in Figure 1 which shows the main Cape power corridors (labeled A, B, C1, C2 and C3) and the proposed nuclear sites (labeled B, D, T, S and Z). The corridors C1, C2 and C3 indicate the existing transmission corridors while A and B indicate new transmission corridors that would need to be established.

The transmission integration requirements at the five sites are as follows:

Thyspunt

This is a standalone site and provides a base load generation injection into the Southern Grid (Eastern Cape) which will consist primarily of the Coega, Port Elizabeth and East London loads. The integration will link into the existing Cape power corridors C3 and C1.

The initial Nuclear 1 phase at Thyspunt will require the following transmission integration to meet the planning criteria:

- 2x Thyspunt-Dedisa 400kV lines
- 1x Thyspunt-Grassridge 400kV line
- New 400/132kV Port Elizabeth Substation (PE S/S)
- 2x Thyspunt - New PE S/S 400kV lines
- 1x New PE S/S - Dedisa 400kV line
- 1x New PE S/S- Grassridge 400kV line

Bantamsklip and Duynefontein

These two sites will inject into the Greater Cape Peninsula area of the Western Grid (western Cape) which will consist of the loads from Saldahna, Cape Town and right down to Mossel Bay. From a Transmission MW Demand balance view they can be considered to be in the same area. The integration of these two sites will link into the existing Cape power corridors C2 and C1.

The Bantamsklip site is relatively remote from any major load centre and a strong 765kV interconnection network with the Eskom network will have to be constructed. Almost all the power will be transported to the 765kV network via the new Kappa 765/400kV substation near Wolseley for further distribution.

The initial Nuclear 1 phase at Bantamsklip will require the following:

- 3x 765kV Bantamsklip-Kappa 765kV lines
- 2x Bantamsklip – Bacchus 400kV lines (instead of one line to Proteus as in original report)

The proposed Duynefontein site is just north of the existing Koeberg power station. The new Omega 765/400kV MTS substation will be established close to Koeberg as part of the Cape Strengthening projects. Some of the Nuclear 1 power will be directly integrated into the Cape Peninsula 400kV network to supply the growing load and the excess power will be transported to the main Eskom network via Omega for further distribution or export to the north.

The initial Nuclear 1 phase at Duynefontein will require the following:

- 3x Duynefontein - Omega 400kV lines
- 2x Duynefontein - Stikland 400kV lines
- Loop in of Acacia-Muldersvlie 400kV line into Omega and Duynefontein

The EIA process indicated that the originally proposed Duynefontein-Philippi 400kV line was not possible and the integration plan was subsequently changed to the second line to Stikland and the loop in of the existing Acacia-Muldersvlei line instead.

1.28 Risk of Debris Flow, Liquefaction and Flooding of the R330 at the Thyspunt Site (Appendix E29)

This specialist study investigates alleged debris flows and debris flow deposits in the Sand River, quicksands and liquefaction of sand, the November 2007 flood that damaged the R330 at St Francis Bay Village and potential for flood damage where the R330 crosses the Sand River. These issues were raised at a key stakeholder workshop held at St. Francis Bay on 25 May 2010 as part of the EIA for a nuclear power station ('Nuclear-1') that Eskom proposes to build.

The possible threats that such events could have on the possible nuclear power station and its associated infrastructure at the Thyspunt site are assessed. The findings are presented in this Addendum Report to the Dune Geomorphology Report.

Available literature on the subject was perused, including diverse reports prepared for Eskom. Various local residents and environmental specialists were consulted. Detailed contour maps and aerial photographs from 1942 to 2007 were analyzed to investigate the behaviour of the Sand River and floodwater flow paths.

Debris flows and debris flow deposits

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

Quicksands and liquefaction of sand

Quicksands often occur in the Oyster Bay dunefield. They are usually formed when loosely consolidated sand is inundated. Vehicles would not be engulfed in quicksands in the Oyster Bay dunefield unless they drive on the bed of the Sand River or around interdune ponds. Vehicles travelling on the R330 are not in any danger of being engulfed in quicksands.

The proposed “eastern access route” that would cross vegetated dunes and wetlands would be built to correct engineering specifications to accommodate any poor foundation conditions so that vehicles can safely use the road. The possible nuclear power station would be founded on solid rock and so quicksands or liquefaction of sand could not have any effect on it.

The November 2007 flood

The November 2007 flood that damaged the R330 is estimated to be a 1:200 year event. The main erosional damage resulted from erosion of sediments by floodwaters flowing down the steep V-drain along the R330. Damage was also caused by the deposition of sediment in the area from the R330 along Lyme Road into the adjacent part of the St. Francis Bay Golf Course. The deposit is an alluvial fan, not a debris flow deposit.

Ninham Shand has proposed improvements to stormwater drainage that would considerably reduce the chances of such damage occurring again. Some of these improvements have been undertaken.

Potential for flood damage where the R330 crosses the Sand River

The R330 crosses the Sand River via a box culvert constructed when the road was rebuilt to its current standard in 1989/1990. The most extensive damage to the R330 since then was in the flood of November 1996, when the wing walls on either side of the culvert were damaged and there was some erosion of the tarred surface by water flowing over the road. The road was still wide enough to accommodate two directions of traffic flow. Other floods caused less or no damage.

Thus the R330 has been damaged by some of the numerous floods of the Sand River but damage was minor in that vehicular access was never interrupted. It is recommended that the culvert be strengthened if necessary, be well-maintained, be checked regularly to see that it is not blocked by sand; and any debris that is caught across it during floods be removed.

1.29 Risk of Debris Flow Assessment (Appendix E30)

First Report

This specialist study investigates alleged debris flows and debris flow deposits in the Sand River, quicksands and liquefaction of sand, the November 2007 flood that damaged the R330 at St Francis Bay Village and potential for flood damage where the R330 crosses the Sand River. These issues were raised at a key stakeholder workshop held at St. Francis Bay on 25 May 2010 as part of the EIA for a nuclear power station ('Nuclear-1') that Eskom proposes to build.

The possible threats that such events could have on the possible nuclear power station and its associated infrastructure at the Thyspunt site are assessed. The findings are presented in this Addendum Report to the Dune Geomorphology Report.

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Second Report (addendum to Thyspunt Access Road Assessment)

This specialist study is the second Addendum Report to the Dune Geomorphology Report. It investigates new western access routes to the Thyspunt site, and the 2011 - 2012 floods.

The MSC thesis of Lauren Elkington was completed in June 2012. It represents the current state of research being conducted by Prof. Ellery of Rhodes University and his colleagues. The thesis was reviewed and relevant information has been incorporated into this report.

Available literature on the subject was perused, including diverse reports prepared for Eskom. Field visits were undertaken. Rainfall records were consulted. Various local residents and environmental specialists were consulted. Detailed contour maps and aerial photographs and images from 1942 to 2012 were analyzed to investigate the dynamics of the dunefields and the flood behaviour of the Sand River. A GIS was used to create digital overlays of the topographic data and images.

Dune morphodynamics in the Cape St Francis Headland-bypass dunefield

The headland-bypass dunefields at Cape St Francis have been cut off from their source beaches due to human activities. If there is no human intervention to counter this (other than continuing to stabilize the dune ridge along Oyster Bay beach), the dunefields will slowly be stabilized over the next 1000 years or so by natural re-vegetation processes and the continuing spread of invasive alien vegetation.

If the dune ridge along the Oyster Bay Village shoreline is allowed to become mobile and over-run the village, the feeder zone will revert to its natural state and eventually start feeding sand into the dunefield. However, if this dune ridge is managed and not allowed to remobilize, the sand supply to the dunefield will remain cut off. This is the more likely scenario.

If invasive alien species like rooikrans are cleared, natural re-vegetation will be slower, advancing dunefields will move faster, and the loss of mobile dunes due to encroachment by alien vegetation will stop. The dunefields will revert to their natural mobility.

It is predicted that if invasive alien species are kept in check the eastern margins of dunefields will continue to advance at their historic rates, i.e. the leading tongues of dunefields will move eastward at rates of 10 to 30 m/yr, and the trailing ends of dunefields will continue to be vegetated at about 5 m/yr.

The localities and nature of wetlands in the dune areas have changed very much over the life of the dunefields, corresponding to their dynamic nature. A large amount of active dune areas has been lost due to human impacts; the numbers of interdune wetlands are correspondingly reduced.

Assessment of access routes across the western end of the mobile Oyster Bay dunefield

The impacts are restricted to issues related to mobile dunes. The proposed routes cross the trailing (western) ends of patches of mobile dunefields, where dune movement is slowing down. The mobile dunes are moving along valleys that would be filled to build the roads. As such the only viable option would be to stabilize the patches of mobile dunes to the west (upwind) of the proposed routes. The main consequence of this would be to lose a small area of mobile dunes. The environmental impact will be low.

As a mitigatory offset, Eskom could undertake to restore mobile dunes that are located within land that they own in the bulk of the Oyster Bay dunefield by removing alien vegetation. An area much larger than what would be stabilized could be re-mobilized.

Assessment of access routes across vegetated parabolic dunes and linear dune ridges

This entails crossing the vegetated dunes with a road that would need cut and fill to create a road with a smooth gradient. 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. There will thus be little effect on the stability of the dunes, apart from the risk of slumping during the construction phase. The environmental impact will be low.

The 2011 and 2012 floods and the Sand River

Flash-floods are caused by moving dunes that block the Sand River channel within the dunefield during dry periods. When the river flows again, water would pond against the dunes until the interdune ponds overflow and breach, causing a catastrophic flash-flood. Large amounts of sediment and plants may be transported by the high energy peak water flow.

The Santareme event of 15 September 2012 provides a dramatic example of the flash-flood that can result when an interdune pond breaches. This dunefield had been artificially stabilized, preserving the transverse dune topography that dams surface runoff. The flood resulted from the rupture of one of these ponds.

It often happens that there is not one big rainfall event, but a number of smaller events. The landscape became progressively saturated with water, so that there is less and less absorption capacity, and the proportion of runoff increases accordingly. A rainfall event of 100 mm or so at the end of a wet season can generate a flood with high peak flow that can cause significant damage. This happened in 2011 and 2012.

The largest event in 2011 was 123 mm on 2/3/4 July. After this rain, a large volume of water accumulated in the nose of the southern tongue of the Oyster Bay dunefield; flow was augmented by water from the cutoff canal. The southern tongue was artificially breached on 7 July. The Sand River culvert was washed away in the ensuing flash-flood, and the Sand River delta in the Kromme estuary gained about 80,000 m^3 of sediment.

The final rainfall event of 2012 was the largest event for that year: 113 mm fell from 17 to 20 October. It resulted in a flood that washed away the temporary Sand River culvert that had been built in August 2011.

The Sand River erodes dunes as it makes its way through the dunefield, entraining much sand. Large amounts of sand as well as plant debris are carried down the Sand River during floods. This is a normal fluvial process, not a debris flow. The sand is ultimately deposited in the Sand River delta in the Kromme estuary. This has been happening for hundreds of years.

Sand River delta in the Kromme Estuary

The Kromme estuary is typically sand-choked. The sand is derived from the Sand River and from tidal currents that carry sand into the estuary from the sea. The Sand River delta has never blocked the Kromme estuary completely, and it is not likely to do so.

Supposed debris flows

The supposed debris flow deposit is a bulldozer deposit.

Recommendations

Alien vegetation across the whole dunefield needs to be mapped to confirm and refine projected scenarios for future dunefield dynamics.

Interdune ponds should be monitored during periods of high rainfall to see if dangerous situations are developing. Aerial surveys from a small aircraft are an efficient way to do this.

The temporary Sand River culvert should be urgently replaced with a suitably designed permanent structure.

1.30 Thyspunt W1W4 Access Road Assessment (Appendix E31)

As result of public meetings held in the Eastern Cape in 2011 as part of the Nuclear-1 Environmental Impact Assessment (EIA) and as well as comments received from Interested and Affected Parties on alternatives for the western access routes to the Thyspunt site, additional specialist studies were commissioned to investigate the options for access roads and their impact on the biophysical, social and economic environments.

The studies included fieldwork investigations and subsequent report writing by the Botany and Dune Ecology, Freshwater Ecosystems, Vertebrate and Invertebrate Ecology, Dune Geomorphology and Heritage specialists. Supporting desktop input was commissioned from the Social, Visual, Noise, Economic and Geohydrological and Geotechnical Specialists.

The alternatives put forward for investigation by the specialist team are described as follows and are illustrated by the figure below:

- The original coastal route, with three alternatives at the end, between Umzamawethu and Oyster Bay (CR-1 + CR-2 + CF/CE/CD)
- A coastal route which swings inland, east of Umzamawethu (CR-1 +IR-1)
- An inland route which also swings east of Umzamawethu (IR-1+IR1-1 or IR1+IR-1-2).

STUDY APPROACH

Each individual specialist tasked with assessing the options for access to the western side of the Thyspunt site approached this assignment within the context of their own field of study in terms of the methods used for scientific investigation. An inception meeting with the team was however conducted prior to fieldwork commencing on 20 November 2012. The purpose of the inception meeting was to give a brief overview in terms of past investigations related to the site as well as to confirm the scope of work going forward and coordinate activities within the field. A closing meeting was held on 22 November 2012. The results of the individual specialist reports have been combined to into the current report.

SUMMARY OF IMPACTS

The summary of impact significance as identified by individual specialists with and without mitigation is given in the table below.

Summary of Impact Significance with and without mitigation

IMPACT	SIGNIFICANCE
IMPACTS ON BOTANICAL RESOURCES AND DUNE ECOLOGY FOR THE PROPOSED WESTERN ACCESS ROAD ALIGNMENT	
Loss of coastal habitat (CR-1)	
Unmitigated - Loss of dune fynbos and thicket	**Medium**
Mitigated – align to avoid good quality vegetation (no mitigation for direct habitat loss, but can avoid good quality and rare sites)	**Low**
Loss of coastal dunes (CR-1/CR-2)	
Unmitigated - Loss stable parabolic dunes, coastal limestones	**High**
Mitigated – align away from limestones; avoid steep slopes of parabolics	**Low**
Loss of coastal forest (IR-1/IR-2)	

IMPACT	SIGNIFICANCE
Unmitigated - Loss of forest patches on parabolic dunes	**High**
Mitigated – align away from forest, preferably in acacia infestation	**Low**
Loss of seeps in transverse dunes and above Slangrivier (IR-1/IR-2)	
Unmitigated - Loss of seeps along route	**High**
Mitigated – realign to avoid seeps	**Medium**
Loss of Slangrivier thicket and forest (IR-1/IR-2)	
Unmitigated - Partial loss of river vegetation and function	**High**
Mitigated – bridge over river to avoid thicket and forest; realign where degraded vegetation	**Low**
Loss of Red Data species (all routes))	
Unmitigated - Loss of Red Data species along route	**Medium**
Mitigated – realign to either avoid species or translocate to a safe place	**Low**
Loss of Slangrivier thicket and forest (IR-1/IR-2)	
Unmitigated - Partial loss of river vegetation and function	**High**
Mitigated – bridge over river to avoid thicket and forest; realign where degraded vegetation	**Low**
Loss of ecosystem function (IR-1/IR-2)	
Unmitigated - Compromising of functioning of transverse dune and hillslope seeps function	**High**
Mitigated - realign away from seeps	**Medium-high**
Cumulative impacts	
Unmitigated - Loss of species, habitat and ecosystem functioning	**High**
Mitigated - difficult to mitigate totally, but where possible locate road away from mobile dunes and wetlands	**Medium-high**
ASSESSMENT OF IMPACTS TO WETLANDS AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Construction Phase: Loss or degradation of coastal seep, valley bottom and depressional wetlands, as a result of (inter alia) infilling, changes in runoff, compaction, disturbance of vegetation, poor water quality	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Operation Phase: Loss or degradation of coastal seep, valley bottom and depressional wetlands, as a result of (inter alia) infilling, changes in runoff, compaction, disturbance of vegetation, poor water quality, channelization, loss of ecosystem function (changes to dynamic system); loss of connectivity, habitat fragmentation: <u>Note that the effect of and mitigation against loss of fragmentation connectivity is dealt with in assessments of individual layouts</u>.	
Unmitigated	**High**
With prescribed mitigation	**Medium**
IMPACTS ASSOCIATED WITH LAYOUT: **Impacts include: Loss of wetland habitat., loss of connectivity, fragmentation of habitats, degradation at a system level; changes in dune dynamics affecting biodiversity and hence wetland status**	
- Coastal Route (CR-1 & CR-2): NPS to Humansdorp Road, between Oyster Bay and Umzamawethu; three alternatives at western end: A-B-C-D/E/F	

IMPACT	SIGNIFICANCE
Unmitigated	**High**
With prescribed mitigation	**Medium**
- Inland Route 1 (IR-1): NPS to west of Umzamawethu: G-H-I	
Unmitigated	**Very High**
With prescribed mitigation	**High**
- Inland Route 2 (IR-2): NPS to west of Umzamawethu: G-H-J	
Unmitigated	**Very High**
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
Coastal to Inland Route 1, alternative 1 (CR-1 to IR-1): A-B-K-I	
Unmitigated	**Very High**
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
Coastal to Inland Route 2, alternative 2 (CR-1 to IR-2): A-B-L- -J	
Unmitigated	**Very High**
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
ASSESSMENT OF IMPACTS TO INVERTEBRATES AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Loss and transformation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Degradation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Fragmentation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Low**
Water contamination of invertebrate wetland habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Water contamination of invertebrate wetland habitat as a result of the operation of the proposed access route	
Unmitigated	**High**

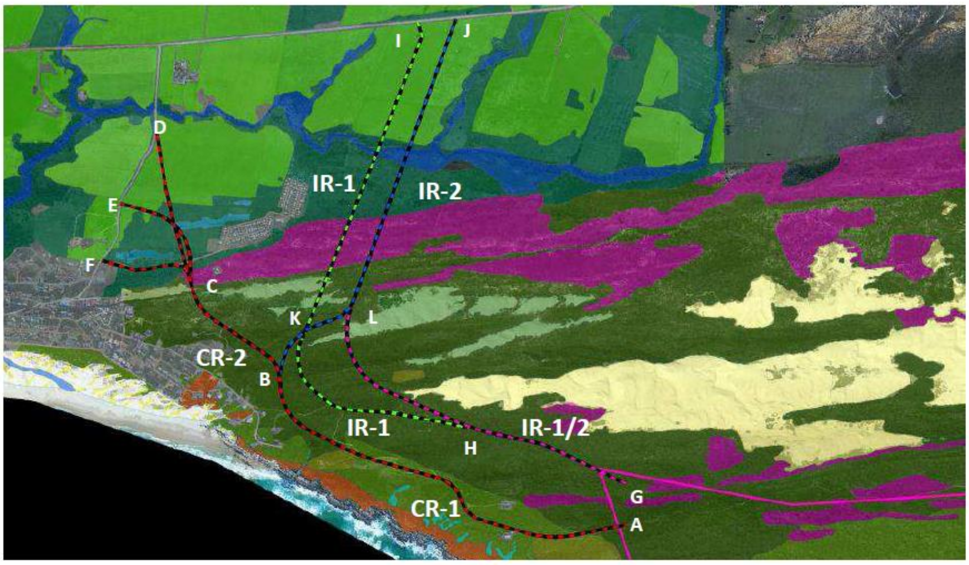
IMPACT	SIGNIFICANCE
With prescribed mitigation	**Medium**
ASSESSMENT OF IMPACTS TO VERTEBRATES AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Route Alternative W1, W2, W3	
Corridor continuity - **The ecological corridor may be disturbed when permanent structures are placed within an functional habitat**	
Unmitigated	**Low**
With prescribed mitigation	**Very Low**
Fragmentation of certain habitats - Certain habitats become isolated from one another due to permanent structures, or if a habitat is small and is divided into sections, these sections will no longer be able to function ecologically	
Unmitigated	**Low**
With prescribed mitigation	**Very Low**
Route Alternative W4	
Corridor continuity - **The ecological corridor may be disturbed when permanent structures are placed within an functional habitat**	
Unmitigated	**High**
With prescribed mitigation	**Very Low**
Fragmentation of certain habitats - Certain habitats become isolated from one another due to permanent structures, or if a habitat is small and is divided into sections, these sections will no longer be able to function ecologically	
Unmitigated	**Very Low**
With prescribed mitigation	**Very Low**
Vertebrate mortality on roads - Frequent truck/vehicle road activity will result in mortality of vertebrates	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Habitat destruction - The construction of roads, widening of existing roads, building of bridges; and site clearing will destroy existing habitats	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Route Alternative W5 (new)	
Corridor continuity - **The ecological corridor may be disturbed when permanent structures are placed within an functional habitat**	
Unmitigated	**Medium**
With prescribed mitigation	**Low**
Fragmentation of certain habitats - Certain habitats become isolated from one another due to permanent structures, or if a habitat is small and is divided into sections, these sections will no longer be able to function ecologically	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Vertebrate mortality on roads - Frequent truck/vehicle road activity will result in mortality of vertebrates	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Habitat destruction - The construction of roads, widening of existing roads, building of bridges; and site clearing will destroy existing habitats	
Unmitigated	**High**
With prescribed mitigation	**Medium**

IMPACT	SIGNIFICANCE
Route Alternative W5 (old)	
Corridor continuity - **The ecological corridor may be disturbed when permanent structures are placed within an functional habitat**	
Unmitigated	**Medium**
With prescribed mitigation	**Low**
Fragmentation of certain habitats - Certain habitats become isolated from one another due to permanent structures, or if a habitat is small and is divided into sections, these sections will no longer be able to function ecologically	
Unmitigated	**Medium**
With prescribed mitigation	**Low**
Vertebrate mortality on roads - Frequent truck/vehicle road activity will result in mortality of vertebrates	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Habitat destruction - The construction of roads, widening of existing roads, building of bridges; and site clearing will destroy existing habitats	
Unmitigated	**High**
With prescribed mitigation	**Medium**
ASSESSMENT OF IMPACTS TO HERITAGE RESOURCES AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Route Alternative CR-1 (B-A)	
Unmitigated	**High**
With prescribed mitigation	**High**
Route Alternative CR-2 (D-B. E-B, F-B)	
Unmitigated	**High**
With prescribed mitigation	**High**
Route Alternative IR-1 (I-G)	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Route Alternative IR-2 (J-G)	
Unmitigated	**High**
With prescribed mitigation	**Low**
ASSESSMENT OF IMPACTS TO NOISE RECEPTORS AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Impact of IR-1 on Noise Receptors due to construction activities	
Unmitigated	**Low**
With prescribed mitigation	**Low**
Impact of IR-1 on Noise Receptors due to construction activities	
Unmitigated	**Low**
With prescribed mitigation	**Low**
ASSESSMENT OF IMPACTS OF THE HYDROGEOLOGICAL ENVIRONMENT ON THE IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Impendence of groundwater flow due to road excavation extending below the groundwater table – All Routes	**Negligible**
Contamination of aquifers by accidental spills of fuel and hazardous chemicals – All Routes	
With prescribed mitigation	**Low**

IMPACT	SIGNIFICANCE
ASSESSMENT OF IMPACTS OF THE HYDROTECHNICAL ENVIRONMENT ON THE IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Introducing point load contamination due to the need for stormwater management to mitigate erosion risks – All Routes	
Unmitigated	**Low**
With prescribed mitigation	**Negligible**
Poor founding conditions introducing excessive cuts through the dunes – All Routes	
Unmitigated	**Medium**
With prescribed mitigation	**Low**

RECOMMENDATION

At the heart of this report lies the questions as to which is the preferred route (see Figure below for alternatives proposed) to access the western side of the Thyspunt site, which is currently the recommended site for the construction and operation of the Nuclear-1 Power Station. The answer to this question required weighing up the impact of the access road on sensitive faunal, floral, wetland, dune and heritage environments and the impact on the inhabitants of the settlements of Oyster Bay and Umzamawethu.



1) **Coastal Route** (CR-1 & CR-2): NPS to Humansdorp Road, between Oyster Bay and Umzamawethu; three alternatives at western end: A-B-C-D/E/F
2) **Inland Route 1** (IR-1): NPS to west of Umzamawethu: G-H-I
3) **Inland Route 2** (IR-2): NPS to west of Umzamawethu: G-H-J
4) **Coastal to Inland Route 1, alternative 1** (CR-1 to IR-1): A-B-K-I
5) **Coastal to Inland Route 2, alternative 2** (CR-1 to IR-2): A-B-L-J

As stated above each individual specialist was tasked with assessing the options for access to the western side of the Thyspunt site approached this assignment within the context of their own field of study. Their preferences are summarised in the table below.

SPECIALIST	CR-1 & CR-2	IR-1 & IR 1/2	IR-2 & IR 1/2	IR-1 & CR-2	IR-2 & CR-2
Biophysical Specialists (not	**X**				

Wetland Specialists					
Wetland Specialists					**X**
Heritage Specialist		**X**	**X**		
Social Specialist			**X**		
Visual Specialist			**X**		
Noise Specialists			**X**		

Coastal routes CR-1 and CR-2 are preferred by all biophysical specialists, apart from the wetland specialist, who prefers the combination of the inland route IR-2 with a portion of the coastal route CR-2. The heritage, social, visual and noise specialists all prefer some combination of the IR-1, IR2 and IR1/2 inland routes above the coastal route.

Whilst the sensitivity of the area from a biophysical point of view cannot be discounted, it must been seen within the context of an area already impacted upon by residential development (Oyster Bay and Umzamawethu) and agricultural practices (extensive areas to the north and east of these settlements). Although the biophysical specialists have indicated negative impacts of high significance on sensitive vegetation communities to the east of Umzamawethu and on the western portion of the Oyster Bay mobile dune field, these impacts need to be considered in context:

- The footprint of the proposed road's biophysical impacts is small compared to those of the existing impacts on these resources in the study area; similarly, the extent and intensity of the impacts caused by the road are small compared to existing impacts caused by other activities.
- The Oyster Bay mobile dune field is compromised by a number of other sources of disturbance that create impacts of far higher significance. The Dune Geomorphology Assessment (Illenberger, 2013) details these and indicates that even with these sources of disturbance, it can be expected that the dune field will continue to function for the next 1000 years. The addition of a road with a reserve of 40 m through the western extremity of the dune field will lead to some loss of function but would not significantly alter or prevent the movement of sand.
- Removal of alien vegetation associated with the proposed project (and already in progress), allowing the re-mobilisation of sand that has been artificially stabilised, will more than compensate for the loss of some function of the dune field where the road is proposed to cross it.
- Although the road would cross patches of sensitive habitat east of Umzamawethu, the biophysical specialist team identified no fatal flaw impacts in these habitats. As above, the creation of a de facto nature reserve around the proposed power station would conserve similar and identical habitat.

Thus, given this contextualisation of the biophysical and heritage impacts of the inland alignment alternatives, combined with the potentially significant impact that the use of the coastal route CR-1 and CR-2 would have on social conditions in Oyster Bay and Umzamawethu, the inland options IR-1 with IR1/2 or IR-2 with IR1/2 are the recommendation routes for western access to the Thyspunt site. **However, considering that the wetland specialist prefers IR-2, the final recommendation is IR-2 with IR-1/2.**

The horizontal and vertical alignments of this recommended route have been optimised by Eskom's engineers to reduce cut and fill, which further reduces the environmental impact. Based on this analysis, Option 4 of the recommended route (**IR-2 and IR-1/2**) is recommended.

All mitigation measures listed in section 4.1.1 of this report in particular must be included in the Environmental Management Plan and implemented during the construction and operational phases of the project.

1.31 Radiological Impact Assessment (Appendix E32)

South Africa considers the construction of a nuclear power plant (NPP) consisting of a combination of reactor units with a total electrical power capacity of up to 4 000 MWe and its associated infrastructure. The Environmental Impact Assessment (EIA) makes provision for the potential future expansion of a NPP to allow for a total capacity of approximately 10 000 MWe on a site. It is envisaged that light water reactors (LWR) and specifically GEN III pressurised water reactors (PWR) will be the selected technology.

The structure of this report is based on a prospective radiological impact assessment as required at an early stage of a nuclear authorisation process in terms of the National Nuclear Regulator Act (NNR Act). This report, therefore, does not follow the typical structure of an EIA specialist report as it applies to non-radiological impacts assessments. These reports include qualitative significance ratings for environmental impacts that are categorised as High, Medium or Low, The significance category of an impact depends on the nature, intensity, extent, duration, consequence and probability of the impact. The fact that the radiological impacts and an assessment of their cumulative effects have to meet NNR regulatory criteria that are based on internationally recognised and accepted systems of radiological protection, result in a low significance of a NPP's radiological impact for normal operations. The result of the cumulative radiological impacts where more than one nuclear facility could impact the same receiving environment, must also meet specific dose and risk criteria equivalent to a low impact.

The potential radiological impacts on the public and the environment at the three proposed sites, Thyspunt, Bantamsklip, and Duynefontein, were investigated as part of an assessment of the feasibility of each of the sites. The investigation included the following aspects:

1) Nuclear power plant radiological discharges to the environment during normal operation and public dose.
2) Nuclear power plant accidents and radiological risk to the public.
3) Radiological risk to non-human biota.
4) Background radiation at the three sites.

The results of the investigations into these four aspects provide responses to four possible questions that interested and affected parties may have regarding nuclear safety.

1) *What is the radiological health risk by living next to one of the sites?*

South African radiological safety regulations specify an annual effective dose limit of 1 milli-Sievert (mSv) to a member of the public from all authorised actions involving nuclear and radioactive material. To ensure that the limit is not exceeded and protective measures are applied to achieve a dose as low as reasonable achievable (ALARA), a dose constraint is also specified for individual sources such as a NPP. In South Africa, the dose constraint is 0.25 mSv per year. The dose constraint value is representative of an extremely low health risk when compared to normal operational discharges of noxious materials from many other industrial activities. The dose constraint is also a small fraction of the natural background radiological dose of 2.4 mSv per year, the global average.

An assessment of operational radioactive discharges from representative GEN III nuclear power plants was carried out by considering specific characteristics of each site and using conservative assumptions. The regulatory dose constraint of 2.50 mSv per year to a member of the public can be met at each of the three sites.

2) *What is the risk of a nuclear accident?*

The majority of NPPs operating today were built in the nineteen seventies and eighties. NPP accidents at Three Mile Island, Chernobyl, and Fukushima resulted in serious questions about nuclear safety and the future of nuclear power plants. An overview is provided of the nuclear safety criteria applicable to accidents and some of the safety assessment methodologies. The safety features of GEN III reactors and the fundamental objective to practically eliminate large releases of radioactivity in the event of a severe accident that involves reactor fuel damage are discussed. It is concluded that GEN III NPP designs should meet the regulatory risk criteria. An assessment of a specific NPP design selected for a site will have to provide the final nuclear safety case before NPP operation will be allowed by the National Nuclear Regulator.

3) *What are the radiological risks to non-human biota?*

The radiological protection of non-human species has evolved considerably over recent years. Where radiological protection used to focus on human protection based on the assumption that, if humans are protected, non-humans living in the same environment would be sufficiently protected, the explicit consideration of Radiological Protection of the Environment is now recommended by the International Commission on Radiological Protection (ICRP). A screening assessment was performed of the radiation dose rates to a set of reference animals and plants from radioactive discharges during normal operation of a NPP. The dose rates are less than the reference value of 10 microgray per hour (μGy/h), a value well below any dose rate where measureable effects in organisms would be detected.

Much research is carried out to determine the effects nuclear accidents on non-human biota. The United Nation Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) produced an authoritative Fukushima report in which radiological exposures of selected non-human biota were estimated. UNSCEAR concluded that the possibility of effects on non-human biota in both the terrestrial and aquatic (freshwater and marine) environments was geographically constrained and that, in areas outside the constrained area, the potential for effects on biota may be considered insignificant.

4) What are the current ionising radiation and radioactivity levels at the sites' environments?

Background radiation surveys were carried over a period of approximately one year at each of the sites. The results indicate that the radiation dose to people living at the coastal areas near the three sites is lower than global average dose of approximately 2.4 mSv per year. One of the objectives of the surveys was to identify any radioactivity anomalies that may exist in the regions where the sites are located.

High terrestrial radioactivity of natural origin was detected at a location west of the Thyspunt site. The radioactivity results of marine biota confirmed international findings on the naturally occurring radionuclide polonium-210 and its potential high dose contribution to humans when compared to other radionuclides. Artificial radionuclides, for example Cs-137, were detected at all three sites. Globally, the presence of Cs-137 is attributed to historic events such as atmospheric atomic weapons tests.

The results of the prospective radiological assessments for the three sites presented in this report confirm environmental impacts of low significance and low cumulative effects.

1.32 Beyond Design Accident Report (Appendix E33)

South Africa considers the construction of a nuclear power plant (NPP) consisting of a combination of reactor units with a total electrical power capacity of up to 4 000 MWe and its associated infrastructure. The EIA makes provision for the potential future expansion of a NPP to allow for a total capacity of approximately 10 000 MWe on a site. It is envisaged that light water reactors (LWR) and specifically GEN III pressurised water reactors (PWR) will be the selected technology.

Accidents at NPPs have always been a concern of the public .This report provides an overview of some of the important NPP safety concepts that address this concern in the case of GEN III NPP designs. Safety analysis techniques applied to NPPs aim to provide confidence that safety principles promoted by the International Atomic Energy Agency (IAEA) and adopted by the South African National Nuclear Regulator will practically eliminate beyond design basis accidents (BDBAs), accidents that have the potential to release large quantities of radioactivity to the environment.

The Gen III NPP designs include distinctive safety characteristics in respect of sequences of events that could result in conditions outside the design basis of a NPP, known as design extension conditions. The results of safety analyses show that beyond design basis accidents that present a significant risk to the public and environment are practically eliminated as a result of provisions for design extension conditions. Examples of these safety characteristics are given below:

- simpler design designs making the reactors easier to operate and more tolerable of abnormal operating conditions;
- passive safety features in the design of the structures, systems and components (SCCs) that avoid use of active control and relying on natural phenomena such as natural circulation of cooling media e.g. cooling of the containment building to avoid over-pressure;
- reduced SCCs failure probabilities and a lower reactor core damage frequency compared to earlier generation reactors (an order of magnitude reduction);
- new design features that provide mitigation should the reactor core melt to reduce the release of radioactivity to the environment significantly; and
- improved resistance to external hazards such as aircraft crash and extreme natural events

Mitigation of off-site consequences in the case of GEN III NPPs should only be required in the most extreme and unlikely accident situations and then only with very limited consequences in space and time, i.e. for short periods emergency actions will be applied in a small radius around the NPP.

There have been three major BDBA reactor accidents in the history of civil nuclear power. Each of these accidents had different impacts on the public and the environment:

- Three Mile Island (USA 1979) - The reactor of unit 2 was severely damaged but radiation was contained and there were no adverse health or environmental consequences
- Chernobyl (Ukraine 1986) – a destruction of reactor unit two caused by a steam explosion and a fire, an accident that killed 31 people in the early phase of the accident and had significant health and environmental consequences. The death toll has since increased.
- Fukushima (Japan 2011) where three older generation boiling water reactors suffered severe damage and together with a fourth, were written off. The loss of cooling to the reactors as a result of the earthquake induced tsunami resulted in a failure to contain the radioactivity released from the damaged reactor cores.

Two of the three NPP BDBAs that were classified as severe accidents involving reactor core melts, were light water reactor designs that include reactor containment, the final barrier against a release of radioactivity to the environment during a BDBA. The NPP at Fukushima Daiichi in Japan were boiling water reactors that were subjected to a combination of extreme external events 11 March in 2011. The reactor containments withstood the challenges of the external events but not the subsequent internal explosions. The pressurised water reactor at Three Mile Island reactor unit two in the United States had limited impact on the environment and people when it suffered a BDBA. It avoided the internal explosions that would have challenged the integrity of the reactor containment. The nuclear industry realised the importance of robust reactor containment design. It has been one of the major safety enhancement areas in the design of Generation III/III+ reactors.

A comparison of the GEN III PWR reactor probabilities (expressed as an annual frequency) of a large radioactivity release during a BDBA, that could result in radiological exposure of the public with a high fatality risk, indicates that the regulatory limit of the National Nuclear Regulator (NNR) will be met. The frequencies in Table E-1 can be compared to the NNR peak individual fatality risk of 5E-06 per year.

Table E-1: Core damage and large release fraction frequencies for GEN III NPPs

GEN III **Reactor Designs for PWR**	**Light Water Reactor Type**	**Core Damage Frequency (events per reactor year)**[7]	**Large Radioactivity Release Frequency (events per reactor year)**
AES-92	PWR	6.10E-07	1.80E-08
AP1000	Pressurised Water Reactor (PWR)	5.10E-07	3.90E-08
APR-1400	PWR	2.70E-06	8.20E-08
APWR	PWR	4.60E-06	8.10E-07
EPR	PWR	6.10E-07	3.90E-08

A new NPP to be built in South Africa will have to submit a safety analysis report that provides the evidence for this provisional conclusion. This evidence have to be based on an analysis of external and internal potential initiating events for purposes of accidents analyses, specific to the selected NPP design and specific site where it will be built.

The safety features of GEN III NPPs are significantly advanced when compared to the NPP designs that suffered BDBAs in the past. However, the lessons learnt from the Fukushima Daiichi accident will remain of paramount importance in the nuclear power industry. In a recently published report on the accident the director general of the IAEA emphasised the culture that has to be entrenched in the nuclear industry:

There can be no grounds for complacency about nuclear safety in any country. Some of the factors that contributed to the Fukushima Daiichi accident were not unique to Japan. Continuous questioning and openness to learning from experience are key to safety culture and are essential for everyone involved in nuclear power. Safety must always come first."

1.33 Town Planning Assessment (Appendix E34)

GIBB Urban and Rural Planning was appointed by Eskom Holdings (SOC) Limited (Eskom) to investigate the potential impacts of the proposed Nuclear-1 power station on town planning related matters at each of the three alternative sites (Duynefontein, Bantamsklip and Thyspunt) in response to comments received from the Department of Environmental Affairs (DEA) received on 25 January 2013. The comments confirmed the need for a town planning specialist study to undertake consultation with the Kouga Local Municipality, Overberg Local Municipality and Cape Town Metropolitan Municipalities and to compile a town planning specialist report. The aim of the report is the assessment of externalities associated with any possible direct or indirect restriction on land use.

[7] The US NRC requirement for calculated core damage frequency is 1E-04, most current US plants have about 5E-05 and Generation III plants are about ten times better than this. The IAEA safety target for future plants is 1E-05.

This report is as such divided into two sections. The first section of the report is a documentation of information gathered from desktop investigations and meetings with the relevant municipalities. The first section therefore discusses the following:

- Confirmation of site locations, property descriptions and all relevant information of properties owned by Eskom;
- Description of the proposed sites and surrounds in terms of its physical location; and
- Relating the site and the proposed development to relevant policy that guides the future development of the region that could impact on the proposed sites.

The second section of the report focuses on the site evaluation. Information received from desktop sources and interviews was analysed to determine the impact of the proposed development on the future planning of the area in which the sites are located. The analysis of the site includes a SWOT analysis and a site evaluation matrix.

SWOT Analysis and Site Evaluation

The aim of this section of the report was to evaluate the sites with respect to their regional and local context, property information and the applicable policy environment by completing a SWOT analysis and developing criteria against which the sites will be analysed. The aim of the analysis is to assist in the decision making process for identifying the site with the least constraints from an urban planning perspective.

Subsequent to the SWOT analysis is the evaluation of the sites in terms of development criteria in order to assist in determining the least constrained site (from a land use perspective) for the placement of the Nuclear-1 facility. The approach taken was to evaluate and measure the sites by making use of the development criteria in order to systematically determine a preferred site.

The SWOT analysis and evaluation of the sites were therefore informed by the regional and local context, property information and the applicable policy environment as described in the report and also by the larger body of work produced as part of the Nuclear-1 Application for Environmental Authorisation. This body of work includes not only the main Environmental Impact Assessment Report and accompanying records of public participation, including submissions received from Interested and Affected parties, Stakeholders and the public at large, but also reports prepared by the Nuclear-1 appointed team of specialists. Of particular importance to the author and to the current study are the findings and recommendations from the following reports:

- Transportation Specialist Study (Appendix E25 of the Final EIR); and
- Social Impact Assessment Study (Appendix E18 of the Final EIR).
- The SWOT analysis was further informed by the comments received from Local and District Municipalities such as the City of Cape Town.

The intention of the SWOT analysis was therefore in summary to identify strengths, weaknesses, opportunities and threats of each site (see the table below). The analysis gave an indication of the critical issues that needed to be addressed as well as identified the positive aspects of each site should the proposed Nuclear 1 facility be located at any of the three sites.

Duynefontein

STRENGTHS	WEAKNESSES
• Located adjacent to the existing Koeberg power station (existing infrastructure available such as civil services, within an existing conservation/ protected area, etc.). • Good road/ vehicular access. • The possibility exists to construct an alternative	• The site is located in the direction of future growth direction of the city. • Locating the facility at the Duynefontein site may impact on the existing transport model/ evacuation model put in place for the Koeberg power station. Amending the approved plan to accommodate the proposed

access to the proposed Duynefontein site, if required. • The site is located in close proximity to urban amenities such as housing, social facilities and a potential workforce. • Existing Emergency Plan with infrastructure.	Nuclear 1 will take a lot of time. • Located adjacent to the existing Koeberg Power Station (national perspective – wanting to spread the generation to more than one area around South Africa).
OPPORTUNITIES	**THREATS**
• Infrastructure present in close proximity to the proposed Duynefontein site. Cost of upgrading may be more cost and time effective than to construct new facilities required. • The area around the nuclear facility will be used for conservation purposes. It may be utilized for recreational purposes such as hiking and mountain biking trails and may accommodate game.	• Future urban development around or in close proximity to the proposed Nuclear 1 site is a risk that will need to be managed. The current trends indicate that urban development will only increase in the area. • Cost of upgrading services to comply with National Nuclear Regulators regulations may be costly, especially when the facility is located in close proximity to the urban development.

Bantamsklip

STRENGTHS	WEAKNESSES
• Upgrade of water infrastructure in the area may be beneficial for the proposed nuclear facility. • The proposed Bantamsklip site is located in a rural part of the country and the expansion of existing towns is limited according to the applicable SDF. • Gansbaai and Pearly beach are small towns and is located to the northwest of the site and along the coast. Development to the south-west is limited, which may be beneficial from a risk management point of view.	• The site is a somewhat isolated and far from urban amenities. The site is located approximately 2 hours from the Cape Town CBD and 1 hour from Hermanus. Gansbaai (30 minutes' drive) and Pearly beach (10 minutes' drive) are the closest towns to the site. • The site can only be accessed via the R43 and from Bredasdorp in the east. Therefore limited opportunities exist for alternative accesses to the site. • Presence of an existing workforce not located within close proximity to the site.
OPPORTUNITIES	**THREATS**
• The construction of the facility at the proposed Bantamsklip site will generate economic opportunities in the area as a result of an increase in population of a skilled workforce. • The area around the nuclear facility will be used for conservation purposes. It may be utilized for recreational purposes such as hiking and mountain biking trails and may accommodate game.	• Second or alternative access to the site is problematic at this stage and may be expensive to implement. • The resulting increased population will put added pressure on service delivery in the towns that will house the project's workers, which may prove to be unfeasible.

Thyspunt

STRENGTHS	WEAKNESSES
• The site is situated on undeveloped land which therefore presents limited urban restructuring. • The site is within 10km of Oyster Bay, Cape St Francis and St Francis Bay, and within 20km of Humansdorp which is one of the largest activity centres within the region. • It is therefore in the vicinity of social services and infrastructure, as well as a labour force.	• The Kouga region is already functioning at full capacity regarding engineering services, including power, water and sanitation. • There is currently only one access route to the site which makes it a lengthy trip to reach the site.

• There is proper access to the site. • The adjacent land uses are compatible with a nuclear facility.	
OPPORTUNITIES	**THREATS**
• The site presents the opportunity for additional access routes. • The site is suitably situated for the proposed nuclear plant to have a minimal visual impact on the surrounding environment. • The adjacent areas can be developed as game farms or uses as such, which will support the region's economy. • Additional jobs may be created as spin-offs from training personnel and facilitating social development.	• The resulting increased population will put added pressure on service delivery in the towns that will house the project's workers, which may prove to be problematic.

Evaluation Matrix

Subsequent to the SWOT analysis an evaluation of the sites in terms of development criteria was conducted in order to assist in determining the preferred site for the placement of the Nuclear 1 facility (see the table below). The approach taken was to evaluate and measure the sites by making use of the development criteria in order to systematically determine a preferred site.

The three pillars of sustainability, according to the Brundtland Commission, are the social environment, economic environment and natural environment. The concept of sustainability has evolved to now acknowledge the role of underlying governance structures. According to a study by the United Nations in 2013, "achieving sustainability in cities can be conceived by the integration of four pillars: social development, economic development, environmental management, and urban governance. In the town planning profession the notion of sustainability is taken another step further by recognising the provision of services (roads, water sewer, etc.) as well as institutional infrastructure such as schools and health facilities. Recognising the dynamic nature of sustainability is critical to development. Therefore the above-mentioned development pillars were used in evaluating the potential project sites. These pillars are used in the preparation of spatial development frameworks or development strategies informing the future growth of cities. To summarise, the town planning report took the following into consideration:

- The social environment;
- The economic environment;
- The physical environment:
- Natural environment;
  - Built environment (provision of services); and
  - The Institutional environment (governance, schools, health facilities, etc.)

The development pillars are therefore the departure point for the establishment of evaluation criteria applicable to the specific context of the project. As a result, evaluation criteria applied to the Nuclear-1 project were centred on ensuring an evaluation in terms of both sustainability principles as well as the attributes of the sites and their surrounding socio-economic and biophysical environments. The choice of specific criteria used within each pillar is in line with criteria for a project of this nature and is determined by the experience of the specialist within his field of study. This enabled a thorough analysis of the possible land use impacts of the proposed Nuclear 1 development on the surrounding areas. This methodology was followed for each of the potential sites. It must be noted that the purpose of this analysis was to determine a physical land development footprint impact and not to consider the potential technology impacts.

Evaluation Criteria	Scoring		
Institutional			
Availability of institutional (municipal) infrastructure	**10km (5)**	**20km (3)**	**30km (1)**
Duynefontein	5		
Bantamsklip		3	
Thyspunt		3	
Economic			
Proximity of existing labour force * **	**10km (5)**	**20km (3)**	**30km (1)**
Duynefontein		3	
Bantamsklip		3	
Thyspunt	5		
Social			
Proximity of resident population	**5km (0)**	**10km (3)**	**20km (5)**
Duynefontein		3	
Bantamsklip			5
Thyspunt		3	
Distance to urban services	**10km (5)**	**20km (3)**	**30km (1)**
Duynefontein	5		
Bantamsklip		3	
Thyspunt	5		
Physical			
Presence of bulk services	**10km (5)**	**20km (3)**	**30km (1)**
Duynefontein	5		
Bantamsklip		3	
Thyspunt	5		
Within the expected growth path of the region	**Y (0)**	**N (5)**	
Duynefontein	0		
Bantamsklip		5	
Thyspunt		5	
Compatible surrounding land use	**Comp (5)**	**Non comp (0)**	
Duynefontein	5		
Bantamsklip	5		
Thyspunt	5		
Accessibility by quality road	**5km (5)**	**10km (3)**	**20km (0)**
Duynefontein	5		
Bantamsklip	5		
Thyspunt	5		
Complexity of transport route upgrades	**Not Complicated (5)**	**Moderate (3)**	**Very Complicated (0)**
Duynefontein	5		
Bantamklip			0
Thyspunt		3	
Potential for additional access*	**Y (5)**	**N (0)**	
Duynefontein	5		
Bantamsklip		0	
Thyspunt	5		
Potential for seamless integration of facility (visual, noise/ smell impact	**Y (5)**	**N (0)**	
Duynefontein	5		
Bantamsklip	5		
Thyspunt	5		
Total			
Duynefontein			46
Bantamsklip			37

Thyspunt			49

* Note: Potential for additional access refers to ease of access to site from existing road infrastructure, furthermore it refers to additional access roads to cater for traffic require for the Nuclear Power Station.

** Please note that the numbers in the table above are indicative numbers and not statistical."

*** Please note that labour force refers to unskilled and semi-skilled individuals.

The above table of criteria indicates Thyspunt as the site with the highest score, therefore being the site with the least constraints from an urban planning perspective for the proposed Nuclear-1 facility.

Conclusion and Recommendation

This study therefore aimed to undertake consultation with the Kouga Local Municipality, Overberg Local Municipality and Cape Town Metropolitan Municipalities, to compile a town planning specialist report and assess externalities associated with any possible direct or indirect restriction on land use as result of the possible location of Nuclear-1 at any of the three identified sites.

The table below summarises the land use impact of Nuclear-1 on the various sites in terms of:

- the direct impact on land use;
- indirect impact on land use;
- compatibility with local planning instruments as polices; and
- the impact of the facility in case of emergency.

In terms of the outcomes of this analysis, the context provided by the SWOT analysis and the evaluation provided by the Matrix it is clear that the Thyspunt site with the highest score, is therefore the site with the least constraints and is recommended from an urban planning perspective for the proposed Nuclear-1 facility

Land Use Impact

	Duynefontein	Bantamsklip	Thyspunt
Direct impact on land use E.g. the impact of the nuclear site as well as the emergency planning zones on urban expansion.	• The proposed development may have an impact on future development of the region i.t.o. land that can be utilised for future development. Areas around the site will need to be protected, densities may need to be lower than if the development was not there and infrastructure upgrades will be required, especially roads.	• The proposed site is not in the growth path of future urban development. • The impact of urban expansion will be limited due to the rural character of the towns. Growth of towns as a result of the Nuclear 1 facility being located at the proposed Bantamsklip site will need to be managed and directed to areas where development and expansion can be accommodated.	• The proposed site is not in the growth path of future urban development. • Growth and developments of nearby towns will have to be managed to comply with the restrictions and regulations concerning a nuclear facility in the vicinity.
Indirect impact on land use	• The influx of approximately 2000 people, as projected when the site is fully operational, will not have a dramatic impact on services and facilities (indirect land uses) required to sustain them as will be the case with the Bantamsklip and Thyspunt sites. This only take into account the increase in population and not the impact of on existing policies as result of the existing Koeberg Power Station.	• The influx of approximately 2000 people, as projected when the site is fully operational, will have a dramatic impact on services and facilities required to sustain them. Especially in an area such as Gansbaai and Pearly Beach that has an existing population of approximately 11 000 and 1500 people respectively.	• The influx of approximately 2000 people, as projected when the site is fully operational, will have a dramatic impact on services and facilities required to sustain them in areas such as Humansdorp.
Compatibility with local planning instruments and policies	• The Nuclear 1 facility is not specifically mentioned in the Municipal SDF, but existing surrounding land uses are compatible with proposed Nuclear-1 land use. • There are some conflicts with future land use as the site is located within the growth path of the city. If the proposed development is implemented, this may have an impact on the future	• The Nuclear 1 facility is not specifically mentioned in the Municipal SDF • Surrounding land use is compatible with the proposed Nuclear 1. • The future planning suggests that the proposed use could be accommodated on the proposed site. • There are legislative processes in place that will require for the submission of an application to the	• The Nuclear 1 facility is only briefly mentioned in the Kouga SDF. • Surrounding land use is compatible with the proposed Nuclear 1. • The future planning suggests that the proposed use could be accommodated on the proposed site. • There are legislative processes in place that will allow for the

	growth of the city i.t.o. urban form (densities allowed, etc.) and the existing risk management/ evacuation model. • There are legislative processes in place that will require for the submission of an application to the Municipality to obtain the rights for the proposed land use.	Municipality to obtain the rights for the proposed land use.	submission of an application to the Municipality to obtain the rights for the proposed land use.
Impact in case of emergency	• There is existing urban development around the proposed site that will be impacted upon, especially to the south and east of the site. • The site is located adjacent to an existing operational nuclear power plant.	• Limited development exists around the site and the impact will be less than in Duynefontein due to the rural character of the Bantamsklip site. • The time it will take to evacuate people around the site will be less than in the case of Duynefontein. There is not a high population concentration around the site. Closest urban areas are Buffeljagsbaai, Pearly Beach and Gansbaai.	• Limited development exists around the site. • The rural character of the area will be supportive of emergency procedures associated with the proposed nuclear facility.

1.34 Transmission Integration Report (Appendix E35)

Three sites were identified and assessed through an Environmental Impact Assessment (EIA) process phase for the establishment of a nuclear power station for the Nuclear-1 project and subsequent phases as part of a nuclear fleet, namely Thyspunt, Bantamsklip and Duynefontein. The integration of a nuclear power station of between 3,000MW and 5,000MW at each site into the main transmission systems was investigated by Grid Planning between 2006 and 2009. Subsequent to these studies there have been a number of major developments regarding the future generation in South Africa as well as changes in the expected load demand in the country.

One of the main developments was the issuing of the 2010 Integrated Resources Plan (IRP) and the commitment to the large scale development of renewable generation by the Government of South Africa, including the introduction of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) which has already completed three Bid Windows of the Renewable Energy Bid (REBID) process. This has resulted in a completely new geographical spread of generation, specifically a potentially large amount of new generation in the Cape Provinces, which will impact on the integration of the proposed nuclear power plants. The proposed date for the Nuclear-1 power station was pushed back to 2023 by the IRP and the integration plans have been reviewed periodically for the three selected sites.

In 2014 the long term strategic "2040 Eskom Transmission Network Study" was completed, the location of Renewable Energy Development Zones (REDZ) identified and preparation work for a large gas fired generation IPP programme undertaken. These all have an impact on the nuclear transmission integration plans.

This 2015 review provides an updated high level assessment of the impact of these changes on the transmission integration of the three Nuclear-1 project site options. Final detailed transmission studies will only be undertaken once there is firm commitment of the target date of the Nuclear-1 power station.