THE KNYSNA STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) AND THE KNYSNA ISDF

Background to SEA in South Africa

In 2004 the then South African Department of Environmental Affairs and Tourism (DEAT) added to their series of integrated environmental management information documents by publishing one on Strategic Environmental Assessment (SEA)\textsuperscript{1}. This document still serves as a good practice guideline.

The document\textsuperscript{1} highlights the fact that the role of SEA is determined by its place in the integrated environmental management decision-making process. It further states that SEA can be used to facilitate the development, evaluation and modification of a policy, plan or programme during the formulation process; or can be used to assess a proposed policy, plan or programme that has already been developed. The first approach is seen as a ‘sustainability-led approach’ and the latter as an ‘EIA-based’ approach to SEA. This distinction is dependent on the stage in the decision-making process at which the SEA is undertaken and the stakeholders involved.

Environmental Management Frameworks (EMF)

Whereas the development of an SEA is not a legislated requirement, regulations that facilitate Environmental Management Frameworks (EMFs) were introduced in South Africa in 2010\textsuperscript{2} and promulgated under the National Environmental Management Act (NEMA) (No 107 of 1998). These regulations enable the national or provincial Environmental Minister to initiate the compilation of an EMF to facilitate the promotion of sustainability and cooperative governance and to ensure environmental protection (Chapter 2, section 3 (a – c)\textsuperscript{2}).

As discussed by Audouin, Lochner & Tarr (2011)\textsuperscript{3} the introduction of these regulations,

\begin{flushleft}
\textsuperscript{1} DEAT (2004) Strategic Environmental Assessment, Integrated Environmental Management, Information Series 10, Department of Environmental Affairs and Tourism (DEAT), Pretoria, RSA.
\end{flushleft}
grounded within legislation, fulfill many of the typical requirements of a SEA and has led to a reduction of the development of formal SEAs in South Africa since 2010. This is not the case in Namibia where the EMF regulations are not applied and a number of SEAs have been published.

Characteristics of SEAs

The SEA guideline document lists the following seven characteristics of SEA:

- It is a pro-active process and informs development proposals.
- It is used to assess the effects of existing natural and socio-economic conditions.
- It relates to areas, regions or sectors of development.
- It enables the development of a framework against which positive and negative impacts of current and proposed developments can be measured.
- It is a process aimed at the development of a sustainability framework to inform continuous decision-making over a period of time.
- It focuses on maintaining a chosen level of environmental quality and socio-economic conditions.
- It reflects a wide perspective with a low level of detail to provide a vision and overall framework.

These pointers can be used to assess the process being followed in a strategic planning assessment.

The Knysna Strategic Development Framework (ISDF)

Knysna Municipality has embarked on an innovative and visionary process to produce an Integrated Strategic Development Framework (ISDF) to guide development planning and management in a coordinated and integrated manner for the long term.

The ISDF in itself is not a legal requirement but it is based on various planning documents most of which are required under the applicable legislation governing local authorities. In particular key input is taken from the Knysna Integrated Development Plan (IDP), the Spatial Development Framework (SDF), the Economic Development Strategy (EDS) and the Integrated Human Settlement Plan (IHSP). The development of a SEA forms a key part of the terms of reference of the ISDF.

The figure below is taken (and adapted by adding numbers) from the DEAT Series 10


Integrated Strategic Development Framework
Knysna
The process followed in developing the Knysna ISDF

The approach and process to the development of the ISDF is shown in the figure below. The numbers indicated correspond to the steps labeled in the SEA process (figure above).

The following are key points from the ISDF development process:

- A ‘Sustainability-led’ SEA approach is being followed for the first round of the process to develop the ISDF (see dotted line in the figure below).

- The Environmental Overview (UNDP, 1992)\(^4\) method is being used to facilitate the process. This process is seen as a type of SEA approach (referenced in DEAT, 2010\(^1\)) and involves the following: (1) participation of a wide range of specialists, stakeholders and Affected Parties in the screening, scoping, vision/mission/focus setting etc steps as depicted in the figure below; (2) an interactive, participatory group process (typically workshops); and (3) a focus on draft documents which are modified and improved via an iterative process until a final stage is reached where sufficient consensus is reached.

The next stage in the ISDF process (January to May 2015) is active engagement with the stakeholders and interested and affected parties to ensure understanding, contributions and buy-in to the required prioritised ISDF action points.

Once the final stage of the SEA Approach I process is reached (Step 7 i.e. auditing against the agreed to Scorecard), the Approach II (EIA-based SEA process) commences and ongoing assessment and improvement are facilitated.

An SEA approach is being followed in the development of the ISDF
(The numbers cross-refer to those in the DEAT and CSIR SEA process diagramme)

Conclusion

In the development of the Knysna ISDF, the SEA process is being followed. The full SEA document will be produced at the end of the first phase to reflect the identified components of the process. The various documents that make up the full SEA are produced as the process unfolds. The first document included the results of the screening and scoping steps reflected as the community aspirations as input to the ISDF. The ISDF document can be seen as the ‘Executive Summary’ of the SEA. Furthermore, it is proposed that the ISDF be seen as an Environmental Management Framework (EMF) as defined under NEMA5 and therefore can be promoted as grounded within legislation.

EXECUTIVE SUMMARY

The Knysna Integrated Strategic Development Framework (ISDF) is owned by the citizens of the Greater Knysna Municipality. As such it seeks to address the needs and aspirations of the people that live, work, play and visit the area utilising the natural, societal and economic environment.

Applying the SEA approach to the development of the Knysna ISDF enables the integration of detailed data and information published in the available sector planning documents into a guiding framework that aims to implement the principles of a Green Economy and the application of innovation in terms of the Blue Economy through facilitating a coordinated and integrated approach to development planning in the long-term (up to and beyond the year 2030).

An ecosystem-based approach is followed and this means that a holistic method has been adopted for managing human activities within the context of the social and ultimately the biological and physical (i.e. the biophysical) context. This the approach considers the links amongst living and nonliving resources. Fundamental to the approach is the acceptance that the specific ecosystem defines the boundaries of the management unit and not the artificial, juridictional boundaries.

Integrated information on the social and economic components of the ecosystem is presented and discussed in the Knysna Integrated Development Plan (IDP), the Spatial Development Framework (SDF), the Economic Development Strategy (EDS), the Integrated Human Settlement Plan (IHSP) that underpin the ISDF.

This document, a summary of the natural environmental context, is a key component of the SEA and seeks to present strategic level information that is available on the biological and physical components of the larger ecosystem within which the Knysna Municipal Area falls and is used as input into the other sector plans as well as the ISDF.

It is indeed fortunate that much strategic level work has been done in this region. These reports provide much detail on the various environmental aspects and are available as reference material.

Principally is the GIS-based information in the Background Information Document of the Garden Route Environmental Management Framework, developed over a period of 4 years by Consultants earthINC on behalf of DEAT. This provides a useful analysis basis for the ISDF as no new data has been published after that study. Other key strategic documents are, for example, the various management strategies developed by SANParks as well as those drawn up by the neighbouring municipalities (Bitou and George) and the Eden District.
Municipality. The 2005 report by Lombard⁹ provides further useful information aimed at decision making and is incorporated into the ISDF. The recently published CSIR report on the biophysical aspects of climate change and in particular the influence on sea level rise and storm surge along the South African coast provides important input to the ISDF.

LOCALITY MAP: THE KNYSNA MUNICIPAL AREA
1 INTRODUCTION

1.1 STUDY AREA

As reflected in the locality map, the boundary of the study area is the current extent of the Knysna Local Municipal Area. Knysna Municipality is in the Eden District which is itself within the Western Cape in the Republic of South Africa.

The Knysna Municipality is bounded to the West and North by the George Municipality and by the Bitou Municipality to the East. The Knysna coastal lagoon and the Indian Ocean forms the physically edge of the Municipality to the South. The Outeniqua Mountains and the Garden Route National Park form the northern boundary and Rondevlei and Swartvlei lakes form the western boundary of the municipal area. The Harkerville forms the boundary on the eastern side.

The four main settlements in the KMA includes Knysna, the primary regional service centre, Sedgefield, the secondary regional service centre and Rheenendal and Karatara which have more rural characteristics. Other settlements include Brenton-on Sea and Buffalo Bay.

1.2 LEGISLATIVE AND POLICY CONTEXT: GUIDING LEGAL FRAMEWORK

The sector plans underpinning the ISDF provide a comprehensive overview and analysis of the guiding legal framework at all levels of government\(^\text{10}\). The key aspects are provided in Appendix 2. The Knysna vision as reflected in the motto ‘Knysna, where People and Nature Prosper’ and the mission ‘To provide affordable, quality services, alleviate poverty, and facilitate social and economic development in the Greater Knysna municipal area through integrated development planning and sustainable use of resources’ reflect the values of the people of Knysna as represented by the Knysna Municipality and depicted below.

\(^\text{10}\) EDS Section 2; SDF Sections 1.2. & 2; HSP Sections 1.3 & 1.4
The strategic objectives that the Knysna Municipality adhere to form an important basis for the strategy. Adherence to Strategic Objective 6 in particular lies at the heart of the Strategic Environmental Assessment approach.

The legal framework governing conservation of natural resources puts the burden of care firmly on the shoulders of the Knysna Municipality and the people of Knysna. Legally, Knysna Municipality and the community as custodians of an area that contains one of the “Biodiversity Hot Spots” of the Cape Floral Kingdom, has the duty to protect and manage natural assets under its control.

This responsibility is accepted by the Knysna Municipality and is reflected in its openly promoted vision, mission and strategic objectives statement as shown above.
2 CURRENT REALITY: NATURAL ENVIRONMENT

2.1 INTRODUCTION

The Sector Plan reports contain comprehensive assessments of the current state of the Knysna social and economic environment. The state of the biological and physical components of the natural environment is presented here and includes brief discussion at a strategic context level. The information is principally drawn from the background information document published as part of the Garden Route Environmental Management Framework. As shown in the adjacent text box, an ecosystem-based approach is accepted for the ISDF. This means that a holistic method has been adopted for managing human activities. This approach considers all the links amongst living and nonliving resources rather than looking at single aspects in isolation. The ecosystem defines the boundaries of the management unit and not the artificial, jurisdictional boundaries.

However planning and management still focuses on human activities within the defined management unit and not on the ecosystem or components thereof. The key information related to the social and economic aspects are comprehensively presented in the respective sector plans.

---

11 SDF Section 7.2
2.2 GEOLOGY

A comprehensive and well-referenced description of the regional geology of the Knysna area from the mountains to the sea is provided in the Garden Route EMF (Appendix B: pages 91 to 103) and is not repeated here. The information shown in the map above is in GIS format and is incorporated as a map layer in the analysis.

Of further interest is Section 3.1.2 (Geology, Geomorphology and Soils) of the area and in particular the Knysna system in Grindley, 1985.

2.3 TOPOGRAPHY

A comprehensive and well-referenced description of the topography of the area is provided in the Garden Route EMF and is not repeated here. The categorisation of the land based on

---

the topography shown in the map below is in GIS format and is incorporated as a map layer in the analysis used in the various sector plans and the ISDF.

Reference to the physical and biological characteristics of both the Knysna and the Swartvlei estuarine systems are summarised in CSIR reports 429 (Knysna)\textsuperscript{14} and 421 (Swartvlei)\textsuperscript{15} produced in 1985 and 1983 respectively. These reports contain important baseline information against which the results of future management activities can be measured.

2.4 SLOPE ANALYSIS

The slope analysis of the Knysna area is provided in the Garden Route EMF and is shown in the map above is in GIS format and is incorporated as a map layer in the analysis. From the information can be seen that the mountainous area in the north has the highest slope aspect, logically due to the high altitude mountainous terrain. The inland plains are flatter with shallow slope aspects (up to 10%). The terrain to the south of the plains drops sharply to form foothills. The coastal dune areas are also characterised by steep slopes around the built-up areas of Knysna and Wilderness.

The slope analyses for steeper than 1:4 (25%) are included in the SDF (Plan 8).

2.5 HYDROLOGICAL CONTEXT

The background information document of the Garden Route EMF provides much information on the hydrological aspects of the study area.

Detailed information on the hydrology of both the catchments of the Swartvlei and the rivers that drain into the Knysna marine embayment are available in a number of research reports and scientific articles. Whereas Grindley (1985) and Whitfield et al (1983) provide a summary of the research done in the area prior to the mid 1980s, further research has been
carried out by a number of researchers of which some are referenced in the GREMP as well as the management plans drawn up by SANParks.

As can be seen on the map below, the Knysna River and the Sout River feed into the Knysna coastal lagoon; the Homtini River bypasses Rheenendal and meets the Goukamma River which in turn flows into the Indian Ocean at Buffalo Bay. The Hoogekraal and Karatara Rivers drain into the sea via the Swartvlei Estuary on the western edge of the Knysna Municipal area at Sedgefield.

Included in the EMF document is information on the water sources and extraction rates as provided by the Knysna Municipality at the time. This information is provided below and is an extraction from the EMF report.
Table 1: Water sources for Knysna

<table>
<thead>
<tr>
<th>Water source</th>
<th>Daily abstraction (litres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knysna River</td>
<td>7257600</td>
</tr>
<tr>
<td>Gouna River</td>
<td>29937600</td>
</tr>
<tr>
<td>Karatara River</td>
<td>2231000</td>
</tr>
<tr>
<td>Glebe dam</td>
<td>500000</td>
</tr>
<tr>
<td>Hornlee Spring</td>
<td>500000</td>
</tr>
<tr>
<td>Goukamma River</td>
<td>230000</td>
</tr>
</tbody>
</table>

Pie chart indicating distribution of water sources in Knysna

2.6 RIVER HEALTH

The GR-EMF document provides background information on the River Health Programme (2007)\textsuperscript{16} which uses a number of River Health Indices to establish the ecological status of river systems in South Africa. The map extracted form the EMF is provided below.

Freshwater ecosystems provide a valuable natural resource, with economic, aesthetic, spiritual, cultural and recreational value. Yet the integrity of freshwater ecosystems in South Africa is declining at an alarming rate largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The first National Spatial Biodiversity Assessment (NSBA) in 2004 provided a national assessment of the status of terrestrial, river, marine and estuarine ecosystems and identified broad priority areas for biodiversity conservation for terrestrial ecosystems. Freshwater ecosystems were lacking as some critical datasets was unavailable. However, the NSBA highlighted the dire state of river ecosystems in South Africa, which were far worse than the state of terrestrial ecosystems.

The National Freshwater Ecosystem Priority Areas (NFEPA) project\(^\text{17}\) was a partnership and collaborative process led by the CSIR with the South African National Biodiversity Institute (SANBI), Department of Water Affairs (DWA), the Water Research Commission (WRC), WWF South Africa, as well as expertise from South African National Parks (SANParks), the South African Institute for Aquatic Biodiversity (SAIAB) and DEAT.

NFEPA takes forward the implementation of the Cross-Sector Policy Objectives for Inland Water Conservation. It also builds on the river component of the National Spatial Biodiversity Assessment (NSBA) 2004, and will feed directly into the NBA (National Biodiversity Assessment) 2010.

NFEPA produced a number of products of relevance to the Knysna Municipal Area. These include an atlas of map products at Water Management Area level as well as Freshwater Ecosystem Priority Areas (FEPA) maps.

The FEPA map for Knysna and adjacent areas is shown below.

The dark green catchments (e.g. 9111 and 9117) are river FEPAs, which means they need to be managed for keeping in a good ecological integrity i.e A or B ecological integrity according to DWAs standards.

The light green sub-catchments are upstream management areas (e.g. 9006 and 9069) that are connected to FEPAs and it is important that any activities in these areas do not degrade the condition of the downstream FEPAs.

For example it means that any development of the water source in these catchments (e.g. a dam) then the dam management will have to release environmental flows and sediment to maintain the good ecological integrity on the downstream FEPAs and the dam needs to be built accordingly.
The cyan colour around water bodies and wetlands indicates that it is a priority wetland or estuary for conservation because of its biodiversity value. The Knysna lagoon is one of these.

### 2.7 VEGETATION ANALYSIS

Knysna Municipal area contains a wide diversity of vegetation types spread across the widely varying topography. The classification system used by Mucina, Rutherford et al is used as a basis for vegetation classification for this document. Eleven vegetation types are identified for the region, within two separate biomes, namely Afrotemperate forest and Fynbos.

The vegetation map (above) depicts land areas with the relevant vegetation type found in the particular area. Sections of particular importance are southern cape dune Fynbos, Southern coastal forest, Outeniqua sandstone fynbos as well as eastern coastal shale Fynbos. There are however, finer classification divisions of the Fynbos biome by Vlok and others, which must be recognised when fine scale planning exercises are done. This will ensure that loss of critically endangered vegetation communities is prevented.

![Vegetation Map](image-url)
Fynbos holds the promise of untapped phytochemicals and other products that may still be uncovered as research progresses. Indigenous groups are already utilising a number of these, such as i.e. Artemesia sp. and Helichrysum sp.

Climate change projections predict the loss of species due to higher temperatures as well as changing rainfall patterns. It is therefore prudent to conserve the remaining Fynbos areas in the municipal area as a priority.

The other important plant community in the municipal control area is the largest contiguous area of Afromontaine (afrotemperate forest) forest, stretching from Harkerville in the east to the mountains above Wilderness.

River banks and valleys usually also carry forest remnants and widely distributed scrub forest patches.

A very important priority forest area is situated along the rim of the Knysna basin in the area between Old Place and the Northern suburbs. This particular forest section is on municipal land and offers exiting prospects for community based co-management.

Department of Forestry and Fisheries control the protection of all forests in the Republic of South Africa under the National Forest Act (Act 48 of 1998). Management of Garden Route forests resort under SANParks.

In terms of conservation management priorities, alien invasive vegetation threatens the conservation of vital biodiversity in the Garden Route.

Large areas in the catchments are infested with alien invasive vegetation such as Acacia mearnsii and A.melanoxolon, while coastal dunes carry heavy loads of Rooikrans(A. cyclops).

Substantial areas in the control area carry commercial plantations. (Pine and Blue gum).

Private land owned by GEO Parkes and PG Bison has commercially important stands of Pine and Blue gum trees.

Inter-tidal salt marshes along the shorelines of the coastal estuaries are considered as particularly important conservation value. Not only does it provide energy rich input into the marine food chain, but it creates a very effective erosion barrier against storm damage.

Similarly, wetlands in catchment drainage systems will have to be recognised for the very important role they play in water conservation (as sponges) water filtration and soil erosion prevention mechanisms.

The Von Kervels vlei deserves special mention as a peat bog of great age worthy of national heritage status.
The term "Interface Zones" in this document, is used to indicate a number of areas that would need special attention during planning and management actions.

Critical biodiversity areas, Ecological support areas (as defined in the GRI planning domain maps) as well as National Parks, Provincial, National Parks, and buffer zones associated with these protected areas are all included in this section. All the important Biodiversity corridors also fall into this group.

Where appropriate, the various sections of the group will be detailed during finer scale planning and management activities.

Buffer areas around the rivers and protected areas will need some innovative thinking to ensure sustainable development for the Knysna community without compromising the functioning and appearance of the particular area.

Special attention will have to be given to the catchment areas where available runoff water will become a critical factor when climate change predictions are taken in consideration.

Interface zones may also present opportunities for water pollution mitigation.
Management of interface zones present a challenge for municipal managers because they are important for conservation purposes but they can easily become dumping grounds for rubbish or illegal squatting activities.

Catchment protection and biodiversity management areas on private land will have to be managed on a co-operative manner, in close participation between land owner and authorities. In this instance, the provincial conservation body as well as Eden municipality will have to add more energy to the present land management programme to ensure successful participation.

Creative incentives for sound land management will have to be produced by the Knysna municipality to ensure that conservation worthy vegetation on state land deserves adequate attention.

## 2.9 LANDSCAPE CHARACTER

Quoting directly from the Garden Route EMF (2010) document:

“Landscape is about the relationship between people and place. It provides the setting for our day-to-day lives. Landscape can be a small parcel of urban wasteland to a mountain range, from an urban park to a vast desert plain. Landscape is the result of the sum of various components of the natural environment – natural (geology, soils, climate, flora and fauna) and cultural (historical and current impact of land use, settlement, and other human interventions). People’s perceptions of land, turn land into landscape. Subjectively landscape is not only about quantitative visual perceptions, but qualitatively of how we see the land, and experientially through tactile sensory feelings, memories, smells, and the emotions and associations they evoke.

Landscape character, the pattern that arises from the particular combinations of the various components as above, provides a sense of place to our surroundings, commonly referred to as Genus Loci, or ‘Sense of Place’.

The comprehensive landscape analysis in the EMF considers a broad spectrum of factors including the landscape character type and description (e.g. urban, archicultural or natural); the landscape value (such as open space); capacity (or resilience to change); and the identified positive key characteristics (that would need protecting and enhancing).

By including a rating / scoring framework it was possible to determine a landscape character ‘score or numerical value and subsequently produce a spatially depicted assessment depicted in the Landscape Character map shown below.
From the analysis the EMF concluded that, generally speaking, the Garden Route area, including the Knysna Municipal Area, can be considered as having a ‘significant scenic landscape value, with a complex mosaic of high quality visual experiences, from numerous prominent visual receptors and viewshed throughout the study area. The Genus Loci of the area is not only limited to the natural and topographical splendour, but is similarly enhanced by the quaint villages and hamlets, which have largely retained their character and developed around the existing sense of place.’

The essence of this conclusion is critical to recognise in economic developmental actions proposed in the ISDF.
2.10 CLIMATE CHANGE (SPECIFICALLY SEA LEVEL RISE)

In response to a request from the DEA, the CSIR produced a research report that summarises the state of the current knowledge and forms the basis of coastal hazard and vulnerability assessments of the South African coastal region. Forming Phase 1 of a planned series that aims to guide climate change response actions in the coastal regions of South Africa, it was commissioned by DEA in March 2013 and published by CSIR in August 2014 as a contract research report that is disseminated by the DEA.

The main tasks and studies that were carried out under this research included a literature review and collation of available data relevant to Phase 1 (of the DEA project); the identification of primary and secondary coastal hazard drivers (leading to vulnerability parameters in the planned Phase 2, which would feed into a coastal vulnerability indexing methodology planned in the follow-up to Phase 1); the formulation of realistic scenarios of future coastal conditions (regarding waves and seawater levels); an analysis of the SA offshore wave climate; the determination and calculation of local tides, wind, wave and hydrostatic setup; and the definition of future sea level and wave runup levels for the coastline. A coarse coastal flooding assessment (i.t.o. storm wave runup elevations) for the whole SA coastline was also undertaken.

The main metocean drivers that pose abiotic hazards to infrastructure and developments in the SA coastal zone were found to be: (1) waves; (2) seawater levels; (3) winds and (4) currents to some extent. In quantifying the hazards and/or to assess the vulnerability of coastal features to coastal flooding/inundation from the sea, direct wave impacts, extreme water levels and wave runup, it was critical to determine the maximum point that storm waves can reach (wave runup). In other words the height to which a wave would run up the beach slope.

Primary components to define this point include determining the extreme offshore wave climate (present and future) and deriving resultant inshore wave conditions. Of course the wave runup component of the hazard only comes into play along those parts of the coastline that are completely or partially exposed to waves that originate from the open ocean. In coastal embayments (such as the Knysna Lagoon), in estuaries (such as the Swartvlei Estuary) and also at ports the direct onslaught of the wave energy is damped and the runup component can become significantly less.

A definition sketch of the various components leading to extreme inshore seawater levels (identifying the components of tide, barometric/hydrostatic setup, wind setup, wave setup, wave runup and SLR) is presented in the figure below.

---

It is important to note that the effect of the energy dissipation when waves break at the coasts (i.e. the elevated water level due to the waves and the runup in the swash zone along a beach) is absent in sheltered areas such as in marine embayments like Knysna and in ports.

**Definition sketch of the various components leading to extreme inshore seawater levels**

The CSIR (2014) report found that, for South Africa, the primary hazards to (physical) coastal infrastructure related to the sea are: (1) direct wave impacts; (2) coastal flooding and inundation; and (3) erosion of soft coasts; and (4) under-scouring of foundations. (It is clearly pointed out in the report that other coastal/marine hazards that should be considered when undertaking such assessments would include ‘biotic’ hazards, for example harmful algal blooms, pollution, oil spills and low-probability hazards, for example tsunamis, but that these were beyond the scope of the Phase 1 study).

The CSIR report on Phase 1 focussed on determining the SA offshore wave climate; the nearshore wave regime; a coarse assessment of storm surge hazards and storm wave-run elevations due to extreme metocean conditions.

**Wave climate**

The CSIR study concluded that the extreme wave conditions (all directions and locations) off SA were determined to range from approximately 8 m to 11 m for 1-in-10-year events and from just over 9 m to just over 12 m for 1-in-50-year events, respectively. This approximately corresponds to offshore significant wave height ($H_o$) ranges from approximately 4 m to just under 11 m for 1-in-10-year events and from just under 5 m to just over 12 m for 1-in-50-year events, respectively.
By application of a wave setup factor, the wave setup for 1-in-10-year events and the 1-in-50-year events was calculated as being in a range from approximately 1.2 m to 1.7 m and from 1.5 m to 2 m respectively. This means that during, for example, a 1-in-50 year seastorm the waterline at the coast can be up to 2m higher than the normal tide level due to the effect called wave setup. The effect of wave setup and runup should be considered at all the coastal areas within the Knysna Municipal area, i.e. Sedgefield, Buffelsbaai, the ocean-facing edge of Leisure Island opposite the entrance channel to the Lagoon, the areas on both sides of The Heads, and at Noetze.

Within the rest of the Knysna Lagoon the wave setup and runup can be ignored. However, the sea level due to tides, the effects of barometric pressure changes (the hydrostatic force) as well as the effect of winds blowing across the water body are considered. The effects of small wind-waves causing a splash-over (overtopping) is also considered.

**Sea Level Rise (SLR)**

A synopsis of the state of scientific knowledge on SLR (as presented in CSIR, 2014) is provided in Appendix 3 as background information.

The CSIR report comments on the latest scientific knowledge on climate change induced SLR and concludes that the best estimate (or central estimate/mid scenario) of SLR by 2100 is around 1 m, with a plausible worst-case scenario of 2 m and a best-case scenario (low estimate) of 0.5 m. The corresponding best estimate (‘mid scenario’) projections for 2030 and 2050 are 0.15 m and 0.35 m respectively.

The problem with SLR is not just the vertical rise but also its interaction with changing storm intensities and wind fields to produce sea conditions that will progressively overwhelm existing infrastructure (e.g. Battjes, 2003; Houghton, 2005\(^\text{19}\)). This is a particularly important risk in the case of the highly exposed SA coastline and a subject that up to now has been little explored (Theron, 2007\(^\text{20}\)).

Although we are not at this time able to reliably estimate changes in storm patterns, windiness, wave energy or direction, the increase in storm activity and severity will probably be the most visible impact and the first to be noticed. For example, higher sea levels will require smaller storm events to overtop existing storm protection measures.

**Storm surge long the South African coast**

The report produced estimates of extreme values for realistic combinations of the inshore seawater level components as applicable to each SA coastal region. Based on these calculations and the wave conditions, estimates are made of the regional storm surge levels

---


around the SA coast for the main offshore wave conditions. This provides a robust first-order coarse storm surge levels assessment for the SA coastal regions.

To illustrate the severity of different return period events, the 1-in-50-year return period wave conditions along each coastal region are considered in combination with the other sea level setup effects as described above. The results are summarised in the figures below. Note that these results are coastal “storm surge” levels and do not include wave runup effects, as discussed below.

South African regional coastal storm surge levels for the 1-in-50-year wave return period and 0.35 m sea level rise scenario by 2050 (i.e. excluding wave run-up) (Figure 4.15 in CSIR, 2014)

The analysis method is described in detail in CSIR (2014). Use was made of long term sea level records taken at Simon’s Town over a period of about 45 years (1965–2010). The dataset archived by the Sea Level Center of the University of Hawaii (UHSLC) was obtained and utilised in the CSIR, 2014 study. It must be noted that the datasets contain substantial gaps with some locations being worse than others. As reported in CSIR, 2014, the extreme analysis was only conducted on the residual water levels where the astronomical tide component was removed through spectral analysis. This is described in detail in CSIR (2014). The table below gives a summary of the return periods of the residual sea level at Mossel Bay, Knysna and Port Elizabeth with respect to MSL.
South African regional coastal storm surge levels for the 1-in-50-year wave return period and 1-m sea level rise scenario by 2100 (i.e. excluding wave runup) (Figure 4.16 in CSIR, 2014)

Residual sea level at selected ports in South Africa (m to MSL)

<table>
<thead>
<tr>
<th>Port</th>
<th>Return period in years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Mossel Bay</td>
<td></td>
</tr>
<tr>
<td>Residual level (m)</td>
<td>0.55</td>
</tr>
<tr>
<td>Knysna</td>
<td></td>
</tr>
<tr>
<td>Residual level (m)</td>
<td>0.65</td>
</tr>
<tr>
<td>Port Elizabeth</td>
<td></td>
</tr>
<tr>
<td>Residual level (m)</td>
<td>0.56</td>
</tr>
</tbody>
</table>

These values are used as the baseline for the storm surge. When added to the level of the Mean High Water Spring (MHWS) level (at the site) and the amount of SLR a hazard level (m to MSL) can be derived for the specific site, climate change and return period.
The MHWS level at Knysna is 1.12 m (MSL)\textsuperscript{21} and from the table above the 1-in-50 year residual storm surge level is 0.96 m (MSL). No wave run-up is considered within the Knysna Lagoon north west of Leisure island and the storm surge hazard (still water) level and without any consideration of SLR, amounts to 2.08 m (MSL).

Allowing for an additional rise in water level due to wind setup and windwave ‘chop’ of an additional 0.5 m, the current (no SLR included) 1-in-50 year hazard level is calculated at 2.6 m MSL. Adding the defined SLR scenarios of 0.35 m by 2050 and 1.0 m by 2100 gives the realistic storm surge hazard level to be used in long term planning for Knysna can be taken at 3.0 m MSL (rounded) in 2050 and 3.6 m by 2100.

### High level vulnerability assessment

#### Introduction

The assessment methodology applied by the CSIR in Mozambique and in South Africa provides a useful basis for a high level assessment of the effect of the sea level rise scenarios. In adopting the CSIR methodology a vulnerability assessment matrix was set up. The focus is on the vulnerability to SLR of municipal infrastructural elements located along the shoreline of the coast and within Swartvlei, the Swartvlei Estuary and the Knysna Lagoon and Knysna Estuary.

Six separate hazard types associated with climate change (CC) and in particular sea level change (SLR) are defined. The hazard types are shown in the tables below. The matrix allows for ‘scoring’ the impact of each hazard type on the defined infrastructural elements as shown in the tables. The following descriptors associated with the vulnerability scores are used:

The position of the various municipal engineering infrastructure elements is provided on GIS maps provided by the Municipality. The GIS data was overlain onto the Google Earth\textsuperscript{TM} images for the Knysna Municipal Area. This enabled a desk-top visual assessment of the various elements against the hazard types using the scoring system above. A limit amount of ground-truthing was done and the scoring is done for the current (2015) situation. To assess for the assumed climate change and SLR scenarios it was assumed that the score would be increased by one point from 2015 to 2050 and two points added to the 2015 score for the 2100 score. A maximum possible score of 5 was assumed.

\textsuperscript{21} SANHO, 2009
### Vulnerability Classification and Score

<table>
<thead>
<tr>
<th>REF</th>
<th>Hazard Type</th>
<th>Vulnerability Criteria</th>
<th>Very Low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H1, H3, H4, H5, H6</td>
<td>Elevation (m to MSL)</td>
<td>&gt;30</td>
<td>21-30</td>
<td>11-20</td>
<td>5 - 10</td>
<td>&lt;5</td>
</tr>
<tr>
<td>2</td>
<td>H1, H3, H4, H5, H6</td>
<td>Distance to shore (m)</td>
<td>&gt;1000</td>
<td>200-1000</td>
<td>50-200</td>
<td>20-50</td>
<td>&lt;20</td>
</tr>
<tr>
<td>4</td>
<td>H4, H5</td>
<td>Geology</td>
<td>Hard rocks (Magmatic)</td>
<td>Medium harness rocks (Metamorphic)</td>
<td>Soft rocks (Sedimentary)</td>
<td>Non-consolidated coarse sediment</td>
<td>Non-consolidated fine sediment</td>
</tr>
<tr>
<td>5</td>
<td>H4, H5</td>
<td>Anthropogenic Actions</td>
<td>Shoreline stabilization intervention</td>
<td>Intervention without sediment sources reduction</td>
<td>Intervention with sediment sources reduction</td>
<td>Without intervention or sediment sources reduction</td>
<td>Without intervention but with sediment sources reduction</td>
</tr>
<tr>
<td>6</td>
<td>H4, H6</td>
<td>Exposure to wave energy</td>
<td>Leeside of large island or extensive spit</td>
<td>Leeside of headland, rocky point or peninsula</td>
<td>Partially sheltered from deep-sea wave energy</td>
<td>Directly exposed to waves only slightly refracted from deep-sea</td>
<td>Directly exposed to storm wave attack, with narrow surf zone</td>
</tr>
<tr>
<td>7</td>
<td>H1, H3, H4, H5, H6</td>
<td>Height of foredune</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HAZARD TYPES: H1: SEA WATER SURGE; H2: RIVER FLOODING; H3 PONDING; H4: OVERTOPPING; H5: EROSION; H6: WAVE RUN-UP
The tables below indicate the results of the assessment for each township in the Greater Knysna Municipality. Scores of 4 and above are deemed to need priority interventions. It should be noted that this is a rough high level desk-top assessment and the responsible way would be to do more intensive ground trothing.

The CSIR (2014) defined a whole range of adaptation and response options for a local authority to plan for and manage the effects of climate change. The practical response strategies (R1 to R6) are listed in the tables below. The actual engineering details of each intervention will need to be determined based on a thorough investigation.
Assessment results

SEDGEFIELD, SWARTVLEI AND SWARTVLEI ESTUARY

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1 SEA WATER SURGE&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td>3&lt;sup&gt;1&lt;/sup&gt; (4)&lt;sup&gt;2&lt;/sup&gt; [5]&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>H3 PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>4 (5) [5]</td>
</tr>
<tr>
<td>H4 OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td>4 (5) [5]</td>
</tr>
<tr>
<td>H5 EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H6 WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
</tbody>
</table>

RESPONSE STRATEGY

<table>
<thead>
<tr>
<th>R1 RETREAT</th>
<th>R2 DEFEND (SOFT ENG)</th>
<th>R3 DEFEND (HARD ENG)</th>
<th>R4 ELEVATE</th>
<th>R5 INVESTIGATE &amp; MONITOR</th>
<th>R6 LEAVE AS IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

NOTES: 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

SLR = These hazards are effected by SLR
CC = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
Knysna Municipality
Integrated Strategic Development Framework
SEA: Natural Environmental Context

## BUFFALO BAY

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1 SEA WATER SURGE&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H2 RIVER FLOODING&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>4 (5) [5]</td>
</tr>
<tr>
<td>H3 PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H4 OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
</tbody>
</table>

### RESPONSE STRATEGY

<table>
<thead>
<tr>
<th>RESPONSE STRATEGY</th>
<th>ELECTRICAL SYSTEM</th>
<th>ROADS/PARKING</th>
<th>BUILDINGS</th>
<th>WATER SYSTEM</th>
<th>SANITATION NETWORK</th>
<th>OTHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 RETREAT</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2 DEFEND (SOFT ENG)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>R3 DEFEND (HARD ENG)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>R4 ELEVATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R5 INVESTIGATE &amp; MONITOR</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6 LEAVE AS IS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**
1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

SLR = These hazards are effected by SLR.
CC = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
Knysna Municipality
Integrated Strategic Development Framework
SEA: Natural Environmental Context

GOUKAMMA ESTUARY MOUTH NEAR BUFFALO BAY

BUFFALO BAY
## BRENTON-ON-SEA

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1</td>
<td>SEA WATER SURGE&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H2</td>
<td>RIVER FLOODING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H3</td>
<td>PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H4</td>
<td>OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H5</td>
<td>EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H6</td>
<td>WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

### RESPONSE STRATEGY

<table>
<thead>
<tr>
<th></th>
<th>RETREAT</th>
<th>DEFEND (SOFT ENG)</th>
<th>DEFEND (HARD ENG)</th>
<th>ELEVATE</th>
<th>INVESTIGATE &amp; MONITOR</th>
<th>LEAVE AS IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:** 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

- **SLR** = These hazards are affected by SLR.
- **CC** = These hazards can be affected by more intense rainfall due to Climate Change. (increase by 1 point for each for 2050 and 2100)
## NOETZE

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1</td>
<td>SEA WATER SURGE&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H2</td>
<td>RIVER FLOODING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H3</td>
<td>PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H4</td>
<td>OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H5</td>
<td>EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H6</td>
<td>WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

### RESPONSE STRATEGY

<table>
<thead>
<tr>
<th>R1</th>
<th>RETREAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>DEFEND (SOFT ENG)</td>
</tr>
<tr>
<td>R3</td>
<td>DEFEND (HARD ENG)</td>
</tr>
<tr>
<td>R4</td>
<td>ELEVATE</td>
</tr>
<tr>
<td>R5</td>
<td>INVESTIGATE &amp; MONITOR</td>
</tr>
<tr>
<td>R6</td>
<td>LEAVE AS IS</td>
</tr>
</tbody>
</table>

NOTES: 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

- **SLR** = These hazards are affected by SLR
- **CC** = These hazards can be affected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
### EASTERN HEAD AREA

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1</td>
<td>SEA WATER SURGE&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H2</td>
<td>RIVER FLOODING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H3</td>
<td>PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H4</td>
<td>OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H5</td>
<td>EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H6</td>
<td>WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

**RESPONSE STRATEGY**

- R1 RETREAT
- R2 DEFEND (SOFT ENG)
- R3 DEFEND (HARD ENG)
- R4 ELEVATE
- R5 INVESTIGATE & MONITOR
- R6 LEAVE AS IS

**NOTES:**

1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

- SLR = These hazards are effected by SLR.
- CC = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
### LEISURE ISLAND

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1</td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td></td>
</tr>
</tbody>
</table>

#### RESPONSE STRATEGY

- **R1** RETREAT
- **R2** DEFEND (SOFT ENG)  
  - X
- **R3** DEFEND (HARD ENG)  
  - X
- **R4** ELEVATE
- **R5** INVESTIGATE & MONITOR  
  - X
- **R6** LEAVE AS IS

**NOTES:**  
1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)  
SLR = These hazards are effected by SLR  
CC = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
LEISURE ISLAND
<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H3 PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H4 OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td>2 (3) [4]</td>
</tr>
<tr>
<td>H5 EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H6 WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
</tbody>
</table>

**RESPONSE STRATEGY**

- **R1** RETREAT
- **R2** DEFEND (SOFT ENG)
- **R3** DEFEND (HARD ENG) X X X
- **R4** ELEVATE
- **R5** INVESTIGATE & MONITOR X X X X X
- **R6** LEAVE AS IS

**NOTES:** 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

- **SLR** = These hazards are affected by SLR
- **CC** = These hazards can be affected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
THESEN ISLANDS AND GEORGE REX DRIVE
## THESEN ISLANDS

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1</td>
<td>SEA WATER SURGE&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H2</td>
<td>RIVER FLOODING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H3</td>
<td>PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
</tr>
<tr>
<td>H4</td>
<td>OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H5</td>
<td>EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
<tr>
<td>H6</td>
<td>WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

### RESPONSE STRATEGY

- **R1** RETREAT
- **R2** DEFEND (SOFT ENG) X
- **R3** DEFEND (HARD ENG) X X
- **R4** ELEVATE X X X
- **R5** INVESTIGATE & MONITOR X X X X
- **R6** LEAVE AS IS X X X X

**NOTES:** 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

- **SLR** = These hazards are effected by SLR
- **CC** = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
## KNYSNA CENTRAL AREA

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H2 RIVER FLOODING&lt;sub&gt;CC&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H4 OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H5 EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>H6 WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESPONSE STRATEGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 RETREAT</td>
</tr>
<tr>
<td>R2 DEFEND (SOFT ENG)</td>
</tr>
<tr>
<td>R3 DEFEND (HARD ENG)</td>
</tr>
<tr>
<td>R4 ELEVATE</td>
</tr>
<tr>
<td>R5 INVESTIGATE &amp; MONITOR</td>
</tr>
<tr>
<td>R6 LEAVE AS IS</td>
</tr>
</tbody>
</table>

**NOTES:** 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

SLR = These hazards are affected by SLR

CC = These hazards can be affected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
CENTRAL AND KNYSNA QUAYS

BELVIDERE
## BELVIDERE

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1</td>
<td>SEA WATER SURGE&lt;sup&gt;SLR&lt;/sup&gt;</td>
</tr>
<tr>
<td>H2</td>
<td>RIVER FLOODING&lt;sup&gt;CC&lt;/sup&gt;</td>
</tr>
<tr>
<td>H3</td>
<td>PONDING&lt;sup&gt;CC&lt;/sup&gt;</td>
</tr>
<tr>
<td>H4</td>
<td>OVERTOPPING&lt;sup&gt;SLR&lt;/sup&gt;</td>
</tr>
<tr>
<td>H5</td>
<td>EROSION&lt;sup&gt;SLR&lt;/sup&gt;</td>
</tr>
<tr>
<td>H6</td>
<td>WAVE RUN-UP&lt;sup&gt;SLR&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RESPONSE STRATEGY</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>RETREAT</td>
</tr>
<tr>
<td>R2</td>
<td>DEFEND (SOFT ENG)</td>
</tr>
<tr>
<td>R3</td>
<td>DEFEND (HARD ENG)</td>
</tr>
<tr>
<td>R4</td>
<td>ELEVATE</td>
</tr>
<tr>
<td>R5</td>
<td>INVESTIGATE &amp; MONITOR</td>
</tr>
<tr>
<td>R6</td>
<td>LEAVE AS IS</td>
</tr>
</tbody>
</table>

**NOTES:** 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

- **SLR** = These hazards are effected by SLR
- **CC** = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
**WEST OF RAILWAY BRIDGE**

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H1 SEA WATER SURGE$^{SLR}$</td>
<td>3 (4) [5]</td>
</tr>
<tr>
<td>H2 RIVER FLOODING$^{CC}$</td>
<td></td>
</tr>
<tr>
<td>H3 PONDING$^{CC}$</td>
<td></td>
</tr>
<tr>
<td>H4 OVERTOPPING$^{SLR}$</td>
<td></td>
</tr>
<tr>
<td>H5 EROSION$^{SLR}$</td>
<td></td>
</tr>
<tr>
<td>H6 WAVE RUN-UP$^{SLR}$</td>
<td></td>
</tr>
</tbody>
</table>

**RESPONSE STRATEGY**

<table>
<thead>
<tr>
<th>RESPONSE STRATEGY</th>
<th>RETREAT</th>
<th>DEFEND (SOFT ENG)</th>
<th>DEFEND (HARD ENG)</th>
<th>ELEVATE</th>
<th>INVESTIGATE &amp; MONITOR</th>
<th>LEAVE AS IS</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:** 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

SLR = These hazards are effected by SLR
CC = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
## BRENTON-ON-LAKE AND WESTERN HEAD AREA

<table>
<thead>
<tr>
<th>HAZARD TYPE</th>
<th>INFRASTRUCTURAL ELEMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTRICAL SYSTEM</td>
</tr>
<tr>
<td>H2</td>
<td>RIVER FLOODING(^{CC})</td>
</tr>
<tr>
<td>H3</td>
<td>PONDING(^{CC})</td>
</tr>
<tr>
<td>H4</td>
<td>OVERTOPPING(^{SLR})</td>
</tr>
<tr>
<td>H5</td>
<td>EROSION(^{SLR})</td>
</tr>
<tr>
<td>H6</td>
<td>WAVE RUN-UP(^{SLR})</td>
</tr>
</tbody>
</table>

### RESPONSE STRATEGY

| R1 | RETREAT |
| R2 | DEFEND (SOFT ENG) |
| R3 | DEFEND (HARD ENG) |
| R4 | ELEVATE |
| R5 | INVESTIGATE & MONITOR |
| R6 | LEAVE AS IS |

**NOTES:** 1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

- SLR = These hazards are affected by SLR
- CC = These hazards can be affected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
## Upstream of the N2 White Bridge

<table>
<thead>
<tr>
<th>Hazard Type</th>
<th>Electrical System</th>
<th>Roads/Parking</th>
<th>Buildings</th>
<th>Water System</th>
<th>Sanitation Network</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1 SEA WATER SURGE&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H3 PONDING&lt;sub&gt;CC&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4 OVERTOPPING&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H5 EROSION&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H6 WAVE RUN-UP&lt;sub&gt;SLR&lt;/sub&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Response Strategy

<table>
<thead>
<tr>
<th>Response</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 RETREAT</td>
<td>X</td>
</tr>
<tr>
<td>R2 DEFEND (SOFT ENG)</td>
<td></td>
</tr>
<tr>
<td>R3 DEFEND (HARD ENG)</td>
<td>X</td>
</tr>
<tr>
<td>R4 ELEVATE</td>
<td>X</td>
</tr>
<tr>
<td>R5 INVESTIGATE &amp; MONITOR</td>
<td>X</td>
</tr>
<tr>
<td>R6 LEAVE AS IS</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1 = 2015; 2 = 2050; 3 = 2100 (The vulnerability ‘score’ increases by 1 point due to the Sea Level Rise scenarios, max = 5 = Very High Vulnerability)

SLR = These hazards are effected by SLR

CC = These hazards can be effected by more intense rainfall due to Climate Change. (increase the 2015 score by 1 point for each for 2050 and 2100)
2.11 LAND USE CLASSIFICATION

Various challenges and threats to the natural environment are identified and discussed in the sector plans\textsuperscript{22}. For the ISDF only the net result of the analysis is presented in the figures below. This information highlights the strengths and prospects for sustainable utilisation within the study area.

The various landuse categories shown in the figure above are based on information obtained form the 1999 national landcover database produced by the ARC and CSIR.

It can be seen that almost 60% of the area is covered by a combination of Indigenous Forest and Plantation Forestry with 20% categorised as Un-utilised Veld/Indigenous Forest area. Of the rest of the area, 6% is categorised as Planted Pasture and 5% as Natural Grazing. The Urban Area makes up a total of just under 5% and Small Holdings just over 3%. The rest of the landuse is categorised as Marshland and Dams.

\textsuperscript{22} SDF Section 3
3 SUMMARY

Knysna sits within an area known for its biodiversity. Development pressure is causing concern that we may be on a point where important natural elements are about to be lost or are already lost.

Knysna Municipality has the responsibility to assist in the management of the natural environment on a local government level, together with Provincial and National Environmental Departments.

The municipal area falls within the Garden Route National Park, a rather unique situation for a town. This complicates management matters somewhat due to the fact that a much heavier emphasis is put on co-operate governance.

Due to the importance of tourism as an income base, it makes sense to protect the “garden” of the garden route, particularly since the stunning natural environment is the one element that draws tourists to this part of the world.

The legal framework governing conservation of natural resources puts the burden of care firmly on the shoulders of the Knysna Municipality and the people of Knysna. Legally, Knysna Municipality and the community as custodians of an area that contains one of the “Biodiversity Hot Spots” of the Cape Floral Kingdom, has the duty to protect and manage natural assets under its control.

This responsibility is accepted by the Knysna Municipality and is reflected in its openly promoted vision, mission and strategic objectives statement.

3.1 DUTY OF CARE

Exercising our duty of care strategically, Knysna could enhance our competitive edge in the Tourism market considerably. There are already some world class sporting events in the area utilising the special landscape features to their advantage. The following areas were identified for attention, planning and action:

<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Description</th>
</tr>
</thead>
</table>
| Pollution  | • pollution is produced in the catchment areas of the lakes and estuaries  
             • downstream lakes and estuaries are no longer flushed efficiently due to human engineering works  
             • Knysna has a waste problem will have to be dealt with innovatively - The present legal position regarding licencing of waste sites is somewhat concerning |
<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Forrests**        | • The municipal forest is in a very poor condition and has been neglected for years  
• Farm animals roam the municipal forest unchecked and cause serious damage to the forest floor  
• State forests in the Municipal area are managed by SANParks under mandate from Dept. of Forestry and Fisheries. These National Assets are well cared for and in good condition although certain sections are plundered for wood and traditional medicine.  
• The forests are well known tourist attractions |
| **Fynbos Management** | • Knysna Municipal area hosts a diversity of vegetation types; Fynbos in particular is highly diverse in composition and distribution  
• The fynbos habitat supports a rich variety of fauna with highly complex relationships between plant and animal  
• Retention of as much diversity as possible - concern about the rate of disappearance of fynbos vegetation through development and agriculture practices  
• potential uses of fynbos vegetation for medicine, essential oils and even possibly as a food resource are still unexploited  
• Management of required fires may lead to conflict between fynbos managers and property owners. |
| **Rivers and Streams** | • River health in the main rivers is still on acceptable levels, but as human pressures increase the need for good river management will become imperative  
• Estuaries occur at the interface between freshwater systems and the sea and are among the most dynamic and productive natural systems  
• Manipulation of streams in the Knysna basin through hardened banks and other structures has had unintended consequences. Accelerated water flowing down the streams is causing massive bank erosion in unprotected areas. |
<table>
<thead>
<tr>
<th>Focus Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Bongani and Hornlee. Cover sands make the areas particularly vulnerable. Siltation of the lagoon is a growing problem, particularly in the Ashmead channel</td>
</tr>
<tr>
<td></td>
<td>• Salt River has been heavily impacted by the Simola development. Fine cover sand is still washing down stream and will be flowing into the lagoon for a long time to come. Large silt traps should form part of the silt management procedures for rivers that feed the lagoon</td>
</tr>
<tr>
<td></td>
<td>• Large areas are denuded to build low cost housing. Low budgets do not allow for soil and erosion protection or adequate rehabilitation. The result of the increase in hardened surfaces is increased storm water runoff. Municipal infrastructure will not be able to cope with the increased volumes and velocity of the downpours</td>
</tr>
<tr>
<td>Biodiversity Protection</td>
<td>• Special critical biodiversity vegetation zones as indicated on the map should be conserved to ensure free movement of biota between the coast and the mountains.</td>
</tr>
<tr>
<td></td>
<td>• Due to the destruction of natural habitat, it is presently only possible to protect the steep slopes and valleys around rivers. These areas are of extreme importance for the preservation of biodiversity and should not be compromised.</td>
</tr>
<tr>
<td>Global Warming</td>
<td>• Fluctuating rainfall patterns will cause damage to infrastructure through changes in precipitation volumes and spacing. Periods of low rainfall will put strain on municipal infrastructure systems.</td>
</tr>
<tr>
<td></td>
<td>• Particular attention should be paid to areas where dwellings and municipal infrastructure are on dune systems close to the shoreline as well as low lying parts of the towns near floodplains. Applications for new developments in low lying areas should be scrutinised for possible vulnerability to the effects of global warming and in particular sea level rise.</td>
</tr>
<tr>
<td>Invasive Removal Alien</td>
<td>• Areas of Concern: Leisure Isle; Buffalo Bay; Costa Sarda; Thesen Island; Knysna Quays; Laguna Grove</td>
</tr>
<tr>
<td></td>
<td>• Alien invasive vegetation reduces biodiversity</td>
</tr>
<tr>
<td></td>
<td>• invaded wetlands and catchment areas lose the ability to retain rainwater runoff that feeds the rivers from which</td>
</tr>
</tbody>
</table>
Focus Area | Description
--- | ---
municipal water supply for the town is obtained
- a loss of riverine vegetation and a concomitant higher rate of erosion that results in estuarine siltation
- The municipality should have an alien invasive vegetation management plan, containing guidelines for officials who have to enforce regulations & guidelines for proper removal and after care for cleared areas

Infrastructure
- Sewage pollution of ground and storm water from leaky pipes
- Fresh water losses through leaky pipes
- Storm water drains not cleaned. Road beds get wet and crumble
- Critical infrastructure close to water’s edge may have to be moved further inland or away from stream banks

Threats to Survival
- Over utilisation of offshore marine resources already damaged the Hake fishing industry
- Land derived pollution of marine ecosystems
- Loss of threatened and endangered vegetation types. Conflicts between land owners and authorities
- Neglect of forests, streams, wetlands and fynbos areas under municipal control

The series of Figures below shows the spatial implications of the various focus areas listed above. The spatial implications will be used to inform the identification of ecological corridors for the Knysna Municipal Area.
3.1.1 Biodiversity Protection

The figure below shows the Critical Biodiversity Areas for the Knysna Municipality as identified in the Garden Route Biodiversity Plan.
3.1.2 Protected Areas

The figure below shows all the protected areas in the Knysna municipal area, including the Garden Route National Park; the Knysna Protected Environment; Wilderness Protected Environment; Conservancies; Forests; Game Farms; Local Nature Reserves; Marine Reserves and Private Nature Reserves.

3.1.3 Alien Infestation
The figure below shows the levels of alien infestation in the Knysna Municipal area.

It is notable that the highest levels of infestation exist in the Eastbrook area between Sedgefield and Karatara and in the Rheenendal agricultural areas.
3.2 STRENGTHS AND WEAKNESSES

3.2.1 Strengths

- Natural Areas protected by Environmental Legislation, ensuring protection of sensitive ecosystems, in perpetuity and at the same time allowing for extensive and controlled recreation / tourism opportunities.
- Very diverse environmental product available to attract visitors. Clean sandy and rocky beaches, rivers and lagoons, forest and fynbos, huge bird habitat for birders, clean rivers and rugged landscape for adventure activities.
- Awareness and participation, albeit by only a few officials (e.g. Cape Nature, SANParks, etc.) as well as Environmental Organizations, NGO’s, etc. of maintaining biodiversity within the area.
- Public environmental awareness increasing and public participation in conservation activities growing.
- Amazing environmental awareness increasing and public participation in conservation activities growing.
- Temperature climate.
- Good quality environmental research and information available to assist in decision-making.
- Knowledge and accuracy about expected rise in sea levels increasing.
- Vegetation mapping for CBA’s and ESA’s available for the municipal area. Biodiversity and natural environment attractive for sourcing donor funding for conservation projects.
- Huge amounts of biomass from invasive alien vegetation available for energy generation.
- Well managed forestry plantations creating more protection for wetlands and streams in their control areas.
- Good quality construction timber production.

3.2.2 Weaknesses

- Perception of a lack of implementation of existing legislation governing the environment and the constraints thereon.
- Vegetation mapping of CBA’s and ESA’s not accurate enough to make sound decisions. The perception exists that this causes resentment towards conservation issues.
- Perception of a lack of proper management of household waste and its acceptable disposal.
- Perception that storm water drainage management is inadequate, resulting in blocked drainage systems and siltation of the Lagoon. Sewage treatment plants in close proximity to an international environmental asset.
- Poor general water catchment management, alien invasion, insensitive developments resulting in cumulative impacts downstream.
- The above resulting in embankment erosion, above ground water and aquifer pollution.
- Using wetlands as dumping grounds for waste and rubble.
The use of natural watercourses for storm water conduits, but not mitigating for accelerated water flows with concomitant stream bed erosion.

Inadequate ‘green lungs’ within the urban environment to allow for people’s daily recreational and spiritual needs.

Perception that a lack of innovative planning has resulted in ad hoc developments, and a degree of urban sprawl.

Limited water supply for farming and relatively small farming areas with poor to medium soil quality.

Lack of clear and attractive conservation incentive schemes to encourage alien eradication and watershed conservation on private land.

Inadequate water collection methods for household use.

Municipal natural environment and fynbos areas poorly protected and managed. Alien encroachment widely visible.

Perception that the municipal environmental section is reactive rather than proactive with low visibility. There is a perception that there is no specialized trained unit doing environmental compliance monitoring.

Perception that there is a lack of knowledge and understanding (on the part of both officials and the general public) to wisely utilise the natural environment for outdoor recreation and sustainable development.

Not taking enough cognisance of international trends in outdoor based recreation and tourism or anticipating change.

The lack of the marketing of smaller animals and insects as a niche tourist market.

Too little use of renewable energy sources.

Unstable geological dune formations limiting opportunities for expansion especially in Sedgefield.

Poor incorporation of Natural goods and services into municipal planning and operation.(creative system of rebates can ensure that biodiversity conservation is effectively managed on private land)

3.2.3 What if we carry on the same as in the Past?

There will be a loss of biodiversity, thus diminishing our natural heritage with all of its benefits and ecosystem services.

Even a perception of polluted rivers, estuaries the lagoon will drive visitors away.

Knysna and environs have a risk of running out of water for human consumption.

Estuaries may sit up and become less usable and attractive for water sport

Fish production in the estuaries and offshore reefs may diminish.

Infrastructure and private dwellings on low lying areas near beaches and estuary shores and rivers will become more vulnerable to storm surges.

Infrastructure and buildings close to the seastorm hazard level and estuary and rivers drainage lines will become more vulnerable to storm water during flood periods.
3.2.4 Conclusion

i. The area encompassed by the Knysna Municipality has many protected natural areas legislated as such by recognized environmental law. These include indigenous state forests, provincial nature reserves and other protected areas within the urban environment. Much of the development that has been allowed in the past has impacted to some degree on the natural environment and has placed strain on the healthy functioning of ecological systems that are so important in sustaining life and providing for man’s resources into the future.

ii. A number of documents have been commissioned and produced in the past, highlighting the state of the environment, notably: the Environmental Management Framework (EMF) by the DEA, the Rapid Conservation Assessment and Corridor Design by Dr Lombard and Knysna’s State of the Environment Report.

iii. Nevertheless, there are still some serious threats to our natural environment which will ultimately impact on the economy and the human population in the future. Of particular note and concern are the impacts on the rivers and streams of upstream activities in the catchment area, which have cumulative impacts on the estuary.

iv. The lack of adequate municipal waste disposal facilities is also a cause for concern. The quality of sewage discharge in Knysna estuary may conform with standards as far as pathogens are concerned, but the influence of amounts of available Nitrogen and Phosphorus clearly show in the green fringe recently developing around the Lagoon. The current state of siltation and pollutants entering into storm water systems and then ultimately into the lagoon, must receive attention.

v. Garden waste disposal as well as reduction of waste taken away to the George dump site should receive urgent attention. Building waste as well as garden waste is a wasted resource.

vi. Increasing population pressures will have an effect both on water resources and living space. This in turn will affect the preservation of biodiversity. The relatively small catchments areas and short rivers do not leave many options in terms of the choice in size and positioning of possible dam sites. The availability of good quality water for domestic and agricultural purposes is important. Related directly to this is the threat of alien invasive vegetation overrunning the catchment areas. Knysna and Swartvlei estuaries both face water quality issues due to eutrophication caused by (a) sewage effluent discharged into the estuary in Knysna and (b) pollution sources derived from agricultural activities and Informal Settlements in the catchment area of Swartvlei and Knysna.

vii. Global climate change creates conditions that may threaten infrastructure through sea level rise as well as greater storm damage. Precipitation may become more erratic causing unpredictable periods of drought and higher intensity rainfall and flooding. This can all potentially result in significant impacts on developments along sensitive river embankments and the shoreline. The predicted change in rainfall regime will put stress on the capacity of existing water resources.
4 ENVIRONMENTAL SYSTEM MAPS

Introduction

The question of whether the waterbody that forms an important feature of Knysna town is an estuary, a coastal lagoon or 'arm-of-the-sea' (marine embayment) has been a point of scientific discussion since early days.

Grindley, 1985\textsuperscript{23}, provides useful information on this and suggests that although the Knysna system is most commonly referred to as a lagoon, it may also correctly be called an estuary. Whereas the upper sections of the system (upstream of the N2 National Road bridges) are strictly estuarine and dependent on river flow, the rest of the system is largely a marine embayment but maintains estuarine characteristics mainly reflecting estuarine biota.

The categorisation of the lagoon part of the system as an estuary or a marine embayment is important for planning and design parameters, especially when specifying which water levels to use in the light of climate change and specifically the effect of sea level rise.

The DEA guideline is set at limiting development to areas above the +5 m MSL level within estuaries. The reasoning is that leaving the floodplain unrestricted below this level will allow the natural processes to prevail whilst removing the flooding risk to property. This guideline certainly holds for the areas where the system is 'strictly estuarine' as suggested in Grindley (1985) because the man-made flow restrictions caused by the road bridges and adjacent embankments (e.g. the White Bridge over the Knysna River and the culverts, bridge and embankments at the South River will cause backflooding during river floods. Tidal action within this 'strictly estuarine' environment further influences the flood water levels.

However, the physical characteristics of a 'marine embayment' implies that river flooding has very little effect on the water levels in this 'arm-of-the-sea'. For Knysna it is the fact that the channel to the sea through The Heads is very deep and offers little restriction to river floods, so no meaningful 'backflooding' due to river flood waters is possible. Having said this, the fact that there are also other constrictions in the 'lagoon' area (e.g. west of the railway bridge) can have an effect, but model studies by CSIR has shown this to be relatively little and insignificant compared to the effect of of the lagoon water level which is principally determined by the tidal state, atmospheric pressure and wind.

This means that the key consideration for development planning in a 'marine embayment' such as the 'lagoon' part of the Knysna system should be the latter.

The previous section has highlighted the key elements of the biological and physical components of the natural system within the study area.

By using a GIS, **Environmental Systems** maps are produced that demonstrate the existing environmental systems within the Knysna Municipality. The natural elements which make up these systems have been grouped and categorized according to the following:

**Core Conservation Area (dark green area on map):**
- SANParks National Park Boundary
- Indigenous Forest Areas
- Proclaimed Nature Reserves and Protected Areas
- Protected wetlands (NFEPA) Watercourses and buffers
- Slopes steeper than 1:4 (25% slope aspect)
- Areas vulnerable to climate change – area within predicted sea level rise (subject to publishing of DEA guidelines)

Development status for these Core Conservation Areas is as identified as statutory **no-go areas**

**Buffer Conservation Area (mid green areas on map):**
- Coastal Development Setback Line (100m in urban areas and 1000m in rural areas)
- Areas vulnerable to climate change – setback line based on hazard assessment according to DEA Guidelines.
- For the Knysna and Swartvlei (when open) the calculation for the 1-in-50 year storm surge level and the ‘best estimate’ SLR scenario of +0,35 m by 2050 and 1 m by 2100 give levels of 3 m in 2050 and 3,6 m by 2100.
- DEA setback guideline for estuaries taken as +5m MSL.

Development status for Buffer Conservation Areas is as identified as limited development outside existing urban areas – subject to appropriate Environmental Approval’s and other applicable legislation.

**Other Environmental - (light green):**
- Critically Endangered and Threatened Ecosystems
- Critical Biodiversity Areas and Ecological Support Areas

Development status for Other Environmental Areas is identified as areas of note where information is to be ground truthed - development subject to appropriate Environmental Approval’s and other applicable legislation.

Areas where sea level rise mitigation guidelines are applicable were also included in this section.. Extract of CSIR study is included (CSIR 2014)
To allow for river flooding, the national setback guideline for development next to estuaries is taken as +5 m above mean sea level.
ENVIRONMENTAL SYSTEM KARATARA & RHEENENDAL

BIND IN A3 MAP
Knysna Municipality
Integrated Strategic Development Framework
SEA: Natural Environmental Context

ENVIRONMENTAL SYSTEM OF THE KNYSNA AREA

BIND IN A3 MAP
APPENDIX 1: GLOSSARY OF KEY TERMS

Aquaponics:

A food production method that combines conventional aquaculture (raising aquatic animals in tanks) with hydroponics (cultivating plants in water) in a symbiotic environment. In normal aquaculture, waste generated by the animals being raised can accumulate in the water, increasing toxicity. In an aquaponic system, water from an aquaculture system is fed to a hydroponic system where the by-products are broken down by bacteria, which are utilised by the plants as nutrients. The water is then recirculated back to the aquaculture system.

Biodiversity:

The biological wealth of a specified geographic region: including the marine, aquatic and terrestrial ecosystems, communities of organisms within these, and their component species, number and genetic variation.

Biomimicry:

The imitation of the models, systems, and elements of nature for the purpose of solving complex human problems.

Blue Economy:

The Blue Economy seeks to identify examples in nature where organic recycling or upcycling occurs and mimic these processes to find out where and how the waste that we generate can be innovatively used again. The Blue Economy aims to analyse natural environmental systems and incorporate these processes into all aspects of development.

The Blue Economy also seeks to alter the way in which industrial processes function and thereby tackle persistent environmental problems, moving away from the use of rare and high-energy costly resources towards solutions based upon simpler and cleaner technologies.

Breaking New Ground (BNG) Housing:

A dwelling unit provided free of charge to an individual who currently earns less than R800 per month and qualifies for a full housing subsidy from the government. This entails one free standing/detached house on an individual, freehold erf.

Brownfield Development:

The reuse of previously developed land.

Civic Precinct:

A concentration of public facilities (e.g. schools, clinics, hospitals, parks, city hall, courthouses, post offices, etc.) located in close proximity to one another.

Coastal Edge:
A demarcated area around the coast, primarily to protect coastal resources, and to avoid hazards and financial risks pertaining to areas at risk of flooding.

**Communal Land:**

Land which is, or is to be, occupied or used by members of a community subject to the rules or custom of that community (Communal Land Rights Act 11 of 2004).

**Community:**

A group of people forming a social unit of any size that shares a common identity that may be based on common locational qualities (like place of work or residence) or other reasons based on social or cultural identity.

**Community Rental Units (CRU):**

A housing programme that targets low income households (currently with a household income of R800 - R1500 per month) who are not able to be accommodated in the formal private rental and social housing market. The programme seeks to bridge the divide between social housing and lower markets.

**Corridor:**

Links between nodes, along which an increased intensity of development may be encouraged. Corridors provide efficient access to a higher level of economic opportunities than would generally be the case in less structured space. They typically include public transport routes.

**Critical Biodiversity Area:**

Terrestrial and aquatic features in the landscape that are critical for conserving biodiversity and maintaining ecosystem functionality, and that are required to meet biodiversity targets (for biodiversity patterns and ecological process features).

**Credible [Spatial Development Framework (SDF)]:**

The definition credible includes the following meanings - plausible, believable, apparently reasonable and valid. It further means capable of being conceived. A credible SDF is therefore, one which has adequately analysed the state of the municipality and details the drivers for change and effectively gives direction for the future growth and development of the municipality in alignment with government policies. It should also be equipped with a thorough implementation plan, comprising costs, responsible persons, and lists of actions both short and long term.

**Cultural Landscape:**

Sites and landscapes of historical significance, areas of scenic beauty and places of spiritual and/or cultural importance.

**Density:**

The number of units (e.g. people, dwelling units, floor area) per unit of land area, e.g. dwelling units/hectare. There are five measures of density:
• population density: people/hectare

• gross dwelling unit density: dwelling units/total land area of a project or suburb including roads, public open space and non-residential land uses.

• net dwelling unit density: dwelling units/land occupied by residential plots only.

• building density: floor area of buildings or footprints/land area.

• settlement density: dwelling units total land occupied by settlement also known as average gross dwelling unit's density.

**Densification:**

Densification is the increased use of space both horizontally and vertically within existing areas/properties or new developments, accompanied by an increased number of units and/or population.

**Development Contributions:**

Contributions, usually financial, levied from a developer by the supply authority for the external provision of services (e.g. water, sewer, electrical) to the development site. Also known as augmentation levy.

**Development Corridor:**

Broad areas of high-intensity urban development focused predominantly on activity/development routes serviced by mass rapid public transport services (i.e. rail or BRT). Also see Corridor.

**Development Objective**

The wider goal or purpose to which the development process or project / programme contributes significantly, but cannot achieve alone.

**Development Services Line:**

A line located within the development corridor or node indicating the limit to infrastructure availability and capacity. This line may coincide with the Urban Development Line (UDL) or may fall within the UDL boundary. The urban area may have a number of development services phasing lines related to future servicing capacity and infrastructure indicating where and when future development can be serviced.

**Ecological Goods & Services:**

Goods and Services that indirectly accrue from the natural environment, and do not have direct market values, such as flood attenuation, natural drainage and erosion prevention, wastewater management through biological treatment, air quality management and filtration, carbon sequestration, and biodegradable waste disposal.

**Efficiency:**
Maximisation of development goals such as sustainability, integration, accessibility, affordability, and quality of living, relative to financial, environmental, and social costs, including ongoing and future costs.

Environmental Management Framework (EMF):

An EMF provides a study of the biophysical and socio-cultural systems of a geographically defined area to reveal where specific land uses may best be practiced. Offers performance standards for maintaining appropriate use of such land.

Finance Linked Individual Subsidy Programme (FLISP):

A housing program that provides individual subsidies linked to the household income of the applicant to enable the applicant to acquire a residential property or to construct a house. This subsidy is subject to the approval of a mortgage loan and targets the low and middle income households (currently household income of R3501 - R15000 per month).

Food Security:

Physical and economic access, at all times, to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life.

Gap Housing:

Housing for households with a current monthly income of between R3 500 and R10 000, that fall outside the government housing subsidy income limit of R3500 per month, and find it difficult to access housing in the private market.

Greenfield Development:

Development of land that has not previously been used for urban uses. The development of virgin or agricultural land.

Green Economy:

An economy that results in reducing environmental risks and ecological scarcities, and that aims for sustainable development without degrading the environment.

Gross Domestic Product-Region (GDP-R):

GDP-R measures the real economic output of a specific geographic area for a particular time period, usually one year.

Hamlet:

A settlement too small to support a church or school.

Heritage Resource:

Any place or object of cultural significance; according to the National Heritage Resources Act (Act 25 of 1999) NHRA Unique, non-renewable and precious locations; including sites and landscapes of historical significance, areas of scenic beauty, and places of spiritual and/or cultural importance.
Hydroponics:

Hydroponics refers to the cultivation of plants by placing their roots in liquid nutrient solutions rather than in soil. Hydroponics is effectively the soilless growth of plants and is therefore not hampered by poor soil quality or unsuitable climates.

Immediate Objective:

The situation that is expected to prevail at the end of the intervention / project / programme and is directly influenced by it.

Incremental Densification:

Small-scale densification that is almost invisible, e.g. subdivision of single plots into two and the addition of second dwellings (granny flats) on single erven.

Infill Development:

Development of vacant or under-utilised land within existing settlements in order to optimise the use of infrastructure, increase urban densities and promote integration.

Informal Settlement:

An unplanned settlement or portion of settlement that has not been constructed according to an approved general plan. Dwellings have often been constructed in an ad hoc manner and without reference to National Building Regulations. Informal settlements also often lack basic services infrastructure or social services.

Integrated Development Plan (IDP):

The Strategic Municipal Development Plan, reviewed on an annual basis, required by the Municipal Systems Act (MSA) (Act 32 of 2000) which guides municipal decisions and budgets as well as the development programs of State Owned Enterprises (SoEs) and the private sector.

Knowledge Economy:

The knowledge economy is the use of knowledge to generate tangible and intangible values.

Land Redistribution:

Redistribution of land to the landless poor, labour tenants, farm workers, and emerging farmers for residential and productive uses to increase livelihoods and improve quality of life.

Land Use Intensification:

The act of providing an increased spectrum of mixed uses (commercial, industrial and residential) through the increased use of space, both horizontally and vertically, within existing areas or properties or new developments, often accompanied by densification.

Land Use Management:
Establishing or implementing any measure to regulate the use or a change in the form or function of land. It includes land development (S1, Land Use Management Bill, 2008).

**Land Use Management System:**

A system used to regulate land use in a municipality, including a town planning or zoning scheme, or policies related to how land is used on an Erf by Erf basis.

**Logical Framework Approach (Logframe)**

A flexible tool for participatory development (DANIDA)

**Mixed Land Use:**

Development that combines two or more different types of land use, such as residential, commercial, employment, and entertainment uses, in close proximity.

**Mobility Route:**

Routes of national significance that connect the Municipality at a national and provincial scale, e.g. the N2.

**Municipal Open Space System (MOSS):**

An interconnected and managed open space network that supports interactions between social, economic and ecological activities, sustaining and enhancing both ecological processes and human settlements; includes natural areas and active and passive recreation areas such as sports fields, parks, and squares but also cemeteries, detention ponds, servitudes, river corridors and road reserves.

**New Development Area:**

An area earmarked for future development.

**Nodal Development:**

Significant and concentrated development in terms of scale, location, impact, diversity and agglomeration of functions (facilities, services and economic activities).

**Node:**

Area where a higher intensity of land uses and activities are supported and promoted. Typically any given municipal area would accommodate a hierarchy of nodes that indicates the relative intensity of development anticipated for the various nodes, their varying sizes, and their dominant nature.

**Node of Opportunity (NoO):**

An area which lends itself to specific economic activities.

**Non-Motorised Transport (NMT):**
Transport modes that are not motorised, e.g. walking and cycling.

**Outputs:**

Tangible, specific and direct products of particular activities within an intervention that is under direct control of the project managers.

**Permaculture:**

The conscious design and maintenance of agricultural productive systems which have the diversity, stability, and resilience of natural ecosystems. It is similar to the Blue Economy concept, but is more specific to agricultural production.

**Priority Intervention Zones:**

A location identified for intervention/action by the Municipality, other spheres of government or state owned enterprises. The interventions may take a variety of forms e.g. dealing with “crime and grime”, investing in bulk infrastructure and social facilities, improvements to the quality of the built environment and the introduction of development incentives.

**Public Transport Interchange:**

Supports the transfer of public transport users between modes (rail/bus/taxi) but also functions to support economic activity.

**Restructuring Zone:**

A restructuring Zone is a geographical area identified by a municipality and which is supported by the relevant provincial government for targeted capital investment in higher density residential developments (excluding detached dwellings) managed by approved housing institutions, where spatial, social and economic restructuring will be achieved. These areas are proclaimed by the Minister of Human Settlements in the Government Gazette.

**Rural Area:**

Area/s outside urban settlements where population densities are less than 150 people / km²; and dwelling densities are less than 1 dwelling unit per hectare.

**Rural Residential:**

Extensive land units (ranging in size) located outside an urban area.

**Scenario:**

A plausible and often simplified model of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships (IPCC, 2007). Often a set of different scenarios are considered as part of the process of agreeing a way forward.

**Strategic Environmental Assessment (SEA):**

A system of incorporating environmental considerations into policies plans and programmes.
Sector Plan:

Municipal plan/s that fulfill different functions such as bio-diversity, conservation, housing, transport, local economic development and disaster management. They may also be geographically based, for example a sub-region, settlement within a local Municipality or a component of a settlement.

Settlement:

A physical space in which people reside.

Social Housing:

Rental or co-operative housing for low to middle income persons with a current monthly household income of R1 501 - R7 500. These units are provided and managed by social housing institutions.

Spatial Planning:

A planning process that is inherently integrative and strategic, takes into account a wide range of factors and concerns and addresses how those aspects should be arranged on the land.

Spatial Development Framework (SDF):

A core component of a Municipality's economic, sectoral, spatial, social, institutional, and environmental vision. An SDF is a tool to achieve the desired spatial form of the Municipality by providing a framework that seeks to guide, overall spatial distribution of current and desirable land uses within a municipality in order to give effect to the vision, goals and objectives of the municipal Integrated Development Plan (IDP). The aims of a spatial development framework are to promote sustainable functional and integrated human settlements, maximise resource efficiency, and enhance regional identity.

Special Economic Zone (SEZ):

An economic development tool to promote economic growth and exports in a specific geographic, using support measures (i.e. tax incentives, lower tariffs etc.) to attract targeted domestic and foreign direct investment.

Stakeholders:

Agencies, organisations, groups or individuals who have a direct or indirect interest in a development intervention or its evaluation (African Development Bank, et al, undated).

Standard Industry Classification (SIC):

Standard Industrial Classification codes (SIC Codes), are an internationally accepted set of codes for the standard classification of all economic activities. The SIC codes are designed for the classification of establishments according to the kind of economic activity, and provides a standardised framework for the collection, tabulation, analysis and presentation of statistical data on establishments.

Strategy:

The pattern of decisions in an organisation that:
• determines and reveals its objectives, purposes, or goals,
• produces the principal policies and plans for achieving those goals, and
• defines the range of business the organisation is to pursue, or
• the kind of economic and human organisation it is or intends to be, and
• the nature of the economic or non-economic contribution it intends to make to its shareholders, employees, customers and communities.

Subsidised Housing:

Housing supplied in terms of the National Department of Housing's housing subsidy scheme.

Sustainable Development:

Development that requires the integration of social, economic and environmental factors in the planning, implementation and evaluation of decisions to ensure that development serves present and future generations (NEMA, 107. of 1998).

Top Structure:

The building on an Erf.

Town Planning Scheme or Zoning Scheme:

A legal instrument for regulating the use of land in terms of provincial or national legislation, Land Use Management.

Traditional Neighbourhood Development (TND):

The development of a complete neighbourhood or town using traditional planning principles. TND may occur in infill settings and involve adaptive reuse of existing buildings, but often involves all-new construction on previously undeveloped land. To qualify as a TND, a project should include a range of housing types, a network of well-connected streets and blocks, humane public spaces, and have amenities such as stores, schools, and places of worship within walking distance of residences.

Transport Orientated Development (TOD):

A mixed-use residential and commercial area designed to maximize access to public transport. A TOD neighbourhood typically has a centre with a train station, bus stop, or taxi stop, surrounded by relatively high-density development and progressively lower-density development spreading outward from the centre. TODs generally are located within walking distance (500m) from stations.

Urban Areas and Urban Development:

Areas that generally conform to the following parameters:

• places where population densities are greater than 150 people / km²
• dwelling unit densities greater than 1 per hectare- settlement contained within an Urban Edge
• services are provided on a centralised on-grid reticulation system

• some primary sector activities and urban agriculture, building materials, resource extraction but mainly secondary and tertiary economic activity

**Urban Core:**

The urban core consists of the inner core areas of the Municipality including the traditional Central Business District (CBD) area and surrounds. The planning within the urban core mainly focuses on redevelopment and regeneration where land uses are unlikely to change significantly but will increase densities and provide an increase in residential opportunities

**Urban Development Line (UDL):**

The SDF uses the term Urban Development Line and not Urban Edge or Development Edge. The UDL is a line demarcating the extent to which urban development will be permitted to be established within an urban Development Corridor or urban node. It is a line that will promote efficient, equitable and sustainable settlement form. The line indicates the outer limit of urban development within a corridor or node. The UDL implies that there is a rural hinterland different in character and servicing needs, and which supports different lifestyles and densities.

**Urban Development Zone (UDZ):**

In an effort to reverse inner city urban decay and revitalise CBD’s, the South African government has sought to introduce an economic incentive to encourage reinvestment in these areas. The Urban Renewal Tax Incentive aims to promote private sector investment in property with the aim of rejuvenating inner city economies. This incentive takes the form of an accelerated depreciation allowance for construction, extensions, additions, improvements and/or refurbishments of buildings undertaken by the private sector within a specified Urban Development Zone.

**Urban Restructuring Zone (URZ):**

A well located area where the National Housing Department subsidy, as defined in terms of the Social Housing Act (No 16 of 2008) applies.

**Urban Sprawl:**

The usually uncontrolled and poorly managed expansion of areas across the landscape and the conversion of natural and agricultural areas to urban areas. Urban sprawl includes the expansion of major roadways, not just housing and commercial areas. It is usually associated with increased automobile usage, water and air pollution and inefficient use of infrastructure.

**Village:**

A clustered human settlement, larger than a hamlet and usually smaller than a town, with the population ranging from a few hundred; often located in a rural area.

**Water Security:**

The reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks.
APPENDIX 2: LEGISLATIVE AND POLICY CONTEXT

The following table provides a summary of the implications for the Greater Knysna Municipality.

<table>
<thead>
<tr>
<th>IMPLICATIONS FOR KNYSNA OF IDENTIFIED KEY DOCUMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knysna Municipality should:</td>
</tr>
<tr>
<td>• have a developmentally orientated approach;</td>
</tr>
<tr>
<td>• ensure the provision of services to communities in a sustainable manner</td>
</tr>
<tr>
<td>• promote social and economic development</td>
</tr>
<tr>
<td>• promote a safe and healthy environment</td>
</tr>
<tr>
<td>Spatial Planning and Land Use Management Act (Act 16 of 2013) (SPLUMA)</td>
</tr>
<tr>
<td>Over the last few years, from 2007 – 2012 the focus of the KM has been on the upgrading of informal settlements, rightly so if one considers that the Socio-Economic Survey for the Eden District Municipality (2006) indicated that almost 50% of the housing stock in the Northern Loop areas of Knysna was (at that stage) informal housing. Though a lot has been done since 2006 there are still approximately 4178 informal dwellings (as per the findings of the Social Economic Survey and Analysis: Knysna Northern Suburbs Report, 2014) in the KMA. Some of the informal settlements lie in areas where environmental constraints, geological conditions and the availability of land make it increasingly difficult to comply with the SPLUMA development principles. Any vacant land (i.e. Heidevallei) which is centrally located is therefore considered extremely valuable and should be carefully assessed to ensure that proposals made comply with the 5 main development principles of SPLUMA.</td>
</tr>
<tr>
<td>Spatial implications of SPLUMA for Knysna include:</td>
</tr>
<tr>
<td>Locate new development for the poor in places that are accessible to municipal services, facilities and amenities;</td>
</tr>
<tr>
<td>Protect prime agricultural land;</td>
</tr>
<tr>
<td>Limit urban sprawl;</td>
</tr>
<tr>
<td>Create viable communities through accessibility and provision of social infrastructure and amenities.</td>
</tr>
<tr>
<td>National Heritage Resources Act, 1999 (Act 25 of 1999)</td>
</tr>
<tr>
<td>This Act makes provision for the grading of Heritage resources. When Council becomes a heritage authority in terms of the National Heritage Resources Act, 1999 (Act 25 of 1999) it may determine the appropriate level of grading of a heritage resource in addition to the assessment criteria set out in the</td>
</tr>
</tbody>
</table>
### IMPLICATIONS FOR KNYSNA OF IDENTIFIED KEY DOCUMENTS

| National Heritage Resources Act, according to the following categories: |
|---|---|
| **Grade I**: Heritage resources with qualities so exceptional that they are of special national significance; |
| **Grade II**: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region, and |
| **Grade III**: Other heritage resources |

The Knysna SDF should identify heritage resources and provide guidelines to ensure protection of the heritage resources.

The identified heritage resources could then be included in overlay zones in the applicable zoning scheme bylaw.


Any activity, be it mining, planning, commercial etc., that impacts on the natural environment must comply with the principles of NEMA.


This act stipulates guidelines with regard to:

- The demarcation of forest areas: If the minister is of the opinion that it is necessary that any demarcated forest or part thereof be entrenched against alienating by being converted into demarcated forest he may, after following a procedure aimed at accommodating objections, declare the demarcated forest or part of a forest to be demarcated;
  - The management of protected deforestation areas;
  - Access to state forests for recreation, educational and cultural activities;
  - Assistance for community forestry.
  - The Knysna plans should indicate:
    - Areas for forestry purposes.
    - Indigenous forest corridors that have to be protected.


This Act prescribes specific guidelines with regard to sustainable water usage and the following requirements are relevant:

- Meeting the basic human needs of present and future generations;
### IMPLICATIONS FOR KNYSNA OF IDENTIFIED KEY DOCUMENTS

- Promoting equitable access to water;
- Redressing the results of past racial and gender discrimination;
- Promoting the efficient sustainable and beneficial use of water in the public interest;
- Facilitating social and economic development;
- Provision in the growing demand for water use;
- Protecting the aquatic and associated ecosystems and their biological diversity;
- Reducing and preventing pollution and degradation of water resources;
- Managing floods and droughts.

#### Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983)

In order to achieve the objectives of this Act the Minister prescribed control measures applying to certain agricultural land users. These measures include amongst others:

- No land user shall cultivate any virgin soil, without the written permission of the executive officer of the Department of Agriculture – *i.e. prevent the transformation of virgin soil for agricultural purposes, unless required for food security*;
- No land user shall cultivate any land if it has a slope of more than 20 percent, without the written permission of the executive officer of the Department of Agriculture – *i.e. avoid agricultural activities on steep slopes*;
- Every land user shall protect the cultivated land on his farm unit effectively against water and wind erosion – *i.e. allow for sufficient buffers along water courses*;
- No land user shall utilise the vegetation in a vlei, marsh or water sponge or within the flood area of a water course or within 10 meters horizontally outside such flood area in a manner that causes or may cause the deterioration of or damage to the natural agricultural resources – *i.e. allow for sufficient buffers along water courses*.

#### National Environmental Management: Integrated Coastal Management Act (No 24 of 2008)

The Knysna Municipality coastal area will be managed by the Eden District Municipality in terms of its Coastal Management Programme.

Development should be located in such a manner that it is not affected by potential hazards. This will require the determination of setback lines and buffer zones.

No development may take place within determined setback lines.

#### Draft Western Cape Provincial Spatial Development Framework (PSDF), (2013)
IMPLICATIONS FOR KNYSNA OF IDENTIFIED KEY DOCUMENTS

On a Provincial level, Knysna Municipality has been identified as an area for:

- Agri-Industrial Investment
- Eastern Tourism Gateway
- Hence the Knysna plans have to strive to support the tourism and agricultural sector.
- Key principles for Knysna to follow as a result of the PSDF include:
  - Protect the municipal area’s sense of place by avoiding inappropriate development.
  - Avoid inappropriate development in rural villages and hamlets in order to retain their sense of scale and rootedness.
  - Align land use planning with transport planning at all scales and move towards transit-orientated development offering optimal levels of pedestrian and public transport accessibility and safety while also reinforcing urban street hierarchies through transport connectivity and diversity.
  - Shift towards more compact, mixed-use settlements where it is easy to get around on foot, bicycle, or by transit.
  - Clarify the economic role and function of towns within a municipality or region to establish a clear settlement hierarchy to guide investment and planning decisions
  - Shift from a uniform model of “housing delivery” to support for delivering housing opportunities and sustainable communities. Pro-active responses to the realities of informal housing must ensure that settlements are made as accessible, safe and liveable as possible. This includes finding constructive and sustainable solutions to informal settlements, the risks associated with backyard dwellers and new migrants.

Draft WC Provincial Growth Potential Study (2013)

According to this study, the towns within the Knysna Municipal Area have been classified as follows:

- Knysna (tourism settlement): High development potential, medium social needs;
- Brenton-on Sea (tourism settlement): High development potential, very low social needs;
- Buffalo bay (tourism settlement): Medium development potential, low social needs;
- Sedgefield (residential/tourism settlement: Medium development potential, low social needs;
- Rheenendal (residential settlement): Medium development potential, high social needs.
- Karatara has not been included in this study but from other studies undertaken, it is clear that this settlement has high social needs and limited development potential.
### IMPLICATIONS FOR KNYSNA OF IDENTIFIED KEY DOCUMENTS

<table>
<thead>
<tr>
<th>Provincial Urban Edge Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Given the criteria, issues and facilities for determining Urban Edges, they should be determined to:</td>
</tr>
<tr>
<td>• Exclude prominent landforms and environmental character areas from the urban area;</td>
</tr>
<tr>
<td>• Exclude valuable soils for agricultural purposes;</td>
</tr>
<tr>
<td>• Exclude valuable soils for mining purposes;</td>
</tr>
<tr>
<td>• Exclude surface and ground water resources that could be used to produce potable water;</td>
</tr>
<tr>
<td>• Exclude surface and ground water features;</td>
</tr>
<tr>
<td>• Exclude ecological resources and establish suitable; ecological corridors to link resource areas;</td>
</tr>
<tr>
<td>• Exclude all statutorily declared, proclaimed and protected natural areas;</td>
</tr>
<tr>
<td>• Exclude high intensity use and high potential agricultural resources and activity areas;</td>
</tr>
<tr>
<td>• Exclude scenic routes and routes of tourism significance;</td>
</tr>
<tr>
<td>• Exclude cultural and heritage resource areas and sites;</td>
</tr>
<tr>
<td>• Exclude areas that have visual sensitivity, skylines, mountainsides, ridgelines and hilltops; and</td>
</tr>
<tr>
<td>• Exclude the WC-PSDF defined core areas.</td>
</tr>
</tbody>
</table>

In the case of Knysna Municipality the following informants, amongst others will play a critical role in the determination of the Urban Edge:

• Core conservation areas with the a focus on its preservation – Proclaimed nature reserves
• Rivers and River buffers
• Steep Slopes
• Scenic landscapes and view shed
• Agricultural land required for food security

### Eden District Municipality SDF, 2009

The Eden District Municipality Spatial Development Framework was completed in 2009. The document proposed policies and strategies for the growth of the Eden District and its settlements.

### Eden District Coastal Management Programme (DRAFT), May 2012
**IMPLICATIONS FOR KNYSNA OF IDENTIFIED KEY DOCUMENTS**

In terms of the EDCMP the following are important for the municipality:

- Reasonable and equitable access to the coastal public property for all must be achieved without negatively impacting on the environment.

- Existing infrastructure and development in the coastal zone (coastal public property, coastal protection zone, coastal access land, coastal protected areas, seashore, coastal waters and exclusive economic zone) must be maintained or upgraded and existing spatial planning strategies should be enforced.

- Future infrastructure and development should be restricted to land already zoned accordingly and no new zonings should be considered in the Coastal Protection Zone (CPZ).

- New spatial planning strategies must regard the CPZ as a “no-go” area for infrastructure and development.

- Innovative spatial planning strategies are required to protect and conserve biodiversity.

- Heritage resources should be recognized, protected and shared with all.

- Water resources are to be managed to ensure a clean and healthy environment.

- Implementation of the CMP should be a priority and funds should be made available.

- Education and awareness programmes related to the environment and coastline should be implemented.

- Create an enabling environment that will encourage economic development, tourism and recreation whilst preserving the integrity of the environment.

- Utilise resources sustainably and in compliance with applicable legislation.

**NDPG Business Plan, Knysna Northern Corridor, 2013**

In 2013, the Knysna Municipality commissioned The Matrix cc, together with Dojon Financial Services, to draft the first part of this Business Plan for the Knysna Northern Corridor, which comprises the area of Knysna from the Gray Street intersection in Knysna’s CBD, looping north and east until it links to the N2 in the east at the SANLAM Node. This Business Plan was designed to propose interventions in the area of the Northern Corridor which could both improve infrastructure and living conditions in this area, as well as unlock commercial investment opportunities.

**Draft NDPG Business Plan, Hornlee, 2014**

From the legislative review in this report, it was concluded that the Hornlee gateway area was identified as an important and potentially catalytic project for the area, as various community facilities as well as the commercial node is located here. Moreover, it was found that the gateway is the main access point into Hornlee and is the first impression people will have of the area, which makes it an
### IMPLICATIONS FOR KNYSNA OF IDENTIFIED KEY DOCUMENTS

**Draft NDPG Business Plan, Sedgefield, 2014**

This business plan reviewed various studies that have been undertaken, projects that have been proposed, and needs that have been identified in the area. It proposed that two main scenarios should be considered, namely (1) the rerouting of the N2 Freeway and (2) retaining the N2 Freeway in its current position, with possible implications and opportunities.

**Bitou Municipality SDF (2013)**

The Bitou SDF was adopted by the Bitou Municipality during May 2013. This SDF abuts the eastern boundary of Knysna Municipality.

The document made strategic recommendations on the growth of the urban settlements within the Bitou Municipal area and its hinterland. Knysna planning needs to take cognisance of these strategies so as to build on synergies, maximise mutual benefits and avoid areas of conflict or the duplication of efforts.

**George Municipality SDF (2013)**

George Municipality borders the western and north-western boundary of Knysna Municipality. The George Municipality’s Spatial Development Framework, dated May 2013, allows Knysna planning to take cognisance of these strategies so as to build on synergies, maximise mutual benefits and avoid areas of conflict or the duplication of efforts.
APPENDIX 3: SEA LEVEL RISE & CLIMATE CHANGE

An extract from CSIR (2014) on Sea Level Rise and Climate Change

Compiled by A. T. Theron of the CSIR (Atheron@csir.co.za)

Global average eustatic or absolute Sea Level Rise (SLR) is mainly due to a combination of an increase in ocean volume due to lower seawater density, arising from a warmer ocean temperature and lower salinity, and an increase in ocean mass due to a redistribution of fresh water from land-based storage (e.g. glaciers, ice sheets, dams, lakes, rivers and groundwater) to the oceans (Ministry for the Environment, New Zealand, 2008). Thus, the sea level rises when meltwater from land-based masses of ice, such as glaciers, flows into the ocean, but the sea level also increases when heat from the atmosphere is mixed into the upper layers of the ocean, causing that water to expand. In recent decades, this thermal expansion has caused, on average, only about one quarter of the SLR seen each year, but its contribution is increasing (Gillett et al., 2011).

Researchers are now pointing towards an even bigger threat from warm ocean waters: the floating ice shelves that ring Antarctica could melt, and so could the seaward end of land-based ice streams, which would lead to a long-term, catastrophic rise in sea level (Gillett et al., 2011). In combination with other factors, such as subsidence and glacial isostatic adjustment, SLR relative to the land will be highly localised (PIANC, 2008). At mid latitudes the mean SLR will be generally higher than in the equatorial area (IPCC, 2007) due to changes in ocean density distribution (steric SLR).
Measured and projected sea level rise (Nicholls & Cazenave, 2010)
(The blue, green and red bars are projections from different authors.)

Recent observations from satellites, very carefully calibrated, are that global SLR over the last decade has been 3.3 +/- 0.4 mm/yr (Rahmstorf et al., 2007). The IPCC AR4 Report (IPCC, 2007) concludes that anthropogenic warming and SLR would continue for centuries due to the timescales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilised. Comparisons between about 30 years of South African tide gauge records and the longer-term records elsewhere show substantial agreement. A recent analysis of seawater levels recorded at Durban confirms that the local rate of SLR falls within the range of global trends (Mather, 2008). Present SA SLR rates for the east coast are + 2.74 mm/yr-1 (Mather et al., 2009).

Comparison of minimum and maximum estimates of global sea level rise by the year 2100 (USACE, 2011)(Note: The post-2007 studies give an overall range of about 0.5 m to 2 m.)

Sudden large rises in sea level (possibly several metres) due to catastrophic failure of large ice shelves (e.g. Church & White, 2006) are still considered unlikely this century, but events in Greenland (e.g. Carlson 2011; Gregory 2004; Overland, 2011) and Antarctica (e.g. Bentley, 1997; Thomas et al., 2004) may soon force a re-evaluation of that assessment. In the longer term, the large-scale melting of large ice masses is inevitable. Recent literature (since IPCC, 2007) gives a wide range of SLR scenarios, as indicated in the figure above.

Some projections and scenarios are even higher, but most “physics-/process-based” projections (e.g. Church et al., 2011; Milne et al., 2009; Nicholls & Cazenave, 2010; Pfeffer et al., 2008; SWIPA, 2011)
for 2100 are in the 0.5 m to 2 m range, as is also concluded in various reviews (e.g. Fletcher, 2009; Rossouw & Theron, 2009; Theron, 2011).

It is concluded that the best estimate (or ‘central estimate/mid scenario’) of SLR by 2100 is around 1 m, with a plausible worst-case scenario of 2 m and a best-case scenario (low estimate) of 0.5 m (Theron et al., 2012). The corresponding best estimate (mid-scenario) projections for 2030 and 2050 are 0.15 m and 0.35 m, respectively.

References:

Bentley, 1997
Carlson 2011
Church et al
Church & White, 2006


Fletcher, 2009
Gillett et al., 2011
Gregory 2004
IPCC, 2007
Mather, 2008
Mather et al., 2009
Milne et al., 2009

Ministry for the Environment, New Zealand, 2008
Nicholls & Cazenave, 2010
Overland, 2011
PIANC, 2008
Pfeffer et al., 2008
Rahmstorf et al., 2007
Rossouw & Theron, 2009

SWIPA, 2011
Thomas et al
Theron, 2011
Theron et al., 2012

USACE, 2011