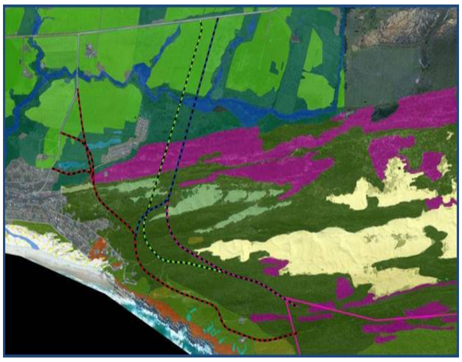
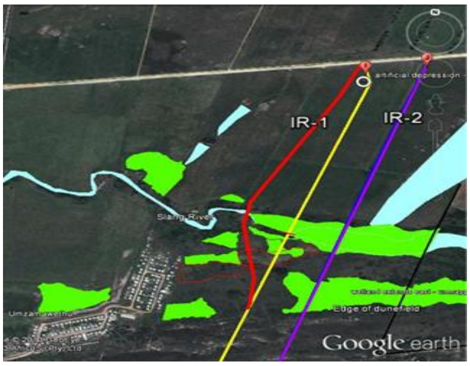
Eskom Holdings Limited

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR-1') AND ASSOCIATED INFRASTRUCTURE: ASSESSMENT OF ALTERNATIVES FOR THE WESTERN ACCESS ROUTE TO THE THYSPUNT SITE





Prepared by: GIBB Pty Ltd

On behalf of: Eskom Holdings Ltd

J27035/J31314

Date: August 2015

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31 January 2013

DECLARATION OF INDEPENDENCE

I, A Barrie Low as duly authorised representative of Coastec, hereby confirm my independence of Coastec as a specialist and declare that neither I nor Coastec has any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear-1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

____

Full Name: Arthur Barrie Low

Title / Position: Owner

Qualification(s): MSc

Experience (years/ months):

Registration(s): MSAIE&ES

The Freshwater Consulting Group

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Zeekoevlei
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20 January 2013

DECLARATION OF INDEPENDENCE

I, Elizabeth (Liz) Day as duly authorised representative of Freshwater Consulting cc (t/a The Freshwater Consulting Group / FCG), hereby confirm my independence as a specialist and declare that I do not have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear-1') – Assessment of Western Access Road Alternatives. I further declare that I am confident in the results of the studies undertaken by FCG and the conclusions drawn – as is described in my report, and subject to the assumptions and levels of certainty stated therein.

____

Full Name: Elizabeth Day
Freshwater Consulting Group
lizday@mweb.co.za

Title / Position: Dr
Qualification(s): BA, BSc, BSc Hons, PhD
Experience: 15 years in freshwater ecosystems
Registrations: Member of IAIA; Member of SAIEES; Registered Professional Natural Scientist by SACNASP (Reg No 400270/08) for fields of Biological Science, Ecological Science and Zoological Science

ACO Associates *cc.*
Archaeology and Heritage Specialists

Postal: 8 Jacobs Ladder, St James, 7945
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24th January 2013

DECLARATION OF INDEPENDENCE

I, David John Halkett as duly authorised representative of ACO Associates cc hereby confirm my independence (as well as that of ACO Associates cc) as a specialist and declare that neither I nor ACO Associates cc have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear-1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

____

Full Name: David John Halkett

Title / Position: Director and Principal investigator
Qualification(s): BA, BA Hons, MA (Archaeology)
Experience (years/ months): 25 years
Registration(s): Member of the Cultural Resource Management section of the Association of Southern African Professional Archaeologists (ASAPA). Member number: 044

10 January 2013

DECLARATION OF INDEPENDENCE

I, Mark Hylton Marshall as duly authorised representative of Sandula Conservation cc. hereby confirm my independence (as well as that of Sandula Conservation cc as a specialist and declare that neither I nor Sandula Conservation cc. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear-1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

____

Full Name: Mark Hylton Marshall

Title / Position: Owner of company

Qualification(s): National Certificate in Nature Conservation

Experience (years/ months): 14 years

Registration(s): 2007/004018/23

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21 January 2013

DECLARATION OF INDEPENDENCE

I, A.W.D. Jongens as duly authorised representative of Jongens Keet Associates, hereby confirm my independence (as well as that of Jongens Keet Associates) as a specialist and declare that neither I nor Jongens Keet Associates have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which Arcus GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear 1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

____

Full Name: Adrian Wynand Doride Jongens

Title / Position: Associate

Qualification(s): M.Sc. (Electrical) Engineering

Experience (years/ months): 39 years

Registration(s): Engineering Council of South Africa, Reg. Nr 805412
South African Institute of Electrical Engineers
Southern African Acoustics Institute
Nederlands Akoestisch Genootschap

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09 September 2015:

DECLARATION OF INDEPENDENCE

I, Elisabeth Nortje as duly authorised representative of GIBB (Pty) Ltd, hereby confirm my independence (as well as that of GIBB as a specialist and declare that neither I nor GIBB have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear-1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

____

Full Name: Elisabeth Maria Nortje

Title / Position: Sector Unit Manager

Qualification(s): BSc (Geology), BSc Hons (Geology), Post Graduate Diploma (Environmental Science)

Experience (years/ months): 16 years

Registration(s): IAIASA

EXECUTIVE SUMMARY

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

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

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

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

STUDY APPROACH

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

SUMMARY OF IMPACTS

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

Summary of Impact Significance with and without mitigation

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

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

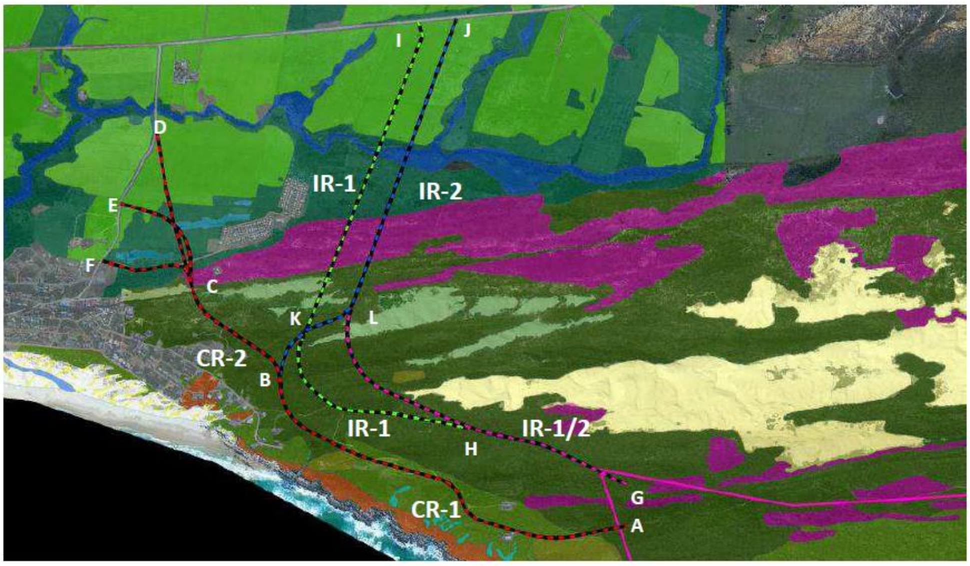
IMPACT	SIGNIFICANCE
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
Coastal to Inland Route 2, alternative 2 (CR-1 to IR-2): A-B-L- -J	
Unmitigated	**Very High**
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
ASSESSMENT OF IMPACTS TO INVERTEBRATES AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Loss and transformation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Degradation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Fragmentation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Low**
Water contamination of invertebrate wetland habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Water contamination of invertebrate wetland habitat as a result of the operation of the proposed access route	
Unmitigated	**High**
With prescribed mitigation	**Medium**
ASSESSMENT OF IMPACTS TO VERTEBRATES AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Route Alternative W1, W2, W3	
Corridor continuity - **The ecological corridor may be disturbed when permanent structures are placed within an functional habitat**	
Unmitigated	**Low**
With prescribed mitigation	**Very Low**
Fragmentation of certain habitats - Certain habitats become isolated from one another due to permanent structures, or if a habitat is small and is divided into sections, these sections will no longer be able to function ecologically	
Unmitigated	**Low**
With prescribed mitigation	**Very Low**
Route Alternative W4	
Corridor continuity - **The ecological corridor may be disturbed when permanent structures are placed within an functional habitat**	
Unmitigated	**High**
With prescribed mitigation	**Very Low**
Fragmentation of certain habitats - Certain habitats become isolated from one another due to permanent structures, or if a habitat is small and is divided into sections, these sections will no longer be able to function ecologically	
Unmitigated	**Very Low**
With prescribed mitigation	**Very Low**
Vertebrate mortality on roads - Frequent truck/vehicle road activity will result in mortality of vertebrates	
Unmitigated	**High**
With prescribed mitigation	**Medium**

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

IMPACT	SIGNIFICANCE
Unmitigated	Low
With prescribed mitigation	Low
Impact of IR-1 on Noise Receptors due to construction activities	
Unmitigated	Low
With prescribed mitigation	Low
ASSESSMENT OF IMPACTS OF THE HYDROGEOLOGICAL ENVIRONMENT ON THE IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Impendence of groundwater flow due to road excavation extending below the groundwater table – All Routes	Negligible
Contamination of aquifers by accidental spills of fuel and hazardous chemicals – All Routes	
With prescribed mitigation	Low
ASSESSMENT OF IMPACTS OF THE HYDROTECHNICAL ENVIRONMENT ON THE IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Introducing point load contamination due to the need for stormwater management to mitigate erosion risks – All Routes	
Unmitigated	Low
With prescribed mitigation	Negligible
Poor founding conditions introducing excessive cuts through the dunes – All Routes	
Unmitigated	Medium
With prescribed mitigation	Low

RECOMMENDATION

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



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

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

SPECIALIST	CR-1 & CR-2	IR-1 & IR 1/2	IR-2 & IR 1/2	IR-1 & CR-2	IR-2 & CR-2
Biophysical Specialists (not Wetland Specialists	X				
Wetland Specialists					X
Heritage Specialist		X	X		
Social Specialist			X		
Visual Specialist			X		
Noise Specialists			X		

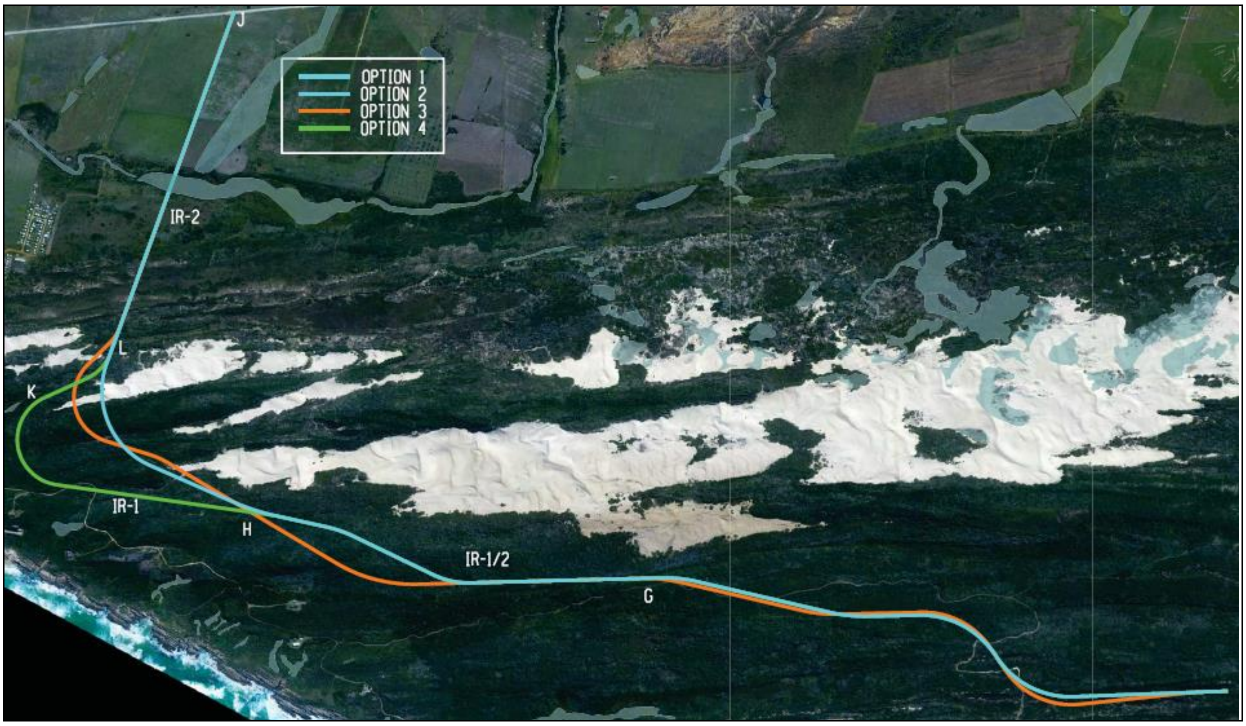
Coastal routes CR-1 and CR-2 are preferred by all biophysical specialists, apart from the wetland specialist, who prefers the combination of the inland route IR-2 with a portion of the coastal route CR-2. The heritage, social, visual and noise specialists all prefer some combination of the IR-1, IR2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

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

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

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

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



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

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR-1') AND ASSOCIATED INFRASTRUCTURE: ASSESSMENT OF ALTERNATIVES FOR THE WESTERN ACCESS ROUTE TO THE THYSPUNT SITE

CONTENTS

TABLES

FIGURES

ABBREVIATIONS

AEM	Agri-environmental Management
CR	Critically Endangered
DD	Data Deficient
EIA	Environmental Impact Assessment
EN	Endangered
HBD	Headland Bypass Dune
IUCN	International Union for Conservation of Nature
LT	Least Threatened
NT	Near Threatened
SABCA	Southern African Butterfly Conservation Assessment
VU	Vulnerable
DEA	Department of Environmental Affairs
ESA	Early Stone Age (see glossary)
GPS	Global Positioning System
HIA	Heritage Impact Assessment
LSA	Late Stone Age (see glossary)
MSA	Middle Stone Age (see glossary)
NHRA	National Heritage Resources Act (Act No. 25 of 1999)
RD	Red Data
SAHRA	South African Heritage Resources Agency

GLOSSARY

Ambient noise
The totally encompassing sound in a given situation at a given time, and is usually composed of sound from many sources, both near and far. It includes the noise from the noise source(s) under investigation.

A-weighted sound pressure level, L_{pA}
The sound pressure level, in decibels, relative to a reference sound pressure, and incorporating an electrical filter network (A-weighted) in the measuring instrument corresponding to the human ear's different sensitivity to sound at different frequencies. It is given by the following equation:

L_{pA} = 10 Log20 *ppA* dBA

A-weighted sound power level, L_{WA}
The A-weighted (as above) sound power level, in decibels, emitted by a sound source relative to a reference sound power of 10^{-12} W

Archaeology
Remains resulting from human activities which are in a state of disuse and are in or on land and which are older than 100 years, including artefacts, human and hominid remains and artificial features and structures.

Biodiversity
Diversity among and within plant and animal species in an environment

District
This is related to, but not necessarily equal to, "land-use zoning" applied in urban and regional planning. For example, mixed-use zoning may comprise a central business district and a residential district.

Early Stone Age
The archaeology of the Stone Age between 700,000 and 2,500,000 years ago.

Equivalent continuous A-weighted sound level, $L_{Aeq,T}$
A formal definition is contained in SANS 10103. The term "equivalent continuous" may be understood to mean the "average" A-weighted sound pressure level measured continuously, or calculated, over a period of time, T.

Equivalent continuous rating level, $L_{Req,T}$ (often referred to as sound level or noise level)
The equivalent continuous A-weighted sound level, $L_{Aeq,T}$, measured or calculated during a specified time interval T, to which is added adjustments for tonal character, impulsiveness of the sound and the time of day. An adjustment of 5 dB is added for any tonal character, if present. If the noise is of an impulsive nature an adjustment of 5 dB is added for regular impulsive noise and 12 dB for highly impulsive noise. Where neither is present, the $L_{Req,T}$ is equal to the $L_{Aeq,T}$.

Fossil
Mineralised bones of animals, shellfish, plants and marine animals. A trace fossil is the track or footprint of a fossil animal that is preserved in stone or consolidated sediment.

Heritage
That which is inherited and forms part of the National Estate (historical places, objects and fossils as defined by the National Heritage Resources Act, No. 25 of 1999).

Howieson's Poort
A phase within the MSA characterised by distinctive formally retouched artefacts (notably segments) in fine grained rocks.

Hz
Abbreviation of the unit hertz used to denote cycles per second of the frequency of sound.

Invertebrate
An animal, such as an insect or mollusc that lacks a backbone or spinal column.

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

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

Palaeontology
Any fossilised remains or fossil trace of animals or plants which lived in the geological past, other than fossil fuels or fossiliferous rock intended for industrial use, and any site which contains such fossilised remains or trace.

Palaeosol
A layer of fossilised soil, usually buried beneath layers of rock or more recent soil horizons.

Rhizolith
Organic items such as roots can become encrusted with Calcium carbonate from surrounding sediment. They are often found in coastal dune fields and may mark old land surfaces.

Structure (historic)
Any building, works, device or other facility made by people and which is fixed to land, and includes any fixtures, fittings and equipment associated therewith. Protected structures are those which are over 60 years old.

Reference sound pressure, p_o (pascal)
The threshold of audibility or minimum perceptible sound pressure = 20 micro pascal at 1000 Hz

Reference time interval

The time interval to which an equivalent continuous A-weighted sound level, $L_{Aeq,T}$, or rating level of noise, $L_{Req,T}$, is referred. Unless otherwise indicated, the reference time interval is interpreted as follows:

– Day-time: 06:00 to 22:00hrs T=16 hours when $L_{Req,T}$ is denoted $L_{Req,d}$

– Night-time: 22:00 to 06:00hrs T=8 hours when $L_{Req,T}$ is denoted $L_{Req,n}$

In the case of a typical working day of 8 hours T=8 hours

Residual noise (often referred to as background noise)
The ambient noise that remains at a given position in a given situation when one or more specific noises (usually those under investigation) are suppressed or absent.

1 INTRODUCTION

1.1 Background

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

Figure 1: Thyspunt Site Locality

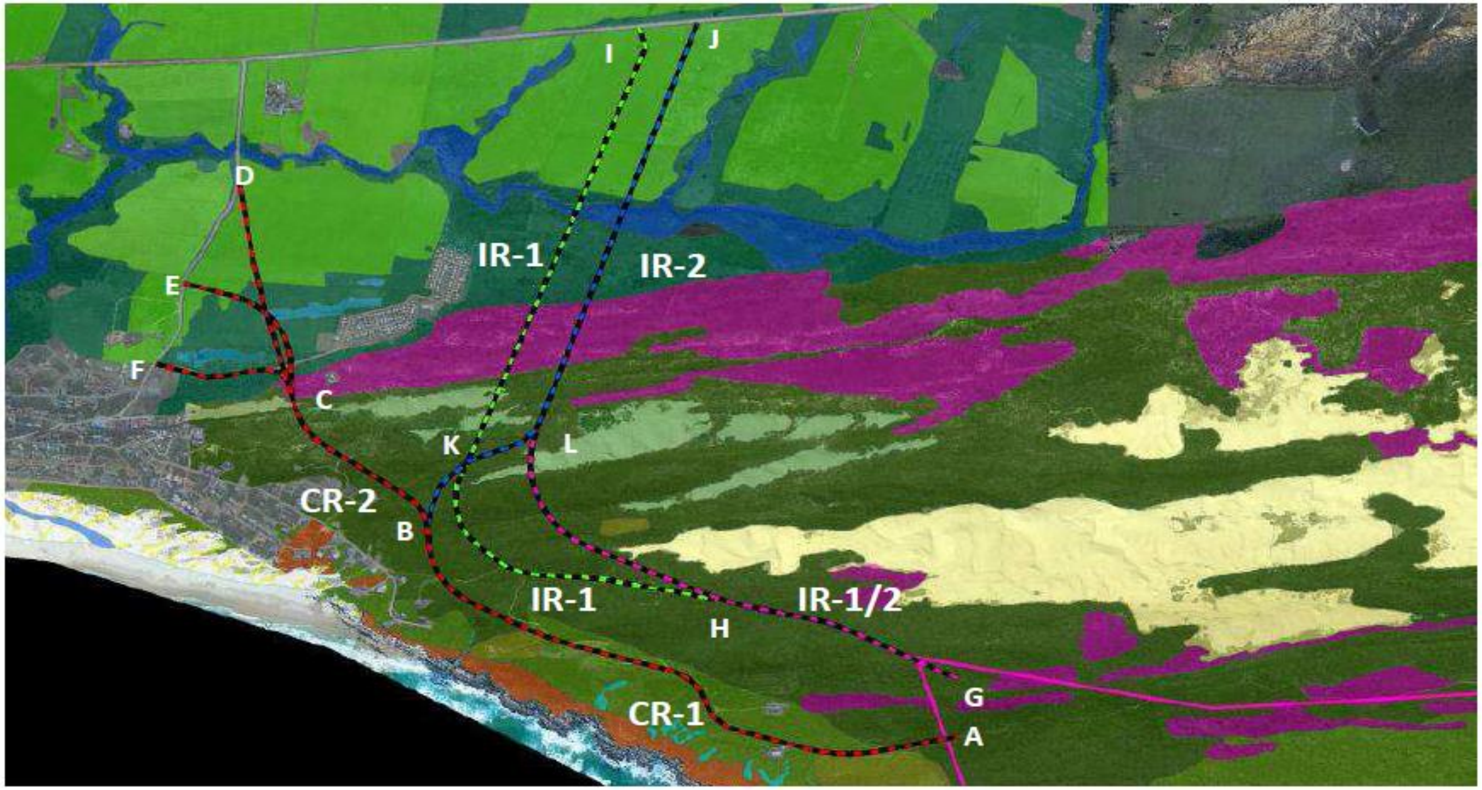
The studies included fieldwork investigations and subsequent report writing by the Botany and Dune Ecology, Freshwater Ecosystems, Vertebrate and Invertebrate Ecology, Dune Geomorphology and Heritage specialists. Supporting desktop input was commissioned from the Social, Visual, Noise, Economic and Geohydrological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

At the heart of this report lies the questions as to which is the preferred route to access the western side of the Thyspunt site, which is currently the recommended site for the construction and operation of the Nuclear-1 Power Station. The answer to this question requires weighing up the impact of the access road on sensitive faunal, floral, wetland, dune and heritage environments and the impact on the inhabitants of the settlements of Oyster Bay and Umzamowethu. As is often required in Integrated Environmental Management a compromise may be required to best mitigate the impact on both the biophysical as well as the socio-economic environments.

The five alternatives put forward for investigation by the specialist team are described as follows and are illustrated in **Figures 2 to 7**:

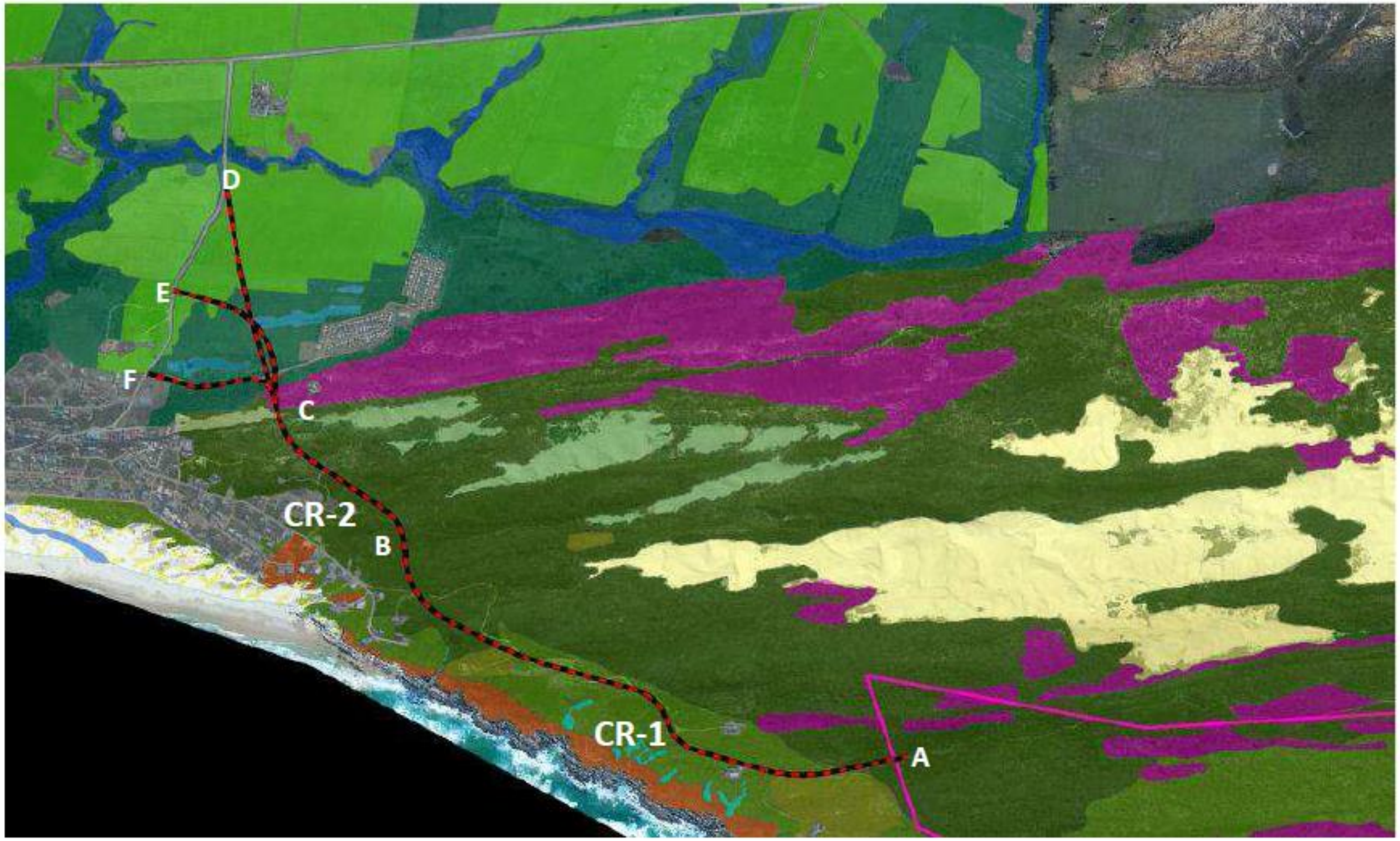
- The original "**c**oastal **r**oute" between Umzamawethu and Oyster Bay which is made up of CR-1 and CR-2. CR-1 stretches from point A to B on the map and CR-2 from point B to C. There are three alternative endings for this coastal route at the western end along the Oyster Bay road the first from points C to F (CF) on the map, the second from point C to E (CE) and the third from point C to D (CD).
- Two "**i**nland **r**outes", which swing inland east of Umzamawethu (IR-1 and IR-2). IR-1 stretches from point I to H on the map and IR-2 from point J to B. Both these routes past trough point K; and
- Two "inland to coastal" routes, which commence near the coast on the Thyspunt site but also swing east of Umzamawethu and end at the same points on the Oyster Bay Road as the above inland routes (CR-1 to IR-1 and CR-1 to IR-2).

Subsequent to the review of this draft report by Eskom and based on GIBB's recommendations, Eskom's engineers have optimised the route alignments and introduced further alternative alignments, based on topographical analysis (**Figure 8**). The horizontal and vertical alignments of the route alternatives have been analysed to assess the need for cut and fill. Besides having advantages in terms of construction, there are significant environmental advantages to reducing cut and fill, as cut and fill slopes can both have significant footprint impacts on the areas adjacent to a road. These alignment alternatives are based on the IR-1/2 and IR-2 alignment.



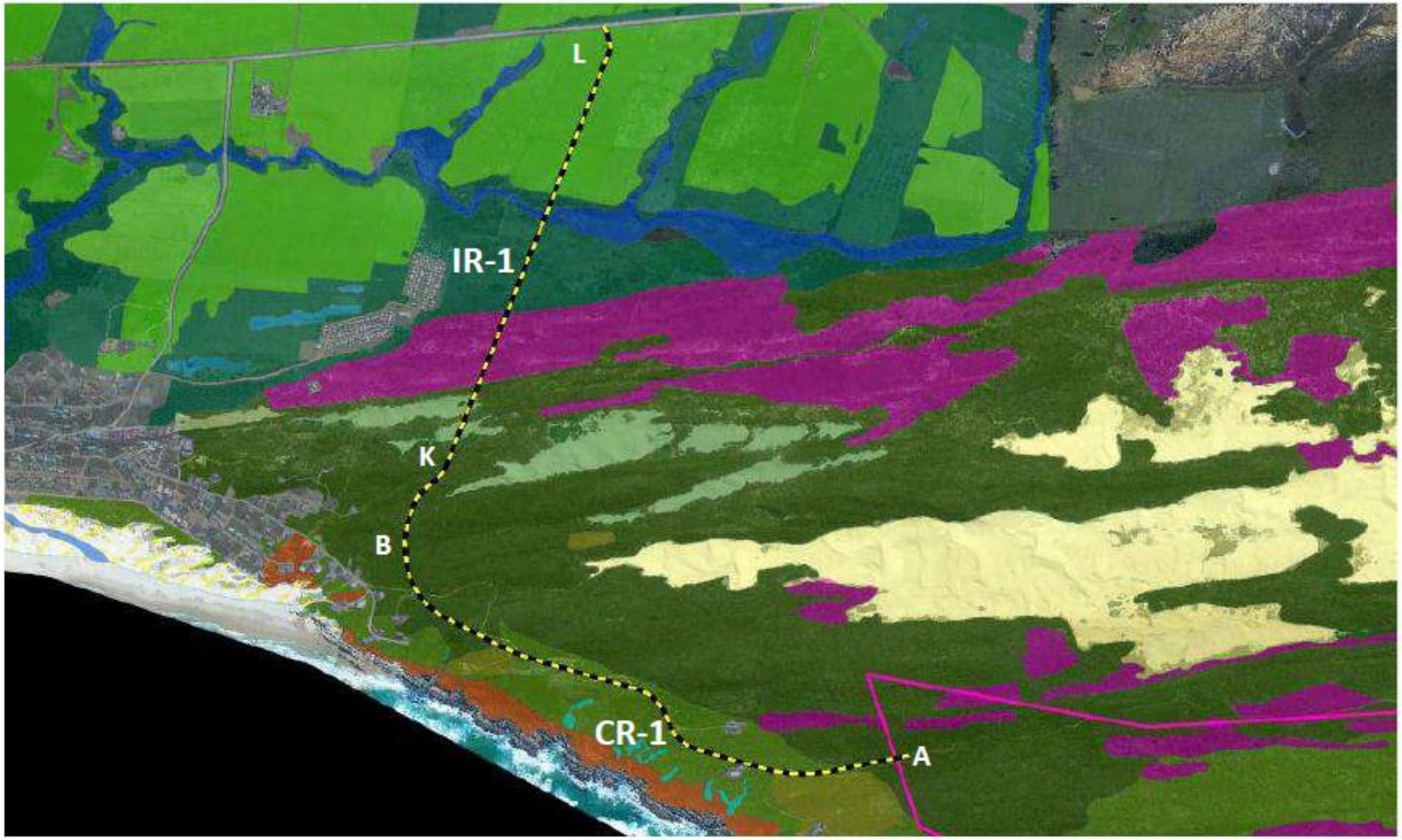
1) **Coastal Route** (CR-1 & CR-2): NPS to Humansdorp Road, between Oyster Bay and Umzamawethu; three alternatives at western end: A-B-C-D/E/F
2) **Inland Route 1** (IR-1): NPS to west of Umzamawethu: G-H-I
3) **Inland Route 2** (IR-2): NPS to west of Umzamawethu: G-H-J
4) **Coastal to Inland Route 1,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

Figure 2: Alternatives put forward for investigation by the Specialist Team



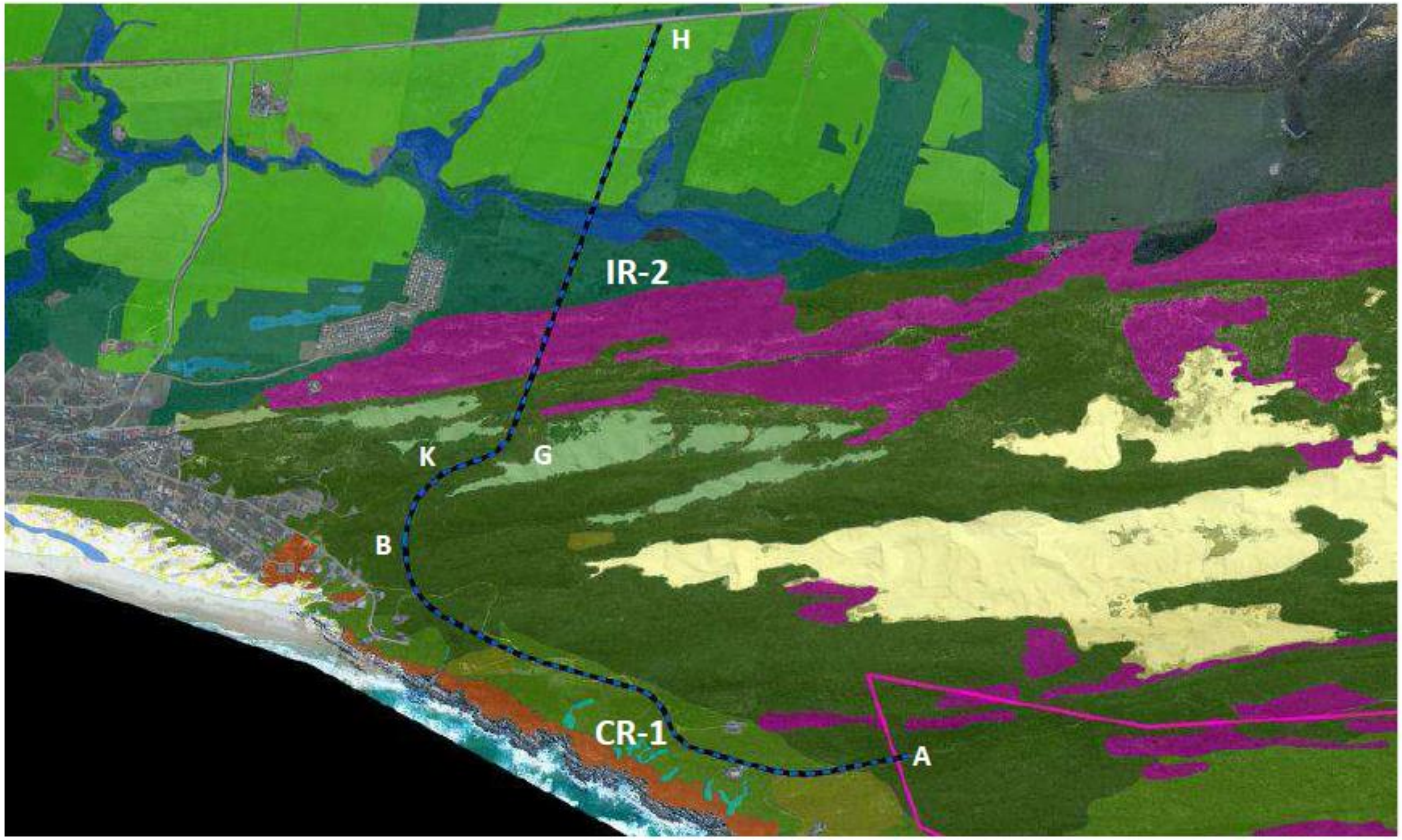
1) Coastal Route (CR-1 & CR-2): NPS to Humansdorp Road, between Oyster Bay and Umzamawethu; three alternatives at western end: A-B-C-D/E/F

Figure 3: Coastal Route



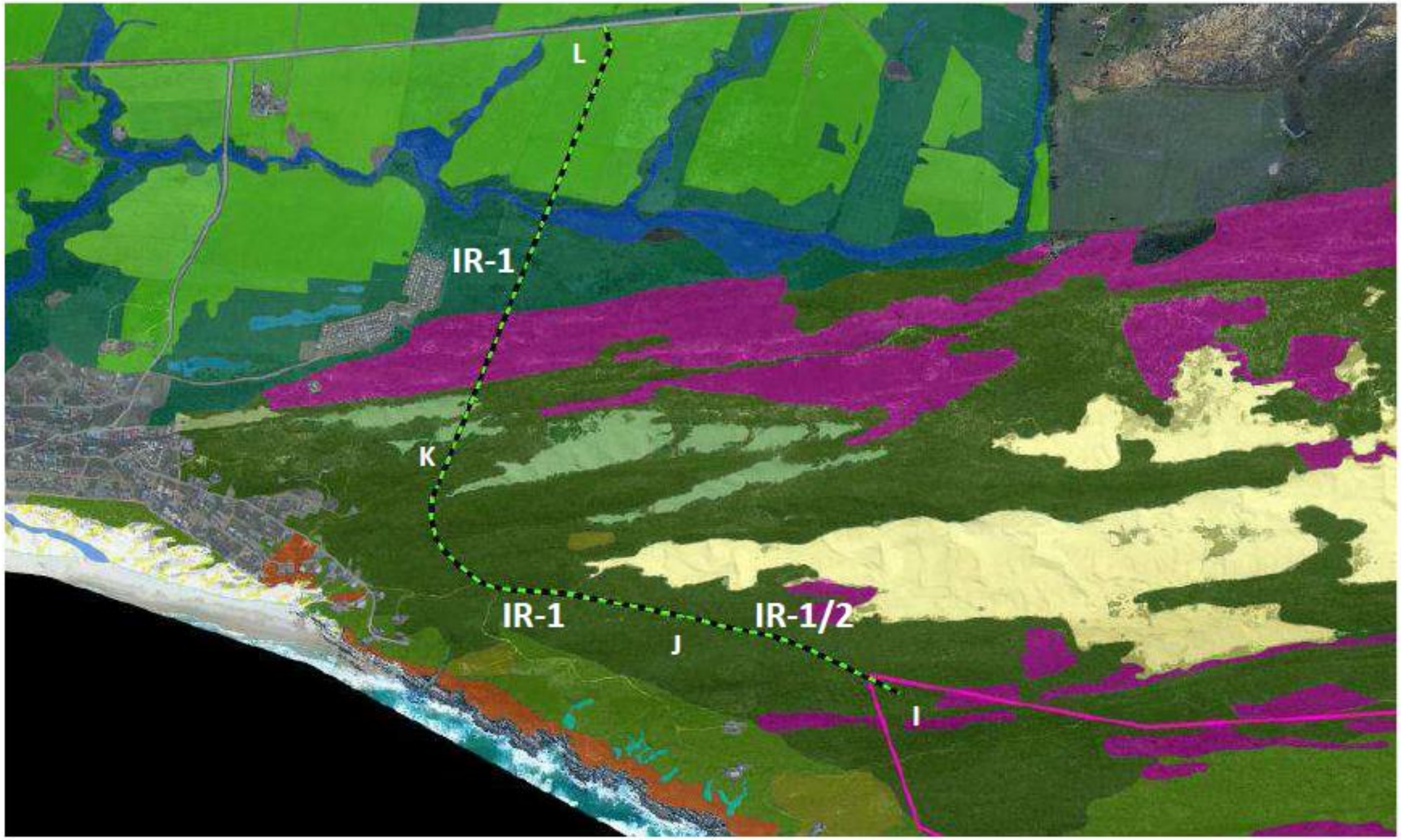
2) Coastal to Inland Route, alternative 1 (CR-1 to IR-1): A-B-K-L

Figure 4: Coastal to Inland Route, Alternative 1



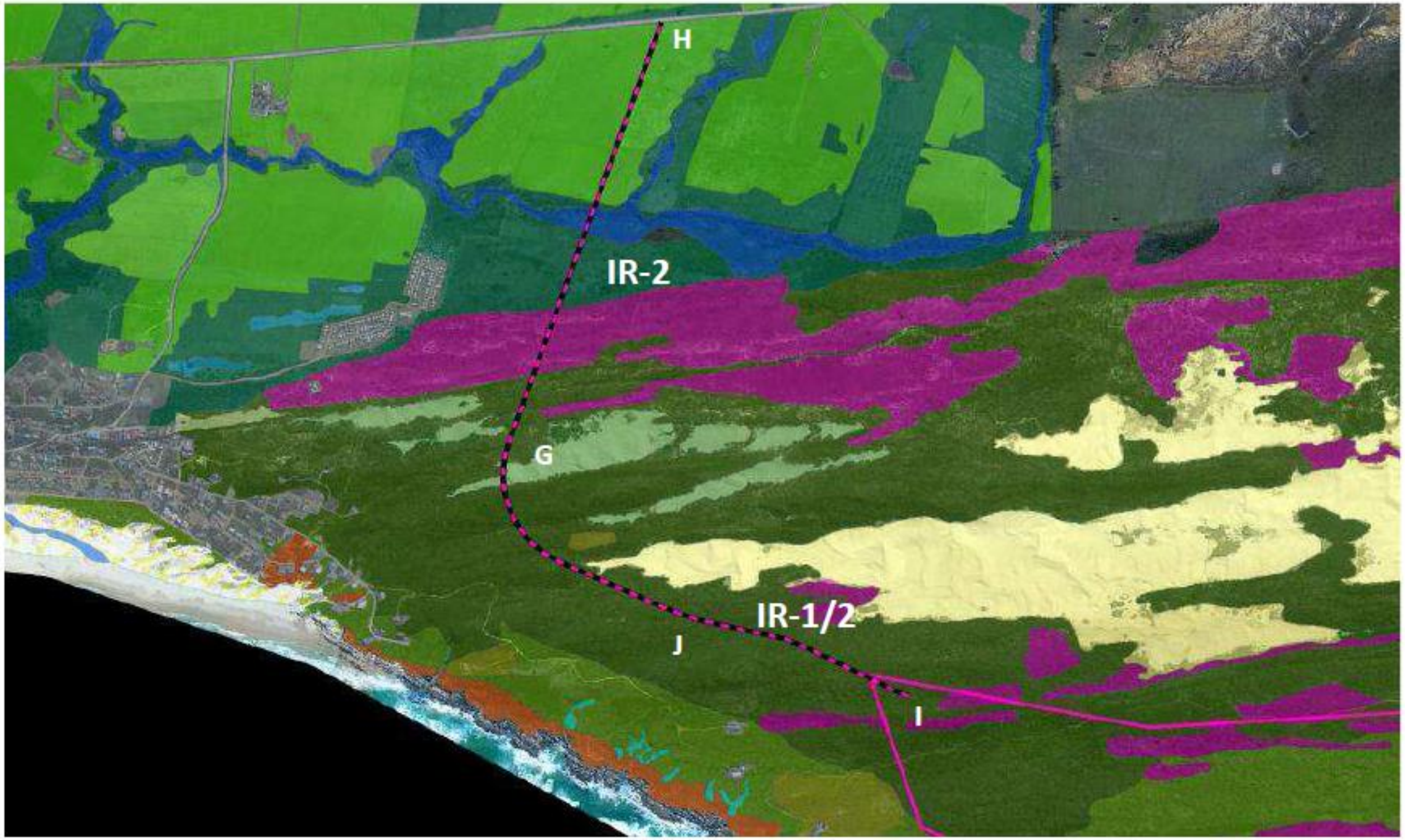
3) **Coastal to Inland Route 2, alternative 2** (CR-1 to IR-2): first section of Coastal Route, bending tc north and then to west of Umzamawethu, to Humansdorp Road: A-B-G-H

Figure 5: Coastal to Inland Route, Alternative 2



4) Inland Route 1 (IR-1): NPS to west of Umzamawethu: I-J-L

Figure 6: Inland Route 1



5) **Inland Route 2** (IR-2): NPS to west of Umzamawethu: I-J-G-H

Figure 7: Inland Route 2

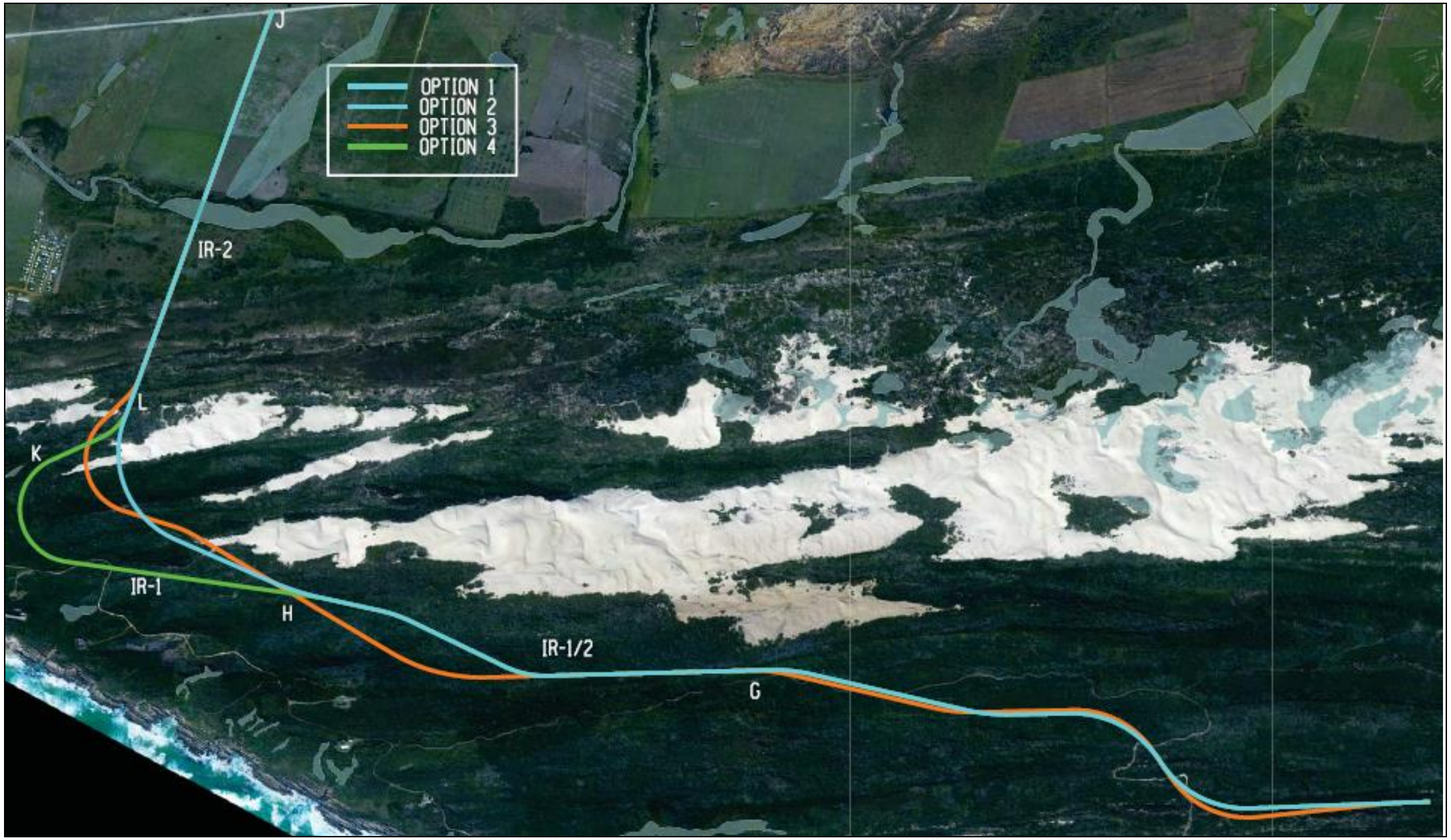


Figure 8: Alternative alignments based on IR-1/2 and IR-2 proposed by engineers in response to GIBB's environmental recommendations

1.2 Study Approach

Each individual specialist tasked with assessing the options for access to the western side of the Thyspunt site approached this assignment within the context of their own field of study in terms of the methods used for scientific investigation. An inception meeting with the team was conducted prior to fieldwork commencing on 20 November 2012. The following individuals were in attendance at the meeting:

Ms Lorraine Ndala	Eskom Generation
Mr Gert Greeff	Eskom Land Management
Ms Bronwyn Stolp	Eskom Land Management
Mr Hennie de Beer	Eskom Land Management
Ms Jongi Dyabaz	Eskom Communications
Ms Jaana-Maria Ball	GIBB
Ms Marielle James	GIBB
Mr Werner Illenberger	Illenberger and Associates
Mr David Halkett	ACO Associates
Mr Dewald Kamffer	Eco-Check
Mr Mark Marshall	Sandula Conservation Group
Dr Liz Day	Freshwater Consulting Group
Mr Barrie Low	COASTEC

The purpose of the inception meeting was to give a brief overview in terms of past investigations related to the site as well as to confirm the scope of work going forward and coordinate activities within the field.

A closing meeting was held on 22 November 2012 with the following individuals in attendance:

Ms Jaana-Maria Ball	GIBB
Ms Marielle James	GIBB
Mr Werner Illenberger	Illenberger and Associates
Mr David Halkett	ACO Associates
Mr Dewald Kamffer	Eco-Check
Mr Mark Marshall	Sandula Conservation Group
Dr Liz Day	Freshwater Consulting Group
Mr Barrie Low	COASTEC

The results of the individual specialist reports have been combined to form the current report.

1.2.1 Invertebrate Assessment

(a) Methods

The invertebrate assessment included a desktop review of the available data as well as a field investigation to assess the status, diversity and extent of the invertebrate habitats in the study area. It should be noted that this assessment focuses on the terrestrial invertebrates and that the aquatic invertebrates are not included in this assessment. The desktop investigation focused on a detailed assessment of the red data invertebrates of the Eastern Cape Province. The habitats present in the study area were compared to the habitat requirements of the Red Data species of the Eastern Cape Province and an estimated probability of occurrence were assigned to each of the species (also considering the known geographic ranges of the species).

(b) Information sources

The following data sources were used during the desktop investigation:

- IUCN 2012. The IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org. Downloaded on 01 January 2013; and
- SABCA 2013. The South African Butterfly Conservation Assessment. Sabca.adu.org.za. Downloaded 01 January 2013.

(c) Assumptions

The following significant assumptions pertain to this invertebrate assessment:

- It is assumed that all data and information gathered during the desktop review is accurate;
- It is assumed that all datasets used are relatively up-to-date; and
- It is assumed that the invertebrate habitat of the study area follows general ecological patterns and diversity-determining principles as observed (pers. obs.) for other terrestrial habitats studied in the southern African subregion.

(d) Limitations

The following limitations have relevance to this invertebrate assessment:

- All specialist assessments for EIA purposes are limited by available time and budget;
- Datasets for all invertebrates are incomplete, many species are yet to be described;
- Environmental information for the rural areas and on the invertebrates of the Eastern Cape is limited; and
- Comparative analyses are by nature open to interpretation and subjectivity.

1.2.2 Vertebrate Assessment

When conducting a study of vertebrate species in the context of development, the first aspect to focus on is the concrete vertebrate species that occupy the study area. Species list are readily available but in terms of the study area in question, it is imperative to ascertain the tangible individual vertebrate species present within the study area (without this, the impacts cannot be identified).

After the individual vertebrate species are identified; their ecological niche, habits and behaviours are investigated.

The available habitat is thereafter studied to ascertain whether or not for example, the animal is habitat locked or can it simply relocate itself if disturbed through development activities.

(a) Methods – Site Inspection

- Conduct an on-foot site visit with physical inspection of the study area, recording of vertebrate species observed and notation of the results.

- Conduct three site visits: one during the day (recording diurnal species); one during the night (recording nocturnal species) and one where evidential presence of vertebrate species, such as spoor, droppings, bird nests etc. are investigated.
- Text book study of the vertebrate species within the study area.
- Habitat investigation, which involves identifying the individual habitats in order to establish a thorough knowledge of the fauna of the habitat.
- Investigate the ecological behavioural aspects of vertebrates i.e. are certain species present due to the time of year? Are certain species hibernating, or will they be overlooked during the construction stage of development as they are hibernating? Are they migratory species which only visit the area for a short duration of time for breeding etc.?
- The species conservation status is noted, for example: is the species vulnerable due to decreased numbers from hunting or is it vulnerable in terms of habitat loss?

(b) Methods – Background Research and Report Compilation

- After determining the vertebrate component of the study area one must study the following aspects of the species. The vertebrate species must be divided into categories for example: birds, reptiles, mammals and amphibians.
- The species relevant to each above category is then studied in terms of its social behaviour, breeding behaviour, feeding grounds and its micro habitat.
- Certain groups of species may co-exist with one another and may therefore occupy the same habitat; or occupy the same habitat at different times (yearly or twenty four hour cycle).
- Questions need to be asked such as: where is this animal’s territory, is this animal a solitary animal or is it gregarious, where does it retreat to during periods of roosting, etc.
- The habitats must be looked at as some habitats may have a limited number of vertebrate species but never the less species may depend on it for other less obvious reasons such as traversing, hunting, etc.
- Habitats are identified by factors such as vegetation, other factors such as: presence of water, heavy wind, heat, etc.
- Vertebral relevance to the habitat: is the animal partially or completely dependent on the habitat? Is the habitat permanent? etc.
- In terms of the above, the impacts are identified.
- The impacts are examined and rated.
- The impacts are mitigated.

1.2.3 Wetland Assessment - Limitations

(a) Limitations on the use of the Wetland Report

The Wetland component of this report was compiled on the strict understanding that it will serve as an addendum report to the existing wetland specialist EIA report of Day (2011), which includes detailed descriptions of wetland form, function and ecological importance across the Thyspunt site and its environs as a whole. The implications of other aspects of the proposed Nuclear Power Station development for wetlands at the Thyspunt site are thus not repeated in the present report, and details of recommended mitigation measures, <u>other than for the western access route</u>, should be sourced from Day (2011). Comments made in the present report on the implications of the western route alternatives for wetland ecosystems supersede those made in previous wetland reports produced by Freshwater Consulting Group (FCG) for this project.

(b) Limitations in the accuracy of wetland analysis and mapping

The wetland assessment was based on 2.5 days of site work, during which the five proposed route alternatives were walked as far as possible, given problems of access resulting from dense alien and indigenous vegetation across large areas of the route, which prohibited access. Large areas potentially traversed by the proposed roads had moreover not been mapped in previous assessments, other than as a desk-top exercise, on the basis of aerial photography. As a result, the extent of wetlands indicated in the broad area of the different alignments should be regarded as indicative, rather than of high accuracy, and their boundaries may be inaccurately reflected by up to 20m, unless otherwise noted.

Another issue affecting wetland mapping accuracy is temporal change in wetness. Since the site was first visited by this author in 2007, significant changes in wetland hydrology have occurred, as a result of changes in the local water table. Since 2010, the site as a whole has experienced high rainfall, resulting in a water table that is higher than in previous years. This has resulted in the promotion of wetland conditions in several areas on the site and its environs, where previously only terrestrial vegetation was supported. This factor means that the extent of wetlands mapped on the site in late 2012 may increase, if wet conditions persist or increase, whereas wetland shrinkage may also occur over time. Removal or encroachment of woody alien vegetation may have similar effects on wetland conditions, increasing or decreasing local soil moisture conditions, respectively. A conservative approach has thus been taken in this report to the treatment of low-lying areas, in which wetland conditions may be periodically but not permanently present.

Finally it is noted that detailed wetland delineations (e.g. by walking the edge with a handheld GPS) were confined to the Eskom-controlled site only. Wetland extent beyond these boundaries was determined mainly by desk-top mapping and these boundaries are likely to be less accurate.

(c) Limitations in wetland sampling

Wetland assessments presented were based primarily on broad scale visual assessments, as outlined in the section above, with soil and plant assessments and analyses being produced for representative habitat types only, rather than across the site. Of these datasets, descriptions of key floral communities characterising different habitat types are produced in the specialist **botanical** report for this project (COASTEC 2013) (included), including wetlands and riparian areas, and the present report refers to very broad plant communities only.

(d) Limitations in data availability/ technical information regarding the proposed project

At the time of writing this report, the specialist team had been provided with only scant details by Eskom regarding the conceptual road design and treatment of the road reserve. This means that the assessment approach has had to assume high levels of impact associated with the proposed roads, across the full width of the road reserve, with recommendations for mitigation measures focusing in many places in specifying standard best practice measures that are otherwise missing from the proposals. Furthermore, the 1m-contour data that would have informed recommendations for the treatment of specific low-points along the route ways were not available from Eskom at the time of writing this report, and such recommendations have thus had to be specified at a more generic and less useful level.

The details of the construction process itself also still need to be supplied to inform the assessment and design of mitigation measures – the details of borrow pits, storage areas and site camps are all important parts of an EIA for a major road construction through sensitive areas and need to be outlined in detail and considered from an ecological perspective.

Finally, although an intensive groundwater monitoring programme is focused on the Langefonteinvlei area, the central mobile dunes just north of the Langefonteinvlei, the coastal seeps and the proposed Nuclear Power Station site itself (Visser et al. 2011 and 2012), the area included by the western access road is not part of this core area, and detailed surface – groundwater interactions could not be deduced to high levels of accuracy as a result. Nevertheless, the model developed by Visser et al (2011) and described below does provide useful principles with which to interpret surface / groundwater interactions in the present study area.

(e) Limitations in extent of road assessment

Note that the route design alternatives include the sections from the western edge of the proposed Nuclear Power Station "envelope". It does not take cognisance of the sensitivity mapping of the envelope itself, as presented in the GIBB (2011) EIR for this project, which identified a preferred area within the envelope, for construction. Further design work would be required at a later stage to finalise the alignment of the selected access route to the actual NPS footprint within the envelope.

1.2.4 Wetland Assessment – Study Approach

Wetland assessment approaches and methodologies used in this study were generally compatible with those used in the Specialist Wetland EIA for the proposed Nuclear Power Station (see Day 2011). This section summarises the methodologies / approaches used.

(a) Timing of site assessments

The proposed route alternatives described in this report were assessed on site in November 2012 (as previously stated), during a site visit attended by the full specialist biophysical team, as well as by personnel from Eskom and the GIBB EIA team. The interpretations of wetland function and condition made during the site visit were however informed by numerous other visits to the Thyspunt wetlands, for assessment or monitoring purposes, including five site visits between 2007 and 2009 (EIA Phase assessments) and at least quarterly visits to the site between 2010 and end of 2012.

(b) Extent of assessments

The focal area for the assessment of western route alternatives was defined as a series of 100m wide corridors, with their widths centred on the centreline of each proposed route, and covering 50m on either side, thus amounting to an assessment width measuring 60m in excess of the proposed 40m road width.

(c) Identification and mapping of wetlands

Identification and mapping of wetlands along the proposed alternative routes was based on a combination of the following activities / approaches:

- The existing wetland map presented in Day (2011) served as the base plan, taking cognisance however of the fact that the map focussed on other portions of the Thyspunt site and its surrounds, and that mapping of areas where no detail had previously been required, particularly areas off-site, was likely to be inaccurate;

- Wetlands were identified on site during the November field trip, and a hand-held GARMIN GPS was used to indicate their spatial location, with GPS co-ordinates being uploaded onto 2011 Google satellite imagery after the site visit;
- Depending on accessibility and the proximity to the wetlands of the proposed road alignments, wetland extent was delineated using a GPS to mark the upland edge of different wetland patches while walking around them; a combination of auguring of soils to indicate signs of periodic or perennial wetness (e.g. the presence of impervious material near the surface; presence of soil gleying and mottles) and the identification of key marker plant species formed the basis for the delineations that were carried out in this manner. This approach conforms largely to that recommended by DWAF (2005) in its guidelines for wetland identification, noting however the implicit difficulties caused by changes in wetland extent as a result of an elevated water table over the past three years.
- The above approaches resulted in refinement of the existing GIS wetland covers to include new information gathered during this exercise – cognisance should be taken of the limitations in data accuracy, as highlighted later in the report.

Figure 9 illustrates the extent of ground-truthing carried out on the site in November 2012, in relation to the proposed road alignments.

(d) Characterisation of wetland soils

Soil samples (**Figure 10**), comprising pooled soil samples from the top 30 cm of the soil surface were collected from five sites considered representative of different wetland or riparian conditions in the focal area of the western access route, and sent for analysis at BEMLAB, in Somerset West.

Samples were analysed for chemical properties (organic carbon, nitrogen and phosphorus nutrient status, major anions and cations, resistivity, bulk density, pH) and physical characteristics (particle size, bulk density etc.). These data were compared where relevant with existing data collected in previous studies on other wetlands on the site, to indicate differences or similarities in wetland structure and (implied) function.

(e) Characterisation of wetland plants

Plant community assessments were carried out by the project botanical specialist in representative wetlands on the affected area of the site. While the detailed floral assessments are presented in the botanical report, descriptions of plant community dominants and characterising species are provided in this report, facilitated by identification of species in the field by Mr Barrie Low (COASTEC).

(f) Classification of wetlands

The revised National Wetland Classification (SANBI 2009) was used as the basis for classifying different wetland types, using the following definition of wetlands taken directly from that of the National Wetland Classification as a starting point:

Wetlands are … "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tides does not exceed ten meters. Wetlands are areas where water is the primary factor controlling the environment and, therefore, wetlands develop in areas where soils are saturated or inundated with water for varying lengths of time and at different frequencies".*

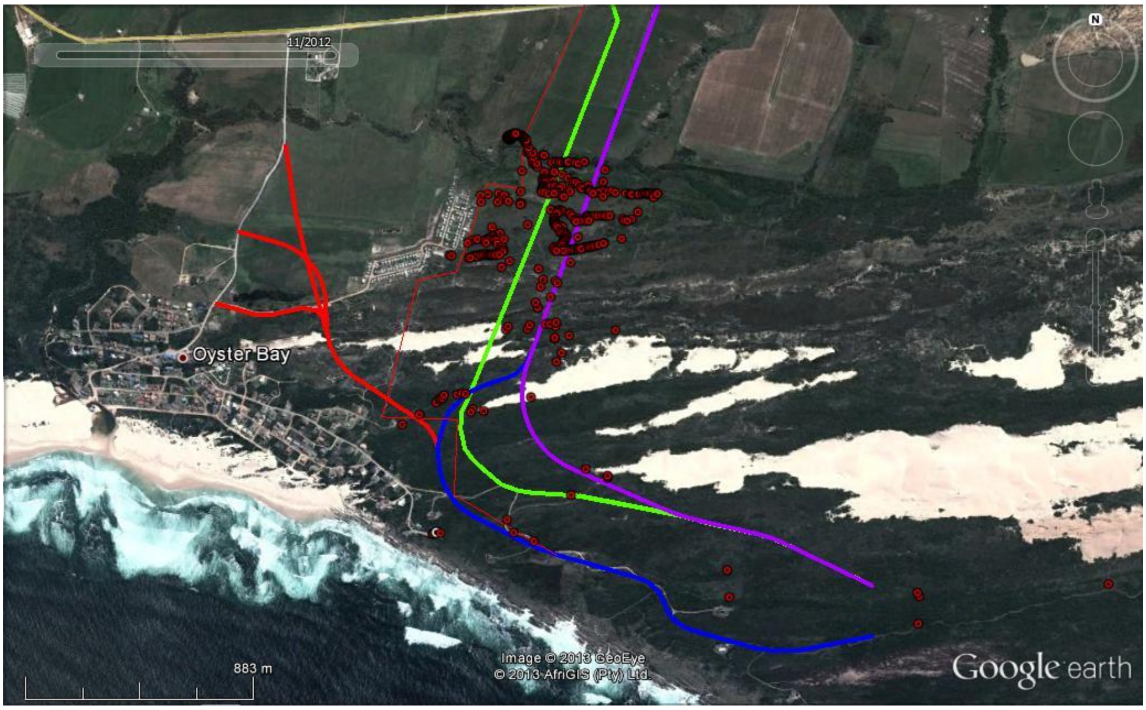


Figure 9: Map showing extent of ground-truthing of wetland areas in November 2012 for assessment of proposed routes

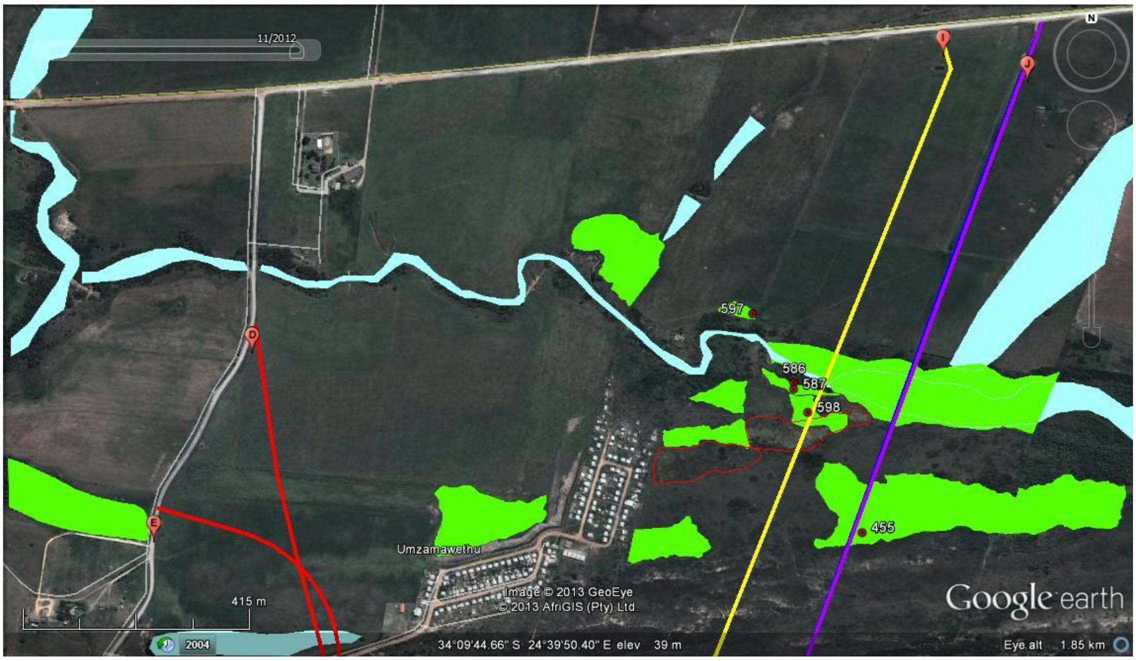


Figure 10: Locations of soil samples (numbered points) in northern portion of the site. Green polygons indicate wetlands as mapped and delineated in the present study; blue polygons indicate wetlands mapped as part of the desk-top exercise of Day (2011) in this portion of the site.

The NWC has a six-tiered structure, with four spatially-nested primary levels that are applied in a hierarchical manner to distinguish between different wetland types on the basis of "primary discriminators" (that is, criteria that distinguish between different categories at each level of the hierarchy) (SANBI 2009). The first of the four spatially nested levels is the Systems Level, which separates Marine, Estuarine and Inland systems. In the case of Inland Systems, which encompass all of the wetlands referred to in this report, Level 1 progresses through to Level 4, at the finest level of spatial detail, namely "Hydrogeomorphic (HGM) Units" (SANBI 2009).

The HGM Unit (Level 4) is the focal point of the classification system, with the higher levels providing the broad biogeographical context for grouping functional wetland units at the HGM level and the lower levels providing a more detailed description of the characteristics of a particular HGM Unit. The HGM Unit and the hydrological regime of an Inland System together constitute a "Functional Unit" (SANBI 2009).

(g) Assessment of the sensitivity and conservation importance of wetlands

A number of protocols exist for the assessment of wetland conservation importance and condition, with different protocols having been developed for particular wetland types and conditions, as well as to allow measurement of particular aspects of wetland function, structure or their value to the management of human socio-economic structures or activities. The assessment protocols selected have all been developed in South Africa and are currently being used in wetland assessment here. They aim to provide (variously) measures of the present condition, functional value and / or conservation-worthiness of the wetlands in question.

DWAF (1999) defines wetland **ecological importance** as "an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales" and "**sensitivity**" as "the extent to which the biota is able to accommodate change in the major physic-chemical features of the system".

The method used in this study to assess the **ecological importance and sensitivity (EIS)** of wetlands is a refinement of the Department of Water Affairs (DWA) Resource Directed Measures for Water Resources: Wetland Ecosystems method (DWAF 1999). It includes an assessment of ecological (e.g. presence of rare and endangered fauna / flora), functional (e.g. groundwater storage / recharge) and socio-economic criteria (e.g. human use of the wetland). The methodology has been adapted to allow for broad-scale EIS assessments of wetlands other than the specific floodplain wetlands for which the methodology was originally developed. The protocol for these assessments is provided in Day (2011).

(h) Assessment of the sensitivity and conservation importance of wetlands

Wetland **condition** was assessed using the desk-top Present Ecological State (PES) methodology, adapted from DWAF (1999). The methodology used in the PES assessment is also outlined in Day (2011). It is based on a comparison of current attributes of the wetland, which are scored against those of a desired baseline or reference condition, resulting in the assignment of a wetland to one of six PES categories, as defined in DWAF (1999) and described in Table 1**.**

Table 1: Interpretation of PES score, using the DWAF (1999) methodology

PES Score	Wetland Description	PES Category	Comment
> 4	Unmodified or approximates natural condition	A	Acceptable Condition
> 3 <=4	Largely natural with few modifications, minor loss of habitat	B	
> 2 <=3	Moderately modified with some loss of habitat	C	
= 2	Largely modified with loss of habitat and wetland functions	D	
> 0 < 2	Seriously modified with extensive loss of habitat and wetland function.	E	Unacceptable Condition
0	Critically modified. Losses of habitat and function are almost total, and the wetland has been modified completely.	F	

1.2.5 Heritage Assessment

At Thyspunt the assessment of surface traces of the heritage resource that may be impacted, is made challenging by the difficulty in assessing the impact sites. This is primarily due to thick vegetation cover, both indigenous and alien, depending on the location. As such, observations from the broader site, where these can be made, are relied upon.

Observations are primarily derived from areas where access to the surface is possible. These include:

- Existing roads and other disturbances (such as drilling sites);
- Areas where thick bush has been cleared by manual interventions or natural causes e.g. fire;
- Areas where bush cover is naturally thinner; and
- Exposed dune areas and coastline.

Observations span a number of years and include observations made by ACO Associates cc and its pre-cursor, The Archaeology Contracts Office at UCT from several visits to the site as part of the Nuclear-1 EIA process. Of particular use is the recent follow up study requested by SAHRA of the Nuclear-1 site (surface inspection of points on a grid over the site at 100x100 meter intervals) (Hart 2012). We can also include observations from a number of weekend forays into the main and secondary dunefields between Thyspunt and Cape St Francis to examine the archaeology of those areas more broadly.

The published results of academic and commercial studies of the site by Dr J Binneman and others (Binneman 1987,1996; Carrion et al 2000), and results from commercial heritage management projects by heritage specialists in the surrounding areas (e.g. van Ryneveld 2010) were also utilised.

(a) Fieldwork method for the November 2012 specialist visit

Shape files of the various alternatives were converted to *.gpx files and transferred to a handheld GPS unit in order to identify the various alternative routes during fieldwork. In addition, Mr Hennie De Beer, the Eskom representative on site, had marked sections of the IR-2/ IR-1/2 routes with flags to facilitate identification in the field during the specialist visit. As the IR-1 route was only suggested during consultation on site, no co-ordinates or flags were available to identify that option, though we did look at sections of it where possible.

Portions of the IR-1 / IR-2, IR-1/2 routes were visited with the specialist team on day 1 to examine the broad environmental issues of those routes. On day 2 the specialist team broke up into smaller groups of similar interest, and went into the field to undertake more focussed assessment. The archaeologist, Mr Halkett, and the geomorphologist, Dr Illenberger, visited on foot, several open dune areas along, and to the east of, the proposed routes to determine what, if any, archaeological and palaeontological sites could be identified in areas not previously visited by ACO associates. Portions of the area had been visited by Dr Binneman in the 1980's and 1990's (Binneman 1996), but at that time mapping of sites was "eyeballed" on 1:10 000 orthophotos, and we were interested to see if we could re-identify and map those sites with a GPS. We were also interested to see what if any shifts of the dunes had occurred over the intervening two years.

The CR-2 route and D, E and F options, and sections of the IR-2 route were assessed on foot by Mr D Halkett the day before the specialist team arrived on site.

CR-1 has variously been assessed during preceding trips by various archaeological teams and was not re-examined on this trip.

1.2.6 Social Assessment

For the Social component of this report a desktop approach was followed, analysing all available information related to the different routes from a social impact perspective.

There is a close relationship between the assessment of social factors and other specialist input such as noise, transport (movement), visual and dust generation. This input will provide valuable understanding in terms of the extent of impacts within the framework of generally accepted standards and levels.

However, from a social perspective, an acceptable standard or level does not imply that the disturbance is socially acceptable. The study approach is therefore focused on the possible level of disturbance or improvement, and not only on the question of acceptable standard or level.

1.2.7 Visual Assessment

The Visual Assessment utilised GIS Shape files of the routes which were transferred to Google Earth in order for the ground cover, topography and land use to be scrutinised from various low level angles.

This provided the three dimensional image of the landform and its relative height and extent experienced in views from the existing provincial roads and from Oyster Bay and west around the bay.

Route alignment drawings of IR-2 that provided the road in the context of the contours and cut and fill sections were studied. This provided information on the extent of the earthworks and the visibility of the road.

Notes regarding the visual exposure and impact on land use of each route section were made.

The areas of visibility were identified and together with the cut and fill map the extent and severity of the visual intrusion of the road on the setting was considered. The preferred route would have the least visual intrusion in views by the closest receivers, in this case the residents of the eastern part of Oyster Bay.

1.2.8 Noise Assessment

The impact of environmental noise is determined in accordance with South African National Standard (SANS) 10103: 2008, *The measurement and rating of environmental noise with respect to annoyance and to speech communication*. Please refer to the glossary for definitions of terms used.

The subjective response by humans to constant or slowly varying levels of environmental noise, such as free-flowing road traffic, is closely related to the measured level of noise averaged over an extended time period, T, and termed the equivalent continuous A-weighted sound level, LAeq,T. When T is the 16-hour daytime period between 06:00 and 22:00 this is termed the equivalent continuous daytime rating level of noise, LReq,d. The value of the outdoor LReq,d in different suburban residential districts with little road traffic is very similar and is typically 50 dBA. In central business districts the typical value is 65 dBA while in rural districts, with little man-made noise, the typical value is 45 dBA. During night-time the outdoor equivalent continuous rating level of noise, LReq,n, is generally 10 dB lower than during daytime. Refer SANS10103.

The assessment of a particular noise is based on comparing the value of the LReq,d or LReq,n of the noise under investigation with the typical LReq,d or LReq,n in the respective district to which the noise is exposed.

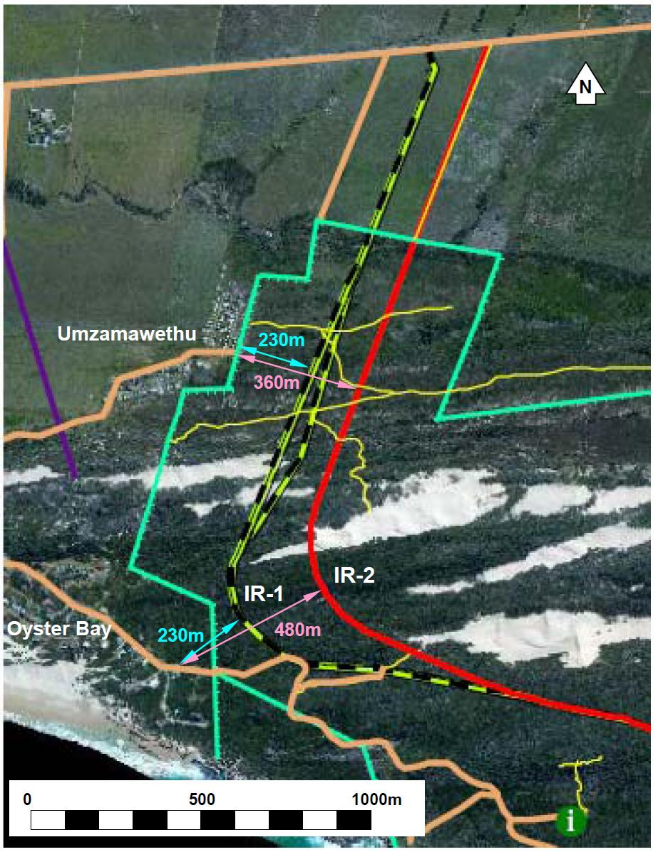


Figure 11: Distances between alternative Western access routes to the Thyspunt Nuclear-1 site

Where the noise emanates from road traffic the LAeq,T whence LReq,d is obtained by calculation in accordance with SANS 10210: 2004, Calculating and predicting road traffic noise using traffic flow data. The latter comprises the number of passenger and heavy vehicles per hour, mean speed, road surface texture, road gradient, angle of view, plus other factors. As such the predicted impact of noise from each of the alternative routes during operation is considered.

The level of noise emanating from construction activities, including that of road building, is not constant over long time periods but can vary considerably. This is also considered in the investigation.

(a) Road Construction

For certification purposes the level of noise emitted by earth moving machinery and heavy duty vehicles is measured under controlled conditions such that the same values are obtained when repeated under specified, constant operating conditions. However, during normal operating conditions the level of noise emitted and duration of operation can vary considerably. Measured results are rarely repeatable, making it difficult to compare and predict the noise emission levels of different vehicles and at different times. It is thus not feasible to calculate the LReq,d of "typical" road construction noise with any degree of accuracy.

The author has measured the noise emission levels of numerous types of heavy-duty vehicles and of earth moving machinery of different manufacturers under controlled conditions as well as under normal operating conditions. Results obtained under controlled conditions were within 0,5 dB of those provided by the manufacturer, where the information was supplied. However, such results excluded additional sounds as are produced by rocks falling into trucks during loading, squealing of the rubble as it slides out of the truck during dumping, reverse hooter and the effect of the engine operating under differing loads. Sound measurements were therefore also recorded of front end loaders, trucks and bulldozers during normal operating conditions.

2 DESCRIPTION OF THE AFFECTED ENVIRONMENT

2.1 Botany

Soils in the area are mainly calcareous with high levels of both calcium and phosphorus, a feature of the marine origin of the dune sands which dominate the landscape. The pH of soils is correspondingly neutral to alkaline. Accumulation of carbon is evident in the wetlands as well as under thicket and forest and this is a major driver in nutrient cycling in the soil as it acts as de facto colloid.

There is a significant dichotomy in most soil variables between older (thicket and forest) and younger (primary and transverse dunes, and dune fynbos) sands and there is a significant dichotomy between the two broad habitats for most soil variables. Thus, as vegetation succession moves towards a climax (its most mature form) build-up of organic matter increases and this has a direct effect on the topsoil. According to Werner Illenberger (Dune Geomorphology Specialist), these older sands are Pleistocene palaeosols, although one would suggest that there is a combination of older, weathered soils and the direct influence of the plant community which influences soil chemistry at on the Thyspunt dunes. Conversely, soils derived from sandstone have more acidic pH and are far more infertile with lower amounts of carbon and nitrogen.

Dune fynbos possesses both the highest species total as well as rarity. It is also shows a weak link to the thicket and forest communities (**Figure 12**), suggesting a community which is distinctive and which is driven by a particular habitat, despite possessing several thicket species such as *Searsia glauca* bloukoeniebos, *Cassine peragua* bastersaffraan, *Euclea racemosa* ghwarrie, *Olea exasperata* slanghout and *Sideroxylon inerme* milkwood. However the dune fynbos-thicket-forest dynamic which is maintained by fire (Vlok & Euston-Brown, Cowling, Low, 2011) is likely to keep fynbos intact until these thicket species dominate and the community changes as a result.

Wetland floras are clustered into three main groups (

Figure 13): coastal seeps, transverse dunes and inland seeps (Slangrivier system). They are separated from their dryland counterparts with virtually no similarity between the two. Subregional analysis indicates these wetlands are distinctive for Thyspunt and are likely to be endemic to the Oyster Bay-Cape St Francis headland bypass dune system. This accords them high rarity and conservation importance.

The total recorded species complement for the Thyspunt site was 383 in 2007 (Low, 2011). This has now been increased to 400 following additions from the current study. Some 161 are found in communities along the proposed route.

Total species rarity is low relative to other coastal sites (Low, unpub.; SaSFlora, 1998 – 2013) (9 species or 5.6%), with most of this rarity found in dune fynbos (Table 2). Species rarity is discussed in greater detail below, under the site rarity assessment.

Wetland habitat signatures are recorded in **Table 3**. Three of the wetlands sampled at Thyspunt have a proportion of terrestrial to obligate wetland species of greater than 40% and this might suggest strong seasonality and even drying out in summer (T10E).

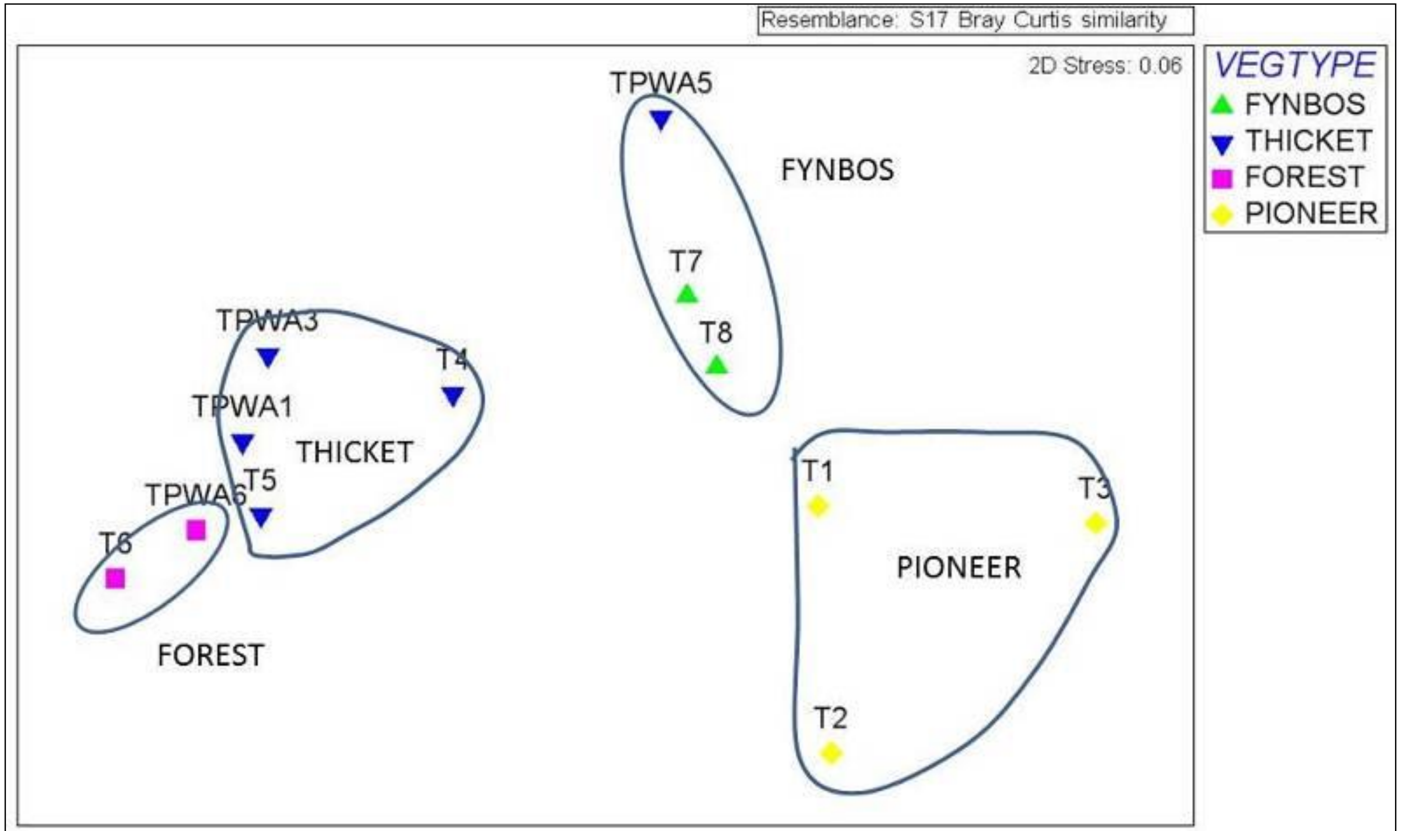


Figure 2.2. MDS analysis of dryland floras occurring in the study site and elsewhere in Thyspunt. There is a strong relationship between Thicket and Forest, but not with Fynbos. Pioneering floras of the rocky shore (T1) and mobile dunes (T2 & T3) are also quite distinctive

Figure 12: Multi Dimensional Scaling (MDS) analysis of the dryland floras occurring in the study site and elsewhere in Thyspunt.

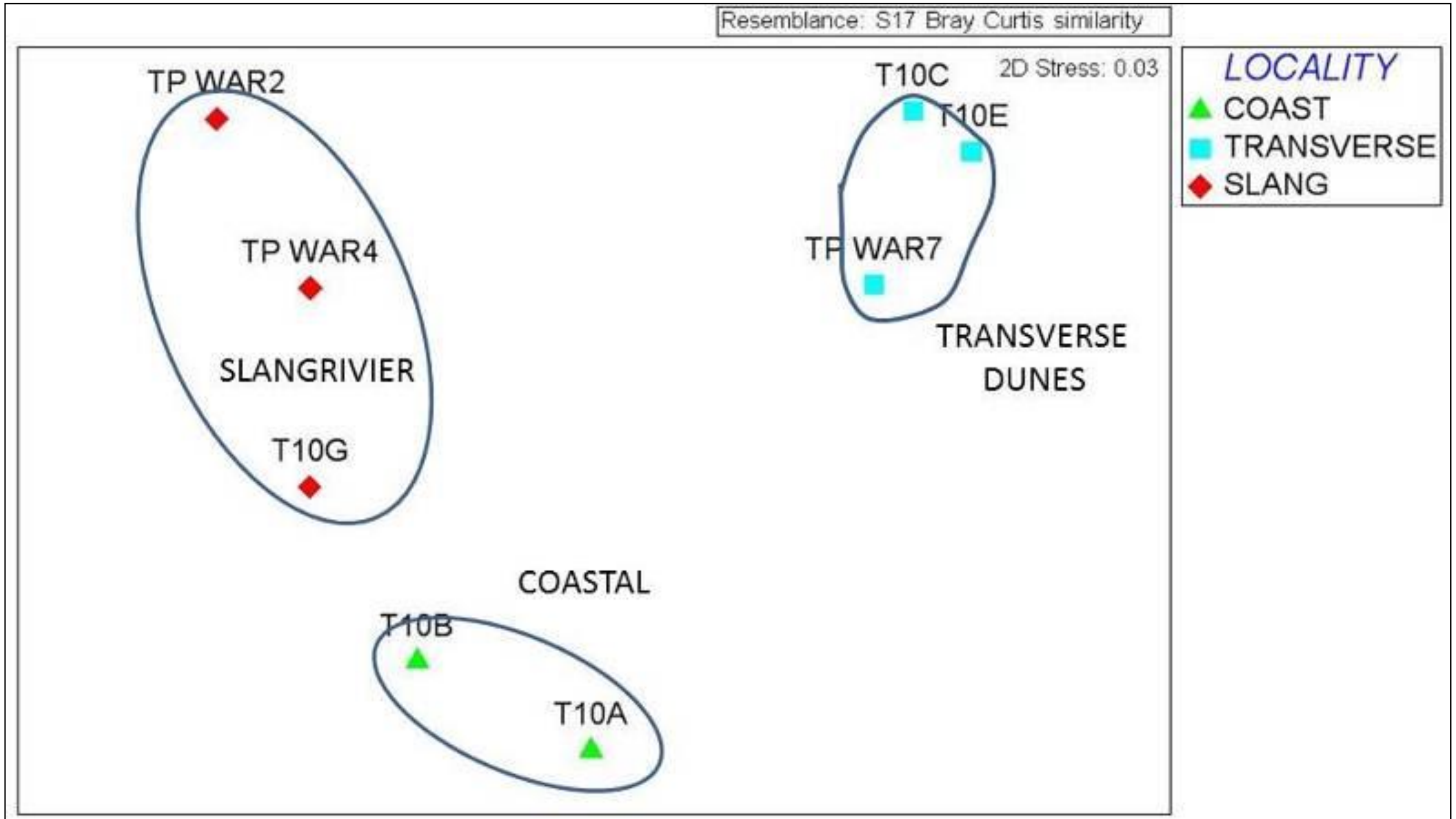


Figure 2.3. MDS analysis of wetland floras for the study area and elsewhere in Thyspunt. There is a moderate relationship (30%) between the coastal and inland wetlands, with the link due to inundation of stable calcareous dune sands. The transverse dune wetlands on the other hand show far lower similarity (20%) with these two groups, reflecting younger sands and a more seasonal wetland habitat

Figure 13: MDS analysis of the wetland floras occurring in the study site and elsewhere in Thyspunt.

Table 2: Red Data species occurring in communities found along the Western Access Road route (RD species from Raimondo et al., 2009)

. Red Data species occurring in communities found along the Western Access Road route (RD species from Raimondo et al., 2009)

Family	Species	Present red data status	Site Description	Plant community
Dicotyledones				
APIACEAE	*Alepidea delicatula*	R	Sandstone	T9
ASTERACEAE	*Othonna rufibarbis*	Th (NT)	Dune fynbos	T7
ASTERACEAE	*Syncarpha sordescens*	VU	Coastal Wetland	T10A
ERICACEAE	*Erica glumiflora*	VU	Dune fynbos	T7/TPWA5
FABACEAE	*Psoralea repens*	NT	Transverse dune Transverse dune wetland	T3 T10C/T10E
GERANIACEAE	*Pelargonium suburbanum* subsp. *suburbanum*	VU	Dune fynbos	T7/TPWA5
GUNNERARCEAE	*Gunnera perpensa*	Declining	Slangrivier hillslope seep	T10G/TPWA4
MYRSINACEAE	*Rapanea gilliana*	EN	Tall thicket Dune fynbos Hillslope seep	T5/TPWA1 T7 TPWA4
	Rapanea melanophloeos	Declining	Riverine thicket/forest Dune fynbos Hillslope seep	T10F/TPWA1, 3, 4
RUTACEAE	*Agathosma stenopetala*	VU	Dune fynbos	T7/TPWA5
SCROPHULARIACEAE	*Selago rotundifolia*	VU	Sandstone wetland	T10D
Monocotyledones				
AMARYLLIDACEAE	*Boophone disticha*	Declining	Dune fynbos	T7
CYPERACEAE	*Tetraria brachyphylla*	NT	Dune fynbos	T7/TPWA5
DIOSCOREACEAE	*Dioscorea sylvatica*	VU	Forest	T6/TPWA6
ORCHIDACEAE	*Eulophia secunda*	Declining	Transverse dunes Transverse dune wetland	T3 T10C/T10E
ORCHIDACEAE	*Satyrium hallackii* subsp. *hallackii*	EN	Transverse dune wetland	T10C/T10E
ORCHIDACEAE	*Satyrium princeps*	VU	Dune fynbos Transverse dune wetland	T7/TPWA5 T10C/10E/TPWA7

NT: Near Threatened; R: Rare; VU: Vulnerable; EN: Endangered
Th: likely to be threatened, but not confirmed; note this is a South African category and is not recognised internationally
Declining refers to a species whose habitat is being degraded and species numbers are decreasing
“T” communities from the earlier study by Low (2011); “TPWA” communities from this study.

Table 3: Habitat signatures for selected wetlands at Thyspunt (from Low (2011) and this study (TPWA sites))

Habitat signatures for selected wetlands at Thyspunt (from Low (2011) and this study (TPWA sites))					
	Obligate species				Proportion riverine & wetland
Locality of wetland	**Riverine**	**Wetland**	**Riverine & wetland**	**Terrestrial**	
Coastal seeps (T10A)	0 (0.0%)	12 (23.1%)	15 (28.8%)	25 (48.1%)	27 (32.7%)
Inland seep between parabolics (Langefontein) (T10B)	0 (0.0%)	13 (23.2%)	18 (32.1%)	25 (44.6%)	31 (55.4%)
Transverse dune seep (T10C)	0 (0.0%)	17 (49.5%)	13 (30.2%)	13 (30.2%)	30 (69.8%)
Transverse dune seep (T10E)	0 (0.0%)	13 (31.0%)	9 (21.4%)	20 (47.6%)	22 (52.4%)
Seep above Slangrivier (west) (TPWA2)	0 (0.0%)	5 (9.8%)	12 (23.5%)	34 (66.7%)	17 (33.3%)
Transverse dune seep (TPWA7)	0 (0.0%)	5 (27.8%)	11 (61.1%)	2 (11.1%)	16 (88.9%)
Seep on northern edge of main dune cordon (west) (TPWA4)	0 (0.0%)	9 (25.0%)	12 (33.3%)	15 (41.7%)	21 (58.3%)
Seep above Slangrivier (east) (T10G)	1 (3.0%)	7 (21.2%)	19 (57.6%)	6 (18.2%)	26 (81.2%)

Four major vegetation types are found along the proposed alternative routes (*sensu* Mucina & Rutherford, 2006). Two of these (threatened status in parentheses – see Rouget *et al*., 2004) - Algoa Dune Strandveld (Least Threatened - LT) (and Southern Cape Dune Fynbos (LT) - are confined to calcareous substrates. In the north, Tsitsikamma Sandstone Fynbos (Vulnerable - V) occurs on quartzitic sandstone and there is a narrow band of Eastern Coastal Shale Band Vegetation (Endangered - E) just outside the site. Cowling (undated) has mapped seven broad communities, which are little more than vegetation types. However he does include forest and thicket (omitted for this area by Mucina & Rutherford, 2006), although one might argue that Algoa Dune Strandveld is a Thicket type and should therefore be covered in Mucina & Rutherford, 2006). Indeed, Cowling (1984) refers to the vegetation of the site as a South Coast Dune Fynbos-Kaffrarian Thicket mosaic and this perhaps provides a more appropriate representation of the resident vegetation, although at a small scale.

A further, albeit undifferentiated, community, is that of wetlands, which lie along the dune slacks in the centre of the site (Cowling, undated). These are all located on calcareous substrates and no doubt occur due to impeded drainage over calcrete and aeolianite.

Mapped plant communities, including plot locations and the route alternatives, are shown in **Figure 14**, with a brief description of communities and a summary of species data in **Table 4**.

The proposed route alternatives cross or run in close proximity to the following broad plant communities:

1. Dwarf coastal thicket on older, stable parabolic dunes nearer the coast;

2. Limestone fynbos (one major outcrop near the conservation offices at the Thyspunt site and a smaller one on the inland route IR-2);

3. Tall thicket, the most common community encountered but locally heavily infested by *Acacia cyclops* rooikrans and mainly on older stable parabolic dunes;

4. Dune fynbos on transverse dunes (but mainly unvegetated mobile sands in the study area);

5. Dune fynbos of older, stable parabolic dunes;

6. Sandstone fynbos, to the north of the main dune cordon – in fair condition south of the Slangrivier, but severely degraded by farming activity north of the river; and

7. Wetland suites as described under “Wetlands” below. In essence there are three botanical suites: These are the coastal seeps, the transverse dune slacks, and the Slangrivier system, with its associated hillslope seeps to the south.

The site is heavily infested by woody aliens, notably *Acacia cyclops* rooikrans and *A.saligna* Port Jackson willow. An extensive clearing programme is underway, being managed by Eskom (Gert Greeff, pers.comm).

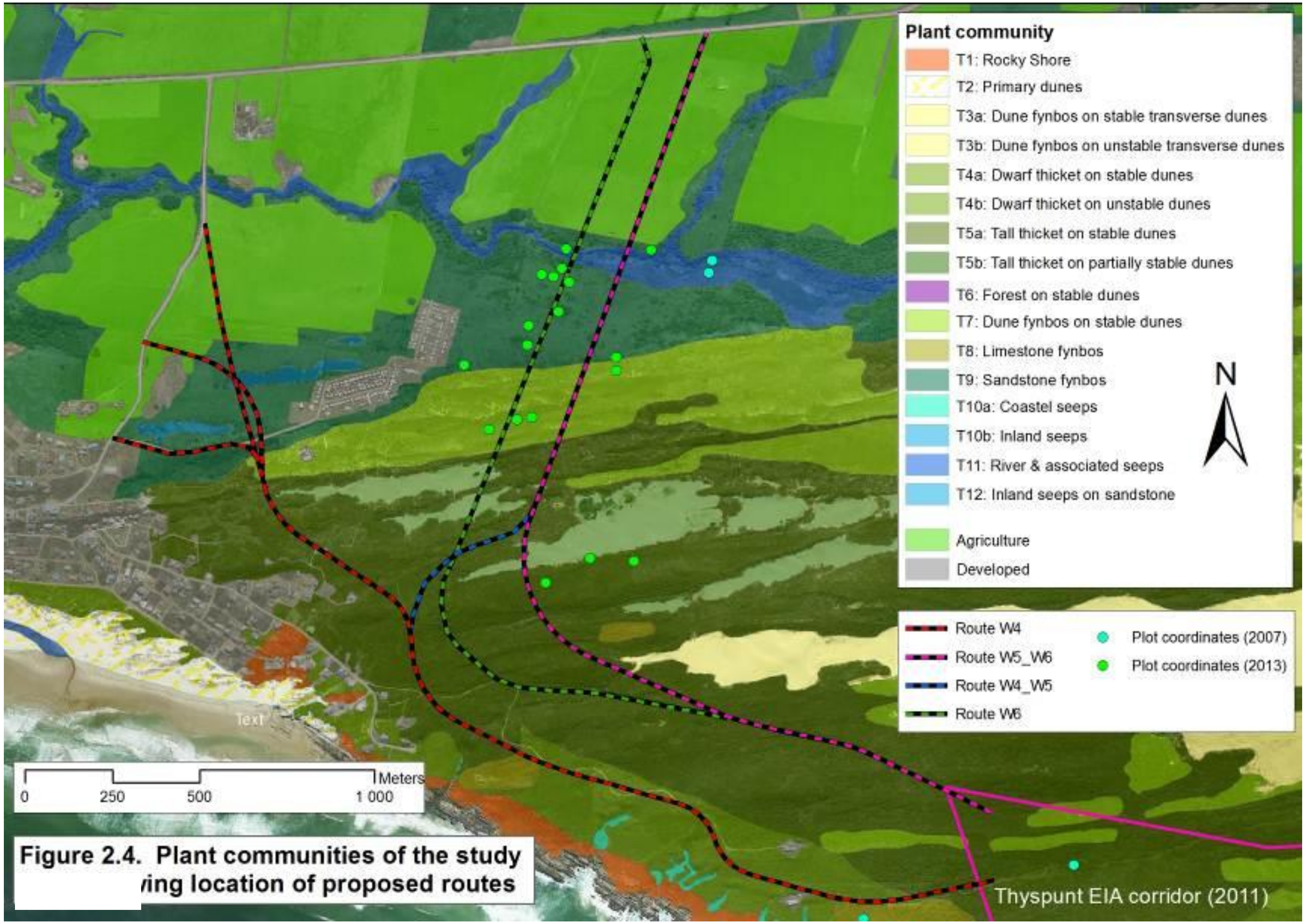


Figure 14: Plant communities of the Study Area

Table 4: Plant communities found at Thyspunt, together with a summary of species data

Plant communities found at Thyspunt, together with a summary of species data (from Low, 2011). TPWA sampling sites included						
Map no	**Description**	**Flora sample**	**Vegetation (plot) sample**	**Total plant species (Red Data)**	**Area (ha)**	**%**
Calcareous sands and limestones						
T1	Rocky shore – shallow sand over sandstone bedrock	Yes	Yes	63 (2)	25.0	1.1
T2	Primary dunes on coast	Yes	No	30 (0)	9.9	0.2
T3	Dune fynbos on mobile to semi-mobile transverse dunes	Yes	Yes	32 (2)	399.5	18.3
T4	Dwarf dune thicket at coast	Yes	Yes	42 (0)	338.5	15.5
T5 (TPWA1&3))	Tall thicket on deflated parabolic dunes inland of coast (includes invasive *Acacia cyclops* rooikrans)	Yes	Yes	44 (1)	680.7	31.2
T6 (TPWA6)	Coastal forest on older dunes inland	Yes	Yes	42 (1)	10.7	0.5
T7 (TPWA5)	Dune fynbos on deflated parabolic dunes	Yes	Yes	141 (5)	403.4	18.5
T8	Fynbos on limestone, chiefly in south-west of site	Yes	Yes	74 (4)	11.1	0.5
Sandstone						
T9	Fynbos on sandstone in the northern part of the site	Yes	Yes	51 (1)	83.6	3.8
Wetlands						
T10A	Coastal seeps on calcareous sands just above the high-water mark	Yes	Yes	52 (1)	4.4	0
T10B	Inland seep in calcareous parabolic dune slack (Langefontein)	Yes	Yes	56 (0)	38.7	1.8
T10C (TPWA7)	Wetlands in main spine of transverse dunes	Yes	No	43 (3)	N/A	N/A
T10D	Valley bottom wetland on upper Slang River	Yes	No	35 (1)	N/A	N/A
T10E (TPWA2&4)	Hillslope seeps on northern edge of transverse dunes	Yes	No	42 (3)	N/A	N/A
T10F	Middle Slang River channel	Yes	No	64 (0)	N/A	N/A
T10G	Valley bottom wetland on middle Slang River	Yes	No	33 (0)	N/A	N/A
Developed	Urban areas and farmland	N/A	N/A	N/A	178.0	8.2
Total (2011				**384 (14)**	**2 183.5**	**100.0**

2.2 Dune Geomorphology

A map of the dune systems for the area is shown in **Figure 15.** Although none of the four dune types present – primary, transverse, parabolic and deflated (oldest) parabolic – is rare, the Oyster Bay-Cape St Francis headland bypass system is unique in terms of its size and biophysical composition. It forms a rich mosaic of dryland and wetland habitats, the latter which rely heavily on the dune systems for their on-going sustainability. In particular the transverse dune slacks offer temporary wetlands which move with the dunes as they progress in an easterly direction.

However, a parallel study by Illenberger (2013) indicates the mobility decreasing rapidly, with 60% of unvegetated mobile sand having become stabilised over the past 70 years. This is largely due to the loss of sand supply at Oyster Bay and is directly linked to development and urban encroachment of the primary feeder system here. Again there is no evidence to suggest the dunes will not re-mobilise under a different climatic regime, as has happened elsewhere along the Cape coast, for example in Hout Bay between 2009 and 2011 (Low & Van Eeden, 2013).

Illenberger (2013) predicts the dune system will remain in a functional state for at least the next 1000 years, well beyond the lifespan of the planned Nuclear 1 Power Station. He also notes the uncertainty surrounding the mobility of dunes as woody alien vegetation is cleared by Eskom. The clear conclusion here is that currently infested dunes are likely to re-mobilise at the expense of indigenous plant colonisation and that the eastern part of the system will retain its mobility for some time (Burkinshaw, 1998).

2.3 Wetlands

Five broad wetland suites have been identified along the route (**Figure 16** to **Figure 18**), with Ecological Importance and Sensitivity - EIS - included in brackets):

1. Seasonal dune slack wetlands, chiefly in the transverse dunes, in the centre of the study area (A);
2. Hillslope seeps, chiefly between the main dune cordon and the Slangrivier (A)
3. Valley bottom wetlands, including the Slangrivier (B);
4. Coastal seeps, occurring exclusively along the coast between the NPS footprint and Oyster Bay (route CR-1/CR-2) (A); and
5. Hillslope seeps in farmland in the northern part of study area and north of the Slangrivier (C).

Wetlands on and associated with the Thyspunt site are intimately connected with the two mobile dunefields. These serve as major recharge areas for the primary aquifer, which is the driving variable that underlies wetland formation in the broader area between the Oyster Bay dunefield and the sea, and thus across most of the proposed power station site (Visser et al 2011). **Figure 16** shows wetlands on and in the vicinity of the Thyspunt site, in relation to major features such as the mobile dunes, as mapped in Day (2011).

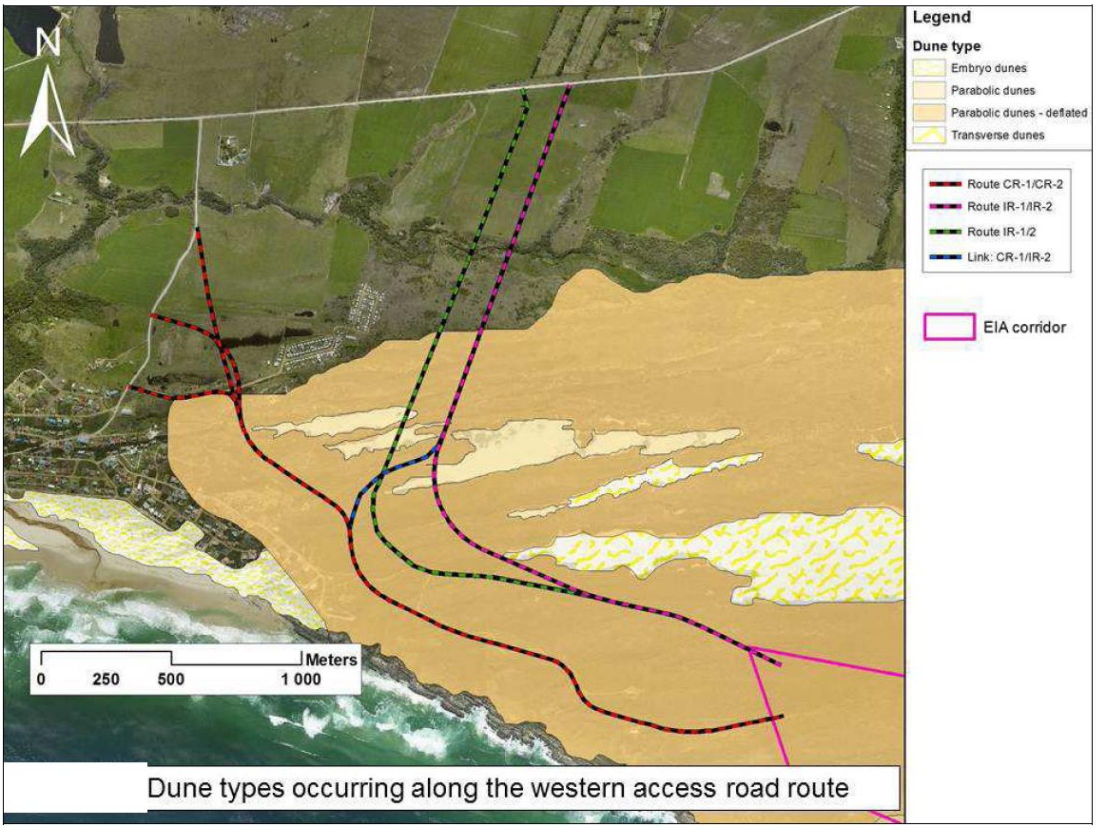


Figure 15: Dune types occurring along the Western Access Route

The eastern quarter of the Oyster Bay dunefield drains into the Sand River – an "episodic" river, which comprises largely shallow subsurface flow, save during flood episodes, when it carries runoff and subsurface flow from the dunes and surrounding farmland and other developed areas into the Kromme River. The only other major river that is associated with the Thyspunt site is the Slang River, which drains into the sea immediately west of Oyster Bay Village, passing through areas in which the proposed western access road alternatives are located. The Slang River receives runoff from valley bottom and hillslope seep wetlands in the northern portion of the Thyspunt site, and flows immediately north of the Oyster Bay dunefield as a channelised, increasingly disturbed valley bottom wetland.

Other wetland types identified on the Thyspunt site and described in detail in Day (2011) include:

- **Wetland depressions** within the mobile dunefields – these wetlands are also referred to as dune slack wetlands, and form against the leeward toe of the mobile dunes. Collectively they comprise an extensive band of periodically inundated depressional pools, ranging from less than 0.3 m in depth to >2 m. The wetlands are aligned in a west-east direction, becoming more extensive in the east, where they widen to form swathes of permanently saturated, vegetated wetlands, which in places span a relatively high proportion of the dune width, and are linked at times by minor channels, which braid across the inter-dune surfaces. The wetlands comprise dynamic systems, undergoing significant shrinkage or expansion, depending on intra- to inter annual rainfall. They are also periodically infilled by encroaching dunes, with new wetlands forming over time as the dune moves through the system. Illenberger **(2009)** differentiates these wetlands from a geomorphological perspective, as:

- o "static" systems, which are periodically filled with sand, as the mobile west-east moving dunes pass through them (many of these are underlain by very fine sediments, which retard the rate of infiltration of water) and:
- o [spatially] "temporary" wetlands, that migrate with the eastward moving dunes;

- **Permanently** to seasonally saturated **hillslope seeps** – Three distinct types of hillslope seeps occur on and in the vicinity of the site, distinguished on the basis of their geographical location, which has implications for wetland character in terms of specific geohydrological and geological influences. The hillslope seeps identified comprise:
  - o **Coastal seeps**, comprising numerous small seeps, which arise just above the high water mark along the rocky shore. They are formed in areas where groundwater, moving along the base of the intergranular aquifer, daylights at the contact with the underlying TMG bedrock along the rocky shore (Visser et al 2011), forming an array of small springs and seeps. Although the individual seeps themselves are small, they form a mosaic of wetland habitat just above the rocky shore to the east of the Thyspunt point, occurring as wide swathes (up to 40 m wide) of wetland vegetation.

    On the original Eskom controlled site, the coastal seep wetlands occur along the rocky shore west of the sandy beach and Thyspunt point itself, as far as the western site boundary and extending on towards Oyster Bay. The highest density of these seeps lies towards the east, in the vicinity of Thyspunt, where the seeps form wide expanses of vegetated freshwater wetland, just above the high shore mark. In the vicinity of Oyster Bay, many of the seeps have been drained and infilled to make way for houses and road infrastructure.
  - o **Northern) hillslope seeps** within the largely agricultural area to the north of the Oyster Bay dunefield, including in the vicinity of the proposed western access road alternatives: some of these drain to the west of the site, via a network of channelized and generally degraded valley bottom wetlands through agricultural areas, while others occur along the northern edge of the Oyster Bay dunefields, and either seep slowly into the aquifer (eastern wetlands) or drain south into the Slang River1 Oyster Bay dunefields, and either seep slowly into the aquifer (eastern wetlands) or drain south into the Slang River2.
  - o **(Southern) hillslope seeps** arising in the area between the two mobile dunefields - the largest of these is the **Langefonteinvlei**.
- **Permanently** to seasonally saturated **valley bottom wetlands** - Two distinct types of this wetland have been distinguished on and associated with the site, namely:
  - o Artificially and naturally channelled **valley bottom wetlands** north of the dunes, which occur in conjunction with extensive hillslope seeps within the largely agricultural area to the north of the Oyster Bay dunefield and either

[1] Note that the suggestion that the north western wetlands drain into the Slang River was presented in the present report, and did not form part of Day (2011)'s original description of these wetlands.
[2] Note that the suggestion that the north western wetlands drain into the Slang River was presented in the present report, and did not form part of Day (2011)'s original description of these wetlands.

dissipate into the main dunefields, feeding into the Sand and Slang rivers or draining directly into the sea, in the vicinity of Oyster Bay;

- **Unchannelled valley bottom wetlands** in the area between the two main mobile dune fields – these wetlands are fed largely by hillslope seeps day-lighting in this area, although they also probably receive direct inflows from groundwater. The main unchannelled valley bottom wetland in this area is the Eastern Valley Bottom wetland, which drains the area between the two mobile dune systems, flowing from a point just east of the Langefonteinvlei and the eastern site boundary, towards St. Francis Bay.

Each of these systems is distinctive with respect to hydrology, geomorphology and floristics (see botany section above) and there is a dynamic interplay between dryland and wetland systems. Their distinctive nature, overall good quality and likely endemism to the Oyster Bay-Cape St Francis headland bypass system accords them a very high conservation value.

Most of the wetlands are in good condition, but east of Oyster Bay and Umzamawethu, wetlands become degraded due to trampling, possible medicinal use of plants, pole cutting, infilling, drainage and channelisation.

The Slangrivier is heavily impacted, with extensive head cut erosion and channel deepening. This has had a negative impact on draining the adjacent wetlands. Cattle provide an additional impact through a river crossing and eutrophication of the system, whilst invasion by woody aliens such as *Populus x canescens* grey poplar and *Cestrum laevigatum* inkberry occurs locally.

2.4 Invertebrates

The area investigated includes four regional vegetation communities: Algoa Dune Strandveld (LT), Eastern Coastal Shale Band Vegetation (EN), Southern Cape Due Fynbos (LT) and Tsitsikamma Sandstone Fynbos (VU).The Eastern Coastal Shale Band Vegetation of the study area has been transformed by agriculture. The remaining natural Tsitsikamma Sandstone Fynbos invertebrate habitat of the study area is considered as sensitive. The wetland habitat associated with the Slang River wetland system and the rare invertebrate habitat of the bare and partially bare mobile dunes are regarded as sensitive invertebrate habitats.

Four red data damselflies and twelve red data butterflies are listed for the Eastern Cape Province. It includes five species listed as Data Deficient, one listed as Near Threatened, six listed as Vulnerable and four listed as Endangered. Based on known geographic ranges and habitat requirements, none of the sixteen red data invertebrates listed for the Eastern Cape Province are considered likely to occur in the region of the study area.

As mentioned five alternative routes were assessed in terms of invertebrate sensitivities considering likely impacts associated with the proposed access road. The Coastal Route includes 1159 meters of transformed or degraded habitat and 2068 meters of natural habitat; it does not include any rare or sensitive habitat and would not incur any fragmentation of the Slang River wetland system or sensitive mobile dunes. Coastal to Inland Route 2 includes 1597 meters of transformed or degraded habitat and 2222 meters of natural habitat as well as 155 meters of sensitive wetland habitat; it would incur fragmentation of the Slang River wetland system but no sensitive mobile dunes. Inland Route 2 includes 2164 meters of transformed or degraded habitat and 808 meters of natural habitat as well as 155 meters of sensitive wetland habitat and 56 meters of mobile dune habitat; it would incur fragmentation of the Slang River wetland system and sensitive mobile dunes. Inland Route 1 includes 2151 meters of transformed or degraded habitat and 1034 meters of natural habitat as well as 116 meters of sensitive wetland habitat and 137 meters of mobile dune habitat; it would incur fragmentation of the Slang River wetland system and sensitive mobile dunes. Coastal to Inland Route 1 includes 1282 meters of transformed or degraded habitat and 2556 meters of natural habitat as well as 116 meters of sensitive wetland habitat and 137 meters of mobile dune habitat; it would incur fragmentation of the Slang River wetland system and sensitive mobile dunes.

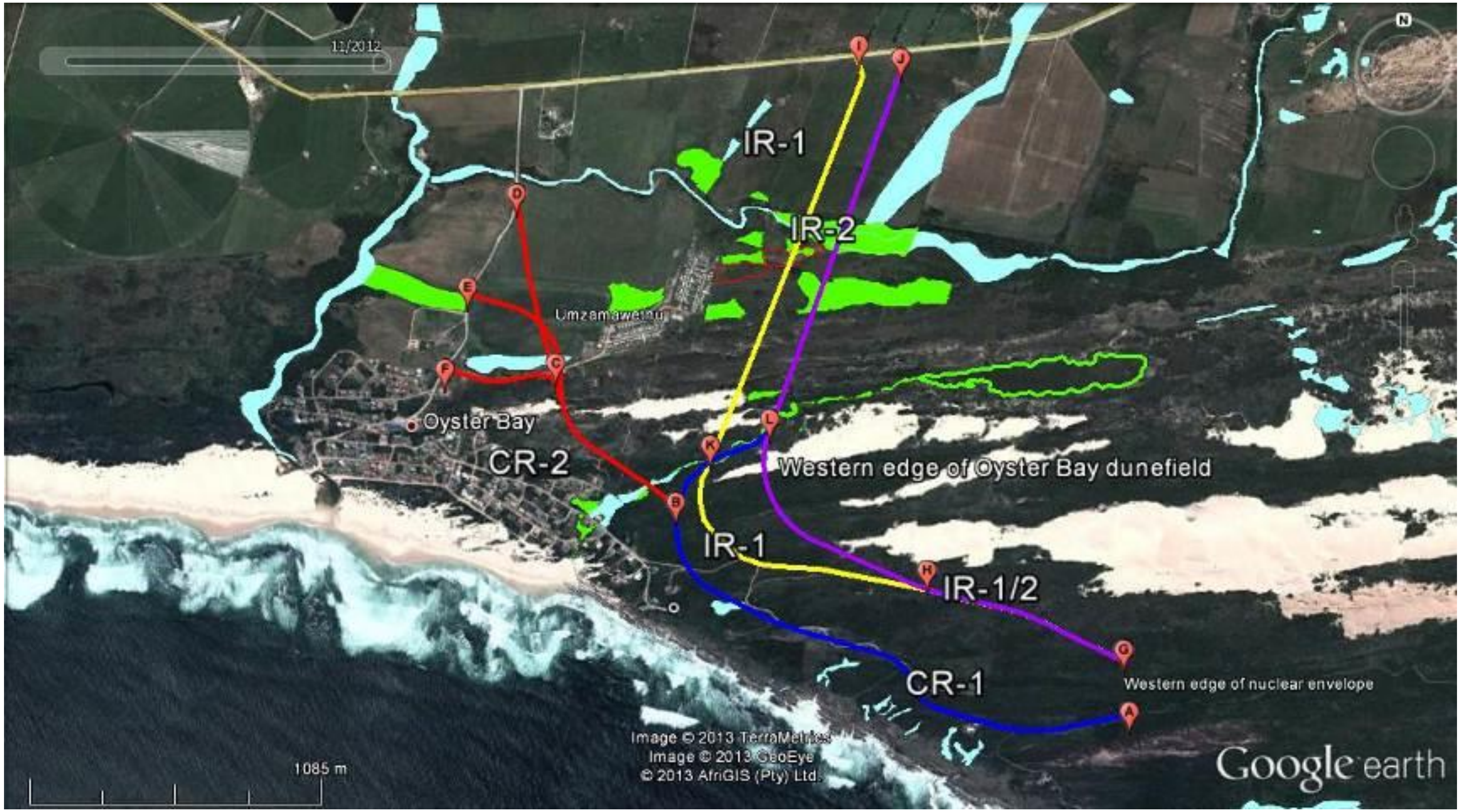


Figure 16: Wetlands associated with the proposed alignments of alternative western access routes to the Thyspunt Site. Filled blue polygons indicate wetlands mapped in Day (2011). Filled green polygons indicate additional wetlands, or wetlands with more accurate delineations, as identified during the more detailed site assessments of this area in November 2012. Empty green polygons indicate wetlands where the full extent has been mapped inaccurately off aerial photography. These wetlands are usually in dense alien vegetation and difficult to delineate on site. Empty red polygons indicate marginal wetland areas, likely to function as wetlands in wetter periods, but where soil and plant indicators do not consistently indicate the presence of even seasonal wetland conditions.

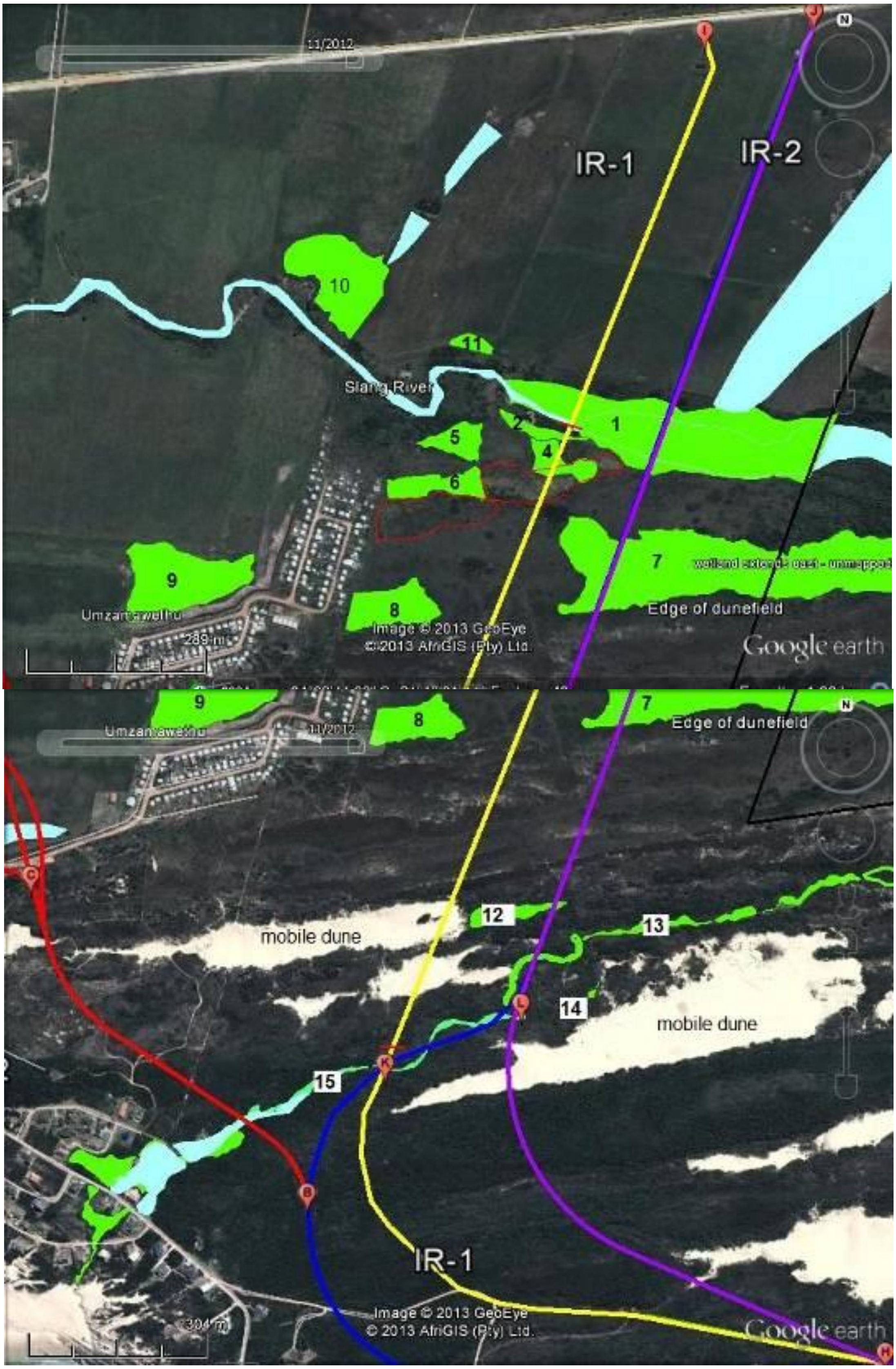


Figure 17: Near view of mapped wetlands showing northern and southern sectors of alternative western access routes IR-1 and IR-2. Filled blue polygons indicate wetlands mapped in Day (2011). Red marker indicates proposed 40 m wide road reserve. Filled green polygons indicate additional wetlands, or wetlands

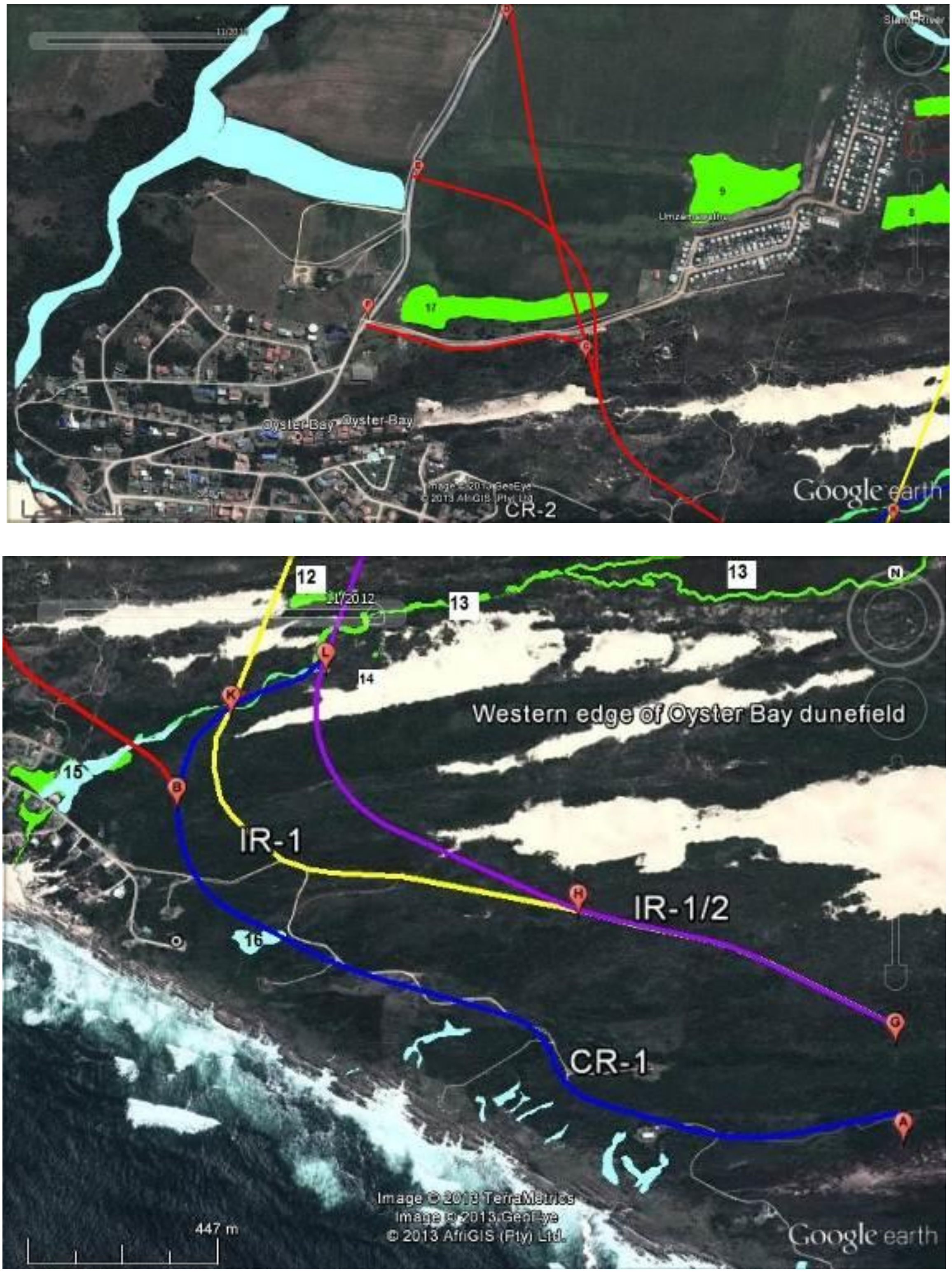


Figure 18: Near view of mapped wetlands showing western and north eastern sector of alternative western access routes CR-2, CR-1, IR-1 and IR-2. Filled blue polygons indicate wetlands mapped in Day (2011). Marker indicates proposed 40 m wide road reserve. Filled green polygons indicate additional wetlands, or wetlands.

2.5 Vertebrates

The approach of the vertebrate component of this study was to determine what species should occur in the area and whether there are any endemics. This was undertaken chiefly through a desktop assessment of likely species presence with casual records of fauna observed in the field.

Low numbers of vertebrate species would be expected in degraded landscapes such as north of the Slangrivier and around human settlements such as at Oyster Bay and Umzamawethu. Alien vegetation is also likely to lead to a decline in species numbers.

Seedeaters (birds) are likely to occur in farmland, especially where grain crops are cultivated.

Roads provide good hunting grounds for owls, and quails and nightjars are also often found here.

The unnaturally (see above under wetlands) steep banks of the Slangrivier provide habitat for Malachite Kingfisher and Spotted Eagle Owl, whilst swifts could nest under a bridge constructed across the Slangrivier.

Large populations of rodents, such as *Rhabdomys pumilio* (three-striped field mouse) and vlei rat, *Otomys irroratus,* were encountered, as were moles and dune mole rat (*Bathyergus suillus*), are some of the mammals found on the site. Birds include the Black Harrier, a common resident of marshy plains and fynbos. Herpetofaunal sightings included the Yellow-bellied house snake and the Leopard Toad (Vulnerable), the latter likely to be restricted to the hillslope seeps south of the Slangrivier.

Golden mole and puffadder were observed along IR-2, with observation of Bush Pig and Blue Duiker scats.

C-1 to IR-1 – observations of Rhombic Skaapsteker, Cross-marked Sand Snake, Francolin, Guinea Fowl, Waxbills and Widows. Common Caco in dune slack wetlands. The dune fynbos to the south supports the padloper (*Homopus signatus*) and Angulate Tortoise (*Chersina angulata*).

It is important not to fragment these habitats as this would lead to a loss of species numbers and even species.

Other mammals observed on the site included Bush Buck, mainly in thicket and forested areas, and grysbok, which seem to prefer more open habitat such as dune fynbos.

The report provides an Appendix of bird, reptile, amphibian and mammal species likely to occur on the site.

2.6 Heritage

The study considers the heritage resources within the affected Nuclear-1 site, specifically those potentially affected by the proposed Western Access route.

In this case, resources are limited primarily to archaeological resources spanning the full extent of the Stone Age period, including the Early (ESA), Middle (MSA) and Late (LSA) Stone Ages. While observations from the more recent historical period do not form a major component of the observations to date, they cannot be excluded from any review.

The broad description of heritage resources were described by Hart (2012) and the text is reproduced below for context.

Figure 19 indicates the western section of the Nuclear 1 site with proposed western access roads indicated. It also indicates archaeological sites recorded by the Archaeology Contracts Office and ACO Associates during various field trips as green triangles and includes sites recorded on the November 2012 specialist trip. We have superimposed the information presented by Binneman (1996) indicating site locations recorded by him from 1987 and 1996 surveys onto Google Earth. Of particular interest to the assessment of the western access roads is the distribution of Binneman's sites in portions of the main dune field now covered by vegetation.

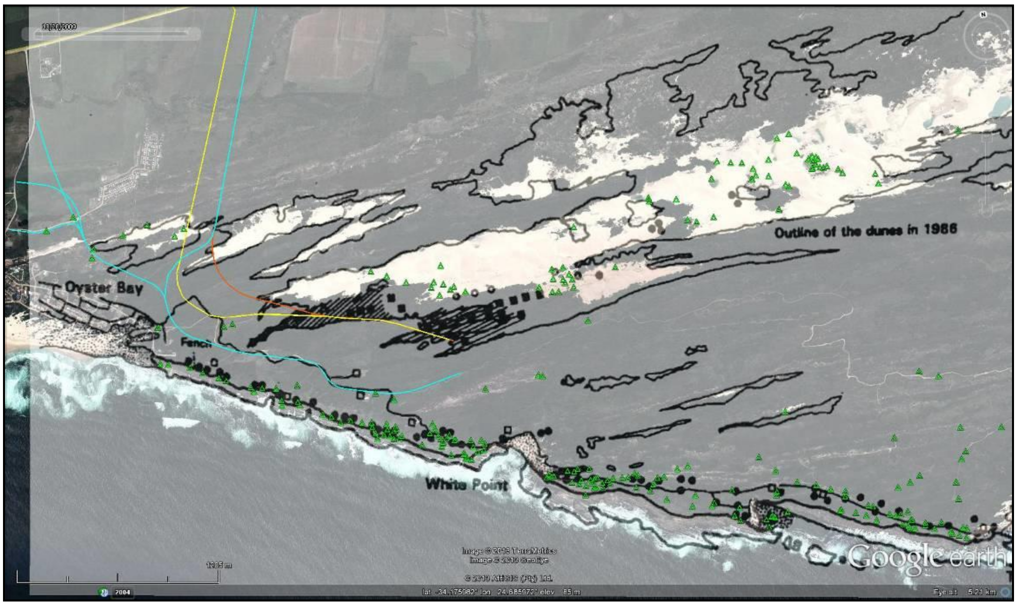


Figure 19: The western portion of the Nuclear 1 site showing the location of proposed access roads. Archaeological sites recorded by the Archaeology Contracts Office and ACO Associates (green triangles). The overlay shows sites recorded by Binneman in 1987 and 1996. Of particular interest to the assessment of the western access roads is the distribution of his sites in portions of the main dune field now covered by vegetation.

While Binneman's site locations are crudely located here due to issues of distortion, and possible imprecise plotting on maps at the time, the broad indication is that the cluster of MSA sites identified in the open dunes (and still seen today) extends to the south west. They appear to be associated with palaeosols indicated by brown to grey sediments, and sometimes extensive exposures of rhizoliths. It was in one of the vegetated areas that a MSA with bone and hyena coprolites was excavated by Carrion et al. (2000).

2.6.1 Palaeontological Resources

The dune field complex at Thyspunt is large and deep, which means that there is a very high potential for Pleistocene palaeontology and archaeology to exist below and within the dune bodies.

The proposed Nuclear-1 corridor at Thyspunt is situated on top of a low-lying coastal platform that has been carved by wave action into resistant, quartzite-dominated sediments of the Nardouw Subgroup (upper Table Mountain Group / TMG). The TMG platform surface mostly lies between 4 to 8 m amsl, rising to a maximum of 10 m amsl, and is mantled with a thin veneer of late Caenozoic coastal sediments of the Algoa Group. Various formations within the Algoa group are potentially moderately fossiliferous.

Of greater *concern* is the more recent Pleistocene palaeontology and archaeology that is exposed from time to time in the active dune system. Carrion et al. (2000) report finding fossil remains within the active dune system. He comments on quantities of fossil bone found lying on palaeosols associated with hyena coprolites and suggests that hyena activity during the Pleistocene may have been responsible. Also identified were extinct mammal species (*Pelorovis antiquus* – giant buffalo) that suggests that the fossil material dates to within the Pleistocene. Binneman (pers. comm.) commented on the high frequency of MSA material within the deflated areas in the dunes, some of which he considered to be relatively undisturbed. Since Binneman had made most of his observations in the 1980's and 1990's the vegetation has encroached (based on aerial photographs - see for example Illenberger 2013) over areas where he had made many of his observations. Today these areas are impenetrable. However, the significance of Binneman's findings is considered in the overall impacts that will result from the proposed activity.

In summary, Thyspunt is likely to produce significant Pleistocene fossils and archaeology. The potential to produce Miocene fossils is very low.

(a) Pre-colonial heritage resources

Taking into account the earlier findings by Binneman (1996, 2001) and the findings of on-going studies of the Nuclear-1 site, the pre-colonial heritage in the study area is extraordinarily prolific, particularly within 300 m of the high water mark and the open dune fields. Along the coast archaeological material was found almost everywhere where ground surface visibility allowed. It stands to reason that the total number of archaeological sites that exists on the affected properties is undoubtedly more than the number of occurrences that were found during the surveys. Shifting dunes and oscillating vegetation patterns have obscured many sites that were identified years ago. Interestingly the vegetated dunes that lie between the coast and the headland bypass dune system are almost entirely devoid of archaeological material. It was noted that despite the high rainfalls that took place in the area in 2011, drainage of this area was very good as the water table was not encountered in any trial excavations including those in the bottom of the dune slacks.

Given the comprehensive amount of work that has taken place to date, good information about the distribution of archaeological sites may be deduced. The area within ~300 m of the rocky shoreline was densely occupied, and probably contains more than seventy percent of the archaeological sites in the entire study area. The shoreline offered pre-colonial people abundant resources. There are sheltered bays and pools where shellfish could be easily collected as well as ample opportunity for fishing. Numerous fresh water springs along the shoreline would have made this locality a veritable paradise for pre-colonial people. It is quite likely that there is a moderate drop off in the frequency of pre-colonial sites adjacent to the sandy beach at Thysbaai as beaches were not nearly as attractive to pre-colonial people as resource rich rocky shorelines. A survey of land adjacent to Thysbaai beach, (although very restricted by dense vegetation growth) indicated a drop off in the frequency of archaeological site in this area opening up a possible less sensitive option within the proposed nuclear corridor.

Middle Stone Age material was noted broadly scattered on almost all exposed palaeosols within the active dune system. While much of the material was dispersed, at least one site – an artefact manufacturing area - appeared to have well-preserved spatial patterning. Fragments of bone are numerous, however much of this is recent and out of context. Due to shifting vegetation patterns and dune movement, the Middle Stone Age Howieson's Poort material was not relocated, although material suggestive of it was found in the dunes during the November 2012 specialist trip in the broad vicinity of the Howieson's Poort site excavated and described by Carrion et al. (2000). The evidence collected by the Heritage Specialist and other authors suggests that the ancient Pleistocene land surfaces that evidently lie preserved under the dune system are highly sensitive. Due to the dynamic state of the dunes, surveys should ideally be repeated over a number of years before a comprehensive picture can be determined.

Late Stone Age shell middens are numerous within 300 m of the coastline and in the active dunes, with the highest concentrations being situated on the shoreline close to shallow bays in rocky shores and spring eyes. During the study some 150 occurrences were observed with many more being noted outside the proposed nuclear corridor. This number is only an indicator of density as some material is likely to be buried within dune bodies. Along the shoreline itself, the material is so profuse that the sites form an almost continuous ribbon of material. Notable is the fact that many middens take on the form of large vegetated mounds, which can be seen from a distance due to the fact that specific kinds of coastal vegetation grow on them. The majority of the middens are very well preserved as access to the coast is restricted and only attainable by off-road vehicle. Within the well-drained vegetated dune areas which make up a large portion of the site between the coast and the headland bypass dune system, archaeological sites are sporadic and ephemeral. They are more numerous towards the east where there are wetlands and standing water (St. Francis Links Golf Course) and eastern areas of the site. The overall distribution of sites correlates very well with the immediate presence of springs and sources of standing water. Hence the spatial distribution of Late Stone Age archaeological material is highly focused around areas of optimal resources.

Middens are characterised by an eclectic mix of shell species. While at Bantamsklip *Haliotis midae* (perlemoen) would seem to have formed the bulk of meat resources, this was not the case at Thyspunt. Very few *Haliotis* spp. shells were seen at all. The staple appears to have been *Turbo sarmaticus* (Alikreukel), which was noted on virtually all sites together with a diversity of limpets *Scutellastra longcosta*, *Cymbula oculus* as well as high numbers of *Scutellastra cochlear*. *Perna perna* (brown mussel) was also noted on most sites. Of particular interest was the presence of *Oyxstele tigrina* dominated middens which are interpreted by Binneman (1996) as being attributable to quick expedient coastal forays that were the style of subsistence during the pastoralist period. While this shellfish is commonly available in the Western Cape it is very seldom present on middens in large quantities – this points to some form of cultural preference at Thyspunt. On all the sites recorded the artefactual assemblage was relatively informal, being dominated by quartzite chunks and flakes, flat boulders used as grinding surfaces. Exotic raw materials such as silcretes and fine grained quartzites are also present. However, formal artefacts quantities are low. Binneman (1996) has reported recording microlith dominant assemblages on sites within the dune system but not on the immediate coast. Fragments of Cape Coastal Pottery are common – much more so than at Bantamsklip. Also noted in at least one instance was the presence of large backed artefacts that fit the description of the Kabeljous Industry first described by Binneman.

Late Stone Age middens were also recorded in the active dune fields between ~700 m and ~2 km inland. Although these sites are quite far from the shoreline, they are surprisingly numerous. They are generally discreet, well preserved and exhibit good within-site spatial patterning including hearths and stone platforms in some instances. Pottery of the Cape Coastal variety is common, some of it elaborately decorated. Bone is in evidence throughout the dune field, although not all of it is archaeological. The dune field sites are remarkably intact considering the dynamic environment in which they exist. Judging by the range of artefacts on them, they have not been picked over by tourists and souvenir hunters. If access control was not in place and the dunes easier to access, the sites would be in far poorer condition.

The vegetated dune system between the coast (300m inland) and the Oyster Bay dune field is largely devoid of archaeological material. Indications are that there is a strong correlation between particularly Late Stone Age sites and the presence of sources of fresh water. Sites are prolific adjacent to the coastal springs, and in the Oyster Bay dune field where pools of fresh water are to be found on an almost permanent basis. Sites may also be observed towards Cape St. Francis, where the Sand River and the many temporary and permanent wetland system exerted a strong influence on human settlement patterns. Conversely, the vegetated dunes are very well drained – immediate sources of surface water are limited, which is a likely reason why archaeological sites occur sporadically in the vegetated area which makes up the bulk of the proposed Nuclear-1 footprint.

(b) The colonial period

The colonial period heritage of the study area is limited. An abandoned farm house situated on farm 735 portion 2 is the only structure on the entire property which could be securely identified as being greater than 60 years of age and thus protected by the general protections of the NHRA. The house dates to the 19th to early 20th century. Joinery and wood work is in place but deteriorating through abandonment. It is possible that this cottage is one of the earlier Welgelegen farm buildings.

A well preserved complex of historical fish traps is situated in the shallow bay below the St Andrews cottage near Thysbaai. Long thought to have been built by pre-colonial pastoralists, new research (Hine, 2007) indicates that they were either built, or inherited by colonists who used them to provide a cheap source of protein for themselves and their staff.

(c) Cultural landscape

The cultural landscape qualities of the study area refer to its natural heritage and high biodiversity in union with the person made landscape in the distinct geographical area defined by Cape St. Francis (east), Oyster Bay (west) and the outer (north) perimeter of the dune system. The landscape, together with the archaeological sites it contains may be viewed as a single holistic entity, which retains the spatial patterning of human use of the landscape in a largely intact natural coastal environment that has not changed significantly since prehistoric times. A rare aspect of the area is the active dune field – a headland bypass system almost 15 km in length, which together with the wide range of archaeological and palaeontological resources on it, place it among a few surviving landforms of this kind and size around the country. This dune field, together with the coastal thicket vegetation, the rich shoreline with its natural springs represents a uniquely intact environment in which KhoeKhoen pastoralists and San hunter-gatherers existed. The Gamtkwa Khoisan Council (stakeholder meeting, Hankey 2010) has indicated that it regards the completeness of this natural and human environment as a holistic entity of extraordinary heritage value to Khoisan descendants.

(d) Significance

The heritage significance of the western approach to the Thyspunt site may be summarised thus:

Palaeontological sites do occur in the dunes. Sometimes however, these have become admixed with archaeological sites due to deflation. Fossil root casts, palaeosols, fossil animal bone and fossil hyena coprolites have all been identified in the dunes and cast light on palaeoclimates and vegetation.

The study area is highly significant in terms of Late Stone Age pre-colonial archaeology, in particular the large quantity and variety and size of shell middens. Many of the middens are very well preserved and are in themselves archives of information about the identity and behaviour of pre-colonial people, as well as the environment in which they lived. Late Stone Age middens on the southern and eastern Cape coasts are known to be sites of human burials.

While shell middens are relatively common, undisturbed middens are becoming increasingly rare. The relatively large number of well-preserved middens is considered to be significant.

The Late Stone Age heritage of the area is directly linked to the heritage of South Africans who are alive today. Particularly relevant is the fact that a high proportion of the middens are less than 2000 years old, pottery rich and associated with time that Khoekhoen herders were the dominant force in the area. Concern has been expressed by a local first nation community, the Gamtkwa, with respect to the future of archaeological material, which is the heritage of the Khoisan people. All pre-colonial material is automatically protected by section 35 of the NHRA.

The MSA and ESA material identified on the fossil dunes is potentially important in scientific terms, especially if it is preserved in an in-situ context on palaeosols under shifting dunes in association with fossil bone and artefacts. The potential exists for very rare human remains of early humans to exist in associated contexts.

The cultural landscape significance of the place relates mainly to its superb natural heritage, pre-colonial heritage, setting and contribution to the wilderness qualities of the region. In terms of the UNESCO definition of a “cultural landscape” – a distinct area containing the combined works of nature and people, Thyspunt and surrounding environments is a uniquely intact pre-colonial cultural landscape that contains the intact evidence of how pre-colonial people used the landscape – a complete settlement pattern.

(e) Sensitivity

Sensitivity is always difficult to determine in the heritage context such as is presented at Thyspunt. In this case an attempt is being made to determine the impact of development on resources that may be hidden or buried, thus it is not always certain that the resources are there, and in what quantity. Thus, best judgement has to be used based on various bits of information, not least the distribution of sites in the broad landscape that can be seen.

Another conundrum is that archaeologists derive a lot of information as a result of development and so, although development may have negative repercussions, positive benefits with respect to archaeology and palaeontology can be obtained. In some instances, leaving an archaeological site untouched can in fact lead to its destruction by natural processes.

Heritage sites are subject to natural disturbance of one kind or another on an on-going basis. A good example is the MSA sites located in the main dune field. With every movement of the dunes, some degradation of site content occurs. Sand deflation distorts spatial patterns and exposed bone becomes brittle and eroded by sand action, or lost altogether. Being covered by vegetation is not always optimal either despite its stabilising influence. Roots may do as much damage to the material, and of course may render the material inaccessible.

There is no doubt that Thyspunt contains a remarkable array of sites from different periods. While the LSA is widespread beyond the site, ESA and MSA sites with associated organic remains are rare. The numbers and preservation of such sites at Thyspunt make it a place worthy of a concerted research program, over and above that required by mitigation of the Nuclear-1 site.

That being said, some portions of the site, where few heritage resources are expected, will have a high tolerance for disturbance, provided that disturbances are quickly rehabilitated and don't lead to disturbances elsewhere (destabilisation of dunes leading to increased sand movement).

It can therefore be concluded that portions of the site will have a low tolerance for disturbance in the absence of mitigation. For example, portions of the IR-1 and IR-2 route alternatives will go through areas where it is highly probable that ESA/MSA and LSA sites may be found within re-vegetated areas. Similarly, we know that LSA sites will definitely be impacted by some sections of the CR-1 and CR-2 route alternatives, and it is highly probable that LSA material will be impacted along the CR-1 route given the size of the road corridor.

2.7 Social Environment

The Thyspunt site is abutted on its western side by the communities of Oyster Bay and Umzamowethu. The social make-up of and activities within these communities are closely linked to the number of retirees and tourists which are attracted to the character of the area. Many residents of Umzamowethu are employed in Oyster Bay and there is thus movement of residents from Umzamowethu and Oyster Bay on a daily basis.

2.8 Noise

Inland Route 1 would pass within 230 m of the Umzamawethu Township as well as the nearest residence of Oyster Bay while Inland Route 2 would pass within 360 m of the Umzamawethu Township and 480 m from the nearest residence of Oyster Bay. The pertinent distances are indicated in **Figure 20**.

Table 5 records the sound power levels, LW (dBA), emitted by typical heavy-duty machinery that might be used during new road construction and the calculated outdoor LReq,d (dBA) at separation distances to the nearest respective receptors for continuous operation during an 8-hour working period.

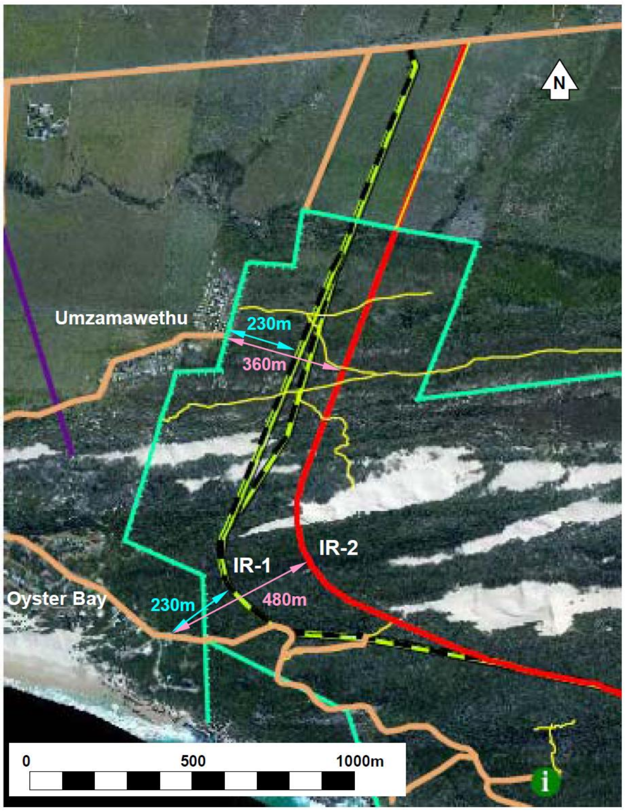


Figure 20: Distances between alternative Western Access Routes to the Thyspunt Nuclear-1 site

These represent the LReq,d of two of the "noisier" activities recorded, including reverse hooters and noise associated with dumping of rubble, and can thus be considered to be worst-case scenarios. In practice, however, vehicles/machinery on a construction site do not generate noise continuously and simultaneously for extended periods of time.

Table 5: L_{WA} emission of heavy-duty machinery and $L_{Req,d}$ for various separation distances to nearest receptors from IR-1 and IR-2 Machinery & operating conditions

	L_{WA}, dBA	$L_{Req,d}$, dBA		
Route		**IR-1**	**IR-2**	
Distance to nearest receptors, m		230	360	480
CAT D11 bulldozer moving earth, reversing and repeating – several cycles	111	54	50	47
CAT5130B front-end loader loading CAT777D truck after approaching and subsequently leaving loading area – several cycles	106	51	47	44

2.9 Visual Impacts

The local setting provides the Nuclear Site with some screening from the community of Oyster Bay. The Western Access Road will be the main access to the site from west and will also connect to the local road to Oyster Bay to the west and to St Francis Bay to the east.

This road will therefore traverse the dune fields between Oyster Bay to west and Cape St Francis to the east.

2.10 Geohydrology and Geotechnical

The regional groundwater occurrence at the Thyspunt site is covered in section 2.3 of the Geohydrological report (appendix E7) as attached to the Revised Draft EIR (Version 1). The Geotechnical environment is described in section 2.1 of the Geotechnical Assessment as attached in Appendix E5 of the Revised Draft EIR (Version 1).

3 IMPACT IDENTIFICATION AND ASSESSMENT

The objective of the assessment of impacts is to assess all the significant impacts that may arise as a result of the Nuclear Power Station and in this instance the construction of a western access road to the Thyspunt site.

In accordance with Government Notice R.385, promulgated in terms of Section 24 of the NEMA and the criteria drawn from the IEM Guidelines Series, Guideline 5: Assessment of Alternatives and Impacts, published by the DEAT (April 1998) specialists were required to describe and assess the potential impacts in terms of the criteria as indicated in Table 6. This table provides a summary of the criteria and the rating scales that were used. The assignment of ratings has been undertaken based on past experience of the EIA team, the professional judgement of the specialists as well as through research. Subsequently, mitigation measures have been identified and considered for each impact and the assessment repeated in order to determine the significance of the residual impacts (the impact remaining after the mitigation measure has been implemented).

Table 6: Impact assessment criteria and rating scales

Criteria	Rating Scales	Notes
Nature	Positive	This is an evaluation of the type of effect the construction, operation and management of the proposed NPS development would have on the affected environment.
	Negative	
	Neutral	
Extent	Low	Site-specific, affects only the development footprint
	Medium	Local (limited to the site and its immediate surroundings, including the surrounding towns and settlements within a 10 km radius);
	High	Regional (beyond a 10 km radius) to national
Duration	Low	0-3 years (i.e. duration of the construction phase)
	Medium	4-8 years
	High	9 years to permanent
Intensity	Low	Where the impact affects the environment in such a way that natural, cultural and social functions and processes are minimally affected
	Medium	Where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way; and valued, important, sensitive or vulnerable systems or communities are negatively affected
	High	Where natural, cultural or social functions and processes are altered to the extent that the natural process will temporarily or permanently cease; and valued, important, sensitive or vulnerable systems or communities are substantially affected.
Potential for impact on irreplaceable	Low	No irreplaceable resources will be impacted.
	Medium	Resources that will be impacted can be replaced, with effort.

Criteria	Rating Scales	Notes
resources	High	There is a high potential that irreplaceable resources will be lost.
Consequence (a combination of extent, duration, intensity and the potential for impact on irreplaceable resources).	Low	A combination of any of the following • Intensity, duration, extent and impact on irreplaceable resources are all rated low • Intensity is low and up to two of the other criteria are rated medium • Intensity is medium and all three other criteria are rated low
	Medium	• Intensity is medium and at least two of the other criteria are rated medium
	High	• Intensity and impact on irreplaceable resources are rated high, with any combination of extent and duration • Intensity is rated high, with all of the other criteria being rated medium or higher.
Probability (the likelihood of the impact occurring)	Low	It is highly unlikely or less than 50 % likely that an impact will occur.
	Medium	It is between 50 and 74 % certain that the impact will occur.
	High	It is more than 75 % certain that the impact will occur or it is definite that the impact will occur.
Significance (all impacts including potential cumulative impacts)	Low	• Low consequence and low probability • Low consequence and medium probability
	Low to medium	• Low consequence and high probability • Medium consequence and low probability
	Medium	• Medium consequence and low probability • Medium consequence and medium probability • Medium consequence and high probability • High consequence and low probability
	Medium to high	• High consequence and medium probability
	High	• High consequence and high probability

An explanation of the impact criteria is provided below. Only the above-mentioned criteria were taken into account in the assessment of impact significance. In addition, the degree of confidence in the prediction of impacts, the nature of applicable mitigation measures and legal requirements applicable to the impacts has been described by the specialists.

(a) Nature

This is an evaluation of the type of effect the construction, operation and management of the proposed NPS development would have on the affected environment. Will the impact change in the environment be positive, negative or neutral? This description must include what will be affected and the manner in which the effect will transpire. It is important to describe the impact (the change in the environment), and not the source of the impact.

(b) Extent or scale

This refers to the spatial scale at which the impact will occur. Extent of the impact is described as: low (site-specific - affecting only the footprint of the development), medium (limited to the site and its immediate surroundings and closest towns) and high (regional and national). Extent or scale refers to the actual physical footprint of the impact, not to the spatial significance. It is acknowledged that some impacts, even though they may be of small extent, are of very high importance, e.g. impacts on species of very restricted range. In order to avoid “double counting, specialists have been requested to indicate spatial significance under “intensity” or “impact on irreplaceable resources” but not under “extent” as well.

(c) Duration

The lifespan of the impact is indicated as low (short-term - 0-9 years, typically impacts that are quickly reversible within the construction phase of the project), medium-term (10-15 years, reversible over time) and high (long-term, 15-60 years, and continue for the operational life span of the power station).

(d) Intensity or severity

This is a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Does the activity destroy the impacted environment, alter its functioning, or render it slightly altered? The specialist studies must attempt to quantify the magnitude of the impacts and outline the rationale used.

(e) Impact on irreplaceable resources

This refers to the potential for an environmental resource to be replaced, should it be impacted. A resource could possibly be replaced by natural processes (e.g. by natural colonisation from surrounding areas), through artificial means (e.g. by reseeding disturbed areas or replanting rescued species) or by providing a substitute resource, in certain cases. In natural systems, providing substitute resources is usually not possible, but in social systems substitutes are often possible (e.g. by constructing new social facilities for those that are lost). Should it not be possible to replace a resource, the resource is essentially irreplaceable e.g. red data species that are restricted to a particular site or habitat of very limited extent.

(f) Consequence

The consequence of the potential impacts is a summation of above criteria, namely the extent, duration, intensity and impact on irreplaceable resources.

(g) Probability of occurrence

The probability of the impact actually occurring based on professional experience of the specialist with environments of a similar nature to the site and/or with similar projects. Probability is described as low (improbable), medium (distinct possibility), and high (most likely). It is important to distinguish between probability of the impact occurring and probability that the activity causing a potential impact will occur. Probability is defined as the probability of the impact occurring, not as the probability of the activities that may result in the impact. The fact that an activity will occur does not necessarily imply that an impact will occur. For instance, the fact that a road will be built does not necessarily imply that it will impact on a wetland. If the road is properly routed to avoid the wetland, the impact may not occur at all, or the probability of the impact will be low, even though it is certain that the activity will occur.

(h) Significance

Impact significance is defined to be a combination of the consequence (as described below) and probability of the impact occurring. The relationship between consequence and probability highlights that the risk (or impact significance) must be evaluated in terms of the seriousness (consequence) of the impact, weighted by the probability of the impact actually occurring. The following analogy provides an illustration of the relationship between consequence and probability. The use of a vehicle may result in an accident (an impact) with multiple fatalities, not only for the driver of the vehicle, but also for passengers and other road users. There are certain mitigation measures (e.g. the use of seatbelts, adhering to speed limits, airbags, anti-lock braking, etc.) that may reduce the consequence or probability or both. The probability of the impact is low enough that millions of vehicle users are prepared to accept the risk of driving a vehicle on a daily basis. Similarly, the consequence of an aircraft crashing is very high, but the risk is low enough that thousands of passengers happily accept this risk to travel by air on a daily basis.

In simple terms, if the consequence and probability of an impact is high, then the impact will have a high significance. The significance defines the level to which the impact will influence the proposed development and/or environment. It determines whether mitigation measures need to be identified and implemented and whether the impact is important for decision-making.

(i) Degree of confidence in predictions

Specialists were required to provide an indication of the degree of confidence (low, medium or high) that there is in the predictions made for each impact, based on the available information and their level of knowledge and expertise. Degree of confidence is not taken into account in the determination of consequence or probability.

(j) Mitigation measures

Mitigation measures are designed to reduce the consequence or probability of an impact, or to reduce both consequence and probability. The significance of impacts has been assessed both with mitigation and without mitigation.

(k) Legal requirements

The specialist identified and listed the relevant South African legislation and permit requirements pertaining to the development proposals. Reference must be provided to the procedures required to obtain permits and describe whether the development proposals have the potential to trigger applicable licensing or permit requirements.

To apply the criteria and to assist in identifying the appropriate significance rating, an Excel spreadsheet was developed to automatically tally the ratings per criterion so that specialists did not have to painstakingly apply the conditions in the impact criteria and come up with a consequence and significance rating. This also ensured consistency amongst the different specialists.

The result of the above assessment methodology will be linked to authority decision-making by Authorities in the following manner:

- Low – will not have an influence on the decision to proceed with the proposed project, provided that recommended mitigation measures to mitigate impacts are implemented;

- Medium – should influence the decision to proceed with the proposed project, provided that recommended measures to mitigate impacts are implemented; and
- High – would strongly influence the decision to proceed with the proposed project regardless of mitigation measures.

3.2 Biophysical Impacts

Significant impacts (without mitigation) created by the construction of the western access road are fragmentation of habitat and partial loss of ecosystem function in parabolic dunes and coastal calcretes; some loss of Red Data species; and possible loss of functionality of coastal and inland seeps, and the Slangrivier system. Localised forest patches could also be lost. A detailed discussion of the proposed route alternatives for both the construction and operational phases are given in the sections below:

3.2.1 Construction Phase

(a) Route CR-1 and CR-2 – Coastal Route (**Figure 21**)

The route leaves the proposed EIA corridor and is aligned close to the coast, mostly along the exposing gravel track, passing through Dwarf Thicket on stable dunes (between points A and B). This plant community is kept low due to strong coastal winds and salt spray. The route skirts limestone fynbos outcrop, before entering Tall Thicket on stable dunes, between points B and C. Localised pockets of forest are also present. Just west of Umzamawethu, at point C, the route splits into three alternatives. D (northern alternative), runs through degraded sandstone fynbos, a degraded, possibly artificial wetland, and farmland; E (middle alternative) also passes through degraded sandstone fynbos and the wetland, but ends in farmland; F (southern alternative) is located along the existing track, which serves Umzamawethu. Furthermore:

- This route does not impact on any mobile dunes;
- This route would impact wetlands 15, 16 and 17 (**Figure 17** and **Figure 18**). The coastal road would cut into the hillslopes with possible sedimentation of drainage lines and exposure of groundwater;
- There is a risk of fragmentation of the coastal seep habitat;
  Wetland 16 would be infilled (upper reaches) and there would be runoff into this wetland;
- Impacts of the rare coastal seeps are likely along the route, with possible infilling and impacts on groundwater and nutrients;
- There could be bank erosion of wetland 15;
- Alternatives D, E & F would cross the degraded wetland 17;
- For invertebrates, there is unlikely to be any impact with fragmentation of the southern and northern habitats on either side of the coastal route. In addition there are no rare or sensitive habitats; and
- Habitat is good for vertebrates along the first section (CR-1) but species numbers drop off rapidly along CR-2 due to presence of Umzamawethu. The road can be constructed with no significant impacts.

Rarity

The proposed coastal route comprises the Least Threatened[3] (Rouget *et al*., 2004) vegetation type (**i.e. low rarity – Figure 22a**), Algoa Dune Strandveld, extending into degraded (farmland) Tsitsikamma Sandstone Fynbos (Vulnerable) (Rouget et al., 2004). Most of the route is along the existing coastal track and loss of vegetation would be permanent, localised, but not significant. Losses of sandstone fynbos are considered to be insignificant given the almost totally degraded nature of the vegetation and the localised loss of this vegetation type to agriculture along the last section of the proposed route.

Whilst vegetation type rarity is on the whole at too broad a scale (*sensu* Rouget et al., 2004) to be meaningful to point scale planning, habitat rarity – although also low at the site - provides a means to address this issue and enables decisions to be made at plant community level. Habitat rarity is also Low for most of the area, but increases to High when the mobile transverse dunes are crossed. The rare coastal seeps, also distinctive and rare, are avoided by the alignment; however crossing of the seeps and Slangrivier would mean impacting on systems with a Very High rarity (**Figure 22 b**).

Low (2011) found species rarity to be extremely low compared to many other coastal sites (Low, *unpub*.; Cowling et al., 1988b), with only 14 (3.6%) on the Red Data list. Accordingly for the coastal route, plant species rarity is not significant (**Figure 22 c & d**) with low numbers of Red Data species recorded from all communities (**Table 4**).

The Vulnerable species are well-distributed throughout Thyspunt and elsewhere in the Cape flora (sensu Manning, 2000), and local impacts on individual species are therefore not a major concern. *Rapanea gilliana* is locally common in Dune Fynbos at Thyspunt as is *Satyrium hallackii* subsp. *hallackii*. These are both Endangered but are well-represented in the subregion.

Red Data species losses would be localised and permanent. A similar situation exists for weighted Red Data species, where species rarity is either lacking or is very low to low (**Figure 22d**). Red Data species losses as above. The following species are potentially affected (**see Table 4**): *Agathosma stenopetala* (Vulnerable - VU), *Boophone disticha* gifbol (Decl.), *Erica glumiflora* (VU), *Othonna rufibarbis* (Near Threatened - NT), *Pelargonium suburbanum* subsp. *suburbanum* (VU), *Psoralea repens* duine-ertjie (NT), *Rapanea gilliana* dwergboekenhout (Endangered - EN), *Satyrium princeps* rooitrewwa (VU) and the sedge *Tetraria brachyphylla* (NT).

Overall rarity for the route (

[3] Rarity of vegetation types after Rouget et al. (2004)

Figure 23), which presents a total, weighted value, for rarity across the site (see Low (2011) for method and data), indicates highest rarity for the transverse dunes, coastal wetlands and sandstone fynbos.

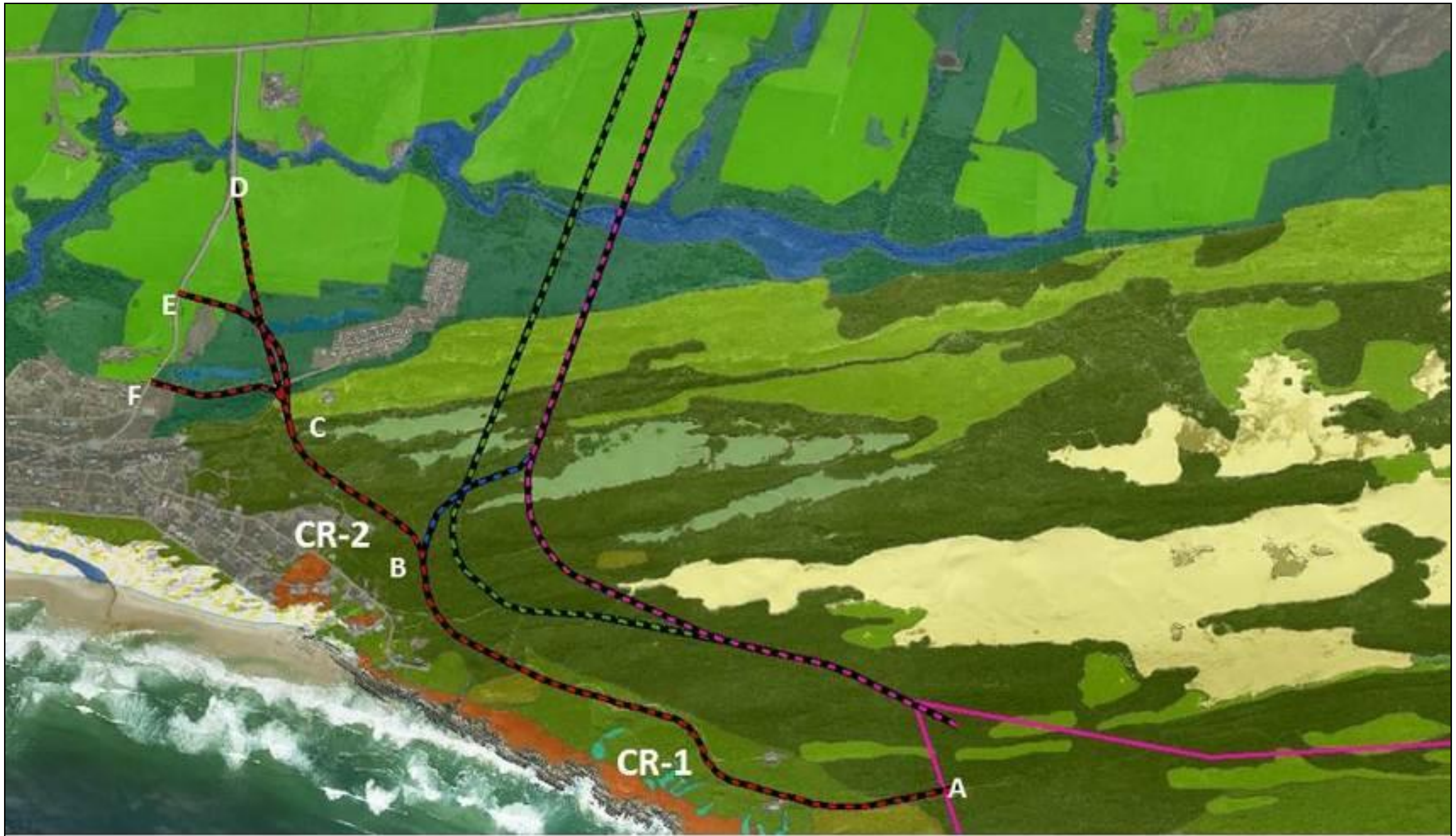
Sensitivity

The route crosses communities of Very Low to Low sensitivity for all criteria except erosion erosion potential (

Figure 24), except for sandstone fynbos, and the coastal and inland seeps where the sensitivity rating increases to Moderate to Very High for susceptibly to drought and fire.

Overall sensitivity (

Figure 25), where the four criteria are weighted and combined (Low, 2011) is Moderate for most of the route indicating due caution should be taken in the construction phase.



Coastal Route (CR-1 & CR-2): NPS to Humansdorp Road, between Oyster Bay and Umzamawethu; three alternatives at western end: A-B-C-D/E/F

Figure 21: Coastal Route

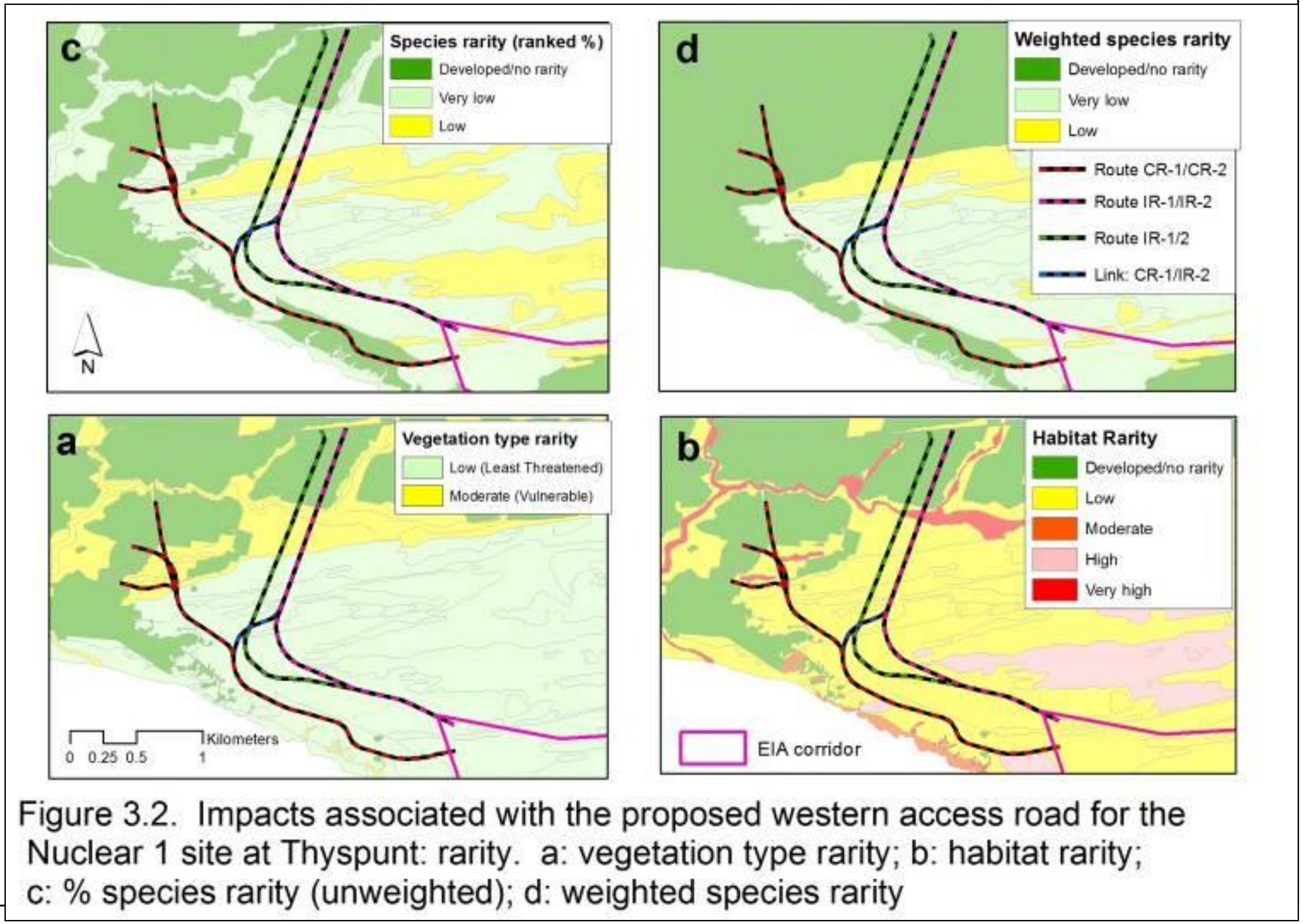


Figure 22: Biophysical Impacts associated with the Western Access Road for the Nuclear-1 site at Thyspunt - description of rarity

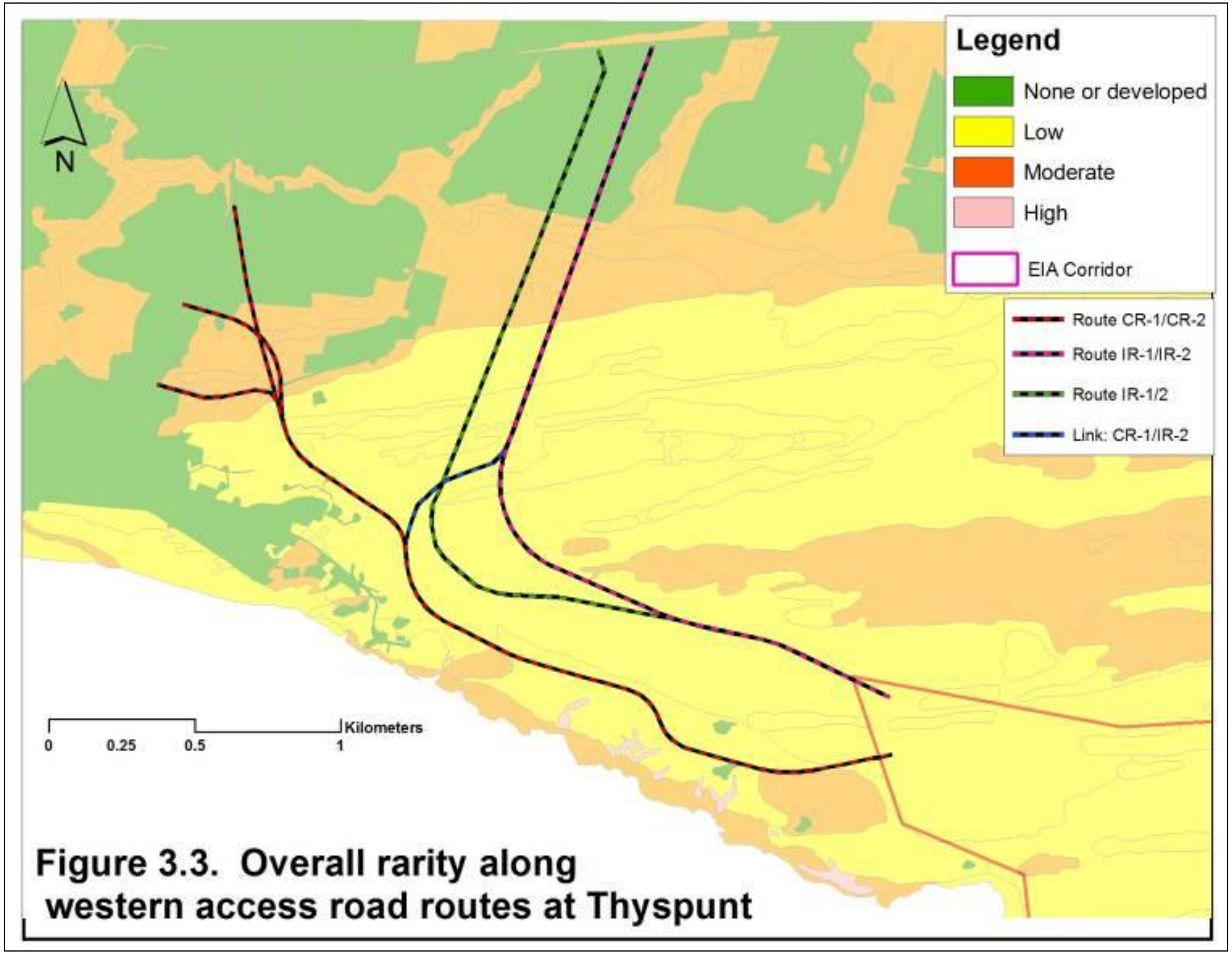


Figure 23: Overall rarity along the Western Access Road Routes at Thyspunt – overall rarity

(b) Route CR-1 and IR-1 (**Figure 26**)

The first section of the route, between A and B **is as for the coastal route discussed above.** From B to K, the route passes through Tall Thicket on stable parabolic dunes, but with localised patches of forest, as well as infestations of *Acacia cyclops* rooikrans and to a lesser extent, *A. saligna* Port Jackson Willow. North of K, two mobile parabolic systems are encountered, after which the route cuts through Dune Fynbos on stable parabolic dunes. North of the main dune cordon there is a gentle north-facing slope with a mosaic of dryland thicket and fynbos and wetland (seep vegetation), before entering the thicket/forest mosaic of the Slangrivier system. Part of the hillslope vegetation has been degraded due to brush-cutting in the past (none of this activity seems to be current after personal observation in the field). Localised woodcutting of species such as *Rapanea melanophloeos* boekenhout is occurring, whilst part of the riverine forest/thicket has also been degraded, mainly due to clearing and various farming activities. *Gunnera perpensa* rivierpampoen is a medicinal plant and could well be harvested for this purpose from the seeps adjacent to Umzamawethu. The last part of the route, north of the Slangrivier, runs through degraded farmland on sandstone.

The route would impact wetlands 1, 2, 4, 12, 13, 14, 15 and 16, as well as the Slangrivier (**Figure 17** and **Figure 18**).**This is thus the most sensitive route for wetlands,** with a general loss of resilience being experienced. Wetland 15 could face possible infilling (streamline) with the route also cutting through a transverse dune. North of here, impacts would increase dune mobility and decrease wetland 12's size and function. This would be associated with an impact on the east-west corridor in the dunes. The integrity of the wetland/dryland mosaic would be compromised between the main dune cordon and the Slangrivier. Wetlands 1 and 4, together with the Slangrivier, will experience infilling and the placement of culverts to divert water away from the road. There will an increase in bank destabilisation on the Slangrivier, requiring major rehabilitation of the river.

Rarity

Rarity for CR-1, the first section of the coastal route (A-B), is described above. The northern section of the route passes through dune communities which lack rarity (**Very Low** to **Low**) for vegetation type, habitat and species. Dryland Red Data species which might be encountered along this section of the road are: *Agathosma stenopetala* (VU), *Boophone disticha* gifbol (Decl.), *Erica glumiflora* (VU), *Othonna rufibarbis* (NT), *Pelargonium suburbanum* subsp. *suburbanum* (VU), *Rapanea gilliana* dwergboekenhout (EN), *R. melanophloeos* boekenhout (Decl.), *Satyrium princeps rooitrewwa* (VU) *and Tetraria brachyphylla* (NT). The tall grass, *Capeochloa cincta* subsp. *sericea* olifantsgras (VU), is found along the edges of the valley bottom wetlands in the transverse dunes, and is likely to be joined by *Eulophia speciosa* (Decl.), together with *Gunnera perpensa* (Decl.) and *Satyrium hallackii* subsp. *hallackii* (EN) in the hillslope seeps south of the Slangrivier. As a result, rarity increases appreciably once the Slangrivier and associated wetlands are reached just north of the main dune cordon. Rarity for the Slang is **Moderate** for habitat.

Although rarity is not mapped at a sufficiently fine scale for the valley bottom wetland (transverse dunes) at point K in this study, as well as the seeps between the dunes and Slangrivier, they would be accorded a **High** rarity status similar to that of the coastal seeps discussed above. Day (2013) provides an accurate map of the wetlands along this section (**Figure 27**), indicating they would be impacted locally by the route. There is no rarity for the sandstone vegetation north of the Slangrivier, where the habitat is almost totally degraded by farming activities.

Overall rarity for the first part of the northern route is **Low**, except for the valley bottom wetland at point K, which has a **High** overall rarity**.** However, this changes to **Moderate** as the hillslope seeps and Slangrivier are crossed. The degraded sandstone vegetation of the agricultural land to the north of the Slangrivier understandably has no overall rarity value.

Sensitivity
Sensitivity for the first part of the route (A-B) has been discussed above. With the exception of erosion potential, which is Moderate, much of the route between point K and the Slangrivier is of **Low** sensitivity (

Figure 24). However, the hillslope systems just south of the Slangriver show sensitivity to drought (**Moderate**) and fire (**High**), with the Slangrivier **Moderate** for erosion, High for fire but **Very Low** for resilience. The farmland to the north of the Slang understandably has no sensitivity rating.

Apart from the Slangrivier (**High**), overall sensitivity for the northern route is **Moderate** (**Figure 26**) but insignificant for the farmland to the north of the Slang.

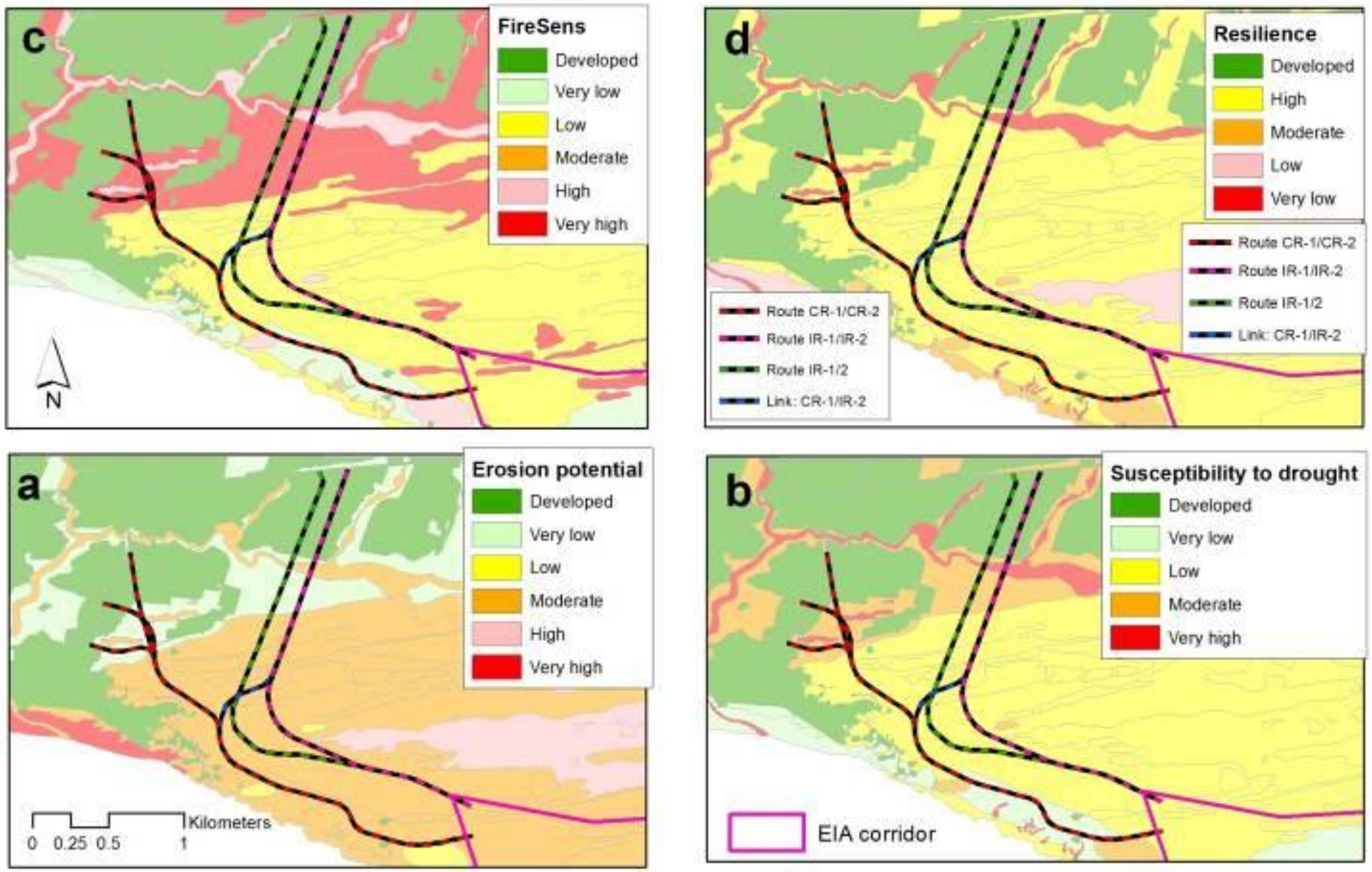


Figure 3.4. Impacts associated with the proposed western access road for the Nuclear 1 site at Thyspunt: sensitivity. a: erosion potential; b: susceptibility to drought; c: proneness to fire; d: resilience (reverse score)

Figure 24: Impacts associated with the Western Access Road for the Nuclear-1 site at Thyspunt – description of sensitivity

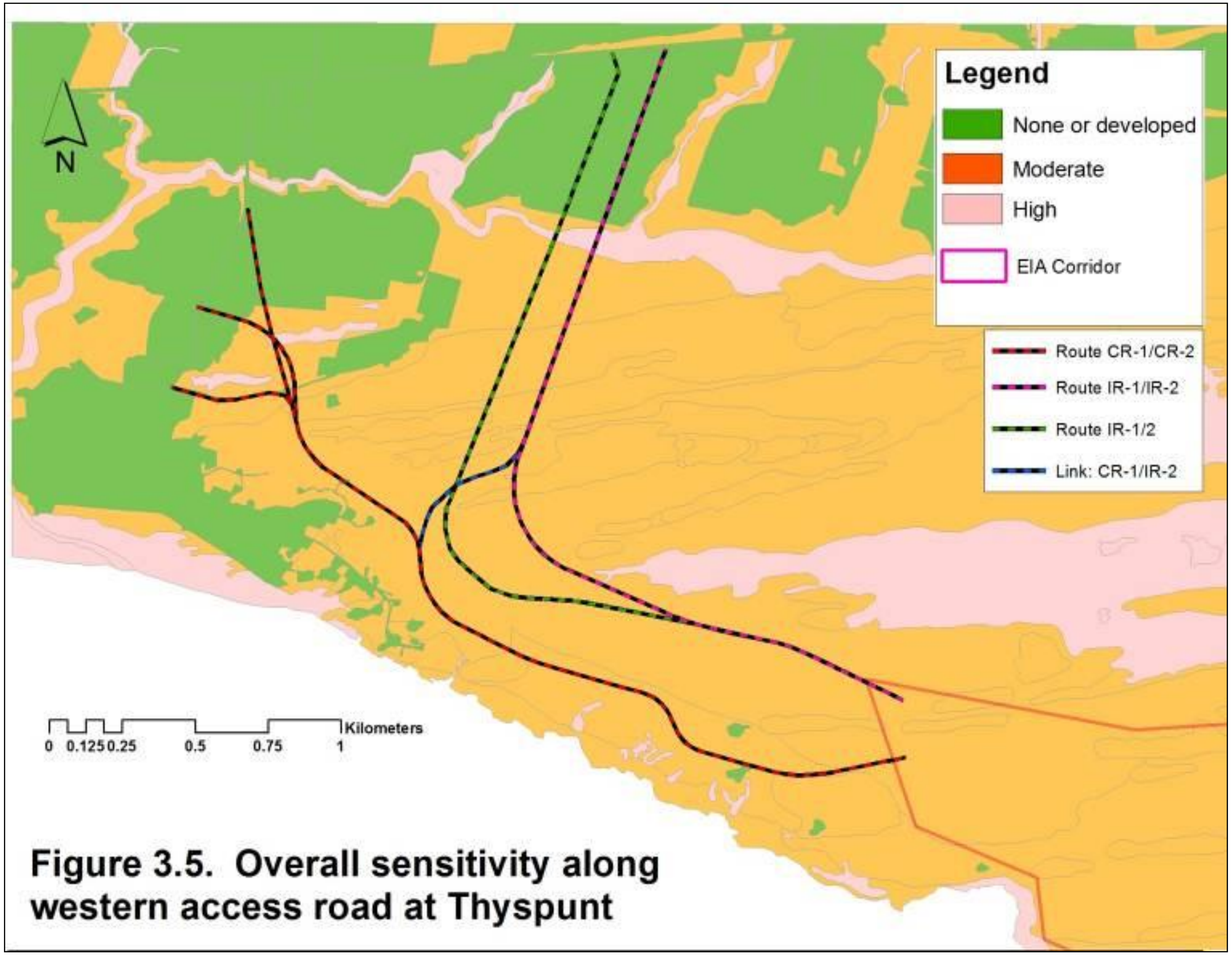


Figure 25: Overall Sensitivity along the Western Access Road at Thyspunt – overall sensitivity

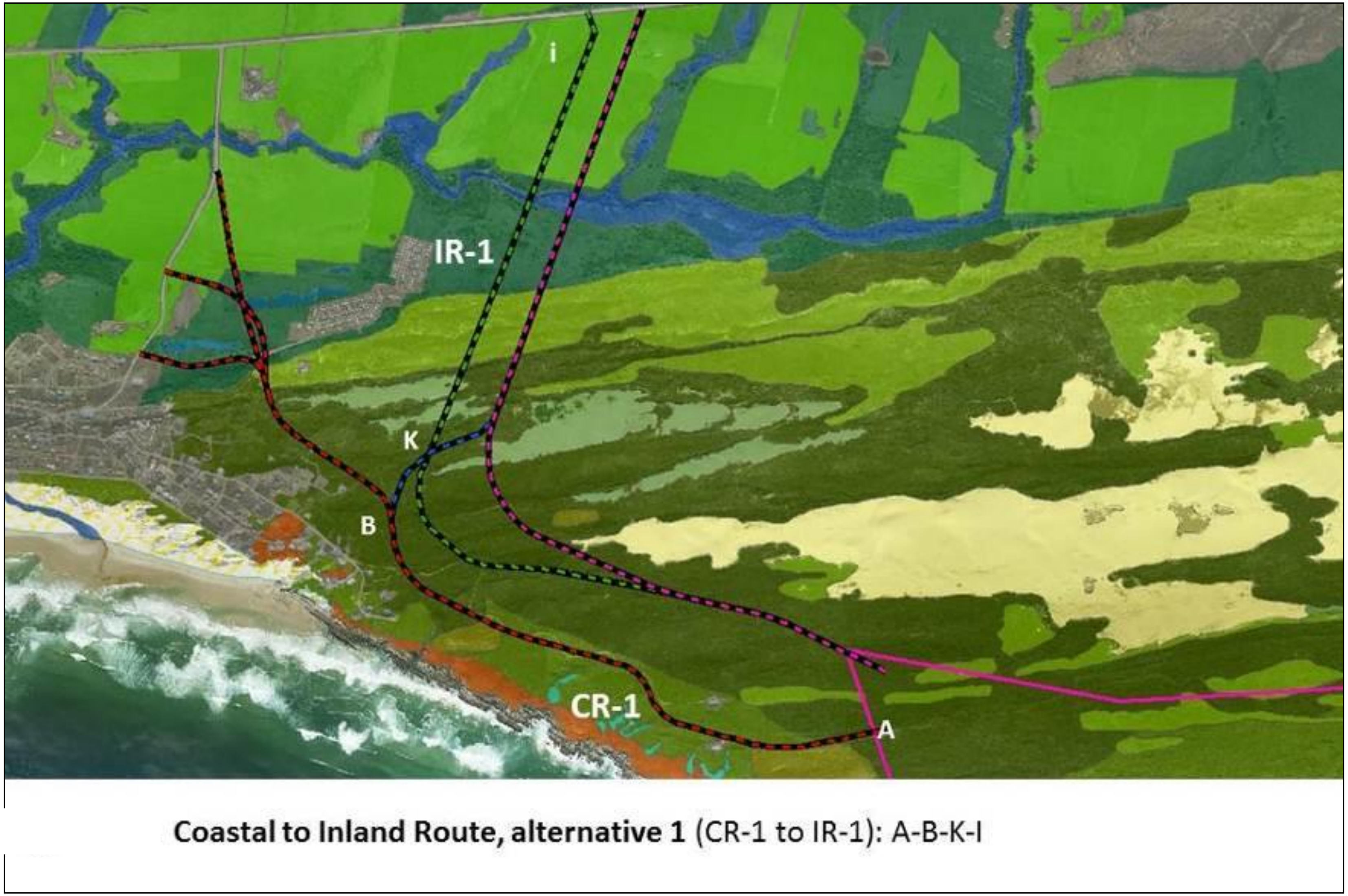


Figure 26: Coastal to Inland Route, Alternative 1

(c) Route CR-1 and IR-2 (**Figure 28**)

The initial stage of this route (A to B) has been discussed above. From here, the route is essentially the same as IR-1, except that it veers to the east, avoiding the mobile dunes (B-L-J).

The route would impact wetlands 1, 7, 12, 13, 15 and 16, and the Slangrivier (Figures 17 & 18). There is a fence along 15 (K-L).

Wetland impacts for IR-2 are similar to those for IR-1, with exhibiting a similar, and high, sensitivity; however the **impacts of IR-1 are likely to be of greater intensity.** For example, the route would cross dunes in better condition than those along the IR-1 route and this would also be further away from the source of disturbance, such as Umzamawethu. There would be major impacts on the six dune slacks and wetland corridors along the route.

Rarity
Rarity is as for IR-1 (

Figure 23 and

Figure 24), with Dune Fynbos, dryland/wetland mosaic on the gentle slope above the Slangrivier, the crossing of the Slangriver, and again into farmland on sandstone to the north of the river. Several hillslope seeps are in the path of the route and this would lead to impacts on these systems (**Figure 27**) with rarity rating as per that discussed above.

Sensitivity

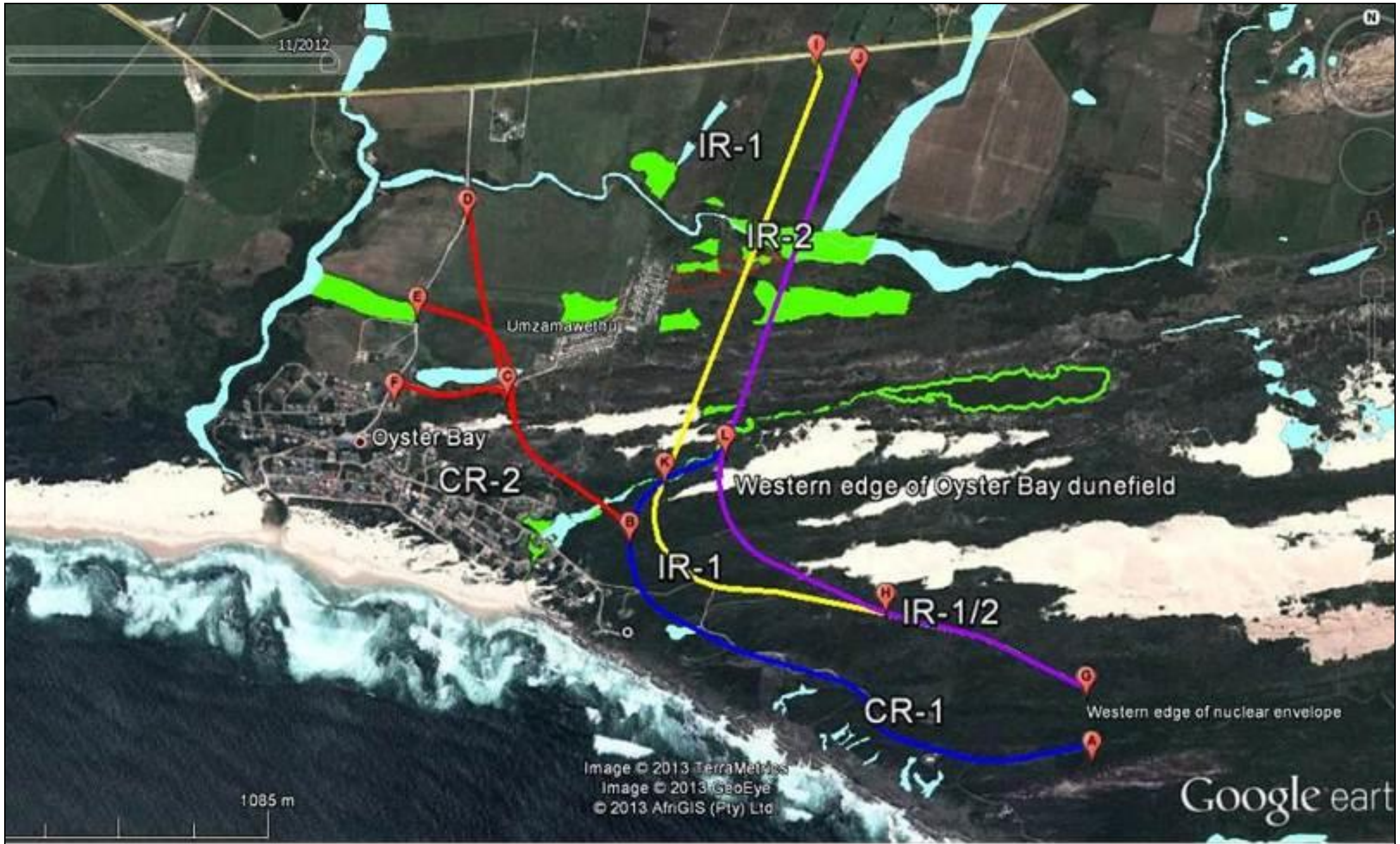
Sensitivity of the route has also been discussed above (CR-1) and is as discussed above and is the same for CR-1/IR-2 (

Figure 24 and

Figure 25).

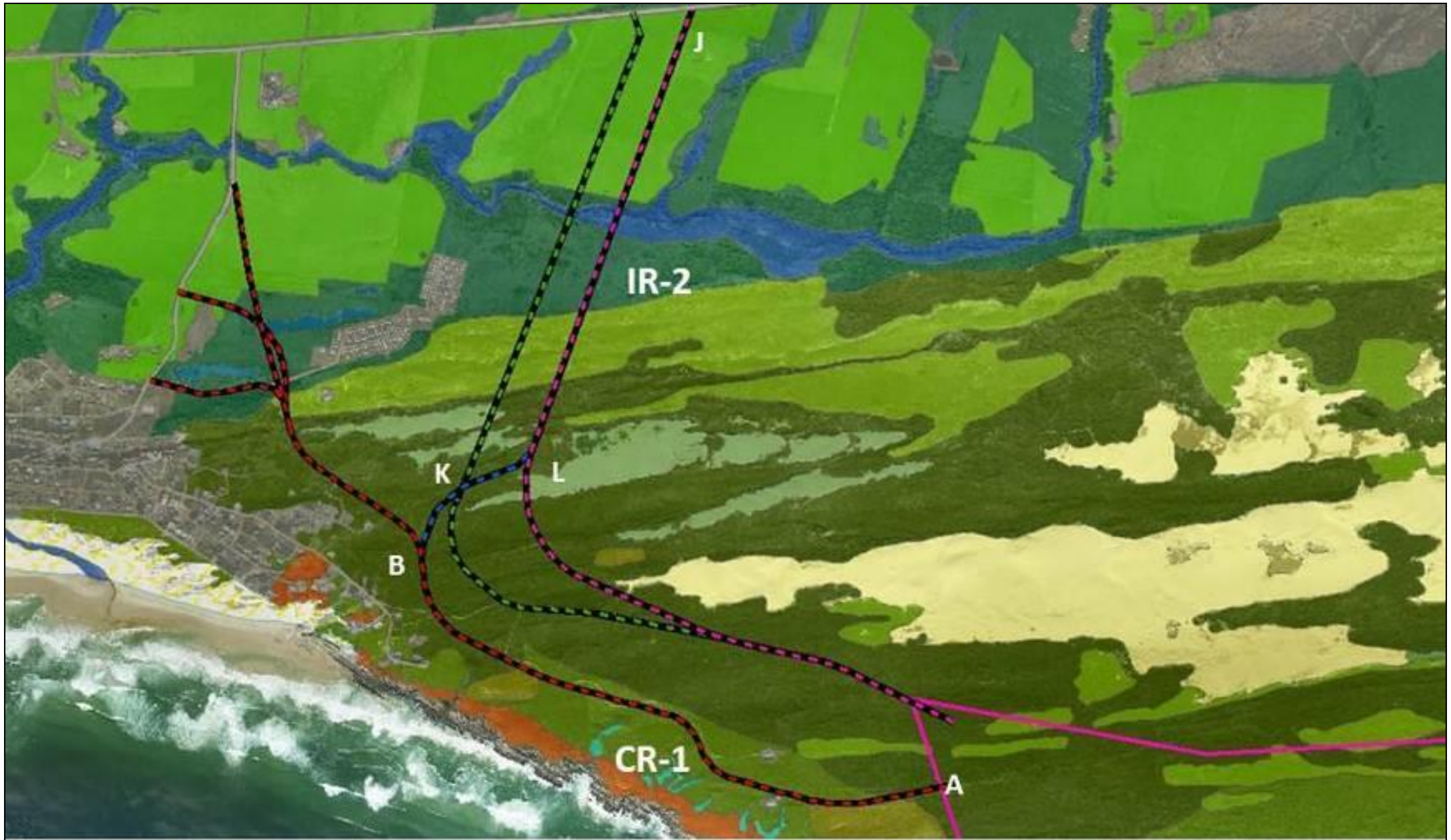
(d) Route IR-1/2 to IR-1 (**Figure 29**)

The first part of the route (I-K) commences in the proposed EIA Corridor and proceeds via J to K. This section exclusively supports Tall Thicket on stable parabolic dunes, but with localised infestations of woody aliens, chiefly *A. cyclops* rooikrans. Local forest patches might also be encountered. The section from K northwards has been described above.



Wetlands associated with the proposed western access road alignments (from Day, 2013).

Figure 27: Wetlands associated with the proposed Western Access Road alignments



Coastal to Inland Route 2, alternative 2 (CR-1 to IR-2): first section of Coastal Route, bending to the north and then to the west of Umzamawethu, to Humansdorp Road: A-B-L-J

Figure 28: Coastal to Inland Route 2, alternative 2

Rarity
Rarity for vegetation type, habitat, and plant species (unweighted and weighted) is **Very Low to Low** . Red data species likely to be encountered along this route are: *Rapanea gilliana* dwergboekenhout (EN) and probably *R. melanophloeos* boekenhout (Decl.). Where forest patches are found, *Dioscorea sylvatica* elephants foot (VU). Overall rarity is **Low** (

Figure 23).

Sensitivity
Sensitivity (

Figure 24) is Moderate for erosion potential, **Low** for drought and fire. Where the mobile dune is crossed, sensitivity increases to **High**. Resilience, however, is **Moderate** for erosion. Correspondingly, resilience is **High**. Overall sensitivity (

Figure 25) is **Moderate**.

(e) Route IR-1/2 to IR-2 (**Figure 30**)

Most of this route has been described above, but mention must be made of the section where it crosses the mobile dune system at L. Dune mobility is unpredictable and confers on the area a far greater rarity (**High**) than the stable form.

3.2.2 Operational Phase – All Routes

Loss of ecosystem functionality would be low, although much of the coastal habitat above the high water mark would be separated by the road from the inland communities. Regular maintenance (such as brush-cutting of road verges) of a 40 m wide road reserve would intensify the separation between southern and northern communities along the coastal route, impacting on movement of pollinators and seed transfer. Likewise, separation would occur between eastern and western communities for both inland routes. The main impact during the operational phase would therefore be the separation of coastal and inland communities by the road. As stated the impact would be on both pollinator movement and seed dispersal across the route. Day (2013) however maintains that impacts on the systems would be far less if appropriate mitigation measures were to be implemented. It should be further noted that the access road is not an impermeable barrier and that flying pollinators will be able to cross the access road into the adjacent communities (as seen at Koeberg).

In terms of the impacts on the mobile dunes any crossing of or location of the road adjacent to mobile dunes or dunes which are likely to mobilise during the lifespan of the NPS, will cause impacts during the operational phase of the road. There are however a number of uncertainties concerning the west-east dune system. Illenberger (2013), in a separate study on dune geomorphology, has found that dune mobility has declined by 60 % over 70 years (1942 to 2011). A major part of this significant decrease in unvegetated dunes is the virtual total loss of sand supply at the start of the system at Oyster Bay due to residential development in close proximity to the eastern and western extremities of the dune system However , the data also shows that the rate of loss has also diminished over the last period investigated (2009 – 2011) (Illenberger, 2013), suggesting that the dynamic between dune mobility and stability is not fully understood and, in fact, is quite unpredictable. Of importance, too, is that Illenberger (2013) claims the dune system could still have a lifespan of a 1 000 years, far longer than that of a nuclear facility at Thyspunt. Illenberger does however finally state that there are some road designs which would allow continued sand movement.

Therefore, the impact on the mobility of the dune system caused by the proposed access road is comparatively a fraction of that caused by the residential development of Oyster Bay and others development in close proximity to the eastern and western components of the dune system.

Another crucial unknown would be the behaviour of the dune system once dense woody alien infestation is removed. Most if not all of the present infestation appears to be on dunes which were previously mobile (1942 – 1961) (*sensu* Illenberger, 2013) and which are likely to re-mobilise once clearing has been undertaken. Currently Eskom is busy with a massive alien eradication programme aimed at ridding the dunes of acacias (chiefly *Acacia cyclops* rooikrans, but also *A.saligna* Port Jackson willow) (Gert Greeff, *pers.comm*.). Much of the alien vegetation lies along the proposed western access road routes, except for the area to the north of the main dune cordon, or is in close proximity to these (**Figure 31**). This would imply that major surges in dune mobility are thus likely along the CR-2, most of IR-1, and most of IR-2. Once these dunes re-mobilise, then westerly winds will once again move the sand eastwards and across the proposed road.

3.2.3 Cumulative impacts

Impacts likely to be incurred in the long term and over the operational phase of the facility will include those that fragment and compromise ecosystem functioning. Key areas of concern are the coastal and hillslope seeps and the Slangrivier, which could be compromised in the long-term if appropriate mitigatory measures are not introduced.

Any fragmentation of the system, both dryland and wetland habitats, would thus have a cumulative impact, leading to loss of functionality and habitat quality. Many of the impacts associated with the road, such as infilling and restricted inflows, would have a long-term significance and are cumulative.

3.2.4 Biophysical Impacts - Positive impacts (from Low, 2011)

The Oyster Bay-Cape St. Francis headland bypass dune (HBD) and its associated wetlands are seen as key priorities for conservation (Tinley, 1985; Cowling et al., 2002, and also La Cock & Burkinshaw, 1996). However, this system is under-conserved with only two reserves in the intact part of the HBD system. Neither of these - Eskom's Thyspunt Natural Heritage Site or the Rebelrus Private Nature Reserve - has any statutory status. The HBD is being threatened by urban and related development such as the St. Francis Golf Course and St. Francis Links, particularly from the east. By 2008, already some 2 944 ha of an estimated 15 469 ha of dunefields (i.e. 19.0% or nearly a fifth of the HBD system) between Oyster Bay and Cape St. Francis had been developed, mainly through residential expansion or golf courses. Just recently, one of the farms between Cape St. Francis and Thyspunt has been granted limited development rights, and it is these developments that are fragmenting the HBD and which could destroy its functioning in totality. Clearly the Eastern Cape EIA process has failed to recognise the importance of the HBD system and is inadvertently permitting the cumulative gradual whittling away of this magnificent dune and wetland complex.

A conservation area on the Oyster Bay-Cape St Francis headland bypass dune system would bring some 1 400 ha of four major dune types to a conservation area. If Eskom follows the example at Duynefontein (Koeberg Private Nature Reserve), a similar reserve could be created here.

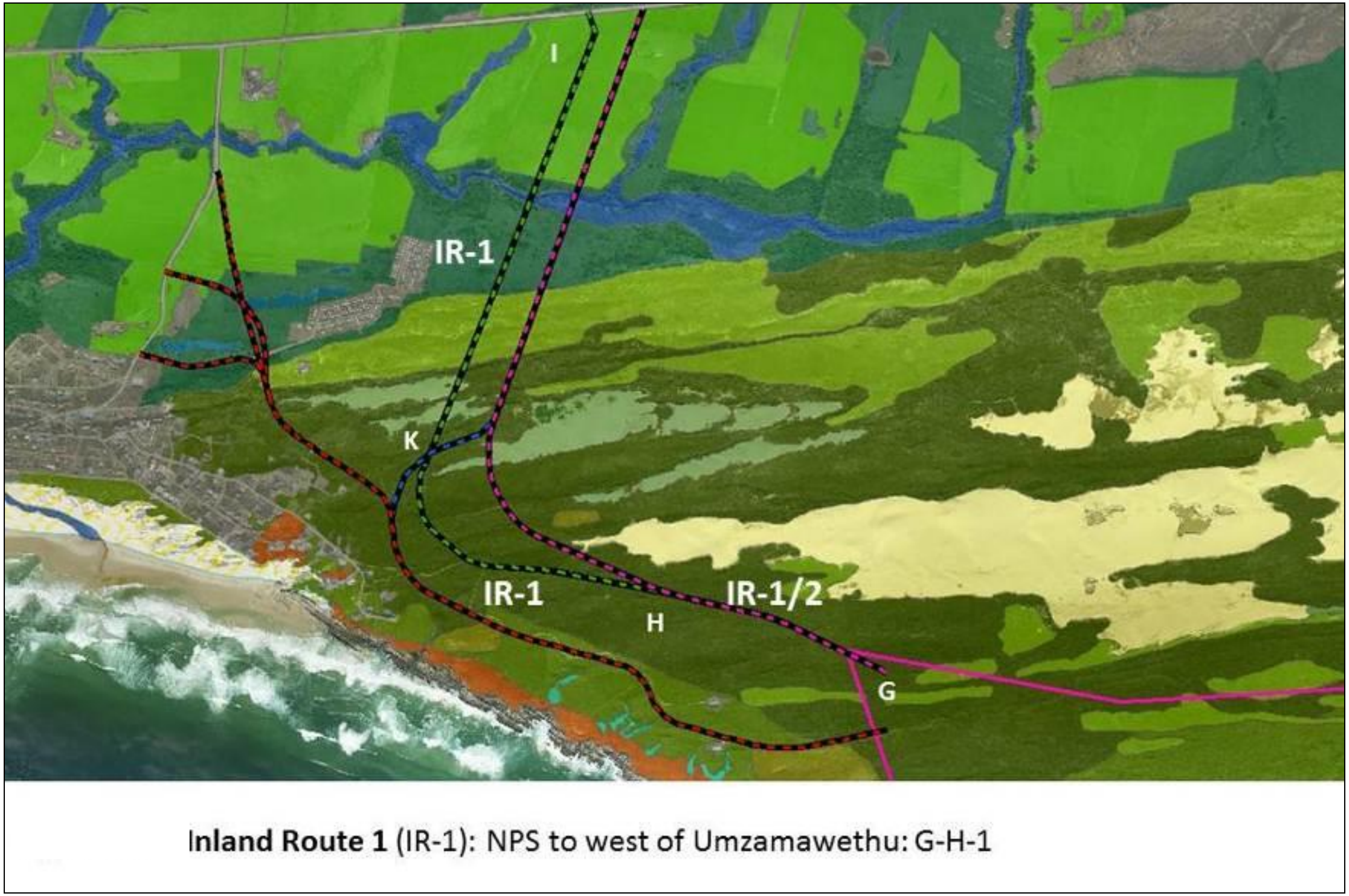


Figure 29: Inland Route 1 (IR-1)

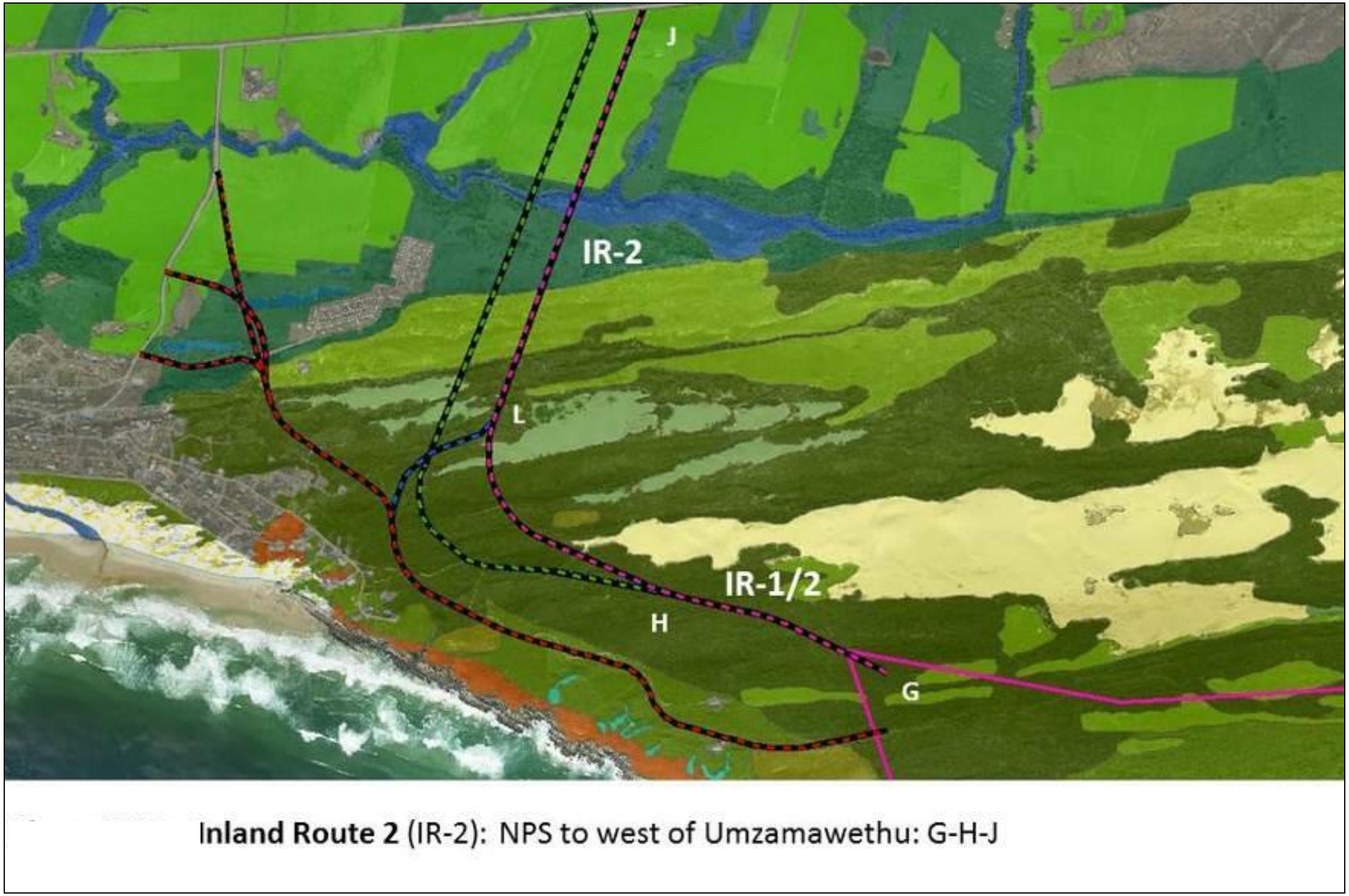


Figure 30: Inland Route 2 (IR-2)

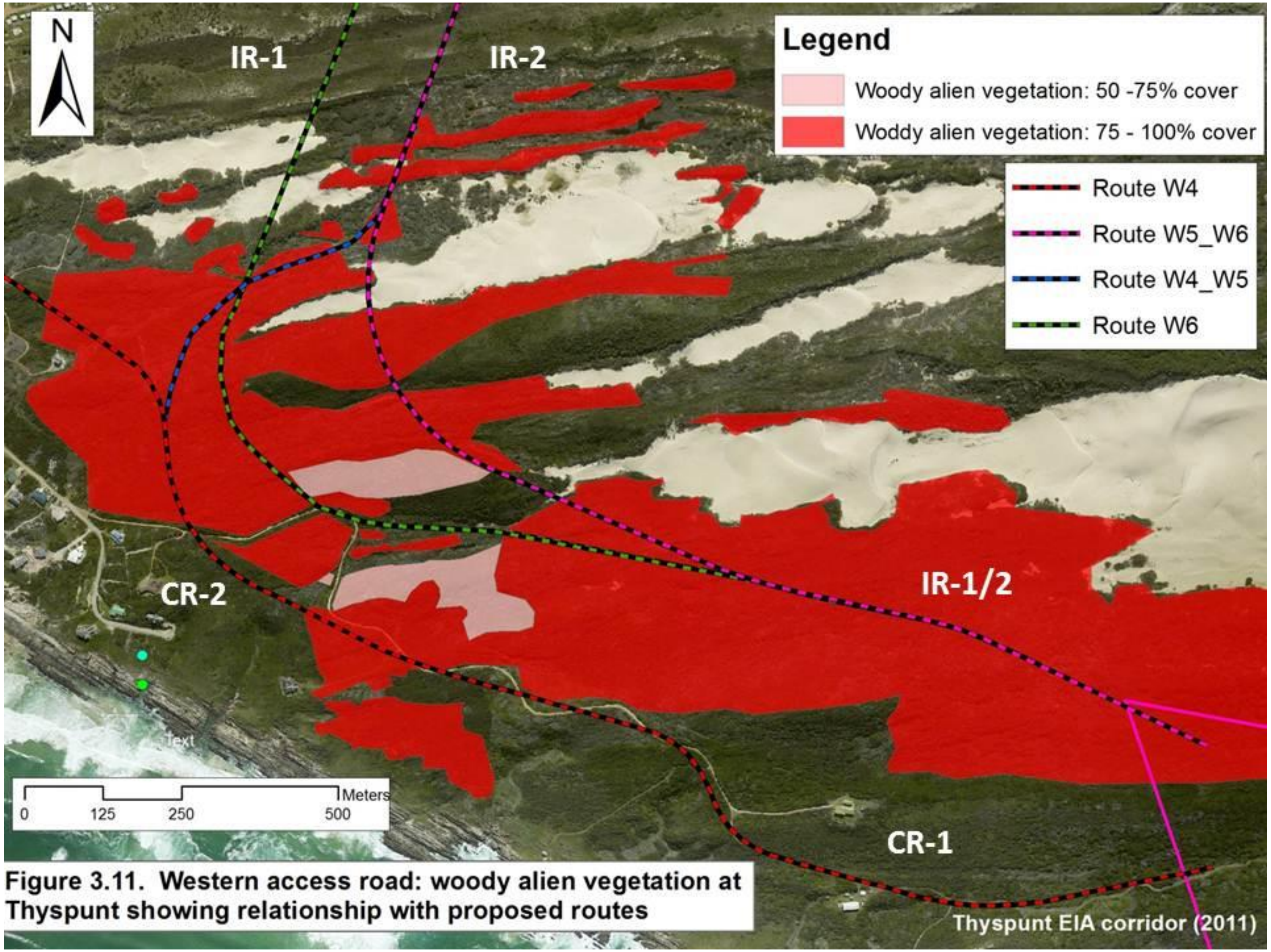


Figure 31: Woody alien vegetation

3.3 Heritage Impacts

Impact on archaeological and palaeontological heritage resources may result from activities related to the alternative western access routes shown in **Figure 32** and listed below:

- Bush clearing in advance of the construction phase;
- Bulk earthmoving (cut and fill) at the construction phase within a 50 meter corridor with cuts up to 80 meters in places for bank stabilisation;
- Stockpiling soil and later movement thereof;
- Installation of culverts, cables and other infrastructure along the route; and
- Destabilisation of vegetation and dunes.

Impact may imply partial or complete removal of archaeological or palaeontological sites. Mitigation can however resolve most issues if the program is properly implemented.

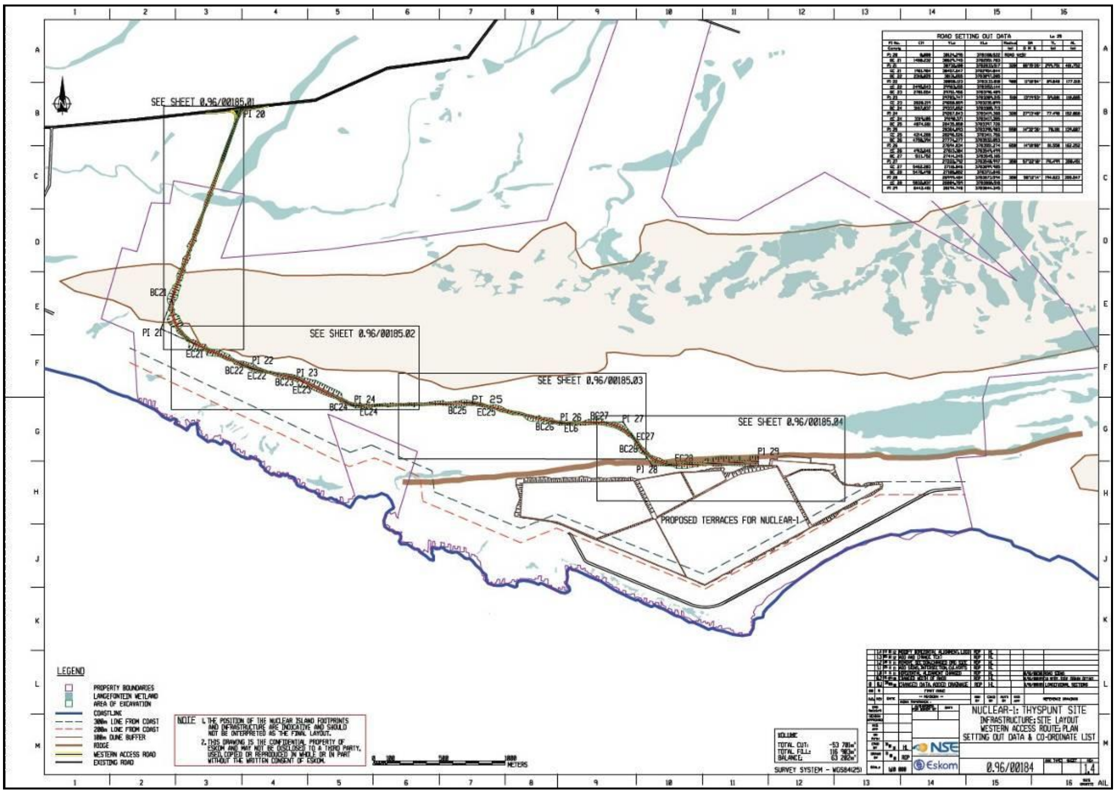


Figure 32: **Engineering specifications of route alternative IR-2 showing positions of embankment cuttings**

Poor visibility of archaeological and palaeontological material along large sections of the route implies that predictions have to be made based on existing knowledge of the site and surrounds. Assessment tables seldom work well for heritage scenarios as described here, given that it is difficult to clearly and immediately identify the affected resource.

Archaeological and palaeontological resources are non-renewable and impacts can remove them forever. Mitigation itself can be an impact if not achieved adequately. Some sites are further of greater significance than others. ESA and MSA sites are rare and generally achieve higher significance than LSA depending on context and content. LSA middens are relatively common along the coastline and are not considered to be rare, but in the context of the site and contested "ownership" by people claiming descent from the Khoin communities who occupied the site, a higher significance must be applied. Human remains may be associated with some LSA sites, thus adding to the significance of the impacts.

Please refer to **Figure 2** for the position of the routes described below.

(a) Route Alternative CR-1 (A-B) – Part of the Coastal Route

It is very likely that LSA impacts will occur which implies and impact on irreplaceable resources, although the route is beyond the belt of identified sites along the immediate coastline. It is suggested that fewer LSA sites will be found but thick vegetation off the existing road prevents accurate prediction. There is a high risk of LSA burials but a much lower risk of ESA/MSA, although some of this material may be encountered at the eastern end of the route. Even if mitigation is carried out, overall perception of the route remains negative due to the possibility of LSA burials and issues that will arise from such discovery and the significance of impact even with mitigation is high.

(b) Route Alternative CR-2 (B to C with three alternative ending CF, CD and CE)

LSA sites are known to occur along this section of the route and so impacts on this resource are definite. There is a very low risk of ESA/MSA material, although exposed aeolianites (fossil dunes) may indicate possible palaeontological material. Even if mitigation is carried out, overall perception of the route remains negative due to the possibility of LSA burials, and issues that will arise from such discover and the significance of impact with mitigation remains high.

(c) Route Alternative IR-1 (I-G)

Very little to no impact is expected on farmland areas to the north and south of the Slang River. It is not impossible that buried ESA material may be found but chances are low. Definite impact on known LSA sites (in sub-dune field) though LSA sites are expected to be far fewer than along the immediate coastline. It is very possible that impact on MSA/ESA sites (especially in vegetated areas west of the main dune) from a range of construction activities will occur. A variety of palaeosols and other geological formations may be impacted by construction. Positive impacts are possible through acquisition of archaeological, palaeontological and geological information through mitigation of rare MSA sites that will be destroyed or lost over time without this mitigation. The significance of the impacts after mitigation in this instance is thus low.

(d) Route Alternative IR-2/ IR1/2 (J-G)

This route traverses similar terrain to IR-1 above, similar impacts can be expected and the impact description is therefore the same as for IR-1.

3.4 Social Impacts

The following social aspects need to be taken into consideration when assessing the possible impact of the different routes:

- Safety of people using or crossing the road;
- Advantages of using the road for motorised or non-motorised transport;
- Noise, visual impacts and dust disturbances;
- Negative impact on tranquillity; and
- Economic and other social activities link to the access road

Please refer to Figure 2 for the position of the routes described below.

(a) Route CR-1 and CR-2 – Coastal Route

Safety of people using or crossing the road
C-F is the existing road used by people in or out of Umzamawethu. Using this part of the road to the site will definitely impact negatively on the safety of the people using the road due to the huge increase of traffic. C-E and C-D cross the existing road between Oyster Bay and Umzamawethu, creating a high risk situation at the crossing. The possible negative impact on the safety of people using this road is considered to be high.

Advantages of using the road for motorized or non-motorized transport
Part C-E and C-D provide a shorter access route to Umzamawethu from Humansdorp as well as the possibility of a better quality road, which will be to the advantage of all road users, including users of motorised or non-motorised transport, including taxis

Noise, visual impacts and dust disturbances
A negative impact on residential areas close to road is anticipated even if the noise and dust levels are within generally accepted levels. Residents may have a negative experience based on the fact that the road was not there before. The road may also be experienced as a visual disturbance, especially from the eastern portion of Oyster Bay.

Tranquillity (movement)
The constant movement of vehicles could be experienced as a disturbance of existing tranquillity for both a large part of the eastern section of Oyster Bay and for a part of Umzamawethu.

Economic and other social activities link to the access roads
Parts C-F, C-E and C-D could provide opportunity for selling of products and services to people making use of the road. A good quality road also provides the opportunity to make use of work opportunities that may exist in Humansdorp. The road can also lead to an improved public transport system (e.g. taxis) lined to economy of scale and affordable fares.

(b) Route CR-1 and IR-1

Safety of people using or crossing the road

No safety challenges are foreseen for the communities of Oyster Bay or Umzamawethu.

Advantages of using the road for motorized or non-motorized transport
No advantages. The “no-advantage” assessment is based on the assumption that these roads will be private and not open for public use.

Noise, visual impacts and dust disturbances
The most eastern part of Oyster Bay and Umzamawethu may be subject to some level of disturbances. Even if it is true that noise, visual and dust levels will be within generally accepted standards and levels, residents could still experience this as negative to their current way of living.

Tranquillity (movement)
The most eastern part of Oyster Bay is most likely to experience disturbance of existing tranquillity together with Umzamawethu.

Economic and other social activities link to the access roads
No opportunities based on the assumption that these roads will be private and not for general public use.

(c) Route CR-1 and IR-2

Safety of people using or crossing the road
No safety challenges are foreseen for the communities of Oyster Bay or Umzamawethu..

Advantages of using the road for motorized or non-motorized transport
No advantages. The “no-advantage” assessment is based on the assumption that these roads will be private and not open for public use.

Noise, visual impacts and dust disturbances
The most eastern part of Oyster Bay and Umzamawethu may be subject to some level of disturbances. Even if it is true that noise, visual and dust levels will be within generally accepted standards and levels, residents could still experience this as negative to their current way of living.

Tranquillity (movement)
Only the easternmost part of Oyster Bay is likely to experience disturbance of existing tranquillity.

Economic and other social activities link to the access roads
No opportunities based on the assumption that these roads will be private and not for general public use.

(d) Route IR-1/2 to IR-1

Safety of people using or crossing the road
No safety challenges are foreseen for the communities of Oyster Bay or Umzamawethu..

Advantages of using the road for motorized or non-motorized transport
No advantages. The “no-advantage” assessment is based on the assumption that these roads will be private and not open for public use.

Noise, visual impacts and dust disturbances
The most eastern part of Oyster Bay and Umzamawethu may be subject to some level of disturbances. Even if it is true that noise, visual and dust levels will be within generally accepted standards and levels, residents could still experience this as negative to their current way of living.

Tranquillity (movement)
Only the easternmost part of Oyster Bay is likely to experience disturbance of existing tranquillity.

Economic and other social activities link to the access roads
No opportunities based on the assumption that these roads will be private and not for general public use.

(e) Route IR-1/2 to IR-2

Safety of people using or crossing the road
No safety challenges are foreseen for the communities of Oyster Bay or Umzamawethu..

Advantages of using the road for motorized or non-motorized transport
No advantages. The “no-advantage” assessment is based on the assumption that these roads will be private and not open for public use.

Noise, visual impacts and dust disturbances
No level of disturbance is foreseen. Even if it is true that noise, visual and dust levels will be within generally accepted standards and levels, residents could still experience this as negative to their current way of living.

Tranquillity (movement)
The road seems to be too far from Oyster Bay and Umzamawethu to disturb the existing tranquillity.

Economic and other social activities link to the access roads
No opportunities based on the assumption that these roads will be private and not for general public use.

3.5 Visual Impact

The visual impacts identified in terms of the proposed alternative access roads are listed in the tables below.

Please refer to Figure 2 for the position of the routes described below.

(a) Inland Routes 1 and 2 (IR-1 and IR-2)

Table 7: Comparison of IR-1 and IR-2

Section	IR-1	Section	IR-2
L - K	• Entrance has good visibility from provincial road • Crosses wetland at narrow point • Lesser gradient up north face of dune • The cut and fill will be less severe because the road alignment follows topography that is less steep	H - G	• Entrance has good visibility from provincial road • Crosses wetland at wider point • Steeper gradient up north face of dune therefore more visible • The visibility is coupled with the some high cuts (approx. 20m cut in the deepest and 10m fill in the highest • Stabilisation of the sand on the slopes will require expert attention to blend the new landform to the existing vegetation pattern and dune form
K – J	• Curve is on flatter portion of dune • Route is closer to the existing houses and more visually exposed • Approx. shortest distance to nearest house 260m	G-J	• Curve is on higher part of dune will require more cut than IR-1. More visible from provincial road to north but less visible from eastern existing houses of Oyster Bay • Approx. shortest distance to nearest house 485m
J – I	• The route section is common so similar visibility applies	J - I	• The route section is common so similar visibility applies

(b) Coastal to Inland Route - Alternative 1 and 2

Coastal to Inland Route - Alternative 1

Table 8: Comparison of Alternative 1 - CR-1 (A to K) and IR-1 (K to L)

Section	CR-1	Section	IR-1
A – K	• Alignment is closer to the coastline that has lower vegetation on a gently sloping land surface to the rock shore • The visibility of the road will be high along the coast and from the higher vegetated dunes to the west where houses are located • The nearness of the road to the existing houses on the eastern edge of Oyster Bay at the bend will make this route constantly	K - L	• Entrance has good visibility from provincial road • Crosses wetland at narrower point • Visibility from Provincial road to the north increased as road travels t up north face of dune field due to cuts and fills

Section	CR-1	Section	IR-1
	visible by the owners		

(c) Coastal to Inland Route - Alternative 2

Table 9: Comparison of Alternative 2 - CR-1 (A to K) and IR-2 (G to H)

Section	CR-1	Section	IR-1
A - K	• Alignment is closer to the coastline that has lower vegetation on a gently sloping land surface to the rock shore • The visibility of the road will be high along the coast in views from the higher vegetated dunes to the west where houses are located and from the western side of the bay • The nearness of the road to the existing houses on the eastern edge of Oyster Bay at the bend will make this route constantly visible by the owners	K - L	• Entrance has good visibility from provincial road • Crosses wetland at narrower point • Visibility from Provincial road to the north increased as road travels t up north face of dune field due to cuts and fills

3.6 Noise Impacts

(a) Inland Route 1

For continuous operation during 8 hours the LReq,d due to the CAT D11 and the CAT5130B plus CAT777D truck would be 54 dBA and 51 dBA, respectively, at the boundary of the township and the nearest Oyster Bay residence. These values are respectively 4 dB and 1 dB in excess of the typical outdoor LReq,d of 50 dBA in a suburban district with little road traffic (refer SANS 10103:2008). Therefore the estimated maximum noise impact for the duration of the construction of the road in the vicinity of the township and nearest Oyster Bay residence would be **Low**.

(b) Inland Route 2

For continuous operation of the same machinery during 8 hours the LReq,d would not exceed the typical outdoor LReq,d of 50 dBA at any of the nearest receptors. Therefore the estimated maximum noise impact for the duration of the construction of the road would be Negligible.

(c) Transportation of materials and equipment to site

An estimate of the traffic to the Thyspunt site during a nine year construction period was made available by Eskom in a one page summary entitled Estimated Eskom and Vendor Staff Traffic Impact. For each year it included the peak staff traffic per hour and the mean construction traffic per hour of an 8-hour working period. During this period construction vehicles would reach a maximum during the 2nd year and reduce to zero in the 7th year. Vendor and Eskom staff traffic would peak in the 6th year, reducing each subsequent year.

From the traffic data the LReq,d due to noise emanating from construction and transportation vehicles as well as Eskom staff vehicles to and from the site was estimated using procedures contained in SANS 10210:2004.

(d) Assessment of noise impact

The calculated LReq,d of road traffic noise emanating from IR-1 and IR-2 for each of the nine years and the associated noise impact on the Umzamawethu Township and the nearest residence of Oyster Bay are recorded in the Tables 13 below.

Table 10: Noise impact of IR-1on Umzamawethu Township

Condition	Year of construction								
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
$L_{Req,d}$	54	56	55	48	50	51	49	48	45
Excess over 50dBA	4	6	5	0	0	1	0	0	0
Impact	Low	Med.	Low	Negligible		Low	Negligible		

Table 11: Noise impact of IR-1 on Oyster Bay nearest residence

Condition	Year of construction								
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
$L_{Req,d}$	51	53	52	46	48	48	47	45	42
Excess over 50dBA	1	3	2	0	0	0	0	0	0
Impact	Low			Negligible					

Table 12: Noise impact of IR-2 on Umzamawethu Township

Condition	Year of construction								
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
$L_{Req,d}$	51	54	52	46	48	48	47	45	42
Excess over 50dBA	1	4	2	0	0	0	0	0	0
Impact	Low			Negligible					

Table 13: Noise impact of IR-2 on Oyster Bay nearest residence

Condition	Year of construction								
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
$L_{Req,d}$	47	50	48	42	44	44	43	41	38
Excess over 50dBA	0	0	0	0	0	0	0	0	0
Impact	Negligible								

The results of the investigation indicated that during the road construction period the estimated maximum noise impact for the duration of the construction of Inland Route

1 in the vicinity of the Umzamawethu Township and in the vicinity of the nearest Oyster Bay residence would be Low at both locations whereas for Inland Route 2 the noise impact would be Negligible at both locations.

During a nine year period of construction of Nuclear-1 at the Thyspunt site construction vehicles, transportation vehicles and Eskom staff using Inland Route 1 would result in a Medium noise impact at Umzamawethu Township during the second year of construction of Nuclear 1 and Low or Negligible during the other eight years. The noise impact at the nearest Oyster Bay residence would be Low during the first three years of construction and Negligible during subsequent years.

3.7 Impacts of Geohydrology

Based on the knowledge obtained during geohydrological investigations for the Site Safety Report (SSR) (SRK, 2012) and the Environmental Impact Assessment (SRK, 2012) projects, the following two geohydrological impacts have been identified that might result from realignment of the access road:

- Impendence of groundwater flow due to road excavation extending below the groundwater table; and
- Contamination of aquifers by accidental spills of fuel and hazardous chemicals.

(a) Road excavation extending to below the groundwater table and affecting/impeding groundwater flow

The risk for this is negligible as the water level where the road is underlain by the Table Mountain Group Aquifer, is generally >4 m below ground level (m bgl) and >10 m bgl where underlain by the Algoa Aquifer. Note that the water level in the Table Mountain Group Aquifer is a piezometric level, i.e. the water was struck at a deeper level, which was 8 m and deeper in this area, from where it rises under hydraulic pressure. In other words, a contaminant will have to percolate down to 8 m and more before it will enter the aquifer zone. The north-south section of the road, which is underlain by the Table Mountain Group Aquifer, is aligned parallel to the natural groundwater flow in this aquifer, therefore impediment of the flow is not a factor. In the east-west aligned portion the road, which is underlain by the Algoa Aquifer, the flow will also not be impeded as the water table in this area is generally >10 m bgl.

(b) Contamination of the aquifers by accidental spills of fuel and hazardous chemicals during construction and use of the road

There is a fairly thick unsaturated zone (generally >10 m) of fine sand above the Algoa Aquifer that will impede and attenuate infiltration of contaminants. In the north-south section where the proposed road is underlain by the Table Mountain Group Aquifer, there might be a slightly higher risk due to the presence of preferential flow along bedding planes that strike in a northwest-southeast direction. Contaminants entering these more transmissive zones may spread faster and further than in the Algoa Aquifer. This risk can be mitigated to a Low probability by good housekeeping during construction and good management of the transport of hazardous substances. It will also be important to have an emergency response team on standby at all times with the correct equipment to contain and clean-up any spills before the contaminant percolates down to the aquifers.

3.8 Geotechnical Factors

The known site geotechnical characteristics introduce certain impacts related to the road alignment as follows:

(a) Introducing point load contamination due to the need for stormwater management to mitigate erosion risks

The topography of the site from the dune peaks in the centre of the site heading south towards the sea is steep. Erosion control (in the form of stormwater management) will be a primary design driver in this portion of the road design. This will concentrate stormwater discharge at controlled outlets, potentially introducing point source contamination from road runoff. This can be effectively mitigated with artificial wetlands or swales designed to accept these point source flows. The impact is deemed to be Low even without mitigation as significant contamination will only occur in the case of spills. With mitigation, this impact would be negligible. Lateral re-positioning of access roads will not effectively mitigate these impacts as the topography remains steep across the site.

(b) Poor founding conditions introducing excessive cuts through the dunes

Dune crests consist of unconsolidated aeolian sands that may require removal to meet road vertical alignment and/or founding specifications. These unconsolidated sands will require slope cutbacks to maintain slope stability, potentially increasing the access road corridor widths in cut areas. Mitigating measures are to construct retaining walls where cuts are excessive and/or to optimise road vertical alignment to minimise the vertical extent of cuts. Optimising the vertical alignment will, in all likelihood, not present a reliable mitigation measure as vertical curves will be legally governed by the sight distances, which are safety-related design constraints. The potential impact is deemed to be Medium, and with mitigation, these impacts would be Low.

3.9 Route alignment optimisation to reduce cut and fill

Subsequent to their review of the environmental findings, Eskom's engineers have performed an optimisation of the horizontal and vertical alignments of the IR-1/2 and IR-2 route alternatives to reduce cut and fill. A number of different variations of the IR-1/2 and IR-2 have been analysed to assess how cut and spoil volumes can be reduced, so as to limit the environmental footprint, but also to improve traffic safety and minimise high embankments, which could act as barriers to the movement of fauna and present safety risks.

These alternative alignments are as follows:

(a) Option 1: Road alignment IR-2 to IR-1/2 with a design speed of 80km/h

Option 1 uses horizontal alignment IR-2 to IR-1/2 (JLHG). Option 1 has high and low points in the natural topology which result in deep cuts and high fills in order to meet the vertical alignment design parameters. The side slope of the cuts and fills of Option 1 is 1: 0,36 (V:H) and makes use of retaining walls such as Loffelstein. This is done to ensure the footprint of the road does not extend over the 35m road reserve. The typical road cross section in **Figure 33** is based on the road widths recommended by the Aurecon design and indicates the maximum heights of cut and fill using a retaining wall system to achieve a 35m road reserve.

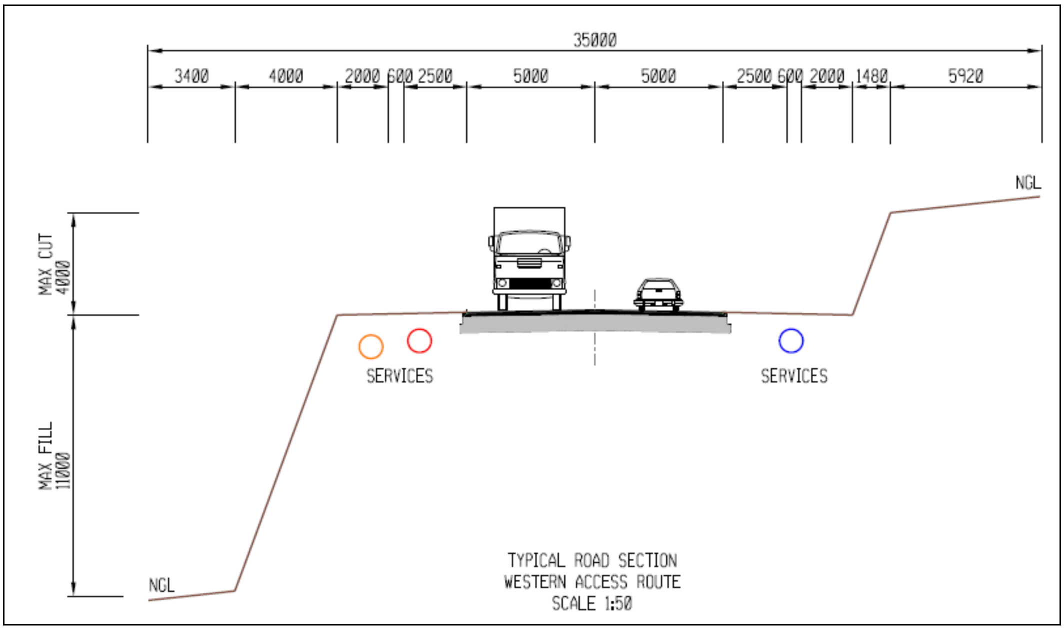


Figure 33: Typical road reserve of Option 1

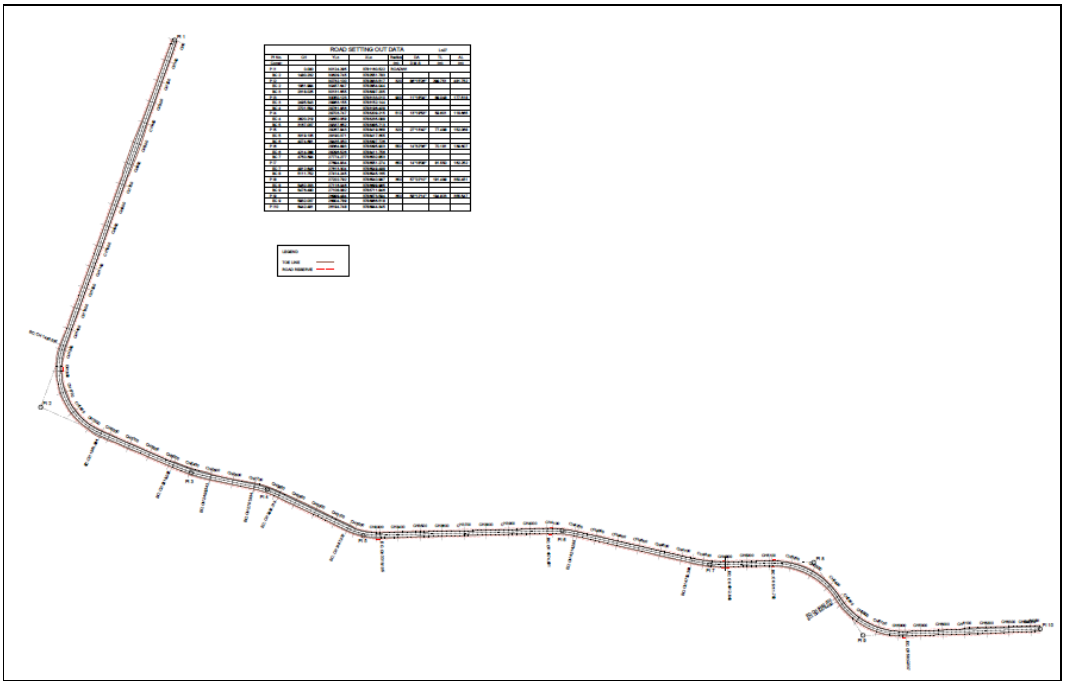


Figure 34: Horizontal alignment of Option 1

(b) Option 2: Road alignment IR-2 to IR-1/2 with a design speed of 60km/h

Option 2 uses horizontal alignment IR-2 to IR-1/2 (JLHG) as in the case of Option 1 but the design speed is reduced to 60km/h, which allows the radii of the horizontal and vertical curves to be reduced.

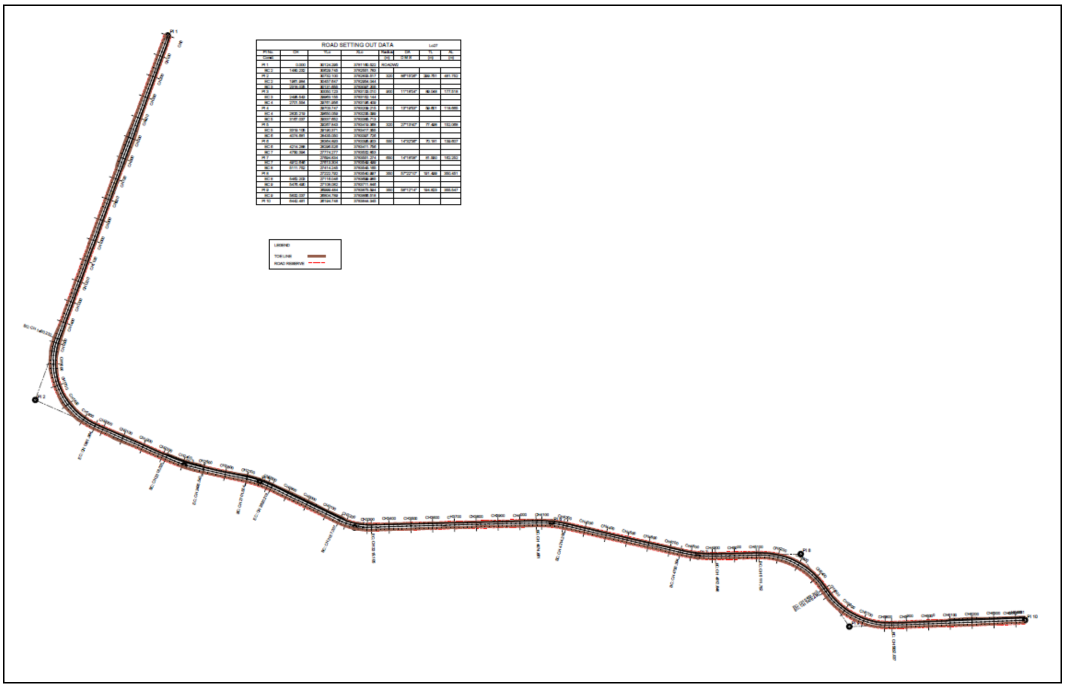


Figure 35: Horizontal alignment of Option 2

(c) Option 3: Road alignment incorporating part of IR-3 with a design speed of 60km/h

Option 3 is based on horizontal alignment IR-2 to IR-1/2 (JLHG), but the layout has been amended to exclude very high and low points in the mobile dune system. The side slopes of Option 3 remain 1: 0,36 (V:H) using retaining walls over 45% of the route length and a slope of 1:2 (V:H) over the balance. The road footprint does not exceed the 35m road reserve.

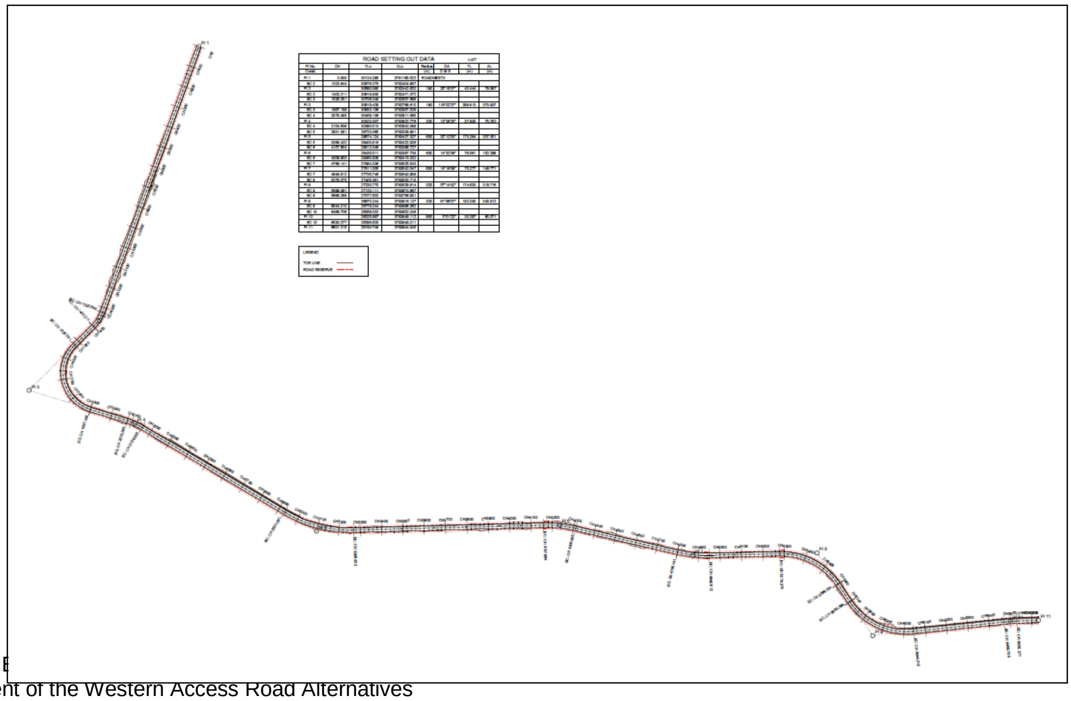


Figure 36: Horizontal alignment of Option 3

(d) Option 4: Road alignment IR-2 (JKBHG) (with slight adjustments from H to G) and a design speed of 60km/h

Option 4 is based on horizontal alignment IR-2 to IR-1/2 (JKBHG). This will exclude high and low points that make it difficult to meet design parameters of the vertical alignment. Option 4 respects the mobile dunes on both sides. The side slopes of Option 4 is based on a normal slope of 1:2 (V:H) with steep retained slopes over 34% of the road length to ensure that the footprint of the road does not exceed the 35m road reserve.

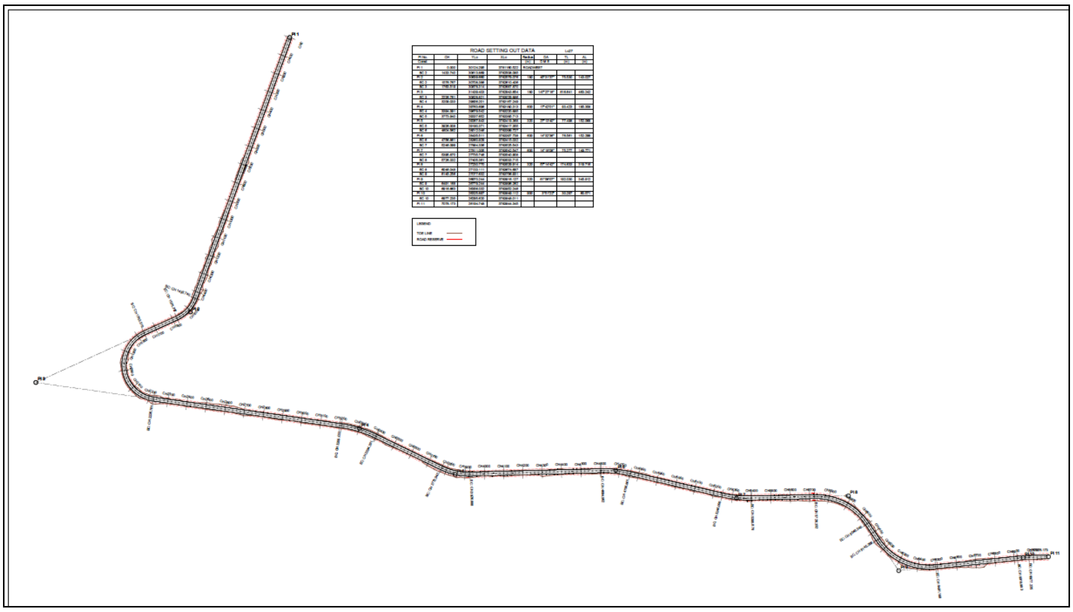


Figure 37: Horizontal alignment of Option 4

Table 14: Comparison of Options 1-4 for the IR-1/2 and IR-2 alignment

	Option 1	**Option 2**	**Option 3**	**Option 4**
Side slopes	1:0,36 (V:H)	1:0,36 (V:H)	1:0,36 (V:H) will cover only 45% of the road	Sides slopes of 1:2 (V:H) over the majority of the road length
Volume of fill	455,769 m^3	517,901 m^3	377,593 m^3	79,815 m^3
Road safety	Sections of the road will be dangerous should a vehicle	Sections of the road will be dangerous should a vehicle	Few potentially dangerous sections	Few potentially dangerous sections

	accidently crash through the Armco barriers	accidently crash through the Armco barriers		

(e) Recommended option

From a safety and environmental perspective, Option 4 is the recommended alternative, as Option 4 avoids high and low points in the topography and therefore has less need for steep and high cut and fill slopes. The fill volume associated with Option 4 is substantially less than the next best alternative (Option 3) or any of the other options. The environmental footprint associated with cut and fill is therefore much reduced with Option 4. Furthermore, Option 4 also reduces impact on the mobile dunes, compared to the Options 1-3.

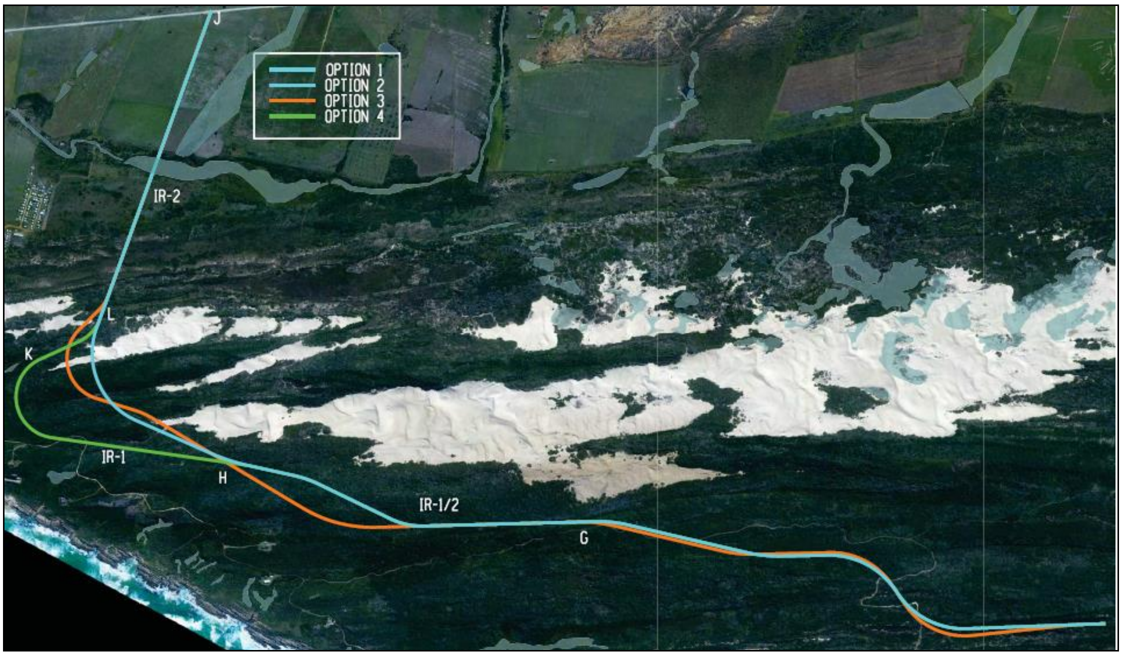


Figure 38: Options 1-4 (Option 4 is recommended)

4 IMPACT SUMMARY AND MITIGATION MEASURES

The summary of impact significance with and without mitigation is given in Table 15 below.

Table 15: Summary of Impact Significance with and without mitigation

IMPACT	SIGNIFICANCE
IMPACTS ON BOTANICAL RESOURCES AND DUNE ECOLOGY FOR THE PROPOSED WESTERN ACCESS ROAD ALIGNMENT	
Loss of coastal habitat (CR-1)	
Unmitigated - Loss of dune fynbos and thicket	**Medium**
Mitigated – align to avoid good quality vegetation (no mitigation for direct habitat loss, but can avoid good quality and rare sites)	**Low**
Loss of coastal dunes (CR-1/CR-2)	
Unmitigated - Loss stable parabolic dunes, coastal limestones	**High**
Mitigated – align away from limestones; avoid steep slopes of parabolics	**Low**
Loss of coastal forest (IR-1/IR-2)	
Unmitigated - Loss of forest patches on parabolic dunes	**High**
Mitigated – align away from forest, preferably in acacia infestation	**Low**
Loss of seeps in transverse dunes and above Slangrivier (IR-1/IR-2)	
Unmitigated - Loss of seeps along route	**High**
Mitigated – realign to avoid seeps	**Medium**
Loss of Slangrivier thicket and forest (IR-1/IR-2)	
Unmitigated - Partial loss of river vegetation and function	**High**
Mitigated – bridge over river to avoid thicket and forest; realign where degraded vegetation	**Low**
Loss of Red Data species (all routes))	
Unmitigated - Loss of Red Data species along route	**Medium**
Mitigated – realign to either avoid species or translocate to a safe place	**Low**
Loss of Slangrivier thicket and forest (IR-1/IR-2)	
Unmitigated - Partial loss of river vegetation and function	**High**
Mitigated – bridge over river to avoid thicket and forest; realign where degraded vegetation	**Low**
Loss of ecosystem function (IR-1/IR-2)	
Unmitigated - Compromising of functioning of transverse dune and hillslope seeps function	**High**
Mitigated - realign away from seeps	**Medium-high**
Cumulative impacts	
Unmitigated - Loss of species, habitat and ecosystem functioning	**High**
Mitigated - difficult to mitigate totally, but where possible locate road away from mobile dunes and wetlands	**Medium-high**
ASSESSMENT OF IMPACTS TO WETLANDS AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Construction Phase: Loss or degradation of coastal seep, valley bottom and depressional wetlands, as a result of (inter alia) infilling, changes in runoff, compaction, disturbance of vegetation, poor water quality	
Unmitigated	**High**

IMPACT	SIGNIFICANCE
With prescribed mitigation	**Medium**
Operation Phase: Loss or degradation of coastal seep, valley bottom and depressional wetlands, as a result of (inter alia) infilling, changes in runoff, compaction, disturbance of vegetation, poor water quality, channelization, loss of ecosystem function (changes to dynamic system); loss of connectivity, habitat fragmentation: Note that the effect of and mitigation against loss of fragmentation connectivity is dealt with in assessments of individual layouts.	
Unmitigated	**High**
With prescribed mitigation	**Medium**
IMPACTS ASSOCIATED WITH LAYOUT: **Impacts include: Loss of wetland habitat., loss of connectivity, fragmentation of habitats, degradation at a system level; changes in dune dynamics affecting biodiversity and hence wetland status**	
- Coastal Route (CR-1 & CR-2): NPS to Humansdorp Road, between Oyster Bay and Umzamawethu; three alternatives at western end: A-B-C-D/E/F	
Unmitigated	**High**
With prescribed mitigation	**Medium**
- Inland Route 1 (IR-1): NPS to west of Umzamawethu: G-H-I	
Unmitigated	**Very High**
With prescribed mitigation	**High**
- Inland Route 2 (IR-2): NPS to west of Umzamawethu: G-H-J	
Unmitigated	**Very High**
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
Coastal to Inland Route 1, alternative 1 (CR-1 to IR-1): A-B-K-I	
Unmitigated	**Very High**
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
Coastal to Inland Route 2, alternative 2 (CR-1 to IR-2): A-B-L- -J	
Unmitigated	**Very High**
With prescribed mitigation	AVOIDANCE MITIGATION: See Mitigated alternatives for **Coastal Route** and for **Inland Route -1**
ASSESSMENT OF IMPACTS TO INVERTEBRATES AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Loss and transformation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**High**
With prescribed mitigation	**Medium**
Degradation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Fragmentation of invertebrate habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Low**
Water contamination of invertebrate wetland habitat as a result of the construction of the proposed access route	
Unmitigated	**Medium**
With prescribed mitigation	**Medium**
Water contamination of invertebrate wetland habitat as a result of the operation of the proposed access route	
Unmitigated	**High**

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

IMPACT	SIGNIFICANCE
Unmitigated	Medium
With prescribed mitigation	Low
Vertebrate mortality on roads - Frequent truck/vehicle road activity will result in mortality of vertebrates	
Unmitigated	Medium
With prescribed mitigation	Medium
Habitat destruction - The construction of roads, widening of existing roads, building of bridges; and site clearing will destroy existing habitats	
Unmitigated	High
With prescribed mitigation	Medium
ASSESSMENT OF IMPACTS TO HERITAGE RESOURCES AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Route Alternative CR-1 (B-A)	
Unmitigated	High
With prescribed mitigation	High
Route Alternative CR-2 (D-B. E-B, F-B)	
Unmitigated	High
With prescribed mitigation	High
Route Alternative IR-1 (I-G)	
Unmitigated	High
With prescribed mitigation	Medium
Route Alternative IR-2 (J-G)	
Unmitigated	High
With prescribed mitigation	Low
ASSESSMENT OF IMPACTS TO NOISE RECEPTORS AS A RESULT OF IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Impact of IR-1 on Noise Receptors due to construction activities	
Unmitigated	Low
With prescribed mitigation	Low
Impact of IR-1 on Noise Receptors due to construction activities	
Unmitigated	Low
With prescribed mitigation	Low
ASSESSMENT OF IMPACTS OF THE HYDROGEOLOGICAL ENVIRONMENT ON THE IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Impendence of groundwater flow due to road excavation extending below the groundwater table – All Routes	Negligible
Contamination of aquifers by accidental spills of fuel and hazardous chemicals – All Routes	
With prescribed mitigation	Low
ASSESSMENT OF IMPACTS OF THE HYDROTECHNICAL ENVIRONMENT ON THE IMPLEMENTATION OF DIFFERENT WESTERN ACCESS ROAD ALTERNATIVES	
Introducing point load contamination due to the need for stormwater management to mitigate erosion risks – All Routes	
Unmitigated	Low
With prescribed mitigation	Negligible
Poor founding conditions introducing excessive cuts through the dunes – All Routes	
Unmitigated	Medium
With prescribed mitigation	Low

4.1 Mitigation Measures

4.1.1 Mitigation of impacts on the biophysical environment

(a) Proposed routes

Avoidance of rare habitats
Care should be taken to avoid any coastal seeps with a functional buffer established between seeps and road (see Day, 2011, for detail). Limestone outcrops should also be avoided and a buffer of 50m minimum set between the latter and the road. Likewise, buffers recommended by Day (2013) should be instituted around the wetlands in the north-east of the route (D, E & F). Mobile dunes should be avoided at all cost.

Habitat fragmentation
Sufficient underpasses that allow both fauna and humans to access either side of the road should be built.). This applies to the west-east coastal road, as well as to the south-north links if IR-1 or IR-2 to be built.

Steep dune slopes
Steep dune slopes should be avoided as this may cause destabilisation of dunes and unnecessary management intervention in the form of costly revegetation.

Road width
Maintain a road width of no more than 40m.

Water table
No excavation within 2 m of the water table where practical.

Spoil
Excess spoil from dune cuts should not be allowed to infill dune valleys and slacks.

Construction near a wetland
No plant, construction or stockpiling of material should be permitted within 50 m of a wetland. No construction camps should be permitted in these areas and should be situated well away from any wetland or sensitive/rare vegetation.

Underpasses
Provide underpasses for fauna and, where required, humans, for example where the south-north corridor is breached along the coastal route.

Fences
No fences should be erected along the roads whilst under construction so as to ensure fauna can move freely. Where fences are unavoidable, barbed wire should not be used.

(b) Search & rescue – plants

For the construction of the proposed road, a search and rescue operation is required to identify all plants that are either extremely rare (i.e. Endangered or Critically Endangered) or which can be used in rehabilitation of the site. This would require the services of a specialist to identify and locate suitable species and to ensure a plan is in place to remove these plants **prior** to site clearance. Plants with a bulb or rootstock have the greatest chance of surviving translocation, whereas most shrubs and many of the graminoids (grasses, sedges, restios), particularly the obligate reseeders, will not translocate successfully.

A selection of species suitable for rehabilitation is shown in Table 16

(c) Search and rescue – fauna

A search and rescue operation should be conducted prior to any clearing for or construction of the road. Animals should be relocated to a safe place.

(d) Rehabilitation plan

Linked with Search and Rescue above should be a rehabilitation plan, which would ensure that all areas disturbed in the development of the proposed facility are satisfactorily rehabilitated with locally occurring indigenous species. This would include the collection of appropriate plant material prior to construction commencing, the storage of such material and/or the growing on of suitable material. Plants would need to be at least two to three years old for use in rehabilitation and thus sampling should commence during the construction period, at least three years before commissioning of the plant. An onsite nursery would be required to accommodate stored and grown on plants and would be an essential requirement for satisfactory rehabilitation. For this purpose a rehabilitation plan needs to be drawn up to identify suitable species, method of storage and/or propagation, methods of planting and maintenance and monitoring of rehabilitation success (see below).

Seed and/or cuttings should be removed from species that will not translocate easily and grown on in the on-site nursery.

Key interventions would be addressing the erosion in the Slangrivier prior to any road construction. This should be included as a part of the construction and operational EMP.

The rehabilitation plan should include the following key elements:

- *Preparation phase*

  At least two years before commencement of construction, an on-site nursery with a manager needs to be set up at Thyspunt. A list of appropriate species needs to be drawn up and both seed and cuttings collected, planted out and suitably hardened off. This would provide material ready for planting as areas require to be rehabilitated. In addition certain species could also be translocated into the nursery. The amount of plant material required will be guided by the extent of construction and areas to be disturbed. Both terrestrial and wetland habitats need to be considered.

  A list of selected species suitable for rehabilitation is found in Table 16

- *Topsoil*

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

Topsoil (0 – 300 mm depth) should be removed from any area being disturbed temporarily or permanently, and stockpiled. Piles should be no more than 1.5 to 2 m high to increase the chance of aeration, but also to avoid too rapid decomposition of organic matter, the latter essential for providing a good start for new plants

Stockpiles should be placed in previously disturbed areas and should definitely not be located on natural vegetation. This would lead to the death of the latter.

- *Planting*

Planting of nursery grown and translocated species should be undertaken at a density set by the rehabilitation specialist, but generally at no less than 1 m apart. Time of planning should be just prior to the onset of the rainy season (April to June) so that plants are provided with good moisture conditions prior to the summer season some six months later. A list of suggested species is proved in Table 12

- *Mulching*

Mulch should be strewn over the planted areas and this should shade the soil, and provide a source of organic matter and some nutrients, as well as retention of moisture for new plants.

The best source for mulch is locally occurring introduced acacias (e.g. *Acacia saligna* Port Jackson willow) and these should be mulched on site after cutting. Care should be taken not to clear these woody aliens when they are setting seed (October-November).

- *Maintenance*

Newly planted areas should be regularly weeded. Where plant death occurs, new material should be planted out. Plants should also be irrigated during the first summer season. For this purpose a simple above ground irrigation system would prove useful if not essential.

All woody aliens should be removed once they reach knee height (for ease of pulling).

- *Monitoring of uninvaded areas*

Where habitats have been unnaturally disturbed but are not invaded by *Acacia cyclops* rooikrans, rehabilitation with indigenous species is to be implemented. Such rehabilitation should follow a plan put together by a rehabilitation specialist, and using locally occurring indigenous species. Rehabilitation success should be monitored on a three monthly basis for the first year, and then six monthly until acceptable species densities and cover are achieved.

- *Monitoring of invaded areas*

Areas invaded by rooikrans should be cleared and rehabilitated using indigenous species (see rehabilitation plan above). Rehabilitation success should be monitored (species density and cover) at three monthly intervals for the first year, and then six monthly until acceptable levels have been reached.

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

Cleared rooikrans should be mulched for later use in rehabilitation (see section (vii) above).

- *Relocation and/or growing on of Red Data species*

Goal: to ensure that all RD species affected by development are relocated or successfully grown on in a nursery and returned to the wild

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

- *Coastal and inland seeps (also see Day, 2013)*

Goal: to ensure that the water levels and general ecosystem health of these systems *are not compromised*

A monitoring programme should be put in place which evaluates the vigour of the plant communities and individual species component, and the level of the water. Both impacts and unimpacted (control) wetlands should be monitored to determine the impacts caused by the development.

- *State of conservation area*

Goal: to ensure that the natural areas of Thyspunt are maintained in a state consistent with that of a well-managed nature reserve.

A conservation area, guaranteed in perpetuity regardless of ownership, should be created. A conservation manager should be appointed to ensure that a management plan is drawn up for the area and implemented. Key performance areas are: alien eradication, rehabilitation, controlled burning, creation of a trail system for the public, control of access and use of the area and control of vehicles entering the area.

4.1.2 Mitigation of Impacts on Heritage Resources

The intention of mitigation of heritage sites broadly takes two positions. First choice will always be to avoid impact and conserve the resource where feasible. This is possible where the resource is immediately identifiable at the surface. However, where this is not the possible, mitigation will often be the only option available, so as not to force changes on a project design at a late stage. If the resource was of such uniqueness that it would have to be retained in place, some attempt at redesign would probably be necessary.

In the case of Thyspunt, it seems unlikely that the latter scenario can be envisaged. Archaeologists, palaeontologists and geologists all derive knowledge from uncovering and sampling of heritage resources. Provided that the mitigation programs are implemented as recommended, impacts can be minimised, and benefits enhanced.

Mitigation should be achievable, provided that sites can be identified during and after bush clearing, and then adequately sampled. Monitoring of earth moving will be required.

(a) Mitigation objectives

In terms of archaeology and palaeontology, each site may display individual characteristics. People and animals after all responded to whatever the landscape presented at the time. In the perfect scenario, remains will have remained perfectly preserved in place for us to uncover and record. This is seldom the reality for older sites and in most cases we will deal with partial remains often distorted over time by secondary processes.

Some level of judging the effectiveness or not of mitigation is to know the extent of the resource that is mitigated and understanding something of its significance within the field. Circumstances may not always permit full estimation of the resource. The effectiveness of mitigation will probably best be judged by the contribution to scientific endeavour arising out of the mitigation. Generally, one must try and mitigate as much of a resource as will be impacted.

(b) Recommended mitigation measures

These are generic mitigation measures that would apply to all of the routes in one way or another.

- Apply for the necessary permits from the relevant Heritage Authority to mitigate known sites and negotiate more general permits to mitigate sites found during monitoring of bush clearing and/or bulk earthworks;
- Create an on-site facility where a heritage team can be based for the duration of the construction phase. Equipment and heritage material will be stored there. Some preparation and analysis of finds will take here;
- Monitor all bush clearing and earthmoving and identify (archaeological, palaeontological and geological) sites where possible. Problems with identification may be experienced with visibility through the build-up of leaf litter and sand;
- If visible, determine extent of resource and possible mitigation actions and if in addition, a palaeontologist and/or geologist needs to be involved in mitigation;
- Depending on visibility at the bush clearing phase, it may be necessary to undertake a program of test excavations along the chosen route as was undertaken in the main power station footprint;
- Inspect soil stockpile and construction and laydown areas;
- Mitigate known sites in advance of construction through either avoidance, collection and/or excavation;
- Analyse, describe and report on the mitigated material; and

- Curate and place material into approved storage.

(c) Effectiveness of mitigation measures

Although located on the West coast, two sites come to mind when considering effective collection strategies for ESA/MSA sites with a paleontological component. The site known as Duynefontein 2 is located within the Koeberg property and was recognised during the assessment of the site prior to and during the construction phase (Klein 1999, Cruz-Uribe 2003). The site of Elandsfontein lies close to Langebaan and has for years been visited by palaeontologists and archaeologists alike to sample the abundant material scattered throughout the extensive dune system. It is the site where a fossil cranium was recovered, which later became known as the Saldanha “man”. Currently a large scale research program is underway in an attempt to locate other fossil hominid remains and collect large samples of the paleao-fauna (Archer and Braun 2010). We still await a number of scientific reports from the site.

These are both good examples of open site excavations providing good baseline data and samples of large systems.

In terms of the LSA, a fairly extensive program of mitigation was carried out during the construction of the golf course at St. Francis (Nilssen 2003, 2006). Further afield, on the West coast, was the mitigation program conducted over a number of years on the De Beers Namaqualand mines (Dewar et al 2006, Halkett 2006, 2008, Halkett & Dewar 2007 (a) (b), Halkett and Orton 2007, Orton and Halkett 2005, 2006, 2007, Orton 2005, 2007)

Apart from the St Francis case, all the others have contributed extensively to scientific knowledge. The point is that there are a number of cases where similar sites have been excavated and the techniques are well tried.

(d) Apply mitigation hierarchy when deciding on mitigation measures

In terms of the hierarchy below (avoidance most preferred and no action least preferred), the avoidance and reduction are probably the two most common options of choice. Unfortunately, rectification is required all too often, but is understandable given the often invisible nature of archaeological and palaeontological heritage resources.

- ***Avoidance***: impact is prevented or substantially prevented (most preferred)
- ***Reduction***: impact is reduced in magnitude and/or significance
- ***Rectification***: impact is mitigated after it has occurred e.g. rehabilitation of areas disturbed by construction
- ***Compensation***: providing a substitute resource for a resource that has been lost because of the project (e.g. “*conservation offsets*”)
- ***No action (least preferred)***

4.1.3 Mitigation of Impacts on Social Environment

The following mitigation measures are proposed:

(a) Safety of people using or crossing the road

The mitigation objective is to ensure the safety of all road users. If the assumption is true that roads 2-5 will not be for the use of public then it is only for the Coastal Route that safety measures will be required.

(b) Advantages of using the road for motorized or non-motorized transport

A shorter and/or improved road to Humansdorp or an improved road to Oyster Bay could contribute positively towards better mobility for people using this road.

(c) Noise, visual and dust disturbances

Inputs from the noise, visual and dust specialists are required in order to assess the reality of possible impacts within the broader context of people's perceptions of these disturbances.

(d) Economic and other social activities link to road

Clear guidelines are needed within the legal framework regarding trading next to roads.

4.1.4 Mitigation of Impacts on the Visual Environment

The following design and implementation aspects are recommended to ensure the road servitude fits the setting the topography and the vegetation through which it passes:

- Cut and fill slopes need to be at a minimum slope of 1:2 vertical to horizontal to allow for successful stabilisation by vegetation.
- The edge of the cuts and fills that is where the slope meets the existing landform must be rounded to visually fit the existing landform.
- The toe of the slope section where cuts are required in dunes should be stabilised by gabions or similar retaining systems.
- Expert advice on the stabilisation of the disturbed / new dune surfaces by vegetation and other means should be obtained. The will ensure that constant of the blowouts and the removal of sand from the route are avoided.
- The south western wind direction should be taken into account in the final form of the windward side of the cut and fill.

Table 16: Selected plant species useful for rehabilitation at Thyspunt (modified from Low, 2011)

Family	Species	Common name	Broad habitat	Form
Dicotyledones				
AIZOACEAE	*Tetragonia decumbens*	kinkelbossie	Parabolic dunes	groundcover
ANACARDIACEAE	*Rhus crenata*	duinekraaibessie	Parabolic dunes	Shrub
ANACARDIACEAE	*Rhus lucida*	blinktaaibos	parabolic dunes	Shrub
APIACEAE	*Dasispermum suffruticosum*	duineseldery	Mobile dunes	Low shrub
APOCYNACEAE	*Carissa bispinosa*	Noem-noem	Parabolic dunes	Medium shrub
ASTERACEAE	*Arctotheca populifolia*	Sea pumpkin	Mobile dunes	Groundcover
ASTERACEAE	Chrysanthemoides monilifera	bietou	Parabolic dunes	Shrub
ASTERACEAE	*Metalasia muricata*	blombos	Parabolic dunes	Shrub
ASTERACEAE	*Tarchonanthus camphoratus*	Wild camphor	Parabolic dunes	Shrub to small tree
CELASTRACEAE	*Cassine peragua*	bastersaffraan	Parabolic dunes	Shrub to small tree
EBENACEAE	*Euclea racemosa*	seeghwarrie	Parabolic dunes	Shrub
ERICACEAE	*Erica chloroloma*		Parabolic dunes	shrub
FABACEAE	Psoralea repens	duine-ertjie	Primary dunes	Groundcover
FABACEAE	*Rhynchosia caribaea*		Parabolic dunes	shrub
GENTIANACEAE	*Chironia baccifera*	bitterbessiebos	Parabolic dunes	Low shrub
GERANIACEAE	*Pelargonium capitatum*	Rose-scented pelargonium	Parabolic dunes	Low shrub
LAMIACEAE	Salvia africana-lutea	Bruinsalie	Parabolic dunes	Shrub
MESEMBRYANTHEMACEAE	*Carpobrotus acinaciformis*	Sour fig	Parabolic dunes	Groundcover
MESEMBRYANTHEMACEAE	*Carpobrotus deliciosus*	perdevy	Parabolic dunes	groundcover
OLEACEAE	*Olea capensis* subsp. *capensis*	ysterhout	Parabolic dunes	Shrub to small tree
POLYGALACEAE	*Polygala myrtifolia*	Septemberbos	Parabolic dunes	shrub
POLYGALACEAE	Nylandtia spinosa	skilpadbessie	Parabolic dunes	Shrub
RUTACEAE	*Agathosma apiculata*	knoffelboegoe	Parabolic dunes	Shrub
RUTACEAE	*Agathosma stenopetala*		Parabolic dunes	Shrub
THYMELAEACEAE	*Passerina corymbosa*	sandgonnabas	Parabolic dunes	Shrub
THYMELAEACEAE	*Passerina rigida*	duinegonnabas	Parabolic dunes	shrub
Monocotyledones				
AMARYLLIDACEAE	*Scadoxus puniceus*	Blood lily	Parabolic dunes	bulb
ARACEAE	*Zantedeschia aethiopica*	Arum lily	Sand plain and parabolic dunes	Bulb
ASPHODELACEAE	*Trachyandra ciliata*	wildeblomkool	Parabolic dunes	Bulb
CYPERACEAE	*Tetraria brachyphylla*		Parabolic dunes	sedge
POACEAE	*Ehrharta villosa*	pypgras	Mobile dunes	Grass
POACEAE	*Merxmuellera cincta* subsp. *sericea*	olifantsgras	Parabolic dunes (also wetter parts)	Grass
RESTIONACEAE	*Ischyrolepis leptoclados*	besemriet	Parabolic dunes	Restio

4.1.5 Mitigation of Impacts on the Geohydrological Environment

Good housekeeping during construction and good management of the transport of hazardous substances will mitigate potential impacts. It will also be important to have an emergency response team on standby at all times with the correct equipment to contain and clean-up any spills before the contaminant percolates down to the aquifers.

The following mitigation measures are proposed:

- Design artificial wetlands or swales to accept potential point source contamination from road run-off; and
- Construct retaining walls where cuts are excessive and/or to optimise road vertical alignment to minimise the vertical extent of cuts.

5 CONCLUSIONS AND RECOMMENDATIONS

Each individual specialist tasked with assessing the options for access to the western side of the Thyspunt site approached this assignment within the context of their own field of study in terms of the methods used for scientific investigation. Each of the specialist were further tasked to identify their preferred option for the western access route to the Thyspunt site, again within the context of their field of expertise, and this information is presented in the section to follow.

5.1 Preferred route for the Western Access to the Thyspunt Site

5.1.1 Preferred route identified by the Biophysical Specialists

Biodiversity assessments of the wetlands, dunes, botany, invertebrates and vertebrates along several alignments for the proposed western access road for the proposed Nuclear-1 facility at Thyspunt emphasised the high quality of habitats and fauna in the area and, in particular, the unique assemblage of dryland and wetland systems. Assessment of habitat quality, rarity and sensitivity produced a suite of criteria, which enabled selection of a preferred route for the road.

Three of the biodiversity specialists involved are in agreement that the **coastal route (CR-1/CR-2) is the most preferred**, with the **wetland specialist opting for a combination of the first section of IR-1 and CR-2**, so as to avoid the coastal seeps.

Mitigation measures are recommended to reduce or eliminate these impacts. A monitoring programme would need to be established to ensure mitigation is implemented effectively.

Creation of a conservation area at Thyspunt is seen as a positive impact and should be a key intervention here.

Prior to any construction, an EMP should be drawn up. An ECO should be present on site to ensure the EMP is effectively implemented.

5.1.2 Preferred route identified by the Heritage Specialist

The two inland routes (IR-1 and IR-2) are favoured over the coastal routes (CR-1 and CR-2 with its alternatives in turn).

While the coastal option is not out of the question, there is a higher likelihood of encountering LSA sites with associated burials. Burials are emotive and best avoided where possible. While there is a chance of encountering burials in LSA sites on the inland routes, the observations of the broader site indicate much lower site density inland. Known sites that were identified along the CR-2 routes are few in number. Thick vegetation prevents a clear understanding of LSA sites along the CR-1 route.

The inland routes are therefore favoured due to the expectation that there will be fewer sites, which translates to less impact and easier management. Part of the routes traverses disturbed farmland where there is only a very low possibility of finding archaeological or palaeontological resources. This is not to say that no sites will be found. However, there is a greater likelihood of encountering older sites from the ESA or MSA in re-vegetated areas as described by Binneman (1996). Although these types of sites are rare, mitigation would provide a positive benefit through access to information about human activity in this time period. The material is at the forefront of archaeological interest at present and any information will contribute significantly to scientific knowledge.

As there was little interest in the past in these sites, opportunities for research were lost due to the locations being closed over by invasive alien vegetation. Such vegetation can be equally destructive due to the actions of roots on organic remains such as bone.

Equally, there is a much more distant relationship between living persons with the archaeological residues that may be found. While finding fossil hominid remains would be of international significance, the chances are low given the very low density of population on the landscape at that time.

Other factors along the inland routes which could have positive benefits is information that will be derived from geological features such as palaeosols. These may help with an understanding of the formation history and age of the landscape and dunes.

5.1.3 Preferred route identified by the Visual Specialist

The visual assessment is primarily guided by the following two objectives:

- The route must have the least visual impact or visual intrusion in views from eastern residential area of Oyster Bay and Umzamawethu; and
- The visible infrastructure of the road should be as far away from the residential areas as practical so as to avoid a constant visual intrusion on the ambience of the residential areas.

The Inland Route IR-2 satisfies both objectives while the Inland to Coastal Routes do not. The route IR-2 is preferred despite the more extensive earth works because it is further way from the residential area on the eastern edge of Oyster Bay and the cuts through the mobile dune system will screen the road in views from this area.

The Coastal Route 1 (CR1) is common to both Alternative Routes and therefore the alignment will be visible to the houses on the eastern side of Oyster Bay due to the closeness of the road and with the alignment closer to the coast it is likely to be visible from the western edge of Oyster Bay and further westwards from the coast looking eastwards. The distances involved in these views are approximately 6 km. However, the road itself will not be a visual intrusion but it will be the operation and lighting that will visually disturb the coastal section east of Oyster Bay, a view that is likely to be appreciated by the existing landowners and visitors.

There is no preferred route as the coastal route alignment in the area of B (See **Figure 2**) is close to the residential area and will be visible in both alternatives.

However if the Coastal Route CR-1 and CR-2 are a lower order road for the primary use of staff vehicles the nearness of these routes to the residential areas will not be as much a visual intrusion as a main access route for construction and equipment.

Should CR-1 and 2 have this purpose the use of route alternative C-F is preferred above C-D because it will form part of the urban road structure and be used as such.

Routes C-D and C-E cross seasonal wetlands, which are linked to the hydrological system up and downstream and which form an integral part of the agricultural /urban interface. It would be preferable that this area should in the future be retained as an urban feature that has a function of providing and managing good quality water. While this is an ecological function argument it also relates to the visual quality of the area and should be taken into account in the positioning of access roads for Nuclear-1.

5.1.4 Preferred route identified by the Social Specialist

The Coastal Route is the least preferred route from a social perspective in comparison to the other alternatives. This road presents the advantage of creating a shorter route to Humansdorp and also a better quality road that could open up the possibility of making use of working opportunities in Humansdorp.

The Inland Route 2 is the most preferred route, followed by the Inland Route 1.

The Coastal to Inland Route 1(alternative 1) and Coastal to Inland Route 2(alternative 2) can be considered as alternatives with limited social impact.

5.1.5 Preferred route identified by the Economic Specialist

Strictly in terms of economic parameters, Option 1 (Points A-H on **Figure 2**) is the most preferable option, followed by Option 3, 2, 5 and 4 in order of decreasing values.

Option 1 is then according to the maps provided the following route:
From A to E, from E to F and F to H.

5.1.6 Preferred route identified by the Noise Specialist

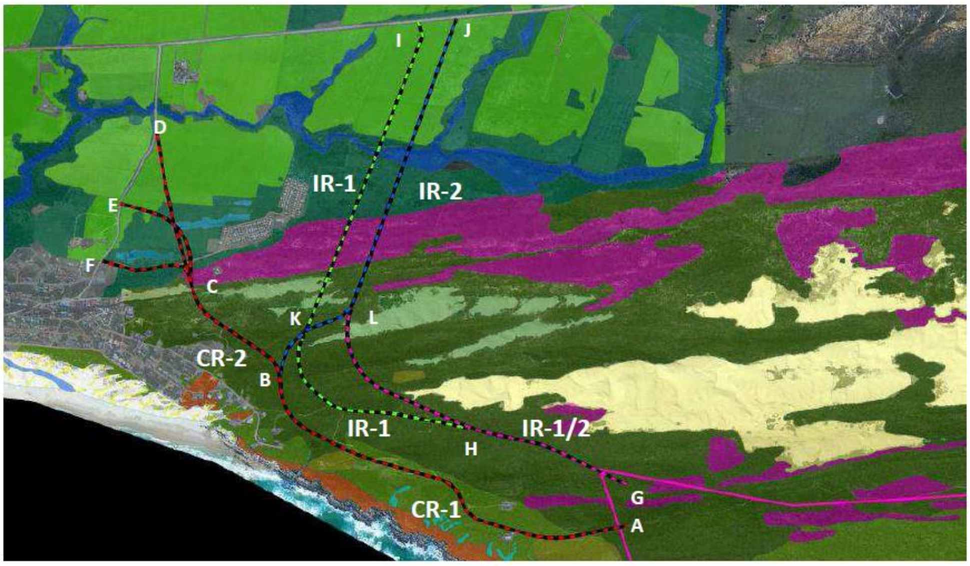
The results of the investigation indicated that during the road construction period the estimated maximum noise impact for the duration of the construction of Inland Route 1 in the vicinity of the Umzamawethu Township and in the vicinity of the nearest Oyster Bay residence would be Low at both locations whereas for Inland Route 2 the noise impact would be Negligible at both locations.

During a nine year period of construction of Nuclear-1 at the Thyspunt site construction vehicles, transportation vehicles and Eskom staff using Inland Route 1 would result in a Medium noise impact at Umzamawethu Township during the second year of construction of Nuclear 1 and Low or Negligible during the other eight years. The noise impact at the nearest Oyster Bay residence would be Low during the first three years of construction and Negligible during subsequent years.

The noise impact at Umzamawethu Township for the same traffic on Inland Route 2 would be Low during the first three years of construction and Negligible during subsequent years. The noise impact at the nearest Oyster Bay residence would be Negligible for all of the nine years.

5.2 Recommended route for the Western Access to the Thyspunt Site

At the heart of this report lies the questions as to which is the preferred route (see **Figure 39** below for alternatives proposed) to access the western side of the Thyspunt site, which is currently the recommended site for the construction and operation of the Nuclear-1 Power Station. The answer to this question required weighing up the impact of the access road on sensitive faunal, floral, wetland, dune and heritage environments and the impact on the inhabitants of the settlements of Oyster Bay and Umzamowethu.



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

Figure 39: Overview of Proposed Alternatives for the Western Access to the Thyspunt Site

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

Table 17: Preferred Access Road Alternative per specialist

	CR-1 & CR-2	IR-1 & IR 1/2	IR-2 & IR 1/2	IR-1 & CR-2	IR-2 & CR-2
Biophysical Specialists (not Wetland Specialists	X				
Wetland Specialists					X
Heritage Specialist		X	X		
Social Specialist			X		
Visual Specialist			X		
Noise Specialists			X		

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

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

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

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

6 REFERENCES

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