Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

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Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

FINAL SEA REPORT

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Note from the Council for Scientific and Industrial Research (CSIR):

The SEA was commissioned in April 2017 by the National Department of Environmental Affairs (DEA), National Department of Energy (DoE) and National Department of Public Enterprises (DPE), as well as iGas, Eskom and Transnet. These aforementioned National Departments changed during the Cabinet restructuring that took place in May 2019. Since the SEA was commissioned by the National DEA, DoE and DPE, these abbreviations have been retained in the Final SEA Report. However, the table below has been provided to indicate the Ministries that have been mentioned in this Final SEA Report prior to and subsequent to the May 2019 Cabinet restructuring to ensure relevance when referring to the report. Therefore, where the Final SEA Report mentions the Department of Environmental Affairs, for example, kindly note that this refers to the Department of Environment, Forestry and Fisheries.

Ministry prior to May 2019 Restructuring	Ministry subsequent to the May 2019 Restructuring
Department of Environmental Affairs (DEA)	Department of Environment, Forestry and Fisheries (DEFF)
Department of Energy (DoE)	Department of Mineral Resources and Energy (DMRE)
Department of Public Enterprises (DPE)	Department of Public Enterprises (DPE)* (**No change*)
Department of Water and Sanitation (DWS)	Department of Human Settlements, Water and Sanitation (DHSWS)
Department of Agriculture, Forestry and Fisheries (DAFF)	Department of Agriculture, Land Reform and Rural Development (DALRRD)
Department of Rural Development and Land Reform (DRDLR)	Department of Agriculture, Land Reform and Rural Development (DALRRD)
Department of Defence (DoD)	Department of Defence and Military Veterans (DDMV)
Department of Labour (DoL)	Department of Employment and Labour (DoEL)
Department of Planning, Monitoring and Evaluation (DPME)	Department of Planning, Monitoring and Evaluation (DPME)* (**No change*)
Department of Co-operative Governance and Traditional Affairs (DCOGTA)	Department of Co-operative Governance and Traditional Affairs (DCOGTA)* (**No change*)
Department of Trade and Industry (DTI)	Department of Trade and Industry (DTI)* (**No change*)

PREFACE

The Department of Environmental Affairs (DEA), Department of Energy (DoE) and Department of Public Enterprises (DPE), together with iGas, Eskom and Transnet, commissioned a Strategic Environmental Assessment (SEA) Process to identify and pre-assess suitable gas transmission pipeline corridors to facilitate a streamlined Environmental Assessment Process for the development of such energy infrastructure, while ensuring the highest level of environmental protection. It is proposed that the final corridors be embedded and integrated into Provincial and Local planning mechanisms to secure long term energy planning.

The Council for Scientific and Industrial Research (CSIR) was appointed in April 2017 to undertake the Gas Pipeline SEA Process, in collaboration with the South African National Biodiversity Institute (SANBI).

The SEA Process is linked to the objectives of Operation Phakisa, which was launched by the South African National Government in July 2014, with the aim of implementing priority economic and social programmes and projects better, faster and more effectively. It includes the 1) Oceans Economy Lab; 2) Health Lab and 3) Education Lab. The Oceans Economy Lab aims to unlock the potential of the South African coast and considers the following four critical areas:

- Marine Transport and Manufacturing;
- Offshore Oil and Gas Exploration;
- Aquaculture; and
- Marine Protection Services and Ocean Governance.

This SEA Process is related to the critical area of Offshore Oil and Gas Exploration. Eleven initiatives were identified as part of the Offshore Oil and Gas Exploration critical area and the development of a Phased Gas Pipeline Network was identified as initiative A1 of the Offshore Oil and Gas Exploration Lab.

Although offshore exploration began as far back as 1967, South Africa's oil and gas sector is arguably in the early development phase but has the potential to create large value for the country in the long run. However, it must be understood that developing South Africa's current oil and gas industry to a level comparable with West African countries like Nigeria, Ghana and Angola will take decades. In order to get a view of actual prospectivity, exploration activity must increase. In 2014, the Offshore Oil and Gas Lab set an aspiration of drilling 30 exploration wells in 10 years (i.e. by 2024). South Africa has possible resources of ~9 billion barrels oil and 11 billion barrels oil equivalent of gas. However, there is great uncertainty in developing these possible resources into reserves. According to the DoE, natural gas presents a significant potential in the energy mix.

In August 2018, the DoE published an updated Draft Integrated Resource Plan (IRP) for public comment. In the 2018 Draft IRP, Gas/Diesel showed a 3 830 MW installed capacity as at 2018, with an additional capacity of 8 100 MW planned by 2030 (equating to 11 930 MW total capacity by 2030) (DoE, 2018[3]). On 17 October 2019, the IRP was promulgated for implementation (DoE, 2019[4]). The revised long term energy mix stipulated in the 2019 IRP takes into account various capacity developments that have taken place since the promulgation of the 2010 – 2030 IRP, as well as a number of changes in assumptions, including electricity demand projection, Eskom's existing plant performance, and new technology costs. Based on the 2019 Final IRP, there is a requirement of 1000 MW in 2024 and 2000 MW in 2027 for energy from Gas/Diesel. Therefore, based on the Final 2019 IRP, Gas/Diesel has a 3 830 MW installed capacity as at

[3] Department of Energy (August 2018). Integrated Resource Plan 2018 (Draft). Pretoria.
[4] Department of Energy (October 2019). Integrated Resource Plan 2019. Pretoria.

2019, with an additional capacity of 3 000 MW by 2030 (equating to 6 830 MW capacity by 2030) (DoE, 2019).

The development and related operation of infrastructure for the bulk transportation of dangerous goods (including gas using a pipeline exceeding 1000 m in length) is identified as Activity 7 of Listing Notice 2 (Government Notice R325) of the 2014 Environmental Impact Assessment (EIA) Regulations (as amended). These activities require Environmental Authorisation in terms of the 2014 EIA Regulations (as amended) via a full Scoping and Environmental Impact Report (EIR) Process, which requires the submission of a Scoping Report and EIA Report to the Competent Authority. The National DEA is the regulated Competent Authority for all Applications for Environmental Authorisation that are submitted by statutory bodies.

Based on observations and previous cases, it has been realised that the authorisation process currently being applied to linear infrastructure, including gas transmission pipelines may be too rigid to be an effective assessment mechanism for these types of structures. The current process locks the routing options to an approved route, determined well in advance of any construction process, which results in the following challenges:

- Higher costs of land to be used as servitudes;
- Late initiation of the EIA Process resulting in the inability to provide strategic input into the alignment of gas transmission pipelines and other key linear infrastructure;
- The inflexibility of the approved routes limits the possibility of adding more users identified after the Environmental Authorisation process;
- There is a high probability of amendments being sought to the route at construction due to maturing of information, including the identification of additional users, changes in the supply and demand scenarios etc.;
- Complication is introduced by the fact that any changes or opposition during the EIA Process resets the project making the delivery of gas to the economy and society either redundant or late;
- For a major gas transmission route, it takes on average between one to two years for an EIA Process to be completed in terms of the National Environmental Management Act (NEMA) (Act Number 107 of 1998, as amended). For long gas pipelines crossing many different land parcels, the risk of an appeal is high, which often results in significant delays in receiving the authorisation.

In addition, strategic planning for servitudes needs to be undertaken well in advance of the final planning of a gas transmission pipeline system. It would therefore be beneficial for the applicant of the major gas pipeline to submit a pre-negotiated route, where the upfront approval of landowners has been obtained. The current EIA Process does not allow for the submission of applications on a pre-determined route.

From the perspective of the National DEA, every effort needs to be made to ensure that the requirements for Environmental Authorisation are streamlined, that they follow an efficient and effective assessment and review process, and achieve the objectives of sustainable development. Therefore, in order to overcome the constraints listed above, and to support the Operation Phakisa, this SEA Process was commissioned with a vision to ensure that strategic development of a gas pipeline network is undertaken in an environmentally responsible and efficient manner that responds effectively to the economic and social development needs of the country. With this vision in mind, the following objectives were developed to guide the study:

- Ensuring sustainable development;
- Enhancing consultation with and participation of stakeholders;
- Ensuring coordination with relevant national, provincial and local plans and policies;
- Developing a streamlined Environmental Authorisation process, including integration with relevant Competent Authorities, as applicable; and
- Facilitating strategic investment.

The SEA Process was undertaken in three Phases, namely:

- Phase 1: Inception Phase;
- Phase 2: Assessment of the Corridors; and
- Phase 3: Decision-support Outputs and Gazetting.

Figure A provides an illustration of the SEA Process and Stakeholder Engagement undertaken. A series of focus group and sector specific meetings and workshops with key authorities and stakeholders were held during the SEA Process in order to gather information from major gas users, and important business and government stakeholders. In addition, two rounds of Authority and Public Outreach Road Shows were undertaken to seek feedback on the Draft Initial Corridors, Draft Refined Corridors and Specialist Assessments, as well as to provide feedback on the progress of the SEA. In this regard, the first Authority and Public outreach was undertaken in November 2017 at strategic locations across the country, i.e. Cape Town, George, East London, Durban, Johannesburg and Springbok. A second Authority Public Outreach was undertaken towards the end of Phase 2, in October 2018. The same locations visited during Round 1 of the outreach were visited during Round 2, with Upington and Port Elizabeth added as additional locations. Four Expert Reference Group (ERG) and Project Steering Committee (PSC) meetings were also undertaken during the SEA Process.

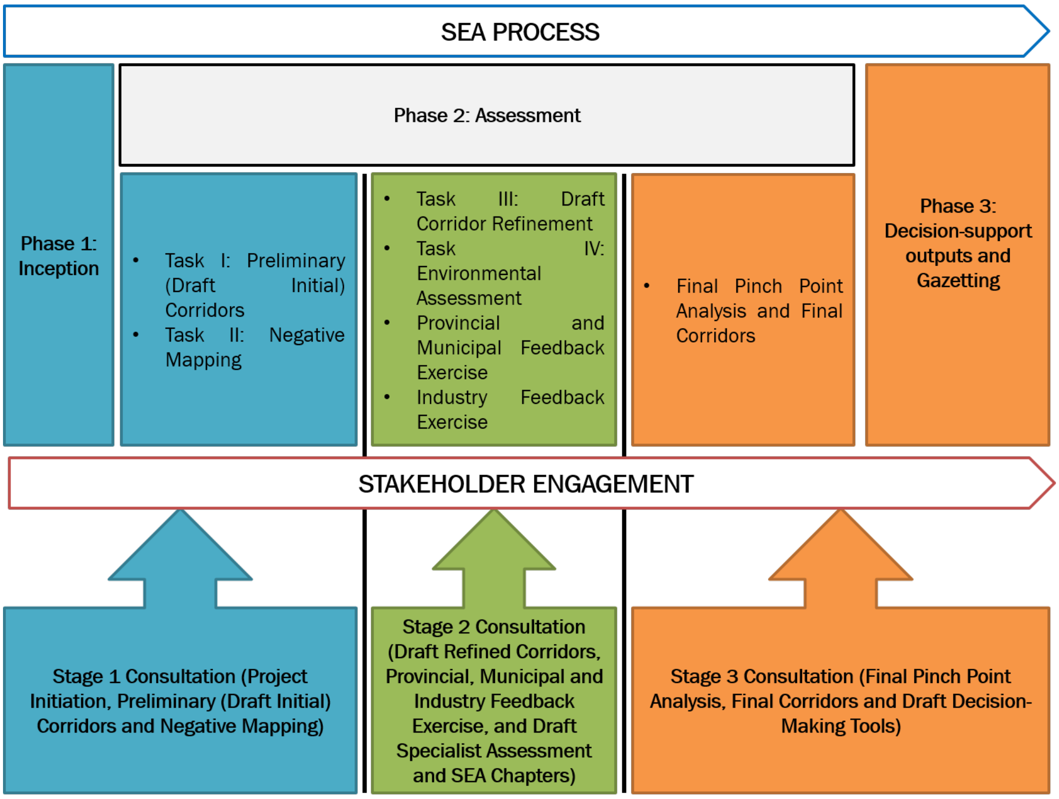


Figure A: SEA Process and Stakeholder Engagement

During the **Inception Phase**, the project team convened the ERG and PSC, as well as established the dedicated project website (https://gasnetwork.csir.co.za/) and project email address (gasnetwork@csir.co.za).

The PSC comprised of authorities with a legislated decision-making mandate for gas pipeline development in South Africa, as well as Provincial Government Departments and District Municipalities. The ERG consisted of, but not limited to, all PSC members, as well as representatives from environmental and conservation bodies, Non-Government Organizations, research institutions and industry. The ERG provided assistance and technical knowledge, as well as insights with respect to the issues relevant to specific sectors.

The project website and email address were created to serve as a dedicated platform for stakeholders and Interested and Affected Parties (I&APs) to obtain project information and to submit their comments on the SEA Process.

Phase 2 consisted of the following four sub-tasks:

- **Task 1**: Identification of the Initial Corridors;
- **Task 2**: Negative Mapping;
- **Task 3**: Corridor Refinement; and
- **Task 4**: Environmental Assessment.

Task 1 entailed the identification of the draft initial gas pipeline corridors. A set of 100 km wide preliminary corridors was identified based on the Phased Gas Pipeline Network proposed in initiative A1 of the Offshore Oil and Gas Exploration component of Operation Phakisa's Ocean Lab (held from July to August 2014). This took into consideration the current opportunities to supply indigenous gas to existing power plants (Ankerlig and Gourikwa Power Stations), the prospects for greenfield power plants in Saldanha, Richards Bay and Coega, as well as other developments outside of Operation Phakisa, i.e. the 2015 Electricity War Room; imported Liquefied Natural Gas (LNG); Karoo Shale Gas; and Eskom's targets for the Gasnosu (Mozambique North-South) pipeline in Mozambique. An inland corridor was also required to assess the possibility of routing the pipeline away from intensive land use areas between Saldanha and Coega. The corridors are titled as follows:

- Phase 1: Saldanha to Ankerlig and Mossel Bay;
- Phase 2: Mossel Bay to Coega;
- Phase 3: Richards Bay to Secunda;
- Phase 4: Mozambique Southern Border to Richards Bay;
- Phase 5: Abraham Villiersbaai to Saldanha and Ankerlig;
- Phase 6: Abraham Villiersbaai to Oranjemund;
- Phase 7: Coega to Richards Bay;
- Shale Gas Corridor;
- Rompco Corridor; and
- Inland Corridor from Saldanha to Coega with a link to Mossel Bay.

It must be noted that the phase numbering indicated above does not necessarily indicate the sequence in which the phases will be constructed. Instead, each phase will be developed based on its own viable business case.

Task 2 included negative mapping, and involved identifying key environmental sensitivities and engineering constraints in terms of gas pipeline infrastructure development. Environmental sensitivities were regarded as environmentally sensitive features that may be negatively impacted by gas pipeline development (e.g. wetlands, estuaries and Protected Areas, etc.). Engineering constraints were considered as environmental features that are likely to impact upon the development of gas pipeline infrastructure (e.g. mining areas, steep slopes and forestry areas, etc.). Dedicated national scale, wall-to-wall environmental sensitivity and engineering constraints maps were developed, highlighting areas of sensitivity and constraints across four tiers (Very High, High, Medium and Low).

Task 3 included a Corridor Refinement process, which entailed a Draft Pinch Point Analysis that was undertaken based on the wall-to-wall negative mapping, and feedback received from the authorities, specialists and the public. This process entailed shifting the corridors slightly, where possible, to obtain as many areas of low sensitivity within the corridors. The national, wall-to-wall, environmental sensitivities and engineering constraints maps from Task 2 were then reduced to the extent of the Draft Refined Corridors to produce a draft environmental and engineering constraints map. This map was carried through to Task 4.

Task 4 included an Environmental Assessment of the corridors. The specialist team was appointed in December 2017 to assess the Draft Refined Corridors. Specialists were required to review, validate and enhance the draft environmental sensitivities map for a range of environmental aspects, as indicated in Figure B. Some of the environmental aspects were addressed by the SEA Project Team (i.e. Defence, Civil Aviation, Heritage, Climate Change and Mining). The Draft Specialist Assessments were presented during the second round of the Public and Authority Outreach. In addition, the Specialist Assessment chapters, and Parts 1 and 2 of the SEA Report, were released for comment from 25 April 2019 to 24 June 2019 via the project website. The comments received from the public and stakeholders were then taken into consideration, where applicable.

The SEA Process also included a Provincial and Municipal Feedback Exercise, as well as an Industry Feedback Exercise in order to seek feedback on the potential need for gas to inform the final corridor alignment. A review of Provincial and Municipal Spatial Development Framework Plans, and Integrated Development Plans were also undertaken in order to seek feedback on future energy intensive developments that may require gas. These components were combined into a Spatial Energy Demand Layer as part of the Demand Mapping process.

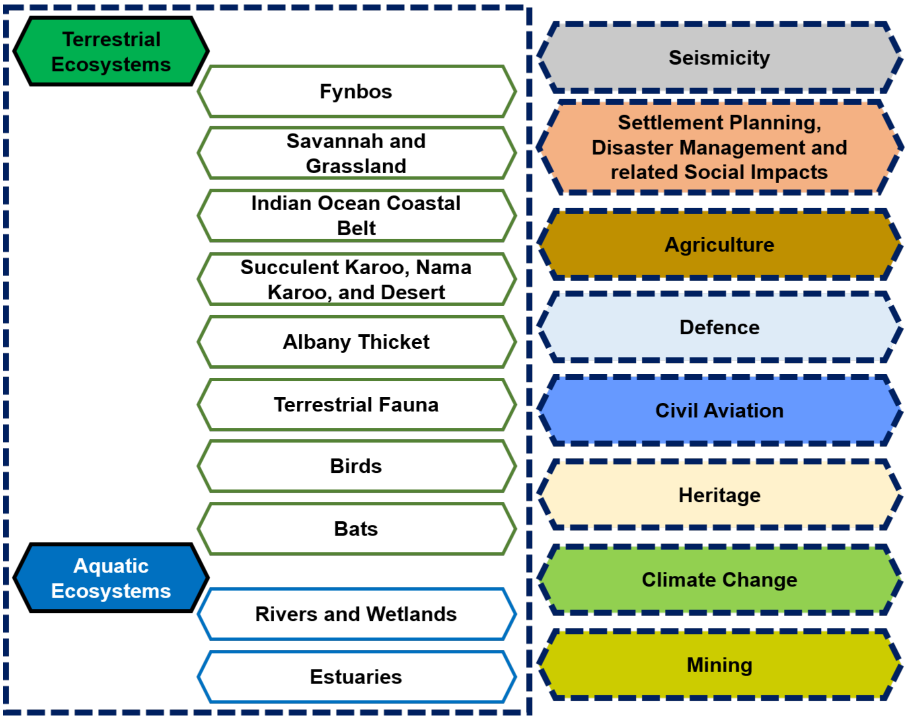


Figure B: Specialist Assessments and Additional Impact Chapters forming part of the Gas Pipeline SEA.

The Final Pinch Point Analysis was thereafter undertaken in order to determine the Final Gas Pipeline Corridors. The findings of the Demand Mapping (i.e. Spatial Energy Demand Layer) and Specialist Assessments, as well as updated Engineering and Environmental Constraints data, and comments from stakeholders were taken into consideration during the Final Pinch Point Analysis. The 100 km wide Corridors were first designed based on the Opportunities Mapping resulting in the 100 km wide Demand Mapping Corridors. The 100 km wide Demand Mapping Corridors were then refined in terms of updated environmental and engineering data and only moved if there was still a pinch point. This led to the identification of the Final 100 km wide Gas Pipeline Corridors.

For illustrative purposes, Figure C shows the key mapping outputs of each phase of the SEA Process.

Phase 3 is the Decision-support Outputs and Gazetting. This phase translates the outputs from Phase 2 into environmental management measures and planning interventions for inclusion in the relevant legal environmental framework and local government planning tools, including Municipal Spatial Development

Frameworks, to ensure that long term energy planning is secured. The final outputs of the SEA Process will be presented by the DEA to Cabinet for approval.

The final outputs of the SEA include the Final Gas Pipeline Corridors, Final Corridor Environmental Sensitivities and Engineering Constraints Map, Generic Environmental Management Programme (EMPr) for Gas Pipelines, and Development Protocols. The Generic EMPr includes generic management objectives and actions in order to manage the construction and operation of the gas pipelines. A Heritage and Palaeontology Protocol was compiled as part of the SEA Process in consultation with relevant authorities in order to capture assessment and minimum report content requirements for environmental impacts on heritage and palaeontological resources. The protocols specify the additional project level assessment requirements that need to be met by the Project Applicant when applying for Environmental Authorisation.
It was planned to compile Minimum Information Requirements as a Decision-Support Output, however these are not required as the requirements of the 2014 EIA Regulations (as amended) are sufficient to address potential impacts of gas pipeline developments within the corridors.

Once the Generic EMPr and Protocols are finalised and undergo vetting processes within the DEA, the final outputs of the SEA will be put forward for public comment through publication in the Government Gazette. Following this, the final outputs of the SEA will be gazetted for implementation. The gazetting process is envisaged to take place in 2020.

Based on the findings of the SEA Process, it is proposed that gas pipeline infrastructure projects planned within the Gas Pipeline Corridors (once gazetted) will be subject to a Basic Assessment Process instead of a full Scoping and EIA Process in terms of the NEMA EIA Regulations. This is in line with the provisions of Section 24 (2) (a) of the NEMA, which provide for the procedure to be followed when applying for Environmental Authorisation in geographical areas of strategic importance. The streamlined Environmental Authorisation process will also include a reduced decision-making timeframe of 57 days. This will ensure that the Environmental Authorisation process of gas pipeline developments within the corridors (once gazetted) are fast-tracked, whilst still maintaining a high level of environmental rigour.

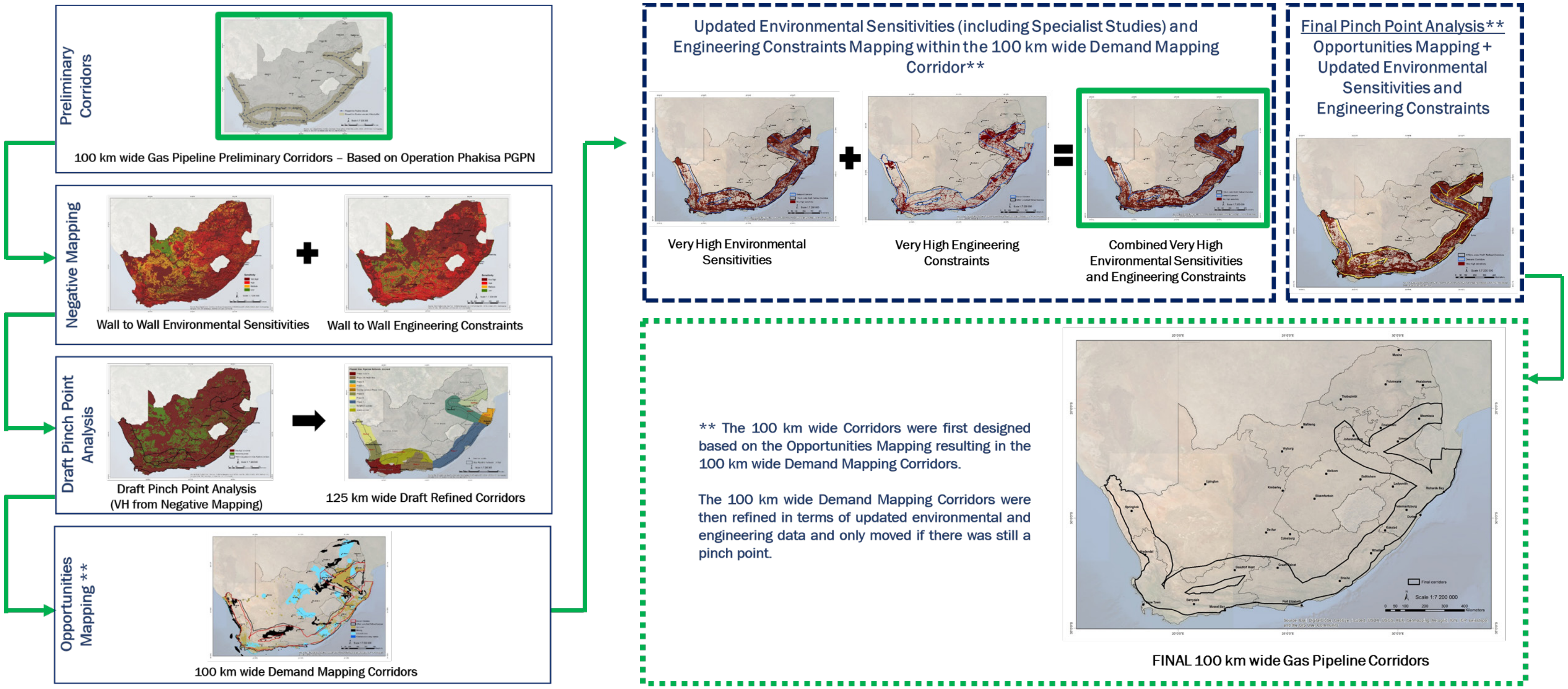
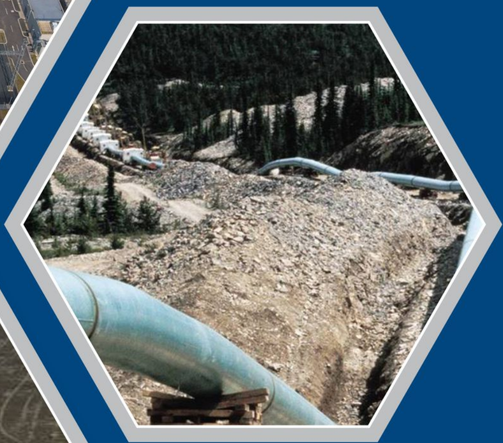


Figure C: Key Mapping Outputs for each Phase of the Gas Pipeline SEA.

CONTENTS

APPENDICES

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa



PART 1

Background to the Phased Gas Pipeline Network Strategic Environmental Assessment

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APPENDIX 1: GAS OPPORTUNITIES ANALYSIS

TABLES

FIGURES

ABBREVIATIONS

bbl/d	Barrels Per Day
BOPD	Barrels of Oil Per Day
CCGT	Combined Cycle Gas Turbine
CSIR	Council for Scientific and Industrial Research
CSP	Concentrated Solar Power
DEA	Department of Environmental Affairs
DOE	Department of Energy
DPE	Department of Public Enterprises
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EGI	Electricity Grid Infrastructure
dti	Department of Trade and Industry
GHG	Greenhous Gas
GTL	Gas to Liquid
GTLR	Gas to Liquid Refinery
GUMP	Gas Utilisation Master Plan
IDZ	Industrial Development Zone
IPP	Independent Power Producers
IRP	Integrated Resource Plan
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MMscfg/d	Million Standard Cubic Feet of Gas Per Day
MRG	Methane Rich Gas
MW	Megawatt
MYPD	Multi-Year Price Determination
NEMA	National Environmental Management Act (Act Number 107 of 1998, as amended)
NERSA	National Energy Regulator of South Africa
OCGT	Open Cycle Gas Turbine
PASA	Petroleum Agency of South Africa
PIM	Project Information Memorandum
PV	Photovoltaic
SANBI	South African National Biodiversity Institute
SCFD	Standard Cubic Feet of Gas per Day
SEA	Strategic Environmental Assessment
SIP	Strategic Integrated Project
SONA	State of the Nation Address
SPLUMA	Spatial Planning and Land Use Management Act (Act 16 of 2013)
TCF	Trillion Cubic Feet

PART 1. BACKGROUND TO THE PHASED GAS PIPELINE NETWORK STRATEGIC ENVIRONMENTAL ASSESSMENT

1.1 Introduction and Background

Operation Phakisa was launched by the South African National Government in July 2014, with the aim of implementing priority economic and social programmes and projects better, faster and more effectively. It includes the 1) Oceans Economy Lab; 2) Health Lab and 3) Education Lab. The Oceans Economy Lab aims to unlock the potential of the South African coast and considers the following four critical areas:

- Marine Transport and Manufacturing;
- Offshore Oil and Gas Exploration;
- Aquaculture; and
- Marine Protection Services and Ocean Governance.

This Strategic Environmental Assessment (SEA) Process is related to the critical area of Offshore Oil and Gas Exploration. Eleven initiatives were identified as part of the Offshore Oil and Gas Exploration critical area and the development of a Phased Gas Pipeline Network was identified as initiative A1 of the Offshore Oil and Gas Exploration Lab. Operation Phakisa recognises that to enable successful offshore oil and gas exploration, adequate infrastructure such as (but not limited to) pipeline networks need to be developed (Transnet, 2016[1]).

The Integrated Resource Plan (IRP) 2010-30 was promulgated in March 2011, and at the time of promulgation it was considered a "living plan" to be updated frequently by the Department of Energy (DoE). Since the promulgation of the IRP 2010-30, there have been a number of developments in the energy sector in South and Southern Africa, and the electricity demand outlook changed from that projected in 2010. As an update to the 2010-30 IRP, the DoE published Assumptions and Base Case documents for public comment in 2016. According to these documents, there is a significance placed on pursuing a diversified energy mix in South Africa, which "reduces reliance on a single or a few primary energy sources" (DoE, 2016[2]).

In August 2018, the DoE published an updated Draft IRP for public comment. The updated report was focused on ensuring security of supply, as well as reduction in the cost of electricity, negative environmental impact (emissions) and water usage (DoE, 2018[3]). One of the main implications of the Draft IRP 2018 and updated process is that the progression and level of new capacity developments needed up to 2030 should be reduced compared to that noted in the 2010-30 IRP (DoE, 2018). It was also concluded that additional detailed studies be undertaken to inform the update of the IRP, and this includes, but is not limited to, undertaking a detailed analysis of the options for gas supply to identify the technical and financial risks and mitigation measures needed for an energy mix that is dominated by Renewable Energy and Gas post 2030 (DoE, 2018).

The Draft IRP 2018 (DoE, 2018), indicated that Gas / Diesel had a 3 830 Megawatts (MW) installed capacity as at 2018, with an additional capacity of 8 100 MW by 2030 (equating to 11 930 MW capacity by 2030). The Draft IRP 2018 (DoE, 2018) also stipulated a total generation capacity of 19 400 MW from Solar Photovoltaic (PV) and Wind Energy excluding Hydropower, Storage Schemes and Concentrated Solar Power (CSP)) by 2030.

[1] Transnet SOC Limited (2016). Long–Term Planning Framework: Chapter 6: Natural Gas Infrastructure Planning.
[2] Department of Energy (November 2016). Integrated Resource Plan Update Assumptions, Base Case Results and Observations Revision 1. Pretoria.
[3] Department of Energy (August 2018). Integrated Resource Plan 2018 (Draft). Pretoria.

The Final IRP was promulgated on 17 October 2019 for implementation (DoE, 2019[4]). The 2019 IRP takes into account various capacity developments that have taken place since the promulgation of the 2010 – 2030 IRP, as well as a number of changes in assumptions, including electricity demand projection, Eskom's existing plant performance, and new technology costs. In terms of Gas / Diesel, based on various reasons, this has decreased to 3 000 MW additional capacity in the promulgated Final IRP 2019 (DoE, 2019) (equating to a total of 6 830 MW capacity by 2030) (DoE, 2019). The promulgated IRP 2019 states that "for the period up to 2030, gas to power capacity in the IRP has realistically taken into account the infrastructure and logistics required around ports/pipelines, and electricity transmission infrastructure. The IRP has therefore adjusted the lead times. As proposed in the draft IRP update (DoE, 2018), work to firm up on the gas supply options post 2030 is ongoing. This work will inform in detail the next iteration of the IRP" (DoE, 2019, page 52).

It is important to note that the entire 6 830 MW capacity could be produced using natural gas only instead of both gas and diesel. This statement is only effective if all diesel generators convert to gas. It is understood that the City of Cape Town may also contribute approximately 360 MW (in terms of a new OCGT plant) towards the additional capacity allocated to Gas/Diesel by 2030.

The Final IRP 2019 (DoE, 2019) has stated an increase in Wind and Solar Energy capacity, equating to 26 030 MW of total installed capacity (excluding Hydropower, Storage Schemes and CSP) by 2030 (DoE, 2019). This value includes 1 474 MW and 1 980 MW of currently installed capacity for Solar PV and Wind, respectively.

As indicated in Figure 1 and Table 1, in terms of the future total installed capacity mix, coal represents the highest percentage, followed in descending order by Wind, Solar PV, Gas/Diesel, Pumped Storage, Hydro, Nuclear, and CSP (excluding Other).

Table 1: Final IRP 2019: Plan for the Period Ending 2030 (DoE, 2019)

	Coal	Coal (Decommissioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Gas & Diesel	Other (Distributed Generation, CoGen, Biomass, Landfill)
Current Base	37 149		1 860	2 100	2 912	1 474	1 980	300	3 830	499
2019	2 155	-2373					244	300		Allocation to the extent of the short term capacity and energy gap.
2020	1 433	-557				114	300			
2021	1 433	-1403				300	818			
2022	711	-844			513	400 1000	1600			
2023	750	-555				1000	1600			500
2024			1860				1600		1000	500
2025						1000	1600			500
2026		-1219					1600			500
2027	750	-847					1 600		2000	500
2028		-475				1000	1 600			500
2029		-1694			1575	1000	1 600			500
2030		-1050		2 500		1 000	1 600			500
TOTAL INSTALLED CAPACITY by 2030 (MW)	33364		1860	4600	5000	8288	17742	600	6380	
% Total Installed Capacity (% of MW)	43		2.36	5.84	6.35	10.52	22.53	0.76	8.1	
% Annual Energy Contribution (% of MWh)	58.8		4.5	8.4	1.2*	6.3	17.8	0.6	1.3	

Installed Capacity
Committed / Already Contracted Capacity
Capacity Decommissioned
New Additional Capacity
Extension of Koeberg Plant Design Life
Includes Distributed Generation Capacity for own use

- 2030 Coal Installed Capacity is less capacity decommissioned between years 2020 and 2030
- Koeberg power station rated / installed capacity will revert to 1926 MW (original design capacity) following design life extension work.
- Other / Distributed generation includes all generation facilities in circumstances in which the facility is operated solely to supply electricity to an end-use customer within the same property with the facility
- Short term capacity gap is estimated at 2000 MW

[4] Department of Energy (October 2019). Integrated Resource Plan 2019. Pretoria.

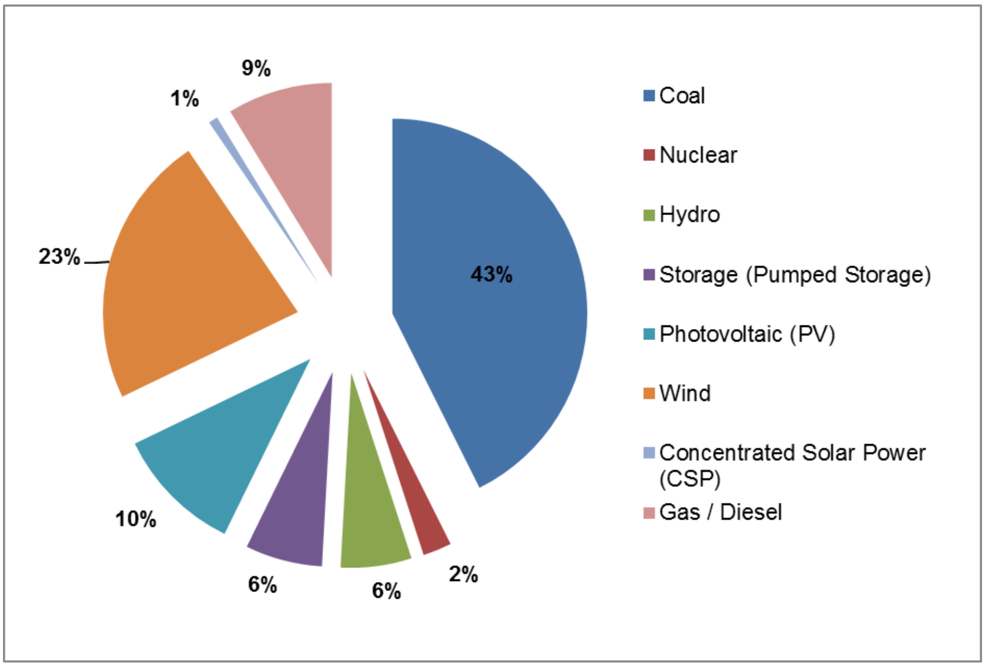

Figure 1: Graph indicating percentages of the future installed capacity mix (taking into consideration Installed Capacity as at 2019; Committed/Already Contracted Capacity; Capacity Decommissioned, and New Additional Capacity based on the Final IRP (DoE, 2019).

It is important to note that at the time of finalization of the Specialist Assessments of this SEA, the 2019 Final IRP was not yet promulgated. Where possible, the relevant chapters of the SEA Report (i.e. Parts 1 and 2) have been updated to include feedback on the new long term energy mix, as stipulated in the 2019 Final IRP (DoE, 2019). However, it is important to note that the results of the Gas Opportunities Analysis study undertaken by Rae Wolpe of Impact Economix (included in Appendix 1 of Part 1 of this Gas Pipeline SEA Report), have not changed and are still valid.

Operation Phakisa and the Department of Trade and Industry (dti) argue that the development of gas could support South Africa's industrialisation as a result of competitively priced energy and stable energy supply (Figure 2).

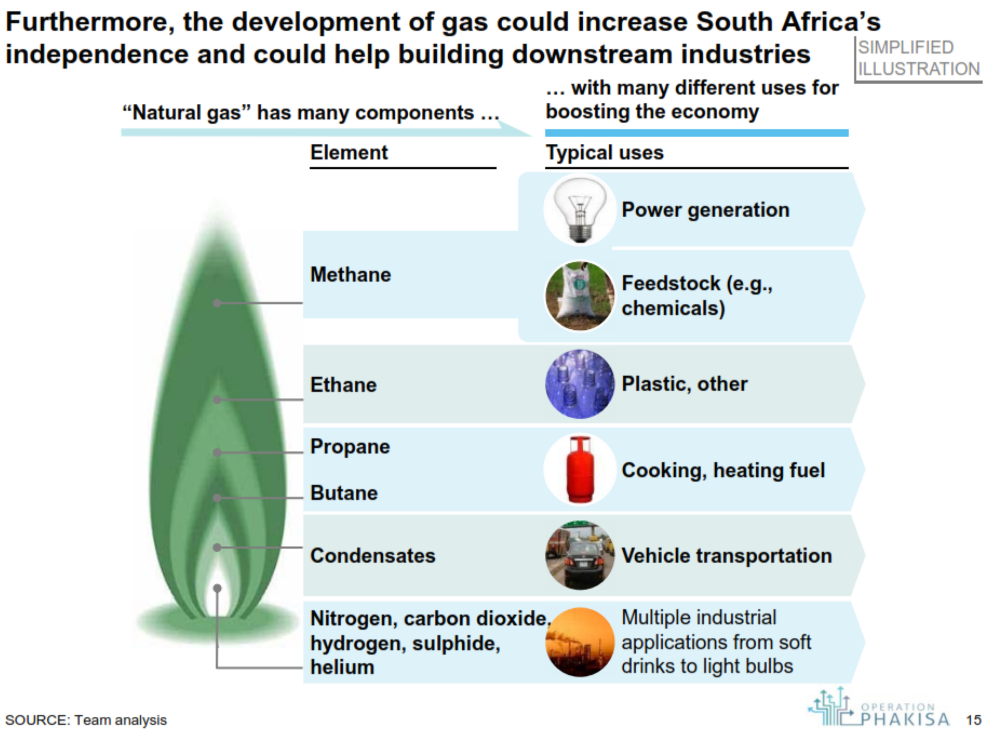

Figure 2. Opportunities to downstream users in using gas (Source: Republic of South Africa Operation Phakisa Offshore Oil and Gas Exploration, 2014).

To support the objectives of the Operation Phakisa Oceans Economy Oil and Gas Lab, to accelerate the planning for gas to power as part of the IRP and as part of the Gas Utilisation Master Plan (GUMP) (which currently is referred to as the Gas Master Plan), and to ensure that when required, Environmental Authorisations are not a cause for delay, the Department of Environmental Affairs (DEA), DoE, and the Department of Public Enterprises (DPE), as well as iGas, Eskom and Transnet, have commissioned the Council for Scientific and Industrial Research (CSIR) to undertake a SEA to identify and pre-assess suitable corridors for a Phased Gas Pipeline Network and for the expansion of the Electricity Grid Infrastructure (EGI) corridors that were assessed as part of a previous SEA Process (which was in response to the Strategic Integrated Project (SIP) 10: Electricity transmission and distribution for all), which concluded in 2016. The CSIR undertook the SEA in collaboration with the South African National Biodiversity Institute (SANBI). Refer to Figure 3 for a breakdown of the SEA Project Team.

This SEA Report deals specifically with the assessment of the Phased Gas Pipeline Network Corridors. The EGI Expansion corridors are subjected to a separate assessment and compiled as part of a separate SEA Report.

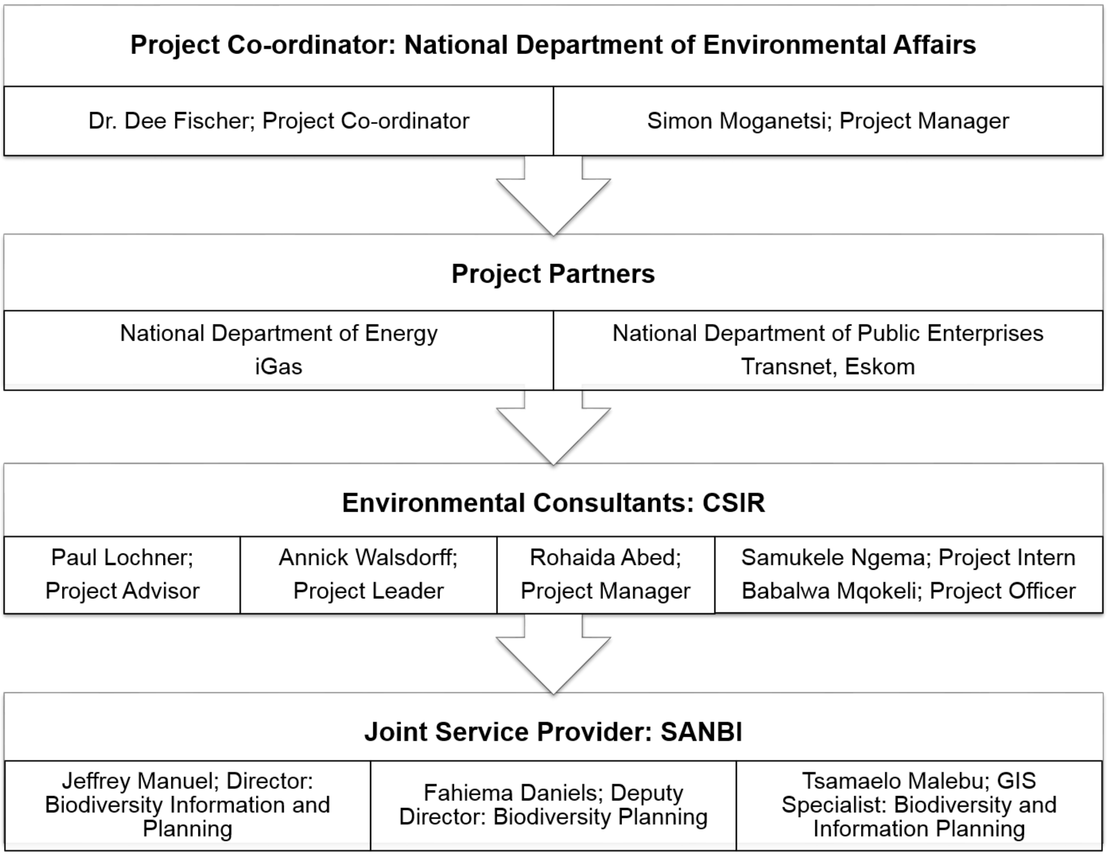

Figure 3. SEA Project Team

1.1.1 The History of Exploration and Production in South Africa

The information included in this section has been provided courtesy of the Petroleum Agency of South Africa (PASA). Table 2 provides a summary of the history of exploration and production in South Africa.

Table 2: History of Exploration and Production in South Africa

Year	Description
1940's	The first organised search for hydrocarbons in South Africa was undertaken by the Geological Survey of South Africa
1965	Soekor (Pty) Ltd was formed by the government. It began its search in the onshore areas of the Karoo, Algoa and Zululand Basins
1967	A new Mining Rights Act was passed and offshore concessions were granted to a number of international companies including Total, Gulf Oil, Esso, Shell, ARCO, CFP and Superior.
1969	First offshore well drilled and the discovery by Superior of gas and condensate in the Ga-A1 well situated in the Pletmos Basin.
1970	Soekor (together with Rand Mines) extended its efforts to the offshore but, despite further encouraging discoveries, international companies gradually withdrew.
Mid 1970's to the late 1980's	Soekor was the sole explorer operating the entire offshore area of South Africa.
1994	The offshore areas were once again opened to international investors via a Licensing Round.
1999	Petroleum Agency SA was established.
2001	A new State oil company, PetroSA, was formed by the merger of Soekor and Mossgas.
2002	The Mineral and Petroleum Resources Development Act was passed.
1 May 2004	The Mineral and Petroleum Resources Development Act became operational.

In the entire offshore area there are now over 300 exploration wells including appraisal and production wells. In addition, 233 000 km of 2D seismic data and 10 200 km of 3D seismic data have been acquired since exploration began offshore. Exploration drilling was most active from 1981 to 1991 during which period some 181 exploration wells were drilled. The Bredasdorp Basin has been the focus of most of the seismic and drilling activity since 1980.

The results of this exploration are the discovery of several small oil and gas fields, and the commercial production of oil and gas from the Bredasdorp Basin of the southern coast of South Africa. In the Pletmos Basin off the west coast of South Africa, there are two undeveloped gas fields and a further six gas discoveries. One oil and several gas discoveries have been made in the South African part of the Orange Basin. One of these discoveries is currently being appraised and developed as the Ibhubesi gas field by Sunbird Energy/Umbono.

Producing Fields

The F-A/E-M and satellite gas fields, situated 90 km offshore the Mossel Bay area, are owned and operated by PetroSA. Production began in 1992 and gas and condensate are piped ashore to the PetroSA Gas-to-Liquid (GTL) Refinery at Mossel Bay where they are converted to petrol, diesel, paraffin and petrochemicals. During 2006, average daily production from these fields was approximately 160 MMscfg/d (million standard cubic feet of gas per day) and 3900 BOPD (barrels of oil per day).

South Africa's first oil production began in 1997 when the Oribi oil field began flowing at an initial rate of 25 000 bbl/d (barrels per day[5]). A floating production facility (the Orca) is used to fill a shuttle tanker, which supplies crude oil to the Chevron refinery in Cape Town. In May 2000 the adjacent Oryx oil field was also brought on stream utilising the same facilities. A third field, Sable, commenced production in August 2003. During 2006 average daily production from Sable was 9700 BOPD. The Oribi/Oryx fields are now almost depleted with only minor production. The Sable field is now producing gas to supplement the feedstock to the Mossel Bay GTL Refinery. Production from these gas fields is also in decline, making exploration for further domestic reserves imperative.

Database

A substantial database has been accumulated during 40 years of offshore exploration. This comprises well, seismic, gravity, magnetic, geochemical, geological, biostratigraphic and other data together with a large volume of interpretation reports and related studies. Most of this data is held by Petroleum Agency SA on behalf of the State and is well organised and accessible. The quality of this database varies considerably from area to area. Seismic data coverage for example, varies greatly in quantity and vintage from one basin to another. Drilling activity shows a similar pattern with a heavy concentration in the Bredasdorp Basin.

1.1.2 Vision for Gas Exploration, Usage & Planning in South Africa

Given this history, and although offshore exploration began as far back as 1967, South Africa’s oil and gas sector is arguably in the early development phase but nevertheless has the potential to create large value for the country in the long run. However, it must be understood that developing South Africa’s current oil and gas industry to a level comparable with West African countries like Nigeria, Ghana and Angola will take decades.

In order to get a view of actual prospectivity, exploration activity must increase. In 2014 the Offshore Oil and Gas Lab set an aspiration of drilling 30 exploration wells in 10 years (i.e. by 2024).

South Africa has possible resources of ~9 billion barrels oil and 11 billion barrels oil equivalent of gas. However, there is great uncertainty in developing these possible resources into reserves. Oil and Gas exploration requires significant investments, particularly in the South African deepwater offshore

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[5] Barrels per day is the unit of measurement of oil output represented by the amount of oil produced in a day. To relate this to natural gas, 1 million scuffs (MMSC) of natural gas amounts to 172.3 barrels of crude oil equivalent.

environment, where a single exploration well can cost over $150 million. To achieve 30 exploration wells by 2024 will require investments in the range of $3 - $5 billion. Given that exploration success rates are below 15%, investors see these opportunities as risky.

The dti (dti, 2017[6]) sees the gas economy developing in three broad phases over the next 15 years and beyond. The first phase (over the next 3-5 years) is focused on imported Liquefied Natural Gas (LNG) and is followed by the importation of regional gas from offshore gas reserves in Phase 2 in the next 7-15 years. Phase 3 (in about 15 years' time) sees the addition of onshore domestic gas reserves to the energy mix. South Africa has a number of large offshore gas fields, which are in an advanced stage of exploration. Blocks 11B/12B, currently being explored by Total is an example of such an area in its advanced stage of exploration.

1.1.3 Pathway to Achieving the Vision

Although infrastructure is currently not a constraint to exploration, particularly for gas, further coordination with other stakeholders may be helpful to incorporate the potential implications of offshore production into infrastructure plans. Infrastructure development is therefore seen as an enabler to offshore exploration. This infrastructure includes port facilities, pipeline networks and multi-purpose research vessels. The Phased Gas Pipeline Network therefore forms part of the infrastructure envisaged as an enabler for the offshore oil and gas development to transport gas from the landing points to domestic markets.

Other drivers of the Phased Gas Pipeline Network include imported LNG (via the LNG to Power Program), Shale Gas developments in the Karoo Region and Imported Pipeline Gas from Mozambique.

1.1.4 Current State of Gas Exploration in South Africa

According to PASA, P50 Gas Resources (which means that there is only a 50% probability that the quantities actually recovered will equal or exceed the estimated quantities) in South African Waters are 28 trillion cubic feet (TCF) off the West Coast; 26 TCF off the South Coast; and 9 TCF off the East Coast. These are quantities of gas that the geology indicates could be there. However, exploration will still have to be undertaken to confirm that actual extractable gas at a P90 (proven) reserve level (Figures 4 and 5 below).

[6] Department of Trade and Industry (dti) (2017). Industrialising the KZN- Gauteng corridor through natural gas. Pretoria.

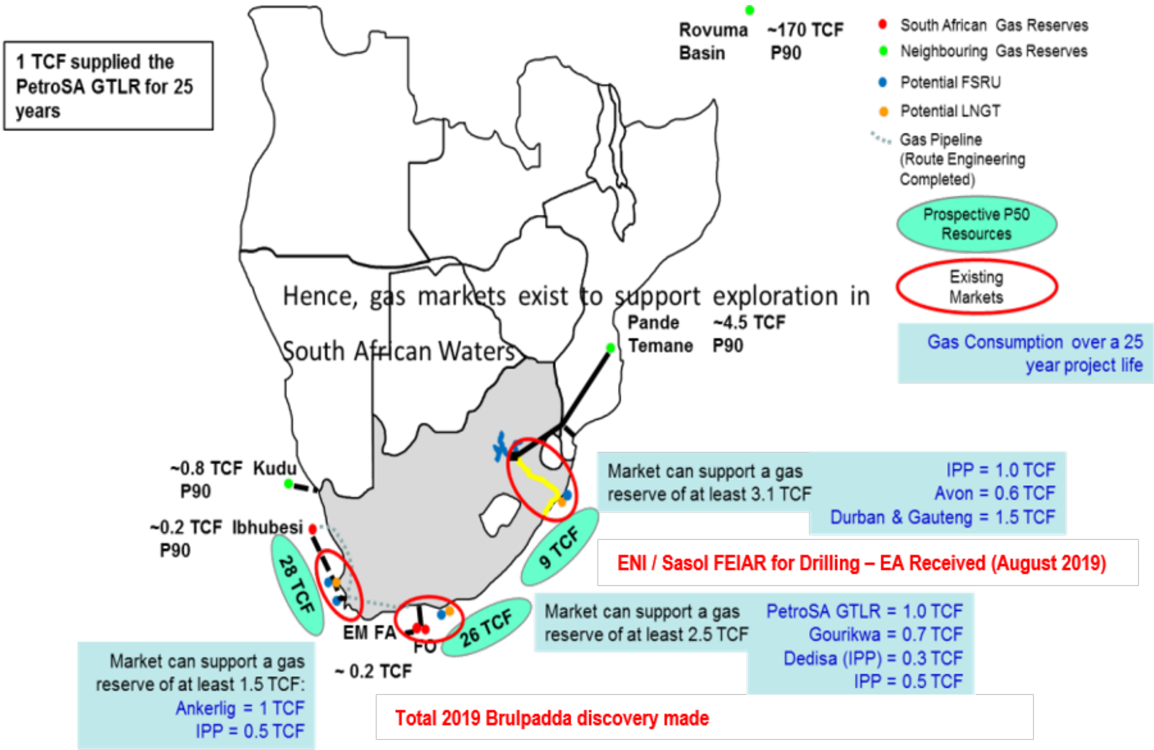

Figure 4: Potential Gas Markets and Planned Pipeline Infrastructure in South Africa

In terms of South African offshore gas finds, these are limited to:

- PetroSA's FA and EM fields off the Mossel Bay coast (largely depleted, but with a tail that can still be utilised, provided other gas sources can be used to supplement the tail). PetroSA has also produced from the FO field, which had a P90 reserve estimate of 0.2 TCF although the recoverable gas turned out to be 10% to 20% of this.
- Sunbird Energy/Umbono is developing a business case for the Ibhubesi Gas field (0.21 TCF P90) to bring the gas to market in the Western Cape, i.e., Eskom's Ankerlig Power Station. iGas has completed the Route Engineering for an onshore pipeline from the original landing point (Abraham Villiersbaai) to Saldanha and Ankerlig. However, Sunbird Energy opted for a development plan that will transport the gas via a subsea pipeline with options for landing points closer to market. Sunbird Energy received Environmental Authorisation for this development on 3 August 2017.
- Figure 5 presents the petroleum exploration and production activities in South Africa. Total started drilling an exploration well off the southern coast of the country in 2014/15 in Block 11B/12B. However, Total stopped the activity due to rougher than expected sea conditions and subsequent mechanical problems with the drilling rig. In February 2018, Qatar Petroleum joined the partnership with Total for exploration in the block and a revised drilling program was devised resulting in the re-instatement of drilling activities (Total, 2018[7]). In February 2019, Total made a large gas condensate discovery on the Brulpadda well located within the block approximately 175 km off the southern coast of South Africa (Total, 2019[8]). The well intersected with a 57 m deep reservoir interval in the Albian section of the southern Outeniqua Basin (PASA, 2019[9]), and was deepened to a depth of about 3633 m (Total, 2019).

[7] Total (2018). *Qatar Petroleum joins Total as a partner in the Exploration Block 11B/12B in South Africa*. Press Release: 5 February 2018. Available on line: https://www.total.com/en/media/news/press-releases/qatar-petroleum-joins-total-partner-exploration-block-11b12b-south-africa [Accessed 27 February 2019].

[8] Total (2019). *Total Makes Significant Discovery And Opens A New Petroleum Province Offshore South Africa*. Press Release: 7 February 2019. Available on line: https://www.total.com/en/media/news/press-releases/total-makes-significant-discovery-and-opens-new-petroleum-province-offshore-south-africa [Accessed 27 February 2019].

[9] PASA (2019). *Total's Brulpadda discovery*. Available on line: https://www.petroleumagencysa.com/index.php/home [Accessed 27 February 2019].

- On 8 March 2018, ENI as operator of Block ER 236 off the east coast of South Africa submitted their Final Scoping Report to drill up to six (6) exploration wells. A final Environmental Impact Assessment (EIA) Report was compiled by ERM in December 2018 and submitted to PASA and Department of Mineral Resources (DMR) for decision-making. An Environmental Authorisation was issued to the Project Applicants by the DMR in August 2019 (Application Number 12/3/236). The prospecting area extends from Port Shepstone in the south up to St Lucia in the north; while the planned exploratory drilling is expected to take place within two areas of interest i.e. off the coast of Richards Bay and Scottburgh in the north and south of KwaZulu-Natal, respectively (ERM, 2018[10]). Drilling is expected to start, once all mandatory permit and authorisation approvals are obtained.

The Kudu gas field in Namibia (0.80 TCF P90) remains unexploited. Past projects that have been contemplated include an 800 MW Power Station in Namibia; or transmitting the gas to Cape Town. Thus far none have developed past conceptual studies. In August 2018, there were reports of the Namibian Government noting that the Kudu Gas to Power Project has been delayed for over 20 years, with the viability of the project being discussed (Engineering News, 2018[11]). It is understood that development of the proposed Boegoebaai Harbour in the Northern Cape is also under discussion, which might have future implications for the Kudu gas field.

[10] ERM (2018). Exploration Drilling within Block ER236, off the East Coast of South Africa. Final EIA Report compiled by ERM for ENI. Available on line: https://www.erm.com/contentassets/9b249338ddb744a2bfa31f57febf7566/final-eia-report-2018/1a.eni-sa-drilling-final-eia-report-chapters-1-5-small.pdf [Accessed 27 February 2019].

[11] Engineering News (2014). *Kudu gas project might not be viable for Namibia – Energy Minister*. Available on line http://www.engineeringnews.co.za/article/kudu-gas-project-might-not-be-viable-for-namibia-energy-minister-2018-08-14 [Accessed 27 February 2019].

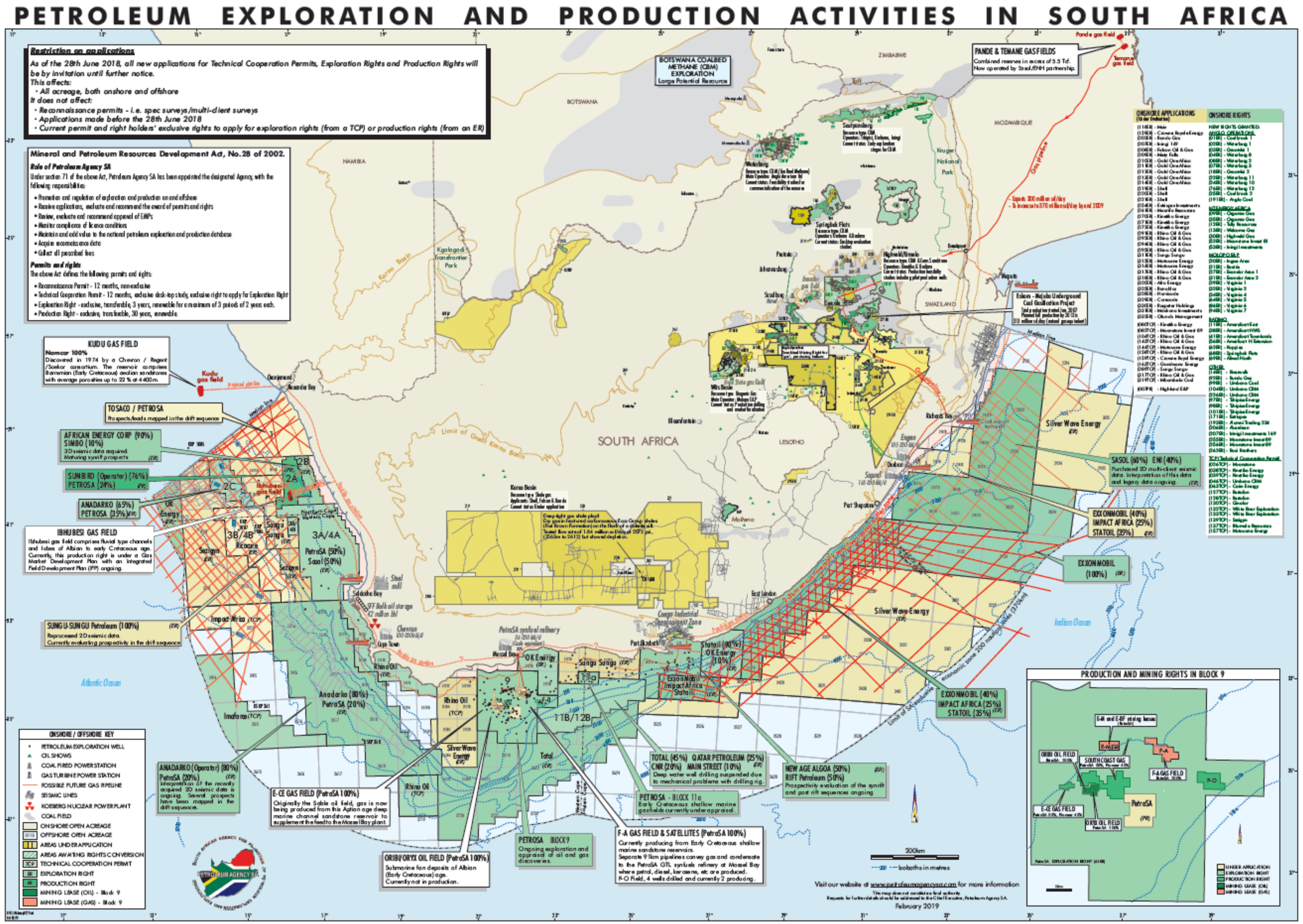

Figure 5: Petroleum Exploration and Production Activities in South Africa (*Source*: Petroleum Agency South Africa https://www.petroleumagencysa.com/images/pdfs/Hubmap0219.pdf)

1.1.5 Current Market in terms of Attracting Offshore Exploration to South Africa

This section is mainly based on the Gas Opportunities Analysis study (included in Appendix 1 of Part 1 of the Gas Pipeline SEA Report), as well as on information submitted by iGas.

Any natural gas found as associated gas with oil in deep waters will probably be re-injected to increase the extraction of oil. Natural gas found in quantities larger than the likely re-injection quantities can immediately supply the South African markets. A prerequisite is a focus on gas to power projects and pre-planning for a gas transmission system before the resource comes into production. Natural gas found in large quantities will, unlike Mozambique, need to be encouraged to first supply the industrialisation of coastal cities and the unsatisfied industrial demand from Gauteng before being exported as LNG to international markets. This opportunity, if the gas reserves are found, has the potential to significantly grow the South African economy.

The principal determinants of energy demand growth are numerous and complex and include: energy policies, rates at which economic activity and population grow, relative energy source prices (and technological developments which impact on the relative costs of exploration, production and distribution) and technology innovations which can have a downward impact on energy prices - amongst other impacts. The demand for gas is highly price elastic.

The identification of potential bulk gas users in South Africa is a complex and ever-evolving challenge for a wide number of reasons. These include changing global energy prices, technological developments, energy switching costs, and the timing of future environmental policies and the magnitude of linked costs to reduce carbon emissions and Green House Gases (GHGs).

Sectoral opportunities fall within the following three main sectors:

1. Electricity generation;
2. Industry and mining; and
3. Transportation.

The potential also exists to expand residential demand for gas. It must, however, be noted that the scope of this SEA is limited to transmission pipelines and does not include gas distribution or reticulation networks.

A critical issue impacting on the nature of future demand for gas is the price of gas and how this differs between Liquefied Petroleum Gas (LPG) and LNG. The complexities of gas prices include the client-specific demand characteristics and requirements. In addition to exchange rate fluctuations and levels, there are a range of costs along the gas logistics chain which also need to be taken into account when determining final gas prices to the customer.

Gas for future **electricity generation** *may* be a major source of future gas demand in South Africa and will most likely *have* to be the anchor for large gas development and importation projects. Eskom's projections show that there will only be a need for new electricity generation capacity to meet peak demand around 2025/2026 (possibly sooner depending on the levels of economic growth). As indicated in Figure 1, the 2019 IRP identifies the need for an additional 3 000 MW of gas/diesel generated electricity by 2030 (DoE, 2019). As noted above, the 2019 Final IRP states that work to firm up the gas supply options post-2030 is ongoing. Based on the comments received during the review of the Draft SEA Report, it is noted that the City of Cape Town will also present detailed studies required to inform the desired energy mix post-2030.

Another factor that may impact on a growing need for gas-powered electricity generation in the longer term is the increased share of electricity from renewable sources (including solar powered electricity) in South Africa's energy mix. The country's 2019 Final IRP calls for the generation capacity of a total of 26 030 MW from renewable energy sources (i.e. Solar PV and Wind only (excluding Hydropower, Storage Schemes and CSP)) by 2030. This value includes 1 474 MW and 1 980 MW of currently installed capacity for Solar PV and Wind, respectively. In February 2018, the Minister of Public Enterprises approved 27 utility-scale renewable energy projects consisting mainly of solar PV and wind (i.e. one from Bidding Window 3.5 and 26 from Bidding Window 4). The agreements were signed into effect under the Minister of Energy in April 2018[12] and the Power Purchase Agreements became effective between April 2018 and 31 July 2018.

Gas represented approximately 3% of South Africa's total energy mix (DoE, 2013[13]) based on the 2012 DoE Integrated Energy Planning Report. Based on the 2018 Draft IRP and the 2019 Final IRP, the **current installed capacity** for gas is 3 830 MW (although this is currently fueled by diesel), representing approximately 5 % of the **future energy mix.** Figure 6 illustrates Eskom's existing power stations, including four gas turbine plants i.e. Acacia, Port Rex, Ankerlig and Gourikwa (two of which are run by IPPs). As indicated in Figure 6, these four power stations represent an installed capacity of 2 426 MW. However, according to the Draft IRP 2018 (DoE, 2018, Page 59) and the Final IRP 2019 (DoE, 2019, Page 54), the total nominal capacity of Ankerlig and Gourikwa decrease to 1327 MW and 740 MW respectively. The Draft IRP 2018 (DoE, 2018, Page 59) and the Final IRP 2019 (DoE, 2019, Page 54) explains that the "difference between installed and nominal capacity reflects auxiliary power consumption and reduced capacity caused by the age of the plant". Additional OCGT power generating capacity comes from the IPP power stations Avon (670 MW) near Salt Rock on the KwaZulu-Natal north coast and Dedisa (335 MW) in the Coega Industrial Development Zone (IDZ). Other generators include Sasol Synfuel Gas (250MW) and Sasol Infrachem Gas (maximum of 175 MW) (DoE, 2018, Page 58; and DoE, 2019, Page 53). Based on the comments received during the review of the Draft SEA Report, it has been noted by the City of Cape Town that the Athlone and Roggebaai OCGT hold a capacity of 36 MW and 42 MW, respectively.

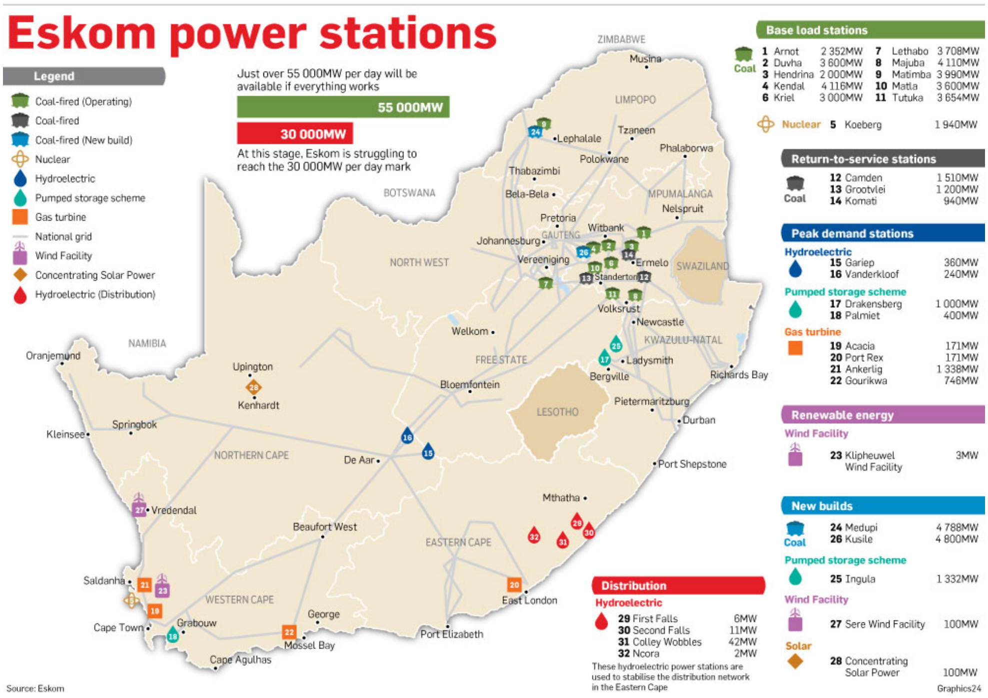

Figure 6. Eskom's current power stations: 2017 (Source: Eskom, October 2017)

[12] Fin 24 (April 2018). Article on line: https://www.fin24.com/Economy/Eskom/jeff-radebe-signs-long-delayed-renewable-power-deals-20180404

[13] Department of Energy (January 2013). Draft 2012 integrated energy planning report executive summary (For Public Consultation). Pretoria. Available online: http://www.energy.gov.za/files/IEP/IEP_Publications/Draft-2012-Integrated-Energy-Plan.pdf

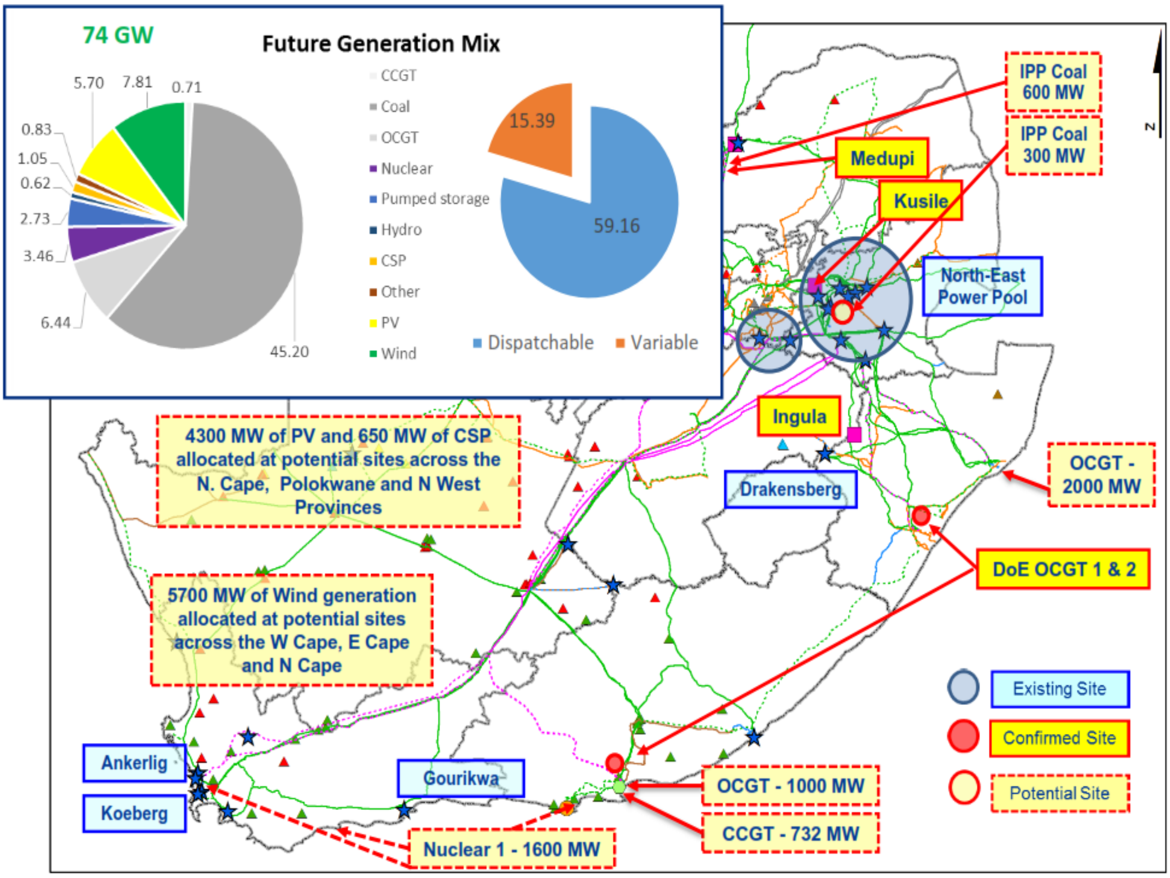

Figure 7. Eskom's 2017 view on potential future power stations (Source: Eskom, October 2017).

The feasibility of Eskom being able to upgrade existing gas turbine power stations to utilise gas has been called into question given the large investment amounts required for these upgrades (According to Eskom, an additional R1.5 billion is required to fully upgrade the Gourikwa and Ankerlig power stations after investing R160 million to convert the burners to dual fuel). As a result, it appears that there may be more scope for the future use of gas to generate electricity by IPPs, which is described further below.

- Eskom's Ankerlig OCGT power station in Atlantis is currently fueled by diesel. However, in the 2015 State of the Nation Address (SONA), Eskom was "directed" to convert all their diesel fired OCGT's to gas. Eskom subsequently embarked on a program to implement this and completed the conversion of both Ankerlig and the Gourikwa Power Station in Mossel Bay to duel fuel burners, i.e., these power stations can now use both diesel and natural gas as fuel. Depending on the operation of Ankerlig and a possible conversion of five of the units to Combined Cycle Gas Turbines (CCGTs), Ankerlig will have a demand of up to 1 TCF of gas over a 25-year period.
- Potential IPP in the Saldanha IDZ (0.5 TCF or greater, depending on eventual size and operation).
- Eskom's Gourikwa OCGT in Mossel Bay has been converted to use both diesel and gas fuel, and with the possible conversion of two units to CCGT the plant will have a demand of 0.7 TCF. A Total gas find off the south coast will definitely be of significance for Gourikwa.
- The DoE IPP Office Project Information Memorandum (PIM) specifies 3000 MW of IPP Gas to Power with 1000 MW at Coega (equivalent to a demand in the region of 0.5 TCF) and the balance at Richards Bay. A Mid Merit IPP at Richards Bay will therefore create a minimum demand of 1 TCF with the potential for more, depending on how big the power plant at Coega will be. It is understood that the Coega Development Corporation (CDC) has commissioned an EIA Process for LNG Import to the Port of Ngqura, and the Draft Scoping Report has been completed. In addition, the CDC has also commissioned an RFP process to commence with an EIA Process for three IPP gas-to-power stations of 1000 MW each within the Coega IDZ. With regards to Richards Bay, the

Final EIA Report for a 3000 MW CCGT power station was submitted for approval. Eskom is anticipated to receive Environmental Authorisation for this plant in January 2020.

- The Dedisa IPP OCGT peaking power plant in the Coega IDZ is currently fueled by diesel and has the capability to use natural gas as fuel. As a result of its peak operating mode it will only have a demand of 0.3 TCF over a 25-year period.
- The Avon IPP OCGT peaking power plant near Salt Rock in northern KwaZulu-Natal is currently fueled by diesel but has the capability to use gas as fuel, creating a demand of 0.6 TCF over a 25-year period.

Eskom's 2017 view of future power stations is illustrated in Figure 7 above.

In terms of **industrial use of gas**, industries are attracted to switching to gas because of the possible price advantages and supply security (which is a major potential attraction since it allows the company to go off the grid). However, the conversion costs for industrial users serve as a potential constraint to switching energy sources. As a result, it is difficult to identify at what cost gas switching is an attractive option for industrial users as the conversion costs first need to be identified and built into a feasibility assessment. A number of industries located in Gauteng, Mpumalanga, and Durban are already making use of Methane Rich Gas from Sasol. As a possibility, existing Durban, Richards Bay and Gauteng markets could be supplied with gas via reverse flow up the Lilly Pipeline or a new gas transmission pipeline to Gauteng (which has an estimated demand of 1.5 TCF over a 25-year period). The dti has conducted a gas market demand assessment for KwaZulu-Natal and found large-scale potential for this demand to grow. The Western Cape Government updated a 2013 Western Cape gas market demand assessment to quantify the demand for gas in the Western Cape and the final report was released in November 2019. A gas find off the Southern Coast of the country will definitely be of significance for the PetroSA's Mossel Bay GTL refinery and encourage fast-tracked developments for the Coega IDZ. As an indication of the volume of gas, note that the PetroSA GTL Refinery (GTLR) in Mossel Bay operated on 1 TCF of gas for 25 years, consuming an average of 210 million standard cubic feet of gas per day (scfd).

There is growing use of gas in many segments of the **transport sector**, including: bus, taxi, road freight, and shipping. Globally, many countries are now setting sales targets for the sale of electric-powered motor vehicles and the phasing out of petrol and diesel powered vehicles (Gray, 26 September 2017[14]). The growth in natural gas powered vehicles appears to be negatively correlated with increases in the oil price. Current opportunities already being explored in South Africa include inner city public transport bus systems, mini-bus taxis, and road transport logistics haulers.

Hence, gas markets **as listed in Table 3** exist to support exploration in South African Waters.

Table 3: Potential gas markets

West Coast	1.5 TCF
South Coast	2.5 TCF
East Coast	Minimum of 3.1 TCF

Based on the above, existing Gas Markets and planned pipeline infrastructure are not the limiting factors for offshore exploration. Baseload IPP CCGT's are currently being planned; will require maturity; and, once offtake agreements are signed will take about 26 months to construct.

[14] Gray, Alex (27 September 2017). Countries are announcing plans to phase out petrol and diesel cars. Is yours on the list? Available online at: https://www.weforum.org/agenda/2017/09/countries-are-announcing-plans-to-phase-out-petrol-and-diesel-cars-is-yours-on-the-list/

The current gas pipeline infrastructure in South Africa includes:

- The 865 km Rompco pipeline from Sasol's Pande and Temane gas fields in Mozambique to Secunda. At the start of production in 2004, these fields had a total P90 reserve estimate of 4.5 TCF. However, in early 2019, Sasol announced that gas imports to South Africa via the Rompco pipeline will start to drop off by 2023. From Secunda, Sasol transmits the gas to Sasolburg and to other industrial users in Gauteng.
- The Lilly Pipeline, in which Transnet transmits Methane Rich Gas (MRG), with a methane content of 85%, from Sasol to Richards Bay and Durban.

In terms of future gas transmission pipeline planning:

- iGas has completed the onshore route engineering for a West Coast gas transmission pipeline from Abraham Villiersbaai to Saldanha and Atlantis to take West Coast Gas to the closest markets;
- PetroSA has completed the Pre-Feasibility Study for a gas transmission pipeline from Saldanha to Mossel Bay and on to Coega to take West Coast gas to the South Coast markets. Alternatively, the flow can be reversed to take South Coast gas to the West Coast markets; and
- In terms of Transnet's <u>**Long-Term**</u> Framework Planning, potential gas transmission pipelines include the following:
  - Line from Secunda to Botswana;
  - Gas from northern Mozambique to link with the proposed Petroline to Secunda;
  - Line from the Northern Cape to Gauteng;
  - Line from Gauteng to the Port of Ngqura;
  - Line from Northern Cape to Saldanha; and
  - Line from Saldanha to Mossel Bay and to Port Elizabeth.

1.1.6 Challenges in terms of the Construction of Gas Pipelines

The market exists and there are unexploited gas reserves on the West Coast, however, the following challenges still exist in terms of constructing gas pipelines:

- Ownership of the gas: Namibia and South Africa have been in discussions for years about developing the Kudu gas field. However, negotiations stalled with South Africa's desire to transport the gas to Ankerlig for power generation and Namibia's desire to build a power station in Namibia and export excess power to South Africa.
- Ibhubesi is too small to support a conventional power station: The P90 reserve of 0.21 TCF is too small to support a large power station like Ankerlig beyond about 5 years.
- Currency and commodity price risk for fuel: Eskom currently buys coal in ZARs and sells electricity in ZARs. Gas prices are typically indexed against oil, and more recently against gas hub prices, e.g. Henry Hub, and priced in USD, introducing both currency and commodity price risks for the fuel. This will require Eskom to buy fuel priced in USD and fluctuating with the oil or gas hub prices but will only be able to sell electricity in ZAR and priced in accordance with the Multi-Year Price Determination (MYPD).
- Spatial planning: Securing servitudes is a significant task for pipeline development, requiring individual negotiations with multiple landowners. Strategic servitude planning needs to be undertaken well in advance of the final planning of a gas transmission pipeline system.
- The development of a Bankable Feasibility Study and completing the relevant business case can only be led by the relevant gas reserve finds with commercial opportunities, i.e., a source of gas and a guaranteed offtaker, prior to the pipeline being constructed.

1.2 SEA Rationale

The development and related operation of infrastructure for the bulk transportation of dangerous goods (including gas, outside of an industrial complex, using a pipeline exceeding 1000 m in length with a throughput capacity of more than 700 tons per day) is identified as Activity 7 of Listing Notice 2 (Government Notice R325) of the 2014 National Environmental Management Act (NEMA) (Act Number 107 of 1998, as amended) EIA Regulations (as amended). These activities require Environmental Authorisation in terms of the 2014 NEMA EIA Regulations (as amended) via a full Scoping and Environmental Impact Report (EIR) Process, which requires the submission of a Scoping Report and EIA Report to the Competent Authority. The National DEA is the regulated Competent Authority for all Applications for Environmental Authorisation that are submitted by statutory bodies.

Based on observations and previous cases, it has been realised that the authorisation process currently being applied to linear infrastructure including gas transmission pipelines may be too rigid to be an effective assessment mechanism for these types of structures. The current process locks the routing options to an approved route, determined well in advance of any construction process, which results in the following challenges:

- Higher costs of land to be used as servitudes: The EIA Process is important in the initial planning and route selection of new gas pipelines. For this reason, it is common practice for the servitude negotiation process to begin after the EIA has been completed. At that stage there is greater confidence in the route to be adopted. The problem with this sequence of events however, is that the Environmental Authorisation locks the developer into a predefined route. Therefore, should a gas pipeline developer encounter an unwilling landowner during the servitude negotiation process, there is little to no flexibility to adapt the course of the route. In these instances, the developer is forced pay above market rates to the landowner for access to the servitude, undergo an expropriation process or reroute the line, the latter requiring an Amendment to the Environmental Authorisation and all options resulting in increased costs and delays to the project.
- The EIA Process is initiated too late to provide strategic input into the alignment of gas transmission pipelines and other key linear infrastructure, as it is usually initiated when the project has been approved by the relevant approval board and by that time the strategic decisions regarding route planning would have been taken and the alternatives in the EIA Process would be limited;
- The inflexibility of the approved routes limits the possibility of adding more users identified after the Environmental Authorisation process;
- There is a high probability of amendments being sought to the route at construction due to maturing of information, including the identification of additional users, changes in the supply and demand scenarios etc.
- As the pipeline network is constructed in phases, authorisations are submitted and processed in phases. This makes it impossible to assess the entire planned gas transmission needs strategically or to give consideration to the cumulative effects of the entire network construction; and
- Complication is introduced by the fact that any changes or opposition during the EIA Process resets the project making the delivery of gas to the economy and society either redundant or late.

Furthermore, for a major gas transmission route, it takes on average between one to two years for an EIA Process to be completed in terms of the NEMA. For long gas pipelines crossing many different land parcels, the risk of an appeal is high, which often results in significant delays in receiving the authorisation. Major routes often trigger additional environmental permitting requirements, such as a Water Use Licence Authorisation, Mining Permit, and Permit for the Removal of Protected Trees, each managed by a different Competent Authority under an independent authorization process. These additional authorizing processes usually commence following the completion of the EIA Process and receipt of the Environmental Authorisation. This means that it can take up to seven years for all the necessary environmental approvals to be awarded, before construction can start.

In addition, as noted above strategic planning for servitudes needs to be undertaken well in advance of the final planning of a gas transmission pipeline system. It would therefore be beneficial for the applicant of the major gas pipeline to submit a pre-negotiated route, where the upfront approval of landowners has been obtained. The current EIA Process does not allow for the submission of applications on a pre-determined route.

From the perspective of the National DEA, every effort needs to be made to ensure that the requirements for Environmental Authorisation are streamlined, they follow an efficient and effective assessment and review process and achieve the objectives of sustainable development. Therefore, in order to overcome the constraints listed above, and to support the objectives of Operation Phakisa, this SEA Process has been commissioned to identify and pre-assess suitable gas routing corridors to facilitate a streamlined Environmental Authorisation process for the development of energy infrastructure related to gas.

1.2.1 Problem Analysis

Linked to the above, the construction of the Phased Gas Pipeline Network to facilitate the transmission of gas to strategic industrial centres, via third party distributors, is seen as a strategic intervention. As an Operation Phakisa project, all government departments that have a mandate with respect to the facilitation and implementation of Operation Phakisa must ensure the efficient and effective administration of this mandate.

As many of the Operation Phakisa initiatives and associated projects will trigger a number of listed activities for which Environmental Authorisation will be required, the DEA will need to prioritise the review and decision making process associated with Phakisa related projects. It has been identified that significant improvements can be made to the assessment and decision making process related to linear activities. This includes gas pipeline infrastructure and the assessment and decision-making process will ensure the highest level of environmental protection. Through the inclusion of a pre-assessment process, which identifies the environmental sensitivities and engineering constraints of proposed linear infrastructure routes, it will be possible to identify gas transmission pipeline corridors and management measures, which avoid environmentally sensitive areas, while following the most socially acceptable and economically viable routing options and applying the most effective and environmentally sound management measures.

PROBLEM STATEMENT

Limited consideration by developers of environmental sensitivities and constraints in the early planning stages is proving costly (both environmentally and economically) and affecting the ability to make strategic investment decisions.

1.3 Study Objectives

In partnership with the DEA, DoE, DPE, iGas, Eskom and Transnet, and in consultation with relevant stakeholders; identify routing corridors, environmental management measures including norms or standards or a streamlined Environmental Authorisation process (potentially via Minimum Information Requirements) for the construction of the linear infrastructure associated with energy provision including a gas pipeline network as well as interventions required to secure long term energy planning corridors and zones identified.

The SEA has been undertaken at a level of detail that will allow the Minister of Environmental Affairs to consider a streamlined Environmental Authorisation process for **the development of gas transmission pipeline infrastructure (including ancillary activities such as pigging stations, access roads but excluding compressor stations)** within the gazetted final gas pipeline corridors.

It is intended that the final gas pipeline corridors identified through the SEA Process be submitted to Cabinet for approval to ensure buy-in from all Departments. It is also proposed that the final corridors be embedded and integrated into Strategic Development Frameworks at local, provincial and national level, to ensure that long term energy planning is secured.

The vision of the SEA is that strategic development of a gas pipeline network is undertaken in an environmentally responsible and efficient manner that responds effectively to the economic and social development needs of the country. With this vision in mind, the following objectives were developed to guide the study:

- Sustainable Development

Sustainable development is a process for meeting societal development needs whilst maintaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depends. *This SEA aims to facilitate sustainable development through the identification of a set of strategic corridors, which fundamentally serve the purpose of connecting demand areas, but are positioned in such a way to maximise opportunities for economic and social development whilst minimising constraints to the environment.* Development inside of the Final Gas Pipeline Corridors will be encouraged to proceed in areas of low and medium environmental sensitivity.

- Participation

The identification of strategic corridors that meet the long term requirements of industry and society whilst also considering factors such as environmental sensitivities, engineering constraints and financial cost requires inputs from a diverse group of stakeholders. Furthermore, the successful implementation of strategic planning initiatives requires the buy-in and commitment from a range of role players. Early consultation and formal agreement amongst stakeholders is thus central to the success of the SEA. From the onset of the SEA Process, extensive consultation was undertaken with all three levels of government, the private sector, non-governmental agencies and the general public.

- Coordination

Legal recognition of the Gas Pipeline Corridors is required to facilitate effective implementation. This process should start with the formal adoption of the Final Gas Pipeline Corridors through a publication in the Government Gazette and end with the recognition of these areas within relevant national, provincial and local plans and policies. The alignment of the corridors across the relevant plans and policies of all three levels of government will signify the high level agreement needed to facilitate effective implementation of the Final Gas Pipeline Corridors.

- Streamlining

In the context of this study, 'streamlining' means better coordination of environmental assessment procedures with the aim of reducing unnecessary administrative burdens, creating synergies and speeding up the environmental assessment process. **'Streamlining' does not imply a weakening of environmental protection requirements under the NEMA.** Instead, the outputs of the SEA are designed to improve the quality of the environmental assessment process and decision making; and better facilitate strategic gas pipeline development in the Final Gas Pipeline Corridors (once gazetted).

The environmental pre-assessment of the corridors undertaken as part of the SEA is comparable to a scoping phase and hence will assist with focusing additional assessment requirements required in further environmental assessment processes. Agreement on and official adoption of the Final Gas Pipeline Corridors in relevant plans and policies should serve to create an advantageous environment for the development of gas pipeline infrastructure. The option of either streamlining or seeking exemption from the Environmental Authorisation process (through the adoption of Norms or Standards) was considered as part of this SEA Process. Based on the consideration of a number of factors, as an output of the SEA, all future gas pipeline development inside of the Final Gas Pipeline Corridors (once gazetted) normally triggering an EIA Process in terms of the NEMA will be subject to a streamlined environmental assessment process (e.g. Basic Assessment Process). Additional information on the outcome and tools of the SEA are described in Section 1.5 of this chapter (i.e. Part 1: Background to the Phased Gas Pipeline Network SEA).

It however remains critical to ensure that any environmental management instrument, Norm, Standard, or Minimum Information Requirement developed as part of this SEA process is comprehensive and environmentally rigorous, whilst still maintaining practicality and feasibility.

- **Integration**

The SEA seeks to achieve integration between the different competent authorities responsible for Environmental Authorisation and licensing. This will be facilitated through the creation and adoption of a commonly agreed upon 'Development Protocols'. The scope of the project level environmental assessment process in the Final Gas Pipeline Corridors will be informed by requirements specified in the development protocol, and undertaken in accordance with the relevant existing regulations. This will ensure that, where separate environmental legislation requires separate assessments, those assessments and associated decision making processes should, as best as possible, be aligned with the respective project specific environmental assessment procedure. Where possible, assessment and decision making procedures will also be integrated to maximise efficiencies. Integration will assist with streamlining processes.

- **Facilitation of Strategic Investment**

The integrated approach followed to identify the Gas Pipeline Corridors, official agreement to these areas, and the alignment of policies and plans together with the pre-assessment work undertaken as part of the SEA, should help to create an enabling environment for gas pipeline development within the Gas Pipeline Corridors.

Streamlined and coordinated processes will ensure that development can take place more quickly. However, the provision of environmental information at the earliest opportunity to inform route planning will also assist with identifying environmentally acceptable routes, which should enable developers of gas pipeline infrastructure to make upfront strategic investment in these areas in advance of formal environmental approval. Also official adoption of the Gas Pipeline Corridors should assist developers with motivating for the necessary funding to enable gas pipeline expansion in the Gas Pipeline Corridors as well as serve as a commitment to industry that investment in pipeline development will be undertaken in these areas.

1.4 Legal Framework

The key pieces of legislation that enable the identification and implementation of the Gas Pipeline Corridors are summarised below. Key legislation is also described in the Specialist Assessments, which are included in Appendix C of this Gas Pipeline SEA Report, and summarised in terms of key findings in Part 4.

1.4.1 National Environmental Management Act (NEMA) (Act Number 107 of 1998, as amended)

NEMA provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote cooperative governance, and procedures for coordinating environmental functions exercised by organs of state.

The SEA is undertaken in terms of Section 24(2) of the NEMA, which allows for the identification of geographical areas (e.g. Gas Pipeline Corridors) based on environmental attributes, and specified in a spatial development tool adopted in the prescribed manner by the Competent Authority, in which specified activities may not commence without Environmental Authorisation from the Competent Authority.

Two options have been considered during the SEA Process to achieve streamlining. These options include 1) exemption from an Environmental Authorisation process with the implementation of a Norm or a Standard; and 2) a streamlined Environmental Authorisation process with compliance with the NEMA EIA Regulations, and potentially Minimum Information Requirements.

Section 24(2)(d) of the NEMA allows the Minister to exclude an activity from the requirements to obtain and Environmental Authorisation from the Competent Authority, but that must comply with prescribed norms or standards. Section 24 (10)(a)(i)(aa) – (ee) of the NEMA allows the Minister to develop or adopt norms or standards for a listed or specified activity, any part of a listed or specified activity, any sector, any geographical area or any combination of activity, sector, geographical area, listed activity or specified activity.

The adoption of Minimum Information Requirements is allowed for in terms of Regulation 19 (3) of the 2014 NEMA EIA Regulations (as amended).

In addition, sensitivity maps prepared as part of the SEA Process give effect to Section 24(3) of NEMA that allows for the compilation of information and maps that specify the attributes of the environment that need to be taken into consideration by all Competent Authorities.

The assessment requirements in the form of Development Protocols prepared through the SEA process further give effect to Section 24(5) of NEMA, which allows for the laying down of procedures to be followed in respect of application for Environmental Authorisation and decision making as well as any matter necessary for dealing with and evaluating applications for Environmental Authorisation.

1.4.2 National Water Act (Act Number 36 of 1998)

This act provides the legal framework for the effect and sustainable management of water resources. It provides for the protection, use, development, conservation, management and control of water resources as a whole. Water use pertains to the consumption of water and activities that may affect water quality and condition of the resource such as alteration of a watercourse. Water use requires authorisation in terms of a Water Use Licence (WUL) or General Authorisation (GA), irrespective of the condition of the affected watercourse. The need for a WUL or GA will be addressed on a project specific basis, and should be aligned with the project specific Environmental Assessment as best as possible.

1.4.3 Infrastructure Development Act (Act Number 23 of 2014)

This act provides for the facilitation and co-ordination of public infrastructure development, which is of significant economic or social importance to the country. It ensures that infrastructure development in the country is given priority in planning, approval and implementation. It furthermore ensures that the development goals of the state are promoted through infrastructure development and improves the management of such infrastructure during all life-cycle phases.

1.4.4 Spatial Planning and Land Use Management Act (SPLUMA) (Act Number 16 of 2013)

SPLUMA as a framework act for all spatial planning and land use management legislation in South Africa seeks to promote consistency and uniformity in procedures and decision-making in this field. The other objectives of the act include addressing historical spatial imbalances and the integration of the principles of sustainable development into land use planning, regulatory tools and legislative instruments. Chapter 8 of the 2014 Draft SPLUMA Regulations prescribes the institutional, spatial planning, and land use management requirements for municipalities in whose jurisdiction a SIP has been designated.

1.4.5 Gas Act (Act Number 48 of 2001)

The inclusion of Natural Gas into South Africa's energy supply is considered important in terms of fulfilling one of the objectives of the White Paper of Energy Policy. The DoE formulated the Gas Act (Act Number 48 of 2001), which aims to promote the orderly development of the piped gas industry; to establish a national regulatory framework; to establish a National Gas Regulator as the custodian and enforcer of the national regulatory framework; and to provide for matters connected therewith. Section 36 of the Gas Act deals with and specifies the provisions of the Mozambique Gas Pipeline Agreement.

It is worthy to note that the Gas Act (Act 48 of 2001) is currently being amended to facilitate gas infrastructure development and investment in South Africa. A consultation document relating to the Gas Master Plan (also previously referred to as GUMP) is currently being finalised by the DoE and various stakeholders. The Gas Act (Act 48 of 2001) and the Gas Master Plan will complement each other.

In line with the above, the National Energy Regulator of South Africa (NERSA) is a regulatory authority established as a juristic person in terms of Section 3 of the National Energy Regulator Act, 2004 (Act Number 40 of 2004). NERSA's mandate is to regulate the electricity, piped-gas and petroleum pipelines industries in terms of the Electricity Regulation Act, 2006 (Act Number 4 of 2006), Gas Act, 2001 (Act Number 48 of 2001) and Petroleum Pipelines Act, 2003 (Act Number. 60 of 2003).

Subsequent to the establishment of NERSA, the Piped Gas Regulations were promulgated in Government Notice 321 on 20 April 2007 in order to promote the orderly development of the piped gas industry.

Pipeline Operators of the Phased Gas Pipeline Network will need to comply with the requirements of NERSA and the DoE in terms of the Gas Act.

1.4.6 Gas Regulator Levies Act (Act 75 of 2002)

The Gas Regulator Levies Act was formulated with the overall objective to provide for the imposition of levies by the National Gas Regulator; and to provide for matters connected therewith.

1.5 Procedure of Environmental Assessment within the Gas Pipeline Corridors: Objectives and Vision

One of the key points that the DEA has realised over time is that unless developers plan with the environment in mind, it is not really considered as a priority. *This SEA is ensuring that the environment is brought to the forefront as a priority in planning*. Once gas finds materialise, there will be a demand for such linear infrastructure being assessed as part of this SEA. One of the outcomes of this SEA is therefore to ensure that environmental approvals for such infrastructure within the corridors are not a cause for delay towards development, whilst still maintaining and ensuring the highest levels of environmental rigour.

To ensure that gas pipeline development within the Gas Pipeline Corridors are not a cause for delay, the following two options were considered during the SEA Process to achieve streamlining of the Environmental Authorisation process:

- Option 1: Allow for exemption from the need to obtain Environmental Authorisation in terms of the NEMA provided that there is compliance with a Norm or Standard; or
- Option 2: Allow for a streamlined Environmental Authorisation process in terms of NEMA (i.e. undertake a streamlined Environmental Assessment (such as a Basic Assessment) instead of an EIA) provided that there is compliance with the NEMA EIA Regulations, and potentially Minimum Information Requirements.

In the first option, complete exemption from the Environmental Authorisation process can only be achieved if there is compliance with prescribed Norms or Standards. This is allowed for in terms of Section 24(2)(d) of the NEMA, as noted above. Although no Environmental Authorisation would be issued, the Standard would, as a fundamental minimum, require site verification to be conducted prior to development, followed by a Compliance Statement confirming that, where applicable, impacts have been avoided/engineered out or as a minimum, that the proposed mitigation results in acceptable residual impacts.

In the second option, streamlining would be achieved by undertaking a streamlined Environmental Assessment (such as a Basic Assessment) instead of an EIA with adherence to the 2014 NEMA EIA Regulations, and potentially Minimum Information Requirements. The Minimum Information Requirements provide a process and regulatory framework for environmental monitoring, assessment and decision-making related to gas pipeline development.

These options were considered and discussed with various SEA Project Team members, Authorities and key Stakeholders, and only one of these approaches have been recommended and put forward at the end of this SEA Process. Both options are considered viable, as they are allowed for in NEMA, and pre-assessment work has been undertaken as part of this SEA and mandatory compliance would be required with the EIA Regulations, as well as either the Standards or Minimum Information Requirements. These instruments would ensure that potential negative impacts are avoided or mitigated and that best practice measures are adopted. <u>Based on feedback received throughout the SEA Process and specific concerns regarding full Environmental Authorisation exemption, the SEA team has therefore recommended the second option of streamlining the Environmental Authorisation Process (such as a Basic Assessment), with compliance with the 2014 EIA Regulations.</u> It was planned to compile Minimum Information Requirements as a Decision-Support Output, however these are not required as the requirements of the 2014 EIA Regulations (as amended) are sufficient to address potential impacts of gas pipeline developments within the corridors.

One of the objectives of this SEA process is also to enable the developers the flexibility to consider a range of route alternatives within the pre-assessed corridors to avoid land negotiation issues and to submit a pre-negotiated route to the department. This has currently been achieved for the development of EGI within any of the five Strategic Transmission Corridors gazetted in February 2018 (Government Notice 113 in Government Gazette 41445), for which (a) a pre-negotiated route can be submitted to the department, and (b) a <u>Basic Assessment</u> procedure needs to be followed in compliance with the 2014 EIA Regulations (as amended) instead of a full Scoping and EIA Process previously triggered by such activities. This fairly recent streamlined environmental assessment process also includes a reduced decision-making timeframe for the Competent Authority (i.e. 57 days as opposed to 107 days). Several factors served as motivation for the abovementioned streamlining of the Environmental Assessment Process, including the fact that the development of linear EGI is a well-known type of development, and the DEA has previously considered and issued Environmental Authorisations for numerous applications in this regard. Therefore, the type of issues and impacts linked to a proposed EGI development is well understood and would apply across many EGI development applications.

Given the similarities between these two linear type developments (i.e. EGI and Gas Transmission pipelines); a similar streamlined Environmental Assessment approach has been sought for the development of gas transmission pipeline within pre-assessed corridors.

It must also be noted that the Decision-Making Tools compiled as part of this SEA would apply to all listed activities that are triggered in the NEMA EIA Regulations by the proposed gas transmission pipeline development – and associated infrastructure <u>directly</u> associated with and required to enable and facilitate its functioning and operation, where applicable - within the gas pipeline corridors. For example, if a road needs to be constructed in order to access the gas pipeline route, then the relevant listed activities linked to such road construction would be included in the streamlined Environmental Authorisation process. However, the construction and operation of compressor stations would be excluded from this streamlined process.

1.6 SEA Report Structure

The Final SEA Report comprises five parts. Part 1 (i.e. this chapter) provides a background of the SEA Process, as well as a description of key applicable legislation, and gas pipeline developments and associated activities in South Africa. Part 2 provides a description of the gas pipeline infrastructure that has been assessed and considered in this SEA. Part 3 provides an overall description of the process followed and methodology adopted for the SEA. Part 4 describes the outputs of the Specialist Assessments and other studies conducted as part of the Gas Pipeline SEA Process and Part 5 explains the process undertaken to identify the Final Gas Pipeline Corridors. Figure 8 illustrates the structure of the SEA Report.

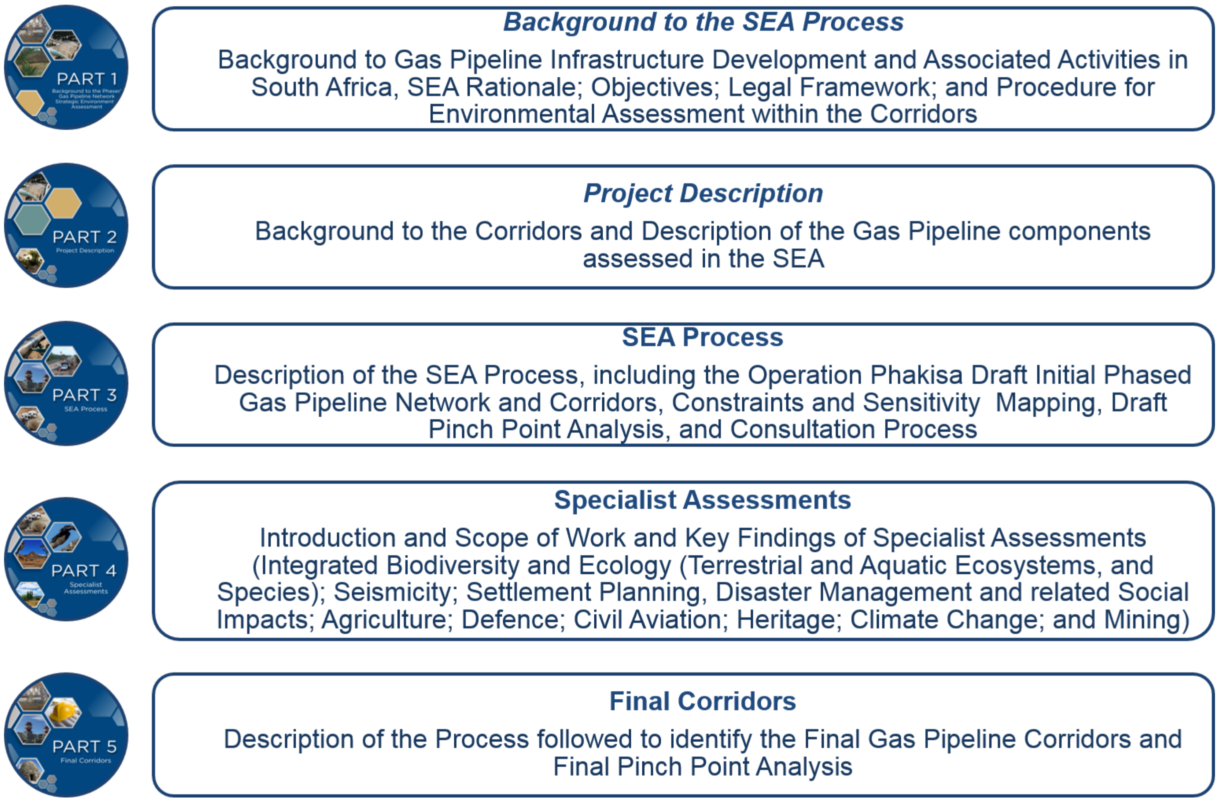

Figure 8: Phased Gas Pipeline SEA Report Structure

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 1

Background to the Phased Gas Pipeline Network Strategic Environmental Assessment

APPENDIX 1

Gas Opportunities Analysis

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Date: Version 1: 24 September 2018
Final: August 2019

Note: At the time of finalization of this Gas Opportunities Analysis, the 2019 Final IRP was not yet promulgated. The results of this Gas Opportunities Analysis Study have not changed and are still valid.

CONTENTS

TABLES

FIGURES

LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

CHEVREF	Chevron South Africa (Pty) Ltd
dti	Department of Trade and Industry
CCGT	Combined Cycle Gas Turbines
CNG	Compressed Natural Gas
DoE	Department of Energy
ECA	Emission Control Area
EIA	Environmental Impact Assessment
ENREF	Engen Petroleum Ltd
FSRU	Floating storage regasification unit
GHG	Greenhouse Gas
GJ	Gigajoule
GTLR	Gas-to-liquids refinery
GUMP	Gas Utilisation Master Plan
IDZ	Industrial Development Zone
IMF	International Monetary Fund
IPP	Independent Power Producer
IRP	Integrated Resource Plan
KZN	KwaZulu-Natal
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
MBTU	Million British thermal units
MRG	Methane Rich Gas
MW	Megawatts
MWe	Megawatt electric
MWh	Megawatt hour
MYPD	Multi-year price determination
NERSA	National Energy Regulator of South Africa
OCGT	Open Cycle Gas Turbine
PJ	Petajoule
PetroSA	The Petroleum Oil and Gas Corporation of South Africa (Pty) Ltd
PIM	Project Information Memorandum
PPA	Power Purchase Agreement
PV	Photovoltaic
REIPPPP	Renewable Energy Independent Power Producers Procurement Programme
ROMPCO	Republic of Mozambique Pipeline Company
SAPREF	South African Petroleum Refineries (Pty) Ltd
SEA	Strategic Environmental Assessment
Tcf	Trillion cubic feet
TNPA	Transnet National Ports Authority
USD	United States Dollars
ZAR	South African Rand

1. Introduction

The purpose of this Gas Corridor: Strategic Environmental Assessment (SEA): Economic assessment is to identify opportunities regarding potential bulk users of gas in South Africa and identify potential benefits that could be realised to South Africa as a result of selected bulk users making greater use of gas in the future. The information contained in this report is gleaned from publicly available reports as well as from a set of interviews conducted with selected role-players (see Annexure C).

This economic assessment is not an economic impact assessment. Instead, it identifies potential future opportunities and benefits based on a rapid review of the gas sector opportunities in South Africa and in selected corridor geographic case studies focusing on potential gas bulk users in South Africa. The scope of this assessment therefore also excludes any benefits which may accrue from offshore exploration activities (even though offshore exploration and production is required to service bulk users in South Africa).

This introductory background section comprises the following sub-sections which provide an important backdrop to identifying and analysing potential gas demand opportunities in the various gas corridors:

- 3.1: Selected international developments regarding the energy sector.
- 3.2: Selected aspects of South Africa's current energy context relevant to future energy demand and sources.
- 3.3: Overview of sectors where opportunities for growing gas demand exist in South Africa.
- 3.4: Discussion of potential benefits (and linked issues) and impacts of growing gas demand in South Africa.

The principal determinants of energy demand growth are energy policies, rates at which economic activity and population grow, relative energy source prices (and technological developments which impact on the relative costs of exploration, production and distribution) and technology innovations which can have a downward impact on energy prices- amongst other impacts.

The identification of potential bulk gas users in South Africa is a complex and ever-evolving challenge for a number of reasons. These reasons include, but are not limited to, the following:

- Technology changes are constantly impacting on the relative costs and attractiveness (for users switching between energy sources) of different energy sources in many ways. For example, the costs of solar power are projected to continue declining. Oil and gas offshore exploration companies are constantly improving efficiencies to reduce exploration costs. Energy storage costs are declining as battery technologies continue to improve (International Renewable Energy Agency, 2017).
- Global economic growth prospects and the demand for petroleum products (and the price of oil and diesel) are constantly evolving.
- There are difficulties in quantifying all relevant cost factors in determining future gas prices. These cost factors include: technology upgrades to facilitate switching by existing users; transportation costs; costs of distribution and other infrastructure (e.g. storage infrastructure). In addition, the economics (and therefore the gas cost and potential demand and feasibility) of servicing bulk users in a particular region are impacted on by economies of scale which can be achieved by sharing road tanker transport costs if multiple customers are serviced in a region (as opposed to only one large industrial bulk user for example).
- There are cultural or behavioural factors which impact on the likelihood of users switching energy sources (e.g. in the transport and residential sectors).
- The extent of future constraints on carbon emissions is not yet clear. These constraints will impact on future energy source choices.

Because of these and other factors, identifying potential bulk user demand for gas in South Africa has proved challenging. According to the Department of Trade and Industry (dti), even large energy sector multi-national companies such as Shell have found it challenging to model market demand for gas based on different price points (key informant interview). A dti official interviewed for this report and involved in efforts to support the South African oil and gas sector believes that only once gas supply can be made available, demand will begin to emerge and evolve. At the same time, dti studies on demand in Kwazulu-Natal (KZN) and Richards Bay have found that industries have expressed an interest in switching to gas at a price of $8/Million British thermal units (MBTU) but that 60% of this demand falls away at a price of $10/MBTU. Demand for gas is therefore highly price-elastic.

For the above reasons, energy and electricity demand forecasters cannot formulate accurate future demand predictions with a high degree of accuracy beyond the short term (1-5 years). Some commentators have stated that there needs to be a shift in focus to smaller and flexible generation plants, with well-known and declining deployment costs, that can be constructed faster – like solar Photovoltaic (PV) and wind power in combination with mid-merit Combined Cycle Gas Turbines (CCGT) (a highly efficient energy generation technology that combines a gas-fired turbine with a steam turbine) and Open Cycle Gas Turbine (OCGT) (a combustion turbine plant fired by gas or liquid fuel (diesel) to turn a generator rotor that produces electricity) plants, pumped storage and other emerging energy storage options for peaking capacity.

2. Scope of this Study

The Terms of Reference for this study include:

- Undertake research in order to identify where the current or most likely bulk users are located (such as (but not limited to) the major ports, Ankerlig and other gas turbine power stations, Coega Industrial Development Zone (IDZ) and other relevant IDZs, mines in Gauteng, potentially Eskom Power Stations that can be converted to gas), as this will inform the need for gas and potential connecting points for “smaller users” (currently not identified).
- Identify the potential benefits that could be achieved should gas be available to the selected bulk users.
- Undertake an opportunities analysis and determine the overall economic benefits (including direct and indirect benefits) of having gas in the energy mix, based on case studies.

Limitations

This economic assessment is a high level assessment, mainly focusing on the review of existing research and limited interviews with key stakeholders in the gas market in South Africa. In addition, numerous market demand research and feasibility reports are confidential in nature and could not be considered as part of the assessment. This study cannot therefore be regarded as a comprehensive assessment of economic opportunities.

This economic assessment is not an economic impact study. Such a study would require a detailed South African market demand analysis and this is beyond the scope of this SEA. This assessment also does not identify any benefits, which may accrue from offshore exploration activities (even though offshore exploration and production is required to service bulk users in South Africa) (over and above providing high-level job creation figures which operation Phakisa has identified for the overall Ocean Economy in South Africa). Finally, this assessment does not examine opportunities and benefits in the residential sector as this requires detailed energy system modelling to identify knock-on effects on the entire energy system.

3. Current energy trends

3.1 Selected international energy market developments

Globally, the International Energy Agency's World Energy Outlook for 2017, notes that "…significant market imbalances that are likely to maintain downward pressure on prices for some time to come: this is the case not only for oil and gas, but also for some other parts of the energy sector such as solar PV panels. They also show an energy system that is changing at considerable speed, with the dramatic falls in the costs of key renewable technologies upending traditional assumptions on relative costs" (International Energy Agency, 2018).

Gas is abundantly available in world markets and trading at prices lower than $10/MBTU. In 2016 and 2017, coal traded at $ 2.11 and $ 2.08 MBTU and natural gas at $ 2.87 and $ 3.39 MBTU respectively[1], making it competitive with coal for electricity generation. Given the competitive pricing, gas has replaced coal as the biggest producer of electricity in the USA in April 2015. Natural gas is a source of carbon for fuel, petro-chemicals and agriculture, and produces electricity with 50-60% less CO_2 emissions than coal (Liang et. al. 2012; National Energy Technology Laboratory, 2010; Salovaaraa. 2011; U.S. Energy Information Administration accessed September 2018[2]).

Global scenarios for 2025 and 2040 for fossil fuel import prices have been developed by the International Energy Agency and show relatively modest increases in the prices of natural gas when compared to both crude oil and steam coal (Table 1).

Table 1. Global scenarios for fossil fuel import prices for years 2025, 2030, 2035 and 2040 (International Energy Agency, 2018)

				New Policies				Current Policies		Sustainable Development	
Real terms ($2016)	2000	2010	2016	2025	2030	2035	2040	2025	2040	2025	2040
IEA crude oil ($/barrel)	38	86	41	83	94	103	111	97	136	72	64
Natural gas ($/MBtu)											
United States	5.9	4.8	2.5	3.7	4.4	5.0	5.6	4.3	6.5	3.4	3.9
European Union	3.8	8.2	4.9	7.9	8.6	9.1	9.6	8.2	10.5	7.0	7.9
China	3.5	7.4	5.8	9.4	9.7	10.0	10.2	10.4	11.1	8.2	8.5
Japan	6.4	12.1	7.0	10.3	10.5	10.6	10.6	10.8	11.5	8.6	9.0
Steam coal ($/tonne)											
United States	37	63	49	61	61	62	62	62	67	56	55
European Union	46	101	63	77	80	81	82	81	95	67	64
Japan	44	118	72	82	85	86	87	86	101	71	68
Coastal China	34	127	80	87	89	90	91	90	101	78	77

Notes: MBtu = million British thermal units; LNG = liquefied natural gas. The IEA crude oil price is a weighted average import price among IEA member countries. Natural gas prices are weighted averages expressed on a gross calorific-value basis. The US gas price reflects the wholesale price prevailing on the domestic market. The EU and China gas prices reflect a balance of pipeline and LNG imports, while the Japan gas price is solely LNG imports; the LNG prices used are those at the customs border, prior to regasification. Steam coal prices are weighted averages adjusted to 6 000 kilocalories per kilogramme. The US steam coal price reflects mine-mouth prices (primarily in the Powder River Basin, Illinois Basin, Northern Appalachia and Central Appalachia markets) plus transport and handling cost. Coastal China steam coal price reflects a balance of imports and domestic sales, while the EU and Japanese steam coal price is solely for imports.

[1] Cost of coal and natural gas for electric generation in the U.S. from 1980 to 2017 (in U.S. dollars per million British thermal units) available at: https://www.statista.com/statistics/189180/natural-gas-vis-a-vis-coal-prices/
[2] Accessed at : https://www.eia.gov/tools/faqs/faq.php?id=73&t=11

It is not clear what factors have been taken into account in the above scenarios. For example, if there is a major switch to electric vehicles in the USA and/or Europe, this may result in a major drop in demand for oil and it is unclear what impact this will have on future oil prices.

3.2 Selected aspects of South Africa's current energy context relevant to future energy demand and sources

3.2.1 Economic and population growth

The International Monetary Fund (IMF) and World Bank produced global and regional economic growth forecasts for 2016-2040 (World Bank. January 2018). These show South Africa's economy a projected growth between 2.1%- 2.9% compared to an overall global average economic growth of 3.4% over the same period (2016-2019) (see the Annexure A for detailed South African economic growth projections). In addition to the growth rate and nature of economic growth, population growth will also impact on future energy demand. South Africa's population is projected to grow from 55 million in 2016 to about 63-64 million in 2030 (a nett increase of 9 million people or 16%) (United Nations, 2017).

The senior Eskom representative interviewed for this study indicated that Eskom's projections show that there will only be a need for new generation capacity to meet peak demand around 2025/2026. However, if economic growth accelerates beyond the above projections, additional peak generation capacity may be required sooner.

3.2.2 Greenhouse Gas emissions targets

Another key factor which will impact on preferred energy sources will be global and national development regarding Greenhouse Gas (GHG) emissions targets and commitments and the scope and level of carbon pricing. This will have a major impact on the relative costs of using different fuels (International Energy Agency, 2018).

South Africa's per capita carbon emissions are relatively high (9.0 tonnes per capita p.a. in 2014 and similar to that of Germany) (World Bank, https://data.worldbank.org/indicator/EN.ATM.CO2E.PC) and there is pressure on the country to reduce this. The Paris Agreement on climate change officially comes into force in 2020. For the first time ever, almost every country has committed to cut its carbon emissions and to limit global warming to "well below" 2˚C above preindustrial levels in order to achieve a collective goal. South Africa (as part of its Nationally Determined Contribution) has pledged to follow a trajectory in which emissions will peak between 2020 and 2025, plateau for approximately a decade, and then decline (Department of Environment, 2015). The agreement sends a clear and unequivocal signal to the private sector – a global political intention to shift to a low carbon, and ultimately zero carbon, future.

National Treasury has indicated that it intends on introducing a carbon tax on 1 January 2019. Projections show this tax will add R13.7 billion to the fiscus in an effort to reduce GHG emissions. On the down side, it is possible that the increased costs to business due to this tax will be passed onto consumers.

3.2.3 Price regulation of energy sources

The relative demand for and supply of different energy sources (as well as the different market structures and ways in which various energy source prices are regulated) can impact on relative energy source prices. Unlike some other energy sources, the price of gas is not dictated by world gas prices as it is largely negotiated on a decentralised basis between suppliers and buyers. The national Energy Regulator of South Africa (NERSA) regulates the maximum price of piped gas in South Africa. The current cost of diesel and Liquid Petroleum Gas (LPG) in terms of cost per gigajoule (GJ) are approximately equal at the time of writing (January 2018).

Given that there are large sources of gas in various stages of development off of South Africa's shore, South Africa is in a good position to negotiate cost-competitive prices for gas supply. However, the 2014 Operation Phakisa report on the oil and gas sector states that a currency and commodity price risk exists for fuel in terms of Eskom's use of gas as "Eskom currently buys coal and sells electricity in ZARs. Gas prices are typically indexed against oil and priced in USD [United States Dollars]. This will require Eskom to buy fuel priced in USD and fluctuating with the price of oil but can only sell electricity in ZAR and priced in accordance with the MYPD [multi-year price determination]. This is currently too much of a risk for them" (Republic of South Africa Operation Phakisa Offshore Oil and Gas Exploration, 2014).

3.2.4 Renewable Energy

Another factor that may impact on a growing need for gas-powered electricity generation in the longer term, is the increased share of solar powered electricity in South Africa's energy mix.

The country's 2010 IRP calls for the generation capacity of 17 800 Megawatts (MW) from renewable energy sources by 2030. The Department of Energy (DoE), through the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP), by the end of its Round 4 Expedited Window, will have awarded around 8000 MW of renewable energy generation capacity. In February 2018, the Minister of Public Enterprises approved 27 utility-scale renewable energy projects consisting mainly of solar PV and wind projects. The agreements were signed into effect under the Minister of Energy in April 2018[3] and the Power Purchase Agreements became effective between April 2018 and 31 July 2018[4].

It is likely that there will be a need for new gas power stations in future due to the increased introduction of renewable energies (including solar energy) into the electricity grid and the Duck Curve (refer to **Annexure B** for further details on the Duck Curve). Essentially, gas powered stations may be required to meet peak demand at some time in the future (although it is difficult to predict when this need may exist in South Africa). However, other solutions to the Duck Curve include connecting multiple energy grids, battery storage power stations (the cost of which will decline as time goes on), and energy demand management interventions.

3.2.5 Allocation of gas powered generation in energy planning policies

The draft 2018 IRP (released in August 2018 by the Department of Energy for public comments) provides the following future energy mix detailed in Table 2, which includes an additional 8,100 MW of energy from gas/ diesel by 2030. The 2018 IRP considered four scenarios and their impact on the future energy mix: Electricity demand scenario, a gas scenario, a renewables scenario and an emissions constrained scenario. The energy mix for 2030 sees the decommissioning of old coal power plants reaching the end of their life.

The least cost scenario shows the new capacity coming on stream from 2019 onwards as illustrated in Table 2.

The costs of new generation technologies have come down - and this has resulted in reduced costs on wind and PV (photovoltaic) projects. Government has recommended the least cost plan, which favours wind, PV and gas. A total of 5,670 MW of energy will be derived from PV, 8,100 MW from wind and 8,100 MW from gas. By 2030, wind will account for 15% of installed capacity, gas 16% and PV 10%.

The Southern African Development Community (SADC) has an inter-State committee working on a gas master plan for the region to look at gas supply issues. Research indicates that the relevant Ministers signed a statement of intent regarding the gas master plan with an overall commitment to improve access to reliable and safe energy in the region, as well as to align the plan with the principles of the Energy

[3] https://www.fin24.com/Economy/Eskom/jeff-radebe-signs-long-delayed-renewable-power-deals-20180404
[4] https://www.iol.co.za/business-report/energy/brown-gives-eskom-the-ipp-go-ahead-13104895

Protocol, and the objectives of SADC Industrialization Strategy Framework[5]. From a national perspective, the Minister of Energy pointed out that it is important for South Africa's national energy plans to be reflected in the regional gas master plan[6].

The DoE's Liquefied Natural Gas (LNG) to Power Independent Power Producer (IPP) Programme aims to identify and select successful bidders and to enable them to develop, finance, construct and operate a gas-fired power generation plant at each of the two ports, Ngqura (up to 1000 MW) and Richards Bay (the balance of 3000MW). The successful bidder/s will also be required to put in place the gas supply chain to fuel the plant with gas from imported LNG. The LNG to Power IPP Programme will provide the anchor gas demand on which LNG import and regasification facilities can be established at various ports, including the Ports of Ngqura and Richards Bay. This will provide the basis for LNG import, storage and regasification facilities to be put in place that can be available for use by other parties for LNG import and gas utilisation development. Therefore, Third Party Access will be a fundamental aspect of the LNG to Power IPP Programme. This will enable the development of gas demand by third parties and the associated economic development (Department of Energy, Undated).

The scope of the projects for each port will include:

- LNG procurement and delivery;
- LNG storage and regasification facilities via a floating storage re-gasification unit (FSRU) or equivalent LNG regasification and storage technology (FSU plus offshore/land based regasification);
- Port infrastructure, including fixed maritime structures and modifications;
- Gas transmission pipelines to connect the FSRU (or equivalent LNG regasification and storage technology) with the new power generation facility;
- LNG and or gas distribution hub(s) for third party off take;
- Power plant, including the high voltage connection to the electrical grid; and
- Arrangements for independent delivery of LNG, and the sale of a modest percentage (5 %) of gas and LNG to external users.

Table 2 IRP 2018: Proposed Updated Plan for the Period Ending 2030 (Source: Department of Energy (2018). Draft Integrated Resource Plan 2018.)

	Coal	Nuclear	Hydro	Storage (Pumped Storage)	PV	Wind	CSP	Gas / Diesel	Other (CoGen, Biomass, Landfill)	Embedded Generation
2018	39 126	1 860	2 196	2 912	1 474	1 980	300	3 830	499	Unknown
2019	2 155					244	300			200
2020	1 433				114	300				200
2021	1 433				300	818				200
2022	711				400					200
2023	500									200
2024	500									200
2025					670	200				200
2026					1 000	1 500		2 250		200
2027					1 000	1 600		1 200		200
2028					1 000	1 600		1 800		200
2029					1 000	1 600		2 850		200
2030			2 500		1 000	1 600				200
TOTAL INSTALLED	33 847	1 860	4 696	2 912	7 958	11 442	600	11 930	499	2600
Installed Capacity Mix (%)	44.6	2.5	6.2	3.8	10.5	15.1	0.9	15.7	0.7	

Installed Capacity
Committed / Already Contracted Capacity
New Additional Capacity (IRP Update)
Embedded Generation Capacity (Generation for own use allocation)

[5] https://www.sadc.int/news-events/news/joint-meeting-sadc-ministers-energy-and-water-held-27th-june/
[6] http://www.engineeringnews.co.za/article/south-africa-to-align-energy-plans-with-sadc-gas-master-plan-2018-06-26

3.2.6 Evolving technologies: gas turbines

Evolving gas turbine technologies may also impact on the potential role that gas can play in terms of power generation in South Africa. Wärtsilä, a Finnish supplier of gas engine technology has completed modelling of the South African domestic power system and has argued that flexibility should be prioritised over project-level cost optimisation, as flexible gas solutions improve system reliability and enable greater levels of renewable energy to be introduced to the grid (Creamer, 20 January 2017).

Using power system modelling software to re-create the domestic power system, the company found that gas serves two key functions: displacing expensive diesel generation; and optimising inflexible coal generation.

3.2.7 Gas supply and potential demand

Operation Phakisa provides a summary of offshore oil and gas exploration potential supply and potential demand for gas, including gas-fired power generation capacity, along South Africa's coastline illustrated in Figure 1.

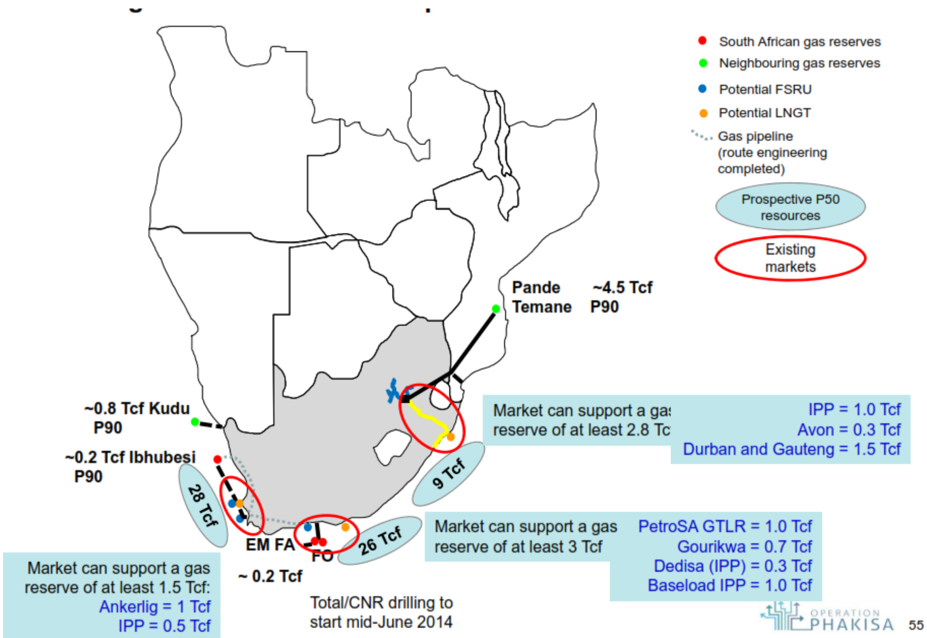


Figure 1. Offshore oil and gas exploration potential supply and potential demand for gas (including gas-fired power generation capacity) along South Africa's coastline (Operation Phakisa Offshore Oil and Gas Exploration, Republic of South Africa, 2014)

Current gas pipelines in South Africa include the 865 km Republic of Mozambique Pipeline Company (ROMPCO) Pipeline from the Pande/Temane gas fields in Mozambique to Secunda. At commissioning, these fields had a total P90 reserve (which means that there is a 90% probability that the quantities actually recovered will equal or exceed the estimated quantities) of 4.5 trillion cubic feet (Tcf). From Secunda, Sasol transmits the gas to Sasolburg and to industrial users in Gauteng. Transnet transmits methane-rich offshore gas from Sasol to Richards Bay and Durban via the Lilly Pipeline network.

South African offshore gas finds are limited to:

- PetroSA's FA and EM fields off the Mossel Bay coast (largely depleted, but with a tail that can still be utilised, provided other gas sources can be used to supplement the tail). PetroSA is also currently producing from the FO field, which has a P90 reserve estimate of 0.2 Tcf.
- Ibhubesi gas field: Sunbird Energy, the current developers plan to bring the gas to market in the Western Cape, i.e., via Eskom's Ankerlig Power Station. iGas has completed the route engineering for an onshore pipeline from the landing point (Abraham Villiersbaai) to Saldanha and Ankerlig. However, Sunbird is currently contemplating a subsea pipeline to these locations.
- The Kudu gas field in Namibia (0.80 Tcf P90), which remains unexploited. Past projects contemplated include an 800 MW power station in Namibia and a gas transmission pipeline to transmit the gas to market in the Western Cape, i.e., also via Eskom's Ankerlig Power Station.

Total is currently exploring off the Southern Coast of the country. Although the official press release from Total indicates a condensate find. A gas find in this region has significance for both the PetroSA Mossel Bay's gas-to-liquids refinery (GTLR), as well the Eskom Gourikwa OCGT; and for encouraging fast-tracked developments for the Coega Industrial Development Zone (IDZ).

According to Operation Phakisa, existing gas markets or markets that can be developed in the short term (within 5 years) include the following (Republic of South Africa, 2014):

West Coast (1.5 Tcf)

- Eskom's Ankerlig OCGT in Atlantis, fuelled by diesel, but with burners converted to use both diesel and gas and plans for the conversion of 5 units to CCGT (1 Tcf). This power station, located on the west coast of the Western Cape, is strategically placed should the opportunity to use natural gas arise in the future.
- Potential IPP in the Saldanha IDZ (0.5 Tcf).

South Coast (3.0 Tcf):

- PetroSA's GTLR in Mossel Bay (1 Tcf).
- Eskom's OCGT in Mossel Bay, currently also fuelled by diesel, but with burners converted to duel fuel (gas and diesel) and the conversion of 2 units to CCGT (0.7 Tcf).
- The Dedisa IPP OCGT peaking power plant in the Coega IDZ – currently fuelled by diesel, but that also use natural gas fuel (0.3 Tcf).
- An IPP mid-merit power station of ~2,400 MW at Coega (1 Tcf).

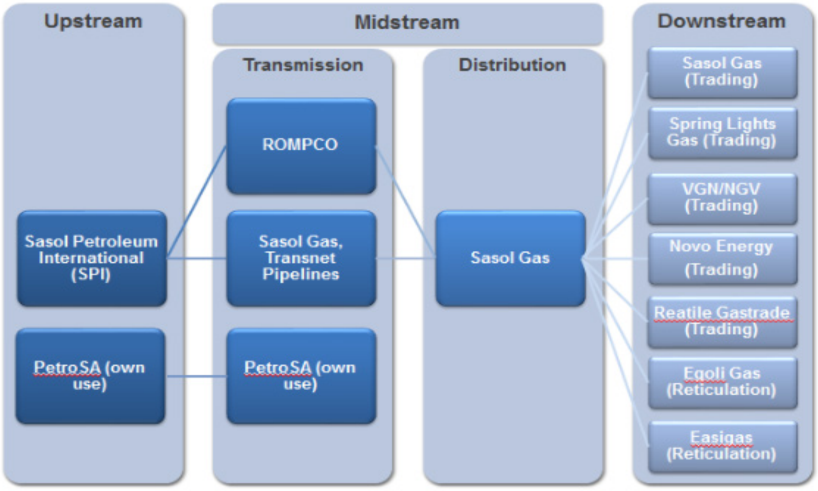
East Coast (minimum of 2.8 Tcf)

- Existing Durban, Richards Bay and Gauteng markets via reverse flow up the Lilly Pipeline or a new gas transmission pipeline to Gauteng (1.5 Tcf).
- The Avon IPP OCGT peaking power plant south of Richards Bay – currently fuelled by diesel, but which can also use gas and fuel (0.3 Tcf).
- A minimum 1,600 MW baseload IPP in Richards Bay (1 Tcf). As aging coal-fired power stations in Mpumalanga are retired, this can be increased depending on the gas availability.

P50 gas resources (which means that there is only a 50% probability that the quantities actually recovered will equal or exceed the estimated quantities) in South African waters are as follows:

- 28 Tcf off the West Coast.
- 26 Tcf off the South Coast.
- 9 Tcf off the East Coast.

Gas markets therefore exist to support exploration in South African waters. The current market structure for pipeline gas in South Africa is as follows (Figure 2):



Note: There are newly licenced operators in the market. These include Molopo which was granted operation and trading licences in the Virginia area of the Matjhabeng Local Municipality of the Free State Province; Spring Lights Gas – CNG which was granted a licence for construction and the operation of the storage facility in KwaZulu-Natal as well as a trading licence; and Columbus Stainless Steel granted a licence for the operation of the pipeline and trading licences in Mpumalanga. These licensees have not been included in the figure above as they have been licenced quite recently and have not commenced operations.

Figure 2. Current markets for pipeline gas in South Africa (Genesis Analytics, 2015)

4. Overview of sectors where opportunities for growing gas demand exist in South Africa.

The dti (2017) sees the gas economy developing in three broad phases over the next 15 years and beyond. The first phase (over the next 3-5 years) is focused on imported LNG (Figure 3). This is followed by the importation of regional gas from offshore gas reserves in Phase 2 in the next 7-15 years. Phase 3 (in about 15 years' time) sees the addition of onshore domestic gas reserves to the energy mix.

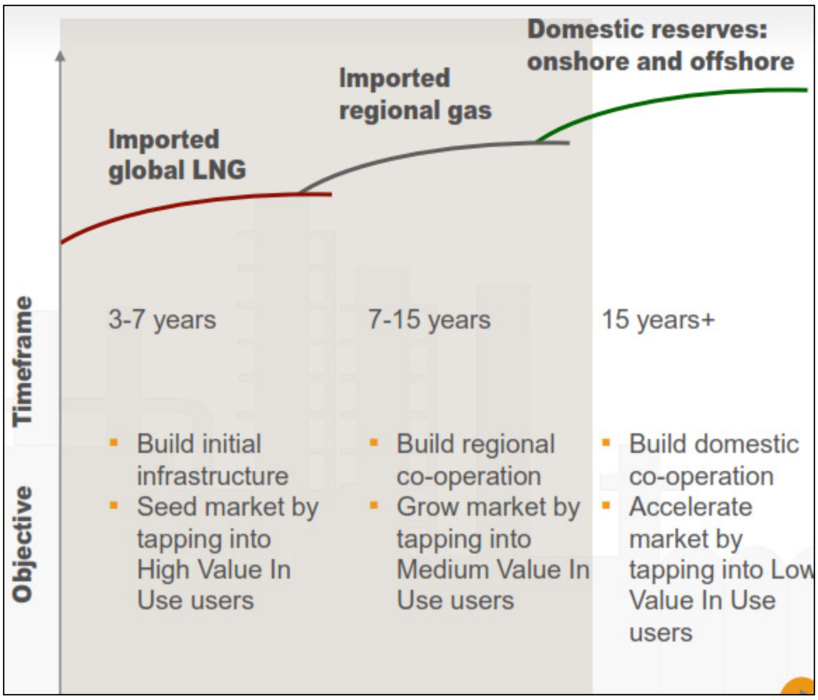


Figure 3. Gas economy developing in three broad phases over the next 15 years and beyond (dti, 2017)

This section discusses opportunities in the following sectors where potential to increase gas demand exists:

1. Electricity generation.
2. Industry and mining.
3. Transportation.

The residential sector is not discussed in any detail, however, it must be noted that potential exists to expand residential demand and that this may impact on reducing the demand for electricity as this takes place.

A critical issue impacting on the nature of future demand for gas is the price of gas and how this differs between LPG and LNG. The complexities of gas prices include the client-specific demand characteristics and requirements. While many view the price of gas as being slightly cheaper than coal (see Section 1.1), this view is not necessarily shared by all role-players in South Africa. There may therefore be value in clarifying the gas-coal price differential (based on certain scenarios and assumptions) so that transparent pricing information can be shared between energy decision-makers in South Africa. Given that the price of gas is seen as linked to the Rand/Dollar exchange rate, an exchange rate risk is also seen to exist in terms of the price of gas. Finally, there are a range of costs along the gas logistics chain (such as transportation as well as gas storage and distribution infrastructure located at the customer) which also need to be taken into account when determining final gas prices to the customer.

It would appear that there is a need for greater transparency and availability of information regarding gas prices in different demand scenarios so as to ensure that ongoing exploration of gas opportunities is informed by pricing information that is as transparent as possible.

4.1 Electricity generation

At the time of writing this report (i.e. Appendix 1 of Part 1 of the SEA Report, February 2018), the South African Department of Energy had not yet released its revised IRP. Both the National Development Plan (National Planning Commission, 2013) and the draft IRP (Department of Energy, November 2016) indicates the intention to diversify South Africa's energy production mix and introduce gas fired electricity generation into this mix. Currently, gas represents approximately 3% of South Africa's total energy mix (Department of Energy, January 2013). Figure 5 illustrates Eskom's existing power stations, including four gas turbine plants (two of which are run by IPPs).

Eskom is currently facing large-scale financial challenges, in part due to its large-scale investments in the Kusile and Medupi coal-fired power stations and in part due to lower than requested increases in electricity tariffs. Eskom's financial challenges may be exacerbated into the future given that it has signed Power Purchase Agreements (PPAs) at a cost of R2.50/kWh and it is now possible (according to one informant interviewed) to sign such PPAs at a cost of R0.44c/kWh. As the cost of solar power continues to fall, it is likely that larger numbers of businesses and residential users will switch to solar and that this will further undermine Eskom's future sales and revenue growth.

The feasibility of Eskom being able to upgrade existing gas turbine power stations to utilise gas has been called into question given the large investment amounts required for these upgrades (According to Eskom, R1.5bn is required to fully upgrade the Gourikwa and Ankerlig power stations). Eskom's recent expenditure on diesel is illustrated below with R340 million being spent in 2016/17; R638 million projected for 2017/18 and R691 million for 2018/19 (it is unclear if all or only a proportion of this expenditure is incurred for Ankerlig and Gourikwa Power Stations): Eskom has indicated that it needs gas supply agreements that are flexible and not based on bulk supply agreements.

Eskom's 2017 view of future power stations is illustrated in Figure 4.

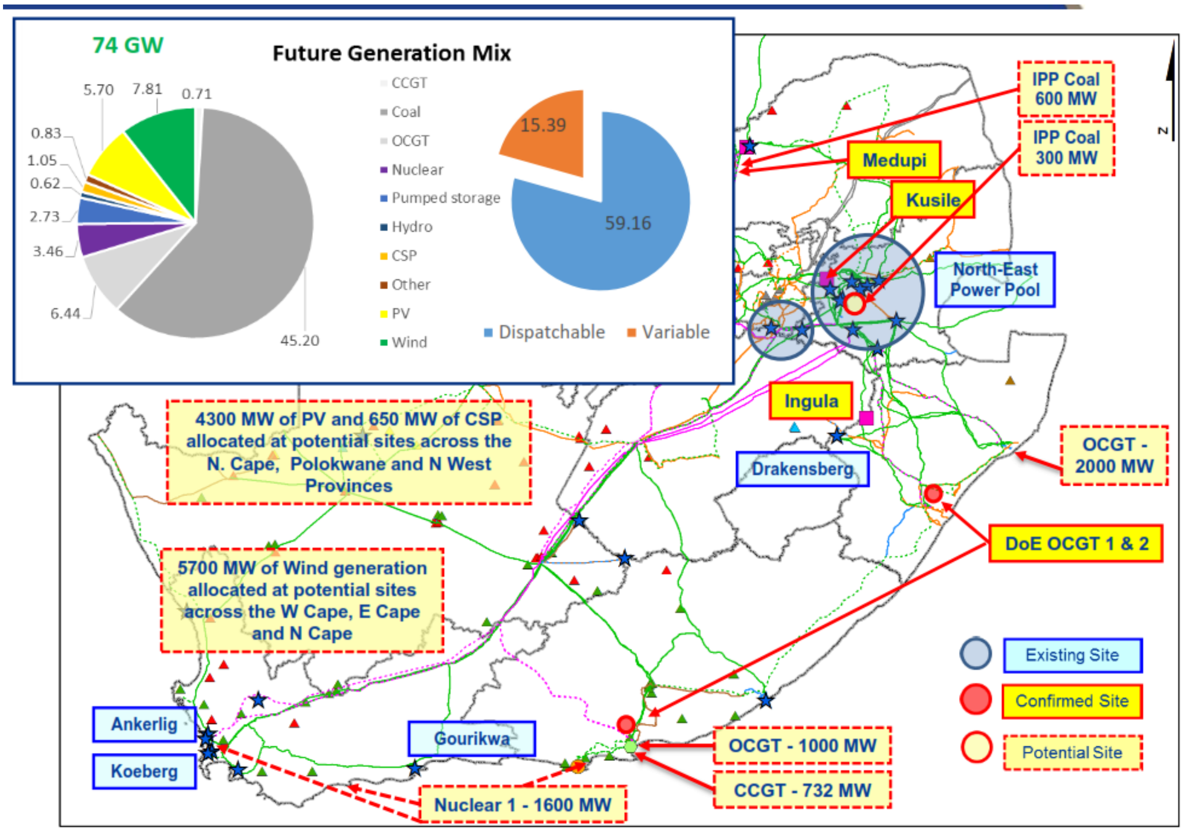


Figure 4. Eskom's 2017 view on potential future power stations. Source: Eskom (October 2017).

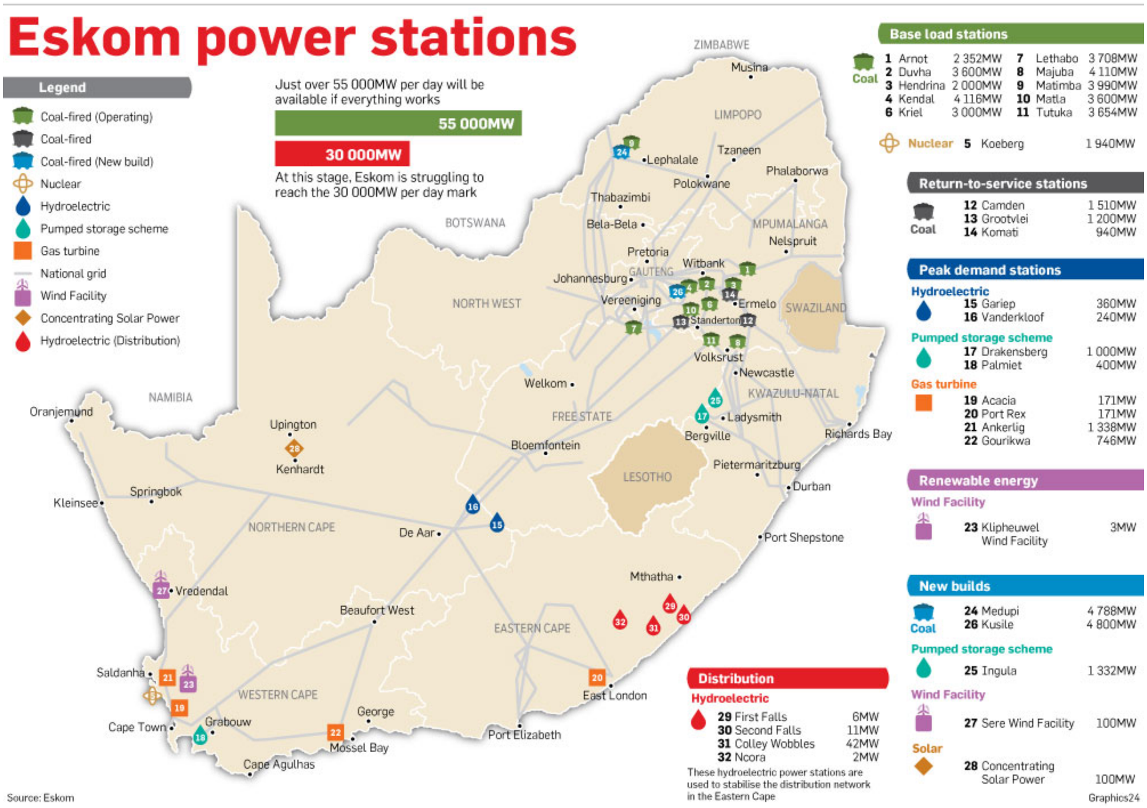


Figure 5. Eskom's current power stations: 2017. Source: Eskom (October 2017).

Table 3. Eskom's detailed primary energy cost for 2016/17 and projected primary energy costs for 2017/18 – 2018/19

	Actuals	Projections	Application
Primary energy costs R'million	2016/17	2017/18	2018/19
Coal usage	44 164	45 642	48 687
Coal obligations provisions	488		1 304
Water usage	1 751	2 185	2 310
Fuel & Water procurement service	163	211	223
Coal handling	1 758	1 874	1 974
Water treatment	423	465	490
Sorbent usage	-	36	63
Gas and oil (coal fired start-up)	2 216	2 268	2 405
Total coal	50 963	52 681	57 456
Nuclear	727	808	865
Coal and gas (Gas-fired)	10	8	9
OCGT fuel cost	340	638	691
Demand Market Participation	194	301	319
Total Eskom generation	52 234	54 436	59 340
Environmental levy	8 087	8 152	7 994
IPPs	21 720	24 450	34 209
International Purchases	2 681	3 127	3 216
Total primary energy	84 722	90 165	104 759

Source: Eskom (August 2017).

Given Eskom's financial challenges[7], it is likely that future gas powered stations may emerge from the IPP process and be driven by large energy intensive users. This will depend in part on the differences in gas and coal supply scenarios. Eskom has begun discussions with various entities to explore the possible supply of gas from Mozambique fields, but these have not yet provided an indication of possible gas supply prices.

Gas and electricity system modelling conducted by the Energy Research Centre at the University of Cape Town (Mervan et al., 2017) has shown that there is a drastic reduction in demand for gas use for power generation at a gas price point of USD$11/MBTU but that below this price point there could be a strong role for gas to play in the future power generation system).

The expansion of South Africa's gas pipeline is seen as a pre-condition for servicing and growing demand for gas in South Africa and Operation Phakisa has established a national task team to take this process forward as part of unlocking a range of opportunities in the Ocean Economy. A draft Gas Utilisation Master Plan (GUMP) was developed in 2014/15 and is reportedly in the process of being updated by the DoE (although this has not been officially confirmed at the time of writing this report in February 2018) and will provide South Africa with a long term gas plan.

This report has not assessed the scope for municipal electricity generation using gas. For example, it is known that the City of Cape Town has done studies on the feasibility of using gas for electricity generation (key informant interview) and is in the process of assessing the results. There may be opportunities for municipalities to grow their demand for gas for electricity generation, however, the scope for such demand will require further research and inputs from municipalities (various municipal studies in this regard have been conducted).

4.2 Industry and Mining

Industries are attracted to switching to gas because of the possible price advantages and supply security (which is a major potential attraction since it allows the company to go off the grid). However, the conversion costs for industrial users serve as a potential constraint to switching energy sources. As a result, it is difficult to identify at what cost gas switching is an attractive option for industrial users as the conversion costs first need to be identified and built into a feasibility assessment.

A number of selected existing large industrial users are located in Gauteng, KwaZulu-Natal (KZN) and Mpumalanga (Table 4).

Table 4. Selected existing large industrial users are located in Gauteng, KZN and Mpumalanga

Company	Manufacturing Facility	Location	Province
Acerlor Mittal	ArcelorMittal South Africa Coke & Chemicals (Vanderbijlpark)	Delfos Boulevard Vanderbijlpark	Gauteng
Ceramic Industries	Gryphon Factory	Farm 2, Old Potchefstroom Road Vereeniging, 1939	Gauteng
Consol	Wadeville Factory	Consol House, Osborn Road, Pretoria, Gauteng	Gauteng
Ferro SA	Enamel Factory	12 Atomic Street, Vulcania, Brakpan	Gauteng
Nampak	Nampak Can	Du Plessis Road, Springs	Gauteng

[7] According to one article, "Eskom's current debt is R350bn and it needs to raise perhaps another R150bn over the next three to four years. This is almost certainly impossible, even with a government guarantee." Source: https://www.businesslive.co.za/bd/opinion/2018-01-22-selling-assets-and-embracing-wind-and-solar-can-solve-eskom-woes/

Company	Manufacturing Facility	Location	Province
PFG Building Glass	Head Office Springs	216 Industry Road, New Era Springs	Gauteng
SAB	SAB Chamdor	Alrode, Alberton	Gauteng
Illovo Sugar	Sezela Plant	Cnr Smuts & Mill Road, Scottburgh, Scottburgh/Umzinto North	KZN
Mondi	Mondi Merebank	Travancore Dr, Merebank East, Merebank	KZN
NCP Alcohols	Head Office Durban	121 Sea Cow Lake Rd Durban	KZN
Columbus Steel	Middelburg Mpumalanga Factory	Hendrina Rd, Middelburg, 1050	Mpumalanga

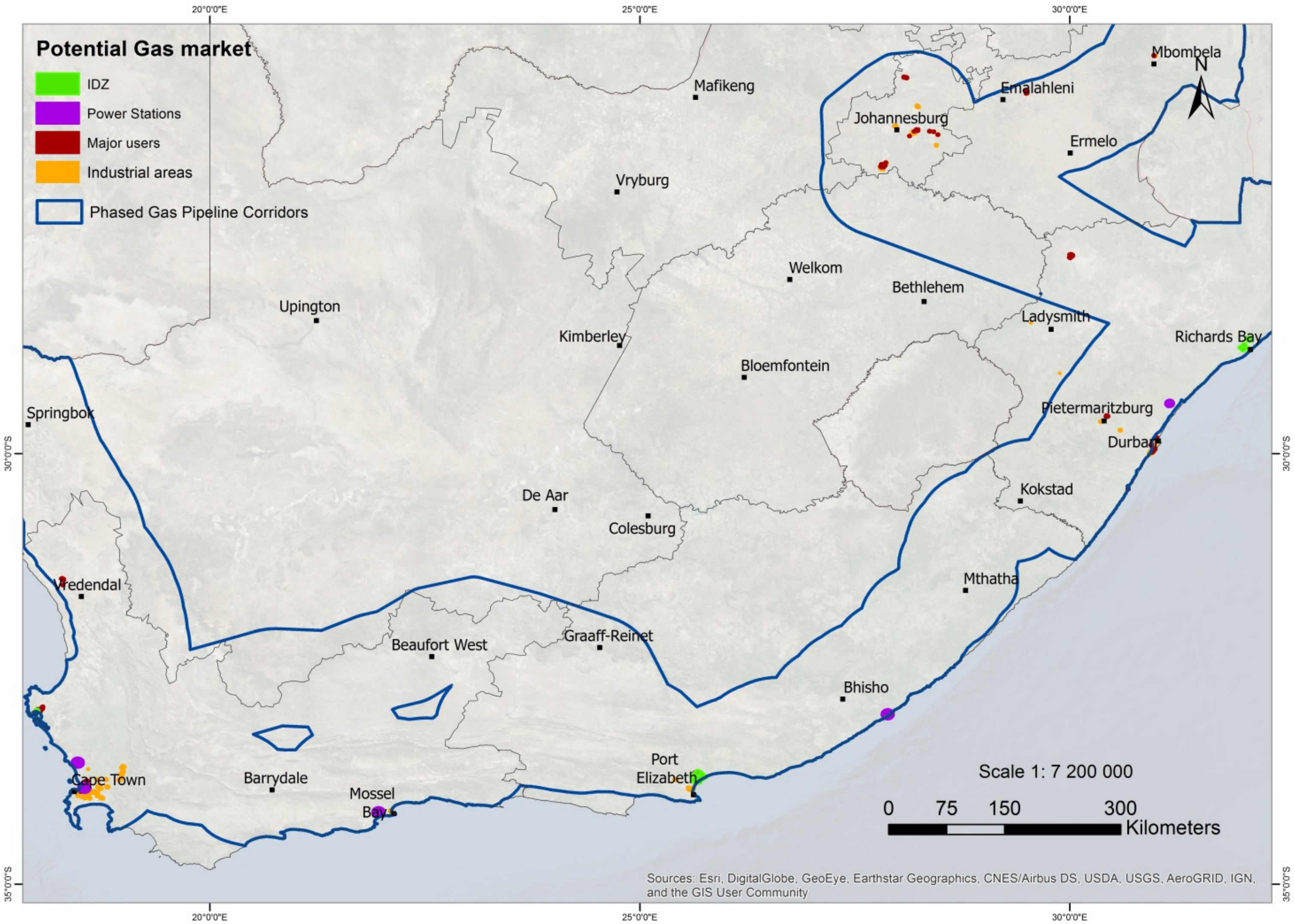


Figure 6. Existing large industrial energy users that could potentially convert to Gas (excludes Mining and Agriculture)

Potential industries also exist at the Saldanha IDZ, Coega IDZ, and Richards Bay IDZ. The 2013 Western Cape Demand assessment found that the industrial potential demand was in the order of 20 million GJ p.a. as follows: "The existing industrial markets which could potentially be converted to natural gas were found to be mostly concentrated in the Cape Town, Atlantis and Saldanha Bay regions. Cape Town, Paarl and Wellington have the largest concentration of "switchable" industries and accounted for about 23 percent, or 20 million GJ per annum".

PetroSA believes that a constraint to industrial users converting to LNG in Saldanha is the absence of a storage facility at the port and the need for such customers to finance and build storage infrastructure on site to provide for 10 days' supply. Building an LNG storage tank at the port as well as a pipeline will reduce the conversion cost for large industrial users and enhance the feasibility of switching to gas (key informant interview).

PetroSA has identified that a LNG opportunity exists in the Mossel Bay/Western Cape/ Eastern Cape sub-region and believes that there are approximately 15 potential large user clients for LNG within a 500 km radius of Mossel Bay. These include automotive companies such as Daimler Chrysler in East London who have expressed a desire to convert to LNG use. A major challenge to converting manufacturers is production down time. PetroSA is looking for clients that will use between 5-7 tonnes of LNG a day. The major challenge in creating this market are the tanker transport costs to service it as the transport costs in servicing one client with one tanker day are large, however, economies of scale can be achieved when smaller clients are also served at the same time. So the more clients serviced, the greater the economies of scale as transport costs are reduced.

The South African dti commissioned a detailed KZN market demand study in 2017. This anchor demand could catalyse latent demand from Industry and Transport in KZN. Gas demand from Industry and Transport is 24 Petajoules (PJ) in the short-term (3-7 years) and 47 PJ in the long-term each with their own dynamics.

There are also mining operations using smelters where there may be an opportunity to convert to gas use. However, detailed feasibilities on these will be required based on identifying all the conversion costs as well as operation disruption issues. No audit has been conducted of the mining conversion opportunities in South Africa.

Refer to Figure 6 for an indication of existing large industrial energy users that could potentially convert to gas (excluding mining and agriculture).

4.3 Transportation sector (road logistics, mini-bus taxis and bus public transport, and shipping)

There is growing use of gas in many segments of the transport sector, including: bus, taxi, road freight, and shipping. Globally, many countries are now setting sales targets for the sale of electric-powered motor vehicles and the phasing out of petrol and diesel powered vehicles (Gray, 26 September 2017). The growth in natural gas powered vehicles appears to be negatively correlated with increases in the oil price (see Figure 7 below) (dti, 2017).

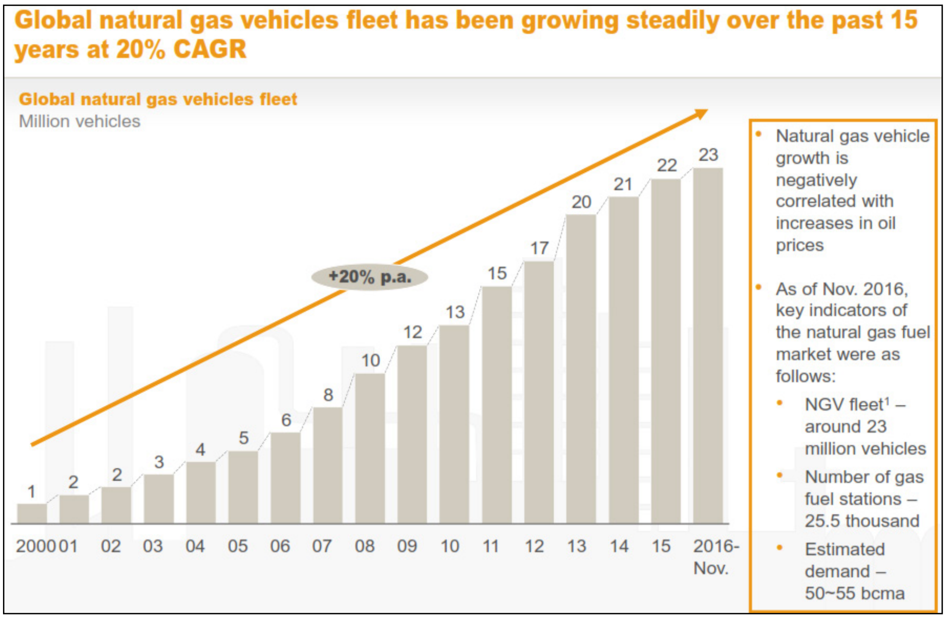


Figure 7. Growth of global natural vehicles fleet (2000-2016) (dti, 2017)

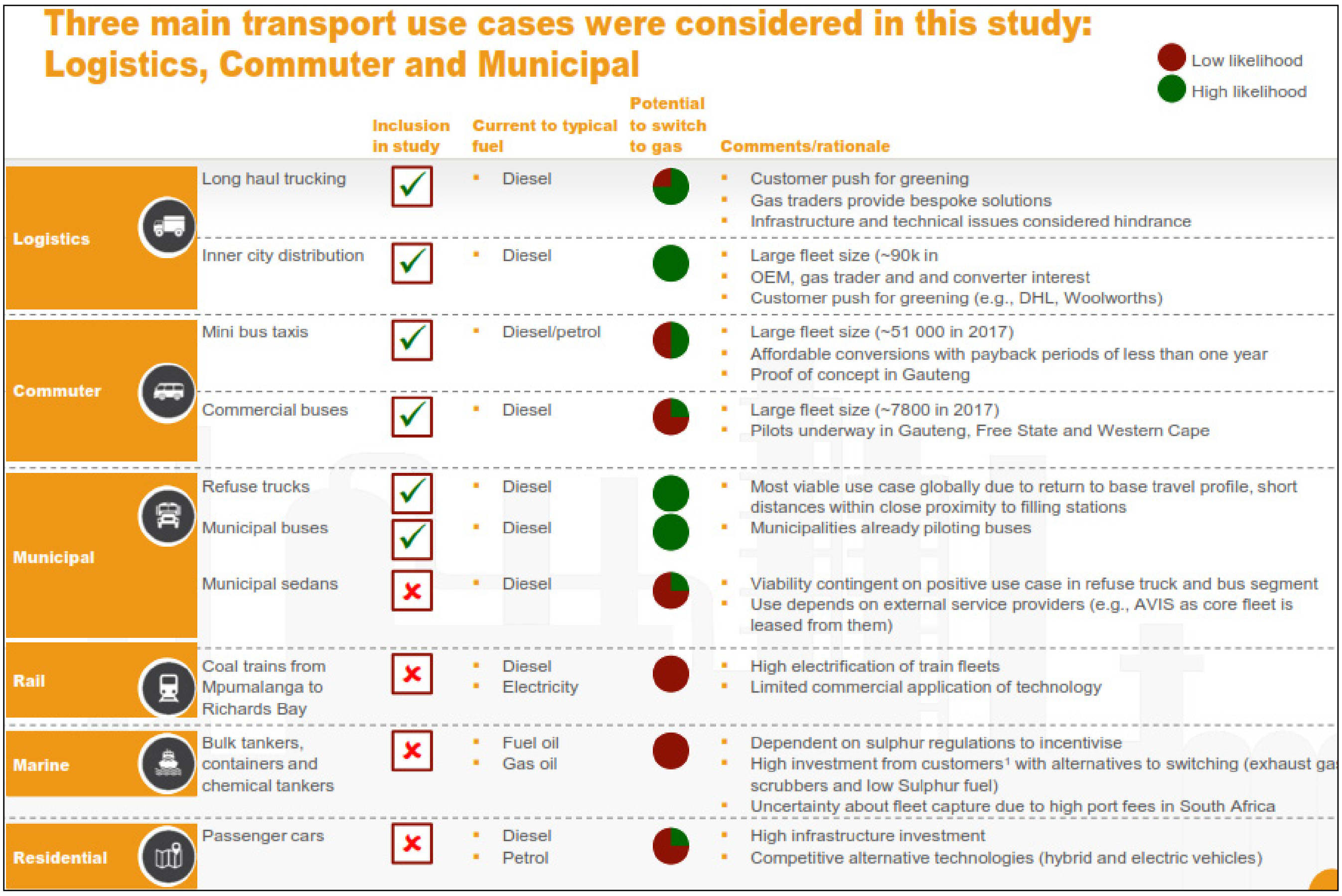
The dti's 2017 transportation sector gas demand assessment identified the main transport sector opportunities as represented in Figure 8 (dti, 2017).

In addition, the study identified barriers to switching to gas use as well as scenarios for the number of vehicles that may switch to gas in the different sub-sectors (Figure 9).

The dti transport demand assessment found that international experience showed that government support in four areas was required to support the successful adoption of gas in the transport sector:

1. Provide policy direction, especially in light of competing technologies (e.g. electric vehicles).
2. Guarantee gas supply at a specific price.
3. Minimise cost of switching (e.g. retrofitting subsidy).
4. Create a local market (e.g. infrastructure, part supply, servicing centres) to minimize vehicle downtime.

In South Africa, the application of the fuel levy by the Department of Transport reduces the price advantage of gas over diesel from 57% to 35% by adding R1.48 to the gas price (using the levy used for bio fuels) (this decreases transport demand by 10% according to the dti study). Transport operators estimate that <40% price differential erodes the adoption of gas.

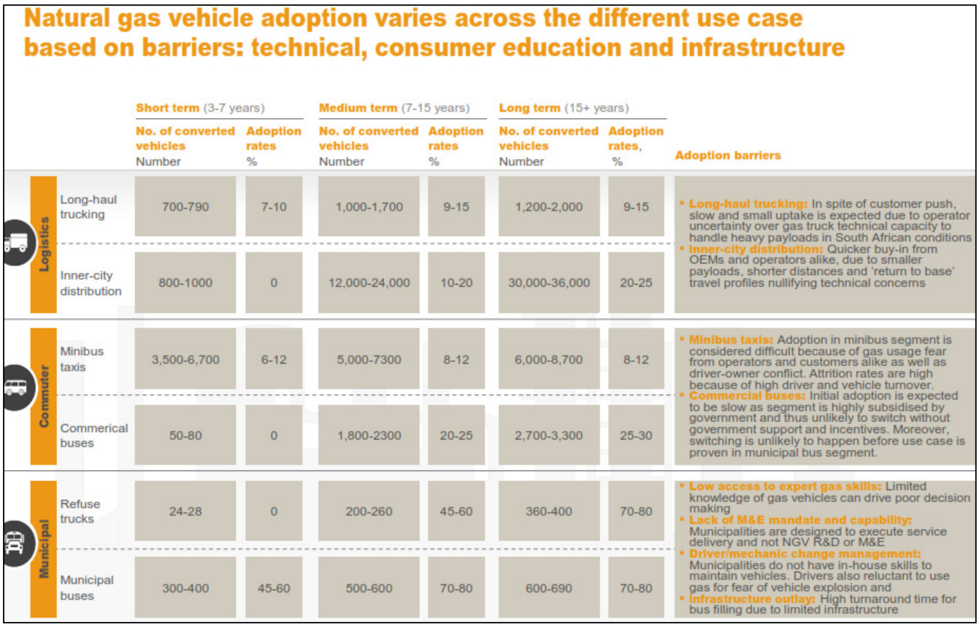


Three main transport use cases were considered in this study: Logistics, Commuter and Municipal

Low likelihood / High likelihood

		Inclusion in study	Current to typical fuel	Potential to switch to gas	Comments/rationale
Logistics	Long haul trucking	✓	Diesel		Customer push for greening; Gas traders provide bespoke solutions; Infrastructure and technical issues considered hindrance
	Inner city distribution	✓	Diesel		Large fleet size (~90k in; OEM, gas trader and and converter interest; Customer push for greening (e.g., DHL, Woolworths)
Commuter	Mini bus taxis	✓	Diesel/petrol		Large fleet size (~51 000 in 2017); Affordable conversions with payback periods of less than one year; Proof of concept in Gauteng
	Commercial buses	✓	Diesel		Large fleet size (~7800 in 2017); Pilots underway in Gauteng, Free State and Western Cape
Municipal	Refuse trucks	✓	Diesel		Most viable use case globally due to return to base travel profile, short distances within close proximity to filling stations
	Municipal buses	✓	Diesel		Municipalities already piloting buses
	Municipal sedans	✗	Diesel		Viability contingent on positive use case in refuse truck and bus segment; Use depends on external service providers (e.g., AVIS as core fleet is leased from them)
Rail	Coal trains from Mpumalanga to Richards Bay	✗	Diesel; Electricity		High electrification of train fleets; Limited commercial application of technology
Marine	Bulk tankers, containers and chemical tankers	✗	Fuel oil; Gas oil		Dependent on sulphur regulations to incentivise; High investment from customers[1] with alternatives to switching (exhaust ga scrubbers and low Sulphur fuel); Uncertainty about fleet capture due to high port fees in South Africa
Residential	Passenger cars	✗	Diesel; Petrol		High infrastructure investment; Competitive alternative technologies (hybrid and electric vehicles)

Figure 8. SA Transport sector gas demand opportunity assessment (dti, 2017)



Natural gas vehicle adoption varies across the different use case based on barriers: technical, consumer education and infrastructure

		Short term (3-7 years)		Medium term (7-15 years)		Long term (15+ years)		
		No. of converted vehicles Number	Adoption rates %	No. of converted vehicles Number	Adoption rates %	No. of converted vehicles Number	Adoption rates, %	Adoption barriers
Logistics	Long-haul trucking	700-790	7-10	1,000-1,700	9-15	1,200-2,000	9-15	Long-haul trucking: In spite of customer push, slow and small uptake is expected due to operator uncertainty over gas truck technical capacity to handle heavy payloads in South African conditions; Inner-city distribution: Quicker buy-in from OEMs and operators alike, due to smaller payloads, shorter distances and 'return to base' travel profiles nullifying technical concerns
	Inner-city distribution	800-1000	0	12,000-24,000	10-20	30,000-36,000	20-25	
Commuter	Minibus taxis	3,500-6,700	6-12	5,000-7300	8-12	6,000-8,700	8-12	Minibus taxis: Adoption in minibus segment is considered difficult because of gas usage fear from operators and customers alike as well as driver-owner conflict. Attrition rates are high because of high driver and vehicle turnover.; Commercial buses: Initial adoption is expected to be slow as segment is highly subsidised by government and thus unlikely to switch without government support and incentives. Moreover, switching is unlikely to happen before use case is proven in municipal bus segment.
	Commerical buses	50-80	0	1,800-2300	20-25	2,700-3,300	25-30	
Municipal	Refuse trucks	24-28	0	200-260	45-60	360-400	70-80	Low access to expert gas skills: Limited knowledge of gas vehicles can drive poor decision making; Lack of M&E mandate and capability: Municipalities are designed to execute service delivery and not NGV R&D or M&E; Driver/mechanic change management: Municipalities do not have in-house skills to maintain vehicles. Drivers also reluctant to use gas for fear of vehicle explosion and; Infrastructure outlay: High turnaround time for bus filling due to limited infrastructure
	Municipal buses	300-400	45-60	500-600	70-80	600-690	70-80	

Figure 9. Barriers for the transport sector to switch to gas. Source: dti (2017)

A number of initiatives are underway in transportation/ road logistics, the taxi sector, and the bus/public transport sector in South Africa and which involve the use of LPG, LNG and Compressed Natural Gas (CNG). In a properly tuned engine, gas combustion delivers lower carbon and GHG emissions compared with the cleanest petrol engines. LPG is more cost effective than diesel or petrol due to lower costs per litre as well as great fuel-efficiency. Fuel consumption on smaller vehicles is around 4 litres/100 km.

A 2015 report[8] states that "…there are less than 10 filling stations in South Africa that offer CNG or LPG re-fuelling facilities to supply gas to motor vehicles. The current number of stations is greater than this, but is not known. The Automotive Industry Centre (AIDC), Sasol and Sabtaco have been driving an initiative to convert taxis in Gauteng. Gauteng has over 32,000 min-bus taxis and there are over 200,000 mini-bus taxis in South Africa.

The following example shows the initiative of one company that has been involved with upgrading taxis to use LPG in Gauteng- to incentivise the process, taxis receive a conversion kit worth about R15 000 at no cost:

Versus Autogas Equipment, has already converted more than 100 minibus taxis from the Johannesburg Southern Suburbs Taxi Association - based in Eldorado Park - and the Randburg United Local and Long Distance Taxi Association. The company installs the required equipment, including an 80-litre LPG tank, in the taxis and turns them into hybrid vehicles that run on both LPG and petrol. One of the people who had his taxi converted is owner/driver Flyman Stanley, 37, who has been a taxi driver for the past 15 years, and bought his first minibus taxi in April 2016. Describing the savings he has accrued since converting his vehicle in November 2016, Stanley said he used to spend approximately R850 a day for a full tank of petrol, which is 50 litres, but now spends about R740 to fill up his 80-litre gas tank, which lasts him longer than the petrol. The price of the LPG is R9.50 a litre.

Gas is currently being used in the Johannesburg Metro bus network:

The Company has in partnership with the University of Johannesburg undertaken a pilot project aimed at converting some of the current diesel run buses to Dual Diesel Fuel, a technology that allows for substitution of diesel with natural gas, which has lower carbon emissions. This project is a first in South Africa, and the company aims to be the leader by developing a Centre of Excellence on Natural Gas vehicle conversions. In the financial year 2014-2015, the company converted 30 buses, thereby contributing positively on the climate and giving the aged buses a new lease of life. As of December 2017[9], Metrobus reported that 150 buses had been retrofitted as dual fuel buses as part of its efforts to minimize the impact of carbon emissions into the environment[10].

This is also under consideration in Cape Town (key informant interview).

Road freight: According to one source interviewed, there will be 12 gas trucks operational in 2019 in Gauteng. There appears to be growing demand in the transport sector to switch from diesel to gas. The established road haulage companies in South Africa are evaluating whether they switch their fleets to electric or gas powered vehicles. The Western Cape Government has just initiated (as of February 2018) a study into the potential for gas demand in the Western Cape transportation sector (key informant interview).

Shipping: Gas carriers around the world have been using LNG as part of their fuel source for decades. Ships entering harbours will also require LNG to power them due to environmental issues at the ports of Saldanha, Cape Town, Durban and Coega. Driven by tougher international and environmental standards, LNG is being termed as the fuel of the future. According to experts, large scale shipping is believed to be sourced by LNG in the near future. LNG offers huge advantages, especially for ships in the light of ever-

[8] http://www.efm.co.za/Media/Documents/pdf/Case-Study-LPG/Auto-Gas-for-Mobility-March-2015.pdf
[9] https://www.mbus.co.za/images/quotations/Metrobus_mid-year_performannce_assessment_report.pdf
[10] https://www.mbus.co.za/index.php?option=com_content&view=article&id=86&Itemid=87

tightening emission regulations. LNG fueled ships are able to reduce sulphur oxide emissions by 90%-95%. This reduction level has also been mandated within the so-called Emission Control Areas (ECAs) by 2015[11]. A similar reduction will be enforced for worldwide shipping by 2020 (Man Diesel and Turbo, undated). Due to lesser carbon content in LNG, release of the harmful carbon dioxide gas is reduced by 20%-25%. While different technologies can be used to comply with air emission limits, LNG technology is a way to meet existing and upcoming requirements for the main types of emissions (SOx, NOx, PM, CO_2).

A few global examples of the use of LNG in shipping include the following:

Wärtsilä, a major ship engine maker has developed and completed conversion from oil-run engines to LNG powered. Such duel fuel engines have now been implemented in several cargo ships. M/V Bit Viking is considered the largest of the vessels afloat and in service with approximately 25,000 dwt powered by LNG. Similarly, M/S Viking Grace is the largest passenger vessel to use LNG fuel. After almost a decade in development of LNG technology, presently, approximately 30 floating vessels are LNG fueled and servicing the European waters (Singh, 2016)

5. Discussion of potential benefits (and linked issue) and impacts of growing gas demand in South Africa.

5.1 Potential Benefits

The expanded use of gas in South Africa's energy mix has a number of potential national benefits. These include the following:

a) **Macro-economic and balance of payments** benefits as a result of reducing the need for imported oil and petroleum-based products to meet the country's growing petroleum demand (mainly transport demand). However, concern has also been expressed that increasing the importation of LNG could have negative balance of payments impacts. There is a need to conduct further macro-economic modelling of various future energy scenarios to better understand the possible macro-economic impacts of these scenarios.

b) **Electricity system benefits**:
Supplementing South Africa's energy mix with natural gas through gas powered electricity generation will have energy system benefits and positive implications for the energy price, energy supply, energy security, environmental emissions, and the overall economy, including:

- Achieving faster growth in energy generation targets than the current energy split;
- Lower energy costs due to the cost-competitive price of gas and which can have further knock-on benefits include reducing inflation pressure as well as enhancing the global competitiveness of export-oriented energy intensive industries in South Africa (e.g. metals) as well as domestic industries supplying the agriculture sector (e.g. fertilisers);
- Ensuring system balancing by supporting flexible, dispatch able generation. Gas supports a quick response energy system where power generation stations can be rapidly started to respond to increases in peak consumption;
- Supports the expansion of renewable energy - gas enables renewables to make a larger contribution to the power generation mix. The availability of fast-ramping gas-fired CCGT plants in the Western Cape region could greatly enhance the grid stability; and
- Improve security of electricity supply and reduce transmission losses. In the Western Cape alone it is estimated that gas-fired CCGT plant(s) would significantly reduce the current requirement to

[11] The ECAs are as follows: The Baltic Sea, the North Sea and the North American Area (coastal areas of the United States (including the United States Caribbean Sea (specifically areas around Puerto Rico and the United States Virgin Islands) and Canada)).

import around 2050MW of capacity from Mpumalanga at peak times. Estimated transmission losses of around 200MW could also be saved, potentially releasing over 2200MW of coal-fired power capacity for use inland (Viljoen, 2013).

c) **Enable private sector investment in power generation and reduce pressure on the fiscus**: LNG imports can enable private sector investment in power generation, reducing pressure on the fiscus. Gas-fired CCGT plants have some key technical advantages over other forms of generation. Gas-fired CCGT plants are relatively small modular plants that typically take between 24 and 36 months to deploy. Large lumpy power investments like nuclear power plants and mega- coal plants by contrast can take more than 10 years to build and are associated with significantly higher financial, operational and construction risk. Nuclear plants and mega-coal projects are seldom financed without some government support - be it direct support in the form of debt or equity, or indirectly through the provision of financial guarantees. Imports of LNG could therefore contribute to increasing private sector participation and investment in electricity generation in South Africa thereby reducing the burden on the fiscus (Deloitte, 2015).

d) **Environmental benefits through a reduction in CO_2 emissions**: LNG is likely to grow in importance as a fuel of the future due to its lower CO_2 emissions when compared to coal and petroleum liquids. As an example, calculation of potential CO_2 emission reductions: Assuming that the additional 9500GWh of gas-fired electricity output in the Western Cape would reduce the requirement to import coal-fired electricity from Mpumalanga by the same amount each year, approximately 3.8 million tons of CO_2 emissions would be saved annually (Deloitte, 2015). In addition, substantial CO_2 reductions from the increased use of gas in the transport, mining, and industrial sectors would further contribute to lower CO_2 emissions.

e) **Environmental benefits through reduced water usage**: Of all the forms of power generation, natural gas-fired CCGT plants have some of the lowest consumption of water per unit of electricity generated, in part because of their relatively high thermal efficiency.

f) **Industrialisation and mining benefits:** These benefits include direct job creation impacts in oil and gas-related firms/ value chains, as well as indirect benefits experienced by large energy intensive industries and mines that are subject to international competition (and often involved in or linked to exports) potentially having access to competitively priced energy from gas and which supports their global competitiveness.

Operation Phakisa and the dti argue that the development of gas could support South Africa's industrialisation as a result of competitively priced energy and stable energy supply (Figure 10):

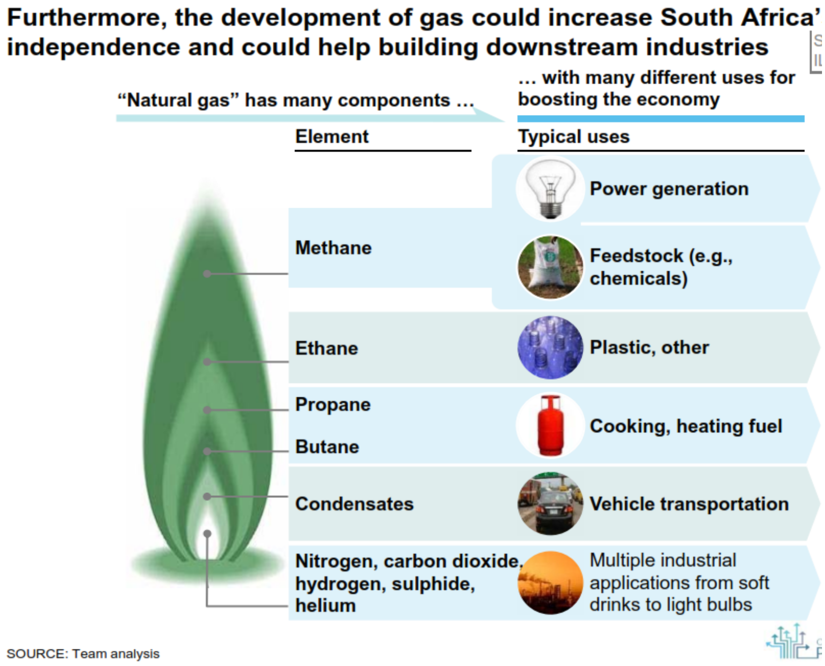


Figure 10. Simplified Illustration of the Opportunities to downstream users in using gas (Source: Operation Phakisa Offshore Oil and Gas Exploration, Republic of South Africa, 2014)

5.2 Potential Impacts

Work conducted on the Oceans Economy in South Africa estimates that the oil and gas and aquaculture sectors (of which gas is a sub-sector) have the potential to create between 500,000-700,000 jobs by 2030[12]. Operation Phakisa has outlined the following possible scenario relevant to understanding selected possible benefits:

The Offshore Oil and Gas Lab has set an aspiration of achieving 30 exploration wells in the next 10 years. Assuming that South Africa could achieve production levels of 370 thousand barrels of oil and gas per day (the likelihood of which is hard to assess at this stage), would mean up to 130,000 jobs are created with annual uplift to GDP of $2.2 billion. The dependence on expensive oil and gas imports would also be reduced (Operation Phakisa Offshore Oil and Gas Exploration, Republic of South Africa, 2014).

Operation Phakisa has identified the following range of potential direct and indirect upstream (exploration) and downstream (South African industries) benefits from developing South Africa's offshore oil and gas industry (Figure 11).

[12] Further information **on ocean economy opportunities** (which include marine transport and boatbuilding, oil and gas offshore exploration and ship repair, small harbour development, and aquaculture) can be found in the dti's ocean economy guide available **at** http://www.thedti.gov.za/DownloadFileAction?id=1120 : The Ocean Economy forms part of Operation Phakisa.

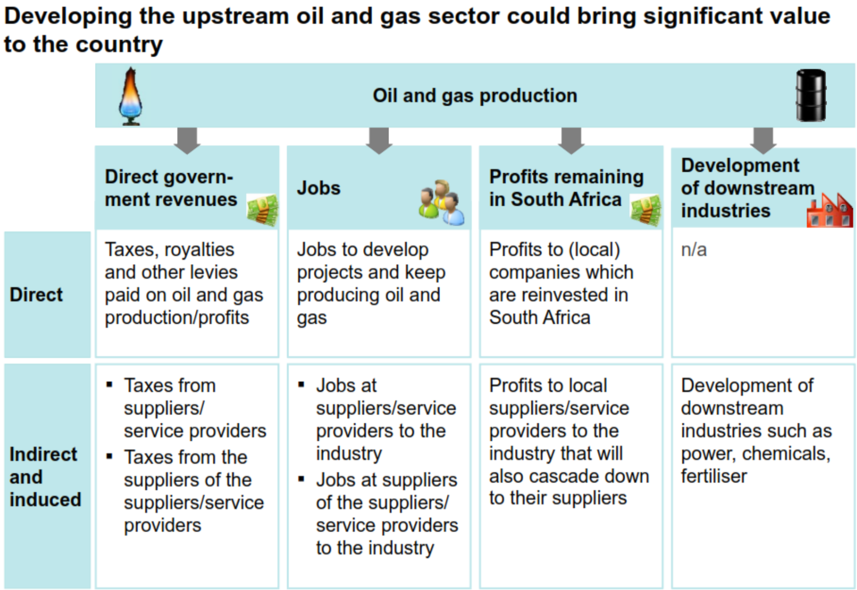


Figure 11. Upstream and downstream benefits of developing South Africa's oil and gas sector (Source: Operation Phakisa Offshore Oil and Gas Exploration, Republic of South Africa, 2014)

Regarding the phased expansion of the gas pipeline in South Africa, a range of limited direct and temporary benefits can be expected from the construction phase. These include the jobs created to build the pipeline as well as jobs created or supported as a result of the materials and supplies required for the pipeline. In this regard, Operation Phakisa has identified the possibility of pipeline fabrication as an opportunity requiring further market research:

If South Africa is to build a network in excess of 3500 km, the opportunity exists to develop the local mills and bring them up to international standards. There is also the opportunity for investment by international pipe fabricators in these mills or in new local mills. Any of these options will establish a South African capability for world class pipe manufacturing and coating and should be pursued as part of Operation Phakisa's objectives before resorting to international pipe mills. However, it must be noted that, globally, there may be an excess capacity for pipeline manufacturing and coating. A thorough marketing exercise, considering global supply and demand must therefore be undertaken, before this opportunity is pursued (Republic of South Africa, 2017: 25).

Regarding the phased timing of realising opportunities and benefits, the first phases for expanding South Africa's gas pipeline network are expected to begin around 2025 (Republic of South Africa, 2014). In 2014, Operation Phakisa estimated that about R1.7 billion would be required to develop this pipeline network over the next 5 years (with the majority of this funding being from non-government sources) but it is unclear if this takes into account projected increases in the cost of construction and other variables subject to change. In addition, an estimated budget of R500 million was identified as being needed to secure servitudes for the gas pipeline (Republic of South Africa, 2014).

iGas has completed the onshore route engineering for a West Coast gas transmission pipeline from Abraham Villiers Bay to Saldanha and Atlantis to take West Coast gas to the Ankerlig power station. PetroSA has completed the pre-feasibility for a gas transmission pipelines from Saldanha to Mossel Bay and Coega to take West Coast gas to the South Coast markets. Alternatively, the flow can be reversed to take South Coast gas to the West Coast markets.

As the 2017 Operation Phakisa document states, "Natural gas found in large quantities will, unlike Mozambique, need to be encouraged to first supply the industrialisation of coastal cities before being exported as LNG to international markets. This opportunity, if the gas reserves are found, has the potential to significantly grow the South African economy." (Republic of South Africa, 2017: 6).

Gas IPPs are expected to provide for initial gas offtakes. In the short term, South Africa will require imported LNG. Baseload IPP CCGT plants currently being planned will require maturity and, once offtake agreements are signed, will take ~26 months to construct.

In addition to future energy price trends favouring gas, other drivers for the gas pipeline network in South Africa (as identified by iGas) include the following:

- LNG importation initially at Richards Bay, followed by Coega and thereafter Saldanha Bay;
- Development of Shale Gas in the Karoo Region; and
- Increased focus on the importation of Gas from Mozambique.

Regarding potential negative impacts of future gas corridors, the potential impact on existing mining rights (especially in Gauteng) has been identified as a potential issue to be mitigated through the optimum routing of any future gas transmission pipelines. It will also be important that the transmission pipelines are designed, constructed and operated in line with best practices and relevant local and international standards. Such transmission pipelines will also need to comply with relevant licences and permits, including the NERSA Licence.

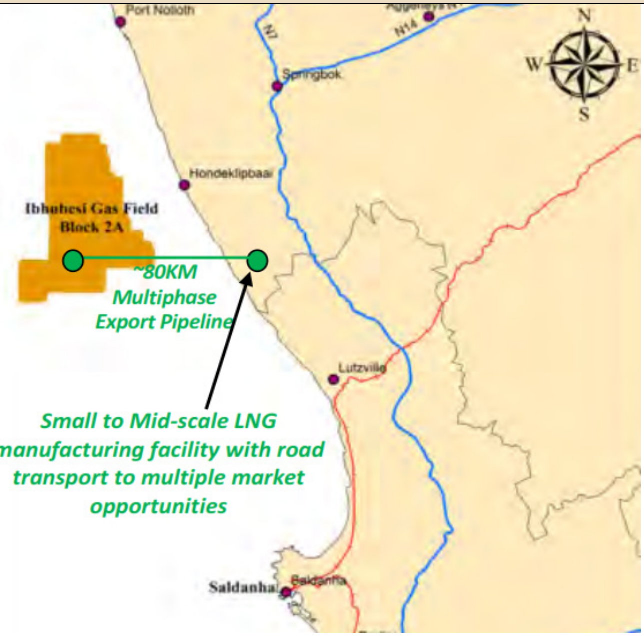
6. Key gas corridor economic attributes and opportunities

This section discusses potential gas opportunities for the various phases of the proposed gas pipeline corridors and has been informed by a limited number of stakeholders' interviews and review of available documents (Table 5).

Table 5. Opportunities identified within the corridors

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
Phase 1: From Saldanha Bay to Atlantis and to Mossel Bay on the south coast; and Phase 6 from Abraham Villiersbaai to Saldanha	Key potential opportunities include the current plans with the Ibhubesi gas fields and the Eskom plans with the Gourikwa power station. However, if Gourikwa will only be used as a peaking plant into the future then it is not clear if its full conversion to gas can be justified. The gas turbine burners chambers have been converted to use natural gas but the infrastructure to transport gas to site and supply it to the gas turbines have not been installed. Related opportunities include future industrial demand in Saldanha, Atlantis and Cape Town and potential transport and residential sector market demand in Cape Town. The Western Cape Government has conducted a 2013 market demand assessment based on detailed bottom up user demand data (see Viljoen, 2013) and has initiated an updated Western Cape Market Demand Study that was expected to be completed by end March 2019, which will also provide detailed bottom up market demand data. This study will also include the identification of preferred contractual options as well as infrastructure needs, requirements and options along the full value or distribution chain to service the identified demand. In addition, a risk analysis and socio-economic impact assessment will be conducted. Ibhubesi gas project has over half a Tcf of proven gas reserves at a P50 level (proved and probable, whereas a level P10 = proved, probable and possible) and situated 80km off of the Northern Cape coast. Current Ibhubesi gas reserves could potentially provide electricity to a city of 1 million people for about ten years. With added investment, up to 8 Tcf or 16 times the current proven reserves, could be added to the domestic energy mix (Sunbird Energy, 2018). An Environmental Impact Assessment (EIA) has been granted to Sunbird Energy in August 2017 to build an offshore pipeline of 300-400 km to deliver gas to Atlantis and the Ankerlig power station (see Annexure A for the Ibhubesi northern and southern pipeline alternatives). This means that there may no longer be a need for an onshore gas pipeline linking Saldanha and Atlantis to the Ibhubesi offshore gas supply. Eskom does not currently require sufficient volume of gas to use Ankerlig as a mid-merit power station and prefer to keep it in its current dispatch mode as a peaking power station. Eskom will also be required to invest approximately R1.56 billion in fully upgrading both the Ankerlig and Gourikwa fuel systems to supply the gas to the dual fuel burners (Eskom key informant citing Eskom feasibility studies). Doubts have been expressed by key informants interviewed as to whether: a) such a conversion will be required based on future Eskom peak power generation capacity relative to demand; and b) Eskom will be able to obtain gas for a price that will allow it to break even after incurring the large financial cost of this conversion to the fuel supply system. An older 2013 Western Cape market demand assessment found the following with respect to the Ankerlig Power Station: The opportunity was however identified, should natural gas become available, for Ankerlig to be converted to a gas-fired CCGT plant, which would not only increase its efficiency from approximately 32 percent to 52 percent, but its generating capacity from 1,350 MWe to 2,070 MWe. The Western Cape has a peak daily electricity requirement of approximately 3,864 MWe. With its local base load generating capacity

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
	by its Koeberg nuclear power plant and the Palmiet hydro-electric pump storage facility, and its electricity export commitments to Namibia, Eskom on average imports about 2 050 MWe of peak power on any given day to the region. The increase in generating capacity by the Ankerlig power station, should it be converted to a gas-fired CCGT facility, could therefore significantly contribute to the reduction of electricity imports to the Western Cape province and at the same time contribute to the reduction in transmission losses, estimated to be in the region of 200MW, during the transmission of electricity to the region. For the purposes of this study, it was included that the existing Ankerlig power station would be converted to a gas-fired mid-merit CCGT power plant. The total energy requirement for Ankerlig in this configuration equated to approximately 66.5 million GJ per annum, roughly about 75 percent of the total identified gas market potential in the Cape West Coast region (Viljoen, 2013: 7). The 2013 Western Cape Demand assessment conducted by Viljoen found that the potential industrial demand was in the order of 20 GJ p.a. as follows: “The existing industrial markets which could potentially be converted to natural gas were found to be mostly concentrated in the Cape Town, Atlantis and Saldanha Bay regions. Cape Town, Paarl and Wellington have the largest concentration of “switchable” industries and accounted for about 23 percent, or 20 million Gigajoule per annum” (Viljoen, 2013). Sunbird energy has signed a 2017 Gas Production and Sales Agreement with Afrox for offtake of LNG (17 November 2017) to purchase up to 365,000 tons p.a. (or up to 900 tons/ day). Planned production will be 600-1200 tons per day, which leaves space to supply other customers (e.g. power generation for peak shaving). Sunbird Energy’s current focus is on conducting a detailed costing exercise over the next 12-18 months to establish an onshore gas processing and LNG facility (Gas dehydration, condensate stripping and storage, LNG manufacture and storage). According to Sunbird Energy (key informant interview), the first gas deliveries are possible by 2022 with LNG being transported by road / truck to multiple sales and delivery points within 400-600 km radius; 200,000-400,000 tons of LNG could be produced p.a. LNG customer delivery point infrastructure required would include: LNG truck offloading bays, LNG buffer storage, regasification heat exchangers, gas conditioning, pressure regulation and metering. According to Sunbird Energy (2018), substantial new and fuel switching markets exist where LNG is price competitive, including: peaker power generation replacing diesel; industrial/ mining replacing diesel or LPG; and transportation (replacing diesel).

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
	 The high-level capital infrastructure investment estimates provided by Sunbird Energy in 2018 total about $800 million as follows (Sunbird Energy, 2018): 

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
	 Source: Sunbird Energy (February 2018).

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
	According to the Western Cape Government (key informant interview), there are 25 industrial investment projects at various stages of the investment process and which are energy intensive. **Cape Town:** In terms of the Chevron/ Caltex refinery in Cape Town, it is not clear what implications the planned purchase of the Chevron oil refinery by Chinese company Sinotec will have. Government has approved the planned purchase recently. This will involve R6bn of upgrading at the facility (Killian and Lazenby, January 2018). In addition, Sinotec has agreed to a number of commitments, including that it will increase the level of LPG that is supplied to black-owned businesses. In addition, the City of Cape Town has undertaken studies on the feasibility of using gas for electricity generation and is in the process of assessing the results.
Phase 2: From Mossel Bay to Coega on the south coast.	As per the previous discussion, challenges and uncertainties related to Eskom's full conversion of Gourikwa power station exist in the short term. Past work on the feasibility of establishing an LNG import facility at Mossel Bay found that this was not feasible (in part due to the rough sea conditions). The current PetroSA gas to liquids refinery facility in Mossel Bay currently manufacture's 4.5 million gigajoules p.a. PetroSA wants to enter the commercial gas market and take LNG to the market and are currently conducting market studies. Once a market has been created, PetroSA may want to import additional LNG. The price of LNG would need to be lower than the price of LPG if sufficient incentive exists for existing customers to use LNG (key informant interview). Current gas supply to PetroSA will run out in about 2020 (key informant interview). PetroSA is a 25% owner of the Ibhubesi gas field off the West Coast. Commissioned in 1992, the PetroSA plant is 27 years old and cannot compete with Sasol in Gauteng due to the low prices at which Sasol imports gas from Mozambique. The future focus of the PetroSA plant is likely to be on gas to chemicals (key informant interview). The PetroSA plant will require major new investments in the refinery to make it possible to focus on LNG in future (the media has reported an investment requirement of R3bn[13], however, PetroSA is still in the process of costing the upgrades needed at the facility) and is in discussions with government regarding how to finance these investments and whether government will provide a guarantee. PetroSA sees the transport sector as a major market for LNG in future. Government is only expected to make a decision regarding the future focus of the PetroSA plant after the next national elections in 2019.

[13] See for example: https://www.businesslive.co.za/bd/companies/energy/2016-10-12-petrosa-to-spend-big-on-mossel-bay-refinery/

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
	PetroSA uses 100 MW of power a day from Eskom. It is unlikely that PetroSA will be able to obtain electricity at a cheaper rate from other sources such as gas or solar. This limits the potential to switch energy sources at Gourikwa. PetroSA believes that the Saldanha port is the best location for an LNG import/export plant. PetroSA will be the largest user of LNG in the Western Cape and will focus on using LNG for chemical production. PetroSA has identified that an LNG opportunity exists in the region and believes that approximately 15 potential large user clients exist for LNG within a 500 km radius of Mossel Bay. These include automotive companies such as Daimler Chrysler in East London who have expressed a desire to convert to LNG use. A major challenge to converting manufacturers is production down time. PetroSA is looking for clients that will use between 5-7 tonnes of LNG a day. The major challenge in creating this market are the tanker transport costs to service it, as the transport costs in servicing one client with one tanker day are large, however, economies of scale can be achieved when smaller clients are also served at the same time. So the more clients serviced, the greater the economies of scale as transport costs are reduced.
Phase 7: From Coega to Durban on the east coast.	DoE plans for a 1000 MW CCGT IPP power station. It is not clear what industrial demand exists for gas at Coega. Apparently, there are plans for a smelter at Coega, which would require gas by 2022 (key informant interview). The cost of gas pipelines to the West and East of Coega will be extensive and is will only be feasible once the Durban market has been saturated. The development of this pipeline therefore seen as a longer term opportunity. Coega could receive gas supplies via the pipeline from Cape Town. The Industrial Development Corporation is involved in financing a new R350 million gas bottling manufacturing facility in Coega. Construction of the plant is scheduled for completion in February 2018. These gas bottles will replace imported bottles and will be gas neutral and not linked to one of the major gas wholesale brands (although the bottles will be sold to these wholesalers). This will allow for gas to be sold to consumers at cheaper prices. The facility has a production target of 500 000 cylinders during its first phase and year of operation, after which, at full capacity, the plant would produce 1.5 million units a year, or 3 200 cylinders a day (Gillham, April 2017).
Phase 7 and 4: From Durban to Richards Bay and to the border of Mozambique to facilitate an import option.	The information in this section is derived from the dti's 2017 KZN market demand assessment (dti, 2017). Richards Bay also in a good position as some of the Eskom Coal Burners will go offline and it is expected that the new LNG import facility will be completed as early as 2020 (although it is not clear if this timeframe is feasible) (key informant interview). The DoE plans for a new IPP CCGT plant to produce 2000 MW and to service growing industrial demand. Offshore seismic exploration is currently taking place near Richards Bay with drilling planned for some time in 2019. The dti commissioned a detailed KZN market demand study in 2017 (dti, 2017). This included obtaining inputs from the following stakeholders (including industries):

<table>
<tr><th>Corridor phase and name</th><th>Summary profile and brief discussion regarding opportunities and related issues</th></tr>
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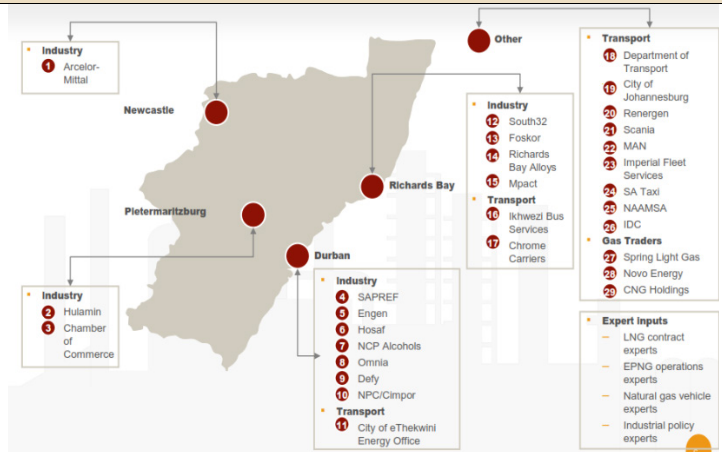


Source: dti (2017).

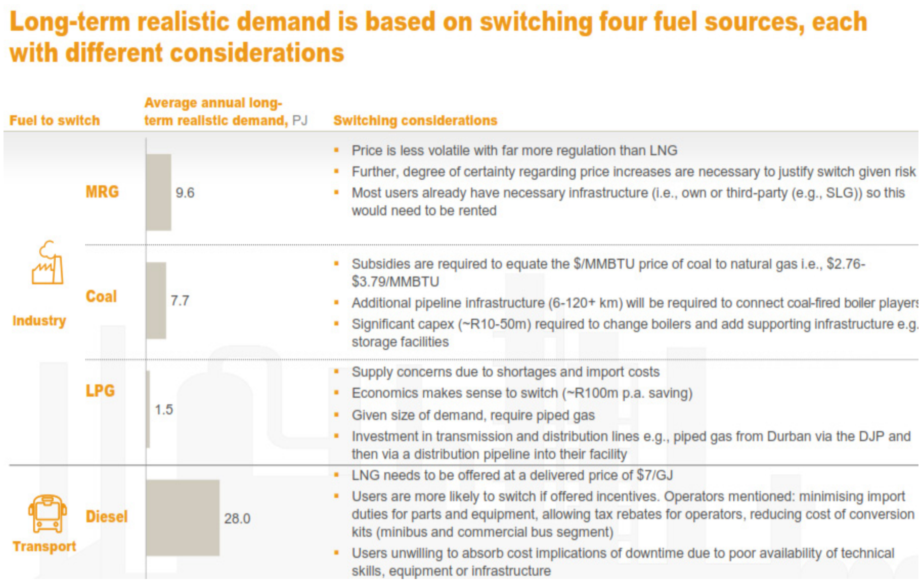
The key findings from this 2017 demand assessment are as follows:

Gas demand in KZN will be anchored by gas-powered electricity generation. This anchor demand could catalyse latent demand from Industry and Transport in KZN. Gas demand from Industry and Transport is 24 PJ in the short-term (3-7 years) and 47 PJ in the long-term each with their own dynamics.

This 47 PJ Industry and Transport demand can be broken down into four fuel groups:

- Methane Rich Gas (MRG): Demand from Industrial users already using MRG amounts 9.6 PJ. Switching requires similar delivered prices to existing gas (expected to be between $ 6-8/MMBTU). Most users already have necessary infrastructure (i.e., own or third-party) but will require some modifications and capital input to switch from MRG to natural gas.
- Coal: Demand from Industrial users, using coal for boilers or blast furnaces, amounts to 7.7 PJ in the long- term. Switching requires investment. To equate the $/MMBTU price of coal to natural gas, gas prices need to be < $4/MMBTU (assuming no CO_2 taxes). Pipeline infrastructure (6-120+ km) will be required to connect coal-fired boiler players and capex (~R10-50m) is required to change boilers and add supporting infrastructure (e.g., storage facilities).
- LPG: Demand from Industrial users already using LPG amounts 1.5 PJ. This is relatively easy to switch given large price differential between LPG and gas, it requires some investment in infrastructure.
- Diesel: Demand from Transport users in the Logistics, Commuter and Municipal segments amounts to 28 PJ. International case studies show that this demand is viable if economic payback for operators is clear and short (<3 years). In South Africa,

</td></tr>
</table>

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
	interviews suggest a delivered gas price of $7/GJ and various incentives such as minimising import duties for parts and equipment, allowing tax rebates for operators, reducing cost of conversion kits (minibus and commercial bus segment). **Switching sensitivity**: Industrial and Transport demand is price sensitive. For industry 80% of demand is lost for a $4/MMBTU increase on delivered price (from $6/MMBTU to $10/MMBTU). For Transport, 75% of demand is lost for a $0.5/l (R7.84/l) price increase through the fuel levy, decreasing demand to 7 PJ in the long-term. **Economic impacts**: Industry: Impact is positive (~+R18m): micro effects are positive (~+R193m); macro effects are negative (~-R175m), these effects are almost solely driven by its impact on the trade balance. Transport: Impact is positive (~+R614m) owing to positive fuel switching economics. The assessment also identified key energy switching issues and gas price requirements for users currently using different energy sources as follows: 

Corridor phase and name	Summary profile and brief discussion regarding opportunities and related issues
Phases 3-4: Replacement or duplication of the existing Lilly Pipeline from Sasolburg to Richards Bay and Durban by a second pipeline following a similar route.	The Lilly pipeline (Secunda to Durban) supplies various industrial users and the Rompco Mozambique to Secunda Pipeline (MSP) supplies natural gas feedstock to the Sasol plants in Secunda and Sasolburg and to industrial users in the Gauteng region. Currently more than 180 million GJ of natural gas or methane-rich gas is delivered, per annum, to customers in Gauteng, Free State, KwaZulu-Natal and Mpumalanga. Transnet currently leases the Lilly pipeline to Sasol and this lease comes to an end around 2022. It is not clear what Transnet's plans are for the pipeline once the Sasol lease comes to an end.
Phase 8: From Sasolburg to the border of Mozambique (including the ROMPCO pipeline)	The ROMPCO pipeline has been expanded 3 times over the past decade as demand has increased. Indications are that there may be sufficient new potential demand to double the pipeline capacity in future if sufficient supplies of new gas can be found (key informant interview) Sasol is currently searching for new gas supplies. The price at which Sasol brings gas to Secunda and Sasolburg is much lower than what LNG will cost (key informant interview). Sasol will prioritise their own usage before go into any other partnerships regarding the use of imported LNG.
Phase 6: From Saldanha Bay to Abraham Villiersbaai (landing point for the Ibhubesi field).	See phase 5 analysis above.
Phase 6: From Abraham Villiersbaai northwards to the Namibian border (Oranjemund), to link to potential Kudu gas extraction; and Phase 3: From the Shale Gas sweet spots to Mossel Bay and Coega.	Supply of shale gas is a long term opportunity. The feasibility of shale gas is also linked to the oil price and one commentator mentioned that an oil price of $85 is required before shale gas becomes price competitive (this figure has not been verified or subject to further scrutiny). If shale gas does become available in the quantities anticipated, gas powered stations will still not create sufficient demand to absorb this supply of domestic gas and therefore export terminals will be needed at key ports to allow for global exports.

The DoE's IPP LNG-to-Power procurement programme has a potential to unlock further possibilities for the growth of the gas industry in South Africa. The Project Information Memorandum (PIM) issued in October 2016 identifies Richards Bay and Coega as destinations for initial implementation while Saldanha will be introduced in a later phase (iGas, undated).

7. Gaps in Knowledge

The following gaps in knowledge, which could deepen the understanding and identification of opportunities to expand gas demand in South Africa, have been identified:

1. **Gas pricing transparency (including gas-coal relative price scenarios):**
It would appear that there is a need for greater transparency and availability of information regarding gas prices in different demand scenarios so as to ensure that ongoing exploration of gas opportunities is informed by pricing information that is as transparent as possible. In addition, transparent scenarios illustrating the possible gas-coal price differentials are important to develop to inform ongoing stakeholder discussions in South Africa. The Department of Energy, in partnership with the dti may be best-positioned to coordinate such an initiative in partnership with other stakeholders such as NERSA and other relevant role-players.

2. **Eskom gas conversion of Ankerlig and Gourikwa power stations and the future Duck Curve**:
It is not clear if Eskom can obtain gas at a price level which will allow it to break even after incurring the costs to fully upgrade the Ankerlig and/or Gourikwa power stations to gas. It is also unclear if such conversions will be required in future based on future Eskom power peak generation capacity relative to demand. There is a need to conduct energy system modelling which looks at the Duck Curve in relation to the future expansion of solar and wind energy in the electricity system to inform a more detailed assessment regarding the possible need for gas. Because of the importance of investigating possible large bulk anchor tenants to support future gas pipeline infrastructure investments, there may be value in commissioning further research into the desirability and feasibility of completing gas conversion of the Ankerlig and Gourikwa power stations.

3. **Demand from municipalities for gas for electricity generation:**
This report has not assessed the scope for Municipal electricity generation using gas. For example, it is known that the City of Cape Town has done studies on the feasibility of using gas for electricity generation and is in the process of assessing the results. There may be opportunities for Municipalities to grow their demand for gas for electricity generation; however, the scope for such demand will require further research and inputs from municipalities (various municipal studies in this regard have been conducted).

4. **Market demand for gas in the transportation sector:**
Further research may be required on the nature of potential gas demand in the transportation sector-although the dti study (dti, 2017) does provide good information at the level of KZN (with some national level constraints enabling issues identified). The Western Cape Provincial Government: Department of Economic Development has just commissioned (with a study beginning in March 2018) a Western Cape Study on this topic which could feed into a national market demand assessment study.

5. **Market demand for gas in the industrial and mining sectors:**
Further research on the conversion costs for different types of industrial and mining sectors may be of value to inform the gas price at which such conversions are attractive and feasible for such users. It is difficult to identify at what cost gas switching is an attractive option for industrial users as the conversion costs first need to be identified and built into the feasibility assessment.

6. **Developing a strategy to enhance the direct economic impacts of building gas pipelines in South Africa** may be advisable in future.

For example, Operation Phakisa has identified the possibility of pipeline fabrication as an opportunity requiring further market research.

7. **Macro-economic and balance of payments impacts of various future energy demand and supply scenarios need to be better understood:**

There is a need to conduct further macro-economic modelling of various future energy scenarios to better understand the possible macro-economic impacts of these scenarios. National Treasury and the dti are apparently discussing an exercise to address this need. It is not clear what the scope of this exercise might be and how other role-players in the energy sector are involved, or could be involved, in this exercise.

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ANNEXURE A: DETAILED SUPPORTING INFORMATION

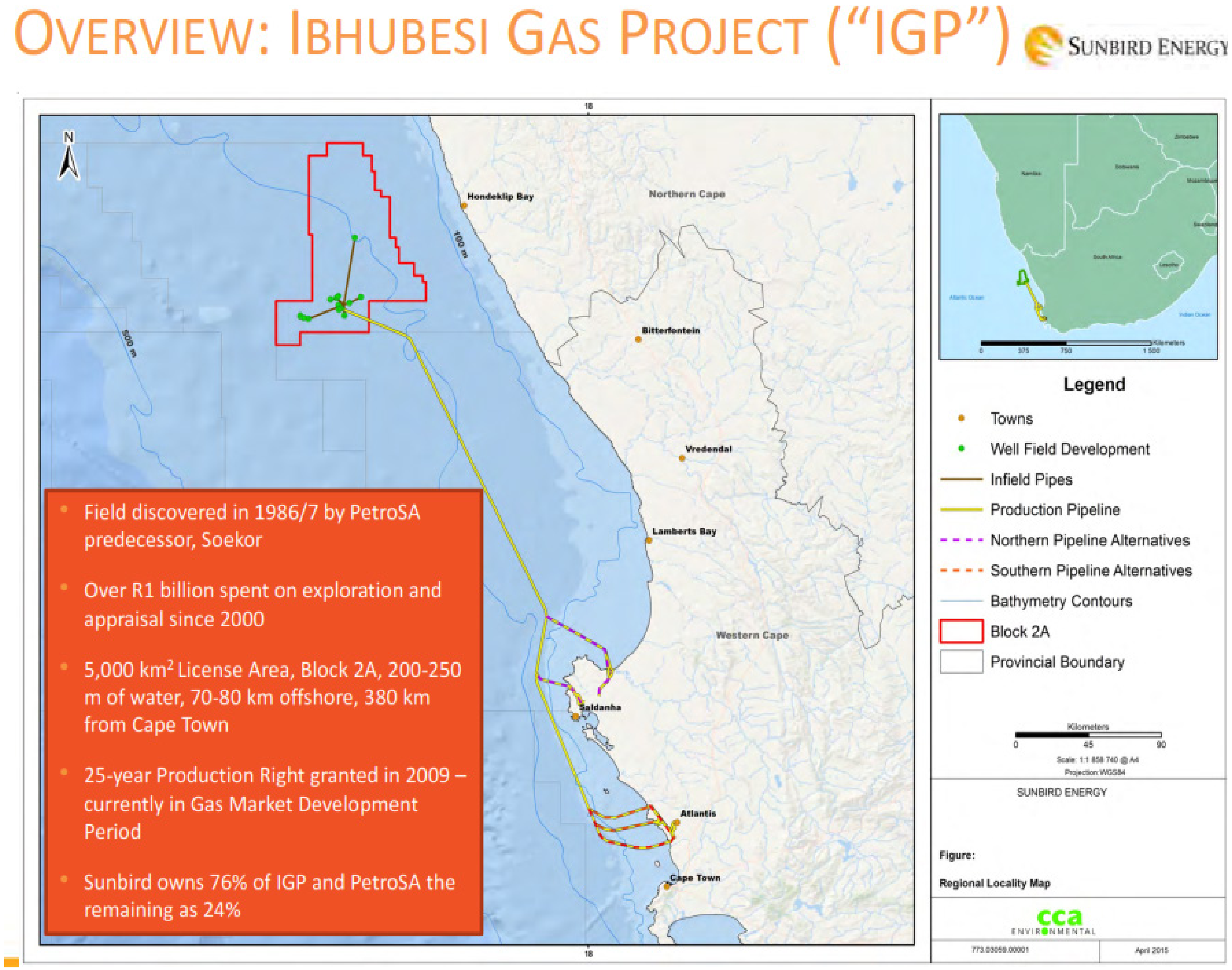
World Bank Future Economic Growth Projections (2017)

	Compound average annual growth rate			
	2000-16	2016-25	2025-40	2016-40
North America	1.8%	2.1%	2.1%	2.1%
United States	1.8%	2.0%	2.0%	2.0%
Central & South America	2.8%	2.3%	3.0%	2.8%
Brazil	2.4%	1.9%	3.0%	2.6%
Europe	1.7%	1.9%	1.6%	1.7%
European Union	1.4%	1.7%	1.4%	1.5%
Africa	4.4%	4.1%	4.4%	4.3%
South Africa	2.9%	2.1%	2.9%	2.6%
Middle East	4.4%	3.0%	3.5%	3.3%
Eurasia	4.1%	2.3%	2.7%	2.6%
Russia	3.4%	1.7%	2.4%	2.1%
Asia Pacific	6.0%	5.4%	4.0%	4.5%
China	9.2%	5.8%	3.7%	4.5%
India	7.2%	7.7%	5.7%	6.5%
Japan	0.8%	0.7%	0.7%	0.7%
Southeast Asia	5.2%	5.1%	4.0%	4.5%
World	3.6%	3.7%	3.3%	3.4%

Notes: Calculated based on GDP expressed in year-2016 dollars in purchasing power parity (PPP) terms. See Annex C for composition of regional groupings.

Sources: (IMF, 2017); World Bank databases; IEA databases and analysis.

Ibhubesi Northern and Southern Pipeline Alternatives



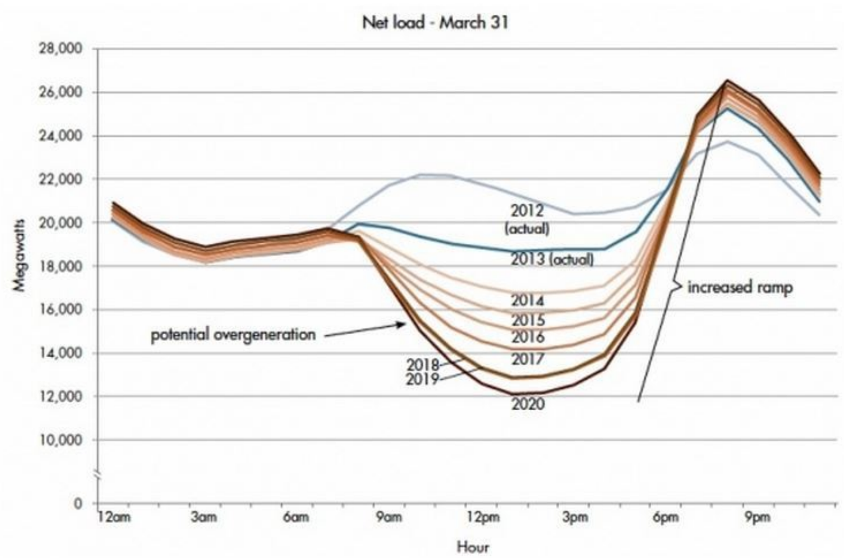
Source: Sunbird Energy (February 2018). Ibubesi Gas Project: Development Update.

ESKOM OPEN CYCLE GAS TURBINE POWER FIRE STATIONS OVERVIEW: GOURIKWA AND ANKERLIG

Power station	Overview (from Eskom)
Ankerlig (Atlantis)	First phase commenced in January 2006 and comprised of 4 x 148 MW units which was completed and handed over for commercial operation by June 2007. The second phase comprising of 5 x 147MW units was declared commercial during February 2009. Technical Details Type: Open Cycle Gas Turbines (OCGT) Number of Units: (Nine) 9 Output per unit: 148MW Installed Capacity: 1327 MW Role The OCGT units are powered by Fuel oil (Diesel). It is intended to supply electricity into the National Grid during peak hours and emergency situations. In addition to its generating capabilities the units are also used to regulate network voltage fluctuations (SCO – Synchronous Condenser Operation)
Gourikwa (Mossel Bay)	First phase commenced in January 2006 and comprised of 3 x 148 MW units which was completed and handed over for commercial operation by June 2007. The second phase comprising of 2 x 148MW units was declared commercial during November 2008. Technical Details: Type: Open Cycle Gas Turbines (OCGT) Number of Units: 5 Output per unit: 148MW Installed Capacity: 740 MW Role The OCGT are powered by Fuel oil (Diesel). It is intended to supply electricity into the National Grid during peak hours and emergency situations. In addition to its generating capabilities the units are also used to regulate network voltage fluctuations (SCO – Synchronous Condenser Operation)

ANNEXURE B: THE DUCK CURVE: WHAT IS IT AND WHAT DOES IT MEAN?

Source: https://alcse.org/the-duck-curve-what-is-it-and-what-does-it-mean/
MAY 29, 2017 BY DANIEL TAIT
So let's talk about the duck curve and what it means in the world of renewable energy. But what is the "duck curve?" Does it involve our adorable little animal friends who quack the day away? Well, kinda, but not really.
Put simply, the duck curve is the graphic representation of higher levels of wind and solar on the grid during the day resulting in a high peak load in mid to late evening. The difference in the Duck Curve and a regular load chart is that the duck curve shows two high points of demand and one very low point of demand, with the ramp up in between being extremely sharp. It looks like a duck! Since renewable energy has become more common over the years, the duck curve is appearing more often and is getting worse. Let's look at an example of what the duck curve looks like:



The duck curve, explained.
As you can see, this chart shows the electric load of the California Independent System Operator (ISO), just think the California grid, on an average spring day. The lines show the net load—the demand for electricity minus the supply of renewable energy—with each line representing a different year, from 2012 to 2020. The chart also shows that energy demand reaches its peak in the morning (between 6 A.M. and 9 A.M.) and afternoon times (between 6 P.M. and 9 P.M). This demand shows that people need more energy as they get prepared for work or school in the morning and when they come home from work or school in the afternoon.
Let's look at lines 2012 and 2017, for example. Comparatively, the 2012 line is much smoother than the 2017 line. This is because the feed of a renewable power supply has not yet been introduced. By slowly integrating solar energy, the demand for electricity from the electrical grid becomes smaller and smaller. However, the renewable energy source is not enough to meet the demand in its entirety, especially in those peaks hours that I referenced earlier. So the electric grid is left to pick up the slack, which can sometimes be problematic.

Why is a duck causing problems?
As you can see by the chart, solar energy works best during the bright hours of the day, which makes energy demand lower greatly. We'll call this the duck's belly: the lowest point of demand. The demand begins to rise rapidly as the sun sets and people get home at 6 P.M. There's no sun to power all of the appliances getting turned on by people returning home from work or school, and the grid is left to answer to that high

demand. Therefore, the demand rises very rapidly (the duck's neck) to a peak in the afternoon hours (the duck's head).

For many decades, energy demand followed a fairly predictable pattern, with very little change in levels of demand. This allowed electrical workers to become experts with sustaining a stable output of energy. Well the duck curve kinda throws a wrench in that. In order to meet the baseline requirement, or "baseload", utilities run BIG power plants that run on either nuclear or coal, which run around the clock. The problem with coal and nuclear power plants is that they're expensive to completely start-up and shutdown, and are more effective in ramping up or down. Then there's the "peak load," which is satisfied by peaker plants that usually run on natural gas, and more frequently renewables.

In order to maintain top efficiency, regulators will often turn peaker power plants off and ramp down the baseline plants during times of very low demand, such as hours of the "duck's belly." However, the sudden and rapid increase in demand means that regulators have to quickly turn back on these power plants, which is not only expensive, but could lead to more pollution and high maintenance costs.

Another problem with the duck curve lies in the belly of the duck. In some places, demand becomes so low that grid operators are forced to turn off the peaker power plants and ramp down the baseline power plants. Then, just a few hours later, they all have to get ramped up again with little to no warning, which can cause problems for grid stability.

So problems with the duck curve lie in those sudden and steep changes in demand. Grid operators and regulators struggle to maintain stability and efficiency by turning power plants on and off, causing instability in the power supply, large expense to taxpayers, and pollution to the environment.

So what can we do about the Duck Curve?
One probable solution for the duck curve can be found in a method called **interconnection**. This strategy involves connecting multiple energy grids together to make a large energy grid. In theory, this would broaden and disperse the load and availability of solar and wind across a larger area, which in turn would flatten the duck curve.

This strategy could provide a long term solution to the problem. However, although the technology already exists, the politics of a large, interconnected grid is unlikely due to "not in my backyard" concerns and securing the rights of way.

The second method of smoothing out the duck curve is committing to the **storage of energy** generated by solar and wind, instead of immediately sending that energy directly to the grid. The energy can then be "dispatched" when it's needed, and would almost definitely flatten the curve. This method could prove very expensive to execute in near term however battery storage continues to fall in price and more utilities are actively seeking it as a viable solution.

ANNEXURE C: KEY INFORMANTS INTERVIEWED

Organisation	Person(s)
Department of Energy	Zita Harber: Demand Modeling Specialist (15th February 2018)
Department of Trade and Industry	Kishan Pillay: Director: Up- and Midstream Oil & Gas: Industrial Development Division (9th February 2018)
Eskom	Kobus Steyn: Group Executive (Acting): Group Capital Division (15th February 2018)
Sunbird Energy (Ibhubesi gas fields)	Kerwin Rana: CEO (9th February 2018)
Petro-SA	Dr. Faizel Mulla: Director: Strategy (5th February 2018) Peter Nelson: Gas Business Manager New Ventures Midstream (6th February 2018)
Price Waterhouse Coopers	Chris Bredenhan (9th February 2018)
South Africa Gas Development Corporation (SOC) Ltd	Neville Ephraim: Senior Project Manager (25th January 2018)
Western Cape Government: Department Economic Affairs and Tourism	Professor Jim Petrie (9th February 2018) (independent consultant) Ajay Trikam (9th February 2018): Director: Energy: Green Economy: Strategic Economic Accelerators and Development
Transnet (13 February 2018)	Adrian Cogills: Transnet Group Capital Imran Karim: Transnet Group Capital Marc Descoins: Transnet Group Capital

ANNEXURE D: ENERGY MARKET IN ATLANTIS, CAPE TOWN METROPOLIS AND SURROUNDS

Potential energy consumption in Atlantis (including Eskom's Ankerlig power station) and the Cape Town, Paarl and Wellington areas

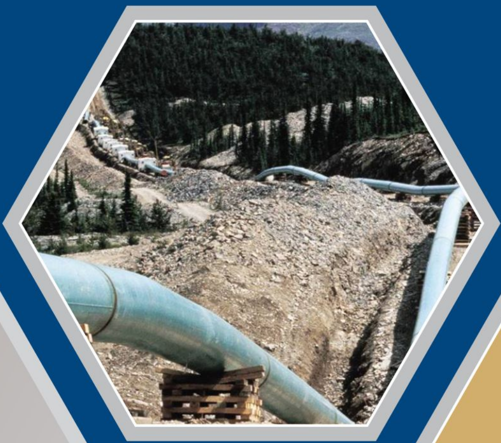
Potential Energy Market – Atlantis, Cape Town Metropolis & Surrounds	
Fuel Type	**Consumption (GJ/a)**
Atlantis Industrial	1 000 000
Atlantis – Ankerlig Power Station	66 500 000
Cape Town Metropolis and surrounds	20 000 000
Total	***87 500 000***

List of currently available markets within the Atlantis and Cape Town corridor susceptible to conversion to natural gas as an energy source.

Potential Customer	Customer Type	Assessed Energy Usage (GJ/a)	Total Energy Usage (GJ/a)
Airport Industria:			
SA Metal	Heating	20,500	**20,500**
Atlantis Industria:			
Ankerlig Power Station	Power generation	66,500,000	
Ahlesa Blankets	Boiler	11,250	
Brits Textiles	Boiler	43,333	
Comar Chemicals	Thermal oil heating	5,000	
Promeal	JT boiler	15,166	
MSA	JT boiler	18,000	
Appolo Bricks	Heat firing	550,000	
Nu Era Packaging	JT boiler	17,250	
Atlantis Foundries	End user	68,400	
Bokomo Foods - Paraffin	Baking & drying	85,625	
Bokomo Weetbix	Drying	34,250	
Braitex Tenslon	JT boiler	18,750	
Craft Box Corugated	JT boiler	76,500	
Kulu Roof Tiles	drying & baking	3,233	
Rotex Fabrics	JT boiler	39,375	
SA Fine Worsteds	JT boiler	28,416	
Elvinco Plastics	Printing	230	**67 514 778**
Beaconvale:			
Cape Galvanising	Heating	14,266	
Golden Girl Hosiery	Heating	5,860	
Metlite	Heating	36,600	
Svenmill	End user	2,220	**58,946**
Bellville South Industria:			
African Products	Boiler	353,095	
Good Hope Bakery	Boiler & baking	25,277	
Grace (Darex)	Boiler	2,195	
Falke Textiles	Boiler	18,750	

Winelands Pork	Heating	43,950	
Latex Threads	Boiler	203,496	
Marley Tiles	Drying & baking	26,410	
Nampak Tissue Cape	Boiler	58,300	
Nestle	Heating & boiler	30,000	
Spekenham (Supreme Foods)	Heating	111,091	
Trade Wipers	End user	3,350	875,913
Blackheath Industria:			
Cape Town Iron & Steel	Heating & smelting	27,519	
Continental China	Firing & baking	116,666	144,185
Brackenfell:			
HBH Textiles	Boiler & drying	11,016	
Everite	Firing & drying	40,693	51,710
Bottelary:			
Crammix Bricks	Drying & baking	286,562	
Cabrico - Coal	Drying & baking	525,000	
Joosten Brick Claytile	Tile firing & drying	685,000	1,496,562
Contermanskloof/Philadelphia:			
Brick & Clay	Drying & baking	225,000	
Much Asphalt	Drying & heating	117,390	342,390
Eersterivier:			
Much Asphalt	Drying & heating	45,800	45,800
Elsies Rivier Industria:			
Continental Knitting	Boiler	9,375	
Mattex	End user	4,000	
Messaris - LO 10	Boiler	19,555	
Romatex	Boiler	29,062	61,992
Epping Industria:			
Allnet	Boiler	18,256	
Anchor Yeast	Boiler	31,050	
Bevcan & Bevcap	Boiler	98,100	
Bowman Ingredients	Boiler	1,221	
Bokomo Ltd	Drying	5,100	
Cape Coaters	Boiler	6,250	
Coca-Cola Canners	Boiler	3,000	
Colas Southern Africa		32,840	
CTC		37,000	
Dairybelle		40,500	
Disaki Cores &Tubes		320	
Distell	Boiler	67,620	
Donaldson Filtration	Boiler	6,400	
DPM Transformers	Heating	5,175	

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa



PART 2

Project Description

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ABBREVIATIONS

AGA	American Gas Association
CPF	Central Processing Facility
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DOE	Department of Energy
DPE	Department of Public Enterprises
DMR	Department of Mineral Resources
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EGI	Electricity Grid Infrastructure
EHS	Environment, Health and Safety
EMPr	Environmental Management Programme
EPC	Engineering, Construction and Procurement
EPCM	Engineering Construction and Procurement Management
FSRU	Floating Storage Re-Gasification Unit
GHG	Greenhous Gas
GIS	Geographic Information System
GTLR	Gas to Liquid Refinery
HDD	Horizontal Directional Drilling
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producers
IRP	Integrated Resource Plan
LNG	Liquefied Natural Gas
LNGT	Liquefied Natural Gas Terminal
MSP	Mozambique to Secunda Pipeline
NEMA	National Environmental Management Act (Act Number 107 of 1998, as amended)
PASA	Petroleum Agency of South Africa
PIG	Pipeline Intelligent Gauge
PIM	Project Information Memorandum
PPE	Personal Protection Equipment
RBI	Risk Based Inspection
SEA	Strategic Environmental Assessment
US EPA	United States Environmental Protection Agency

PART 2. PROJECT DESCRIPTION

2.1 Introduction

This section of the report provides a description of the key project components. The Phased Gas Pipeline Corridors are founded on a set of nine phased gas pipeline routings, based on a conceptual Phased Gas Pipeline Network identified as part of the Operation Phakisa Offshore Oil and Gas Lab (Refer to Figure 1). The approach undertaken for identifying and refining the corridors was developed in line with the context and study objectives described in Part 1 of the Gas Pipeline Strategic Environmental Assessment (SEA) Report.

2.2 Identification of Preliminary Corridors

As discussed in Part 1 of this Gas Pipeline SEA Report, pre-planned national gas transmission pipeline corridors are a means to accelerate gas development within South Africa. Linked to this, the Operation Phakisa Oceans Economy Lab mandated a State-Owned-Company to oversee the Phased Gas Transmission Pipeline Network planning under the A1 Workgroup, including:

- Engaging with the National Department of Environmental Affairs (DEA) in terms of commissioning the SEA for the Phased Gas Pipeline Network, the output of which is this current report (as well as other outputs described further in relevant part of this document);
- Using the outcomes of the SEA to engage with land owners and secure servitudes as required;
- Undertaking Route Engineering studies for the various phases of the Phased Gas Pipeline Network, excluding sections already completed; and
- Engaging with Independent Power Producers (IPPs) and Eskom for gas offtake negotiations as power generation is the most likely anchor client for these projects.

Therefore, the Department of Energy (DoE), DEA and Department of Public Enterprises (DPE), together with iGas, Transnet and Eskom, were mandated to oversee the implementation of the SEA Process.

2.2.1 Initial Phased Gas Pipeline Network (Based on the Operation Phakisa Offshore Oil and Gas Lab – 2014)

As noted above, the Preliminary Corridors were identified based on the Phased Gas Pipeline Network as envisaged during the Operation Phakisa Offshore Oil and Gas Lab held between July and August 2014 (refer to Figure 1).

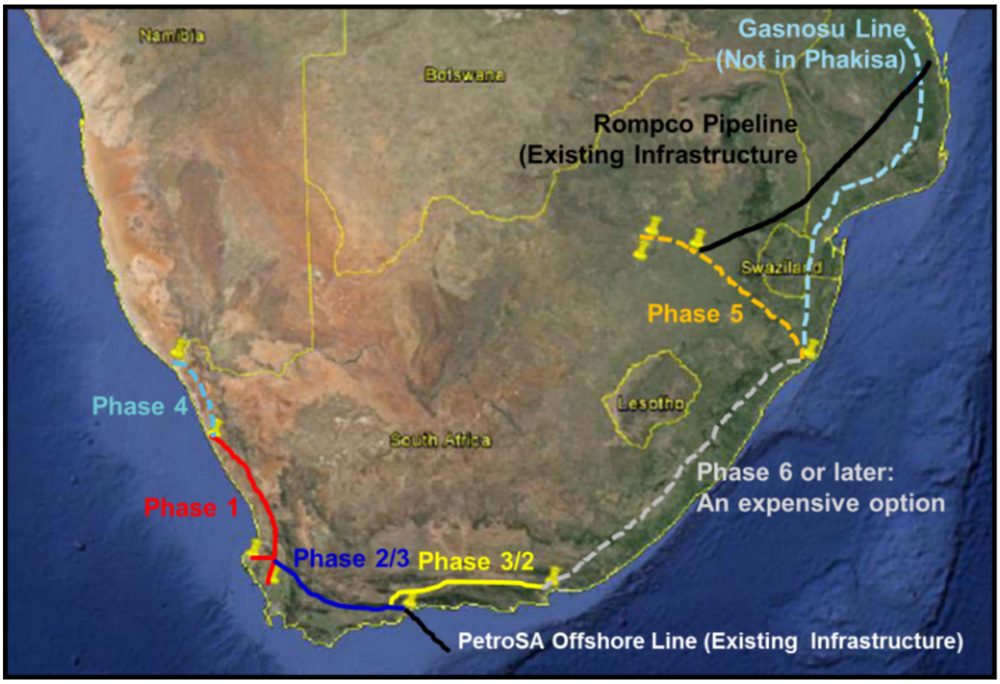


Figure 1: Proposed Phased Gas Pipeline Network for South Africa (Operation Phakisa Offshore Oil and Gas Lab, 2014)

The following Phases were **envisaged:**

- **Phase 1** extends from Abraham Villiers Bay to Saldanha/Atlantis, and would serve the Ibhubesi Gas field and other West Coast gas finds, transporting gas from the landing point in Abraham Villiers Bay down to Saldanha and the Ankerlig Power Station in Atlantis. The route engineering for this section has been completed. Sunbird Energy/Umbono, the Ibhubesi Gas field developer, has opted for a subsea pipeline to Saldanha or Grotto Bay. Should the landing point be located at Saldanha, then only the section of Phase 1 from Saldanha to Atlantis would be required. If the landing point is located at Grotto Bay, this phase will not be required until additional gas reserves are discovered off the West Coast of South Africa.
- **Phase 2** extends from Saldanha to Mossel Bay, and **Phase 3** extends from Mossel Bay to Coega. The technical pre-feasibility study has been completed. These two phases would transport gas to the PetroSA Gas-to-Liquid Refinery (GTLR) and the Gourikwa Power Station in Mossel Bay. These phases are interchangeable, depending on where the gas will originate, i.e. if more and significant gas finds originate on the West Coast of South Africa then the pipeline from Saldanha to Mossel Bay is proposed to proceed first. However, if gas is found on the South Coast, then it will most likely land in Mossel Bay to service the existing PetroSA GTLR and Gourikwa markets. If the gas can service more than the Mossel Bay market, then it can service the Saldanha and Coega markets via Phases 2 and 3, the phasing being dependent on the commercial viability of each of those markets.
- **Phase 4** extends from Oranjemund (at the border of Namibia) to Abraham Villiers Bay, and was contemplated to bring in Kudu gas from Namibia to markets in South Africa. This Phase may proceed if positive and enabling agreements are reached. This is at conceptual stage.
- **Phase 5** links Richards Bay to the Gauteng market, unlocking opportunities for gas off the east coast of South Africa, specifically the Tugela Basin.
- **Phase 6** links Coega to Richards Bay. This Phase is expensive and unlikely to proceed, except into the long term future. This is primarily due to the significant length of the pipeline; the absence of major markets in-between; the fact that the gas markets will be developed at the point it is landed rather than transporting the gas to a market far away; and, the existence of better options to supply gas at either end, i.e., Coega and Richards Bay.

- The Gasnosu/Rovuma North-South pipeline that is conceptually considered to be from Palma in the north of Mozambique to Richards Bay in the south was not envisaged to be a part of this program because it did not enable offshore gas exploration in South Africa.

2.2.2 Revised Initial Phased Gas Pipeline Network (Subsequent to the 2014 Operation Phakisa Offshore Oil and Gas Lab)

The above description of the initial identification of the Phased Gas Pipeline Network emanated from the Operation Phakisa Oceans Economy Offshore Oil and Gas Lab held from July to August 2014. **However, shortly after the initiation of the A1 Workgroup, the State Owned Companies forming part of the A1 Workgroup, i.e. iGas, Transnet and Eskom were requested to ensure strategic alignment of the Phased Gas Pipeline Network. In addition, the Workgroup requested a prioritisation of the phases.**

The strategic alignment and re-numbering of the phases is presented in this section (Figure 2) and carried forward into the SEA as the Draft Initial Corridors. This alignment takes into consideration the current opportunities to supply indigenous gas to existing power plants (Ankerlig and Gourikwa Power Stations), the prospects for greenfield power plants in Saldanha, Richards Bay and Coega, as well as other developments outside of Operation Phakisa, i.e. the 2015 Electricity War Room; imported Liquefied Natural Gas (LNG); Karoo Shale Gas; and Eskom's targets for the Gasnosu (Mozambique North-South) pipeline in Mozambique.

Refer to Part 1 of the Gas Pipeline SEA Report for additional background, as well as for the information on the specific gas development projects referred to in the following sub-sections.

2.2.2.1 Phase 1a: Saldanha to Ankerlig

Given the limited reserves of the Ibhubesi Gas field, the pipeline between Saldanha/Grotto Bay and Ankerlig can be viewed as a strategically sensible precursor to LNG import at Saldanha if no additional gas is found on the West Coast. This is therefore targeted as Phase 1a of the Phased Gas Pipeline Network.

2.2.2.2 Phase 1b: Saldanha to Mossel Bay

Further exploration for gas reserves on the West Coast may be promoted with the forthcoming construction of the Sunbird Energy subsea pipeline for the development of the Ibhubesi gas field. Sunbird Energy/Umbono received Environmental Authorisation for this project on 3 August 2017. The Environmental Authorisation approved the following infrastructure 1) Offshore Production Facility; 2) Offshore Production Pipeline to Grotto Bay; 3) Offshore Production Pipeline to St. Helena Bay East; 4) Grotto Bay Southern Shore Crossing and Production Pipeline; 5) St Helena East Northern Shore Crossing and Production Pipeline; and 6) Onshore Gas Receiving Facility at Ankerlig. According to the Addendum Report compiled for the Sunbird Energy Ibhubesi Project, the St. Helena Bay East pipeline link to industrial activities in the region would depend on end-user locations[1]. Exploration on the South Coast has also been targeted, signalled by the arrival of the Total drill ship in South African waters late in 2018. Refer to Part 1 of the Gas Pipeline SEA Report for feedback on the gas find made by Total in February 2019. This would service the Mossel Bay and south coast markets. However, if these finds are large enough, they could also supply the Saldanha/Ankerlig/Cape Town market via a pipeline between Saldanha and Mossel Bay.

Alternatively, if gas finds (beyond Ibhubesi) off the West Coast are not forthcoming, LNG is anticipated in Saldanha. This will also target the Gourikwa Power Station and the PetroSA GTLR once the indigenous gas off the South Coast of South Africa is depleted and if there are no other gas opportunities offshore of the South African coast. The pipeline between Saldanha and Mossel Bay is therefore prioritised as Phase 1b.

[1] CAA Environmental (2017). Proposed Development of the Ibhubesi Gas Project Final EIA Report: Addendum Report. Prepared for Sunbird Energy (Ibhubesi) (PTY) Ltd.

2.2.2.3 Phase 2: Mossel Bay to Coega

The gas pipeline from Mossel Bay to Coega adds to the linkages of industrial requirements for gas along the coastal areas. In the same way that Mossel Bay and Saldanha are target markets for South and West Coast gas, so is Coega, which can access the gas via a pipeline between Mossel Bay and Coega. Additionally, any gas off the coast of Coega can service the Mossel Bay and Saldanha markets. LNG imports at Coega, as contemplated in the 2016 DoE IPP Office Project Information Memorandum (PIM) could also service the Mossel Bay market. The pipeline between Mossel Bay and Coega is therefore prioritised as Phase 2.

2.2.2.4 Phase 3: Richards Bay to Secunda, and Gauteng

Richards Bay and Secunda are currently linked via the Lilly Pipeline owned by Transnet SOC Limited and operated by Sasol. However, this pipeline is currently operating at 70% capacity and may not be sufficient to supply the target markets in Gauteng should sufficient gas be found of the East Coast of South Africa or if LNG import to Richards Bay proceeds. The pipeline between Richards Bay and Secunda is therefore prioritised as Phase 3 to unlock gas off the east coast, particularly considering that, currently, ENI anticipates the start of a drilling program off the coast of Richards Bay in 2019/2020. A final Environmental Impact Assessment (EIA) Report was compiled by ERM for the ENI project in December 2018 and submitted to the Petroleum Agency of South Africa (PASA) and Department of Mineral Resources (DMR) for decision-making. A decision authorizing the project was issued in August 2019. Refer to Part 1 of the Gas Pipeline SEA Report for additional feedback on this project.

2.2.2.5 Phase 4: Mozambique (Southern Border) to Richards Bay

iGas has undertaken a conceptual evaluation on the Gasnosu / North-South pipeline in Mozambique from Palma to Maputo and extending down to Richards Bay. However, as the focus for Operation Phakisa is on infrastructure within South Africa's perimeter, the Gasnosu pipeline is noted as an opportunity but not considered within this work stream. Additionally, as one of the objectives of the A1 Workgroup is to negotiate and secure servitudes, the servitude for the Gasnosu pipeline will be a single negotiation with the Mozambican Government as there is no private land ownership in Mozambique. Hence, in order to support South Africa's aspiration for investment in the Gasnosu / North-South pipeline; focus should only be on the section of pipeline from Mozambique's southern border to Richards Bay.

It should be noted that this phase of the Phased Gas Pipeline Network is introduced to access Mozambican gas coming from the Rovuma Basin. If the pipeline proceeds, it is a way of introducing gas from an established gas reserve to South Africa and is therefore prioritised as Phase 4.

2.2.2.6 Phase 5: Abraham Villiers Bay to Saldanha and Ankerlig

From an Electricity War Room perspective, gas to Ankerlig was seen as a short to medium term (3 to 5 years) objective for gas supply. The gas pipeline from Saldanha to Ankerlig is a critical part of the ongoing supply of gas to Ankerlig. If no gas beyond the Ibhubesi gas field on the West Coast is commercially viable, LNG supply at Saldanha, either via a Floating Storage Regasification Unit (FSRU) or a land based terminal (LNGT), can be the long term solution. The overall solution for Ankerlig as described here could therefore be: 1) gas from the Ibhubesi Gas field in the medium term; and 2) LNG import at Saldanha in the long term, if additional gas is not discovered off the West Coast.

The pipeline between Abraham Villiers Bay and Ankerlig is therefore prioritised as Phase 5.

2.2.2.7 Phase 6: Abraham Villiers Bay to Oranjemund

With Namibia's intention to utilise Kudu Gas in country via a gas fired power station, there is currently limited opportunity for the monetisation of Kudu gas in South Africa. Nevertheless, with the power station contemplated, the Kudu gas field will be depleted within 20 years of commissioning. The opportunity then exists for the supply of gas from the possible West Coast gas opportunities or Saldanha LNG, whichever proves to be viable. Phase 5 of the Phased Gas Pipeline Network, partway to the Namibian border could be a part of that West Coast opportunity; hence the extension from Phase 5 to the Namibian border is prioritised as Phase 6. However, this decision can be revisited if the possibility develops to bring Kudu gas to South Africa.

2.2.2.8 Phase 7: Coega to Richards Bay

This phase contemplates transporting gas between Coega and Richards Bay, targeting markets at either end. For reasons discussed in Section 2.2.1 above, this is an expensive and unlikely scenario due to the significant length of the pipeline and the absence of substantial markets (except domestic use) between the two ends. However, should gas reserves prove to be large enough that it warrants linking these two markets, then the construction of this phase of the pipeline would be justified. Therefore, the pipeline between Coega and Richards Bay is prioritised as Phase 7.

2.2.2.9 Shale Gas Corridor and Inland Corridor from Saldanha to Coega

As noted above, the Operation Phakisa Phased Gas Pipeline Network was initially contemplated to unlock offshore exploration in South African waters. However, the possibilities of shale gas in the Karoo are noted and, in consultation with the Project Partners, and relevant stakeholders, a link from the shale gas "sweet spot" in Beaufort West to Phase 2 was included in the SEA. The shale gas "sweet spot" referred to above was based on the findings of the CSIR Shale Gas SEA (Scholes et al., 2016[2]).

Additionally, an inland corridor from Saldanha to Coega was also required and justified as the coastal corridor (i.e. Phase 2) was indicated by stakeholders to have a more intensive and complex land use than the inland option running through the Karoo. This inland corridor coincides with the shale gas area and can create potential synergies for shale gas utilisation. The inland corridor is also aligned with portions of the gazetted central and eastern Electricity Grid Infrastructure (EGI) corridors. In addition to bypassing the high land usage area of the Phase 2 corridor, the inland corridor also links the shale gas area to the coast at Saldanha, Mossel Bay and Coega.

2.2.2.10 Rompco Pipeline Corridor

The Rompco Mozambique to Secunda Pipeline (MSP) crosses the South African – Mozambique border at Komatipoort and then proceeds in an almost straight line to Secunda in Mpumalanga Province. With the advent of Rovuma gas coming to the south of Mozambique via the Gasnosu North-South pipeline, the possibility of additional gas to Mpumalanga and Gauteng provinces via the Rompco MSP becomes a future possibility. However, except for a small percentage, the MSP essentially has no spare capacity, and additional capacity via additional loop lines would be required. The South African and Mozambican governments have been in discussions via the Bi-National Commission and on this basis; the DoE requested that the Rompco MSP corridor be included in the SEA to accommodate this expansion for additional branches of gas from Mozambique to the Mpumalanga and Gauteng provinces.

[2] Scholes, R., Lochner, P., Schreiner, G., Snyman-Van der Walt, L. and de Jager, M. (eds.). 2016. Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks. CSIR/IU/021MH/EXP/2016/003/A, ISBN 978-0-7988-5631-7, Pretoria: CSIR.

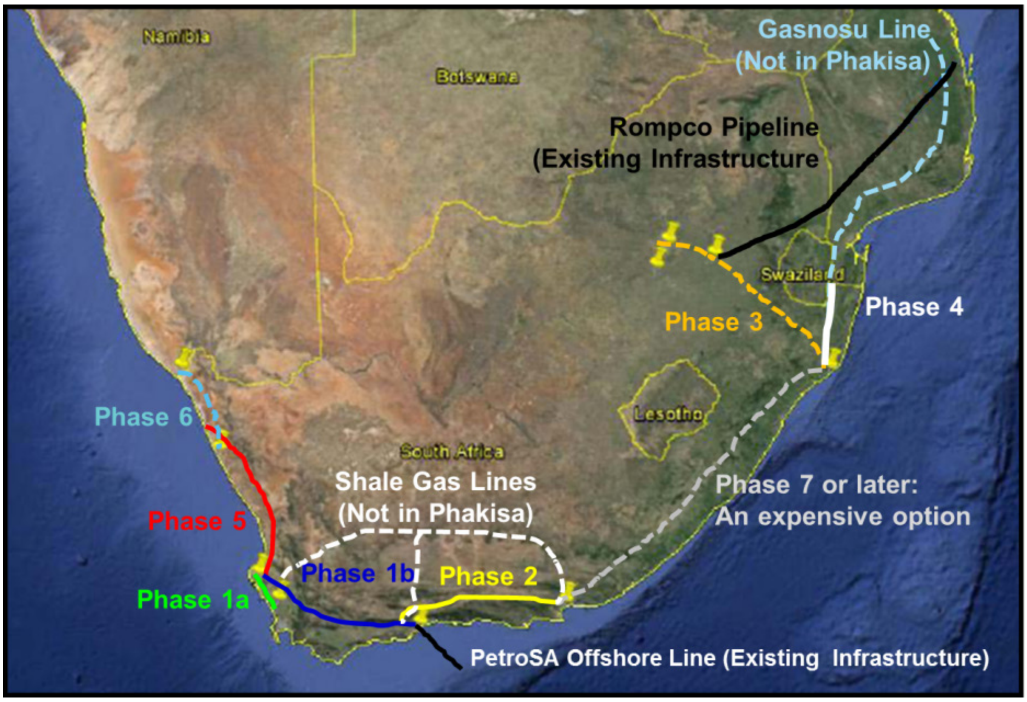
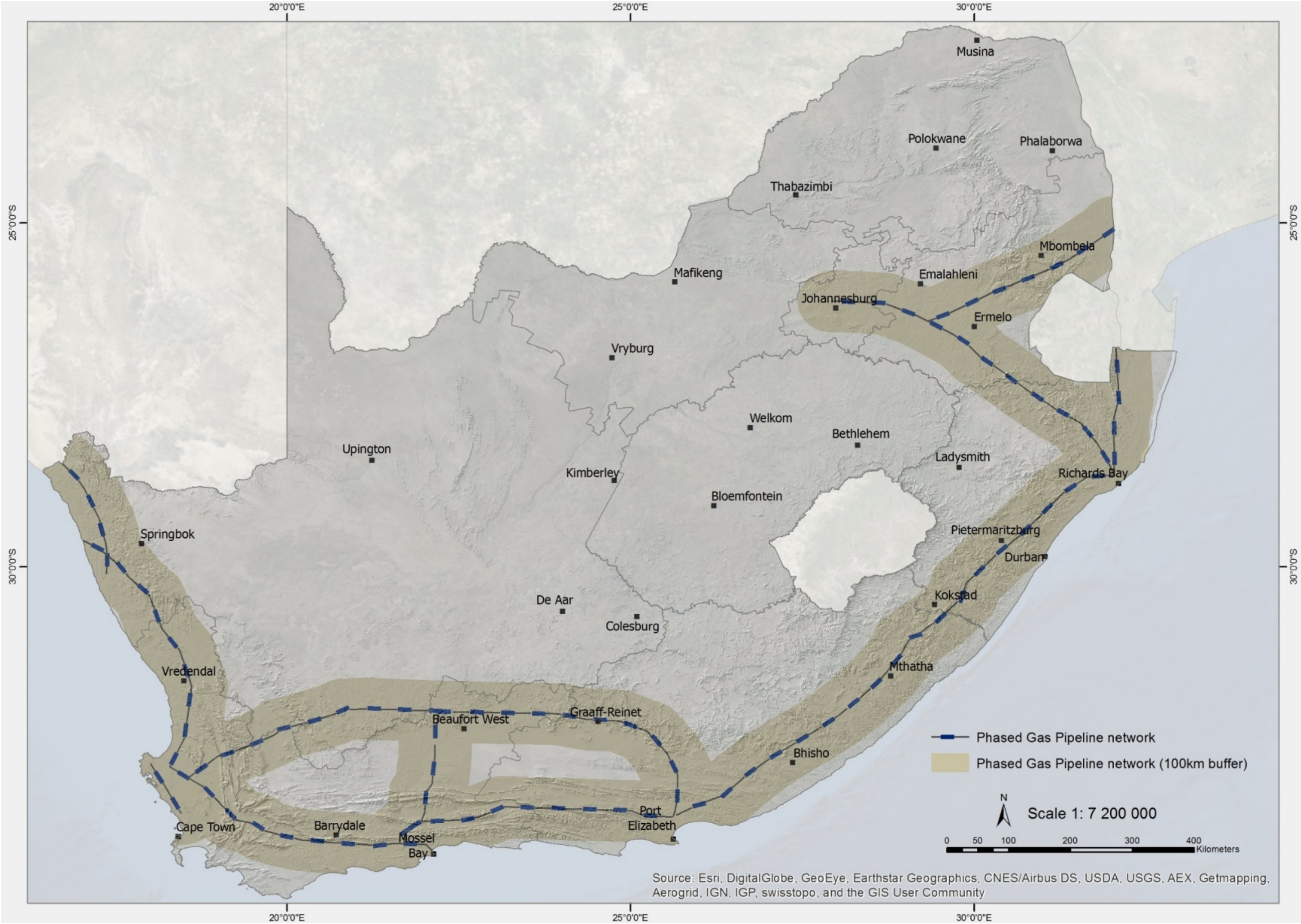


Figure 2: CEF Group-Eskom-Transnet Strategically Aligned Phased Gas Pipeline Network

Linked to Figure 2 and the preceding information, it must be noted that, although these phases have been prioritised in order of anticipated construction, they will not necessarily be developed in this order. Rather, they will be developed according to economic viability, i.e. a source of supply and a guaranteed offtake comprising a viable business case for each phase of the Phased Gas Pipeline Network.

As part of this SEA Process, using Geographic Information System (GIS) software, ArcMap 10.4, the Phased Gas Pipeline Network described above (and shown in Figure 2) were buffered by 50 km on either side to produce 100 km wide corridors. The 100 km wide corridors were guided by and encompassed the Phased Gas Pipeline Network. These are referred to as the Preliminary Corridors, which are indicated in Map 1 below.



Map 1: Preliminary Corridors

2.3 Project Description

It is also important to describe the technical aspects of gas transmission pipeline infrastructure. The information provided in this section has been provided by the Project Partners and Sasol.

2.3.1 Specifications

- **Pipeline Location (Onshore versus offshore):**

With a pipeline around the South African coast, two technology options are possible, i.e. onshore and offshore pipelines. However, the costs of offshore pipelines are approximately 40% more than that of onshore pipelines. In addition, offshore pipelines will limit the ability to expand easily to accommodate new customers. They will also require landing points and transmission networks from these landing points to the market demand centres. This could eventually lead to almost parallel onshore networks. Therefore, only onshore pipelines are considered in this SEA Process.

- **Pipeline Pressure:**

This SEA is only focused transmission pipelines (main trunk lines), with a pressure of more than 15 bar as defined in the Gas Act. The suppliers of the gas into the pipeline are usually responsible for compressing the gas before supplying it at the inlet flange. Distribution pipelines (branch lines to industrial areas and reticulation offtake points) with a pressure range of 2 to 15 bar and reticulation (lines to homes and small industry) pipelines, with pressures less than 2 bar, are not considered in this SEA Process.

- **Pipeline Depth, Above-Ground Infrastructure and Crossing of Waterbodies:**

The pipelines will be below-ground. The top of the proposed pipeline would be approximately 1 m underground all along the route, with pigging stations above ground approximately every 130 km but possibly as far apart as 250-500 km (based on new technology options for pigging). The limitations linked to the distance between pigging stations are mainly based on the capability of the PIG (Pipeline Intelligent Gauge) in terms of battery life and on-board memory storage. Pigging stations are generally 30 m x 80 m in size. Block valves will also be required every 30 km along the pipeline route, which will consist of a concrete slab on the surface that will cover a concrete valve chamber below ground. The valves can be automated, i.e., remotely activated to close a specific section of the line in the event of a leak (i.e. close two valves on either side of the leak). If the line needs to be repaired, the remaining gas within the line may be vented off. However, technology exists to repair "live" lines with pressurised gas still inside, and this is the preferred option for repairs and modifications for pipeline expansion. In addition, the pigging stations themselves will also contain block valves to isolate the above ground sections from the underground pipeline.

When the crossing of a waterbody is required for the Phased Gas Pipeline, either trenching or trenchless techniques will be used. Trenching mechanisms include open cut under normal conditions, as well as open cut within water bodies, which include both dry and wet open cuts (Figure 3). Trenchless techniques typically include pipe-jacking or horizontal directional drilling (HDD) (Figure 4). Figures 3 and 4 are based on the information contained in the Specialist Assessments (Appendix C of the Final SEA Report).

Sub-surface flow below the river bed can be corrosive. Therefore, the pipe must be deep enough under the river bed with corrosion protection. Attaching the gas pipeline to a suspension bridge is not considered as the safest option, therefore this was not considered in the SEA Process. Additional detail regarding the pipeline crossing of water bodies is included in the Biodiversity Assessment specialist studies (Appendix C of the Final Gas Pipeline SEA Report).

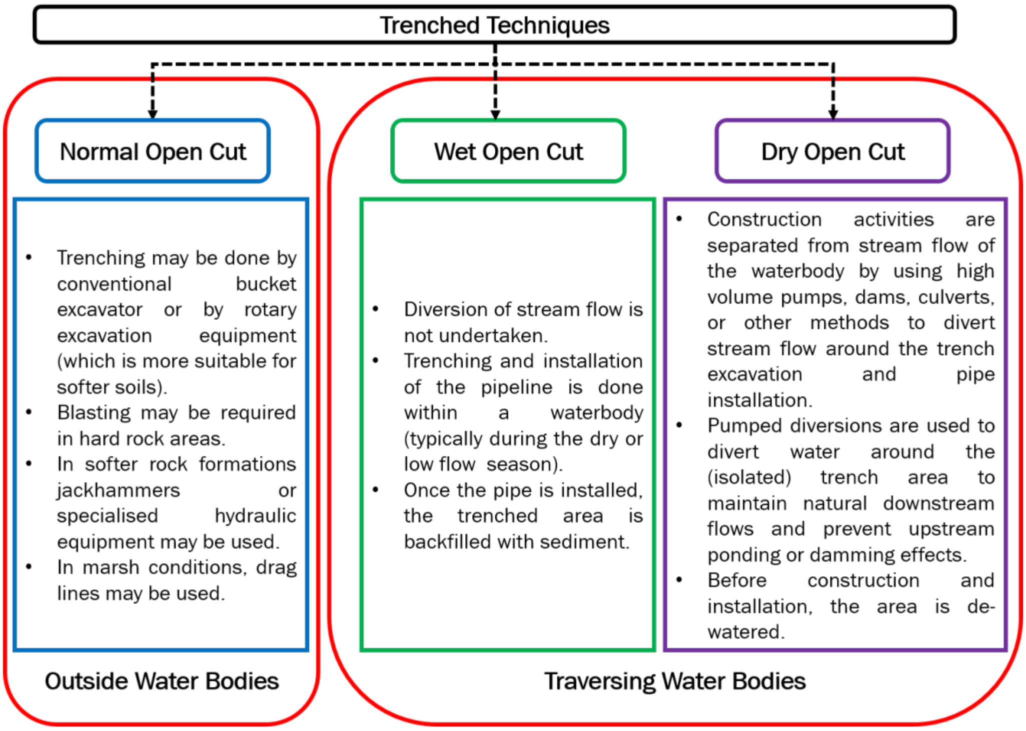


Figure 3: Trenching Techniques in a Typical Gas Transmission Pipeline Project

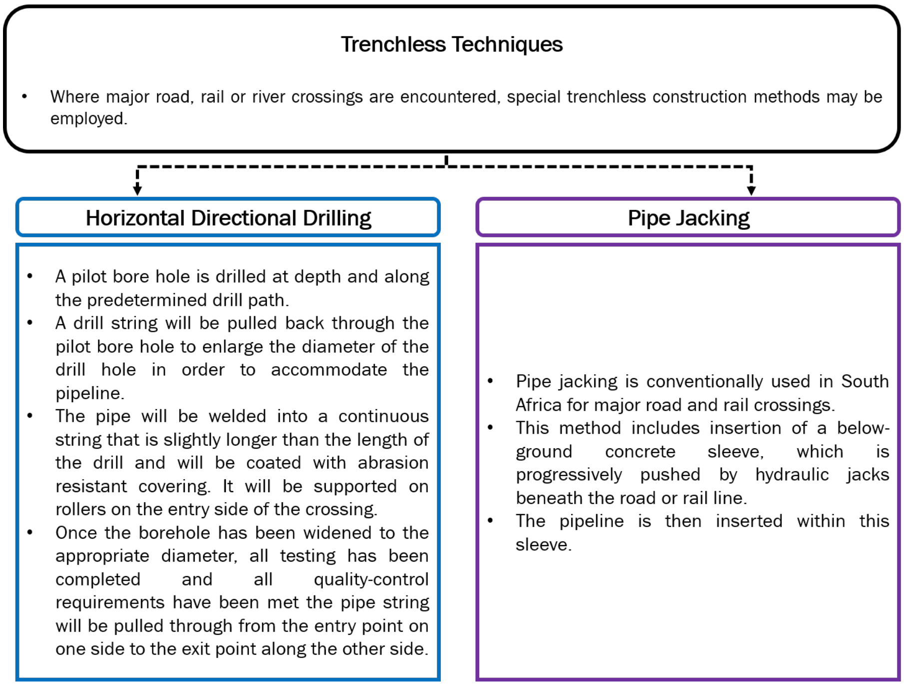


Figure 4: Trenchless Techniques in a Typical Gas Transmission Pipeline Project

- **<u>Pipeline Diameter and Wall Thickness:</u>**

Transmission pipelines can typically range in size anywhere from 6 to 48 inches in diameter, depending on the economics and their function. The typical pipeline diameter, for purposes of this SEA, is estimated at 26 inches (660 mm), similar to that of the Rompco MSP. Thickness of the pipeline wall is estimated to range between 10 – 17 mm, depending on the proximity to human settlements.

- **Pipeline Material, Specification and Sourcing:**

The Phased Gas Pipeline Network will be designed in accordance with the latest editions of internationally accepted standards, e.g., ASME B31.8 and the line pipe material should be in accordance with API 5L (latest edition) or an equivalent international material specification. The pipeline will be composed of steel. Steel transmission pipelines may be functional underground for about 50-70 years depending on maintenance plans/frequency of that specific pipeline. The material grade should be either X65 or X70 or possibly higher grades. X65 is more conducive to manual welding. X70 is a higher strength material than X65. The calculated wall thicknesses are therefore thinner. As such the benefit is a lighter pipe which is beneficial for both transport and material handling. A possible disadvantage is that, while it can be manually welded, it is more conducive to automatic welding. Welders experienced in welding this grade of material are scarcer, but can be qualified by a competent construction contractor. The final decision on the material grade will be made during engineering of the pipeline phases. The pipes will need to be supplied in 18 m lengths. While mills capable of producing 12 m lengths of pipe are more readily available, 12 m pipes will require 50% more welding during construction. This creates more scope and opportunity for weld failures.

The acceptable manufacturing processes are:

- Electric resistance or induction welded
    - HFW High Frequency electric welding
- Submerged arc welding
    - LSAW longitudinal weld seam
    - HSAW Helical weld seam (spiral welded pipe)

LSAW is the most expensive of the three processes because it is made from plate material. HSAW is the cheapest and is made from coil material. HFW pipe is also made from coil material but has a longitudinal weld seam. The cost is marginally higher than HSAW pipe material. Operators prefer longitudinally welded pipe as it is easier to tie-in to at a later stage than spirally welded pipe. As long as the appropriate inspection plan is in place and all defects are addressed or rejected, any one of the three processes will be acceptable. The decision for a specific type should therefore be cost and schedule (availability) driven.

The pipeline will be an all-welded system, so there is no possibility of leaking from flanges or failed gaskets.

In general, the pipelines are also covered with a specialised coating to ensure that it does not corrode once placed in the ground. The purpose of the coating is to protect the pipe from moisture, which causes corrosion. There are a number of different coating techniques. In the past, pipelines were coated with specialised coal tar enamel. Today, pipes are often protected with what is known as a fusion bond epoxy. In addition, cathodic protection is often used; which is a technique of running a low voltage electric current (typically equal to or less than 3V) through the pipe to ward off corrosion. Internal factors, such as corrosion, may also lead to explosive damage to the gas pipeline. This is specifically related to rust if a high enough oxygen content is present in the pipeline. The typical concentration of natural gas to air for an explosion (fireball) to occur is between 5% and 15% methane to air. This will never be achieved in a gas pipeline as, before commissioning the pipeline is purged with nitrogen before gas is introduced.

- **Local Opportunity for Pipeline Fabrication:**

If South Africa is to build a Phased Gas Pipeline Network in excess of 3500 km, the opportunity exists to develop the local mills and to ensure that they reach international standards. There is also the opportunity for investment by international pipe fabricators in these mills or in new local mills. Any of these options will establish a South African capability for world class pipe manufacturing and coating and should be pursued as part of Operation Phakisa's objectives before resorting to international pipe mills. However, it must be noted that, globally, there may be an excess capacity for pipeline manufacturing and coating. A thorough marketing exercise, considering global supply and demand will need to be undertaken by the developer once a phase of the pipeline network would be proposed to be constructed. This is therefore not considered as part of this SEA.

- **Compression:**

Reservoir gas is generally at a high pressure or compressed at the production facility to transport the gas to onshore locations. An inlet pressure of between 100 bar and 125 bar is generally sufficient to transport gas up to 500 km. After that, compression becomes necessary to increase throughput. As an example, for the first expansion project for the Rompco MSP, a compressor station was installed at Komatipoort, approximately 500 km from the Central Processing Facility (CPF). Compression will be required if the network has a single source input transporting gas over long distances. However, if there are multiple inputs 500 km apart, then compression will generally not be required, unless an increase in throughput is required. The installation of compressor stations will be considered during the engineering studies for each phase of the pipeline network. As a design principle, compression along the pipeline route should be avoided in the initial construction and should be left for capacity increase during later stages of the pipeline operation when market demand increases, requiring increased throughput. Therefore, **compressor stations have not been considered as part of this SEA Process**, and should be considered on a project specific basis.

- **Access Roads:**

During the construction phase, access roads will be required to the pigging stations, site camp(s), and construction right-of-way. It is estimated that the access roads will extend about 8 – 10 m in width. A service road along the pipeline route is not planned, however some level of access to the pipeline will be required during maintenance. As such, a number of access roads will be kept. In some cases, a driving track is maintained along the pipeline within the 10 m wide servitude and accessed from various farms that the pipeline passes through. This is not a formalised road that is maintained, but rather a track to enable a 4x4 to drive along, normally with grass between the wheel tracks.

2.3.2 Construction Activities

- **Skills and Labour Requirement**

With this SEA and other initiatives to increase the role of natural gas in the country's energy mix, skills will be required on a national scale to enable implementation. From a gas infrastructure design and construction perspective, the following skills will be required:

- A knowledge of local and international standards for the design of gas pipelines, together with the ability to design the pipelines and develop dynamic models of the pipelines using computer software. This competence must reside with both the pipeline owners / operators as well as with engineering contractors and consultants. South Africa does currently have this level of skill within the engineering contractors and at least one operator (Sasol Gas).

- An in-depth understanding of large Engineering Construction and Procurement Management (EPCM) and Engineering, Construction and Procurement (EPC) contracts. Core competencies required are in Project and Contract Management and administration. Large EPCM and EPC contracts have been undertaken in the country both for petrochemical facilities and pipelines. Major international engineering contractors with experience in this field have offices in South Africa that are capable of executing these projects. These companies can also draw on experience and personnel from their international offices, giving them the benefits of both a knowledge of the local regulatory and business environment as well as an international experience base. Smaller South African companies have the competency and experience to execute EPCM contracts of this nature. However, it is doubtful that they have the financial resources to execute an EPC project.

- Construction Contractors: South Africa has the competence for the implementation of large pipeline construction projects, developed in the civil and water pipeline construction industries. However, experience in petrochemical pipelines is limited to the few projects executed over the past decade.

- Welders: South Africa has a skills shortage of suitably qualified welders capable of welding high strength gas transmission pipeline material. Currently, this requirement is filled by the construction contractors from a pool of international welders that are willing to travel abroad, living in construction camps for between 6 and 8 weeks at a time while working on petrochemical pipeline projects. South Africa can train welders to meet this requirement. However, it should be noted that if around 150 km of pipelines are not constructed in a year, these welders may be lost to the international pool. Nevertheless, on a positive note, these South African welders will then gain the necessary international experience.

- Servitude Negotiations: The South African legal fraternity should be well versed in the area of servitude negotiations, as this has been an ongoing process for Eskom's power transmission lines; and water, sewerage and other pipelines. The notable difference for gas pipelines is that the product is flammable and even explosive within a range of gas to air mixtures. Safety aspects will be dealt with in the design of the pipelines and those negotiating with landowners for the servitudes must be able to deal with concerns regarding safety and the responsibility placed on land owners for non-interference with the pipeline. However, the current existence of thousands of kilometres of gas pipelines in the country without major incidents should serve to alleviate concerns.

- Pipeline Operators: There are a few gas pipeline operators in South Africa, e.g., Sasol Gas, Transnet Pipelines, Egoli Gas, Virtual Gas Network, Novo Energy, Reatile Gastrade, Easigas, and Tetra4. However, most of their experience is limited to distribution and reticulation pipeline operations. Gigajoule, a South Africa company is a shareholder in and the operator of the Moamba Pipeline in Mozambique. If South Africa is to develop a gas transmission pipeline network, pipeline operators need to be developed and enter this space to promote effective gas on gas competition.

- <u>Construction Processes</u>

During pre-construction, when servitudes and construction areas (including laydown areas) are determined and mapped, the Pipeline Owner needs to undertake the following:

- Identification of the type of vegetation and trees within the servitude area, and its conservation status, and ensure rehabilitation is undertaken as per the Generic Environmental Management Programme (EMPr);
- Aerial photographs of the servitudes noting and tagging all buildings and human usage of the areas for record purposes;
- Communication with the provincial government noting the sensitivity of the servitudes for future provincial planning;
- Interaction with neighbouring communities, and provincial and municipal authorities for temporary labour requirements;
- Agreement with local government structures in terms of the type of labour required and the percentage use of local labour and necessary training;
- Provide information to the surrounding affected communities (including formal structures such as provincial government) on the details of the construction process, such as the purpose and duration of the construction work;
- Identification of borrow pits (for bedding and padding soil) if required and completing the permitting process for use of the pits;
- Identification of water sources for hydro-testing;
- Planning for rehabilitation;
- Agreement with land owners regarding permanent or temporary fencing or access;
- Engineering and construction teams to be mobilised; and
- Ensure that all necessary permits are in place prior to the commencement of construction, including work permits for expatriates and import/export permits for equipment. This also includes

complying with the outcomes of the SEA Process such as the Generic EMPr, and Protocols to ensure that the necessary environmental approvals are obtained before construction commences.

Once the above tasks are completed, the construction process is generally ready for commencement. The establishment of the gas pipeline will typically entail the steps and processes illustrated in Figure 5.

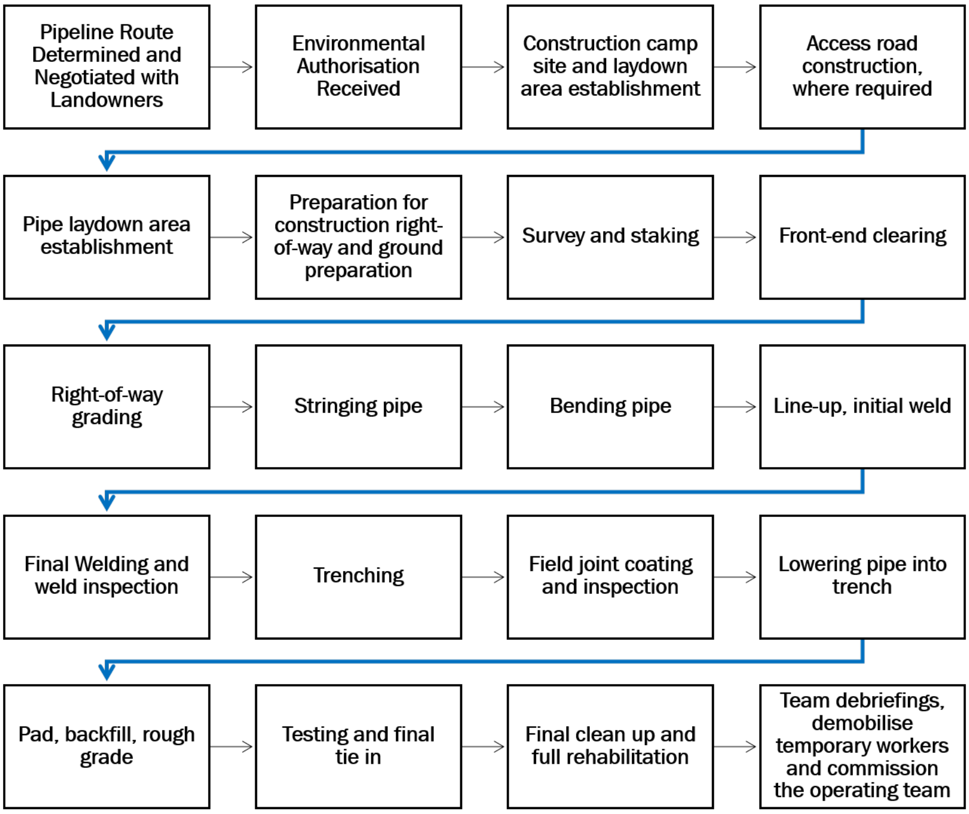


Figure 5: Typical Construction process for a Gas Transmission Pipeline Project

The above steps are detailed below, as applicable:

- <u>Construction Camps and Work Fronts</u>

Experience indicates that for an approximately 100 km long pipeline, one single construction camp is sufficient. In general, construction camps are set up in the middle of the pipeline length so that construction starts in the middle and proceeds in a single work front towards one end and then reverting to the middle and proceeding towards the other end. For pipelines of the length considered in the Phased Gas Pipeline Network, more than one construction camp will be required. These can be about 50 km from the start of one end and then spaced 100 km apart. Depending on the schedule, a single camp and work front can be used, moving the camp as construction proceeds. If the schedule is more critical, multiple construction camps and work fronts can be used, proceeding from the two ends of the pipe until they meet in the centre.

All aspects of the site camp need to be signed off by the relevant parties, prior to the commencement of construction. This includes the approval of the camp design, including the acceptable quartering for all site personnel, obtaining certificates of compliance for generators and other site equipment, ensuring potable water supply is suitable and sufficient, ensuring waste disposal and sewage treatment is operational, finalising plans for medical care on site, as well as ensuring that catering supply and facilities are in place. In addition, spare parts for equipment and basic Personal Protection Equipment (PPE) needs to be in place prior to commencement of construction. In places where there is no mobile network coverage, radio communication will be used at the work fronts. In addition, internet connection will be set up at the site camp.

In general, about 20 experienced personnel from the contractor and 3 – 10 pipeline owner personnel will be on site during pipeline construction from an EPC Management perspective. At peak times, about 550 construction personnel could be on site, with an average of 300 personnel ranging from welders to cathodic protection specialists and third party inspectors. The ‘peak time’ mentioned here refers to the peak construction period with the highest number of simultaneous construction activities requiring the largest work force. The work force grows as the pipeline construction activities increases during the first six months and tapers down as the activities of the “starting work” fronts are completed.

The number of personnel at a construction camp is dependent on the remoteness of the specific camp. Experience indicates that for a very remote camp site, personnel on site averages between 250 and 300 and may peak as high as 500. Moreover, there are about 18 work teams or work fronts active during a pipe laying project and they are following each other in a specific logical sequence. Some activities are fully mechanical and others demand more human interaction. The number of people per work front varies from 8 to 30 people.

While reference is made to a work front, there is no single point where all construction activity is concentrated at any given time. Rather, activities such as surveying and staking, front-end clearing, grading, pipe stringing and bending, etc. are spread out across several kilometres. All of these construction personnel must be transported from and to the construction camp, entailing round trips of up to 100 km on a daily basis.

- **Construction Right-of-Way and Work Space**

A 30 m to 50 m wide construction right-of-way will be required during the construction phase. Space is required for trenching and other construction activities listed above, as well as for the storage and stockpiling of soil, pipes and equipment. The overall footprint required for the pipeline includes the right-of-way and the temporary work space. Figure 6 below provides an illustration of the construction right-of-way and work space.

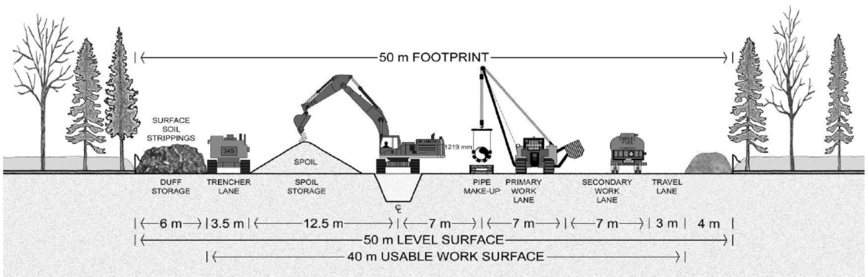


Figure 6: Cross-sectional View of the Right-of-Way and Work Space

- **Pipe Material Receipt, Transport to Site and Stockpiling**

As noted above, it is anticipated that the pipes will be imported and received at the relevant Port. It will then be offloaded and transported to the site via trucks. Once it reaches the site, it will be stockpiled in an area close to the pipeline right-of-way. The stockpile area will be cleared of vegetation.

- **Pipe Stringing, Bending, Line-Up, Welding, Inspection and Coating**

Once the right-of-way is completed, the pipe stringing and bending will take place. This will be followed by lining up of the pipes and welding, as described above. Once the welding is complete, inspection will be undertaken (i.e. Automatic Ultrasonic Testing in line with the applicable standards and codes), and this will be followed by field joint coating, which will either include heat shrink or painting.

- **Trenching**

Trenches will be dug using mechanical trench diggers or excavators. Depending on the pipe diameter, an approximately 1 - 2 m wide section will be trenched. The excavated soil and topsoil will be stockpiled separately adjacent to the trench for infilling and rehabilitation purposes.

- **Lowering of Pipeline, Bedding and Padding**

Once the trenching is complete, the pipeline will be lowered into the trench and bedding and padding will be completed. Where rocky substrate occurs within the trench, it is possible that imported soft soil (from a borrow pit) will be placed within the trench. Alternatively, the material excavated from the trench could be sieved in-situ to ensure better padding and bedding.

- **Pipeline Hydrostatic Testing and Cleaning**

Thereafter, the pipe will be hydrostatically tested and cleaned. Water will be used from local sources as per an approved Water Use Licence (WUL) or General Authorisation. The water is generally treated with a biodegradable corrosion inhibitor. In order to limit the volume of water used, the pipeline can be tested in 30 km "slugs" between the block valves, pushing the water from section to section along the length of the pipeline.

- **Reinstatement and Rehabilitation**

The right-of-way will be rehabilitated progressively as the construction of the pipeline advances. A 10 m wide servitude should ideally be maintained during the operational phase, however, shallow rooted vegetation will be allowed to re-establish within the servitude. Deep rooted vegetation will not be allowed to establish within the 10 m operation servitude as they pose a risk to the underground pipeline and a constraint to future maintenance of the pipeline. Shallow rooted crops over the servitude will be cultivated at the land owners risk, should it be required to be removed for maintenance purposes. However, in cultivating these shallow rooted crops, land owners must be aware of the depth of the pipeline and the ploughing equipment.

- **General Construction Timeframes**

As previously mentioned, this SEA does not necessarily equal to or guarantee construction of any phase of the assessed corridors. A particular phase may only be constructed if there is a guaranteed supply of gas and a guaranteed customer for the gas. Based on this, it is difficult to estimate timelines. However, in general and based on previous experience, it takes approximately 15 months to construct a 130 km pipeline section excluding landowner negotiation in terms of servitude requirements and other related authorisation(s). For a 300 km line, two to three years can be estimated, if a single construction front is used, or less if multiple construction fronts are used.

- **Potential Employment Opportunities**

The potential employment opportunities during the construction phase, the exact transhipment/distribution points or employment likely at these points and relative quantity and cost of gas cannot be specified. This level of information would only be available on a project specific basis. Any potential job creation would be limited and temporary during the construction phase (if the construction of the proposed pipeline does materialise, the extent of such jobs would be determined per project, based on its business case).

2.3.3 Operational Activities

The operation activities for the phased gas pipeline network will include transmission of gas in the pipeline within the 10 m wide registered servitude and maintenance activities.

During the operational phase, the gas temperature within the pipeline is around 20°C and after compression, the gas normally cools from temperatures of up to 55°C back down to 20°C. Once underground (below 1 m depth), the temperature cools naturally to the ambient ground temperature.
Below ground, at a minimum depth of 1 m, the ambient ground temperature does not vary to the extent that it will cause expansion and contraction of the pipeline. The ground therefore stabilizes the temperature of the outside pipe. Above ground, the pipeline has expansion bends to control material stresses caused by expansion. However, the above ground sections of pipe are limited.

The servitude agreement with the land owner will specify the requirements of the Pipeline Operator. Maintenance activities will include pigging, cleaning and inspections. The pigging stations will be accessed on a regular basis for maintenance of the stations (generally 4 to 6 times per year).

Pigging is essentially used for cleaning, maintaining and inspecting the pipelines, as well as to detect areas of degradation, corrosion and defects in order to prevent leaks. The smart robotic PIG is inserted into a "pig launcher" which is then closed and the pressure-driven flow of the product in the pipeline is used to push the pig along the pipe until it reaches the receiving trap or "receiving station". PIGS can also test pipe thickness, and roundness, inspect for signs of corrosion, and any other defect along the interior of the pipeline that may either impede the flow of gas, or pose a potential safety risk to the operation of the pipeline. PIGS can also assess the state of the external coating of the pipeline. The pigging exercise usually does not interrupt production, though minor quantities of gas are vented when the PIG is extracted.

During the operational phase, pipelines are usually monitored through a suitable system to manage and monitor the transmission of the gas through the pipeline. These systems are essentially sophisticated communications systems that take measurements and collect data along the pipeline and transmit it to the control centre. Flow rates through the pipeline, operational status, pressure, and temperature readings may all be used to assess the status of the pipeline at any one time. These systems also work in real time, meaning that there is little lag time between the measurements taken along the pipeline and their transmission to the control station. This enables quick reactions to equipment malfunctions, leaks, or any other unusual activity along the pipeline.

In addition to inspection and monitoring listed above, there are a number of safety precautions and procedures that can be used to minimise the risk of accidents. A few of the safety precautions associated with gas pipelines may include:

- Aerial Patrols – Helicopters surveys are used to ensure no construction activities are taking place too close to the route of the pipeline, particularly close to residential areas. Unauthorised construction and digging is considered a huge threat to pipeline safety.
- Odour - In its natural form, gas is odourless, colourless and tasteless. Mercaptan, a harmless chemical added to natural gas contains sulfur, which makes it detectable by smell. However, Mercaptan is generally not added at the transmission level, only at the distribution and reticulation levels.
- Leak Detection – Natural gas detecting equipment is periodically used by pipeline personnel on the surface to check for leaks. This is especially important in areas where the natural gas is not odourised, as discussed above.
- Pipeline Markers – Signs on the surface above gas pipelines indicate the presence of underground pipelines to the public, to reduce the chance of any interference with the pipeline. Pipeline markers will be installed every 1 km aboveground to indicate the presence of the pipeline so that future developers and adjacent land users are aware of its location.
- Preventative Maintenance – This involves the testing of valves, repairing of defects, repairs of washaways and the removal of surface impediments to pipeline inspection. Pigging every 5 years also forms part of the preventative maintenance activities.
- Emergency Response – Emergency response teams that are prepared for the possibility of a wide range of potential accidents and emergencies.

Risks to the gas pipeline in the event of a fire (controlled burning for crops or veld fires) during operation has been raised as a concern during stakeholder engagement undertaken as part of the SEA process. The Cape Nature Disaster Management team confirmed that given the depth of the pipeline between 1 - 2 m underground, fire would not pose a risk as the soil below ground returns to normal temperatures from about 10 cm below ground level. Root fires may have a different impact, however, deep rooted vegetation will not be allowed to establish above the pipeline within the registered servitude. In addition, forest areas will be avoided for the development of the pipeline. Additional detail regarding fire risk is included in Part 4.3.8 of the Gas Pipeline SEA Report.

2.3.3.1 Greenhouse Gas Emissions

During the last 100 years, a measurable increase in global temperature has become evident and this can only be explained if human activities are taken into consideration (IPCC, 2007 in CSIR, 2011[3]). The rate of anthropogenic emissions of greenhouse gases has been increasing over time, which has resulted in an increase in temperatures, which in turn has resulted in various other changes to the climate system (CSIR, 2011).

As noted in Part 1 of the Gas Pipeline SEA Report, the Draft 2018 Integrated Resource Plan (IRP) (released in August 2018 by the DoE for public comment) presented the future energy mix which included an additional 8 100 MW of energy from gas/diesel by 2030 (totalling to 11 930 MW of the total installed capacity mix by 2030) (DoE, 2018[4]). The Final 2019 IRP was promulgated in October 2019, and stipulates a reduced additional capacity of 3 000 MW of energy from gas/diesel by 2030 (totalling to 6 830 MW of the total installed capacity mix by 2030) (DoE, 2019[5]). The Draft 2018 IRP and Final 2019 IRP was focused on ensuring security of supply, as well as reduction in the cost of electricity, negative environmental impact (greenhouse gas emissions) and water usage (DoE, 2018). The Final 2019 IRP was also developed to take into account diversified electricity generation sources, localisation and regional development.

Based on feedback received during the Authority and Public outreaches conducted during the SEA Process, the use of natural gas in the energy mix is perceived by stakeholders to result in excessive Greenhouse Gas (GHG) emissions, with some organisations taking a stand against any Oil and Gas development, including Exploration. These concerns are duly noted by the SEA Project Team. Research indicates that natural gas (Methane (CH_4)), although having a global warming potential that is greater than Carbon Dioxide (CO_2), is the cleanest-burning hydrocarbon with an emission factor for combustion of 56g of CO_2 per MJ, and it has lower polluting potential than oil (77g of CO_2 per MJ) and coal (96g of CO_2 per MJ) (PWC, 2012[6]; EThekwini Municipality Energy Office, 2015[7]). It is however still associated with GHG emissions and this is largely the basis of concern from stakeholders.

It must firstly be reiterated that the scope of this SEA only covers the assessment of 100 km wide onshore corridors at a strategic level. The impacts associated with the exploration and extraction of gas, its transmission to the landing points as well as the usage of gas (e.g. generation of power using natural gas via a power station) fall outside the scope of work of this study and will need to be subjected to separate Environmental Assessment Processes (as applicable).

The information required for the undertaking of a full life cycle assessment (LCA) with respect to GHG emissions can only be finalised at a project specific level, once a specific transmission gas pipeline route

[3] Council for Scientific and Industrial Research (CSIR) (2011). Climate Risk and Vulnerability: A Handbook for Southern Africa. Council for Scientific and Industrial Research, Pretoria, South Africa, pp 92.
[4] Department of Energy (August 2018). Integrated Resource Plan 2018 (Draft). Pretoria
[5] Department of Energy (October 2019). Integrated Resource Plan 2019. Pretoria.
[6] PWC (2012). The Gas Equation: An analysis of the potential of the natural gas industry in South Africa. https://www.pwc.co.za/en/assets/pdf/the-gas-equation-june-2012.pdf [on-line]. Accessed 25 February 2019.
[7] EThekwini Municipality Energy Office (2015). Natural Gas Position Paper: EThekwini Municipality. Paper developed by Price Waterhouse Coopers Incorporated, Sunninghill. http://www.durban.gov.za/City_Services/energyoffice/Documents/Natural_Gas_Position_Paper_eThekwini_Municipality_2015.pdf [on-line]. Accessed August 2017.

has been determined and a detailed design analysis undertaken (i.e. once there is a viable business case, meaning a guaranteed supply of gas and sufficient demand). In addition, a full LCA requires several details such as the source of gas, quantity of gas transported, usage of gas, location of take offs, location of compressor stations (if any), etc. This level of information is unknown at this stage. There are still currently uncertainties regarding the likelihood and the timeframe for the construction of such pipelines and no real guarantee whether they will be constructed.

In addition, during the project specific stage, developers are most likely to apply for funding from banks. The lending sector has various requirements to ensure that the project they are funding is feasible, viable and sustainable and that it supports national policy. One of the requirements from the lending sector is to demonstrate that a specific project is compliant with relevant national and international standards, such as, but not limited to, the Equator Principles, International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines). One of the requirements of the Equator Principles is to demonstrate the "viability of project operations in view of reasonably foreseeable changing weather patterns/climatic conditions, together with adaptation opportunities" (The Equator Principles Association, 2013[8]; Page 6). Therefore, climate change impacts on the gas pipeline itself and as a result of the gas pipeline will definitely be considered during the project specific stage.

The concerns regarding gas usage cannot be solely addressed as part of this Gas Pipeline SEA. As a country, there needs to be national legislation promulgated that considers the role of gas and its contribution to climate change. This should include the proposed extraction, processing, transmission, distribution, reticulation of gas, as well as its usage and consumption. The legislation needs to discuss the Paris Agreement commitments made by South Africa specifically in relation to gas usage and how this will contribute to "limiting the increase in the global average temperature to well below 2°C above pre-industrial levels, while also pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (DEA, 2018[9], Page 194).

The following sub-sections briefly discuss potential GHG emissions associated with the construction and operation of gas transmission pipelines. Assumptions had to be made given that details such as pipeline engineering design, supply, demand etc. are not yet available.

- <u>Construction Phase</u>

During the construction phase of the proposed gas pipeline development, GHG emissions are likely to occur as a result of the operation of construction vehicles and equipment (such as diesel generators, pumps, excavators, etc.). These emissions, associated with any large scale construction project, are anticipated to be temporary and of low environmental significance. Nonetheless, adequate management actions, detailed in the Generic EMPr, will be implemented to reduce GHG emissions during the construction phase, such as ensuring construction vehicles and equipment are maintained sufficiently.

- <u>Pipeline Commissioning</u>

Commissioning of gas pipelines involves complete displacement of air in the pipeline by natural gas before pressure is increased to the required operation level. Inert gas (usually nitrogen) is used to displace the air before displacement of nitrogen by natural gas. According to the American Gas Association (AGA), "it is usually necessary to use at least 1.5 to 2.5 volumes of inert gas per volume of free space in purging. When purging a pipeline, the area of contact may be so small that little mixing will occur. Advantage can be taken of this condition to conduct an inert purge by use of a quantity of inert gas that is only a fraction of the volume of combustible gas or air to be replaced. It is possible to introduce just enough inert gas to form a

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[8] Equator Principles Association (2013). The Equator Principles, June 2013: A financial industry benchmark for determining, assessing and managing environmental and social risk in projects, Accessed online (May 2019): https://equator-principles.com/wp-content/uploads/2017/03/equator_principles_III.pdf
[9] Department of Environmental Affairs (DEA) (2018). *South Africa's Third National Communication under the United Nations Framework Convention on Climate Change*. Accessed online (June 2019): https://unfccc.int/sites/default/files/resource/South%20African%20TNC%20Report%20%20to%20the%20UNFCCC_31%20Aug.pdf

"slug" or piston between the original gas (or air) content and the entering air (or gas) [cushioned between foam pigs]. This slug and the original gas or air ahead of it, is pushed along the pipe to the end of the section being purged by air or gas introduced after it" (AGA, 2011[10]). For a 26" pipeline, the calculated natural gas released at each pigging station ranges between 5 kg and 6 kg during that operation. As a comparison, this is the quantity of gas in a typical gas bottle used for camping.

This release may result in the formation of an explosive vapour cloud, which could present a threat to those situated close to the venting. It is therefore important to know the flammable limits of the combustible gas in air when undertaking purging operation. The gas must also be vented via a vent stack with an outlet in excess of 10 m above ground level to allow the gas to disperse quickly before forming a combustible vapour cloud.

The following mitigation measures have been recommended in the EIA Report compiled for the installation, commissioning and operation of a high-pressure natural gas transmission pipeline from Sasol Synfuels in Secunda to Sasol Chemical Industries in Sasolburg (Niemand et al. 2009[11]):

- The relevant authorities must be notified in writing prior to the venting being undertaken.
- As best as possible, ensure that the volume of methane vented is kept as low as possible.
- It is recommended that venting is undertaken during suitable atmospheric conditions, such as during windy conditions and at an elevated ambient temperature.
- As best as possible, venting must be avoided at night.
- Venting must be closely monitored and controlled. Ensure that all possible sources of ignition are eliminated or controlled.

▪ <u>Operational Phase under Normal Conditions</u>

During the operational phase, GHG emissions are most likely to occur as a result of the following:

- Pigging operations; and
- Compressor station operations.

As noted in Section 2.3.1 of this chapter, compressor stations are not being considered within the scope of this SEA Process. Compressor stations are generally required to assist with the transmission of gas over long distances, in areas with varying topography and to maintain an adequate pressure profile within the pipeline. In general, compressor stations are fuelled from the gas contained within the pipeline (EThekwini Municipality Energy Office, 2015). Compressor stations also include liquid separators to ensure that potential water and hydrocarbon condensate emanating from the gas during transport are removed (EThekwini Municipality Energy Office, 2015).

If a compressor station is required, then a separate Environmental Authorisation Process will need to be undertaken in accordance with the relevant EIA Regulations in force at the time. This EIA Process would therefore need to consider the potential GHG emissions of compressor stations, as well as any relevant cumulative impacts based on the energy mix and surrounding developments at the time.

During pigging operations, an estimated 5 kg of methane would typically be released in the atmosphere during removal of the pig for each pig run (iGas, 2018, Personal Communication[12])[13]. This is equivalent to 125 kg of CO_2 equivalent (IPCC, Fourth Assessment Report, 2007[14]; Greenhouse Gas Protocol[15]) per pig

[10] American Gas Association, 2001. Purging Principles and Practice. 3rd edition.

[11] Niemand, A., Conradie, D., Duff, A., Maphathe, N., and Niemand II, A. (2009). Environmental Impact Report and Environmental Management Plan for the installation, commissioning and operation of a high-pressure natural gas transmission pipeline from Sasol Synfuels in Secunda to Sasol Chemical Industries in Sasolburg, via Balfour. Report compiled for Sasol Gas Limited. DEA Project Reference Number 12/12/20/1067.

[12] iGas (2018). Personal Communication.

[13] Assumptions: Pipe Diameter = 26 inches, Pig length= 10m, Pressure = 2 bars

[14] IPCC Fourth Assessment Report. Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in

run for each pigging station. Pigging is undertaken once every five years and there is approximately one pigging station every 130 km along the pipeline route (but possibly 250 km to 500 km apart depending on whether newer technology will be used). For purposes of this calculation, it is assumed that pigging stations will be constructed every 250 km along the route (i.e. 4 stations/1000 km of pipeline). Assuming that 6 pig runs are carried out for each pigging station, approximately 750 kg of CO_2 equivalent would be released at each pigging station (i.e. 6 pig runs * 125 kg of CO_2 equivalent per pig run). Based on the above, it is estimated that approximately 3000 kg of CO_2 equivalent would be vented to the atmosphere per 1000 km of pipeline length every 5 years. Figure 7 provides an example of a pigging station.

It must be noted that although the proposed gas transmission pipeline network presented in this study runs over approximately 5000 km along the coast, it is still to be determined if all of the corridor phases will be constructed. Each phase (or section of a phase) would only be constructed based on its own viable business case (i.e. availability of gas, guaranteed off taker, and sufficient demand).

By way of comparison, according to the United States Environmental Protection Agency (US EPA), an average car (i.e. typical passenger vehicle) emits about 4 – 5 tons of CO_2 per year (US EPA, 2018[16], Ashwoods Lightfoot Limited 2019[17]). This estimate, however, may vary based on the distance travelled, the type of fuel used, and the fuel consumption economy (US EPA, 2018). Based on the latest live vehicle population as per the National Traffic Information System – eNaTIS (2019[18]), 12 506 592 vehicles (light, heavy, trailers, motorcycles, etc.) have been registered in South Africa with the Department of Transport (as at January 2019). Therefore, using the above estimates for CO_2 emissions for an average car, it can be derived that the release of CO_2 from motor vehicles in South Africa is 48 – 60 million tons per year. Research indicates that in 2009, road transport activities resulted in a total of 43.5 million tons of CO_2 equivalent in South Africa, whereby motor vehicles and trucks formed 70.6 % of the total emissions (Tongwane *et al*. 2015[19]).

Figure 7: Example of a pigging station (Photo from Mr N Ephraim, iGas).

Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Accessed: https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter2-1.pdf

[15] Greenhouse Gas Protocol: Global Warming Potential Values. Accessed: https://ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

[16] United States Environmental Protection Agency (US EPA) (2018). Greenhouse Gas Emissions from a Typical Passenger Vehicle. https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle [on-line]. Accessed 25 February 2019.

[17] Ashwoods Lightfood Limited (2019). How much CO2 does a car emit per year? https://www.lightfoot.co.uk/news/2017/10/04/how-much-co2-does-a-car-emit-per-year/ [on-line}. Accessed November 2018.

[18] National Traffic Information System – eNaTIS (2019). Vehicle Population Statistics for December/January 2019. http://www.enatis.com/index.php/statistics/13-live-vehicle-population [on-line]. Accessed 25 February 2019.

[19] Tongwane, M., Piketh, S., Stevens, L. and Ramotubei, T. (2015). Greenhouse gas emissions from road transport in South Africa and Lesotho between 2000 and 2009. *Transportation Research* Part D 37 (2015) 1–13.

- **<u>Operational Phase under Abnormal Conditions</u>**

Compared with other methods for transporting hazardous chemicals, such as rail or road, transmission pipelines can be very safe, and transmission pipeline accidents are relatively rare and have caused few fatalities. However, if product releases (leaks or ruptures) occur during the operational phase, it may constitute a considerable safety risk for the surrounding community.

In South Africa, Sasol Gas operates a network of Gas Transmission and Distribution Pipelines. Based on feedback provided in the year 2000, Sasol documented the following incidents over a 30-year period and over approximately 1 260 km of pipeline (Niemand et al. 2009; Page 7.37):

- One incident caused by the rupture of a high-pressure pipeline and ignition of gas caused by a bulldozer ripper while excavating for adjacent road construction. This resulted in severe injury of the operator of the bulldozer.
- Thirty-five incidents of damage by third parties resulting in leaks.
- Twenty-five incidents of valve failure and corrosion resulting in leaks.
- Sixteen incidents of mechanical defects resulting in minor leaks.
- Three leaks due to other causes.

Sasol also provided feedback on key additional incidents that occurred on their network since January 2013. These are described in Table 1 below.

Table 1: Incidents on Sasol's Gas Pipelines (Source: Sasol, 2019)

Date	Key Description of Incident and Type of Incident (leak, rupture, explosion)	Cause of Incident	Measures implemented to rectify resultant impacts and improvement measures implemented
January 2013	Sasolburg to Iscor Arcelor Mittal Transmission Pipeline – Gas Leak	Third Party Damage	• Utility Threat and Prevention Seminars were initiated. • Route inspections and monitoring of the Gas Infrastructure by Gas Pipeline Controllers was undertaken. • Pipeline Route Markers were installed. • Stakeholder Liaison Programme with key stakeholders namely, Excavators, Public Officials, Emergency Services and affected members of the public was commissioned. • Department of Labour provides training to its Occupational Health and Safety Inspectors and Municipal Officials using the gas pipeline as a case study.
July 2014	Secunda to Springs Transmission Pipeline – Gas Leak	Third Party Damage	
May 2015	8 inch Pipeline Damage – Gas Leak	Third Party Damage	
January 2016	Mozambique to Secunda Transmission Pipeline – Gas Release / Leak	Operational Failure	
October 2016	Wadeville Germiston East/ Oos Transmission Pipeline – Gas Leak	Third Party Damage	

In addition, Transnet provided the following feedback (Table 2) on an incident on the Lilly Pipeline.

Table 2: Incidents on Transnet's Gas Pipelines (Source: Transnet SOC Limited, 2019)

Date	Key Description of Incident and Type of Incident (leak, rupture, explosion)	Cause of Incident	Measures implemented to rectify resultant impacts and improvement measures implemented
24 December 2001	The Petronet gas transmission ("Lilly") pipeline (now owned by Transnet) ruptured in the Tongaat area, and it was attributed to a landslide that occurred.	Landslide	• A Commission of Inquiry was convened and the findings of the inquiry confirmed that the incident was attributed to a landslide; all other recommendations e.g. gas servitude awareness campaigns were implemented.

Research indicates[20] that the main causes of gas pipeline leaks or spillages in Europe include third party accidents, mechanical failure, and corrosion, followed by natural hazards on a smaller scale. Third party accidents generally occur by parties other than the Pipeline Operator, for example excavating equipment being used to maintain or construct adjacent services without consideration of pipeline markers or existing service plans from the municipalities. Mechanical failures generally include failures of the pipeline infrastructure for various reasons, ranging from excessive operating pressure to welding failure. These types of mechanical failures will be avoided by ensuring that adequate mitigation and maintenance measures are taken into consideration in the design and operation of the pipeline. It is thus imperative that careful, coordinated and integrated planning must take place when considering the development of a gas transmission pipeline, ensuring that the location maps of the servitudes are readily available. It is also important to ensure that third parties do not have access to the pipeline servitude without prior notification.

The Pipeline Operator will therefore ensure that the pipeline is designed to relevant international and national standards, taking into consideration the lessons learnt from previous regional operations. Leaks are normally detected by abnormal pressure drops and a loss of transported volumes. Risk Based Inspection (RBI) via scheduled intelligent pigging of the pipeline sets an initial baseline and thereafter monitors the condition of the pipeline. If a section of the pipeline needs to be repaired, the remaining gas within the isolated section can be vented off, however, using the technology described below, venting of entire sections is seldom necessary. This methodology of RBI has been successfully employed on the Rompco Pipeline, detecting corrosion and signalling maintenance and repair long before failure actually occurs. As has been previously mentioned, technology such as the TD Williamson Stoppel exists to isolate and/or perform maintenance and tie-ins on “live” pipelines that are still under pressure. This technology is available in South Africa and has been successfully employed on the Rompco Pipeline for tie-ins.

In addition, regular pipeline monitoring will be implemented, along with stringent emergency response procedures. Various design and mitigation measures that respond to potential leaks and incidents have been included in the Generic EMPr.
As noted in Section 2.3.1 of this chapter, block valves will be installed at set intervals (30 km) along the gas pipeline route in order to isolate sections of the lines in the event of leaks and to undertake pipeline repairs. In order to illustrate an example of emissions if a major leak occurs within one 30 km long section of the pipeline, the following assumptions are made:

- Pipeline Length (one section between block valves) = 30 000 m;
- Pipeline Diameter = 26 inches = 0.66 m;
- Pipeline Radius = 13 inches = 0.33 m;
- Pipeline Volume (in one section between block valves) = 10 263.58 m^3;
- Natural Gas Specifications = Generic;
- Natural Gas Composition = Generic and not exact specifications (Methane = 94.240%; Ethane = 2.046%; Nitrogen = 1.804%; Water = 0.006%; and [Propane; Butane; Pentane; Hexane; Heptane; Octane and Other] = 1.904%)
- Leak = Assume all gas molecules from the 30 km long pipeline section will be lost.

Based on the above, natural gas density was determined using the AGA8 detailed characterization equation (i.e. AGA8-92DC)[21].

The calculations confirmed that in the unlikely event of a major leak (full bore rupture), approximately 7 tonnes of natural gas would be emitted to the atmosphere if the pipeline operates at atmospheric operating conditions and approximately 860 tonnes if the pipeline is operating at its maximum pressure (i.e. 100 bar and 20 °C). The amount of methane emitted to the atmosphere will be slightly less than the above amounts as it accounts for 94.24% (in terms of molecular %) of the total constituents of natural gas.

[20] Mark Wood Consultants (2001). Final EIA for a Proposed Natural Gas Pipeline between Komatipoort and Secunda: MAIN REPORT. Prepared for Sasol Gas.
[21] A computational analysis is available from: https://www.unitrove.com/engineering/tools/gas/natural-gas-density

It must be reiterated that the example provided above is illustrative of a 26 inch diameter pipeline operating at a pressure of 100 bar, and currently in South Africa 26 inches is the largest diameter pipeline used. Furthermore, 100 bar is the most likely operating pressure of the pipeline although in South Africa, most operate below this pressure. The assumption is that there will be automatic shut off valves on the pipelines for immediate response in the event of a pipeline rupture, which is currently not the case for any of the pipelines in South Africa.

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 3

SEA Process

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ABBREVIATIONS

BS	Baseline Scenario
CBA	Critical Biodiversity Areas
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
EGI	Electricity Grid Infrastructure
EMPr	Environmental Management Programme
ERG	Expert Reference Group
ESA	Ecological Support Area
GIS	Geographic Information System
HDD	Horizontal Directional Drilling
IBA	Important Bird Area
IDZ	Industrial Development Zones
KCAAA	Karoo Central Astronomy Advantage Area
LNG	Liquefied Natural Gas
PSC	Project Steering Committee
SALT	South African Large Telescope
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zone
SKA	Square Kilometer Array

PART 3. SEA PROCESS

3.1 Introduction

This section of the report describes the process undertaken and methodology adopted for the Gas Pipeline Strategic Environmental Assessment (SEA). The SEA undertook to identify the Preliminary Corridors and refine them to ensure optimal placement in support of sustainable development, as well as the consideration of environmental and engineering constraints, together with the needs of authorities and key stakeholders. The approach is broadly based on an integrated spatial analysis of the best available data at the time.

3.2 Process Overview

3.2.1 Context

The SEA Process aims to add spatial context to national level policies, plans and programmes. The SEA will allow for proactive investment as well as faster and more coordinated permitting procedures. This will ensure that priority gas transmission pipeline projects are implemented more effectively, *whilst maintaining the highest level of environmental assessment and protection*.

It should be noted that the SEA Process is undertaken at a strategic level and cannot replace the requirements for project level environmental studies. The high level environmental, social and economic data utilised to identify the 100 km wide corridors and to undertake environmental pre-assessment of the corridors, is not sufficient for project-level decision making. The SEA should therefore be considered as a scoping level exercise used to identify key potential impacts. Additional environmental studies will be necessary at a project level, together with effective public participation, to determine the significance of impacts. These requirements are stipulated in the Decision-Making Tools.

As illustrated in Figure 1, the SEA Process consists of the following three phases:

- Phase 1: Inception;
- Phase 2: Assessment of the Corridors; and
- Phase 3: Gazetting and Decision- Making Framework.

3.2.2 Phase 1: Inception

The SEA Process began in April 2017 and a dedicated project specific website (https://gasnetwork.csir.co.za) and email address (gasnetwork@csir.co.za) were created to ensure that stakeholders are able to access project specific information and download reports available for comment. The project email address served as the main mechanism of communicating with stakeholders. Feedback on the project website and corresponding updates made are included in Appendix A of the Gas Pipeline SEA Report.

An Expert Reference Group (ERG) and Project Steering Committee (PSC) were also convened during the Inception Phase, with assistance from the Department of Environmental Affairs (DEA). The PSC comprises authorities with a legislated decision-making mandate for gas pipeline development in South Africa, as well as relevant National and Provincial Government Departments, and District Municipalities. The ERG consists of, but is not limited to, all PSC members, as well as representatives from environmental and conservation bodies, Non-Government Organizations, research institutions and industry. The ERG provides assistance and technical knowledge, as well as insights with respect to the issues relevant to specific sectors. Additional information on the composition of the ERG and PSC, as well as a description of the meetings held and notes of the ERG meetings are included in Appendix A of the Gas Pipeline SEA Report.

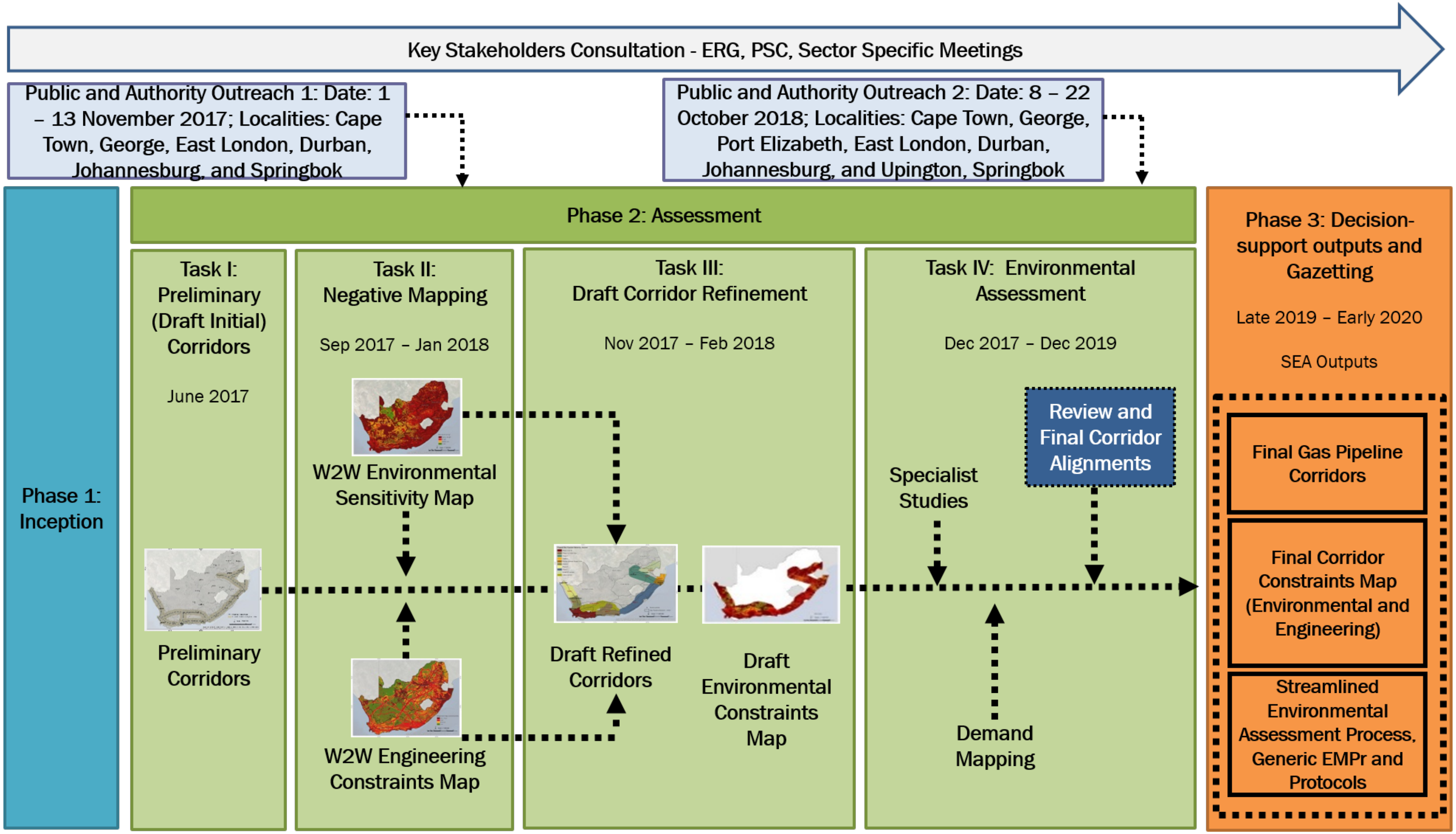


Figure 1: Phased Gas Pipeline SEA Process

3.2.3 Phase 2: Assessment of the Corridors

Phase 2 of the SEA Process consisted of the following four tasks, which were focused on identifying and refining the Preliminary Corridors:

- Task I: Confirmation of Preliminary Corridors;
- Task II: Negative Mapping (Sensitivities and Constraints);
- Task III: Corridor Refinement; and
- Task IV: Environmental Assessment.

Additional information on the consultation process undertaken during this phase is included in Appendix A of the Gas Pipeline SEA Report.

3.2.3.1 Task I: Confirmation of Preliminary Corridors

A set of 100 km wide preliminary corridors was identified based on the Phased Gas Pipeline Network proposed in initiative A1 of the Offshore Oil and Gas Exploration component of Operation Phakisa's Ocean Lab (held from July to August 2014). This was the starting point of the SEA. Shortly after the initiation of the A1 Workgroup, iGas, Transnet and Eskom were requested to ensure strategic alignment of the Phased Gas Pipeline Network, and prioritisation of the phases. This resulted in a strategic alignment and re-numbering of the phases. As highlighted in Part 2 of the SEA Report, this alignment takes into consideration the current opportunities to supply indigenous gas to existing power plants (Ankerlig and Gourikwa Power Stations), the prospects for greenfield power plants in Saldanha, Richards Bay and Coega, as well as other developments outside of Operation Phakisa, i.e. the 2015 Electricity War Room; imported Liquefied Natural Gas (LNG); Karoo Shale Gas; and Eskom's targets for the Gasnosu (Mozambique North-South) pipeline in Mozambique. An inland corridor was also required to assess the possibility of routing the pipeline away from intensive land use areas between Saldanha and Coega. The corridors are illustrated in Figure 2 and are titled as follows:

- Phase 1: Saldanha to Ankerlig and Mossel Bay;
- Phase 2: Mossel Bay to Coega;
- Phase 3: Richards Bay to Secunda;
- Phase 4: Mozambique Southern Border to Richards Bay;
- Phase 5: Abraham Villiersbaai to Saldanha and Ankerlig;
- Phase 6: Abraham Villiersbaai to Oranjemund;
- Phase 7: Coega to Richards Bay;
- Shale Gas Corridor;
- Rompco Corridor; and
- Inland Corridor from Saldanha to Coega with a link to Mossel Bay.

It must be noted that the phase numbering indicated above does not necessarily indicate the sequence in which the phases will be constructed. Instead, each phase will be developed based on its own viable business case.

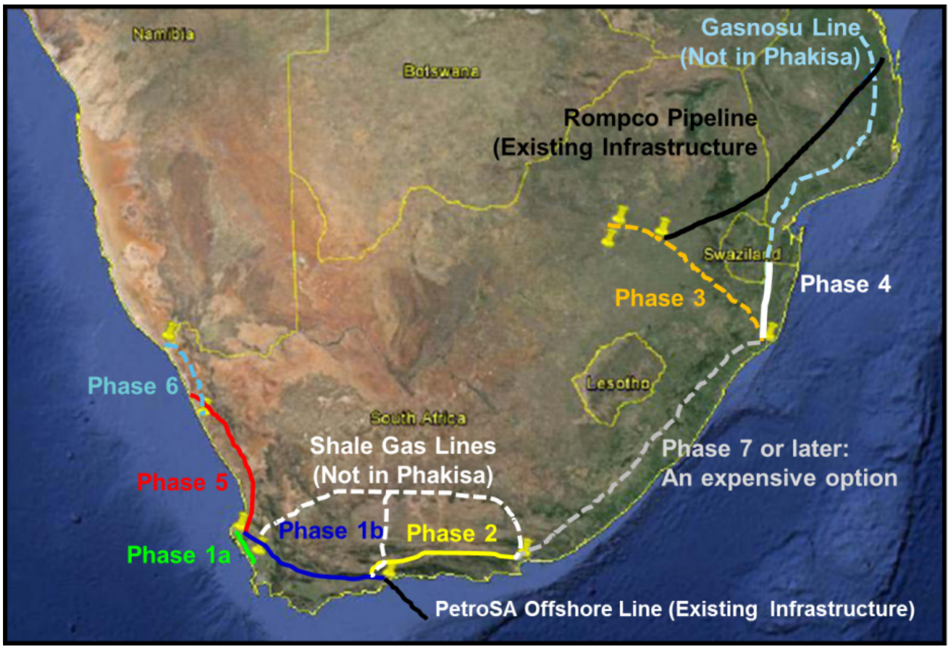


Figure 2: Proposed Phased Gas Pipeline Network for South Africa (Operation Phakisa Offshore Oil and Gas Lab, 2014).

3.2.3.2 Task II: Negative Wall to Wall Mapping (Sensitivities and Constraints)

Task II involved negative mapping to identify key environmental sensitivities and engineering constraints in terms of gas transmission pipeline infrastructure development. Environmental sensitivities were regarded as environmentally sensitive features that may be negatively impacted by gas pipeline development. Engineering constraints are environmental features that are likely to impact upon the development of gas pipeline infrastructure. These are features that developers preferably avoid when planning a gas pipeline development due to the increased cost of constructing and or maintaining the infrastructure in these areas.

Dedicated national scale, wall to wall environmental sensitivity and engineering constraints maps were developed during this task, highlighting areas of sensitivity and constraints across four tiers (i.e. Very High, High, Medium and Low).

In terms of consultation, an initial Authority and Public Outreach was undertaken during this phase in November 2017. Various sector specific meetings and key stakeholder meetings were undertaken during this phase as well.

Additional detail on and the results of the Negative Mapping Task is described in Section 3.4 of this chapter.

3.2.3.3 Task III: Draft Corridors Refinement

Task III is referred to as the Corridor Refinement (Pinch Point Analysis) phase. Task III verified whether any pinch points (significantly constrained areas) exist at any position within the corridors and accordingly refined the preliminary corridors. This task involved aggregating the spatial information captured in Tasks I and II to determine optimal placement of the corridors from both an 'opportunities' and 'constraints' perspective, i.e. where opportunities are maximized whilst ensuring suitable transmission routing alternatives are available from a constraints and sensitivities (both environmental and engineering) perspective.

The output from this process was a set of refined corridor positions i.e. the Draft Refined Corridors.

The national wall to wall environmental sensitivities and engineering constraints maps from Task II were then reduced to the extent of the Draft Refined Corridors to produce a draft environmental and engineering constraints map. This map was carried through to Task IV and assessed by the Specialists. Additional detail on and the results of the Draft Pinch Point Analysis Task is described in Section 3.5 of this chapter.

3.2.3.4 Task IV: Environmental Assessment

Task IV of Phase 2 included Specialist Assessments, which involved scoping level pre-assessments and sensitivity mapping within the Draft Refined Corridors. Specialists were required to review, validate and enhance the draft corridor environmental sensitivities map for a range of environmental aspects (as specified below).

The following specialist studies have been commissioned as part of the SEA:

- Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species, including Bats and Avifauna);
- Impacts of seismicity; and
- Settlement Planning, Disaster Management and related Social Impacts.

The potential impact of the gas pipeline on Agriculture, Defence, Civil Aviation, Heritage, and Mining were also considered. In addition, climate change factors that may affect the operation of a gas transmission pipeline, such as extreme rainfall events, inland flooding and coastal flooding, was also discussed.

In terms of consultation, a second Authority and Public Outreach was undertaken towards the end of Phase 4, in October 2018, to present the findings of the specialist studies and Draft Refined Corridors. The Specialist Assessments were also released to stakeholders for a comment period extending from 25 April 2019 to 24 June 2019 via the project website.

A Demand Mapping Exercise was also undertaken during this task to map any existing and future energy intensive developments and activities within and close to the Draft Refined Corridors. The aim of this exercise was to determine where investment into the development of gas transmission pipeline infrastructure might be best utilised.

Based on the outputs of the Demand Mapping and the specialist studies, as well as inputs from stakeholders following the review of the specialist studies, a Final Pinch Point Analysis was carried out to determine the Final Refined Corridors for consideration by Cabinet. Additional detail on the Demand Mapping Exercise and the Final Pinch Point Analysis is described in Part 5 of this Gas Pipeline SEA Report.

3.2.4 Phase 3: Gazetting and Decision- Making Framework

Phase 3 translates the outputs from Phase 2 into environmental management measures and planning interventions for inclusion in the relevant legal environmental framework and local government planning tools, including Municipal Spatial Development Frameworks, to ensure that long term energy planning is considered within these plans.

The outputs of the SEA (i.e. Final Gas Pipeline Corridors, Generic Environmental Management Programme (EMPr), and Development Protocols) will be released for public comment through publication in the Government Gazette. The gazetting process is envisaged to take place in 2020.

Figure 3 illustrates the process of the SEA since inception until the project specific Environmental Authorisation process.

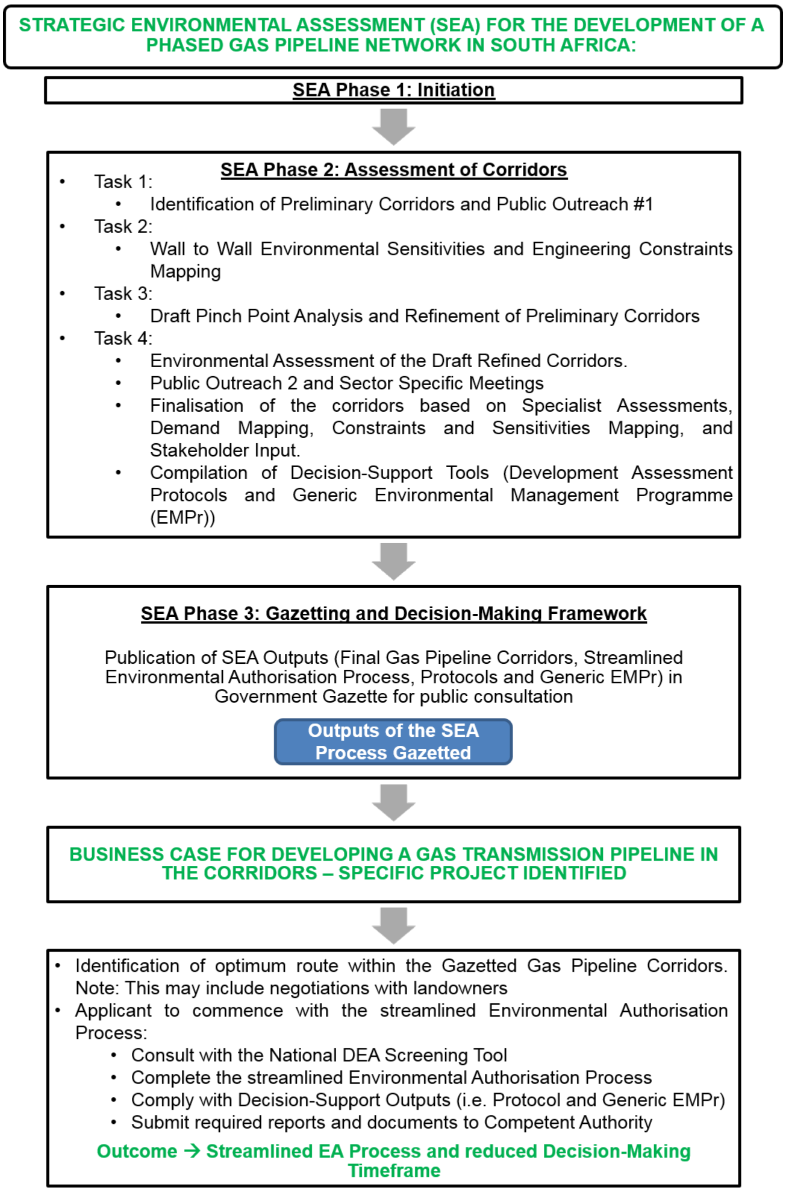


Figure 3: Phased Gas Pipeline SEA Process from Initiation to Project Specific Environmental Authorisation Process.

3.3 Consultation with Stakeholders

In addition to consulting with key stakeholder groups through the ERG and PSC, as well as engagement with key and sector specific stakeholders, public consultation was conducted throughout the duration of the SEA through the exchange of information and data via the project website (https://gasnetwork.csir.co.za/). Additional public engagement was undertaken through newspaper advertisements at key stages of project delivery as well as two Public Outreach programmes. Table 1 below lists the various mechanisms used to engage the public as part of this SEA. Further details on the public engagement process can be found in Appendix A of this Gas Pipeline SEA Report.

Table 1: Summary of Public Engagement undertaken during the SEA

Date	Mechanism
July 2017	Advertisements placed in provincial newspapers to inform stakeholders of the SEA (as part of the Project Initiation).
October 2017	Advertisements placed in provincial and national newspapers to notify stakeholders of the planned Public Outreach – Round 1.
1 November 2017 to 13 November 2017	Public Outreach – Round 1 undertaken.
6 July 2018	Article published online in Engineering News provide a progress update on the SEA.
August 2018	Advertisements placed in provincial newspapers to provide an update on SEA Process
September 2018 and October 2018	Advertisements placed in provincial and national newspapers to notify stakeholders of the planned Public Outreach – Round 2.
8 October 2018 to 22 October 2018	Public Outreach – Round 2 held.
May 2019	Advertisements placed in local and provincial newspapers to notify stakeholders of the additional Public Information Sharing Session held in Durban.
13 June 2019	Additional Public Information Sharing Session held.
July 2019	Engagement with recommended communities within KwaZulu-Natal

The first Authority and Public outreach was undertaken from 1 November 2017 to 13 November 2017 at strategic locations across the country, i.e. Cape Town, George, East London, Durban, Johannesburg and Springbok. During the Authority Meetings, discussions on the proposed corridors and their alignment with provincial and regional planning were undertaken.

The same locations visited during Round 1 of the outreach were visited during Round 2 in October 2018, with Upington (for an Authority Meeting only) and Port Elizabeth added as additional locations. The opportunity was used to identify additional information and potential concerns from stakeholders and provincial departments that needed to be taken into consideration in the SEA Process.

3.4 Task II: Constraints and Sensitivities Mapping

A series of focus group and sector specific meetings and workshops with key authorities, key stakeholders, members of the PSC and ERG, and the general public were held during Phase 2 in order to inform stakeholders of the SEA, to confirm the location of the Preliminary Corridors and to seek feedback on potential constraints, sensitivities and opportunities, including any major infrastructure projects that needed to be considered in the corridor refinement process.

3.4.1 Environmental Sensitivities

The mapping exercise was undertaken for the entire country and involved identifying high level environmental sensitivities for gas pipeline infrastructure development based on the best available data at a national scale. The identification of sensitive features, applicable buffers and datasets was undertaken in consultation with the relevant authorities and key stakeholders. In instances where data for certain environmental aspects was not available, indicative sensitive areas were provided by relevant key stakeholders in consultation with the specialist fraternity. Also included were existing and future conflicting planned land uses such as mining activities and the Square Kilometre Array (SKA). Projects which encroach upon these features are considered more likely to encounter delays, appeals or a negative decision for Environmental Authorisation. The output of this exercise is a map indicating areas to be avoided (Very High sensitivity), areas which are sensitive for various reasons (High-Medium sensitivity), and areas which demonstrate no or low sensitivity (Low sensitivity).

3.4.2 Engineering Constraints

Engineering constraints in the context of the SEA refers to technical challenges posed by the landscape and surrounding environment on the construction and operation of gas pipeline infrastructure. The mapping exercise was undertaken for the entire country and based on the best available data at a national scale. The identification of features and delineation of constraint level (sensitivity) for each engineering feature was done in consultation with engineering representatives from iGas and Transnet, as well as Eskom. Typical engineering related features include steep slopes, commercial forestry areas, coastal areas and deep river gorges. Engineering constraints also include proximity to other linear infrastructure such as high voltage power lines and railway lines that present corrosion problems for the pipelines if they run parallel to this infrastructure for extended distances.

The level of constraint attributed to each feature (f_n) was determined according to a crude cost assessment. The cost assessment considered the impact of each feature on an optimal cost effective Baseline Scenario (BS) (x). The BS in this instance was the construction and maintenance of a 1 km of 26" gas transmission pipeline in optimal conditions for construction.

Level of constraint (c) associated with a feature in the context of the BS (x) was therefore represented as $(c) = (x)*(f_n)$.

3.4.3 Constraints Criteria

Based on feedback from the consultation process and expert inputs, the list of features, buffers and associated level of constraint (Very High, High, Medium and Low) as well as the originating datasets used during the 2016 EGI SEA were reviewed and, where available, updated datasets were used (refer to Tables 2 and 3).

In addition, from an engineering constraints perspective, the following parameters will also need to be considered during the project specific stage, when the pipeline routes are determined:

- Soil type and salt content to determine overall suitability of the soil from a salt content perspective to understand the corrosion risk;
- Rock outcrops in order to gauge the risk in terms of excavations considering the local changes in geology and topography. This will have an implication on associated costs in terms of excavation and importing piping and bedding material. Rock outcrops or shallow rock is often associated with steep slopes; and
- Slope stability, which is considered to be localised and can be engineered to eliminate or avoid based on severity.

These factors are mainly related to the highly variable nature of expected geological conditions and associated constraints, which may change over short distances and would require detailed mapping and planning of routes.

Furthermore, the American Standard ASME B38.1-2016 could not be utilised at this strategic level of the SEA, however it will be recommended for use during the pipeline route planning stage in order to consider building structure types and pipeline wall thickness required.

Table 2: Features and Datasets used to prepare the High Level Draft Environmental Sensitivities Wall to Wall Map to inform the Identification of the Draft Refined Corridors

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
Protected Areas	South African Protected Areas Database (SAPAD) - Q4, 2018 , South African National Parks (SANParks) and Provincial	National Parks	Very high	feature	Protected Areas are meant to stay in a natural or near natural state for biodiversity conservation purposes, hence the Very High sensitivity allocation. In some cases, such as the Mountain Catchment Areas and Protected Environments categories, the reason for the designation of protection is very specific and they may have mixed landscapes within the boundaries of the Protected Area i.e. they may have agricultural land, etc. In these cases, the sensitivity is lower. The proposed construction would require excavation of soils, potentially affecting flora, fauna and microbes.
		Nature Reserves	Very high	feature	
		World Heritage Sites (Core)	Very high	feature	
		Mountain Catchment Areas	High	feature	
		Protected Environments	High	feature	
		Forest Nature Reserve	Very high	feature	
		Forest Wilderness Area	Very high	feature	
		Special Nature Reserve	Very high	feature	
Protected Areas Buffers	SAPAD - Q4, 2018 and South African Conservation Areas Database (SACAD) - Q1,2017	10 KM buffer around National Parks or buffers received from SANPARKS	High	feature	Areas in the legislated buffers around National Parks and Nature Reserves need to be kept as natural or semi-natural as possible. For National Parks, delineated SANParks buffers were used. The 2014 Environmental Impact Assessment (EIA) Regulations Listing Notice 3 was used to guide the allocations for the remaining Protected Areas. The construction phase of gas pipeline development would result in significant impacts in comparison to the operational phase, and a "High" Sensitivity allocation has been allocated as a result of the excavation work required for trenching and laying of the pipeline.
		Buffer around World Heritage Sites (Buffers are Site Specific)	High	feature	World Heritage Sites are of international importance. However, the buffers are often large and in some cases may not have important biodiversity. The core areas of these World Heritage Sites are often Protected Areas, which have been allocated a Very High sensitivity. Some World Heritage Sites have palaeontological features, which could be affected by linear gas pipeline infrastructure that requires excavation; hence, a High Sensitivity has been allocate here.
Conservation Areas	South African Conservation Areas Database (SACAD) -Q1,2017 (DEA)	Biosphere reserves (Buffer area of the biosphere reserve, core areas are already protected)	Medium	feature	The buffers around biosphere reserves is assessed as having Medium sensitivity as these areas are often large and are transition zones areas that have non-natural landscapes within in them. Hence, there are many options and potential to not impact on biodiversity.

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
		Botanical gardens	Medium	feature	Botanical gardens are often in urban centres. They have been allocated a Medium sensitivity because they have largely landscaped areas and some natural or semi natural parts.
		Ramsar Sites (not already protected)	Very high	feature	Ramsar sites are of international importance. Most are already protected. Where they are not protected, they still are of Very High sensitivity because of their nature. The proposed gas pipeline routes would need either to avoid these areas or implement engineering solutions. Ideally building in/near Ramsar sites should be avoided as they are important wetland features, and are important for aquatic fauna and flora at an international scale.
	UNESCO Website / SAHRA	UNESCO tentative sites	High	feature	The proposed gas pipeline routes will try to avoid areas of international heritage importance.
National Protected Areas Expansion Strategy	Priority Areas for Protected Area Expansion, 2017 (including updated Northern Cape Priorities) Department of Environmental Affairs (DEA)	Protected Areas Expansion Priority Areas (Primary)	High	feature	There areas have been allocated a High sensitivity because they are fine scale areas, identified as priority areas for Protected Area expansion. They are small focused areas that provinces are looking to secure as part of the Protected Area network. If the areas are not yet Protected Areas then they can be assessed as Medium sensitivity with the correct mitigation measures in place for gas pipelines as there is little maintenance required during the post construction phase.
Natural Forests	National Forest Inventory (NFI), sourced 2016, Department of Agriculture, Forestry and Fisheries (DAFF)	National Forest Inventory	Very high	feature	Natural forests are protected in terms of the National Forestry Act (Act 84 of 1998), and are highly sensitive environmental features. For the development of proposed gas pipelines, a 30 – 50 m wide servitude would need to be cleared, therefore a Very High sensitivity has been allocated and will be avoided.
Critical Biodiversity Areas	Provincial datasets (GP-2011 (with an update to the report in 2014), EC-2018, FS-2016, KZN- 2012, Limp- 2013, MP-2013, NW-2014, WC-2017, NC-2016)	Critical Biodiversity Area (CBA)	Very high	feature	By definition, CBAs are "an area that must be maintained in a natural or semi-natural state" in order to meet biodiversity targets. CBAs collectively meet biodiversity targets for ecosystem types, species of conservation concern and ecological processes. These areas are of Very High sensitivity and often have sensitive ecosystem types and species. They are the minimum areas required for biodiversity persistence. Gas pipeline development would have a significant impact on the species and

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
					ecosystems that CBAs help conserve if not routed correctly. Micro-siting could help minimise the impact.
		Ecological Support Area (ESA)	Medium	feature	An ESA is an area that must be maintained in at least fair ecological condition (semi-natural/moderately modified state) in order to support the ecological functioning of a CBA or Protected Area, or to generate or deliver ecosystem services. ESAs are assessed as Medium sensitivity because only ecosystem functioning needs to be maintained and some types of development such as gas pipelines are compatible with ESAs.
Threatened Ecosystems	DEA and the South African National Biodiversity Institute (SANBI) 2010	CR (Critically Endangered)	Very high	feature	A CR ecosystem type has very little of its historical extent (measured as area, length or volume) left in a natural or near natural state. Thus, any loss of remaining habitat will have a highly significant impact on the ecosystem type, therefore these areas are assessed as Very Highly sensitive and gas pipeline development within them should be carefully planned to either avoid or minimise impact.
		EN (Endangered)	High	feature	An EN ecosystem type is one that is close to becoming Critically Endangered i.e. that has little of its historical extent left in a natural or near natural state. Thus any loss of remaining habitat will have a highly significant impact on the ecosystem, thus these areas are assessed as sensitive. Gas pipeline development would have a significant impact on the species and ecosystems that ESAs help conserve if not routed correctly. Micro-siting could help minimise the impact.
		VU (Vulnerable)	Medium	feature	A VU ecosystem type still has the majority of its historical extent in a natural or near natural state. Gas pipeline development would need to be done in a sustainable manner, one in which impacts on key features and species of conservation concern are minimised.
Thicket	Thicket Vegetation, SANBI Vegetation Map, 2012 and the STEP Remnant Layer, 2003	Thicket Vegetation Types	Very high	feature	Thicket vegetation types are often dense and shrubby. Some thicket vegetation is already highly degraded. For gas pipeline construction, thicket vegetation types will need to be removed from the construction right-of-way during the construction phase. Thicket takes a very long time to recover, and grow back, therefore it has been assessed as very highly sensitive. Ideally, these areas

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
					should be avoided.
Species of conservation concern	Endangered Wildlife Trust (EWT), SANBI and BirdLife South Africa (2017)	Critical Habitat for highly restricted Species Global Extent of Occurrence < 10 km^2	Very high	feature	This is the only remaining habitat for highly restricted or threatened species, and loss of these areas could result in extinction. At the time of this SEA, this dataset was only available for plants (with fauna to be rolled out soon). These areas are seen as a fatal flaw and should be avoided as far as possible. These areas are often very small, so micro-siting and design of the gas pipeline can limit impact on these species.
		Confirmed occurrences of rare and threatened species	High	feature	These are areas known to have threatened species, as they have recent confirmed records of species. These areas are highly sensitive and mitigation measures will need to be employed to avoid impacting these species. At the time of this SEA, this dataset was only available for plants. Route design for both gas pipeline should try to avoid or minimise impact on these areas.
		Suitable unsurveyed habitat for threatened, rare and data deficient species.	Medium	feature	These areas may contain threatened or rare species, which need to be verified during the project specific phase; hence, a Medium sensitivity has been allocated. If species are present then the area becomes highly sensitive, and if nothing is present it becomes a low sensitivity.
		No known or expected threatened or rare species.	Low	feature	Rationale not required.
Bats	Roost dataset from the South African Bat Assessment Advisory Panel (SABAAP), 2017	Colony of 1 – 50 Least Concern bats + colony of 1 – 50 Low Risk Conservation Important bats	Very high	feature	Bat colonies are highly sensitive and these areas need to be avoided as far as possible for the routing of the gas pipeline.
		Colony of 50 – 500 Least Concern bats + colony of 50 - 500 Low Risk Conservation Important bats + Colony of 1 – 50 Med-High Risk Conservation Important bats	Very high	feature	
		Colony of >500 High Risk Least Concern bats + colony of 50 - 500 Med-High Risk Conservation Important bats + colony of 500 - 2000 Low Risk Conservation Important bats	Very high	feature	
		Colony of 500 - 2000 Med-High Risk Conservation Important bats	Very high	feature	

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
		Colony of >2000 Bats of any status or risk level	Very high	feature	
	Ecoregions (for bats), SABAAP, 2017	KwaZulu-Cape coastal forest mosaic	Medium	feature	These broad ecoregions are known to house habitat for bat species. Verification for presence of roosts need to be undertaken as applicable during the project specific phase. These have been allocated a Medium sensitivity because the sensitive areas within these broad areas need to be verified.
		Maputaland-Pondoland bushland and thickets	Medium	feature	
		Maputaland coastal forest mosaic	Medium	feature	
		Zambezian and Mopane woodlands	Medium	feature	
Birds	BirdlifeSA exclusions Phase 1 SEA	Priority colonies	High	feature	The location of priority bird species colonies/targeted bird species are of High sensitivity. Construction of the gas pipeline can affect populations, and these areas need to be avoided or appropriate mitigation measures applied in order to minimise the impact on populations.
		Transkei vulture Important Bird Area (IBA)	High	feature	
		Amur nests	High	feature	
		Bearded vulture nest	High	feature	
		Verloernvlei Flyway	High	feature	
		Lesser Kestrel	High	feature	
		Potberg Cape Vulture	High	feature	
		Saldanha Flyway	High	feature	
	Vulture Data, 2017, VULPRO	VULPRO Cape Vulture colonies	High	feature	
		VULPRO Cape Vulture roosts	High	feature	
		VULPRO Cape Vulture restaurants	High	feature	
	Vulture Roost Sites, 2017, NMMU	NMMU Cape Vulture roost sites	High	feature	
	Bearded Vulture Risk Model, 2017, KZN Wildlife	Bearded Vulture collision risk model	High	feature	This is not really applicable as there is no collision risk relating to gas pipelines.
	IBAs for South Africa, Bird Life, 2016	IBA (Formally Protected)	Very high	feature	These areas have been identified as priority areas for bird conservation and are already existing Protected Areas. They are thus Very High sensitivity and to be avoided.
		Partially protected	High	feature	These IBAs are not formally protected, however they are still of High sensitivity because of their importance as bird areas. Appropriate avoidance and mitigation needs to be taken in the construction phase to avoid important bird habitat.
		Unprotected	Medium	feature	
Estuaries	Estuaries, including flood plains, 2011, National Biodiversity Assessment, SANBI	All estuaries	Very high	feature	Estuaries are very highly sensitive and dynamic ecosystems, which significant scouring potential. Gas pipeline development needs to avoid estuaries because they are ecologically sensitive, and would result in

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
					cascading environmental impacts if developed within. Ideally they should be avoided as far as possible.
Freshwater Features	Rivers - 1:50 000 scale river lines from the Department of Water Affairs, 2015; Wetlands, updated National Biodiversity Assessment wetland layer, SANBI, 2017	Wetlands	Very high	feature	Natural wetlands are very highly sensitive ecosystems. Gas pipelines need to avoid routing through wetlands because they are ecologically sensitive, and would require diversion or infilling of watercourses for construction in wetlands. Ideally they should be avoided as far as possible.
		Rivers	Very high	feature	Rivers are very highly sensitive ecosystems. Gas pipelines need to avoid routing through rivers because they are ecologically sensitive, and would require diversion of watercourses for construction in rivers. Ideally they should be avoided as far as possible, or an engineering solution such as Horizontal Directional Drilling (HDD) should be used to go under these features, where possible.
Freshwater Feature Buffers	Buffered Rivers and Wetlands	32 m buffer around Rivers	Very high	32m buffer and feature	Riparian buffer areas are very highly sensitive and dynamic ecosystems. Gas pipelines need to avoid routing through river buffers because they are ecologically sensitive and prone to flooding. They would require diversion of watercourses for gas pipeline construction in rivers. Ideally they should be avoided as far as possible, or an engineering solution such as HDD should be used to go under these features, where possible.
Strategic Water Source Areas (SWSAs) - Surface and Groundwater	Council for Scientific and Industrial Research (CSIR) April 2018	SWSAs (Natural Areas)	High	feature	The natural area in the SWSA need to be maintained in a natural or semi-natural condition because these areas are the water factories of the country and construction/ development within them should be kept at a minimum. The run off from these areas that make up 10% of the country, supplies 50% of the country's water. Gas pipelines would only affect these areas during the construction phase, and appropriate mitigation measures to avoid degradation and limit pollution could reduce the risk.
Land Cover	National Land Cover 2013/2014, DEA Habitat Modification Layer (Improved Land Cover) SANBI	Natural areas	Low	feature	These are the other natural areas, available for sustainable gas pipeline development.
		Modified areas	Low	feature	These modified areas are not priority for the natural environment, and are thus preferred for gas pipeline

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
	2017				development.
		Old fields (mapped from imagery)	Low	feature	These are formerly ploughed areas that are degraded, which are more favourable than natural areas for sustainable gas pipeline development.
Agricultural Land Capability	Land Capability Layer, 2016, DAFF	Land capability features with values ranging from 11-15	Very high	feature	These are areas with very high agricultural potential, and are earmarked for agricultural expansion. These areas are Very high Sensitivity from an agricultural point of view and should be reserved for agricultural activities to ensure food security. Gas pipeline construction should aim to apply appropriate measures to minimise the impact on these areas.
		Land capability features with values ranging from 8-10	High	feature	These are areas that are of high agricultural potential, and are earmarked for agricultural expansion. These areas are High Sensitivity from an agricultural point of view and should be reserved for agricultural activities to ensure food security. Gas pipeline construction should aim to apply appropriate measures to minimise the impact on these areas.
		Land capability features class 6 to 7	Medium	feature	These are areas that are of Medium agricultural potential. These areas are Medium Sensitivity from an agricultural point of view. Gas pipeline construction should aim to apply appropriate measures to minimise the impact on these areas.
		Land capability features class 1 to 5	Low	feature	These are areas that are of low agricultural potential. Gas pipeline construction is favoured in these areas.
Field Crop Boundaries	Field Crop Boundaries, 2017, DAFF	Irrigated Areas (pivot agriculture)	Very high	feature	Irrigated pivots have fixed infrastructure that would need to be moved temporarily for gas pipeline development in the construction phase. Ideally, gas pipeline routes should be minimised in pivot agriculture areas.
		Shadenet	Very high	feature	Shadenet crops have fixed infrastructure that would need to be moved temporarily for gas pipeline development in the construction phase. Ideally, gas pipeline routes should be minimised in shadenet areas.
		Viticulture	Very high	feature	Viticulture represents high value agricultural crops that support the Gross Domestic Product. Ideally, gas pipeline routes should be minimised in viticulture areas.
		Horticulture	Very high	feature	Horticulture represents high value agricultural crops that support the Gross Domestic Product. Ideally, gas pipeline routes should be minimised in horticultural areas.

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
		Other cultivated areas	High	feature	Ideally, high value agricultural areas should be avoided where possible to prevent loss of income/economic impact.
Coastline	Coastline, 2015, SANBI and Department of Rural Development and Land Reform	Buffered coastline (1 km)	Very high	1 km	Coastal areas are particularly sensitive to development that may cause coastal erosion and often have human settlements. Additionally, the coastline is dynamic. This is very highly sensitive to gas pipeline development as these ecosystems are sensitive and changes in the coast often has cascading effects.
Karoo Central Astronomy Advantage Area (KCAAA)	KCAAA Footprint, obtained via CSIR (2017)	KCAAA	Medium	feature	This area is assessed as Medium sensitivity and is used as a flag for the KCAAA. The appropriate mitigation needs to be taken into account when constructing gas pipelines in this area.
Square Kilometre Array (SKA) Area	SKA Core Area, 2017, from SKA via CSIR	SKA study area	Very high	Feature	The SKA study area serves as a flag for the SKA telescopes. Gas pipeline development needs to be avoided where the SKA telescopes are placed.
		SKA Telescopes with 20km buffer	Very high	0-20km	The SKA study area serves as a flag for the SKA telescopes. Gas pipeline development needs to be avoided where the SKA telescopes are placed and their 20km buffer.
Defence	Defence Data, 2017, South African National Defence Force	Forward Airfield	Very high	1 km	These areas have airfields that are important for the Military. Access is limited and therefore the gas pipeline route identification in these areas need to be limited, as these areas cannot be compromised for such construction.
		Air Force Bases	Very high	1 km	These areas have Air Force Bases that are important for the Defence Force. Access is limited and therefore the gas pipeline route identification in these areas need to be limited, as these areas cannot be compromised for such construction.
		High Sites	Very high	1 km	These High sites bases are important for the Defence Force. Access is limited and therefore the gas pipeline route identification in these areas need to be limited, as these areas cannot be compromised for such construction.
		Operational Military Bases	Very high	1 km	These areas have Operational Military Bases that are important for the Defence Force. Access is limited and therefore the gas pipeline route identification in these areas need to be limited, as these areas cannot be

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
					compromised for such construction.
		Military Training Areas	Very high	2 km	These areas have Military Training Areas that are important for the Defence Force. Access is limited and therefore the gas pipeline route identification in these areas need to be limited, as these areas cannot be compromised for such construction.
		Bombing Ranges	Very high	1 km	These areas have Bombing Ranges that are important for the Defence Force. Access here is limited, and gas pipeline routes should not coincide with bombing ranges because of the high risk of explosions.
			High	2 km	This serves as a flag for areas within the buffer area from a Defence Force Bombing Range. The location of the bombing range must be taken into account in design and identification of gas pipeline routes.
			Medium	5 km	
		Shooting ranges	Very high	1 km	These areas have Shooting Ranges that are important for the Defence Force and are of Very High sensitivity. Access here is limited, and gas pipeline routes should not coincide with shooting ranges because of the potential risk of explosions.
		Border Posts	Very high	1 km	These Border Posts are important for the Defence Force. Access is limited and therefore the gas pipeline route identification in these areas need to be limited, as these areas cannot be compromised for such construction.
		Ammunition Depots	Very high	10 km	These areas have ammunition deposits that are important for the Defence Force and are of Very High sensitivity. Access here is limited and gas pipeline routes should not coincide with these areas.
		All Other DoD features (Including Naval Bases, Housing, Offices etc.)	Very High	1 km	These are important areas for the Defence Force. Access is limited and therefore the gas pipeline route identification in these areas need to be limited, as these areas cannot be compromised for such construction.
Airports (major, landing strips, small aerodromes)	REDZs 1 SEA Dataset and EGI SEA Dataset, 2017	Major Airports	Medium	8 km	This serves as a flag for a buffer area around the feature. The gas pipeline route identification process must make a note of this. This feature is allocated a Medium sensitivity.
		Other civil aviation aerodromes (small aerodromes)	Medium	8km	

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
Paleontological Heritage Resources	Geological features and substrates of Palaeontological Importance, Geology Layer, 2014, Council for Geosciences	High sensitivity areas: • Adelaide • Asbestos Hills • Boegoeberg Dam • Bothaville • Brulsand • Campbell Rand • Clarens • Drakensberg • Dwyka • Ecca • Elliot • Enon • Ghaap • Kameeldoorns • Koegas • Kuibis • Matsap • Molteno • Prince Albert • Rietgat • Schmidtsdrif • Schwarzrand • Stalhoek • Sultanaoord • Tarkastad • Vryburg • Whitehill • Witteberg	High	feature	This layer identifies substrates with a high probability of containing palaeontological items/features. For gas pipeline construction, this is of importance during the construction phase. Areas with High and Very High sensitivity should be avoided as best as possible in order to minimise impact.
		Medium sensitivity areas: • Achab • Allanridge • Bidouw • Bredasdorp • Ceres • Concordia Granite • Dwyka • Fort Brown • Geselskapbank • Gladkop • Grahamstown • Hartebeest Pan Granite • Hoogoor • Kalahari • Kamieskroon Gneiss • Karoo Dolerite • Kookfontein • Korridor • Mesklip Gneiss • Modderfontein • Granite/Gneiss • Naab • Nababeep Gneiss • Nakanas • Nardouw • Nuwefontein Granite • Rietberg Granite • Skoorsteenberg • Stinkfontein • Styger Kraal Syenite • Table Mountain • Tierberg	Medium	feature	This layer identifies substrates with a medium probability of containing palaeontological items/features. For gas pipeline construction, this is of importance during the construction phase. Areas with significant palaeontological sensitivity should be avoided as best as possible in order to minimise impact.

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
		• Khurisberg • Konkyp Gneiss • Waterford • Volksrust			
Heritage	Mapped Heritage Features, SAHRA, 2018	World Heritage Sites (Core)	Very high	feature	Protected Areas are meant to stay in a natural or near natural state for biodiversity conservation purposes, hence the Very High sensitivity allocation. The proposed construction would require excavation of soils, potentially affecting flora, fauna and microbes.
		World Heritage Sites (Buffer)	High	feature	World Heritage Sites are of international importance. However, the buffers are often large and in some cases may not have important biodiversity. The core areas of these World Heritage Sites are often Protected Areas, which have been allocated a Very High sensitivity. Some World Heritage Sites have palaeontological features, which could be affected by linear gas pipeline infrastructure that requires excavation; hence, a High Sensitivity has been allocate here.
		Grade I sites	Very high	2 km	These mapped heritage features are of Very High sensitivity, and ideally these areas should be avoided by the gas pipeline. The gas pipeline would require excavation, therefore the risk of finding significant finds are very high.
		Grade II sites	Very high	1 km	
		Grade IIIa sites	High	150 m	These mapped heritage features are of High sensitivity, and ideally these areas should be avoided by the gas pipeline. The gas pipeline would require excavation, therefore the risk of finding significant finds are high.
		Grade IIIb sites	High	100 m	
		Grade IIIc sites	High	50 m	
		Ungraded	Very high	100 m	These mapped heritage features are of Very High sensitivity, and ideally these areas should be avoided by the gas pipeline. The gas pipeline would require excavation, therefore the risk of finding significant finds are very high.
		Battlefields (Grade IIIb)	Very high	5 km	
Visual	Modelled from Digital Elevation Model, 2015, NGI	Slopes > 25% or 1:4	Medium	feature	Areas with high slope/angle to be avoided as they can affect the stability of the gas pipeline during and after construction.
	Provincial data sets on Game Farms and Private Reserves (2014-2017); SACAD Q2, 2017, DEA	Private reserves and game farms	High	0 - 2.5 km	Visually sensitive only during the construction phase of the gas pipeline, otherwise pipelines are buried during the operational phase. The High/Medium sensitivity is due to the proximity to the private reserve/ game farm.
			Medium	2.5 - 5 km	

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
			Low	5 - 10 km	Far enough to not have any affect game farms, visually.
			Low	> 10 km	
	Location of the South African Large Telescope (SALT), sourced from the CSIR, 2017	SALT	Very high	0 - 25 km	This is not compatible with the construction of gas pipelines. The location of the SALT must be avoided due to its sensitivity during the construction phase.
	Mapped Heritage Features, SAHRA, 2015	Heritage feature: Grade I sites	Medium	Feature - 1.5 km	Visually sensitive only during the construction and rehabilitation phases as the pipelines are buried.
		Heritage feature: Grade II sites	Medium	1- 1.5 km	
		Heritage feature: Grade IIIa sites	Medium	150 m - 1.5 km	
		Heritage feature: Grade IIIb sites	Medium	50 m - 1.5 km	
		Heritage feature: Grade IIIc sites	Medium	30 m - 1.5 km	
	Location of Towns, AfriGIS Towns – 2017	Town, villages and settlements outside large urban areas	Very high	0 m - 500 m	These areas need to be avoided for safety reasons (especially with regards to potential leaks and accidents), as well as to avoid re-settlement concerns. It is best to avoid these areas during the routing of the pipeline.
			High	500 m - 1 km	
			Medium	1 km - 2 km	The sensitivity is not as high because the proximity is further from towns, but there is still some potential risk for gas pipeline related incidents.
Major Towns	Location of Towns, AfriGIS Towns – 2017	Towns, villages and settlements and urban areas	Very high	5 km	These areas need to be avoided for safety reasons (especially with regards to potential leaks and accidents), as well as to avoid re-settlement concerns.
Urban Areas and High Density Rural Settlements	Eskom SPOT Building Count, 2013 (100 m x 100 m grid cell resolution).	Grid cells containing ≥ 3 dwellings	Very high	1 km	

Table 3: Features and Datasets used to prepare the High Level Draft Engineering Constraints Wall to Wall Map to inform the Identification of the Draft Refined Corridors

Feature category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
Coastline (including Estuaries)	SANBI 2004	Coastline & Estuaries	Very High	1 km	The corridors need to be at least 1 km away from the coastline due to corrosion and erosion concerns.
Slope	25m NGI DEM	>45°	Very High	feature	Expansive engineering solutions may be required in order to route the gas pipelines up very steep slopes. These areas are therefore rated with a Very High sensitivity.
		25-45°	High	feature	Expansive engineering solutions may be required in order to route the gas pipelines up very steep slopes. These areas are therefore rated with a High sensitivity.
		15-25°	Medium	feature	A Medium sensitivity has been allocated because areas of medium steepness does not significantly increase the cost of construction.
		0-15°	Low	feature	A Low sensitivity has been allocated because these areas are considered as accessible.
Access/Roads	Eskom - NGI Roads Layer 2016	Roads	Low	feature	A Low sensitivity has been allocated because access to the gas pipelines for maintenance purposes are not considered as a significant cost. In most cases a gravel track is maintained to allow a 4x4 to access the route, and this will be within the 10 m operational servitude.
Geology	Council for Geoscience, 1997	Dolomite (and other rock types)	High	feature	Need to avoid rocky substrates and soil with many boulders as this would increase the cost of the trenching and pipeline installation. In addition, geology that may pose a subsidence risk should also be avoided as best as possible.
		Dolomite restricted to Gauteng and Mpumalanga	Very high	Feature	
Seismicity	Seismic Hazard in South Africa 2011 (Council for Geoscience Report number: 2011-0061)	Generally confined to Cape Fold Belt region of Southern Cape	High	feature	Potential seismicity risk in these areas may mean that the design of the pipeline would need to be modified to accommodate this i.e. thicker walls and implementation of sensors etc. This would increase the cost of the development.
Gully Erosion	DAFF Gully Erosion Datasets	Footprint of erosion/gully > 500 m^2	Very High	feature	Areas with deep gully erosion should be avoided, as there is a risk that the pipelines may be exposed in areas prone to such erosion. Areas with existing gullies may result in further erosion that may cause instability for the pipeline.
Soil Erodibility	DAFF Soil Erosion Hazard Classes - South Africa and Lesotho, 2010	Hazard Class - High	High	feature	Areas with high soil erodibility do pose a risk to the pipeline stability but the data is too coarse scale to weigh it higher.
		Hazard Class - Medium	Medium	feature	Areas with high soil erodibility do pose a medium risk to the pipeline stability but the data is too coarse scale to

Feature category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
					weigh it higher.
		Hazard Class - Low	Low	feature	These areas are considered to be suitable or favoured for gas pipeline development.
Settlements	AfriGIS Towns Layer	Towns, villages and settlement spatial footprints	Very high	feature	Towns and settlements need to be avoided because of the cost associated with having to remove existing infrastructure and potentially relocate settlements. In addition, safety is a significant factor and the pipeline may need to designed in a certain way to accommodate settlements.
Railway Lines (All Railways)	DRDLR Topo, 2006 - Transnet	0 - 1 km around railways	Very High	1 km	The gas pipeline needs to be at least 1 km away from railway lines because current leakage from the railway line to earth, which may lead to corrosion. A 1 km buffer is therefore required. Less than 1 km is not acceptable unless there is no other option and special provision is made for frequent wall thickness measurements and frequent repair or replacement of the line as required.
		1 - 5 km around railways	High	1 - 5 km	Refer to the rationale provided above.
		5 - 10 km around railways	Medium	5 - 10 km	These areas are considered to be suitable or favoured for gas pipeline development.
Industrial Areas	DEA 2013/2014 land cover	Existing industrial areas	Low	feature	These areas are considered to be suitable or favoured for gas pipeline development.
Industrial Expansion	SDFs, IDPs, consultation with authorities	Planned industrial activities	Low	feature	These areas are considered to be suitable or favoured for gas pipeline development.
Mining	DMR, 2018 (SAMRAD Mining Applications)	(Retention Permit, Reconnaissance Permission/Permit, Prospecting Right, Prospecting Right Renewal, Mining Right, Mining Permit, Exploration Right, Burrow Pit, Amending An Existing Right	Very High	feature	Ideally all areas with existing and abandoned mining areas should be avoided as they pose a risk to the pipeline infrastructure, especially for underground mines. Subsidence and instability caused by mining is unfavourable for the gas pipeline.
Mining	Transnet	Undermining. Localised areas in northern KwaZulu-Natal and Mpumalanga associated with old coal mines	High	Feature	Undocumented undermining is a risk, as described above. These areas are localised and can be avoided.

Feature category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
Major dams	DWA Dams Data	Dams	Very High	feature	Avoid these areas because of the cost of HDD, which would be needed to route the gas pipeline below the dam. In addition, the depth of the dam would need to be established.
Estuaries	National Biodiversity Assessment (NBA) 2017/18	All Estuaries	Very High	feature	Avoid these areas because of the cost of HDD, which would be needed to route the gas pipeline below the estuary. In addition, the depth of the estuary and its scouring potential would need to be established. Estuaries also pose a risk to the gas pipeline due to their ephemeral and dynamic nature, as well as scouring potential.
Wetlands	Wetland Data 2017	All Wetlands	Medium	feature	Where trenching through wetlands is not feasible, HDD will be required. This would lead to higher cost.
Rivers	NFEPA River Data 2010 and NGI Mapped River Footprint	Drainage Lines	Very high (Order 6-7)	> 500m	Avoid all rivers wider than 500 m as HDD is not advised.
			High (Order 4-5)	Between 10 and 500 m	An additional cost is required in order to undertake HDD to cross these rivers.
			Medium (Order 1-3)	<10m	Temporary cut to be used to go through smaller rivers during construction phase; hence it has been allocated a Medium Sensitivity.
	NBA 2018 (South African Inventory of Inland Aquatic Ecosystems)	Valley Bottom include Stream (Exclude Northern Cape)	Very High	feature	Often these are very wide and too wide for HDD, hence it has been allocated with a Very High sensitivity.
WULA Agreements	NFEPA River and Wetland Data 2010	Rivers and wetlands buffered by 500 m	High	500 m buffer around feature	Additional cost associated with having to apply for a Water Use Licence
Natural Forests	Department of Agriculture, Forestry and Fisheries, 2017. NFI	Natural forests	Very High	feature	These areas should be avoided at all costs because of the deep root systems that pose a risk to the belowground pipeline. In addition, a permit for the removal of protected trees to establish the operational servitude is a considerable investment and risk (as there is no guarantee of approval).
Forestry Potential (EC)	EC Parks and Tourism Agency 2014	Potential Areas for Forestry	Medium	feature	These areas should be avoided at all costs because of the deep root systems that pose a risk to the belowground pipeline. There is potential future conflict.
Thicket	Albany Thicket, SANBI Vegetation Map, 2017	National	High	feature	This has been rated a High sensitivity because of the additional cost associated with clearing of the Thicket during the construction phase, as the thicket is dense and potentially deep-rooted.

Feature category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
Sugar Cane	KZN Land Cover 2011 [Sugar cane farming and emerging farming data]	Sugar Cane Farm Boundaries	High	feature	This has been rated a High sensitivity because of the potential safety risk that applies due to burning operations.
Commercial Forestry	Data on Commercial Forestry provided by DAFF in June 2016	DAFF Commercial Forests	Very high	50 m buffer	These areas should be avoided at all costs because of the deep root systems that pose a risk to the belowground pipeline.
Field Crop - Short term	Agriculture Field Crop Boundary Data 2016	All	Medium	feature	Some short-term crops may pose a concern in terms of deep rooting systems.
Field Crop - Long term	Agriculture Field Crop Boundary Data 2016	All	Very High	feature	Long-term crops should be avoided, as the roots may be an issue.
High incidence for lightning strikes	Eskom, July 2014	Highest 10% risk areas	Low	feature	The pipeline will be belowground; hence, areas that have a high incidence for lightning strikes would not be a concern for the gas pipeline.
High incidence for fire	Eskom, November 2016 (2002-2017)	Highest 10% risk areas	High	feature	Veld fires would not pose a significant risk as the soil below ground returns to normal temperatures from about 10 cm below ground level. However, this has been rated as a High sensitivity due to safety concerns.
High incidence for wind	Eskom, July 2014	Highest 10% risk areas	Low	feature	The pipeline will be belowground; hence, areas that have a high incidence for wind would not be a concern for the gas pipeline.
High incidence for flooding	Eskom, 2015 (sourced in 2018)	Highest 10% risk areas	Medium	feature	Areas that have a high incidence for flooding could pose an erosion risk and buoyancy concerns. Extra cost would be needed for buoyancy control within the pipeline.
Electrical Transmission Cables (Voltages Above 60 kV)	DRDLR Topo, 2006 - Transnet	0 - 1 Km	Very High	< 1 km	Very high potential for an induced current to be created in the pipeline that could lead to corrosion of the pipeline. Therefore, this area needs to be avoided.
		1 - 5 km	High	1 - 5 km	High potential for an induced current to be created in the pipeline that could lead to corrosion of the pipeline. Therefore, this area needs to be taken into consideration.
		5 - 10 km	Medium	5 - 10 km	Medium potential for an induced current to be created in the pipeline that could lead to corrosion of the pipeline.
		> 10 km	Low	> 10 km	These areas are considered to be suitable for gas pipeline development.
Electrical Transmission Cables (Voltages Below 60	DRDLR Topo, 2006 - Transnet	0 - 1 Km	High	< 1 km	High potential for an induced current to be created in the pipeline that could lead to corrosion of the pipeline. Therefore, this area needs to be avoided.

Feature category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer	Rationale for Mapping Sensitivity
kV)		1 - 5 km	Medium	1 - 5 km	Medium potential for an induced current to be created in the pipeline that could lead to corrosion of the pipeline.
		5 - 10 km	Low	5 - 10 km	These areas are considered to be suitable for gas pipeline development.
Existing Gas and Fuel Pipelines	iGas, 2017 (Rompco Gas Pipeline); Transnet, 2018 (Future and Existing Gas and Fuel Pipelines)	Gas and Fuel Pipelines (feature)	Medium	feature	Based on previous operations, a distance of about 5 – 10 m should be used between gas pipelines; and between gas pipelines and oil pipelines. This is also governed by the servitude size. For example, if the servitude ranges between 6 – 10 m, then the buffer distance would be 10 m between gas pipelines. The law is not prescriptive in this regard and the team is not aware of any API standards linked to this. The wall thickness of the pipeline could also be increased to avoid using a 10 m wide buffer. Therefore, a Medium sensitivity has been allocated.
Water Pipelines	DWS, 2017 (Bulk Infrastructure)	Existing and Future Bulk Water Pipelines and Infrastructure	Medium	feature	A Medium sensitivity has been allocated in order to account for the costs associated with having to undertake HDD in these areas.

3.4.4 Wall to Wall Constraints Maps

Based on the updated list of features and sensitivities, the constraints mapping outputs were developed at a national scale for both environmental sensitivities and engineering constraints:

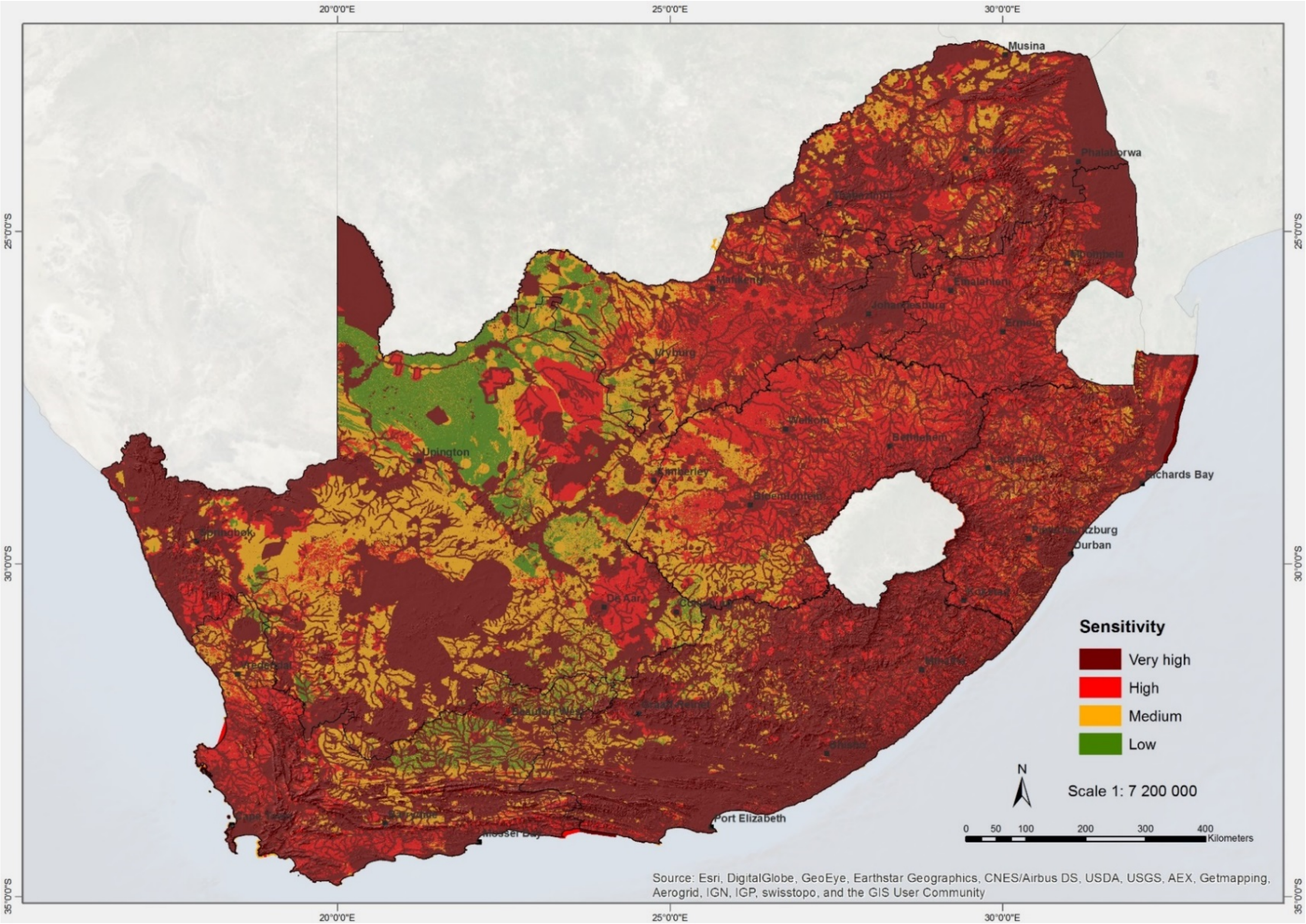
- The four tiered wall to wall draft environmental sensitivities map and the interpretation of each tier of constraint is illustrated in Map 1 and Table 4, respectively.
- The four tiered wall to wall draft engineering constraints map and the interpretation of each tier of constraint is illustrated in Map 2 and Table 5, respectively.

Table 4: Interpretation of Environmental Sensitivities

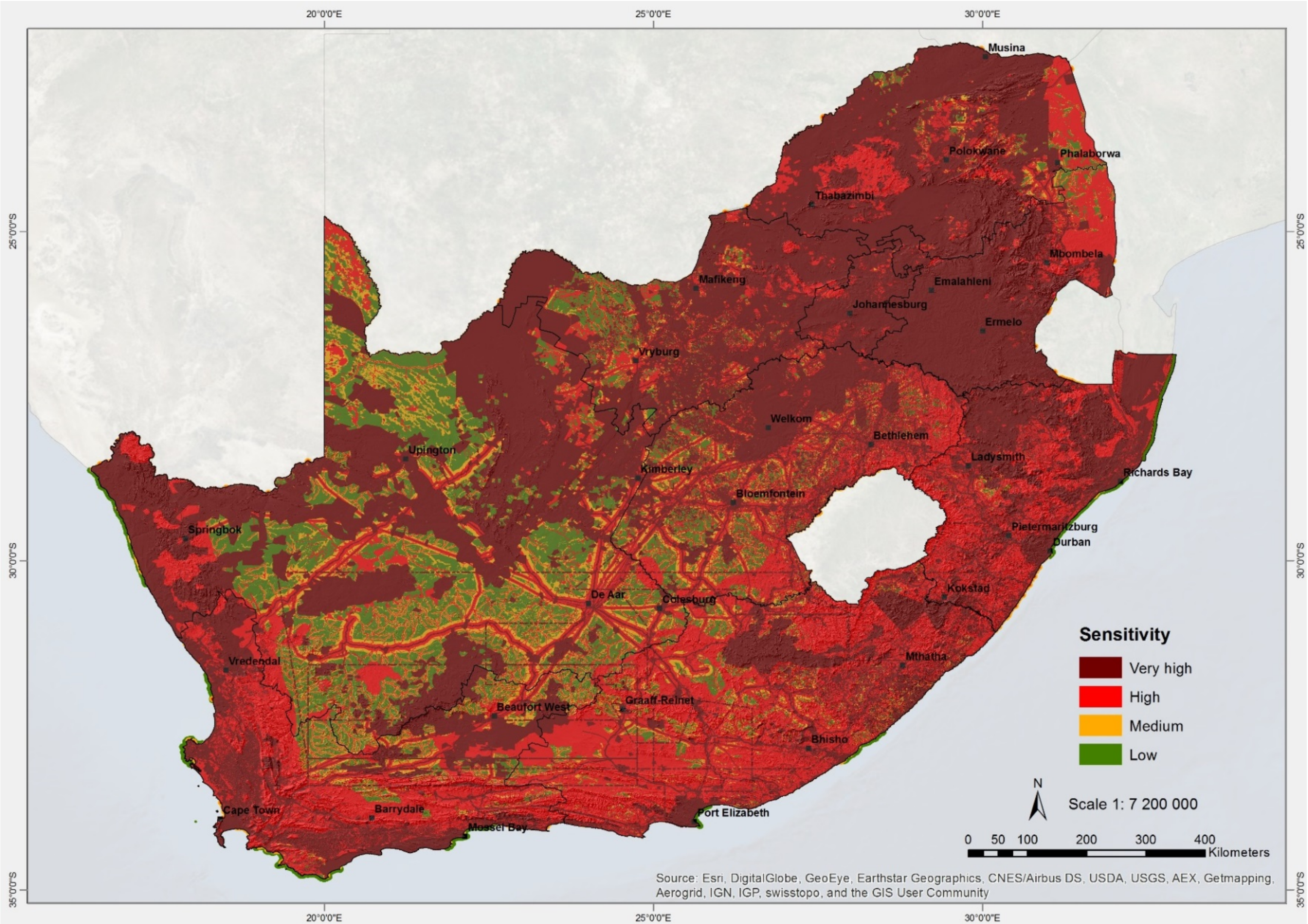
Environmental Sensitivities	
Sensitivity	**Description**
Very High	The area is rated as extremely sensitive to the negative impact of gas pipeline infrastructure development. As a result, the area will either have very high conservation value, very high existing/ potential socio-economic value or hold legal protection status.
High	The area is rated as being of high sensitivity to the negative impact of gas pipeline infrastructure development. As a result, the area will either have high conservation value and or existing/potential socio-economic value.
Medium	The area is rated as being of medium sensitivity to the negative impact of gas pipeline infrastructure. As a result the area will either have medium levels of conservation value and/or medium levels of existing/potential socio-economic value.
Low	Area is considered to have low levels of sensitivity in the context of gas pipeline infrastructure.

Table 5: Interpretation of Engineering Constraints

Engineering Constraints		
Constraint	**Description**	**Feature Cost**
Very High	The lifetime cost associated with development in this area is greater than 160% the baseline lifetime cost index.	c=>1.60x
High	The lifetime cost associated with development in this area is between 140% and 160% the baseline lifetime cost index.	c=>1.40x and ≤1.60x
Medium	The lifetime cost associated with development in this area is between 120% and 140% the baseline lifetime cost index.	c=1.20x and ≤ 1.40x
Low	The lifetime costs associated with development in this area is less than 120% times the baseline lifetime cost index.	c =<1.20x



Map 1: Draft Environmental Sensitivities Wall to Wall Map



Map 2: Draft Engineering Constraints Wall to Wall Map

3.5 Task III: Draft Pinch Point Analysis

The Draft Pinch Point Analysis was undertaken at the end of Task II to guide and inform the location of the corridors to be assessed by the specialists in Task IV.

This analysis involved the refinement of the preliminary corridors in order to guide and inform the location of the corridors prior to the commencement of the Specialist Assessments. The Pinch Point Analysis is a method that identifies where "bottle necks" or "choke-points" are located within the landscape (McRae *et al*. 2008[1]). The analysis works by synthesizing and overlaying the constraints mapping (sensitive environmental and engineering features) outputs to determine where possible available routing options exist within the corridors. Based on the wall to wall constraints maps, a single layer of all **Very High** sensitive areas (only) was created at a national scale (Map 3). Multiple unique routing options, outside of Very High sensitivity areas and at all points along each of the corridors, are desirable in the context of this study as this allows developers a degree of flexibility when negotiating without having to consider development in a very sensitive area.

Due to their sensitivity, Very High sensitive areas potentially impact the design of the phased gas pipeline network, and consequently the location of the corridors. Some examples of features rated with a Very High sensitivity includes the Protected Areas, mountainous areas, Critical Biodiversity Areas, and threatened ecosystems.

A complete pinch point was defined as a point within a corridor where no clear pipeline routing opportunities exist without having to traverse an area delineated as Very High sensitivity from either an environmental or engineering perspective, i.e. 98 - 100% of the corridor is covered in Very High Sensitive features. A partial pinch point was defined as the instance where there were fewer than five unique routes through different land parcels without having to traverse an area delineated as Very High sensitivity, i.e. where 80-97% of the corridor was covered in Very High sensitive features.

In the event of a complete or partial pinch point, the area immediately adjacent to that point and outside the corridor was considered from an environmental and engineering constraints perspective. Where relief (i.e. a less sensitive area) outside of the corridors was shown to be present, the corridor boundary was shifted in the direction of relief to allow for a minimum of five unique routing options. This was carried out without compromising the intersection of the corridors with the key anchor points, as best as possible. Where no obvious relief was shown to be present, the position of the corridor remained unchanged.

3.5.1 Identification of Pinch Points

The main focus area for the Phased Gas Pipeline Network is along the coast due to offshore oil and gas activities taking place. Therefore, the Project Partners advised that the refinement and adjustment process should ensure that the corridors are located as close to the coast as possible due to the escalating cost associated with developing the infrastructure away from the coast. However, because of the sensitivity of coastal areas, the corridors are set back at least 1 km from the coastline (in some cases).

As part of the Draft Pinch Point Analysis, the following two pinch points were identified:

- Pinch Point 1 – Phase 6 and Phase 5 Gas Pipeline Corridors falling within the Northern Cape and a minor portion in the Western Cape.
- Pinch Point 2 – Phase 3 Gas Pipeline Corridor falling within KwaZulu-Natal, Free State, Gauteng, and Mpumalanga, and to a small extent in the North-West.

[1] McRae, B.H., Dickson, B.G., Keitt, T.H. and Shah, V.B., 2008. Using circuit theory to model connectivity in ecology, evolution, and conservation. *Ecology*, *89*(10), pp.2712-2724.

3.5.1.1 Pinch Point 1

The pinch point identified in the Phase 6 and Phase 5 Gas Pipeline Corridors (Figure 4A) was resolved during the Draft Pinch Point Analysis by shifting the corridor 25 km away from the coastline to the east to ensure that the extent of Very High sensitivity areas within the corridors are reduced. The main constraints that influenced the pinch point include the following:

- Diamond mining areas close to the coast within the Northern Cape, which pose a threat to potential gas pipeline development, mainly from a stability and safety perspective. Additional detail on the impact of mining areas on gas pipeline infrastructure and vice versa is captured in Part 4.2.9 of this Gas Pipeline SEA Report;
- The Richtersveld National Park and World Heritage Site, and Critical Biodiversity Areas (CBAs);
- Other Protected Areas.

3.5.1.2 Pinch Point 2

The pinch point identified in the Phase 3 Corridor (Figure 4B) was resolved during the Draft Pinch Point Analysis by shifting the corridor in a south-westerly direction to move away from the Swaziland border in Mpumalanga and to move towards the Free State to ensure that the extent of Very High sensitivity areas within the corridors are reduced. The main constraints that influenced the pinch point include the following:

- Mining areas in northern KwaZulu-Natal and parts of Mpumalanga, which pose a threat to potential gas pipeline development, mainly from a stability and safety perspective. Additional detail on the impact of mining areas on gas pipeline infrastructure and vice versa is captured in Part 4.2.9 of this Gas Pipeline SEA Report;
- Densely populated regions such as Gauteng, which are under development pressure; and
- CBAs; Protected Areas and World Heritage Sites (including the Drakensberg Escarpment).

The shift of the Phase 3 corridor was also undertaken in order to expand the corridor width to enable a greater area of assessment and to include more low sensitivity areas as best as possible.

3.5.1.3 Re-alignment

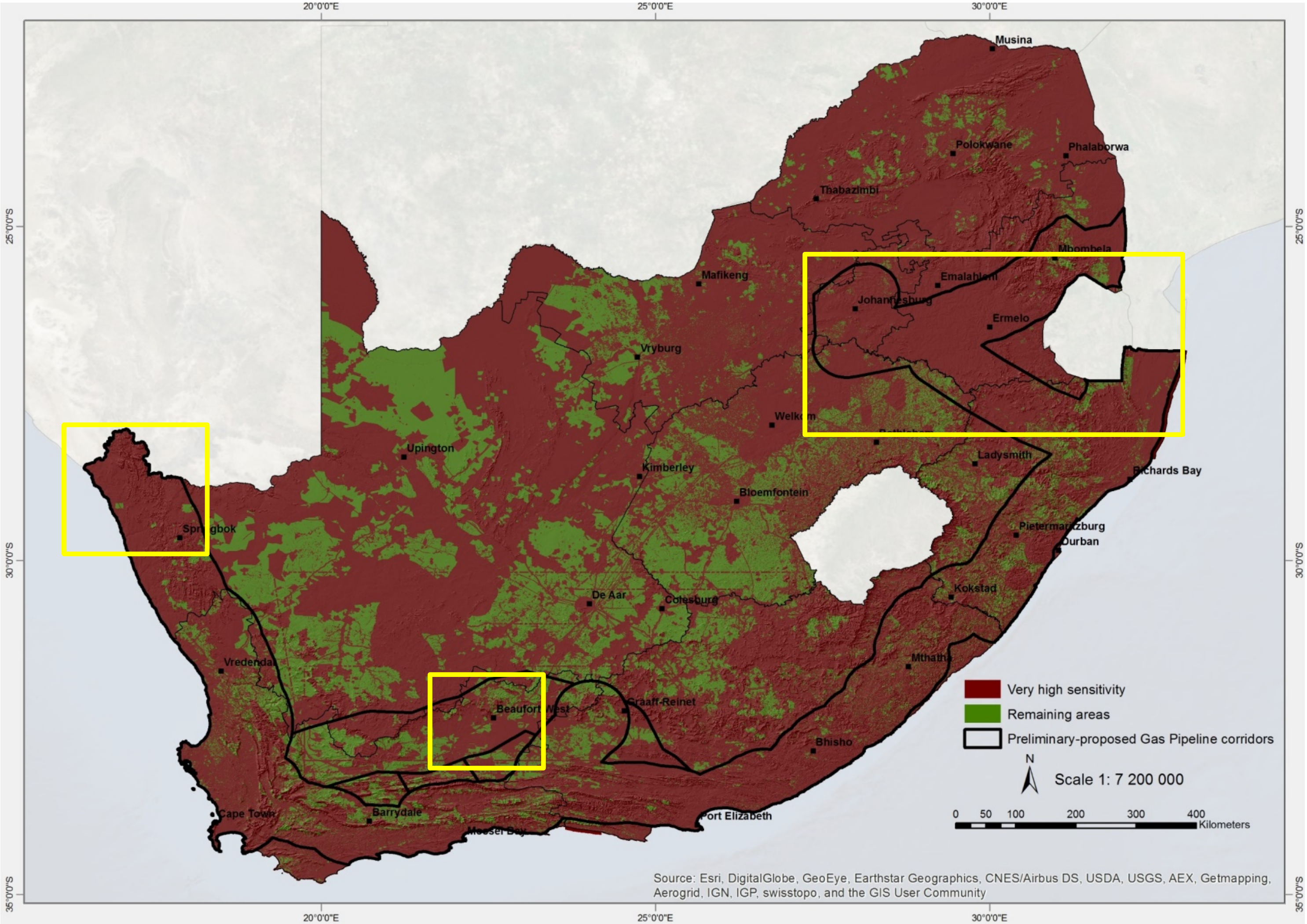
In addition to the re-alignment undertaken as part of the Pinch Point Analysis, the Phase 2 and Inland Gas Pipeline Corridors (Figure 4C) were also shifted to make sure that they align with (a) the gazetted Central and Eastern Power Corridors (based on the 2016 Electricity Grid Infrastructure (EGI) SEA[2]); and (b) the Shale Gas Sweet Spot (based on the 2016 Shale Gas SEA[3]). This was undertaken to ensure that the corridor aligns with the outputs of previous SEAs, where such areas have been assessed and updated datasets and specialist inputs resulting from these studies are more readily available.

3.5.2 Draft Refined Corridors

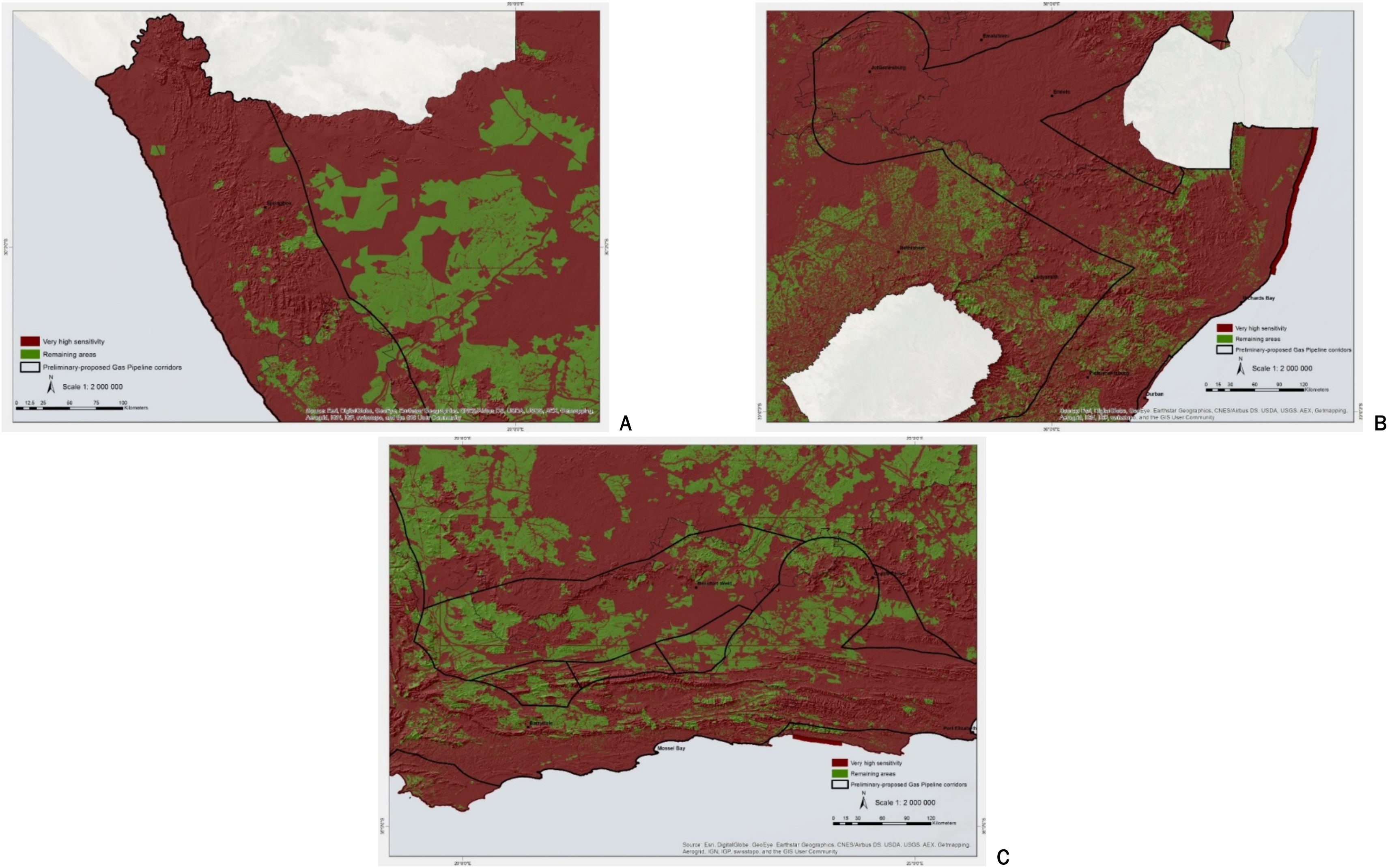
The output from this process was a set of Draft Refined Corridors that represent areas of highest demand for gas without compromising on the environment (Maps 5 to 7). A 25 km assessment buffer was added to the 100 km wide corridors. As a result, 125 km wide corridors were used in the Specialist Assessment Phase (Task IV). This was undertaken to make provision of potential realignment of the corridors subsequent to the specialist studies and consultation.

[2] Department of Environmental Affairs, 2016. Strategic Environmental Assessment for Electricity Grid Infrastructure in South Africa. CSIR Report Number: CSIR/02100/EMS/ER/2016/0006/B. Stellenbosch.

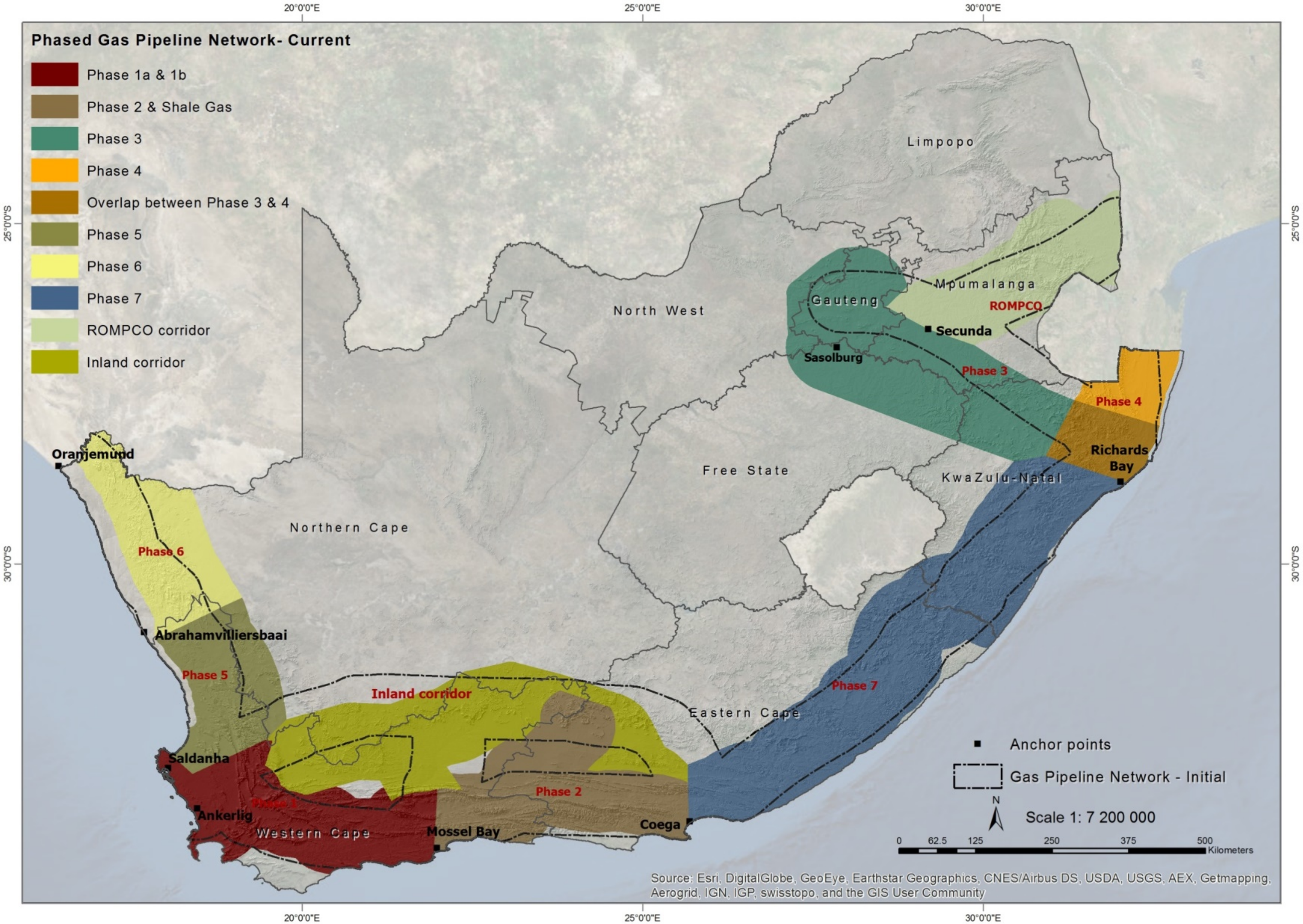
[3] Scholes, R., Lochner, P., Schreiner, G., Snyman-Van der Walt, L. and de Jager, M. (eds.). 2016. Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks. CSIR/IU/021MH/EXP/2016/003/A, ISBN 978-0-7988-5631-7, Pretoria: CSIR. Available at http://seasgd.csir.co.za/scientific-assessment-chapters/



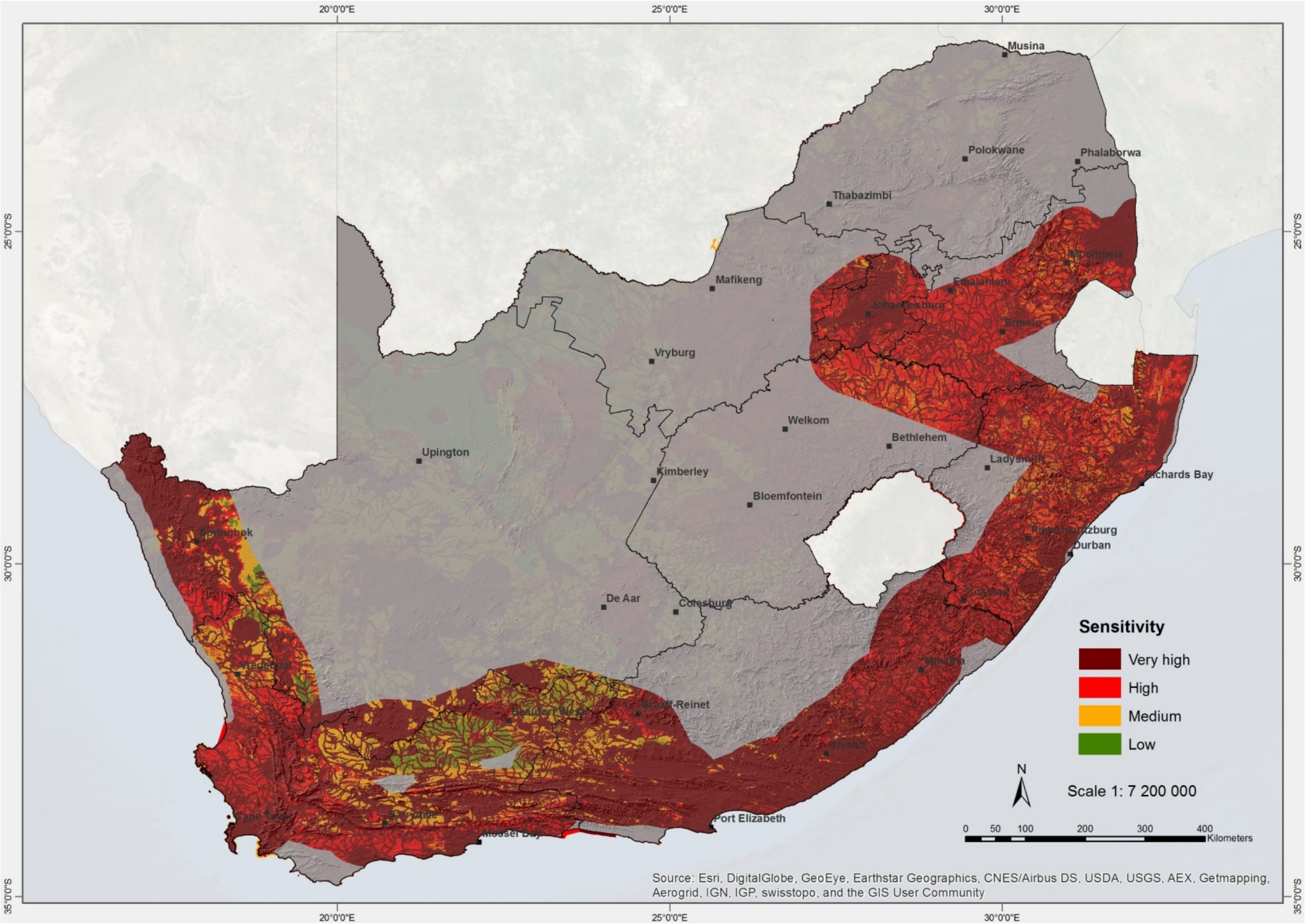
Map 3: Draft Pinch Point Analysis Results at a national scale. Rivers have been excluded due to scale.



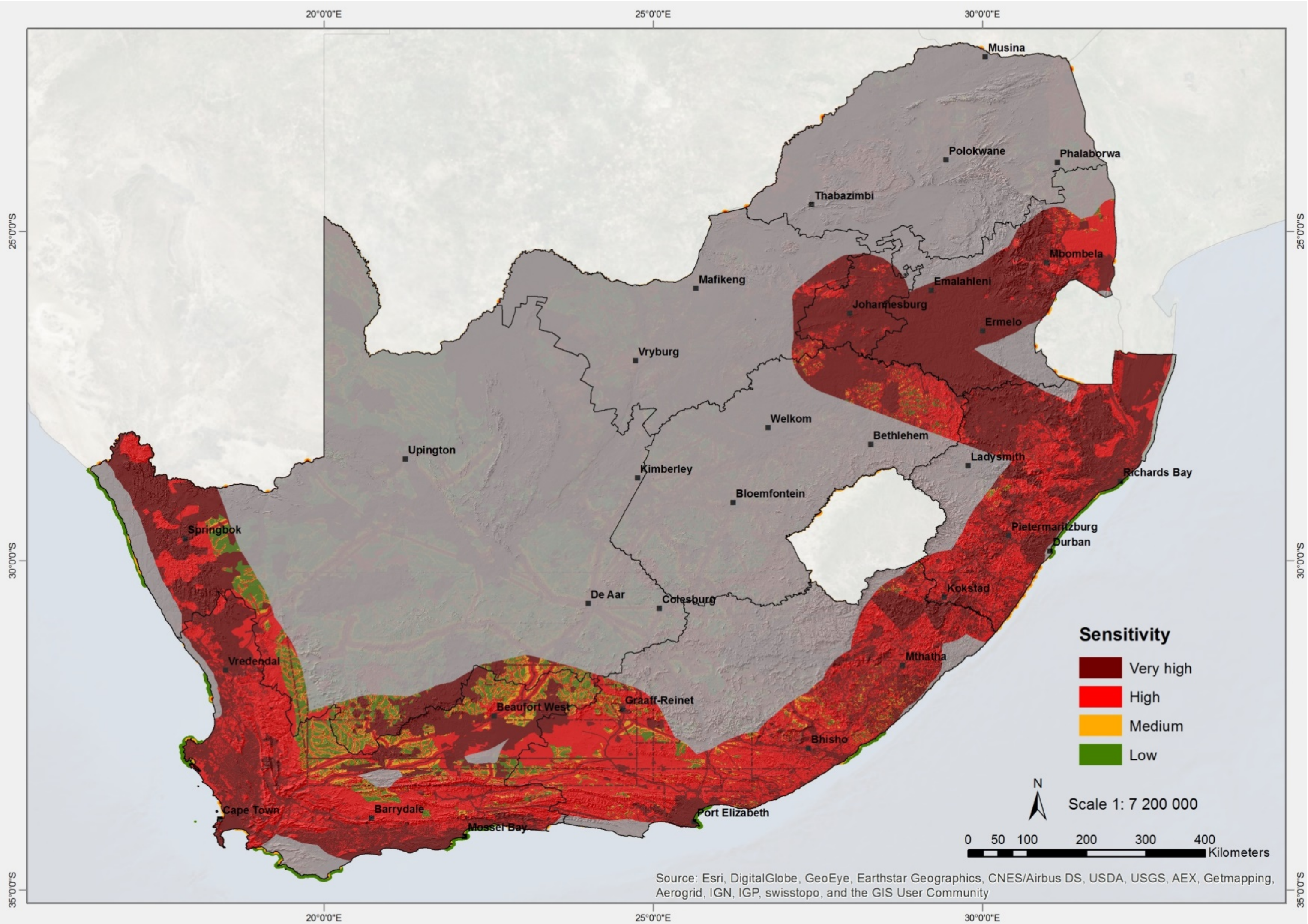
Map 4: Zoomed in maps for the **A)** West Coast Pinch Point 1; **B)** East Coast Pinch Point 2; and **C)** Inland and Phase 2 Corridor re-alignment. Rivers have been excluded due to scale. Figure A and B show the Very High sensitive areas for the Draft Pinch Point Analysis.



Map 5: Preliminary Corridors and Draft Refined Corridors following the completion of the Draft Pinch Point Analysis



Map 6: Draft Refined Environmental Sensitivities Corridor Map



Map 7: Draft Refined Engineering Constraints Corridor Map

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

Part 4.1. - Introduction and Scope of Work

Part 4.2. - Key Findings of Specialist Assessments

Part 4.2.1. Integrated Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species Assessment Report)

Part 4.2.2. Seismicity Assessment

Part 4.2.3. Settlement Planning, Disaster Management and related Social Impacts

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Part 4.2.6. Civil Aviation

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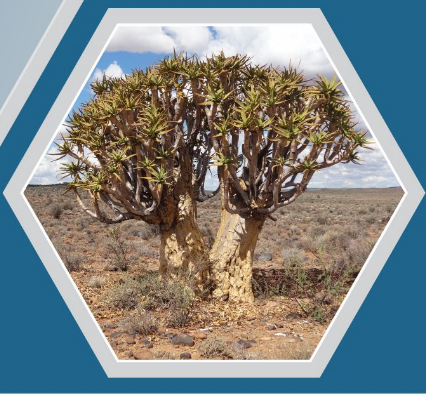
Part 4.2.8. Climate Change

Part 4.2.9. Mining



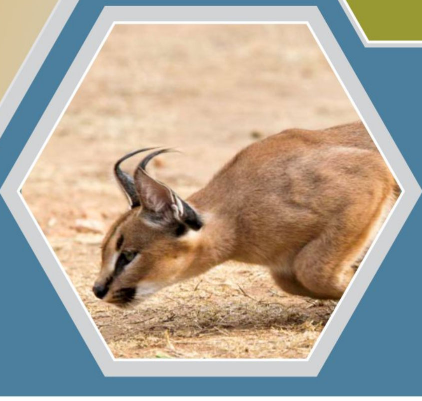
Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.1

Introduction and Scope of Work



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ABBREVIATIONS

ACSA	Airports Company of South Africa
BA	Basic Assessment
BSc	Bachelor of Science
CSIR	Council for Scientific and Industrial Research
EGI	Electricity Grid Infrastructure
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMPR	Environmental Management Programme
GIS	Geographic Information System
ILASA	Institute of Landscape Architects of South Africa
MSc	Master of Science
NRE	Natural Resources and the Environment
PV	Photovoltaic
SABAAP	South African Bat Assessment Advisory Panel
SACAP	South African Council for the Architectural Profession
SACLAP	South African Council for the Landscape Architectural Profession
SACNASP	South African Council for Natural Scientific Professionals
SAIA	South African Institute of Architects
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment

PART 4. SPECIALIST ASSESSMENTS

Part 4.1 Introduction and Scope of Work

This section of the Gas Pipeline SEA Report describes the process undertaken for the assessment of the Draft Refined Corridors (Task IV). This includes assessments undertaken by Specialists and the Project Team. The latter is informed by previous Strategic Environmental Assessments (SEAs) undertaken by the Council for Scientific and Industrial Research (CSIR) (such as the Electricity Grid Infrastructure (EGI) SEA in 2016), as well as discussions with various specialists, experts and authorities.

4.1.1 Scope of Work and Approach

4.1.1.1 Scope of Work

The geographic scope of the assessment focused on the Draft Refined Corridors (as described in Part 3 of the SEA Report). The Specialist Assessments considered the construction and operation of onshore gas transmission pipeline infrastructure and associated infrastructure, such as pigging stations, block valves and access roads (excluding compressor stations), and include an assessment of social, economic and biophysical opportunities and risks associated with the proposed development. The scope of issues addressed in the SEA was informed by an in-depth review of similar assessments undertaken locally and globally, as well as through engagement with stakeholders and governance groups.

In order to advance the principles of balance and comprehensiveness, the main specialist topics in the assessment have been addressed by multi-author teams. Each Specialist Assessment therefore has multiple authors, which were selected on the basis of their acknowledged expertise, inclusive of appropriate formal qualifications and experience, peer-group recommendations and track record of outputs.

Each team includes one Integrating Author, several Contributing Authors and in some cases Corresponding Authors. The Integrating Authors were responsible for ensuring that all the components written by Contributing and Corresponding Authors were delivered punctually and incorporated in a logical manner in each Chapter; and that the scope of the Chapter was addressed. Integrating Authors also reviewed the input from Contributing and Corresponding Authors, and compiled sections of the assessment chapters. They were also responsible for ensuring that comments from experts, project partners, project team members, stakeholders and peer reviewers were adequately addressed and/or incorporated and documented.

Contributing Authors were responsible for compiling text, references, tables and graphics for sections of the assessment chapters. These were submitted to the Integrating Authors, based on agreed formats and templates. They also assisted in addressing reviewer comments relating to text they have contributed.

The Corresponding Authors were also responsible for delivering text, references, tables and graphics to the Integrating Authors. They were also selected to conduct reviews and provide expert feedback on relevant sections of the assessment reports.

During the SEA Process, two Multi-Author Workshops were held with the Specialist Teams. The Integrating and Contributing Authors were expected to attend all writing workshops and actively participate in the discussions and decisions taken. The first Multi-Author Workshop took place on 7 December 2017 to inform the Specialist Team of the scope of the project, as well as to discuss and confirm the scope of the specialist assessments and the report structure, and potential alignment between studies, data requirements, gaps, and any concerns raised. The second Multi-Author Workshop was held on 20 April 2018 in order to discuss the first draft reports compiled by the Specialists, as well as to discuss information requirements, gaps and tasks for completion.

4.1.1.2 Specialist and Author Team Expertise

Table 1 illustrates the Specialist Assessments that have been undertaken as part of this SEA, as well as the associated authors. Table 2 includes a description of the Specialist and Author Team expertise. Signed specialist declarations of independence are also included in Appendix B of the Final SEA Report.

4.1.1.3 Review Process

In this Gas Pipeline SEA, the review of reports, tools and outputs during various stages of the SEA was considered a significant element of the process. These included review by key stakeholders and experts that have in-depth knowledge and insights into the subject of the SEA, as well as review by academic peers and members of the public. These types of reviews promote transparency and enables concerns raised by affected parties to be considered, where applicable. It also ensures that the SEA is relevant and scientifically comprehensive. Academic peer review of specialist chapters compiled for the SEA promotes overall robustness of the process and ensures that scientific credibility is upheld. The overall review processes undertaken for this SEA are described in this section.

- **Initial SEA Team Review**

The first draft of each Specialist Assessment chapter was reviewed internally by the SEA Project Team consisting of the Council for Scientific Industrial Research (CSIR) and South African National Biodiversity Institute (SANBI). The chapters were then revised by the specialists based on the initial review comments and a second draft was compiled.

- **Peer Review and Project Partner Review**

The second draft of the chapters was then sent to the Peer Reviewers and Project Partners for review (i.e. the National Departments of Environmental Affairs, Energy and Public Enterprises, as well as Eskom, iGas and Transnet).

The expert peer reviewers were identified from existing scientific publications collected throughout the process and through nominations from the SEA Project Team, general stakeholders, Expert Reference Group and the Specialists. A total of 13 peer reviewers, from NGOs, academia and research institutions; and the private sector provided peer review comment. The peer reviewers that were appointed for the Gas Pipeline SEA Process are listed in Table 1.

The Peer Reviewers were requested to provide their comments in a standardised document making reference to the specific page number and line number of the specialist assessments when documenting their comments. When the Specialists were re-drafting the third version of their reports for public and stakeholder review (as described below), they were requested to detail, in the Peer Review Sheets, how the comments have been addressed and incorporated in the Specialist Assessment Chapters. The completed Peer Review Sheets and Specialists Responses are included as annexures to each Specialist Assessment chapter included in Appendix C of this Final SEA Report. Copies of these sheets and specialist responses were also released to the stakeholders during the review period.

- **Stakeholder and Public Review**

The chapters were then revised by the specialists based on the partner and peer review comments, and a third version was finalised and released for wider public and stakeholder review extending from **25 April 2019** to **24 June 2019**. To facilitate the stakeholder review process, the Specialist Chapters and introductory and background chapters were uploaded to the project website (https://gasnetwork.csir.co.za/) for access and downloading. In order for the authors to respond efficiently, the comment submitted needed to be clear and specific. In line with this, a guideline detailing the manner in which comments on the report chapters needed to be prepared and submitted was provided to stakeholders and uploaded to the project website, along with a comment form (Microsoft Excel Spreadsheet). Each chapter that was released for review was labelled, formatted and included page numbers. In addition, each page included line numbers on the left margin, which restarted at line 1 on every new page. Stakeholders were therefore requested to clearly specify the exact passage of text to which their comment refers, by indicating the page number and line number for the beginning and end of the text. Additional detail regarding the mechanisms adopted to inform stakeholders of the review period is included in Appendix A of the Final SEA Report (i.e. Consultation Process).

- <u>Final SEA Team Review</u>

Following the stakeholder review period, the specialist assessments were updated where relevant and where required. These chapters were reviewed internally by the SEA Project Team, followed by the finalisation of the chapters by the specialists for inclusion in this Final SEA Report. The final chapters are included in Appendix C of this Final SEA Report, with summaries provided in Part 4.2.1 to Part 4.2.3.

Table 1: Details of the Specialist Assessment Chapters, Specialist Team and Peer Reviewer Team

Specialist Chapter	Integrating Author	Specialist Section	Contributing Author	Corresponding Author	Peer Reviewer
Integrated Biodiversity and Ecology Assessment (Terrestrial and Aquatic Ecosystems, and Species)	Luanita Snyman-Van der Walt, CSIR	Fynbos Biome	▪ Dr. David Le Maitre; CSIR		▪ Professor Brian W. van Wilgen; Academic/Researcher (associated with the University of Stellenbosch)
		Savannah and Grassland Biomes	▪ Dr. Graham von Maltitz; CSIR ▪ Bonolo Mokoatsi[1]; CSIR		▪ Professor Bob Scholes; University of the Witwatersrand Johannesburg
		Indian Ocean Coastal Belt Biome	▪ Simon Bundy and Alex Whitehead; SDP Ecological and Environmental Services		▪ Duncan Hay, Catherine Pringle, and Leo Quayle, Institute of Natural Resources
		Succulent and Nama Karoo Biomes	▪ Lizande Kellerman; CSIR ▪ Simon Todd; 3 Foxes Biodiversity Solutions		▪ Professor Sue J. Milton-Dean; Renu-Karoo Veld Restoration
		Albany Thicket Biome	▪ Dr. Derek Berliner; Eco-Logic Consulting	▪ Dr. Werner Marais; Independent Consultant, affiliated with University of Pretoria ▪ Jon Smallie; Birdlife South Africa ▪ Dr. John Midgely; Academic/Researcher ▪ Dr. William Branch; Academic/Researcher ▪ Werner Conradie; Academic/Researcher ▪ Dr. Dean Pienke/WWF, ECPTA	▪ Professor Sue J. Milton-Dean; Renu-Karoo Veld Restoration
		Estuaries	▪ Dr. Lara Van Niekerk, Carla-Louise Ramjukadh[1] and Steven Weerts,; CSIR		▪ Professor Janine Adams; Nelson Mandela University
		Wetlands and Rivers	▪ Gary de Winnaar and Dr. Vere Ross-Gillespie; GroundTruth		▪ Duncan Hay, Catherine Pringle, and Leo Quayle, Institute of Natural Resources ▪ Nancy Job; SANBI
		Avifauna	▪ Albert Froneman and Chris van Rooyen; Chris Van Rooyen Consulting		▪ Jonathan Booth and Robin Colyn, Birdlife South Africa

[1] Note that this specialist is no longer under the employ of the CSIR.

Specialist Chapter	Integrating Author	Specialist Section	Contributing Author	Corresponding Author	Peer Reviewer
		Bats	▪ Kate MacEwan; Inkululeko Wildlife Services		▪ Refer to **Note 1** below
		Fauna	▪ All of the above (Refer to **Note 2** below)	▪ Kate MacEwan; Inkululeko Wildlife Services	
Seismicity Assessment	Prof Raymond Durrheim; University of the Witwatersrand	Impacts of Earthquakes, Seismicity and Faults	▪ Brassnavy Manzunzu; Council for Geoscience		▪ Professor Andrzej Kijko; University of Pretoria ▪ Dr Alistair Sloan; University of Cape Town
Settlement Planning, Disaster Management and related Social Impacts	Surina Laurie[1], CSIR Annick Walsdorff, CSIR	Settlement and Development Planning	▪ Elsona van Huyssteen; CSIR ▪ Cheri Green; CSIR ▪ Dave McKelly; CSIR ▪ Zukisa Sogoni; CSIR	▪ Tony Barbour; Tony Barbour Environmental Consulting and Research ▪ Dr Hugo van Zyl; Independent Economic Researchers	▪ Peter Magni; Independent Consultant
		Disaster Management	▪ Professor Doreen Atkinson; Nelson Mandela University		
Additional Issues (Agriculture, Defence, Civil Aviation, Heritage, Climate Change and Mining) - Refer to **Note 3** below	Annick Walsdorff[1], CSIR Rohaida Abed, CSIR	Agriculture	▪ Johann Lanz; Independent Consultant		
		Defence Civil Aviation Heritage Climate Change Mining	▪ Fahiema Daniels, SANBI ▪ Tsamaelo Malebu, SANBI		
Gas Opportunities Analysis	Rae Wolpe; Impact Economix	A Gas Opportunities Analysis Report was commissioned to mainly provide a brief overview of the potential future opportunities and benefits of gas within the region and included a rapid review of the gas sector opportunities focusing on potential gas bulk users in South Africa. This study is included as Appendix 1 of Part 1 of this Final SEA Report.			

<u>Note 1:</u> A detailed assessment of impact on bats as a result of the gas pipeline development was not required as it is not expected to be of extreme significance. However, the report does discuss potential impacts relating to habitat destruction or disturbance during the construction of a gas pipeline. This high level assessment is deemed suitable for an SEA study of this nature and where necessary the site specific studies will provide more detail.
<u>Note 2</u>: Note that faunal input was provided by the Specialist Contributing Authors for each Biome and Ecosystem Report included in the Integrated Biodiversity and Ecology Assessment (Terrestrial and Aquatic Ecosystems, and Species). This input was reviewed and augmented by Kate MacEwan of Inkululeko Wildlife Services.
<u>Note 3:</u> Due to its linear nature, the impact of gas pipeline development on Agriculture, Defence, Civil Aviation, and Heritage features is anticipated to be avoidable or of limited significance. This section is largely based on the 2016 EGI SEA Assessment due to impact similarities and where required additional specialist input was obtained. In addition, in terms of the National Heritage Resources Act (Act 25 of 1999), a Heritage Impact Assessment will need to be done for the gas pipeline during the project specific phase. The input on Mining has been included to highlight some of the risks associated with development of gas pipeline infrastructure in proximity to mining areas, as well as the potential impact gas pipelines may have on mining areas. The input on Climate Change has been included to display some of the areas in South Africa that are likely to experience climate change in terms of flooding, coastal flooding, extreme rainfall, change in drought tendencies, and increased fire danger (based on the CSIR Green Book, 2019) to ensure these areas could potentially be flagged during the pipeline planning stage.

Table 2: Specialist and Author Team Expertise

Specialist and Affiliation	Project Role	Biosketch
Integrated Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species Assessment Report)		
Luanita Snyman-Van der Walt, CSIR	Integrating Author	Luanita Snyman-Van der Walt commenced work at CSIR in January 2014, after completing a BSc Botany-Zoology-Tourism, a BSc Honours in Environmental Science, as well as a MSc in Environmental Science at the North West University, Potchefstroom Campus. She is currently pursuing an MSc in Geographical Information Science at Vrije Universiteit Amsterdam, and is registered as a Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) (Registration Number 400128/16). Her work at the CSIR involves strategic environmental assessment and management, with a focus on Geographic Information System (GIS) analyses for environmental assessment and decision-making. She has conducted numerous ecological specialist studies and served as project manager for several EIAs and BAs across South Africa. She assisted in managing the shale gas development scientific assessment. She also fulfilled the role of Integrating Author for the Biodiversity Assessment of the Gas Pipeline and EGI Expansion SEA. She also provided technical GIS and mapping support on the Strategic Environmental Assessment Aquaculture Development in South Africa.
Dr. David Le Maitre; CSIR	Contributing Author	Dr. David Le Maitre has more than 30 years of research experience in the ecology of Cape fynbos vegetation, as well as fire ecology and management. His work focuses on assessing the hydrological and ecological impacts of invading alien plants and in the dynamics of invasion processes. His area of interests lies in the impacts of invasions on river and wetland systems and the ecosystems services they generate, including river assimilatory capacity; and developing diagnostic tools to assess the impacts of land-use and land management practices on water quality regulation based on the landscape features and water flows. David Le Maitre is a research associate at the Centre for Invasion Biology, Stellenbosch University, and an associate professor extraordinary at the School of Public Management and Planning, at the same university. Le Maitre holds a PhD in plant ecology, specialising in invasion ecology and hydrology from the University of Cape Town.
Dr. Graham von Maltitz; CSIR	Contributing Author	Dr. Graham von Maltitz specialises in large, integrated multidisciplinary projects involving the interface between humans and natural resource management in the terrestrial environment. He holds a PhD in ecology from the Nelson Mandela Metropolitan University and has over 30 years of experience in environmental and global change, focused on unique problems associated with resource ecology and management in southern Africa, with a special focus on areas of communal land management. He has worked extensively in the savanna, forest and grassland biomes of southern Africa, focusing particularly on natural resource use within the communal areas. More recently he has focused on the causes and consequences of global change. This included terrestrial feedbacks to climate processes, land use and land-use change as well as biomass-based energy. He has been involved in a number of global science/policy forums and processes, including links with the United Nations Convention to Combat Desertification and the Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services.
Bonolo Mokoatsi; CSIR	Contributing Author	Bonolo Mokoatsi is a GIS analyst and emerging environmental researcher with a B.A. Honours in Geography from the University of Johannesburg. She commenced work at CSIR in April 2018 while pursuing a MSc in Environmental Management. With her MSc research, she aims to support precision agriculture through a non-destructive approach for monitoring crops' seasonal responses to variable-rate fertilizers and irrigation. Her work at CSIR involved GIS support and satellite image processing for multi-disciplinary studies, NEXUS trade-off analyses, environmental assessments and technical reports. She fulfilled the role of GIS specialist for the Biodiversity Assessment of the Gas Pipeline and EGI Expansion SEA. She also provided GIS support for assessing canopy cover versus above-ground biomass in an effort to map the distribution of bush encroachment in the Savannah and Grassland biomes of South Africa. Bonolo also serves as an external marker for the University of South Africa in the subject of GIS and remote sensing.
Simon Bundy; SDP Ecological and	Contributing Author	Simon Bundy has been involved in environmental and development projects and programmes since 1991 at provincial, national and international level, with employment in the municipal, NGO and private sectors, providing a broad overview and understanding of the function of

Specialist and Affiliation	Project Role	Biosketch
Environmental Services		these sectors. Simon Bundy has a core competency in coastal ecological systems, coastal management and botanical issues including the undertaking of EIAs and Specialist Assessments. He has local and international experience, and in South Africa, he has been involved in a number of large scale power projects as well as the development of residential estates, infrastructure and linear developments in KwaZulu-Natal, Eastern Cape and Western Cape, where he has provided both technical support, as well as the undertaking of rehabilitation programmes. From a technical specialist perspective, Simon focuses on coastal ecological systems in the near shore environment and is competent in a large number of ecological methodologies and analytical methods including multivariate analysis and canonical analysis. He is competent in wetland delineation and has formulated ecological coastal set back methodologies for EKZN Wildlife and for the Department of Economic Development Tourism and Environmental Affairs in conjunction with the Oceanographic Research Institute. He has also worked on coastal marine pollution projects for various insurance and salvage companies and has undertaken projects for the Global Environment Fund of the United Nations. He acts as botanical and environmental specialist for Eskom Eastern Region and provides technical support to the IEM division of the CSIR, Stellenbosch. He is a registered Professional Natural Scientist (Ecology – Registration Number: 400093/06) with SACNASP.
Alex Whitehead; SDP Ecological and Environmental Services	Contributing Author	Alex Whitehead is an Ecologist registered with SACNASP (400176/10). He holds a BSc Honours specializing in Ichthyology and Fisheries Science from Rhodes University. He serves as a lead specialist in a number of terrestrial, aquatic and wetland studies. His specialist involvement has been linked with a diverse range of development scenarios, including waste water treatment works, housing estates, industrial estates, bulk infrastructure such as water and power lines, harbours, piers, renewable energy (solar and wind power), dams, and aquaculture and agri-industrial facilities. His specialist fields of interest include aquatic ecology (both freshwater and estuarine, ichthyofauna and invertebrates); wetland delineation and functionality assessments; and terrestrial ecology (fauna and flora). Alex has 13 years of experience, which includes projects undertaken throughout South Africa, as well as in Ghana.
Lizande Kellerman; CSIR	Contributing Author	Lizande Kellerman holds a Bachelor's degree in Zoology and Entomology, with an Honours and Masters in Botany both at the University of Pretoria. She is currently completing her PhD in Conservation Ecology from Stellenbosch University. She is a registered Professional Natural Scientist (Botanical Sciences – Registration Number: 400076/10) with SACNASP. She has more than 10 years' experience in environmental assessment and management studies, primarily in planning, preparing, managing and conducting environmental assessments (BA, EIA and SEA), environmental management plans (EMPs), environmental screening studies, fatal flaw assessments, cultivation rights and license applications for air emissions, water use, waste management, mining, bioprospecting and biodiversity permitting for numerous projects in the agricultural (including aquaculture), construction, environmental, mining and renewable energy sectors.
Simon Todd; 3 Foxes Biodiversity Solutions	Contributing Author	Simon Todd has 18 years' experience as a terrestrial ecologist in arid systems and biodiversity assessments. His primary focus includes examining the impacts of land use on biodiversity with the arid ecosystems of South Africa. He has contributed to the REDZ SEA, Shale Gas SEA, SKA, as well as the ESKOM EGI SEA. Apart from the above studies, he has also worked extensively across the Nama and Succulent Karoo and has provided specialist ecological assessments for more than 150 different developments. He is the Nama and Succulent Karoo representative on the National Vegetation Map Committee. He is a recognised arid-areas ecological expert and is a past chairman of the Arid-Zone Ecology Forum and has 20 years' experience working throughout the country. He is registered with SACNASP (Registration Number: 400425/11).
Dr. Derek Berliner; Eco-Logic Consulting	Contributing Author	Dr. Derek Berliner is an independent environmental consultant, with over 25 years of experience. He obtained a BSc in Agriculture, and BSc Honours in Wildlife Management from the University of Pretoria. He also holds a MSc in Botany from the University of Witwatersrand and a PhD in Botany from the University of Cape Town. Some of his key areas of expertise are forest ecology and conservation planning; biophysical baseline studies for community conservation planning and impact evaluation; biodiversity and EIA and application of the mitigation hierarchy in SEIAs; training for application of IFC performance standard 6: biodiversity safeguards; and developing environmental management, and biodiversity offset plans.

Specialist and Affiliation	Project Role	Biosketch
Dr. Lara Van Niekerk; CSIR	Contributing Author	Dr. Lara van Niekerk joined the CSIR in 1994, where she fulfils a role of Senior Scientist. Lara is part of a core team that developed the ecological flow requirement methods, strategic/operational policies and legislation required for the effective management of South Africa's estuaries. She has been involved in over 50 estuarine freshwater flow requirement studies. Lara is the architect of the SA National Estuarine Management Protocol and related planning guidelines. She led the team of specialists that assessed the ecosystem condition of all South Africa's estuaries as part of the SA National Biodiversity Assessment in 2011 and in the process of refining this for 2018.
Carla-Louise Ramjukadh; CSIR	Contributing Author	Carla-Louise Ramjukadh served as a Candidate Researcher in the Coastal Systems Research Group of the Natural Resources and the Environment (NRE) group in CSIR from 2016 - 2018. She is currently working for the South African Weather Services – Marine Research Institute as a Scientific Researcher. She holds a BSc and BSc Honours in Environmental and Water Science from the University of Western Cape, as well as a MSc in Biological Science from the University of Cape Town. She has been involved in various research projects, including but not limited to, Estuarine Management Plans in the Western Cape Province, effect of climate change in coastal systems, and characterisation of pH in estuarine systems.
Steven Weerts; CSIR	Contributing Author	Steven Weerts joined the CSIR in 2004 as a Senior Scientist, and currently fulfils the role of Research Group Leader for the Coastal Resources Group. He holds a BSc., BSc Honours and MSc from the University of Natal, and the latter from the University of Zululand. He has extensive experience in Marine Ecology and has authored more than 150 contract research and specialist consultancy reports to private and public sectors clients, stakeholders and users. He has also published many scientific publications. He has worked on several Estuary Management Plans, Outfall Monitoring Programmes, and Port Planning projects, and also served as the Integrating Author for the Marine Ecology chapter of the Strategic Environmental Assessment Aquaculture Development in South Africa.
Gary de Winnaar; GroundTruth	Contributing Author	Gary de Winnaar has over ten years of experience in professional consulting services while conducting assessments of aquatic and terrestrial ecosystems, and associated fauna and flora. He has provided specialist input for a range of studies requiring solutions regarding practical and applied terrestrial and aquatic ecology, including abilities to integrate aquatic and terrestrial elements, survey fauna and flora, characterise and map biodiversity features (including sensitive habitats), conduct specialist GIS modelling and mapping, as well as identifying and assessing impacts to biodiversity and the environment. He is particularly interested in the assessment of environmental flows to ensure that biodiversity patterns and processes are supported by sustained water flow. He managed and integrated specialist teams and inputs covering specialist fields such as terrestrial invertebrates, botany, and ecosystem services/resource economics, etc. He is a registered Professional Natural Scientist (Ecological Science – Registration Number: 400454/13) with SACNASP.
Dr. Vere Ross-Gillespie; GroundTruth	Contributing Author	Dr. Vere Ross-Gillespie currently manages the Rivers Division of GroundTruth, where work consists of conducting environmental flow and Instream Flow Requirement studies, biological and water quality monitoring, impact assessments, river ecological surveys, rehabilitation and also research. Vere has eight years of experience in the field of aquatic entomology and freshwater ecology. He is also involved in a wide range of active research projects, both local and internationally. Vere's research interests include Aquatic Ecology, Entomology, Limnology, Climate Change and Biology. Current/recent research projects include Adaptability and Vulnerability of Riverine Biota to Climate Change, the development and application of Periphyton as Indicators of flow and nutrient alterations for the management of water resources. He is a registered Professional Natural Scientist (Ecological Science) with SACNASP.
Albert Froneman; Chris Van Rooyen Consulting	Contributing Author	Albert Froneman has more than 15 years' experience in the management of avifaunal interactions with industrial infrastructure. He holds a M.Sc. degree in Conservation Biology from the University of Cape Town. He managed the Airports Company South Africa (ACSA) – Endangered Wildlife Trust Strategic Partnership from 1999 to 2008 which has been internationally recognized for its achievements in addressing airport wildlife hazards in an environmentally sensitive manner at ACSA's airports across South Africa. Albert is recognized worldwide as an expert in the field of bird hazard management on airports and has worked in South Africa, Swaziland, Botswana, Namibia, Kenya, Israel, and the USA. He has served

Specialist and Affiliation	Project Role	Biosketch
		as the vice chairman of the International Bird Strike Committee. At present he is consulting to ACSA with wildlife hazard management on all their airports. He is also an accomplished specialist ornithological consultant outside the aviation industry and has completed a wide range of bird impact assessment studies and pre-construction monitoring reports. He was a specialist author on the Avifauna Assessment of the 2016 EGI SEA. Since 2009 Albert has been a registered Professional Natural Scientist (Registration Number 400177/09) with SACNASP, specialising in Zoological Science.
Chris van Rooyen; Chris Van Rooyen Consulting	Contributing Author	Chris van Rooyen has nineteen years' experience in the assessment of avifaunal interactions with industrial infrastructure. He was employed by the Endangered Wildlife Trust as head of the Eskom-EWT Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has consulted in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. He also has extensive project management experience and he has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author and/or co-author of 17 conference papers, co-author of two book chapters, several research reports and the current best practice guidelines for avifaunal monitoring at wind farm sites. He has completed more than 100 power line assessments; and has to date been employed as specialist avifaunal consultant on more than 30 renewable energy generation projects. He has also conducted numerous risk assessments on existing power lines infrastructure. He also works outside the electricity industry and he has done a wide range of bird impact assessment studies associated with various residential and industrial developments. He was also a specialist author on the Avifauna Assessment of the 2016 EGI SEA.
Kate MacEwan; Inkululeko Wildlife Services	Contributing Author	Kate MacEwan is a SACNASP registered zoologist and environmental scientist and holds a BSc (Honours) in Zoology from Wits University. She has over 20 years of zoological and practical bat conservation experience and wide diversity of contacts with various African bat academics and biologists. Kate is currently the chairperson for the South African Bat Assessment Advisory Panel (SABAAP), and a co-author of both the South African Good Practise Guidelines for Surveying Bats in Wind Farm Developments: 4th Edition (Sowler et al 2016) and the South African Good Practice Guidelines for Operational Monitoring for Bats at Wind Energy Facilities: 1st Edition (Aronson et al., 2014). Kate is also the co-author on several bat species accounts (including some from Mozambique) in the latest southern African Red Data mammal listings (Child et al. (2016)). She has also served as a specialist author in the Phase 1 Renewable Energy Development Zones SEA, and is also part of the Phase 2 assessment.
Seismicity Assessment		
Professor Raymond J Durrheim; University of the Witwatersrand Johannesburg	Integrating Author	Professor Raymond Durrheim is the South African Research Chair of Exploration, Earthquake and Mining Seismology and holds appointment as a research chair and supervisor at the University of the Witwatersrand School of Geosciences. He is co-director of the AfricaArray research and capacity-building programme and was co-leader of the Japanese-South African collaborative project "Observational studies in South African mines to mitigate seismic risks" (2010-2015). He holds a BSc in Geology and Physics from the University of Stellenbosch; a BSc Honours in Geophysics from the University of Witwatersrand; a MSc in Geophysics from the University of Pretoria, and a PhD in Geophysics from the University of Witwatersrand. Research conducted by Professor Raymond Durrheim may be divided into three categories: (i) investigations of the structure and evolution of the crust and mantle (exploration seismology); (ii) earthquake physics and seismic hazard assessment; and (iii) engineering seismology (particularly related to deep mining).
Brassnavy Manzunzu; Council for Geoscience	Contributing Author	Brassnavy Manzunzu is a seismologist with the Council for Geoscience. He completed a MSc in Geophysics in 2013 and is currently undertaking his PhD at University of Witwatersrand. He joined the Zimbabwe Meteorological Services as a trainee Meteorologist in 2007. In April 2008 he moved to the seismology section where he began his career as a trainee seismologist and eventually fulfilled the position of Seismology Manager.

Specialist and Affiliation	Project Role	Biosketch
		In 2012, he joined the Council for Geoscience as a seismic hazard scientist. He has worked on several projects on seismic hazard in Africa. He has published a number of peer reviewed international journal articles. He has been part of the GEM- sub-Sahara Africa since its inception.
Settlement Planning, Disaster Management and related Social Impacts Report		
Surina Laurie, CSIR	Integrating Author	Surina has more than 7 years of experience in environmental assessment and management and is a Senior EAP in the Environmental Management Services (EMS) group of the CSIR with a Masters degree in Environmental Management from the University of Stellenbosch and a Certificate in Environmental Economics from the University of London. She is a Registered Professional Natural Scientist (Registration Number: 400033/15) with the SACNASP. Surina has experience in the management and integration of various types of environmental assessments in South Africa for various sectors, including renewable energy, industry and tourism. She has also been part of advisory teams advising on financing, real estate, corporate, construction, environmental and regulatory aspects for various sponsors, developers and lenders during the DOE's first and second bidding windows in 2012 and 2013. Surina has undertaken several Solar Photovoltaic (PV) and Wind Energy Environmental Assessments (i.e. EIAs, BAs, and Amendment and Appeal Processes) in the Northern Cape, Western Cape and Free State. She also served as the Integrating Author for the Socio-Economics chapter of the Strategic Environmental Assessment Aquaculture Development in South Africa.
Annick Walsdorff, CSIR	Integrating Author	Annick Walsdorff is a Principal Environmental Assessment Practitioner in the Environmental Management Services group of the CSIR. She holds a Degree in Chemical Engineering which was obtained with Great Distinction from the Université Libre de Bruxelles in Belgium, and a Masters Degree in Chemical Engineering (Cum Laude) from the University of Stellenbosch. She has more than 16 years' experience in environmental assessment and management and has been involved in several environmental studies of national importance including Preliminary Environmental Assessments, EIAs and Environmental Management Plans (EMPs). She played a key role in the Integrated Environmental Management Plan for the SKA.
Elsona van Huyssteen; CSIR	Contributing Author	Elsona van Huyssteen is a Principle Urban and Regional Planner at the CSIR and has over 20 years' experience in research, and policy development. She has lead collaborative multi-disciplinary initiatives in the urban and regional development planning field. Her interest focuses on innovative ways to engage collective futures through profiling spatial growth dynamics impacting cities, settlements and regions; transdisciplinary and multi-stakeholder initiatives, and action-orientated leadership.
Cheri Green; CSIR	Contributing Author	Cheri Green has over 30 years' research experience in fields of accessibility, transportation planning, land use development, facility location planning (in urban and rural context), and social facility provision norms. She is a Registered Town & Regional Planner and Senior Researcher at the CSIR. She has been involved in several studies in the Karoo region since 2002, including the development of Integrated Transport Plans.
Dave McKelly; CSIR	Contributing Author	David McKelly currently works in the Western Cape Office of the Built Environment research group of the CSIR where he practices as a GIS Specialist. He holds a Master of Science degree in Geographical Information Science and Systems obtained from the University of Salzburg in Austria through distance learning (UNIGIS). He is registered as a Professional GISc Practitioner (PGP 1288) with the South African Geomatics Council. He has more than 30 years of experience working with ESRI (ArcGIS and Arc/Info) software for developing GIS databases, data creation and data mining. He regularly demonstrates his skills in relational databases, Structure query language (SQL), project management and customer interaction. He is a critical thinker who is continuously looking at ways to solve difficult geo-spatial problems in a research environment. He excels in geo-spatial analysis, map production and data mining.
Zukisa Sogoni; CSIR	Contributing Author	Since joining the CSIR at the beginning of 2014, Zukisa Sogoni has been involved in project application work in the fields of accessibility analysis and facility location planning with a specific focus on GIS based-advanced spatial analysis. Zukisa has worked on accessibility analysis and facility allocation for eThekwini Municipality, City of Tshwane and social facilities planning for the City of Cape Town. He has also been involved in

Specialist and Affiliation	Project Role	Biosketch
		advanced GIS spatial analysis and social facilities provision standards for a project involving the Department of Rural Development and Land Reform, Geographical Spatial Decision Support for SEDA, and spatial analysis for the project involving the Presidential Infrastructure Coordinating Commission (PICC) and Department of Higher Education and Training. Zukisa is currently part of the technical team compiling the draft of the first National Spatial Development Framework.
Tony Barbour; Tony Barbour Environmental Consulting and Research	Corresponding Author	Tony Barbour holds a master's degree in environmental science and has 23 years' experience in the environmental sector. His experience includes ten years as an environmental consultant in the private sector in South Africa followed by four and a half years at the University of Cape Town's Environmental Evaluation Unit. In 2004 he established his own environmental consulting company, Tony Barbour Environmental Consulting and Research, with a focus on Social Impact Assessment (SIA), Strategic Environmental Assessment (SEA), Independent Review Work, Training and Capacity Building and Environmental Project Management. Tony has conducted over 40 Social Impact Assessments and is the lead author of the Western Cape Provincial Government guidelines on social specialist inputs into EIAs.
Dr Hugo van Zyl; Independent Economic Researchers	Corresponding Author	Dr. Hugo van Zyl holds a PhD in economics from the University of Cape Town and has more than 18 years' experience focusing on the analysis of projects and policies with significant environmental and development implications. Hugo van Zyl is the director of Independent Economic Researchers, focusing on economics impact assessment, project appraisal and applied environmental resource economics. He has been involved in over 60 economic and socio-economic appraisals of infrastructure projects, industrial developments, mixed use developments, mining, energy projects, conservation projects and eco-tourism initiatives throughout southern Africa. The majority of these appraisals have involved the use of economic impact assessment tools and cost-benefit analysis in order to inform decision-making. He has lead, participated in and co-ordinated research in environmental resource economics (including environmental valuation, payments for ecosystem services, policy reform), socio-economic impact assessment, strategic assessment and protected area business planning. From a policy perspective he has provided economic inputs and guidance to national water tariff, air pollution, biodiversity conservation, biofuels, mine closure funding and climate change policy. Dr Van Zyl is also the lead author of the Western Cape Provincial Government guidelines on economic specialist inputs into EIAs. These guidelines have been accepted at a national level and are applied throughout the country.
Professor Doreen Atkinson; Nelson Mandela University	Contributing Author	Doreen Atkinson is a Research Associate at the Nelson Mandela University. She is also a trustee of the Karoo Development Foundation (non-profit Trust). She holds a BA and BA Honours in Political Studies from the Rhodes University, a MA in Political Science from University of California, Berkeley; and a PhD in Political Science from the University of Natal. Her areas of research expertise include local government, community development, intergovernmental relations, policy analysis, governance, local economic development, small towns and rural development, land reform, sustainable livelihoods, project and programme evaluation, and regional development. Doreen has extensive research on Karoo tourism, and has organised five Karoo conferences since 2009.
Additional Issues (Agriculture, Defence, Civil Aviation, Heritage, Climate Change and Mining)		
Annick Walsdorff, CSIR	Integrating Author	Annick Walsdorff is a Principal Environmental Assessment Practitioner in the Environmental Management Services group of the CSIR. She holds a Degree in Chemical Engineering which was obtained with Great Distinction from the Université Libre de Bruxelles in Belgium, and a Masters Degree in Chemical Engineering (Cum Laude) from the University of Stellenbosch. She has more than 16 years' experience in environmental assessment and management and has been involved in several environmental studies of national importance including Preliminary Environmental Assessments, EIAs and Environmental Management Plans (EMPs). She played a key role in the Integrated Environmental Management Plan for the SKA.
Rohaida Abed, CSIR	Integrating Author	Rohaida Abed is an Environmental Assessment Practitioner in the EMS group of the CSIR, based in Durban. She holds a MSc Degree in Environmental Science from the University of KwaZulu-Natal. She has nine years of experience in the Environmental Management field, and has

Specialist and Affiliation	Project Role	Biosketch
		been involved in various transport infrastructure related projects as an Environmental Control Officer. She has also been involved in BAs and EIAs relating to Port infrastructure, Bulk Liquid Storage facilities and Renewable Energy in the capacity of Project Manager. She is a registered Professional Natural Scientist (400247/14) with the SACNASP.
Fahiema Daniels, SANBI	Contributing Author	Fahiema Daniels is a Deputy Director of the Biodiversity Planning Directorate at SANBI. She obtained a BSc (Ecology and Environmental & Geographical Science); BSc Honours (Botany: Plant Ecology); and MSc (Conservation Biology) from the University of Cape Town. Fahiema Daniels plays a key role in supporting biodiversity planning in South Africa by leading spatial analyses for National-scale projects, such as the Electricity Grid Infrastructure SEA, Shale Gas SEA and REDZ SEA. Additional projects include listing of threatened ecosystems; supporting the spatial prioritization for identifying Biodiversity Economy Nodes in South Africa, and developing the spatial layers that feed into the Department of Environmental Affairs Natural Resource Management Land User Incentive tool.
Tsamaelo Malebu, SANBI	Contributing Author	Tsamaelo Malebu is a GIS Specialist in the Biodiversity Information and Planning Directorate of SANBI. He holds a BSc Degree (Environmental Science) and BSc Honours in Ecology, Environment and Conservation from the University of the Witwatersrand. He has supported the 2016 EGI SEA, the development of the South African Mining and Biodiversity Guideline, provided technical support to the GEF funded Grasslands Programme and the identification of Marine Protected Areas as part of the Operation Phakisa Oceans Economy lab.
Johann Lanz; Independent Consultant	Contributing Author	Johann Lanz is registered as a Professional Natural Scientist in the field of Soil Science with SACNASP (Registration Number 400268/12). He holds a BA (English, Environmental & Geographical Science) from the University of Cape Town, a BSc. Agriculture (Soil Science, Chemistry) from the University of Stellenbosch, and a M.Sc. (Environmental Geochemistry) from the University of Cape Town. He provides soil specialist study inputs to EIAs, SEAs and EMPRs. These focus on impact assessments and rehabilitation on agricultural land, rehabilitation and re-vegetation of mining and industrially disturbed and contaminated soils, as well as more general aspects of soil resource management. He was also a specialist author on the Agricultural Assessment of the 2016 EGI SEA. He also undertakes soil resource evaluations and mapping for agricultural land use planning and management, and has conducted several recent research projects focused on conservation farming, soil health and carbon sequestration.
Gas Opportunities Analysis		
Rae Wolpe; Impact Economix	Contributing Author	Rae Wolpe has twenty years' experience working as a development economist and economic development professional in both the public and private sectors, and he has project managed over 50 projects at national, provincial, and local level in South Africa. Rae has a Masters in City and Regional Planning (with Distinction) from the University of Cape Town and an MPhil in Monitoring and Evaluation from the University of Stellenbosch. Rae recently authored an input to the SKA Socio-economic Impact Assessment on the "National Economic Impacts of the SKA".

4.1.1.4 Terms of Reference and Methodology

The Terms of Reference of each Specialist Assessment are detailed in the corresponding chapters (Appendix C of this Final SEA Report); however, the overall general study requirements are noted below:

- Undertake a review of existing literature (including the latest research undertaken both locally and internationally); maps and aerial photographs; and relevant data (if available) to compile a baseline description applicable to each corridor; including a list of species or features that are sensitive to gas pipeline infrastructure that have been observed and/or are likely to occur in each corridor;
- Identification of any additional features of interest or any gaps in information within the corridors not identified in the existing sensitivity analysis, making use of datasets made available through the draft environmental constraints map and additional information sourced by the specialist;
- Review and update, where required, the environmental sensitivity for the proposed gas pipeline corridors provided by the CSIR and SANBI and develop/verify the approach for classing each sensitivity feature according to a four-tiered sensitivity rating system i.e. Very High, High, Medium or Low;
- Assess the proposed corridors in terms of the potential impacts associated with the construction and operation of gas pipelines on the various environmental features, ecosystems and habitats, and outline proposed management actions to enhance benefits and avoid/reduce/offset negative impacts;
- Conduct a risk assessment based on a function of probability and consequence; and
- Provide input to the pre-construction site-specific environmental assessment protocol, as applicable (e.g. additional information and level of assessment required in each sensitivity category before an authorisation should be considered), Standards or Minimum Information Requirements[2], and Environmental Management Programme (EMPr).

4.1.1.4.1 Risk Assessment Methodology

As noted above, each Specialist Assessment Chapter includes a rigorous and systematic risk assessment of the impacts relating to gas pipeline development. The risk assessment is an approach for considering all impacts of an issue in a common way. Risk[3] is represented as probability or likelihood of a positive or negative impact occurring as a result of gas pipeline development, considered in relation to the consequence of that impact, without and with mitigation. Risk and opportunity is therefore calculated as likelihood multiplied by consequence (on a qualitative basis), as illustrated in Figure 1. The probability terms range from extremely unlikely to very likely. The consequence terms ranging from slight to extreme for risk, and minor to outstanding for opportunity, are calibrated per Specialist Assessment Chapter topic so that there is consistency with regards to the manner in which risk is determined. This allows for suitable integration across different Specialist Assessment Chapters and disciplines.

Risk and opportunity is assessed for each key impact, within each study area and for different types of receiving entities or environments – e.g. a sensitive wetland or estuary. The assessment is qualitative and uses the following categories: undiscernible/none, very low, low, moderate, high and very high. The risk categories are predefined as a set of criteria which explain the nature and implications of the attributed risks (Table 3).

[2] As noted in Part 1 of the Final SEA Report, various options were considered for the streamlining of the Environmental Authorisation process. The option to streamline the Environmental Authorisation process from a full Scoping and Environmental Impact Assessment to a Basic Assessment (for proposed gas pipeline development within the corridors (once gazetted)) has been recommended to take forward into the Decision-Support Outputs and Gazetting Phase of the SEA.

[3] IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130.

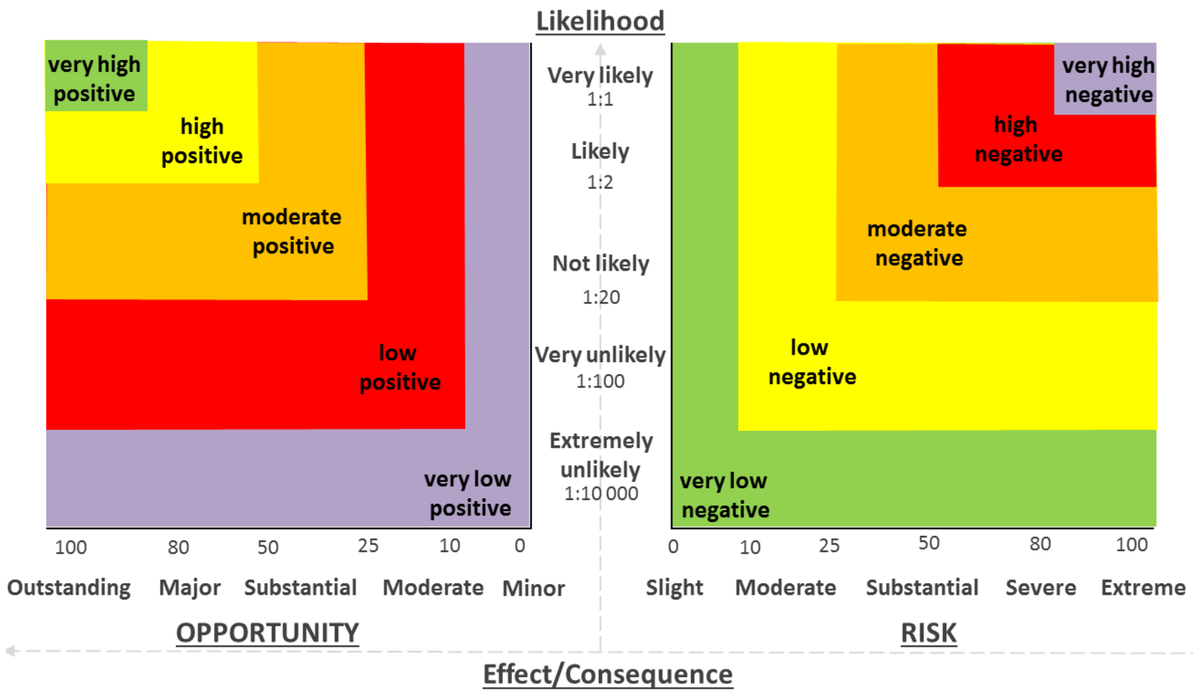


Figure 1: Risk Assessment Diagram for Risk and Opportunity Calculation

Table 3: Example of a predefined set of criteria applied across the Specialist Assessment Chapters

Risk category	Definition
No discernible risk	Any changes that may occur as a result of the impact either reduce the risk or do not change it in a way that can be differentiated from the mean risk experienced in the absence of the impact.
Very low risk	Extremely unlikely (<1 chance in 10 000 of having a consequence of any discernible magnitude); or if more likely than this, then the negative impact is noticeable but slight, i.e. although discernibly beyond the mean experienced in the absence of the impact, it is well within the tolerance or adaptive capacity of the receiving environment (for instance, within the range experienced naturally, or less than 10%); or is transient (< 1 year for near-full recovery).
Low risk	Very unlikely (<1 chance in 100 of having a more than moderate consequence); or if more likely than this, then the impact is of moderate consequence because of one or more of the following considerations: it is highly limited in extent (<1% of the area exposed to the hazard is affected); or short in duration (<3 years), or with low effect on resources or attributes (<25% reduction in species population, resource or attribute utility).
Moderate risk	Not unlikely (1:100 to 1:20 of having a moderate or greater consequence); or if more likely than this, then the consequences are substantial but less than severe, because although an important resource or attribute is impacted, the effect is well below the limit of acceptable change, or lasts for a duration of less than 3 years, or the affected resource or attribute has an equally acceptable and un-impacted substitute.
High risk	Greater than 1 in 20 chance of having a severe consequence (approaching the limit of acceptable change) that persists for >3 years, for a resource or attribute where there may be an affordable and accessible substitute, but which is less acceptable.
Very high risk	Greater than even (1:1) chance of having an extremely negative and very persistent consequence (lasting more than 30 years); greater than the limit of acceptable change, for an important resource or attribute for which there is no acceptable alternative.

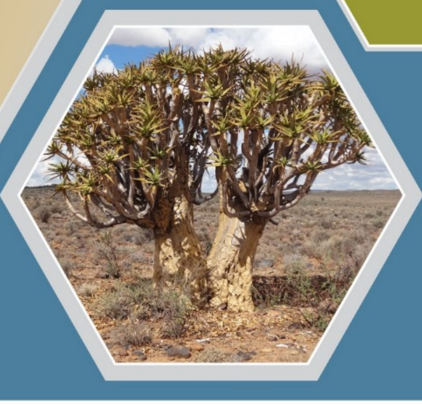
Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2

Key Findings of Specialist Assessments



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PART 4. SPECIALIST ASSESSMENTS

Part 4.2 Key Findings of Specialist Assesments

This section provides a summary of the key findings of the specialist assessments undertaken as part of this SEA. These assessments were carried out on the Draft Refined Corridors and the findings thereof were considered in the identification of the Final Corridors.

Key findings of the following studies are included in this section:

- Part 4.2.1: Integrated Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species Assessment Report - Appendix C.1 of the Final SEA Report);
- Part 4.2.2: Seismicity Assessment - Appendix C.2 of the Final SEA Report;
- Part 4.2.3: Settlement Planning, Disaster Management and related Social Impacts - Appendix C.3 of the Final SEA Report;
- Part 4.2.4: Agriculture;
- Part 4.2.5: Defence;
- Part 4.2.6: Civil Aviation;
- Part 4.2.7: Heritage;
- Part 4.2.8: Climate Change; and
- Part 4.2.9: Mining.

The complete specialist assessments are included in Appendix C of this Final SEA Report (Specialist Assessment Reports).

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.1

Integrated Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species Assessment Report)

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FIGURES

ABBREVIATIONS

CA	Conservation Area
CBA	Critical Biodiversity Area
CR	Critically Endangered
ECBCP	Eastern Cape Biodiversity Conservation Plan
EFZ	Estuary Functional Zone
EIA	Environmental Impact Assessment
EI	Ecological Importance
EN	Endangered
ES	Ecological Sensitivity
ESA	Ecological Support Areas
HDD	Horizontal Directional Drilling
IAP	Invasive Alien Plants
IUCN	International Union for Conservation of Nature
KZN	KwaZulu-Natal
LT	Least Threatened
NP	National Park
NPAES	National Protected Areas Expansion Strategy
ONA	Other Natural Area
PA	Protected Area
PES	Present Ecological State
ROW	Right of Way
SABAP	The Southern African Bird Atlas
SCC	Species of Conservation Concern
SEA	Strategic Environmental Assessment
VU	Vulnerable
WHS	World Heritage Site

PART 4. SPECIALIST ASSESSMENTS

Part 4.2 Key Findings of Specialist Assessments

Part 4.2.1 Integrated Biodiversity and Ecology Assessment

4.2.1.1 Introduction

The Integrated Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species) Assessment Report (included in Appendix C.1 of this Final SEA Report) consolidates and summarises the key findings of the following specialist investigations on the potential impacts from the development of gas transmission pipeline infrastructure on terrestrial and aquatic ecology and biodiversity in the draft refined gas pipeline corridors:

- Biodiversity and Ecological Impacts (Terrestrial Ecosystems and Species):
    - Fynbos Biome (Appendix C.1.1 of the Final SEA Report);
    - Savanna and Grassland Biomes (Appendix C.1.2 of the Final SEA Report);
    - Indian Ocean Coastal Belt Biome (Appendix C.1.3 of the Final SEA Report);
    - Succulent and Nama Karoo Biomes (Appendix C.1.4 of the Final SEA Report);
    - Albany Thicket Biome (Appendix C.1.5 of the Final SEA Report);
- Biodiversity and Ecological Impacts (Aquatic Ecosystems and Species):
    - Estuaries (Appendix C.1.6 of the Final SEA Report);
    - Wetland and Rivers (Appendix C.1.7 of the Final SEA Report);
- Biodiversity and Ecological Impacts - Avifauna (Appendix C.1.8 of the Final SEA Report); and
- Biodiversity and Ecological Impacts - Bats (Appendix C.1.9 of the Final SEA Report).

Furthermore, it recommends management actions and best practice mechanisms to avoid and minimise any potential negative impacts to sensitive ecosystems, the ecological processes that underpin their functioning, and the plant and animal species inhabiting those ecosystems.

Gas pipeline developments[1] are linear in nature and require total clearance of the aboveground vegetation for the installation of the underground pipes. Although this is a relatively narrow strip (~ 50 m wide for the construction right-of-way (ROW)), the cumulative length of hundreds of kilometres of pipelines can translate to thousands of hectares of destroyed biodiversity, if not restored appropriately. Furthermore, the soil disturbance during pipeline installation can leave these areas highly susceptible to invasion by invasive alien plant (IAP) species (e.g. Tyser & Worley, 1992), which will require active and long term control to prevent a number of secondary environmental impacts, such as sedimentation of watercourses.

The trench in which the pipeline is buried represents a substantial disruption of soil and drainage to a depth of approximately 2 m and width of 1.5 m, some effects of which, despite restoration, can persist for centuries. During construction, the trench acts as a temporary, but significant obstruction to animal movement.

Post-installation, and assuming full revegetation with indigenous flora, impacts are expected to be substantially less, although the vegetation in a narrow corridor (i.e. a 10 m wide operational servitude) will mostly exclude deep-rooted vegetation and large trees. Subsequently, the habitat along the pipeline may differ in species composition and structure from the original habitat, fragmenting the landscape, and impeding the movement of insects, small animals, birds, and plant propagules (Forman & Gordon, 1986; Xiao et al., 2014), especially if not fully restored to its initial biodiversity and vegetation structure. Additionally, if the routing of the pipeline is placed parallel to environmental gradients it is likely to have

[1] See Part 2 of the Gas Pipeline SEA Report for a detailed project description.

greater potential impacts on species movement and migration, and also may well cut through a large proportion of any one vegetation type as the vegetation also tends to follow gradients.

Figure 1 shows the location of the Draft Refined Gas Pipeline Corridors assessed in the Integrated Biodiversity and Ecology Assessment together with the key terrestrial and aquatic ecosystem components.

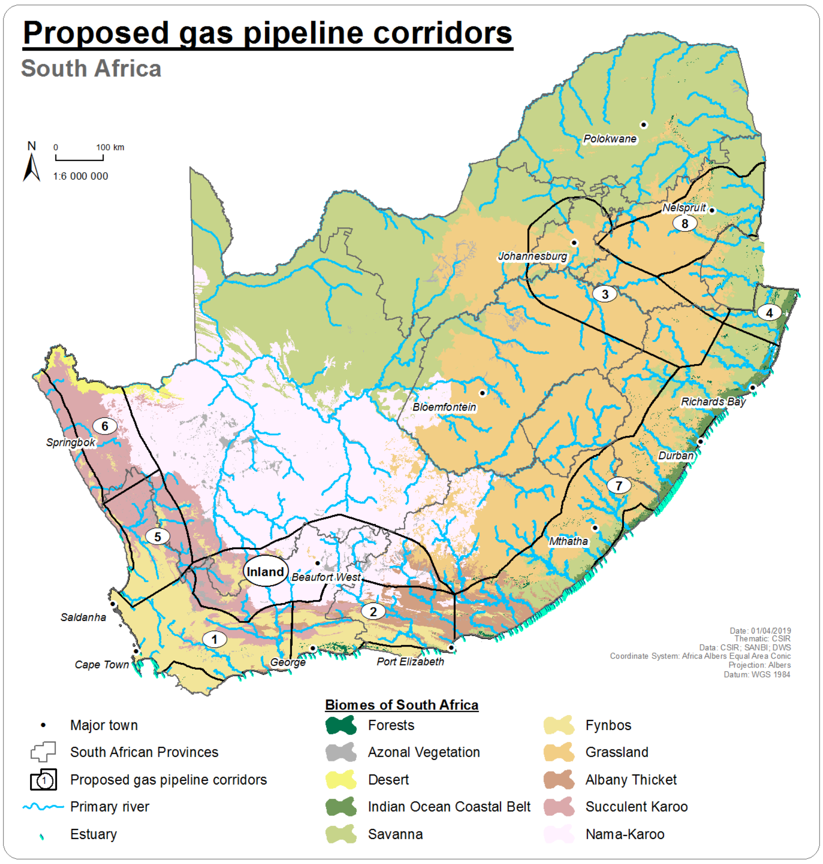


Figure 1: Location of the proposed Draft Refined Gas Pipeline Corridors in South Africa with the key terrestrial and aquatic ecosystem components considered in the Integrated Biodiversity and Ecology Assessment.

4.2.1.2 Scope of the Assessment

The ecological and biodiversity environmental aspects of the proposed gas pipeline phases have been grouped according to the biomes that are found within the corridors, which act as the point of departure for terrestrial ecosystems and the fauna that inhabit these systems. The forest biome has not been included in the SEA as it represents an engineering constraint for the gas pipeline due to the deep rooted tree systems. Therefore, the forest biome will be avoided for the routing of the gas pipeline. Impacts on avifauna and bats posed by gas pipeline development are indirect, and mainly due to habitat destruction potentially resulting in displacement and/or mortality. The aquatic ecosystems considered in the SEA include freshwater and estuarine habitats, and associated species.

Figure 2 provides an overview of the topics forming part of the assessment, focusing on biomes, sensitive ecosystems, the ecological processes that underpin their functioning, and the plant and animal species inhabiting those ecosystems.

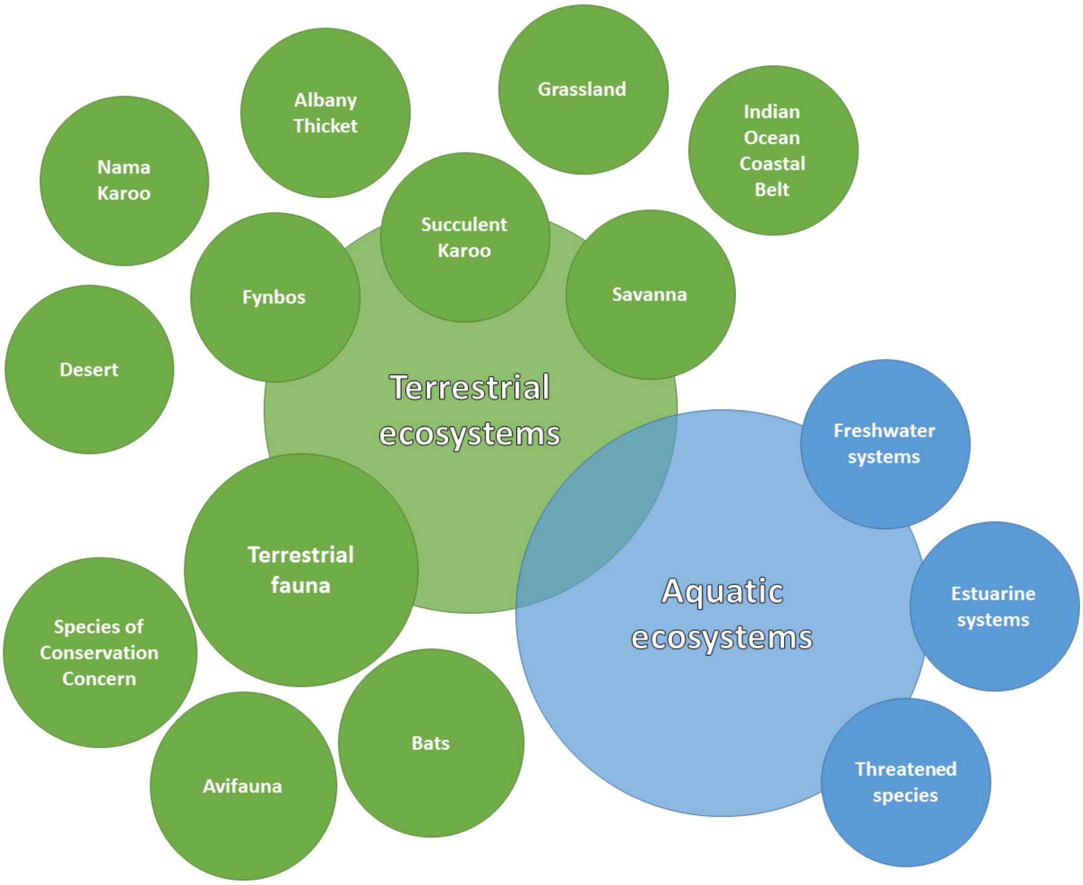


Figure 2: Overview of the terrestrial and aquatic ecosystem topics forming part of the Integrated Biodiversity and Ecology Assessment.

4.2.1.3 Spatial Data and Key Assumptions

The features considered sensitive to the development of transmission gas pipeline infrastructure and included in the biodiversity assessment are listed in Table 1. The list of the spatial datasets used in this assessment can be found in Section 3.2 of the Integrated Biodiversity and Ecology Assessment Report (Appendix C.1 of the Gas Pipeline SEA Report).

This assessment made use of existing literature and available useable spatial information, i.e. no fieldwork was done and no additional raw data were collected and/or processed. Some datasets are outdated, or lacking data for certain areas of ecological importance within each biome. For species, in particular, records are limited to primarily areas which are easy to access and where monitoring is safe to undertake e.g. in Protected Areas (PAs). Those datasets are therefore likely to contain sampling bias. In addition, data contained within some of the fauna species databases are coarse and insufficient to be able to identify endemics with any certainty, and the threat status of most invertebrate groups has not been assessed according to the International Union for Conservation of Nature (IUCN) criteria.

It is thus important to keep in mind that the consideration of ecological pattern and process in this assessment is limited by the resolution and scale of the spatial data. For site-specific routings of gas pipeline infrastructure, ground-truthing will still be required.

Table 1: Available Spatial Data pertaining to Terrestrial Ecosystems, Aquatic Ecosystems, and Species used in the Integrated Biodiversity and Ecology (Terrestrial and Aquatic Ecosystems, and Species) Assessment Report.

Feature
Terrestrial Ecosystems
Provincial conservation planning
Protected and Conservation Areas
National Protected Area Expansion Strategy (NPAES) Focus Areas
Vegetation of South Africa
Threatened ecosystems
National Land Cover
Ecoregions
National Forests
Karoo ecological and biodiversity sensitivity
Field crop boundaries
Aquatic Ecosystems – Freshwater Ecology
SQ4 sub-quaternary drainage regions (referred to as SQ4 catchments)
River Ecoregions (Level 1 and 2)
River Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES)
NFEPA Rivers and Wetlands
Ramsar Sites
National Wetland Vegetation Groups
Provincial Wetland Probability Mapping
Mpumalanga Highveld Wetlands
Aquatic Ecosystems – Estuarine Ecology
Estuarine health
Estuary ecological classification
Estuaries in Formally /desired protected areas
Estuaries of high biodiversity importance
Important nurseries
Important estuarine habitats
Natural or near natural condition estuaries
Species – Terrestrial and Aquatic Fauna
Red Data Species
Species – Birds
The Southern African Bird Atlas 1 (SABAP1)
The Southern African Bird Atlas 2 (SABAP2)
Crane, raptor and vulture nests
National vulture restaurant database
Eagle nests on Eskom transmission lines in the Karoo
Locality of Red Data nests
Cape Vulture colonies
Blue Swallow breeding areas
Southern Ground Hornbills nesting areas.
Various Red Data bird species nests
Southern Bald Ibis breeding colonies
Important Bird and Biodiversity Areas of South Africa
Potential Bush Blackcap, Spotted Ground-Thrush and Orange Ground-Thrush breeding habitat.
Yellow-breasted Pipit core distribution
Rudd's Lark core distribution
Botha's Lark core distribution
White-winged Flufftail confirmed sightings 2000 – 2014
Bearded Vulture nest sites in KwaZulu–Natal
Red Data nest localities in the Western Cape
Species – Bats
Terrestrial Ecoregions
Geology
Bat Roosts
Bat species occurrence data

4.2.1.4 Key Environmental Features

Due to the vast extent of the proposed gas pipeline corridors, all of the biomes of South Africa are potentially affected[2] (Table 2). Note that proposed gas pipeline corridor Phases 3, 6, 8 and Inland do not border the coastline, as such, estuaries are not directly affected by these corridors.

Table 2: Extent of the biomes within each of the proposed gas pipeline corridors.

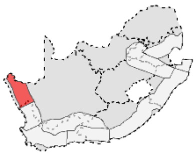
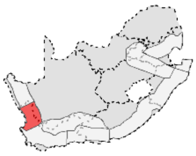
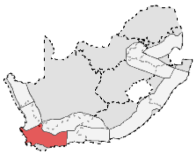
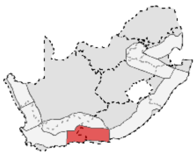
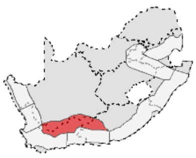
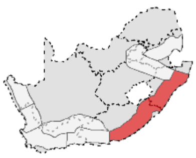
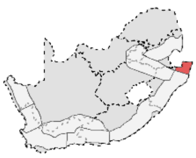
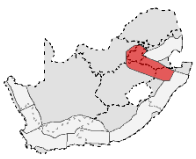
Biome	Extent (% of each proposed gas pipeline corridor)								
	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Phase 8	Inland Phase
Succulent Karoo	15	10			56	65			16
Nama-Karoo	1	15				21	1		62
Fynbos	79	36			38	2	1		7
Azonal Vegetation	2	4	< 1	2	4	1	1	< 1	8
Albany Thicket	4	33					11		4
Grassland		1	86	2			46	62	3
Indian Ocean Coastal Belt				16			7		
Savanna			14	73			31	38	
Desert						12			
*Forests**	*< 1*	*1*	*< 1*	*5*	*< 1*		*2*	*< 1*	

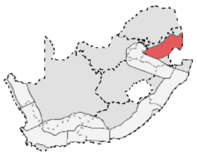
**The Forest biome presents and engineering constraint for gas pipeline development and also contains sensitive and rare environments. Therefore it is assumed that it will be avoided and not considered for regulatory streamlining.*

Table 3 provides a summary of the key environmental features of the Draft Refined Gas Pipeline Corridors.

[2] Not all the corridors will eventually be developed. The development of the phased gas pipeline network is based on a viable business case, market demand, and finding a gas source. It is likely that only one of the corridors will be developed, depending on where natural gas is imported or exploited locally.

Table 3: Summary of key environmental features of the Draft Refined Gas Pipeline Corridors.

Proposed gas pipeline corridor	Brief description	
Phase 6 	• This proposed gas pipeline corridor is situated within Desert, Fynbos, Succulent Karoo, Nama Karoo vegetation types in the Northern Cape and Western Cape Provinces. • Mostly arid environment, with prominent protected areas that include the Richtersveld and Namaqua National Parks (NPs), with extensive areas earmarked as potential National Protected Areas Expansion Strategy (NPAES) focus areas. • Relatively untransformed when compared to the other proposed gas pipeline corridors.	Arid / winter rainfall
Phase 5 	• This proposed gas pipeline corridor is situated within Fynbos, Succulent Karoo vegetation types in the Northern Cape and Western Cape Provinces. • Notable protected environments include the Cederberg and Winterhoek Mountains. • Relatively transformed by settlements and cultivation.	
Phase 1 	• This proposed gas pipeline corridor is situated within Fynbos, Succulent Karoo, Nama Karoo, Albany Thicket vegetation types in the Western Cape Province. • Extensively transformed by settlements and cultivation, as such many of the remaining ecosystems are of conservation importance and currently protected.	
Phase 2 	• This proposed gas pipeline corridor is situated within Fynbos, Succulent Karoo, Nama Karoo, Albany Thicket, Grassland vegetation types in the Western Cape and Eastern Cape Provinces. • Extensively transformed around major towns (Mossel Bay, George, Port Elizabeth) due to urban settlement and agriculture.	
Inland 	• This proposed gas pipeline corridor is situated within Fynbos, Succulent Karoo, Nama Karoo, Albany Thicket, Grassland vegetation types in the Western Cape, Northern Cape and Eastern Cape Provinces. • Relatively untransformed when compared to the other proposed gas pipeline corridors.	
Phase 7 	• This proposed gas pipeline corridor is situated within Fynbos, Nama Karoo, Albany Thicket, Savanna, Grassland, Indian Ocean Coastal Belt vegetation types in the Eastern Cape and KwaZulu-Natal Provinces. • Transformed by urban settlement and agriculture, especially between Durban and Richards Bay in the KwaZulu-Natal Province. • Many aquatic systems (rivers, wetlands and estuaries) present.	
Phase 4 	• This proposed gas pipeline corridor is situated within Savanna, Indian Ocean Coastal Belt vegetation types in the KwaZulu-Natal Province. • Relatively untransformed when compared to the other proposed gas pipeline corridors, with many protected areas associated with large wetlands present.	
Phase 3 	• This proposed gas pipeline corridor is situated within Savanna, Grassland vegetation types in the KwaZulu-Natal, Free State, Mpumalanga, Gauteng, and North-West Provinces. • Extensively transformed by settlements, agriculture and mining.	Higher / summer rainfall

Proposed gas pipeline corridor	Brief description	
Phase 8 	• This proposed gas pipeline corridor is situated within Savanna, Grassland vegetation types in the Mpumalanga Province. • Extensively transformed by settlements, agriculture and mining, with the Kruger NP occupying the eastern part of the corridor. • Kruger National Park occupies most of the eastern corner of this corridor.	

4.2.1.5 Sensitivity Criteria and Mapping

Sensitivities and buffers (where relevant) were assigned to various important environmental features (Refer to Tables 4a and 4b). The sensitivities of the various features within the different biomes may vary, as they are known to have various degrees of resilience and recoverability. For example, rehabilitation may be more easily and successfully achieved in the Savanna and Grassland vegetation types than in Fynbos and Karoo vegetation types.

Table 4a: Approach to the allocation of Sensitivity Ratings to important environmental features of the Desert, Succulent Karoo, Nama Karoo, Fynbos, Albany Thicket, Indian Ocean Coastal Belt, and Grassland and Savanna Biomes; and important freshwater and estuarine features.

Feature Class	Sensitivity Rating
Desert, Succulent Karoo and Nama Karoo Biomes	The biodiversity sensitivity values are adapted from CBA classifications from provincial systematic conservation plans for the Northern, Western and Eastern Cape provinces, as well as relevant specialist experience and previous SEAs conducted in these biomes.
Fynbos Biome	The Fynbos sensitivity analysis relied primarily on the most recent conservation plans for the areas concerned as they already include all the relevant layers of information such as threatened vegetation, threatened vertebrates, protected area expansion strategies and climate adaptation corridors in their CBAs and Ecological Support Areas (ESAs) and the latest information on the protected areas.
Albany Thicket Biome	The Albany Thicket sensitivity analysis made extensive use of data resources arising from the updated, revised Eastern Cape Biodiversity Conservation Plan and the Western Cape Biodiversity Spatial Plan. The inherent fragility of the receiving environment will vary depending on the specific type of biodiversity feature being considered, however, for any given feature a number of contingent factors will influence fragility, typically these will include the slope and rainfall of the site being impacted. For any given impact, receiving environments on steep slopes (> 30 %), and with very high or very low rainfall will be more fragile, and susceptible to cumulative and secondary impacts, such as erosion or poor recovery after rehabilitation. However, this criterion should be considered at finer scales of planning, where for example adjustments to routing paths may be considered based on topography.
Indian Coastal Belt	For the Indian Ocean Coastal Belt areas of high conservation value, existing conservation plans were selected as basis for the sensitivity analysis.
Grassland and Savanna Biomes	The sensitivity of biodiversity and ecological features was based largely on sensitivities as used in Provincial biodiversity conservation plans.
Freshwater Ecosystems	The sensitivity rating for freshwater ecosystems is a combined rating for rivers, wetlands and freshwater biota. The total score for each sub-quaternary drainage regions (SQ4 catchment) were collapsed into the four sensitivity classes using a quantile data split. This coverage provides an integration of all data pertaining to freshwater biodiversity and ecosystems, and is particularly useful for identifying preferred alignments for gas pipeline infrastructure in order to reduce impacts on freshwater ecosystems and associated biodiversity.
Estuaries	Sensitivity was assigned to a suite of environmental indicators for estuaries, such as protected areas, biodiversity importance, importance as nurseries, condition of the estuaries, conservation importance, coastal rovers, wetlands and seeps.

Table 4b: Sensitivity ratings assigned to important environmental features of the various biomes

Feature Class	Sensitivity Rating
Desert, Succulent Karoo and Nama Karoo Biomes	
Conservation planning	
- CBA 1	Very High
- CBA 2	High
- ESA	Low
Protected areas	
- Protected Area (PA)	Very High
- NPAES Focus Area	Medium
- Old agricultural fields	Low
- Old agricultural fields + CBAs	Medium
- Agricultural fields	Low
Specific Vegetation types	
- Azonal wetland related vegetation types	Very High
- Azonal non-wetland related vegetation types	High
- Vegetation types which have a high abundance of SCC	High
- Vegetation types considered vulnerable to disturbance (dunes)	High
Threatened ecosystems	
- CR	Very High
- EN	High
- VU	Medium
Species of Conservation Concern	
- Quinary catchments where fauna and flora SCC are present	High
- SCC Plant Habitats	Very High
Other areas of biodiversity significance	
- Specialist identified sensitive areas in Karoo and Desert ecosystems	High
- Areas of biodiversity significance identified in the Shale Gas SEA.	High
Fynbos Biome	
Protected Areas Western Cape	
- NPs, Nature Reserves, World Heritage Sites	Very High 10 km Buffer[a]: High
- Mountain Catchment Areas	High
- Private Conservation Areas (all types)	Medium 5 km Buffer: Medium
- Protected Environment	5 km Buffer: Medium
- NPAES	5 km Buffer: Medium
- Nature Reserve Buffer	5 km Buffer: Medium
Protected Areas Northern Cape (all types)	Very High
- PA	5 km Buffer[b]: High
- NPs	10 km Buffer[b]: High
Protected Areas Eastern Cape	
- WHS, NP, Nature Reserve, DAFF Forest Reserves	Very High
- Biosphere Reserves, Protected Environments	High
- Private Nature Reserves	Medium
Conservation Planning	
- CBA1	Very High
- CBA2	High
- ESA	Medium
- Land Cover : Natural Area	Medium
- Land Cover: Transformed	Low

Feature Class		Sensitivity Rating
- Other Natural Areas		Medium
[a] *EIA Regulations, No. R. 982, 4 December 2014 as updated in GN 324 to 327 in GG 40772 of 7 April 2017.*		
[b] *In the Northern Cape CBA plan all PAs were buffered by 5 km and National Parks by 10 km as minimum.*		
Albany Thicket Biome		
- PA (including Biosphere Reserves, WHS, State Owned - SANParks and ECPTA, and Protected Environments)*		Very high
- CA (including Private Nature Reserves, De Facto Private Nature Reserves, and DAFF Forest Reserves)*		High
- CBA 1		Very high
- CBA 2		High
- ESA 1		Medium
- ESA 2		Medium
- Other Natural Areas		Medium
- Non Natural Areas		Low
**Buffers included as used in ECBCP (DEDEAT, 2017).*		
Indian Ocean Coastal Belt Biome		
- Coastline		1 km buffer: Very High
- PA		5 km buffer: Very High
- WHS		Very High
- Ramsar Sites		High
- NPAES		Medium
- National Forests		Very High
- Conservation categories from KZN BSP	CBA Irreplaceable	High
	CBA Optimal	Medium
	ESA	Low
- EKZN Wildlife Stewardship areas		Very High
- Conservation categories (Eastern Cape Biodiversity Conservation Plan (ECBCP))	PA	5 km buffer: Very High
	CA	High
	CBA 1	High
	CBA 2	Medium
	ESA 1	Low
	ESA 2	Low
	ONA	Low
- Land cover	Modified	Low
	Field Crop Boundaries	Low
- Vegetation	LT	Low
	VU	Medium
	EN	High
	CR	Very High
	Thicket Vegetation	High
- Ecoregion		Medium
- Private Nature Reserves and Game farms	Game Farms Title Deeds	5 km buffer: Medium
	Nature Reserves /PA	5 km buffer: Medium
Grassland and Savanna Biomes		
- PAs: national and provincial parks, forest wilderness, special and forest nature reserves		Very High
- Coastlines		Very High
- All indigenous forests		Very High
- CBA (CBA1 for EC)		Very High
- CBA 2 Eastern Cape		High
- Threatened ecosystems	CR	Very High

Feature Class		Sensitivity Rating
	EN	High
	VU	Medium
- Land Cover: Natural Area - Land Cover: Modified areas		Low
- Game Farms		Medium
- SANParks Buffer		High
- Protected Environments		High
- NPAES focus areas		Medium
- Mountain Catchment Areas		High
- Biospheres		Medium
- Botanical Gardens		Medium
- ESA		Medium
Freshwater Ecosystems		
- Wetlands: CR wetlands and Irreplaceable CBAs (aquatic)		200 m buffer: Very High
- Wetlands: Ramsar wetlands, KZN priority wetlands, EN or VU wetlands, Optimal CBA (aquatic)		100 m buffer: High
- Wetlands: NFEPA wetlands, NT wetlands and ESA (aquatic)		50 m buffer: Medium
- Probable wetland, non-NFEPA wetlands, LT wetlands, ONA (aquatic), formally protected aquatic features		32 m buffer: Low
- River ecosystems (including instream and riparian habitats) tell		200 m buffer Very High
		100 m buffer: High
		50 m buffer: Medium
		32 m buffer: Low
- Freshwater fauna and flora per quinary catchment	CR Data Deficient	Very High
	EN VU	High
	NT Rare	Medium
	LT	Low
Estuaries		
- Estuaries in Formal / desired PAs		Very High
- Estuaries of high biodiversity importance		Very High
- Important nurseries		Very High
- Important estuarine habitats		Very High
- Natural or near natural condition estuaries		Very High
- Estuaries that support species of conservation importance		Very High
- Other estuaries		High
- Coastal rivers, wetlands and seeps above or adjacent to estuaries		5 km around EFZ: High
- Coastal rivers, wetlands and seeps		5 - 15 km buffer around EFZ: Medium
- Terrestrial environment		15 km or more from EFZ: Low

CA = Conservation Area; CBA = Critical Biodiversity Area; CR = Critically Endangered; ECBCP = Eastern Cape Biodiversity Conservation Plan; EFZ: Estuarine Functional Zone; EN = Endangered; ESA = Ecological Support Area; KZ – KwaZulu-Natal; LT = Least Threatened; NPAES = National Protected Area Expansion Strategy; ONA = Other Natural Area; PA = Protected Area; SCC = Species of Conservation Concern; VU = Vulnerable; WHS = World Heritage Site.

Highly sensitive ecological features exist in all corridors, and are mainly related to protected areas and areas identified in Provincial Conservation Plans as Critical Biodiversity Areas. Critical Biodiversity Areas are areas characterised by key ecological processes, ecosystems and species required to meet conservation targets and to protect the biodiversity of South Africa. Areas that have already been transformed by anthropogenic activities such as urbanisation and agriculture are mainly of low sensitivity. Aligning the proposed pipeline routings to follow existing disturbance corridors presents an (environmental) opportunity.

Proposed gas pipeline corridors in more arid areas (i.e. Phases 6 and Inland) are less sensitive from an aquatic ecology perspective due to the relatively limited presence of aquatic features. Due to existing pressures from other anthropogenic activities many of the aquatic ecosystems in the rest of the country are threatened and are resultantly highly sensitive to new development. The most sensitive aquatic ecosystems must be avoided as far as reasonably possible, or mitigated using engineering solutions and best practice to reduce potential impact.

The sensitivity ratings assigned to environmental features have then been expressed spatially as sensitivity maps. Figures 3, 4 and 5 below respectively illustrate the sensitivity of terrestrial features, freshwater aquatic features and estuarine features for all phases of the Draft Refined Gas Pipeline Corridors. Figure 6 illustrates the sensitivity of birds to gas pipeline development, whilst Figure 7 illustrates the sensitivity of bats. The individual sensitivity maps per corridor and theme are included in Section 5.2 of the Integrated Biodiversity and Ecology Assessment (Appendix C.1 of the Final SEA Report), and in the individual assessments (Appendices C.1.1 to C.1.9 of the Final SEA Report) respectively.

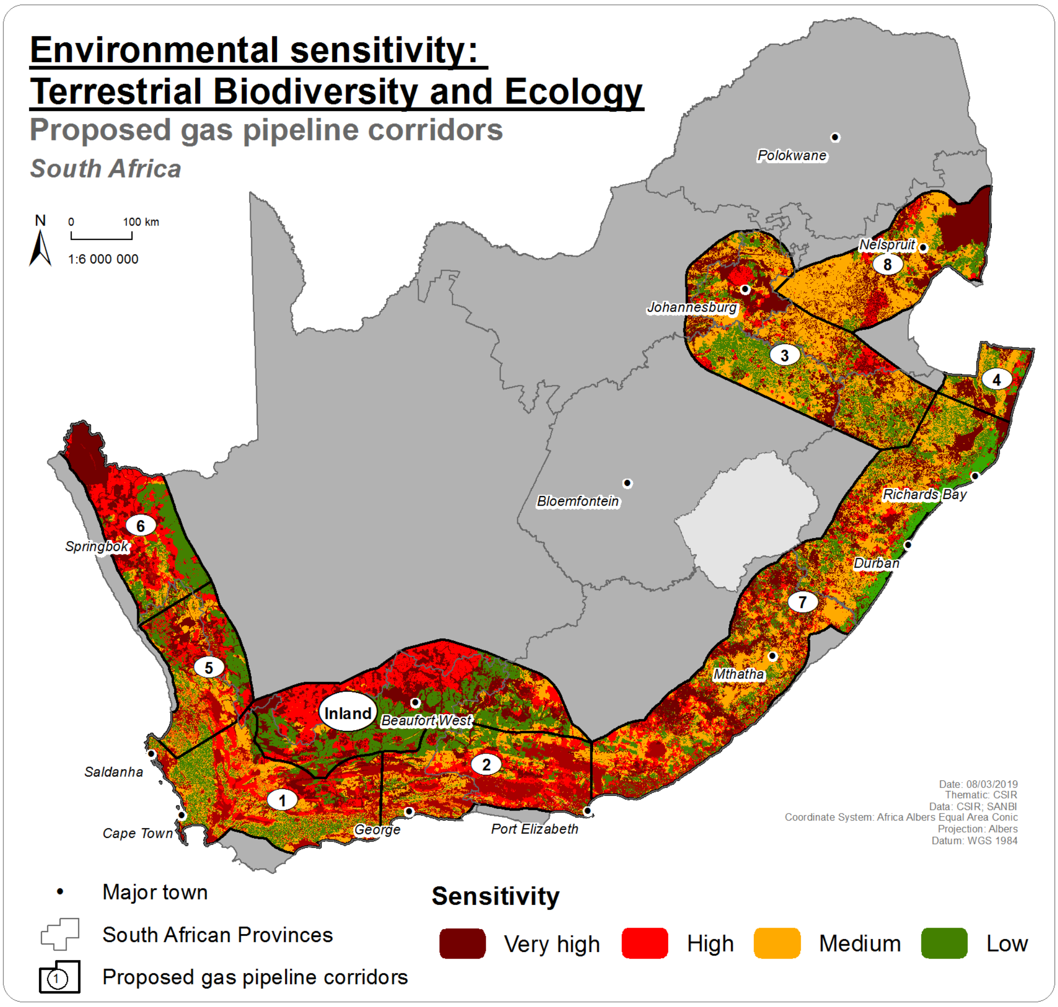


Figure 3: Environmental sensitivity of terrestrial ecosystems in relation to proposed gas pipeline development.

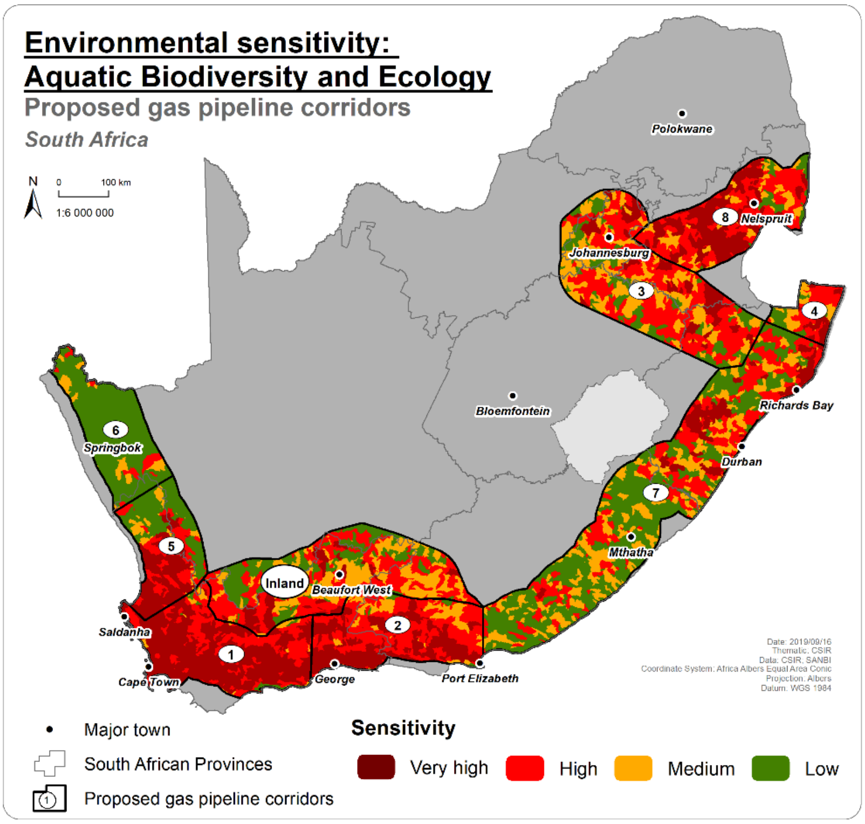


Figure 4: Environmental sensitivity of freshwater aquatic ecosystems in relation to proposed gas pipeline development.

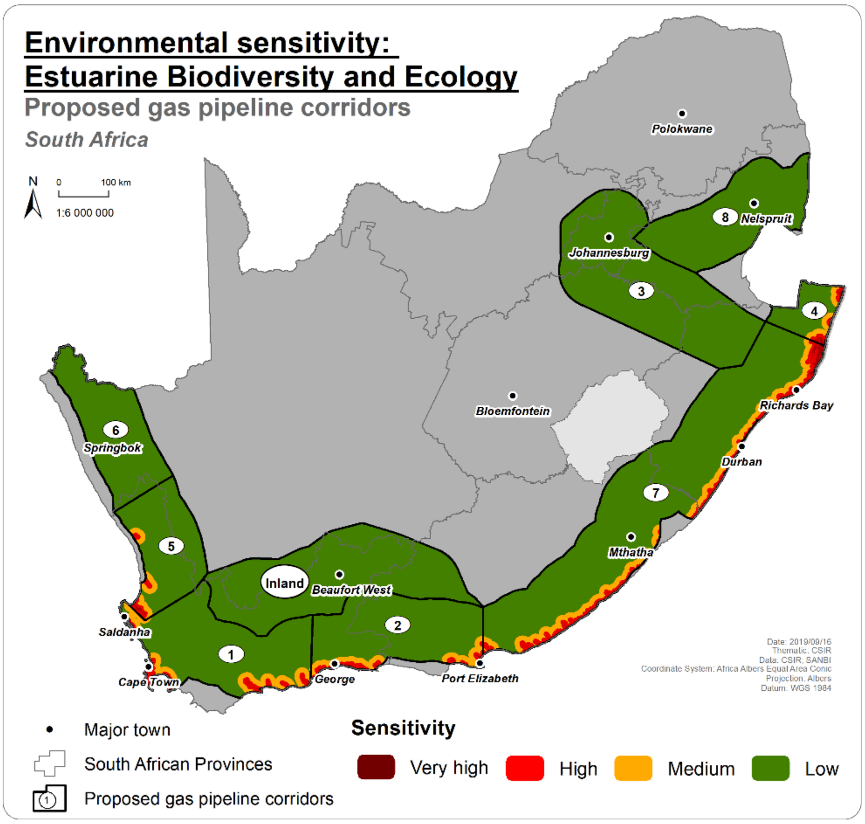


Figure 5: Environmental sensitivity of estuarine ecosystems in relation to proposed gas pipeline development.

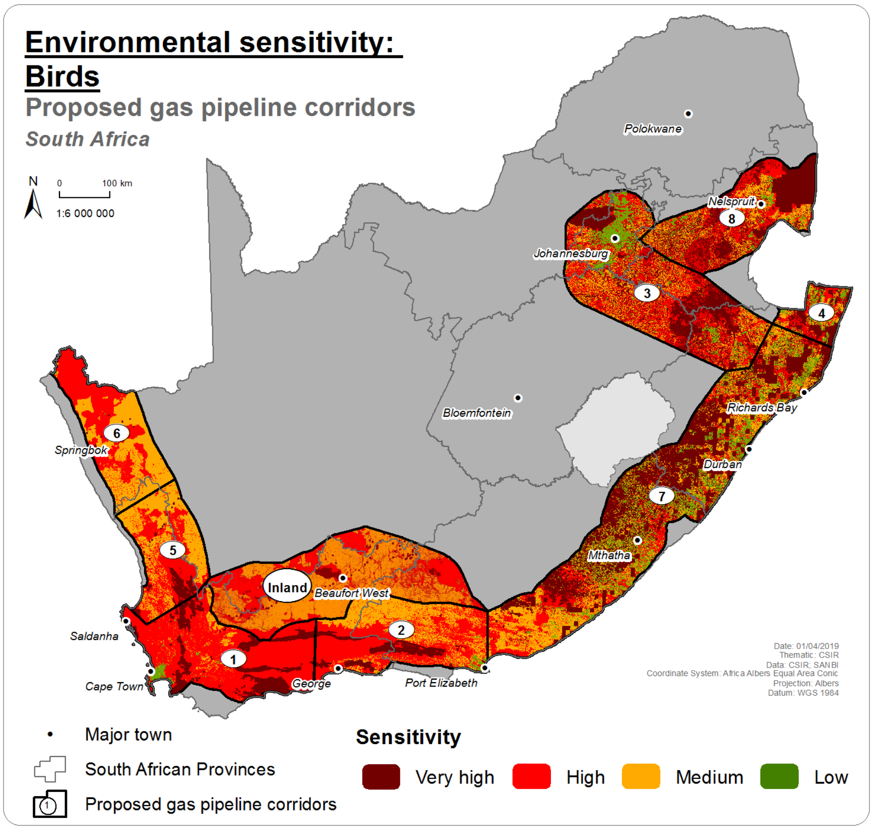


Figure 6: Sensitivity of birds in relation to proposed gas pipeline development.

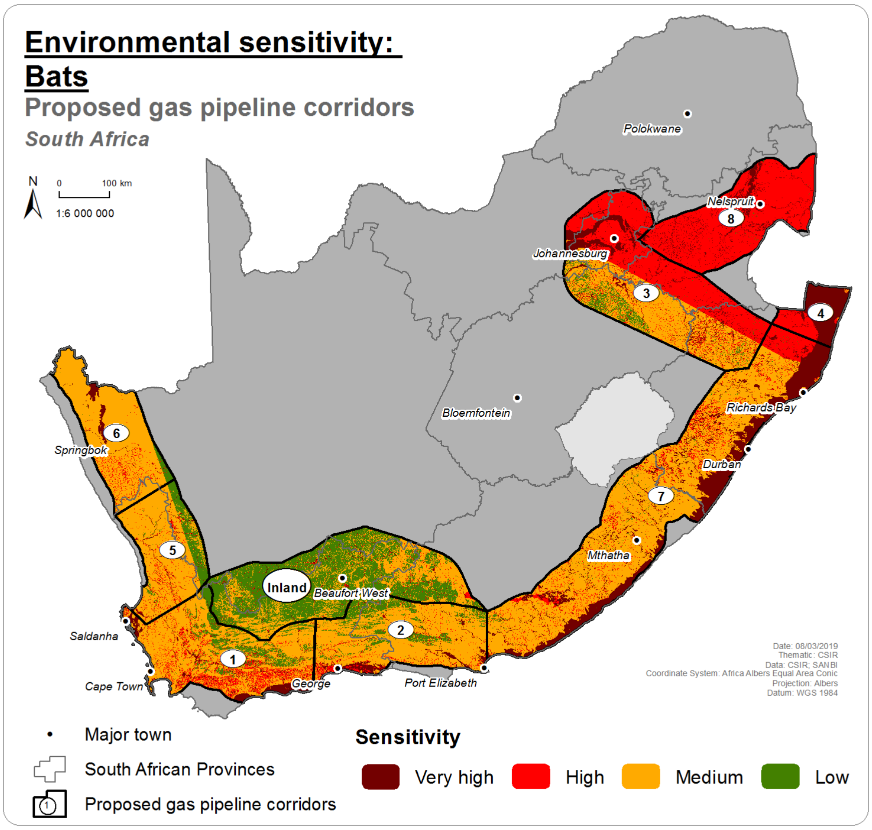


Figure 7: Sensitivity of bats in relation to proposed gas pipeline development.

4.2.1.6 Key Potential Impacts and Mitigations

Key potential impacts of proposed gas pipeline development to terrestrial and aquatic ecosystems and biodiversity are mainly related to vegetation clearance and digging of trenches during construction, which may have consequences for terrestrial fauna directly (e.g. animals becoming trapped in open trenches), as well as birds (especially ground-dwelling species, and through habitat alteration and loss) and bats (mainly via habitat alteration and loss) (Figure 8). Risk was assessed for each key impact, within each study area and for different types of receiving entities or environments – e.g. a sensitive wetland or estuary. The assessment is qualitative and uses the following categories: undiscernible/none, very low, low, moderate, high and very high. The risk categories are predefined for each theme, as a set of criteria which explain the nature and implications of the attributed risks.

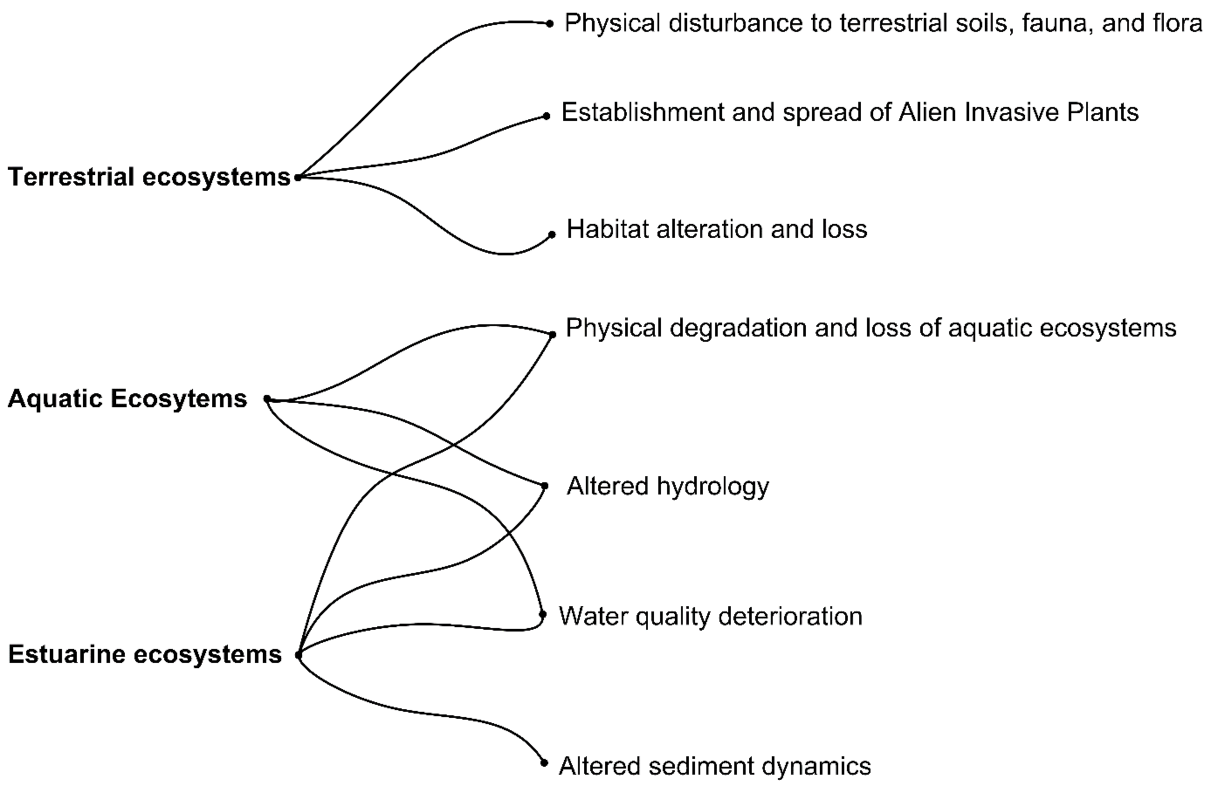


Figure 8: Key potential impacts of proposed gas pipeline development to terrestrial and aquatic systems.

The mitigation hierarchy must be applied during all development phases of the proposed gas pipeline. Key mitigation measures include:

- Avoid, as far as possible, the most sensitive areas identified in this assessment and areas identified by specialists in the field during subsequent environmental assessment (as and where required);
- Minimise footprint and construction duration;
- Minimise new development footprints through utilising existing infrastructure and disturbance corridors as far as possible;
- Minimise the potential impacts to terrestrial fauna through measures to ensure they do not become trapped in trenches and can continue to move freely;
- Manage and continuously control Invasive Alien Plants;
- Manage and continuously control soil erosion;
- Manage people and vehicles on- and around the site through proper induction, environmental awareness and monitoring of their activity; and
- Rehabilitate to a near-natural state as far as possible.

It must be noted that in this risk assessment, biodiversity value equates to biodiversity sensitivity, implying that for any given activity (like vegetation clearing) the associated impacts will be higher on areas of 'high biodiversity' value than on areas with 'medium' or 'low' value biodiversity. However, it requires the assumption that the same sensitivity designations will respond to impacts in a similar way. This is not always true as there may be different reasons (biodiversity features) for sensitivity classifications, and these biodiversity features may not respond the same to any particular stress.

Based on the risk assessment undertaken as part of this SEA, two impacts were rated as Very High residual risk, i.e. risk after the implementation of mitigation measures:

1. Physical disturbance to soils, fauna and flora and alien invasive plants establishment and spread can ultimately manifest as ecosystem alteration and loss (including changes in ecosystem function, and local extinction or decline in the populations of endemic and rare species), particularly in very high and high sensitivity areas, in the low rainfall parts of the Fynbos biome. These areas can be found in Phases 5, 6 and the inland gas pipeline corridors. The rehabilitation success rates in these areas are expected to be low based on the extent of arid Fynbos and Renosterveld vegetation types. In addition, because deep-rooted plants have to be excluded from the vicinity of the pipeline, most if not all of the shrub components of the ecosystems will have to be excluded from the servitude. Therefore, it will be very difficult to return these ecosystems to something closely resembling their original botanical and faunal composition and structure.

   Consequences of ecosystem alteration and loss include:

   - Changes in local habitat features and ecological processes;
   - Changes in habitat suitability for local species;
   - Reduction/loss in endemic and rare species populations;
   - Local or global extinction;
   - Changes in species movements, abundance and distribution,
   - Changes in ecosystem functions, interactions, and resilience;
   - Decline in ecosystem services;
   - Soil erosion;
   - Habitat fragmentation; and
   - Exposure of adjacent communities to unfavourable edge effects (susceptibility to invasions by alien species).

   It is recommended to implement the mitigation measures proposed above.

2. The potential alteration of physical and sediment dynamics within the estuary caused by pipeline construction (via open trench or Horizontal Directional Drilling (HDD) at shallow depths (< 20 m)); e.g. infilling, altered channel migration and increased mouth closure has also been rated as a very high risk with the implementation of mitigation measures. Estuaries are high energy environments and their channel morphology is highly dynamic. Estuarine channels can develop and migrate anywhere within the Estuary Functional Zone (EFZ) under the influence of tidal flows, river inflow and floods.

   Stabilising sections of the estuary morphology or floodplain through pipeline construction can lead to changes in long-term physical dynamics, i.e. disrupting channel and bed formation, altering sediment structure, changing estuary hydrodynamics, mouth dynamics, and ultimately catchment and marine connectivity. This can lead to altered functioning of a system and ultimately affect biota. Loss of estuarine productivity and connectivity in turn will reduce nursery function and associated fisheries value derived along the South African coast.

   Over time migrating estuarine channels will expose pipeline infrastructure, changing flow velocities, and cause ongoing sediment erosion from such sites. This, in turn, can cause sediment deposition and accumulation in other parts of the estuary, causing drying out of the riparian zone, loss of water column habitat and can result in premature mouth closure if the tidal flows are constricted enough. Changes in estuarine physical dynamics will lead to altered estuary productivity and biodiversity.

Avoidance of the EFZ greatly reduces/virtually negates risk to estuaries. However, if pipeline infrastructure cannot be avoided within the EFZ, mitigation is unlikely to be possible / effective for isolated open trenches, whilst HDD with the pipe buried at bed rock level or to depths of greater than 1:100 year potential bed scouring levels will reduce the overall risk to estuaries to Moderate/Low.

Overall, if mitigation and best practice measures are adhered to, it is expected that the risk to terrestrial and aquatic ecosystems and biodiversity from gas pipeline development can be reduced to acceptable levels.

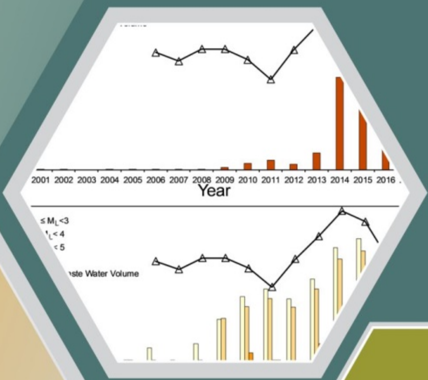
Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.2

Seismicity Assessment



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ABBREVIATIONS

CGS	Council for Geoscience
DRR	Disaster Risk Reduction
M_{max}	Maximum Credible Magnitude
MMI	Modified Mercalli Intensity
PGA	Peak Ground Acceleration
PSHA	Probabilistic Seismic Hazard Assessment
SANSN	South African National Seismograph Network
SCR	Stable Continental Region
SEA	Strategic Environmental Assessment

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.2 Seismicity Assessment

4.2.2.1 Introduction

South Africa is generally described as a 'stable continental region' (SCR) as it is remote from the boundaries of tectonic plates and active continental rifts. This does not mean that large earthquakes cannot occur, but that they occur far less frequently than in places such as California, Italy and Japan, and the maximum credible magnitude M_{max} is somewhat lower. Earthquakes are driven either by geological forces (e.g. motion of tectonic plates, isostatic response to erosion, volcanism) or certain human activities (e.g. mining, impoundment of reservoirs, fluid injection or extraction).

Eight damaging earthquakes ($5.0<M<6.3$) have occurred in South Africa during the last 120 years. Earthquake activity in South Africa is reviewed in Appendix A of the Seismicity Assessment (Appendix C.2 of the Final SEA Report). Five had an unequivocal tectonic origin, while three were in mining districts. Mining-related earthquakes (M_{max}5.7) are restricted to the regions where deep and extensive gold mining has taken place, notably the Welkom and Klerksdorp districts. Thus a potentially damaging earthquake (about $5.0<M<6.5$) occurs somewhere in South Africa, on average, every 10-20 years; structural damage is limited to a radius of 100 km from the epicentre. Three of these earthquakes caused deaths (i.e. 1969 Ceres-Tulbagh; 2005 Stilfontein; and 2014 Orkney).

Larger tectonic earthquakes ($6.5<M<8.0$) are rare in stable regions, but may occur both on faults with a recent (100s-10,000s years) history of earthquake activity, and in areas with no known precursory activity. Such events could therefore take place anywhere. Thus, the locations of historical earthquakes cannot be taken as reliable indicators of areas where large earthquakes will occur.

Gas pipeline networks are "lifelines", a term used by the Disaster Risk Reduction (DRR) community to describe "man-made structures [that are] important or critical for a community to function, such as roadways, pipelines, power lines, sewers, communications, and port facilities" (Aki & Lee 2003: 1821[1]).

These lifelines are vulnerable to damage (potential leakage or rupture of the pipeline) caused by seismic (related) hazards such as (a) ground displacement across the earthquake fault (direct impact) or (b) ground displacements triggered by the earthquake shaking, such as landslides, liquefaction and lateral spreading (indirect impact). This in turn may lead to social, environmental and economic risks.

4.2.2.2 Scope of the Assessment

The Seismicity Assessment addresses the risks posed by earthquakes and associated phenomena on the Gas Pipeline within the proposed Draft Refined Corridors. The following issues have been assessed:

- What damage could earthquake-related phenomena (e.g. strong ground motion, surface displacement as the result of fault rupture, landslides triggered by strong ground motion, liquefaction of soils induced by ground shaking, tsunami) cause to gas pipeline networks?
- What impact would the damage to gas pipelines have on the environment and people?

[1] Aki, K and Lee, WHK, 2003. Glossary of interest to earthquake and engineering seismologists, In: WHK Lee, H Kanamori, PC Jennings & C Kisslinger (Eds). *International Handbook of Earthquake and Engineering Seismology*. Part B. Amsterdam: Academic Press. 1793-1856.

Gas pipelines do not affect seismicity in any known way. High-level conclusions and recommendations have been included in the assessment, which were based on the evidence contained in the following appendices of the Seismicity Assessment Report (Appendix C.2 of this Final SEA Report):

- Appendix A: Earthquake monitoring, hazard and risk assessment in South Africa;
- Appendix B: OpenQuake Probabilistic Seismic Hazard Assessment (PSHA) computation for South Africa and the energy corridors; and
- Appendix C: Vulnerability of Gas Pipelines.

The assessment focuses primarily on the interpretation of existing data and is based on defensible and standardised, and recognised methodologies. It discusses potential impacts, and identifies any gaps in information linked to earthquakes and seismicity with respect to gas pipelines. Due to the strategic nature of the SEA and extent of the assessed area, a quantitative Seismicity Assessment was not undertaken. Findings of the Seismicity Assessment were used to inform the location of corridors and the sensitivities within.

4.2.2.3 Data Sources

The analysis made use of the primary information sources indicated in Table 1.

Table 1: Primary Information Sources used in the Seismicity Assessment Report.

Feature	Information Source and Description
Landslide Geohazard for South Africa	This provides a detailed study on landslides in South Africa. Singh et al. 2011.
Council for Science (CGS) Geohazard Atlas	This provides information on collapsing and swelling soils. The data source is indicated below[2].
Earthquake Seismology	This provides a comprehensive review of earthquake monitoring, hazard and risk assessment in South Africa. Durrheim 2015.
The history of mining seismology	This provides a comprehensive review of mining-induced earthquake monitoring, hazard and risk assessment in South Africa. Durrheim & Riemer 2015.
Homogeneous earthquake catalogue for Southern Africa	This contains an earthquake catalogue for South Africa. Mulabisana 2016 (MSc dissertation).
Seismic sources, seismotectonics and earthquake recurrence for the KwaZulu-Natal (KZN) coastal region	This includes active faults in the KZN coastal region. Singh 2016 (PhD thesis).
A palaeoseismic investigation of Late Quaternary reactivation of the Kango Faults and its relevance to the siting of critical structures in the southern Cape Fold Belt, South Africa	This includes active faults in the southern Cape region. Goedhart 2017 (PhD thesis, in examination).
Seismotectonics of South Africa	This includes a Seismotectonic model for South Africa, which includes active faults and earthquake source mechanisms. Manzunzu et al. 2019.
The Probabilistic Seismic Hazard Assessment (PSHA) of South Africa	This includes the PSHA for South Africa. Midzi et al. 2018 (in review).
Development of a South African Minimum Standard on ground vibration, noise, air-blast and flyrock near surface structures to be protected	This includes blasting-induced ground vibrations. Milev et al. 2016.
Global catalogues of earthquakes in stable continental regions	This includes a global catalogue of earthquakes in stable continental regions. Johnston et al. 1994

The assumptions and limitations applicable to the study are captured in Section 2.4 of the Seismicity Assessment (included as Appendix C.2 of this Final SEA Report).

[2] http://197.96.144.125/jsviewer/Geohazards/index.html#

4.2.2.4 Key Environmental Features and Attributes

As noted above, most earthquakes in Southern Africa are induced by deep-level mining for gold and platinum, and thus restricted to the mining districts. However, natural earthquakes do take place from time to time. Figure 1 shows the location of recorded earthquakes in Southern Africa from 1811 to 2014 in relation to the Gas Pipeline Corridors.

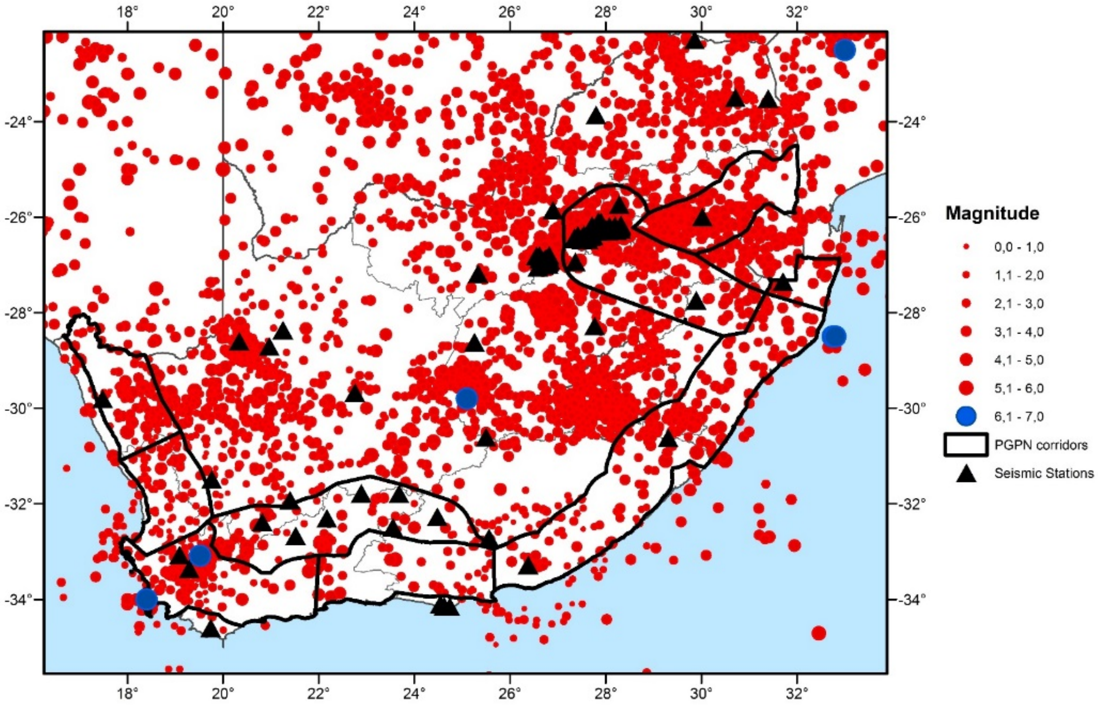

Figure 1: Location of recorded earthquakes in Southern Africa from 1811 to 2014 and the Gas Pipeline Corridors. The black triangles indicate the position of the stations that comprise the South African National Seismograph Network (SANSN).

Feedback on active faults within the corridors are noted below:

- Phase 1 (Saldanha to Mossel Bay): Presence of active faults determined from seismicity interpretation. The date of last major earthquake to cause surface rupture is unknown.
- Phase 2 (Mossel Bay to Coega with a link to the Karoo for Shale Gas): The Kango Fault produced a M7.4 earthquake with a ca. 80 km long and 2 m high fault scarp in the Little Karoo ca. 10,000 years ago.
- Phase 3 (Richards Bay to Secunda, Sasolburg and Gauteng): Many active faults in deep gold mines. Seismicity is induced by mining activity and the active faults are confined to mining areas.
- Phase 4 (Richards Bay to southern border of Mozambique): A fault near the KwaZulu-Natal – Mozambique border that displaced the 75,000 year-old Port Durnford Formation by 30 m is described by Kruger and Meyer (1988[3]).
- Phase 5 (Abrahamvilliersbaai to Saldanha): No active faults have been mapped.
- Phase 6 (Abrahamvilliersbaai to Oranjemund (Border of Namibia)): Several faults have been mapped as "potentially active" by Manzunzu et al. (2019[4]).
- Phase 7 (Richards Bay to Coega): The Tugela Fault has been mapped as "potentially active" by Manzunzu et al. (2019[4]).
- Phase 8 (Mozambique border to Gauteng (Rompco Pipeline Corridor)): No active faults have been mapped.

[3] Kruger GP & Meyer R. 1988. A sedimentological model for the northern Zululand coastal plain. Proceedings of the 22nd Earth Science Congress of the Geological Society of South Africa, pp.423-426.
[4] Manzunzu, B, Midzi, V, Mulabisana, TF, Zulu, B, Pule, T, Myendeki, S and Rathod, GW. 2019. Seismotectonics of South Africa. *Journal of African Earth Sciences*, 149:271-279.

- Inland Corridor (Cape Town/Saldanha to Coega): No active faults have been mapped.

Earthquake-related hazards are divided into the following two categories:

- Primary hazards (direct impacts), i.e. ground shaking and displacement; and
- Secondary hazards (indirect impacts), i.e. landslides and soil liquefaction.

Parts of the Gas Pipeline Corridors that are sensitive to earthquake hazards lie within the following regions:

- Regions with **elevated seismic hazard**. An earthquake may cause the ground and gas pipeline to shake to such an extent that damage occurs; or the earthquake rupture causes a displacement between opposite sides of the fault that is large enough to damage structures or break pipelines that straddle it.
- Regions prone to **landslides** and/or characterised by **problem soils** (i.e. soils that are prone to collapse, swelling or liquefaction). Earthquake shaking may trigger landslides and rockfalls and cause soils to liquefy. All these phenomena may lead to damage and loss.

These hazards are detailed below.

a) **Probabilistic Seismic Hazard Assessment**

The levels of the shaking intensity scale experienced on the surface of the earth can be roughly related to the Peak Ground Acceleration (PGA). It is expressed either in terms of gals (cm/s^2) or the acceleration of gravity (g, 9.8 m/s^2). The latest and most complete assessment of seismic hazard (PSHA) in South Africa was performed by the Council of Geoscience (CGS) (Midzi et al. 2018[5]) using an up-to-date homogenised earthquake catalogue. For this study, the CGS assessment was extended to cover the Gas Pipeline Corridors. The main results of the PGA calculations are shown in Figure 2.

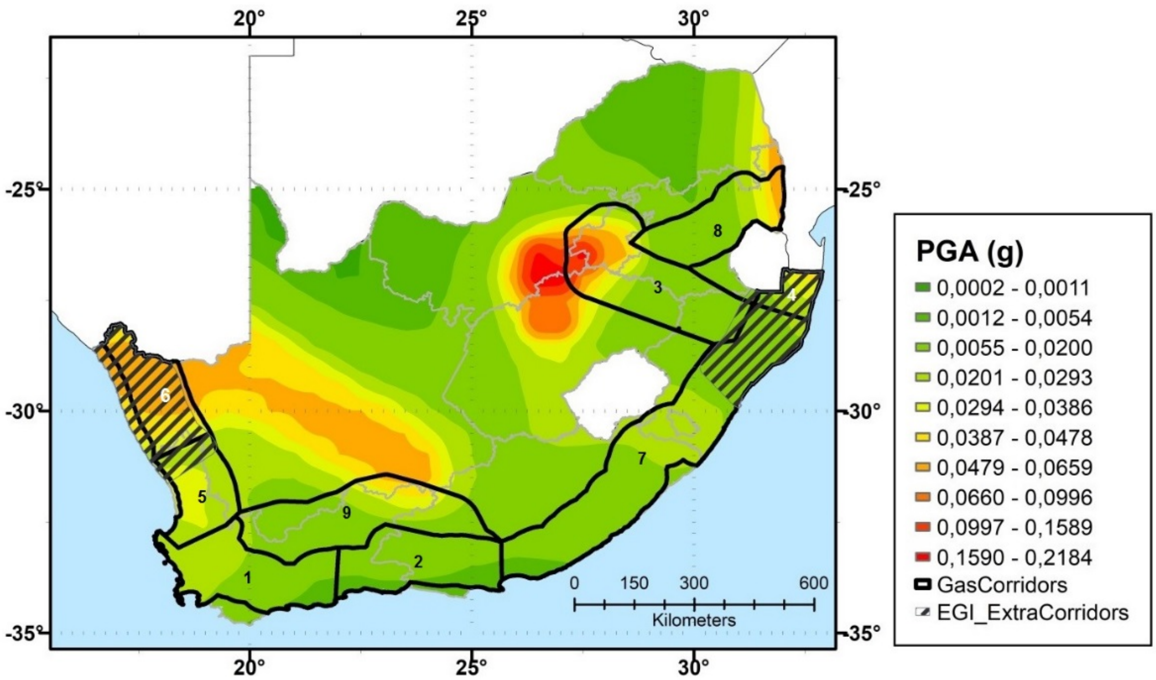

Figure 2: PGA (g) with 10% probability of exceedance in 50 years.

[5] Midzi V, Manzunzu B, Mulabisana TF, Zulu BS, Pule T, Myendeki S & Rathod, G. 2018. The Probabilistic Seismic Hazard Assessment of South Africa. *Journal of Seismology* (in review).

As indicated in Figure 2, the PGA (10% probability of exceedance in 50 years) does not exceed values of about 0.07 g in most of the Gas Pipeline Corridors. These values are typical of Modified Mercalli Intensity (MMI) VI, where the shaking is strong enough to cause alarm but only cause minor damage to buildings and well below the damage thresholds of modern gas pipelines. Larger events are possible, but have recurrence times of centuries.

The risk is relatively high (but still quite low) in Gas Pipeline Corridor 3, which includes mining districts in the Gauteng, North West and Free State Provinces (as noted above). The PGA (10% probability of exceedance in 50 years) in these regions reaches values of about 0.2 g, which is typical of MMI values of about VIII where the shaking is strong enough to cause slight damage to earthquake-resistant structures, considerable damage to solid buildings, and great damage to poorly-built buildings.

b) <u>Landslide Hazards</u>

Figure 3 depicts the landslide susceptibility based on comprehensive surveys conducted by Singh et al. (2008[6], 2011[7]). It should be noted that the predominant trigger of landslides is intense rainfall, not earthquakes. As depicted in Figure 3, landslide susceptibility is low for most of the area covered by the Gas Pipeline Corridors considered in the assessment, with some areas with rugged terrain found in corridors 1, 2, 5, 7 and 8.

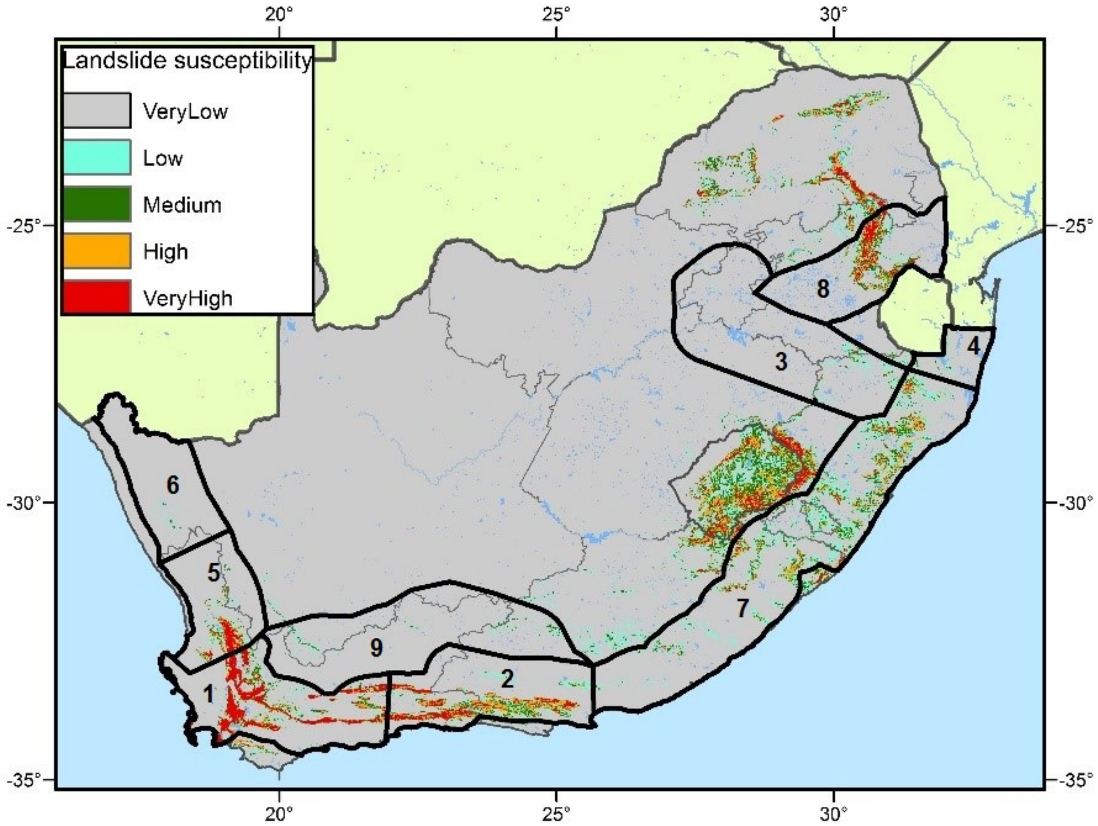

Figure 3: Landslide Susceptibility Map (Singh et al. 2011[7]).

[6] Singh RG, Botha GA, Richards NP & McCarthy TS. 2008. Holocene landslides in KwaZulu-Natal, South Africa. *South African Journal of Geology*, 111:39-52.

[7] Singh, RG, Forbes, C, Chiliza, G, Diop S, Musekiwa C & Claasen D. 2011. *Landslide Geohazards in South Africa.* Report No. 2011-0016, Council for Geoscience.

c) Problem Soil Hazards

Problem soils are divided into two main categories (i.e. collapsible soils and swelling soils). Collapsible soils are indicated in Figure 4. They are also known as metastable soils and are unsaturated soils that undergo a large volume change upon saturation. The sudden and usually large volume change could cause considerable structural damage. Collapsible soils are mainly found in corridors 3, 7 and 8, with the remaining of the corridors only containing minimum amount of those soil types (Figure 4).

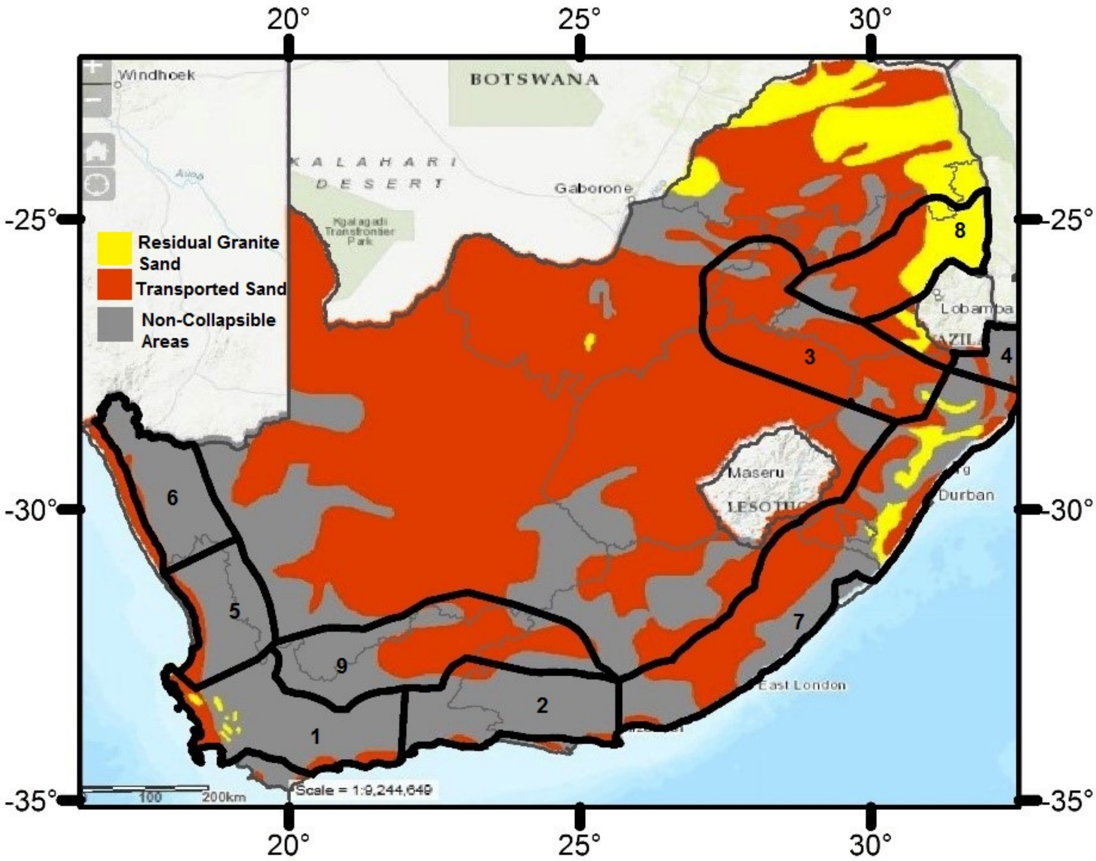

Figure 4: Collapsible Soils in South Africa based on the CGS Geohazard Atlas.

Swelling soils are prone to large volume changes (swelling and shrinking) that are directly related to changes in water content. Soils with a high content of expansive minerals can form deep cracks in drier seasons or years. As indicated in Figure 5, the occurrence of swelling soils in the Gas Pipeline Corridors mainly ranges from "very low" to "moderate". Very small sections of the Phase 5 Gas Pipeline Corridor includes "high" occurrence of swelling soils. The Phase 3 corridor includes "moderate to high" and "high" occurrence of swelling soils.

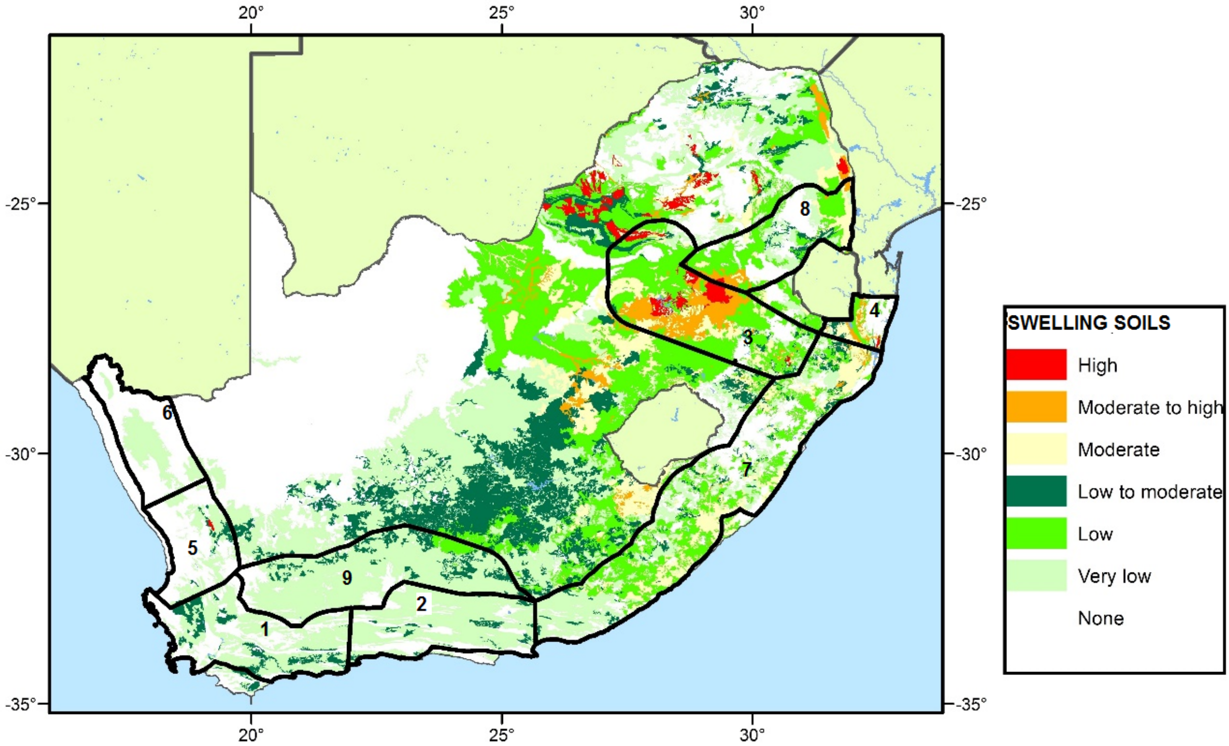

Figure 5: Swelling clays in South Africa based on the CGS Geohazard Atlas.

4.2.2.5 Sensitivity Criteria

Based on the above, the following criteria are proposed to identify regions where gas pipelines may be sensitive to the effects of earthquakes:

- **Elevated seismic hazard**, i.e. regions that have:
  - Historical or instrumental records of M>5 earthquakes;
  - Palaeoseismic evidence of M>6 earthquakes (age <100,000 years, indicated by mapped and dated fault scarps);
  - PGA>0.05 g (475 years recurrence, equivalent to 10% probability of exceedance in 50 years); or
  - Active faults (indicated by present-day seismic activity).
- **Elevated vulnerability**, i.e. sub-regions that have:
  - Steep topography prone to seismically-triggered landslides;
  - Thick near-surface low-seismic-velocity layers prone to site amplification; or
  - Saturated soils and sands prone to liquefaction when shaken.

The above should be considered during the planning stage.

Sensitivity maps have not been produced for this specific topic due to the poor resolution of PSHA, large uncertainties, and the lack of detailed information regarding currently active faults and near-surface geology.

4.2.2.6 Potential Impacts and Mitigation

Section 4 of the Seismicity Assessment (Appendix C.2 of the Final SEA Report) includes detailed feedback on the potential seismic related impacts associated with the gas pipelines. This section provides a summary of the potential impacts and key mitigation measures identified.

The key potential impact identified in the assessment is that earthquakes can cause direct and indirect damage to gas pipelines. A direct impact would constitute a M>7 earthquake that causes fault displacement over 20-80 km that ruptures the gas pipeline. An indirect impact would be landslides, liquefaction or lateral spreading that damages a gas pipeline triggered by a M>6 tectonic earthquake or M>5 shallow mining-related earthquake. As indicated above, the effects of these potential direct and indirect impacts include disruption of gas supply, as well as a cascade of other hazardous phenomena that may cause harm to the environment and people, such as fires, explosions, asphyxiation and electrocution (secondary impacts), as a worst case.

Based on the information presented above, local conditions that might increase the hazard posed by secondary effects of earthquakes should therefore be taken into account when siting and constructing gas pipeline networks; i.e. steep slopes that are prone to landslides and thick soils and alluvium that may amplify ground motions and/or liquefy when shaken. These areas should either be avoided, or the gas pipelines protected or reinforced, or ground improvement measures implemented (i.e. stabilising the sites e.g. driving piles, using raft foundations, dewatering potential landslides, anchoring critically-balanced rocks etc.).

4.2.2.7 Summary of the Risk Assessment

Overall, the risk posed by gas pipelines in the event of earthquakes in South Africa is considered to be generally low, provided local ground motion amplification, liquefaction and landslide phenomena are taken into account.

It is assumed that all transmission gas pipelines will be built with appropriate mitigation measures. For example:

- Pipelines will be built to most recent applicable international standards.
- Pipelines will be equipped with valves that will stop gas flow in a specific section if there is a significant drop in pressure.
- Sites prone to landslides, lateral spreading and liquefaction will be identified. The sites will either be avoided; or the pipeline will be strengthened or made more flexible as deemed appropriate; or the ground will be improved; or some combination of the above measures will be implemented.

Furthermore, it is proposed that the gas pipeline will mostly run outside of populated built-up regions; thus the exposure of people and assets to harm and loss will generally be low.

There is abundant local and international literature describing the risks that earthquakes pose to gas pipeline networks and the required mitigation measures. Although further work (e.g. sensitive seismic monitoring, detailed geological and geotechnical mapping) would be beneficial in confirming site specific hazards, gas pipelines built according to international standards are generally resilient to moderate levels of ground shaking expected in South Africa.

Given that South Africa is low seismic hazard region and providing that the recommended design and management actions are effectively implemented in areas prone to landslides and/or characterised by problem soils, risks posed by primary or secondary effects of earthquakes are considered to be low for the development of a gas pipeline within the proposed corridors.

Based on the above, all the proposed gas corridors are deemed suitable for the Phased Gas Pipeline Network development as far as the risk posed by earthquakes is concerned. In must be noted that earthquake risk should not be seen in isolation. The risk posed by other natural hazards, such as floods and non-seismic landslides should also be considered.

Additional Best Practice Measures and Monitoring Recommendations are provided in Section 5 of the Seismicity Assessment.

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.3

Settlement Planning, Disaster Management and related Social Impacts

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ABBREVIATIONS

ALARP	As Low as Reasonably Practicable
CSIR	Council for Scientific and Industrial Research
IDP	Integrated Development Plan
IDZ	Industrial Development Zones
SDF	Spatial Development Framework
SEA	Strategic Environmental Assessment
SEZ	Special Economic Zones
Stats SA	Statistics South Africa

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.3 Settlement Planning, Disaster Management and related Social Impacts

4.2.3.1 Introduction

The Settlement Planning, Disaster Management and related Social Impacts Assessment Report (Appendix C.3 of the Final Gas Pipeline SEA Report) aimed to identify key social, settlement planning and development considerations relevant to the development of the gas pipelines within the assessed corridors, and to outline the various parties that need to be involved in disaster management as part of the proposed gas transmission pipeline operations.

This study should be read in conjunction with the chapter on Agriculture (Part 4.2.4 of this Final Gas Pipeline SEA Report) which includes the identification of existing agricultural resources and agricultural potential within the proposed gas pipeline corridors and potential impacts associated with the development of gas transmission infrastructure.

4.2.3.2 Scope of the Assessment

The study assessed potential impacts that the construction of a gas transmission pipeline within the proposed corridors may have on the livelihoods of communities, including well-being in local communities and safety hazards, temporary construction related job creation, disruption of population and service delivery. The alignment planning, servitude demarcation and construction of the gas pipeline will have wide-ranging impacts on settlement and development fabric in all parts of the corridors and can potentially impact land development, town growth and sustainable regional and settlement development. The study therefore also examined implications related to urban development and spatial planning, effects of the construction of a gas transmission pipeline on land use management (land use application, servitude proclamation and the required changes to land use schemes, if and where applicable, risks of resettlement, and development pressure). The assessment also considered the anticipated complexities where the gas transmission pipeline would cross land on communal tenure (tribal authority areas). It must be re-iterated that each phase will only be developed based on its own business case, as well as whether there is a guaranteed source of gas and confirmed off-taker. Furthermore, given that the operational servitude of the pipeline (if constructed) will span only 10 m wide, it is highly unlikely that the entire population within a corridor would be affected by the gas pipeline development.

Although ruptures of gas transmission pipelines are relatively rare, impacts on surrounding communities in such an unlikely event may be catastrophic. Safety and disaster management are therefore key aspects of gas transmission pipeline planning and operations. Disaster Management, in the South African context, and the capability of public institutions to anticipate, prevent, manage, and mitigate potential gas-related disasters are therefore also considered in the assessment. National, provincial and municipal governments need time, funding, staff and skills to develop disaster management capacity. In South Africa, municipalities vary from highly effective and resourced, to very under-capacitated. Very often, under-capacitated municipalities will require sustained guidance and assistance.

The assumptions and limitations applicable to the assessment are captured in Section 3.4 of the Settlement Planning, Disaster Management and related Social Impacts Assessment Report (Appendix C.3 of the Final Gas Pipeline SEA Report).

4.2.3.3 Spatial Data and Approach

The analysis made extensive use of data resources listed in Table 1.

Table 1: Available Spatial Data used in the Settlement Planning, Disaster Management and related Social Impacts Assessment Report.

Date Title and Source	Data Description
Council for Scientific and Industrial Research (CSIR) Functional Town Areas, 2018 (CSIR, 2018)	▪ This includes a set of settlements or settlement areas classified largely on the basis of economic and demographic information.
Settlement Footprint Layer, 2017 (CSIR, 2017)	▪ This was used to provide a more accurate extent of the built up footprints of South Africans settlements.
Demographic information, disaggregated. Base Sources: Statistics South Africa (Stats SA), 2011, Quantec, 2016. Spatial specific indicator: CSIR, Meso-frame Socio-Economic Indicators, 2017	▪ This consists of a series of datasets from various sources as indicated. Socio-economic data from these different sources were re-assigned to the relevant analysis units, e.g. mesozones or settlement footprints.
Economic information disaggregated. Base source: Quantec, 2016. Spatial indicator: CSIR, Meso-frame Socio-Economic Indicators, 2017	▪ The information was processed/assigned to the relevant analysis units.
Major initiatives with potential impact on growth. This includes plans and development frameworks.	▪ This includes a range of official sector and/or provincial and/or State Owned Enterprise (SOE) plans and development frameworks.
Various municipalities' annual reports submitted to National Treasury (accessed online).	▪ These include annual reports submitted by local municipalities to the National Treasury.

With regards to **preparedness of municipalities in terms of Disaster Management**, according to the Disaster Management Plan (2002) and the Amendment Act (2015), each metropolitan, district and local municipality must establish capacity to respond to disasters they are exposed to. A disaster is considered to be a pipeline incident that causes a serious disruption, occurring over a relatively short time, of the functioning of a community or a society involving widespread human, material, economic or environmental loss and impacts, which exceeds the ability of the affected community or society to cope using its own resources. The fire-fighting capabilities of the affected municipalities were considered as a proxy for the Disaster Management preparedness of a municipality and, where available, were reviewed as part of this study. The following procedure was undertaken to determine a basic profile of strengths and weaknesses of the various affected municipalities in terms of disaster management preparedness:

- The following website: www.municipalities.co.za (hosted by National Treasury) was used as the key source of information.
- The latest municipal annual reports that are required to be submitted to National Treasury were consulted.
- Where annual reports were unavailable or incomplete, municipal Integrated Development Plans (IDPs) were consulted. However, IDPs generally focus on future goals and targets and do not often provide actual status quo information. In addition, in some cases IDPs were also not available.
- Where comparable information was available, the following data was extracted, as indicators of municipal preparedness, which was ranked from "marginal" to "good":
    - Their status as "main" or "satellite" fire-fighting offices.
    - Number of fires and incident call-outs.
    - Number of fire fighters, disaster management volunteers and volunteers.
    - Number of vacancies (unfilled posts).
    - Number of "appliances" (vehicles and specialised equipment).
    - The repairs expenditure, to show municipal commitment to Operations and Maintenance.

4.2.3.4 Key Features and Attributes

Of the 35.7 million population within the Draft Refined Corridors, about 23.62 million live in large metropolitan areas (Cape Town, eThekwini, Gauteng and Nelson Mandela Bay), cities and large regional service centres (big towns), about 4.5 million live in medium and large towns, and about 1.45 million live in small towns. Figure 1 provides an illustration of the population size and growth characteristics of the local municipalities that fall within the Draft Refined Gas Pipeline Corridors.

Whilst these mostly constitute high density formal and informal settlement areas, the bigger city and town areas also constitute a significant number of traditional settlement areas which have the additional complexity of traditional or communal land tenure issues that need to be considered (Figure 2). Within the major metropolitan areas and cities, and large regional towns, more than 1 million people are actually living on traditional settlement land areas. More than 6 million people live in dense rural settlements in the study area, of which the majority are settlements under traditional authority jurisdiction, largely in the east coast corridor area (shown in green in Figure 2).

On a district level (including metropolitan municipalities), the majority of the municipalities were found to have a good to fair Disaster Management preparedness currently in place (Figure 3). At a local municipality level however, the majority of the municipalities were determined to have a "marginal" rating or no information was readily available (Figure 4). The Disaster Management preparedness is an important component of disaster management and would require upfront consultation and plans to ensure that the Disaster Management functions are properly determined and the municipalities adequately capacitated to manage potential disasters.

Table 2 provides a summary of the population, development intensity, land tenure and management, disaster management preparedness within the assessed corridors.

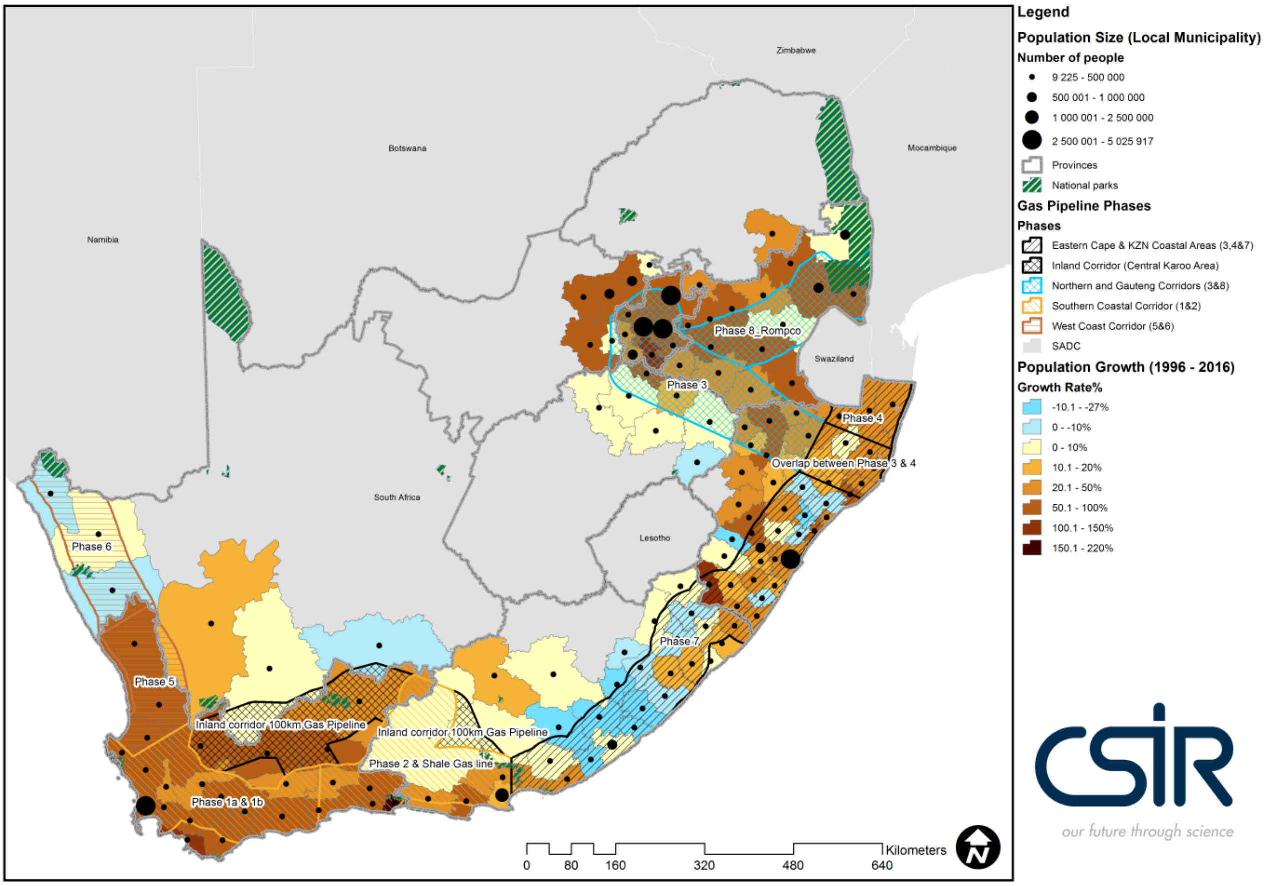


Figure 1: Population number and growth characteristics of local municipalities within the Draft Refined Gas Pipeline Corridors (Source: StepSA Town Area Typology, 2018).

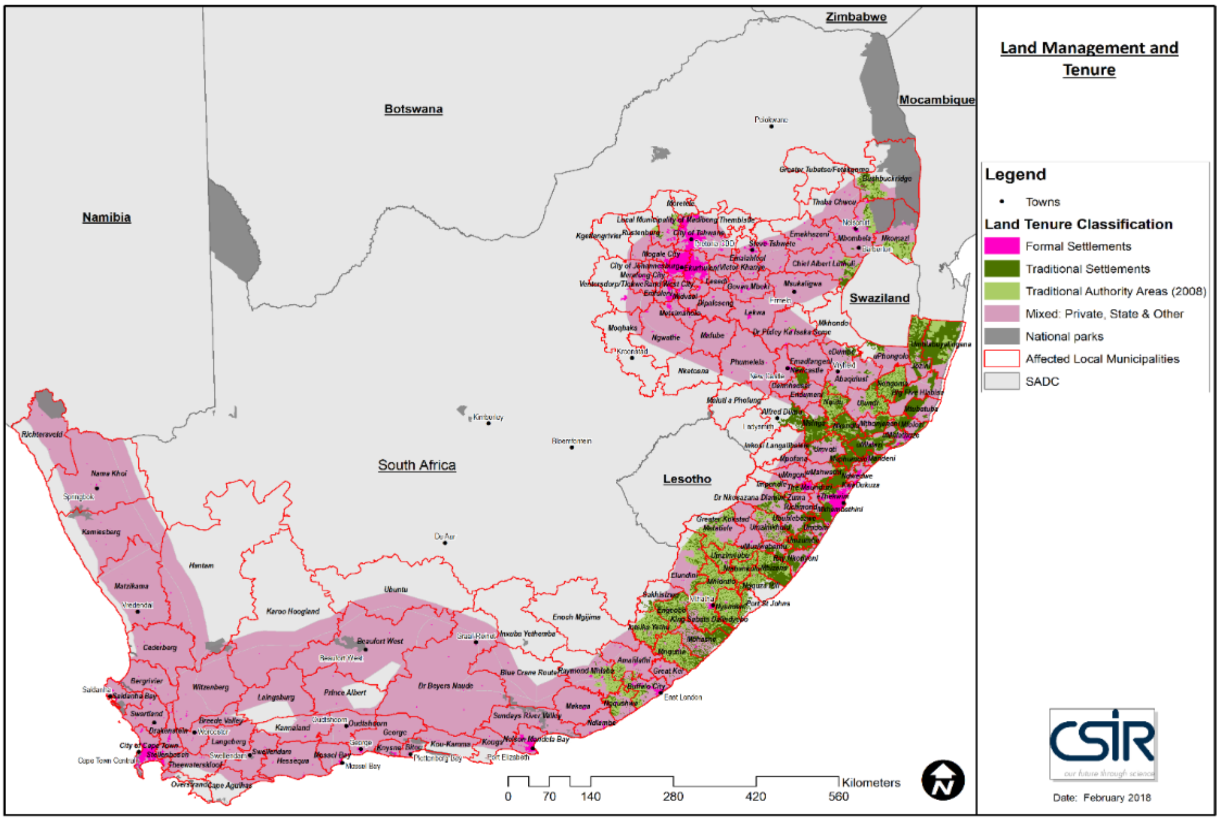


Figure 2: Land management and tenure in the Draft Refined Gas Pipeline Corridors (Source: StepSA Town Area Typology, 2018).

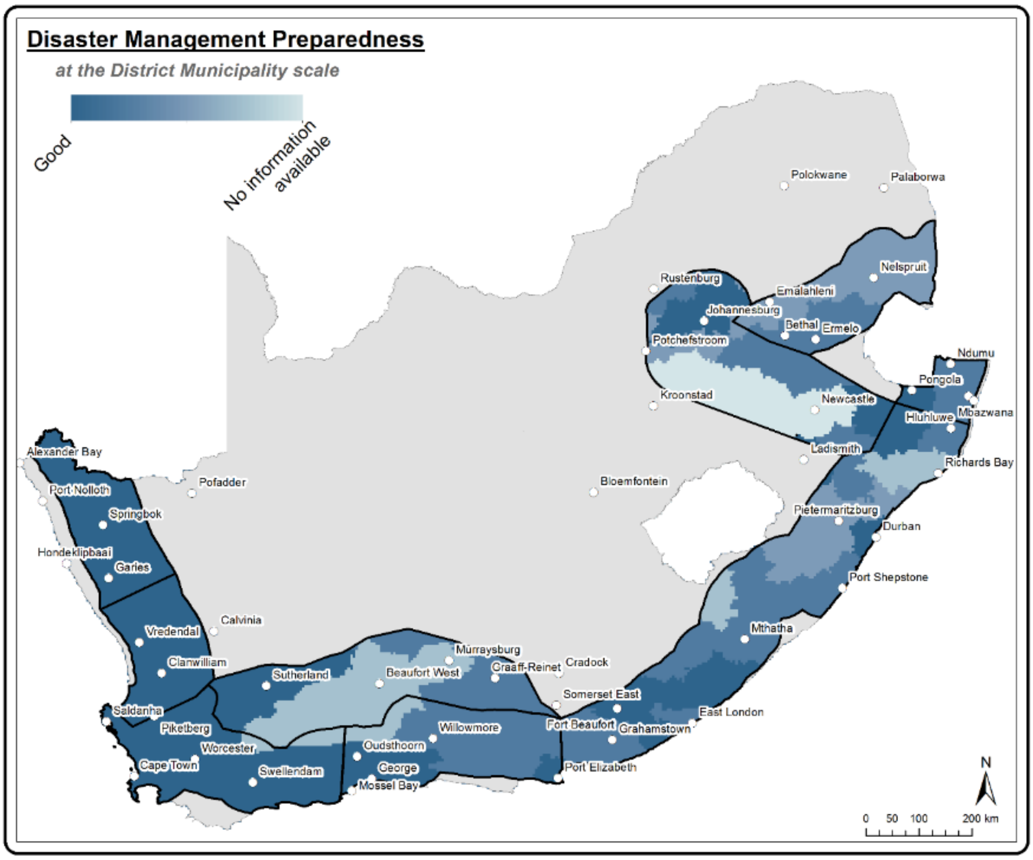


Figure 3: Disaster Management Preparedness of District Municipalities within the Draft Refined Gas Pipeline Corridors.

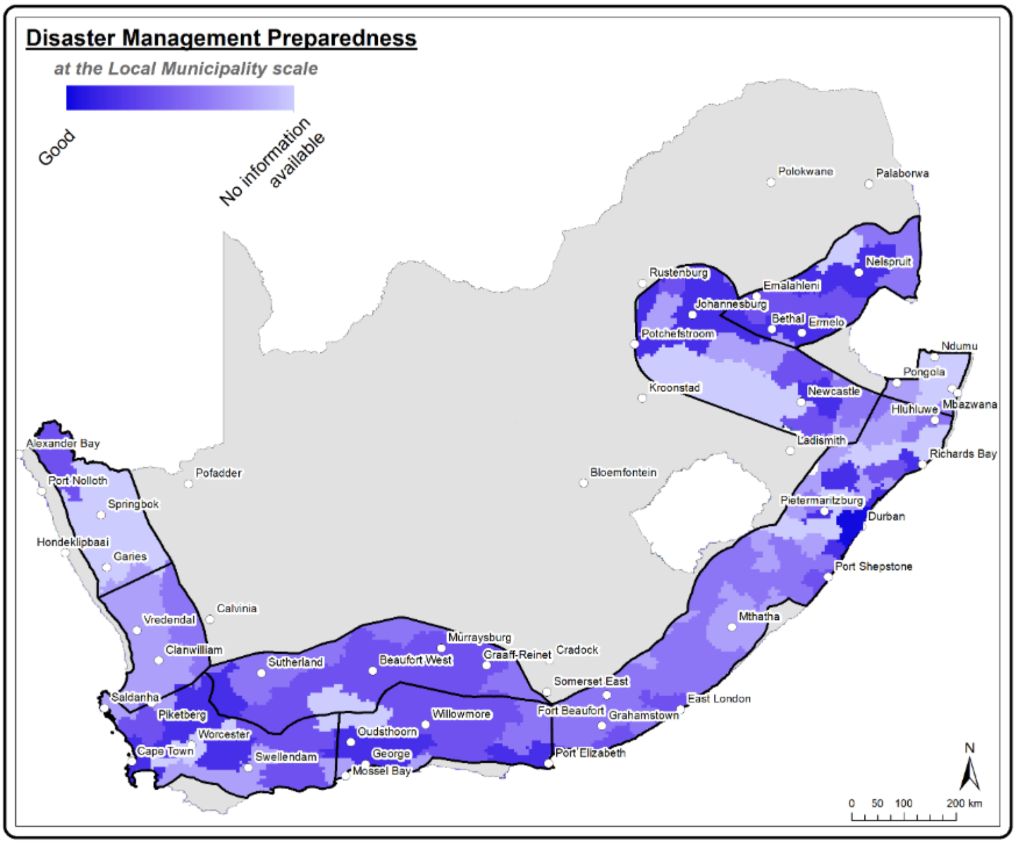


Figure 4: Disaster Management Preparedness of Local Municipalities within the Draft Refined Gas Pipeline Corridors.

Table 2: Summary description of the Draft Refined Gas Pipeline Corridors in terms of population, development intensity, land tenure and management, disaster management preparedness.

Date Title and Source	Data Description
West Coast Corridor (Phases 5 and 6)	▪ These areas are characterised by small towns surrounded by arid and semi-arid areas and are the most sparsely populated and also declining in population. Areas within Phase 5 are mostly mixed economy while Phase 6 is mostly dependent on Government sector and services. ▪ The majority of the district and local municipalities that fall within these corridors have good to fair fire-fighting capabilities currently in place.
Southern Coastal Corridor (Phases 1 and 2)	▪ It includes the major metropolitan areas of Cape Town, the Winelands district and the southern coastal towns and Garden Route tourism corridor featuring a large number of towns and major economic infrastructure. ▪ It also includes the large parts of the Eastern Cape Province Coastal areas including Nelson Mandela Bay Metropolitan. ▪ Areas within Phases 1 and 2 are mostly mixed economy. The area is also a very productive farming area, along the coastal plain between Cape Town and Port Elizabeth, also important tourist areas, and national parks etc. ▪ Various fire-fighting capabilities exist within these corridors depending on the district and local municipality being considered. Most of the district municipalities within the southern coastal corridors have good fire-fighting capabilities currently in place. Thirteen of the affected local municipalities (approximately 50%) have a 'fair to good' rating. The remainder of the local municipalities either do not have suitable fire-fighting capabilities currently in place or no information in terms of fire-fighting was readily available during this assessment.
Inland Corridor (Central Karoo)	▪ This area is characterised by low density semi-arid farmland interspersed with small towns and rural villages. The area is the subject of Shale Gas exploration, which may have a major impact on settlement growth and development in future. The northern section of the inland corridor is sparsely

Date Title and Source	Data Description
	populated and also declining in population. The economy is highly dependent on Government sector and services. ▪ Within the Inland corridor, various levels of fire-fighting capabilities exist, depending on whether district or local municipalities are being considered.
Eastern Cape & KZN Coastal areas (Phase 7, Phase 3 and 4 overlap, Phase 4, and part of Phase 3)	▪ These corridors extend from the Eastern Cape along the N2 highway through the former homeland areas of Ciskei and Transkei, which are areas of tribal land authority and communal ownership into KwaZulu-Natal. Phase 4 extends from St Lucia all the way up to the South Africa – Mozambique border. This area includes the eThekwini Metro, East London, Richards Bay and Mthatha as well as extensive areas of dense rural settlement. The traditional areas are home to some of the most disadvantaged people in the country. Parts of the eastern section (Phase 7) are however sparsely populated (declining in population). The economy is highly dependent on Government sector and services. ▪ The majority of the local municipalities within these corridors have a ''marginal" rating in terms of fire-fighting capabilities currently in place. In terms of district municipal capabilities, 50% of the affected municipalities within these corridors have a good or fair fire-fighting capability.
Northern and Gauteng Corridor (Phases 3 and 8)	▪ Phase 3 includes the Gauteng City region and extends southward to eThekwini and Phase 8 extends west from the border of Gauteng, across Mpumalanga and ends at the Mozambique border. The area is densely developed in terms of population, economy and infrastructure; and land management issues are likely to be highly complex. The corridors also include areas under tribal authority jurisdiction. Areas within Phases 3 and 8 are mostly mixed economy. ▪ Approximately 50% of district municipalities potentially affected within these corridors have a good to fair rating in terms of fire-fighting capabilities. The fire-fighting capability currently in place in the local municipalities varies largely across the corridors and do not correlate with the capability of the district municipality which contains them.

Figure 5 provides an overview of key new infrastructure (rail and road) within the Draft Refined Gas Pipeline Corridors based on a review of development projects contained in available Provincial Growth and Development Strategies (January 2018). However, relevant local and provincial plans must be reviewed for each sector during the pipeline planning stage in order to consider other developments at the time.

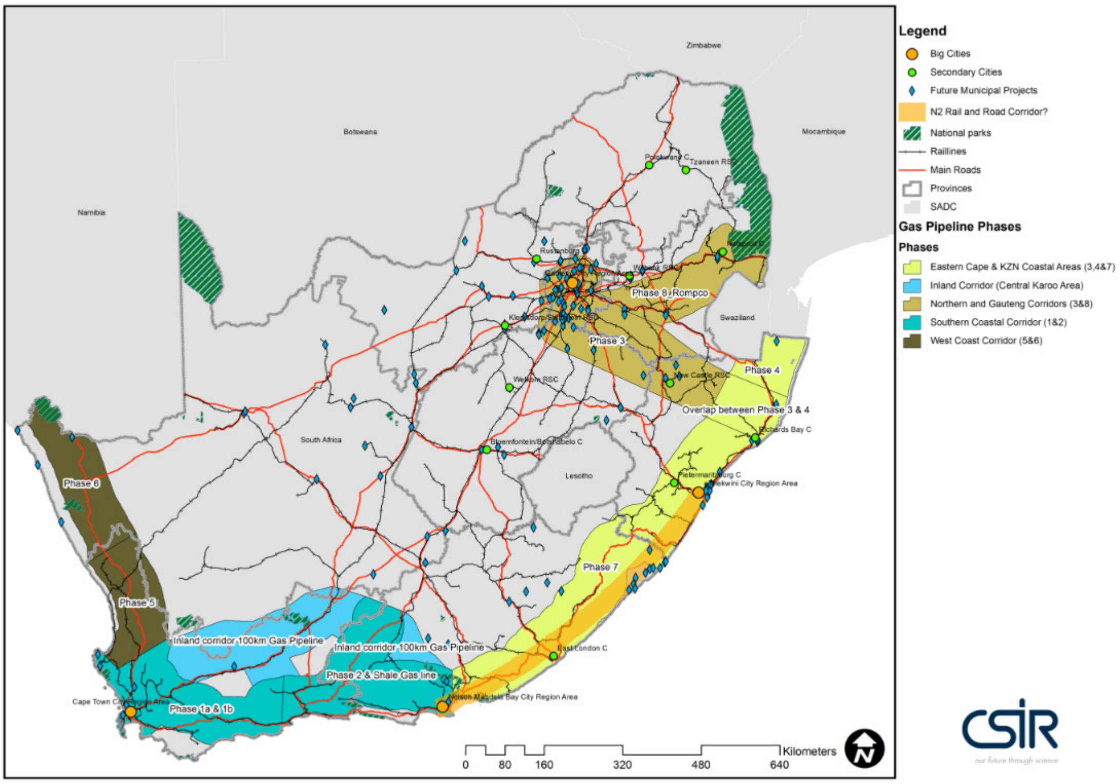


Figure 5: Road and rail infrastructure and planned municipal projects in the Draft Refined Gas Pipeline Corridors.

4.2.3.5 Sensitivity Criteria and Mapping

The sensitivity towards to the construction and operation of gas transmission pipelines has been assessed with the following three key components of the built environment:

- **Sensitivity in terms of population density**: This includes the number of people, households and dwellings affected. Due to the potential impact of construction and/or potential safety hazards related to the gas transmission pipeline construction and operation on lives and livelihoods of people within the proposed identified corridors, the areas of high population density are foreseen as highly sensitive in relation to the planned gas transmission pipeline. These specifically include cities, large coastal and inland towns and other densely settled areas.

- **Sensitivity in terms of development intensity and extent**: This includes settlement development and economy extent, size and complexity. Settlement and development nodes play critical roles as:
    - Dense clusters of complex socio-economic and ecological systems providing access to housing, services and livelihood opportunities;
    - Anchors in local and regional economies through agglomeration benefits for social and economic functions;
    - Provision of centralised social services within the broader areas; and
    - Infrastructure nodes within transport, trade, service delivery and engineering service networks.

- **Sensitivity in terms of land-use management and tenure**: This includes the complexity of the land ownership issues in different parts of the proposed gas pipeline corridors. The key characteristic of this component is the number of impacted land holders and municipal authorities that would be involved in land negotiation.

An overall sensitivity map for spatial and development planning, taking into consideration the three above criteria, is shown in Figure 6 below.

Areas of high population density are foreseen as highly sensitive in relation to exposure to the planned gas transmission pipeline. These specifically include cities, large coastal and inland towns and other densely settled areas. Settlement and economic development nodes play critical roles and are therefore also regarded as highly sensitive (in terms of social and planning related impacts). Economic development nodes (such as Industrial Development Zones (IDZ), Special Economic Zones (SEZ) etc.) are however also regarded as areas of future development, which could benefit from the availability of gas and were taken into consideration when finalising the alignment of the proposed corridors. High levels of sensitivity related to institutional and land-use management and development of regulatory systems are foreseen in cities and large towns due to the number of landowners and municipal authorities that would be affected. Lower levels of sensitivity are foreseen in sparsely populated areas and in small towns.

Table 3 summarises the overall sensitivity within the draft refined corridors towards the development of gas transmission pipeline infrastructure.

Table 3: Overall sensitivity of the Draft Refined Corridors towards the development of gas transmission pipeline infrastructure.

Date Title and Source	Data Description
West Coast Corridor Phase 5 and 6	▪ The majority of this corridor has a low overall sensitivity as there are no areas of communal tenure and no large urban areas or areas of extensive economic activity. Commercial farmland covers the largest extent of the low sensitive areas. The corridor also contains some National Parks. There are a few areas of medium level sensitivity in a small number of towns with medium or dense population. These towns cover less than 5% of the area.
Southern Coastal Corridor Phase 1 & 2	▪ In these corridors, the highest levels of sensitivity are within the greater Cape Town City Region area and around the coastal cities and medium sized service towns, which have high populations and intensive development and economic activity. The low sensitivity areas in the corridors are dominated by sparsely populated commercial farmland.
Inland Corridor (Central Karoo)	▪ In this corridor the highest sensitive areas are dominated by the medium sized service towns which include Beaufort West, Laingsburg and Prince Albert as well as smaller settlements like Nelspoort. These towns cover less than 1% of the area. The remainder of the area is of low sensitivity. Commercial farmland covers the largest extent of the low sensitive areas.
Eastern Cape & KZN Coastal areas (Phase 7, Phase 3 and 4 overlap, Phase 4, and part of Phase 3)	▪ These corridor sections have concentrations of very high sensitivity due to the large cities with high population and intensive economic development, which include the greater eThekwini - Pietermaritzburg City Region area, Richards Bay urban complex, large, densely populated service towns and the coastal settlement corridors. It also has extensive areas of moderate sensitivity due to the extent of the densely settled rural areas, which are mainly within traditional authority areas. The low sensitivity areas are a mixture of sparsely populated state and privately owned land and commercial farmland.
Northern and Gauteng Corridor Phase 3 and 8	▪ In the Phase 3 and 8 corridors, the very high sensitive areas are dominated by densely populated and intensively developed economic zones comprising the Gauteng City Region and larger cities. There are also areas of moderate sensitivity characterised by dense population settlements in areas under tribal authority jurisdiction. In all these areas, land rights and land management issues are likely to be highly complex. The low sensitivity areas are a mixture of sparsely populated state and privately owned land and commercial farmland.

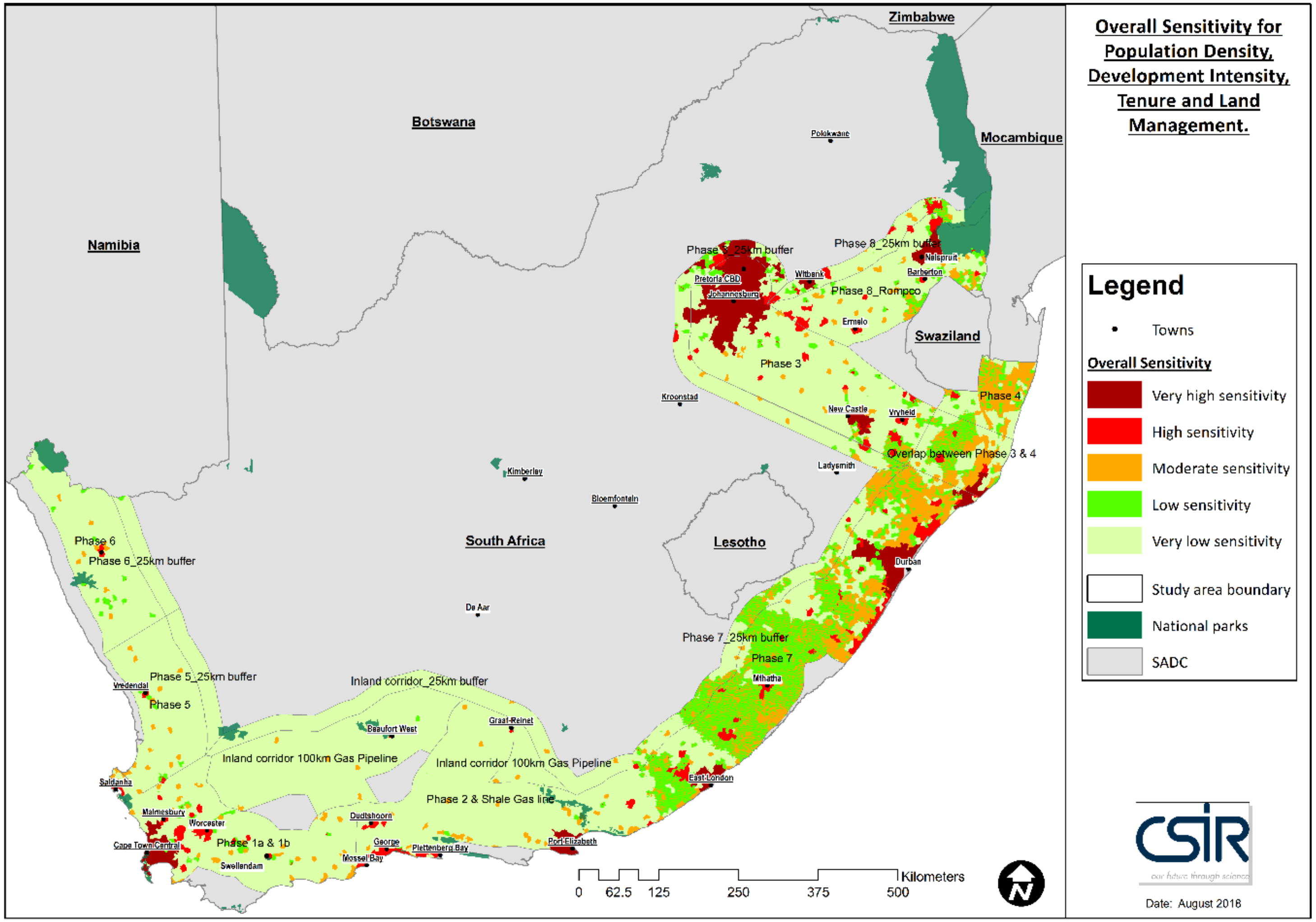


Figure 6: Combined overall sensitivity for Population Density, Development Intensity, and Tenure and Land Management in relation to proposed gas pipeline development.

4.2.3.6 Potential Impacts and Mitigation

Construction of a gas transmission pipeline has the potential to cause substantial disruption to lives and livelihoods should it be constructed within (or proximal to) existing or future settlements. Negative impacts of a gas transmission pipeline may manifest in land-use management implications (e.g. alienation of existing land uses making these uses untenable), tenure management considerations (i.e. number of landowners and municipal authorities affected), the potential need for resettlement, restriction in future development potential of a parcel of land and negative impacts on service delivery and local economies. With the implementation of the appropriate management actions, most of the potential impacts on lives and livelihoods are expected to be low risk. The following two impacts, however, were rated as a Very High/High risk with the implementation of mitigation measures:

- Disruptive impact on businesses contributing to the local economy during construction in very high sensitivity areas (High Risk); and
- Resettlement and relocation/displacement impacts in very high sensitivity areas (Very High Risk) and high sensitivity areas (High Risk).

While pipelines are generally the safest method of transporting hazardous chemicals, product releases (leaks or ruptures), if such releases occur, may constitute a safety risk for the surrounding community during the operational phase. It is thus imperative that careful, coordinated and integrated planning must take place when considering the development of a gas transmission pipeline. A pipeline incident can result from the operation of the gas pipeline system itself (e.g. aging, corrosion etc.), natural disasters or from a human error (e.g. breakages or pipeline strikes during maintenance work on other infrastructure).

Furthermore, it is assumed that various factors will influence the magnitude of the incident such as vulnerability (of the affected people or the environment), the hazard (rupture, fire or explosion) and the capability to respond to it (access to suitable resources). A single incident could escalate to a “disaster” and have major impacts through loss of life, possibility of injuries or environmental impacts, due to high operating pressures and large volumes of escaping gas, causing an explosive atmosphere. Pipeline incidents and disasters have specific management requirements.

Safety and disaster management are critical matters for the pipeline operators themselves, but also for public agencies such as the local fire departments who are often the first responders in disasters, and have to manage subsequent impacts and recovery processes. Disaster management, therefore, requires collaboration between public agencies and private-sector pipeline developers and operators. It is critical that such collaboration is built up and sustained long before any incidents occur. Institutional relationships also need to be clarified before disasters happen. Very often, disasters are accompanied by conflict and confusion regarding the hierarchy of decision-making. This causes delays in disaster management interventions and recovery activities. Recovery management is a complex and often expensive phase, requiring several public agencies. It may also be important to reassure and empower communities about future safety precautions and the role that they can play to manage a pipeline disaster.

Overall, the West Coast and Southern Coastal Corridors have a good to fair fire-fighting preparedness currently in place. In contrast, municipalities within the Inland Corridor, Eastern Cape and KwaZulu-Natal Coastal areas, and the Northern and Gauteng Corridors will need to address disaster management preparedness prior to the commissioning of a gas transmission pipeline. It is expected that health and safety impacts related to potential incidents (gas leaks) be a low risk with the effective implementation of recommended mitigation measures.

Table 4 is a summary of the impacts considered and assessed in the Settlement Planning, Disaster Management and related Social Impacts Assessment Report, as well as the key mitigation measures.

Table 4: Summary of Key Impacts assessed in the Settlement Planning, Disaster Management and related Social Impacts Assessment.

Impact	Management Action
Spatial and development planning, and land use management	
Land-use management and tenure implications	▪ Major sensitivity in dense rural settlements and communally owned land should be avoided. ▪ Timeous negotiations and detailed studies must be undertaken to minimise negative impact in vulnerable communities especially in traditional authority areas
Resettlement and relocation/ displacement impacts	▪ Accepted international best practice requires that involuntary resettlement be avoided where possible. If this is not possible the number of people affected should be minimised. The key mitigation measure therefore involves siting of transmission pipelines so as avoid the need for resettlement.
Impact on the location options of new developments	▪ At time of planning a section of the proposed gas transmission pipeline, the developer must verify growth direction of nearby settlements as well as existing and approved township development applications and land use rights. New development areas indicated in Spatial Development Frameworks (SDFs) and applicable municipal infrastructure masterplans must also be taken into consideration. ▪ The pipeline design would need to be carefully considered together with relevant design and building standards should it be constructed in the vicinity of higher density population areas and economic nodes such as eThekwini, Cape Town, Nelson Mandela Bay and Gauteng.
Impacts on property values	▪ Ensure a fair compensation process is implemented by the developer. ▪ Avoid high value land uses (luxury estates, high end game farms etc.) where possible.
Impact on livelihoods and communities	
Disruption of population livelihoods due to construction activities as well as impacts on service delivery and local economies during construction	▪ Avoidance of sensitive areas: o Avoidance of built-up areas in identified cities and functional city region areas. o Avoidance of functional areas around identified service towns and rural service settlements recommended. o Avoidance of high density population and economic nodes within the bigger Cape Town city region area for bulk pipelines. ▪ Where avoidance of a populated area is not possible, the following management measures need to be put in place: o Detailed route design considering existing and planned land use and developments to minimise impact on people and livelihoods as far as possible. o Consult and inform the stakeholders. o Ensure agreed time frames are respected. o Ensure alternative access to properties is identified. o At the time of construction, ensure that clear access to public facilities and public transport is maintained (e.g. detour less than 500 m (walking distance)), as well as clear 24 hour access to emergency services.).
Impacts associated with project workers/workforce	▪ Ensure all engagement, management and communication with workers are in line with the requirements stipulated by the Department of Labour. Labour management measures that fall within the ambit of the Department of Labour include employment contracts, working hours, minimum wage, working clothing and compensation for occupational injuries and diseases. ▪ Develop a Code of Conduct for the construction/maintenance phase. The code should identify which types of behaviour and activities are not acceptable, such as trespassing, hunting, stock theft etc.
Disaster Management	
Health Risks associated with a gas transmission pipeline leak,	▪ Undertake a metre by metre risk assessment over the entire length, ensuring that all threats are eliminated or at least minimised such that

Impact	Management Action
rupture or fire. Minor leak/small fire, large leak/fire requiring specialist fire-fighting, and major leak/large fire/impact on other critical infrastructure are considered.	risk of leak/rupture of the pipeline is avoided or at least reduced to As Low as Reasonably Practicable (ALARP); ▪ Ensure that pipelines located in high population density areas or areas requiring high levels of protection for the public, are designed to leak rather than break (full bore rupture) in the event of an incident, e.g. if impacted, for example, by an excavator, or if some material failure occurs; and ▪ Ensure that pipelines are designed and built according to international standards and based on the surrounding land-use. ▪ Ensure that infrastructure masterplans are available to relevant authorities to guide maintenance workers.
Preparedness in responding to a disaster	▪ Ensure a sustained collaboration between public agencies and private-sector pipeline developers and operators ▪ Ensure that the Disaster management teams are adequately trained and regular drills undertaken to ensure that the correct procedures are known. ▪ During a pipeline-related disaster, the key strategies that apply to all natural gas emergencies are to establish command and a safe staging area, secure the scene, evacuate at-risk occupants and bystanders, effect viable rescues, eliminate ignition sources, and co-operate with the local utility company.

Mitigation measures are described in detail in Section 7 of the Settlement Planning, Disaster Management and related Social Impacts Assessment Report; with detailed Best Practice Recommendations provided in Section 8.

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.4

Agriculture

CONTENTS

TABLES

MAPS

ABBREVIATIONS

ARC	Agricultural Research Council
CARA	Conservation of Agricultural Resources Act (Act 43 of 1983)
DAFF	Department of Agriculture, Forestry and Fisheries
EGI	Electricity Grid Infrastructure
EMPR	Environmental Management Programme
PDALB	Preservation and Development of Agricultural Land Bill
SACNASP	South African Council for Natural and Scientific Professions
SALA	Subdivision of Agricultural Land Act (Act 70 of 1970)
SEA	Strategic Environmental Assessment

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.4 Agriculture

4.2.4.1 Introduction and Scope

This chapter covers the potential impacts on agriculture associated with the development of a gas pipeline within the proposed corridors. The approach to the sensitivity analysis and the assessment of impacts relating to agriculture as part of this Strategic Environmental Assessment (SEA) is similar to that undertaken for the 2016 Electricity Grid Infrastructure (EGI) SEA (DEA, 2016[1]) considering the similar linear nature of the projects.

The subsequent sections are therefore predominantly based on the Agriculture Assessment undertaken as part of the 2016 EGI SEA (DEA, 2016), which was desktop based and focused mainly on the interpretation of existing data (Appendix C.1 of the 2016 EGI SEA Report). In addition to being based on the latter assessment, this section is also informed by discussions with relevant authorities (such as the Department of Agriculture, Forestry and Fisheries (DAFF) and the Agricultural Research Council (ARC)) and an Agricultural Specialist (Johann Lanz). It includes the identification of existing agricultural resources and agricultural potential within the proposed gas pipeline corridors.

The data sources and the rationale used to identify agricultural features and assign a sensitivity to each of them are described in sections 4.2.4.3 and 4.2.4.5 respectively. The assumptions and limitations applicable to this study are listed in Table 1.

Table 1: Assumptions and Limitations to the Agricultural Study

Limitation	Included in the scope of this study	Excluded from the scope of this study	Assumption
Resource availability	Only existing, published datasets used with limited desktop verification	Field verification of datasets and outcomes, and extensive local expert consultation	Reasonable accuracy of data layers used. Field verification will take place on a site by site basis linked to development proposals.
Data accuracy	Use of existing data sets only.	Confirmation of on the ground situation in cases where data sets overlap	Areas of overlap with field crop boundaries and plantations were categorised as the former because of the greater accuracy of those data sets compared to the forestry data set.

4.2.4.2 Relevant Legislation

The following legislation is considered relevant to the proposed gas pipeline development:

- The Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA):
    - The objective of this Act is the protection of natural agricultural resources including soils. The Act applies to all agricultural land (grazing and cultivated). It manages rehabilitation after disturbances to agricultural land. Any disturbance to soil conservation works such as contour banks requires permission in terms of this Act.

[1] Department of Environmental Affairs, 2016. Strategic Environmental Assessment for Electricity Grid Infrastructure in South Africa. CSIR Report Number: CSIR/02100/EMS/ER/2016/0006/B. Stellenbosch.

- Subdivision of Agricultural Land Act (Act 70 of 1970) (SALA):
    - The objective of this Act is the preservation of agriculturally viable farm portions. Consent use or change of land use (re-zoning) for developments on agricultural land need to be approved in terms of this Act. This means that any servitude or use of an agriculturally zoned piece of land for non-agricultural purposes requires approval from the DAFF in terms of the SALA.

- DAFF Guidelines for the Evaluation and Review of Applications pertaining to Renewable Energy on Agricultural Land, dated September 2011:
    - These guidelines were compiled with the main objective of the preservation of arable land through prohibition of the development of renewable energy facilities (wind and solar) on cultivated and high potential agricultural land. These guidelines were not produced to be applicable to linear infrastructure such as pipelines, but may have some relevance in terms of DAFF's general concerns about loss of agricultural land.

- Draft Preservation And Development Of Agricultural Land Framework Bill
    - This Act, once promulgated, will repeal SALA and replace the DAFF Guidelines noted above. The Bill seeks to improve DAFF's fulfilment of its mandate to protect agricultural land for agricultural production. One of its aims is to ensure that development does not lead to an inappropriate loss of land that may be valuable for agricultural production. Any use of agricultural land for non-agricultural purposes will require authorisation in terms of this Act.

4.2.4.3 Data Sources

The list of updated data used in this current Gas Pipeline SEA is indicated in Table 2 below.

Table 2: Agricultural Data used in the Gas Pipeline SEA as part of the Environmental Sensitivity Analysis

Dataset	Source and Date of Publication	Data Description
Field Crop Boundaries	DAFF, 2017	Delineates the boundaries of all cultivated land, based on satellite and aerial imagery. Five different categories of cultivated land are distinguished. These are irrigated areas (pivot agriculture); horticulture; viticulture; shadenet; and other cultivated areas.
National Land Cover and Habitat Modification Layer (improved land cover)	DEA, 2013/2014 SANBI, 2017	Delineates natural areas, modified areas, and old fields (mapped from imagery)
Land Cover (Sugar Cane Farming) KwaZulu-Natal Land Cover Sugar Cane Farming and Emerging Farming Data	KZN Provincial land cover, Ezemvelo KZN Wildlife, 2011	Delineates all sugar cane fields, including emerging farmers in Kwazulu-Natal.
Land Cover (Viticulture)	Western Cape DEADP (Cape Nature), 2014.	Raster data indicating viticulture as a land cover category.
Agricultural Land Capability	DAFF, 2016	Categorises all land nationally into 15 different classes of agricultural land capability. The classification is based on soil, terrain and climate parameters.
Demarcated High Value Agricultural	DAFF, outstanding	Preservation and Development of Agricultural Land Bill (PDALB) requires the demarcation of high value agricultural areas, which is a combination of land capability; crop suitability, agricultural land uses etc. on a priority rating of A, B, C and D (not yet released).

4.2.4.4 Corridor Descriptions

This section describes the main characteristics of each section of the proposed phased gas pipeline corridors. Refer to Maps 1 and 2 for an indication of the type of Field crops and land capability classes within the various corridors.

- Phase 1:

There is diverse and productive agriculture across the Phase 1 corridor. The most important agricultural enterprises are deciduous fruit and wine and winter small grains (wheat). The corridor is a winter rainfall area. Mean annual rainfall varies between approximately 600 mm and 150 mm in the drier northern parts, although much higher rainfall occurs in the mountainous areas. Grazing capacity varies from 6 hectares per large stock unit on the southern coast to 54 in the north and even lower (to 108) in some of the mountainous areas. Land capability varies from 1 in mountainous areas to as high as 10 near Cape Town and in the Boland.

- Phase 2:

There is diverse and productive agriculture across the southern part of the Phase 2 corridor, but the northern part is constrained by arid conditions. The most important agricultural enterprises are cattle and dairy, deciduous fruit and vegetables. The northern part is restricted to sheep farming. The corridor is predominantly a winter rainfall area. Mean annual rainfall varies from > 1000 mm along the coastal mountains to approximately 180 mm in the drier northern parts. Grazing capacity varies from 6 in the east to 60 hectares per large stock unit in the west and even lower (to 140) in some of the mountainous areas. Land capability varies from 1 in mountainous areas to as high as 11 along the southern coast.

- Phase 3:

There is productive agriculture across the Phase 3 corridor. The most important agricultural enterprises are maize and cattle. The corridor is a summer rainfall area. Mean annual rainfall varies between approximately 550 in the west and 1000 mm in the east. Grazing capacity is high and varies mostly between 3.5 and 7 hectares per large stock unit, although it is as low as 20 in small parts in the west. Land capability is mostly greater than 8 and goes up to 12, although in some isolated areas it drops as low as 2.

- Phase 4:

The Phase 4 corridor is not a highly productive agricultural area. The most important agricultural enterprises are cattle in the southern parts, with subsistence farming in the north. There is some forestry in the north-west. The corridor is a summer rainfall area. Mean annual rainfall varies between approximately 500 and 1000 mm. Grazing capacity is high and varies between 4 and 20 hectares per large stock unit. Land capability is mostly greater than 8 and goes up to 10, although in the more mountainous terrain it drops as low as 2.

- Phase 5:

There is diverse and productive agriculture across the southern part of the Phase 5 corridor, but the northern part is constrained by arid conditions. The most important agricultural enterprises in the south are citrus fruit, table grapes, and winter grains. The northern part is restricted to sheep farming. The corridor is a winter rainfall area. Mean annual rainfall varies between approximately 400 mm in the south and 150 mm in the north. Grazing capacity is low and varies from 28 hectares per large stock unit to 75 and even lower (to 120) in some of the mountainous areas. Land capability varies from 1 in mountainous areas to as high as 9 in the extreme south, but is mostly around 5.

- Phase 6:

The agricultural potential of the entire Phase 6 corridor is severely constrained by limited climatic moisture availability making it unsuitable for most agriculture other than the extensive sheep farming which is almost the only agricultural land use throughout the corridor. Rainfall generally decreases northwards in the corridor from a high of approximately 200 mm per annum to as low as 30 mm per annum in the

Richtersveld in the north. Grazing capacity is low and varies from a high of 42 hectares per large stock unit in the south to 120 hectares per large stock unit in the north. Land capability varies between 5 and 1.

- Phase 7:

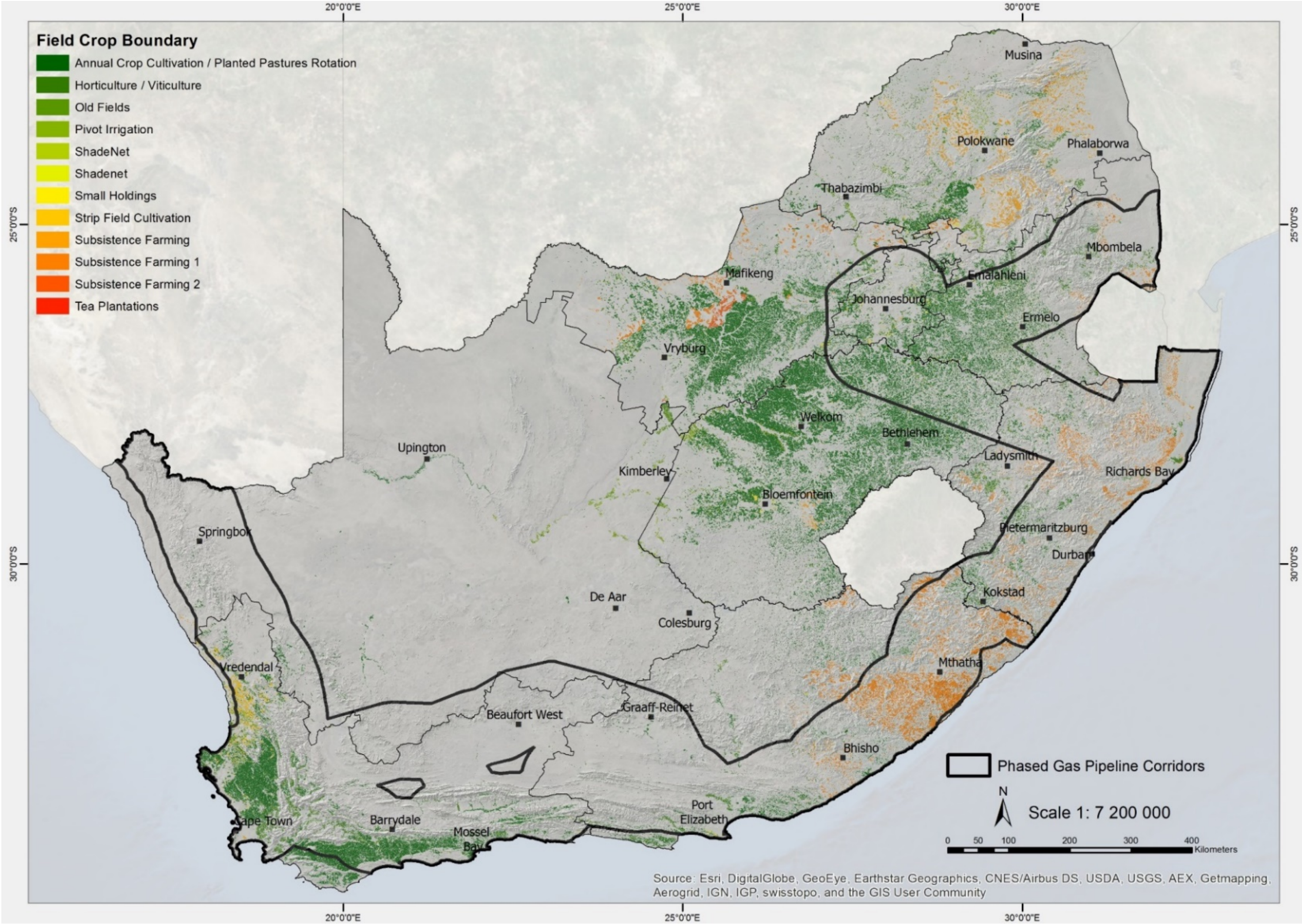
There is very diverse agriculture across the Phase 7 corridor, which varies greatly from the south to the north. The most important agricultural enterprises in the south are subsistence farming and cattle. In the north it is sugar and subsistence farming, with some forestry. The corridor is a summer rainfall area. Mean annual rainfall varies mostly from approximately 500 mm to >1000 mm, but is lower in some isolated parts. Grazing capacity is high and varies between 3 and 20 hectares per large stock unit. Land capability is mostly greater than 7 and goes as high as 15 in some places, although in the more mountainous terrain it drops as low as 2.

- Phase 8 (Rompco Pipeline Corridor):

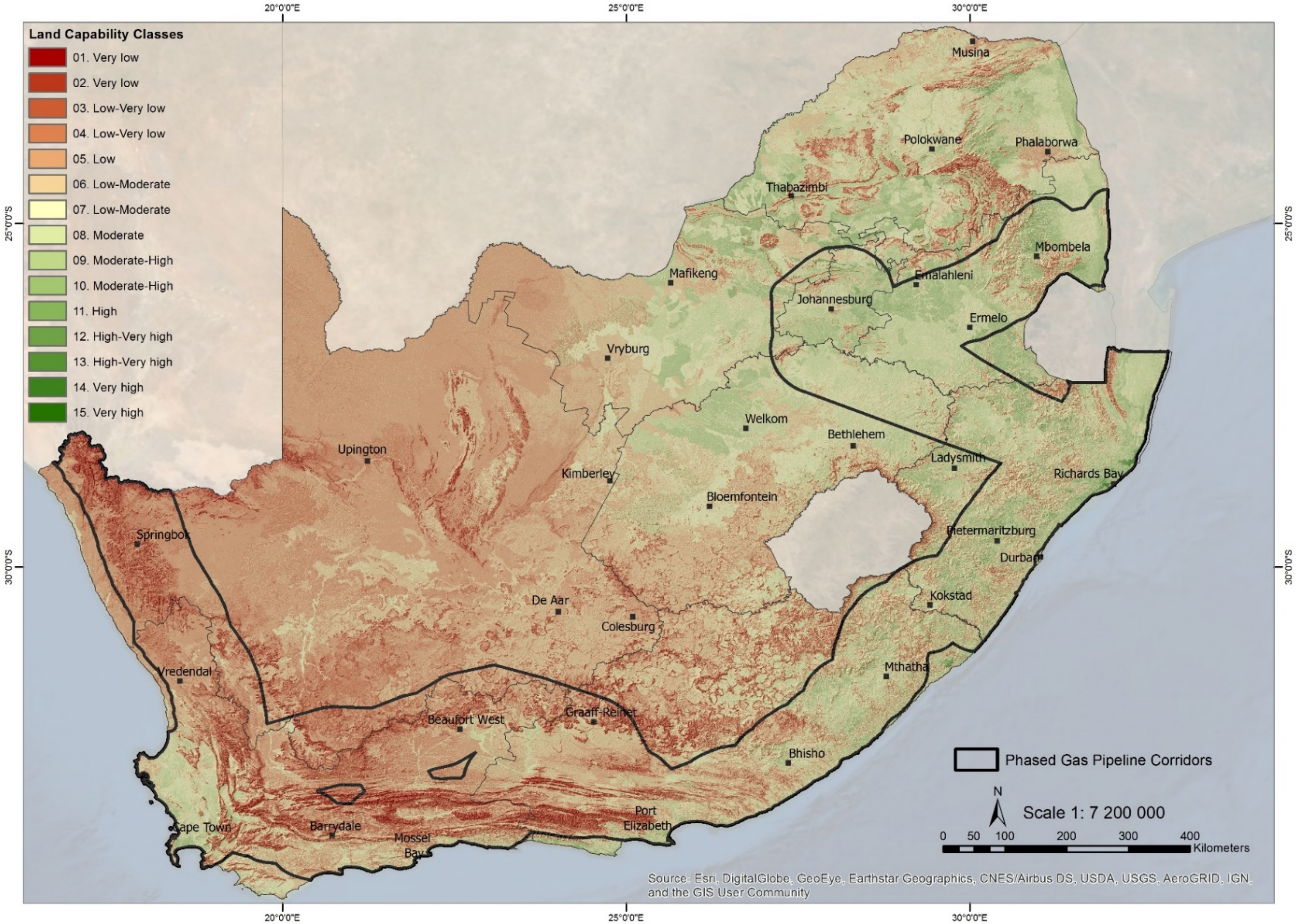
There is diverse and productive agriculture across this Phase 8 (Rompco Pipeline Corridor). On the Highveld portion of the corridor, the most important agricultural enterprises are maize and cattle. On the Lowveld it is fruit and sugar, with forestry on the escarpment. The corridor is a summer rainfall area. Mean annual rainfall varies between approximately 650 in the west and >1000 mm on the escarpment, with some areas of lower rainfall in the eastern Lowveld. Grazing capacity is high and varies between 4 and 11 hectares per large stock unit. Land capability is mostly greater than 8 and goes up to 13, although in some isolated areas it drops as low as 2.

- Inland Corridor:

The agricultural potential of the entire Inland corridor is severely constrained by limited climatic moisture availability making it unsuitable for most agriculture other than the extensive sheep farming which is almost the only agricultural land use throughout the corridor. Rainfall varies from approximately 450 in isolated parts to 180 mm per annum. Grazing capacity is low and varies from a high of 12 hectares per large stock unit in the east to mostly around 55 in the west, but goes as low as 140 hectares per large stock unit in the extreme west. Land capability varies from 1 in mountainous areas to 8.



Map 1: Field Crop Boundaries Map for the Phased Gas Pipeline Development



Map 2: Land Capability[2] Map for the Phased Gas Pipeline Development

[2] Note that the classes specified in the legend represent **land capability classes** and **not** the **sensitivity levels** assessed as part of this SEA.

4.2.4.5 Sensitivity Analysis

The agricultural features that would be impacted by gas pipeline development are indicated in Table 3. The following three factors were identified in the 2016 Agriculture Assessment Report (DEA, 2016) to determine the sensitivity of the agricultural features as a result of EGI development.

- Factor 1: The first is the reduction of the potential agricultural productivity (per unit area and unit time) of the affected land;
- Factor 2: The proportion of agricultural land that is affected; and
- Factor 3: The degree of disturbance that will occur. This axis increases from zero disturbance through minor alterations to agricultural activity and on to total prevention of agriculture equating to a loss of agricultural production on a particular piece of land. It also includes any alterations that a particular agricultural activity would impose on the standard gas pipeline.

This approach has also been used to determine the sensitivity of agriculture features towards the development of a gas pipeline due to its similar linear nature.

The following sensitive agricultural features have been determined:

- Pivot irrigation: In terms of the three factors discussed above pivot lands are high on the first axis, but not on the second two. The proportion of land affected is confined to the linear construction line of the pipe. The degree of disturbance is not high because after effective rehabilitation, crop production can continue above the buried pipeline. These areas therefore do not constitute a constraint from an engineering perspective but are classified as **Very High** environmental sensitivity.

- Areas of viticulture, horticulture have been classified as **Very High** environmental sensitivity features as agricultural productivity is generally high in these areas, which makes it sensitive to disturbance.

- Shadenet areas are a highly productive, irrigated, cultivated piece of farmland with a high level of infrastructure established on it. This makes it sensitive to disturbance. These areas are therefore classified as **Very High** environmental sensitivity.

- Other cultivated areas represented under Field crop boundaries are also classified as **High** environmental sensitivity. In addition, short-term and long-term crops have been respectively rated as Medium and Very High constraints from an engineering perspective. Deep rooted crops (i.e. with those that have roots extending beyond the pipeline depth) will not be permissible within the operational pipeline servitude due to the risk of damage to the infrastructure. However, other shallow rooted crops are permissible within the servitude, whereby restrictions and ploughing mechanisms will be specified in the servitude agreement with the landowner and pipeline developer.

- Timber plantations are lower productivity enterprises in comparison horticultural areas and vineyards, but larger areas are impacted with a greater level of disturbance in that deep rooted trees are excluded from the entire servitude width (as described above). These areas would therefore be completely avoided due the risk the deep roots pose to the below ground gas pipeline infrastructure.

- Land Capability Classes 11 – 15 and 8[3] - 10 have been included in the **Very High** and **High** environmental sensitivity categories respectively given that within the context of South Africa's very limited agricultural land resources, the entirety of these high potential lands should be preserved for agricultural production as far as possible, and these are also to be earmarked for agricultural expansion.

- Areas demarcated as high value agricultural areas are earmarked for agricultural expansion to support food security, as described further below:
    - Very high potential agricultural lands (priority rating of A and B) will be classified as **Very High** sensitivity once this data will become available.
    - Areas with a priority rating of C and D have been classified as **High** sensitivity once this data will become available.
    - The DAFF also recommended that the demarcated high value agricultural areas need to have an additional feature with an E and F rating.

- The agricultural impact of the construction of a gas pipeline on all other land is low. The actual footprint of impact is small and agriculture can continue largely undisturbed above gas pipelines (with the exception of deep rooted crops). However, there are some differences between different agricultural features and for this reason certain features have been identified as **Medium** sensitivity, i.e. land capability classes 6 - 7 that should also be preserved for agricultural production where possible.

- Sugar cane fields may pose a risk to the gas pipelines as a result of the frequent burning undertaken, which might lead to safety concerns should the pipeline integrity be compromised.

- In terms of land cover, natural areas, modified areas and old fields have been rated with a **Low** sensitivity. Natural areas are "Other natural areas", which are available for sustainable development. Modified areas are not an environmental priority and are preferred for development. Old fields are formerly ploughed areas that are degraded, and are more favourable than natural areas for development.

- All agricultural land not included in the categories above is therefore classified as **Low** sensitivity (i.e. Land Capability Class 1 – 5).

- Soil erosion was not included in the categorisation of agricultural sensitivity. There are several reasons for this:
    - Mitigation measures for erosion should be implemented across all gas pipeline developments, regardless of their status according to large scale erosion risk data. Mitigation strategies are largely generic for all developments but the detailed level of required mitigation will vary from site to site and therefore cannot be usefully informed by large scale data.
    - Erosion risk is primarily a function of slope steepness which is already taken into account in terms of engineering constraints but could also be a risk in areas that have or are poorly managed and have lots of existing dongas/ rills/ gullies. The risk of erosion is higher in these areas as the surfaces are already impacted.

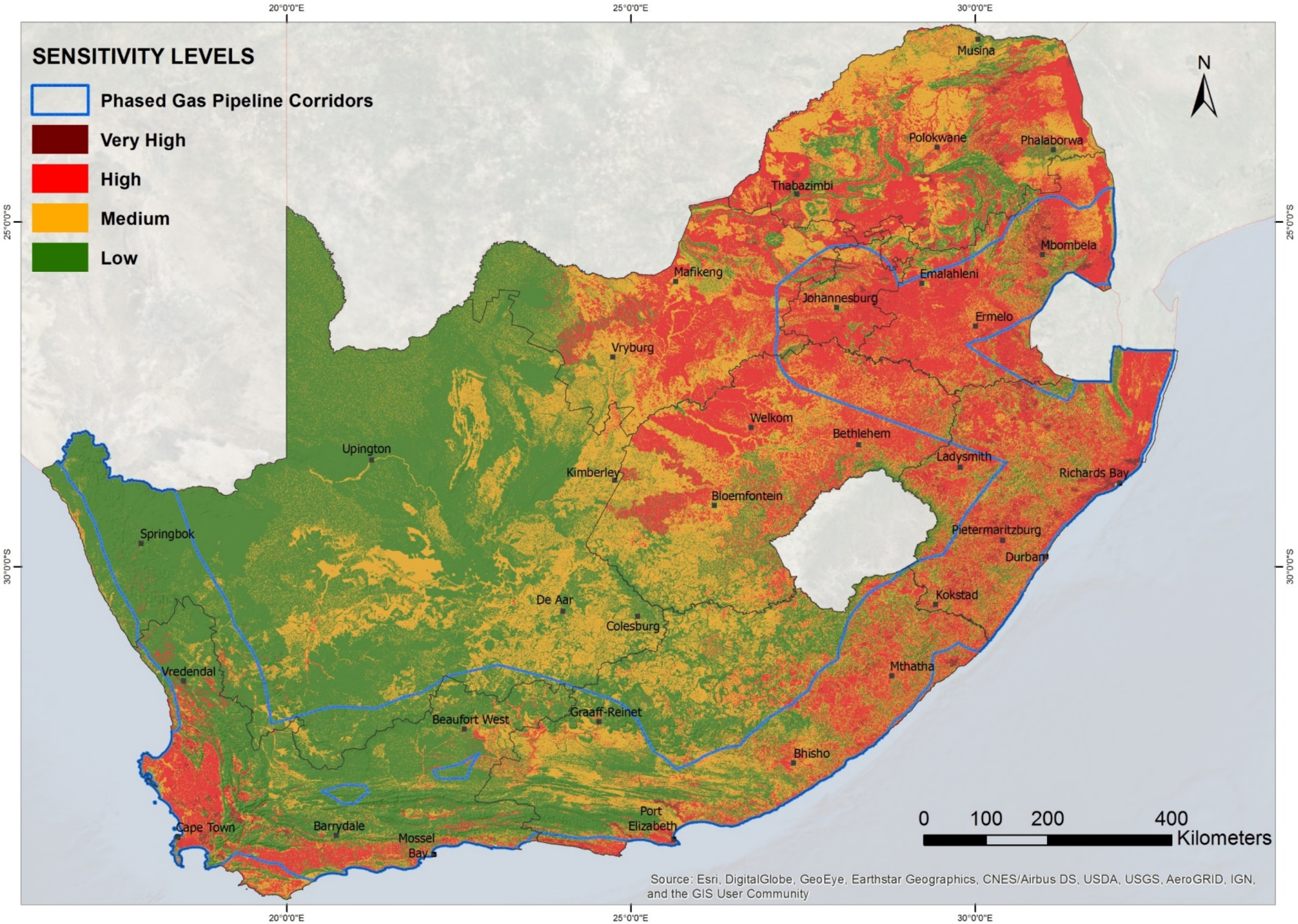
A sensitivity map (Map 3) was produced for the Gas Pipeline corridors according to the criteria set out in Table 3 to classify agricultural sensitivity spatially into four tiers namely, Very High, High, Medium and Low.

[3] DAFF requested that Land Capability Class 8 be classified as high sensitivity as most of the viable long-term farming takes place on Land Capability Class 8. In the 2016 Agriculture Assessment Report (DEA, 2016), Class 8 was classified as Medium sensitivity.

Table 3: Summary of Datasets used per Agricultural Feature in the Gas Pipeline SEA as part of the Environmental Sensitivity Analysis

Sensitivity Feature	Data Source + Date of Publications	Data Preparation and Processing	Sensitivity
Pivots (Irrigated Areas)	Field Crop Boundaries, DAFF, 2017	Extracted from field crop data.	Very High
Shadenet	Field Crop Boundaries, DAFF, 2017	Extracted from field crop data.	Very High
Horticulture	Field Crop Boundaries, DAFF, 2017	Extracted from field crop data.	Very High
Viticulture	Field Crop Boundaries, DAFF, 2017 Land Cover (Viticulture), DEADP, 2014	Union process between field crop data and Land cover (viticulture) data.	Very High
Land Capability Class 11 - 15	Land Capability, DAFF, 2016	Extracted from the Agricultural Land Capability data.	Very High
Other cultivated fields/areas	Field crop boundaries, DAFF, 2017	Extracted from field crop data.	High
Land Capability Class 8 - 10	Land Capability, DAFF, 2016	Extracted from the Agricultural Land Capability data.	High
Sugar Cane	KwaZulu-Natal Land Cover Sugar Cane Farming and Emerging Farming Data, 2011	Union process between Land Cover Sugar Cane Farming and Emerging Farming Data.	Medium
Land Capability Class 6 - 7	Land Capability, DAFF, 2016	Extracted from the Agricultural Land Capability data.	Medium
Land Capability Class 1 - 5	Land Capability, DAFF, 2016	Extracted from the Agricultural Land Capability data.	Low
Natural Areas	National Land Cover, DEA, 2013/2014 Habitat Modification Layer (improved land cover), SANBI, 2017	Extracted from the land cover classes in the habitat modification layer representing natural features/ ecosystems.	Low
Modified Areas	National Land Cover, DEA, 2013/2014 Habitat Modification Layer (improved land cover), SANBI, 2017	Extracted from the land cover classes in the habitat modification layer representing modified areas (e.g. urban areas, mining areas, industrial areas).	Low
Old Fields	Habitat Modification Layer (improved land cover), SANBI, 2017	Extracted from Habitat Modification Layer. Old fields were mapped using aerial photographs to identify areas that were ploughed and left fallow before the 1990 land cover reference point.	Low

Note: These agricultural features are listed in their order of sensitivity.



Map 3: Combined Agriculture Sensitivity Map for the Phased Gas Pipeline Development

4.2.4.6 Impact Description and Mitigation

Agricultural impact is understood as "any impact that translates into reduced agricultural production (including forestry). This may occur by way of a degradation of the agricultural resource base or by way of a direct disturbance to agricultural activities". The significance of agricultural impacts increases as the agricultural productivity of the land (its agricultural sensitivity), the surface area of disturbed land and the level of disturbance increases. In the case of a gas pipeline, even if the sensitivity is high, impact is generally of low to medium significance because both the surface area of disturbed land and the level of disturbance is moderately low. In most cases, agriculture (with the exception of deep rooted plants) can continue to grow after the pipeline is installed, provided that rehabilitation measures are suitably and adequately adopted. Since the gas pipeline will be below ground, there will be minimal above ground disturbance during the operational phase (i.e. this will be limited to pigging stations, block valves and access roads). The main activity that is predicted to have an impact on agriculture is the trenching required during the pipeline installation, which results in potential disturbance of the soil profile and change of soil composition, which in turn may result in changes to the agricultural potential of the soil. Therefore, it is vital that mitigation measures are adopted to ensure that the soil is adequately rehabilitated and returned to its pre-disturbance land capability.

During the construction phase, a 30 – 50 m wide area will be cleared for the construction right-of-way. This area will be reduced to a 10 m wide servitude during the operational phase. The rest of the disturbed area will be rehabilitated in line with best practice recommendations and the Environmental Management Programme (EMPr). A servitude agreement will be entered into between the landowner and the pipeline developer. This agreement will specify all requirements that the landowner needs to consider and abide by as a result of having an operational gas pipeline on their property. For example, if the gas pipeline were to be constructed on a property containing crops, then the servitude agreement will specify the type of crops that can be grown within the servitude (i.e. no deep rooted crops). In addition, the agreement should also include the developer's responsibilities, such as expected rehabilitation levels, access to the land etc.

In general, the significance of the impacts increases as the agricultural productivity of the land, the surface area of the land and the level of disturbance increases.

The potential negative impacts of gas pipeline development on agriculture are listed below:

- Loss of agricultural land use, caused by direct occupation of land by the footprint of gas pipeline infrastructure, which removes the affected land portions from agricultural production.
  - <u>Mitigation measure</u>: Plan the fine-scale positioning of pipelines, block valves, pigging stations, access roads and construction camps to have minimal disturbance on agricultural <u>activities</u> and agricultural land. The gas pipeline infrastructure should be positioned on existing boundaries or edges of agricultural units of land wherever possible, so as not to interfere with agricultural activities within a unit.
- Loss of agricultural land use due to fragmentation of agricultural land as a result of the gas pipeline infrastructure, which can cause the division of fields and isolation of land portions into non-viable small areas for cultivation. Such fragmentation leads to an effective additional loss of agricultural land over and above that lost to the direct footprint.
  - <u>Mitigation measure</u>: As <u>above</u>.
- Limitation to the existence of deep rooted plants and trees, plantation trees and wind break trees within the operational servitude as a result of the risk posed to the below ground pipeline. Exclusion of wind breaks has the effect of reducing the environmental suitability and therefore agricultural potential of affected land for horticultural crops.
  - <u>Mitigation measure</u>: All deep rooted areas, including forest areas should be avoided in terms of gas pipeline development.
- Soil erosion caused by alteration of run-off characteristics due to vegetation removal and surface disturbance and compaction, particularly on access roads and construction camps. The disturbance of existing contour banks and drainage systems used for erosion control, by

construction activities on or near them, can also cause erosion. Erosion causes loss and deterioration of soil resources.

- Mitigation measure: Implement an effective system of run-off control, where it is required, that collects and safely disseminates run-off water from all hardened surfaces and prevents potential down slope erosion. Soil surface stabilising measures must be used if necessary on all areas that are highly susceptible to erosion. Plan the fine-scale positioning of gas pipelines, block valves, pigging stations, access roads and construction camps to avoid land that has contour banks. If any contour banks are disturbed, fully restore their integrity and that of the run-off system of which they are a part, after disturbance. The effectiveness of the run-off control system and the occurrence of any erosion on site or downstream must be monitored. Corrective action must be implemented to the run-off control system in the event of any erosion occurring.

- Degradation of vegetation and compaction of soil beyond the direct footprint due to construction disturbance, dust and vehicle trampling.
  - Mitigation measure: Restrict all vehicle traffic within the footprint of disturbance and control dust during construction. Ensure that the site is rehabilitated following construction.
- Loss of topsoil due to poor topsoil management (burial, erosion, etc.) during construction, related soil profile disturbance (levelling, excavations, road surfacing etc.) and resultant decrease in the capability of that soil to support plant growth.
  - Mitigation measure: Since the construction activity will mechanically disturb below surface areas, it is important that any available topsoil should first be stripped from the entire surface to be disturbed and stockpiled separately for re-spreading during rehabilitation. Topsoil stockpiles must be conserved against losses through erosion by establishing vegetation cover on them. Dispose of all subsurface spoils from excavations where they will not impact on undisturbed land. During rehabilitation, the stockpiled topsoil must be evenly spread over the entire disturbed surface. Erosion must be controlled where necessary on newly topsoiled areas, which are likely to be susceptible to erosion. During discussions with the DAFF, it was recommended that in areas with high and very high land capability, and where the excavations disturb the below surface, then the soil layers need to be excavated and stockpiled separately and then re-instated in the order in which they were removed during infilling.
- Disturbance to agricultural practices and management during construction.
  - Mitigation measure: Not possible.

4.2.4.7 Gas Pipeline Development and Agricultural Consent

As noted above, according to the new Draft Preservation and Development of Agricultural Land Framework Bill, as it is currently proposed, authorisation of all gas pipeline servitudes will be required in terms of the Bill. Authorisation will require ministerial approval and a comprehensive process if it involves any cultivated land, and a slightly less rigorous process if it only involves grazing land. The new Bill requires a fairly high minimum level of assessment for all levels of risk to agricultural land. The registration of the servitude needs to be done per farm portion. Long gas pipelines will more often than not traverse many portions, each of which would need a separate agricultural authorisation. This is likely to complicate and significantly lengthen the time required for gas pipeline servitude approval.

With the foregoing in mind and due to the low to medium significance impact of gas pipeline development on agriculture, particularly within the Power corridors as the proposed corridors are positioned to avoid agriculturally important areas where there was a pinch point for very high sensitivity, this section of the report recommends, for gas pipeline development, an alternative process for agricultural assessment to that proposed in the Draft Preservation and Development of Agricultural Land Framework Bill. The Bill may therefore need to make provision for such a process for gas pipeline development.

This report recommends that the process of agricultural authorisation for gas pipeline development inside the corridors triggering either a Basic Assessment or Environmental Impact Assessment process in terms of National Environmental Management Act 107 of 1998 (as amended) is done in terms of an exemption from the requirements stipulated in the Bill, and that an Agricultural Compliance Statement be prepared by a soil scientist/agricultural specialist registered with the South African Council for Natural and Scientific Professions (SACNASP), on the site being submitted as the preferred development site. The compliance statement must indicate whether or not the proposed development will have an unacceptable negative impact on the agricultural production capability of the site. Such a statement should also focus on and clearly highlight, only the essential aspects that are important for the preservation of agriculturally productive land within gas pipeline developments rather than insist, as the Bill does, on a detailed agro-ecosystem report, much of which might be irrelevant under conditions of low agricultural productivity. These essential aspects making up the recommended way forward are briefly presented in Table 4 and will be included in the decision support outputs currently under development as part of this SEA.

4.2.4.8 Interpretation of Sensitivity Maps

Table 4 provides information on the interpretation of the agricultural sensitivity and associated assessment requirements inside the Gas Pipeline Corridors.

Table 4/…

Table 4: Interpretation of Agricultural Sensitivity and associated Assessment Requirements inside of the Gas Pipeline Development Corridors

<table>
<tr><th>Sensitivity Class</th><th>Interpretation of Sensitivity</th><th>Further assessment requirements for Gas Pipeline Developments</th></tr>
<tr><td>Very High

Land capability evaluation values 11 – 15; all irrigated land; horticulture and viticulture; demarcated high value agricultural areas with a priority rating of A and/or B.</td><td>These areas are potentially unsuitable for development owing to:
• high agricultural value and preservation importance
• high production capability
• high capital investment made
• unique agricultural land attributes.</td><td rowspan="4">It is recommended that an Agricultural Compliance Statement be prepared by a soil scientist/agricultural specialist registered with the SACNASP, on the site being submitted as the preferred development site and indicates whether or not the proposed gas pipeline development will have an unacceptable negative impact on the agricultural production capability of the site.

The Agricultural Compliance Statement must contain, as a minimum, the following information:
1. Details and relevant expertise as well as the SACNASP registration number of the soil scientist/agricultural specialist preparing the statement including a curriculum vitae;
2. A signed statement of independence by the specialist;
3. A map showing the proposed development footprint (including supporting infrastructure) with a 50 m buffered development envelope, overlaid on the agricultural sensitivity map generated by the national web based environmental screening tool;
4. Calculations of the total development footprint area for each land parcel as well as the total footprint area of the development (including supporting infrastructure);
5. Confirmation from the specialist that all reasonable measures have been taken through micro-siting to avoid or minimize fragmentation and disturbance. A substantiated statement from the soil scientist/agricultural specialist on the acceptability of the development and a recommendation on the approval or not of the development (i.e. impacts to the agricultural resource are temporary and the land in the opinion of the soil scientist/agricultural specialist based on the mitigation and remedial measures, can be returned to the current land capability within two years of the completion of construction phase);
6. Any conditions to which the statement is subjected;
7. Where required, proposed impact management outcomes or any monitoring requirements for inclusion in the EMPr; and
8. A description of the assumptions made and any uncertainties or gaps in knowledge or data.

If this statement is subject to any conditions these must also be clearly stated; and where required, proposed mitigation measures for inclusion in the EMPr.</td></tr>
<tr><td>High

Land capability evaluation values 8 - 10 including all cultivated areas including sugar cane areas and demarcated high value agricultural areas with a priority rating of C and/or D.</td><td>Avoid where possible because it will lead to some disturbance and loss of existing or potential agricultural (or forestry) production. High sensitivity areas are still preservation worthy since they include land with an agricultural production potential and suitability for specific crops.</td></tr>
<tr><td>Medium

Land capability evaluation values 6 – 7. Likely to be very marginal arable land.</td><td>Re-route onto lower sensitivity agricultural land (where possible and where all other factors are equal) because it will lead to very minor disturbance and loss of existing or potential agricultural production.</td></tr>
<tr><td>Low

Land capability evaluation values 1 – 5.</td><td>Insignificant impact on agriculture.

Likely to be non-arable land, and is therefore land onto which most development should be steered.</td></tr>
</table>

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.5

Defence

CONTENTS

TABLES

MAPS

ABBREVIATIONS

DOD	Department of Defence
EGI	Electricity Grid Infrastructure
SAAF	South African Air Force
SACAA	South African Civil Aviation Authority
SAMHS	South African Military Health Service
SANDF	South African National Defence Force
SAPS	South African Police Service
SEA	Strategic Environmental Assessment

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.5 Defence

4.2.5.1 Introduction and Scope

This chapter covers the potential impacts on defence facilities and features associated with the development of a gas pipeline within the proposed corridors. The approach to the sensitivity analysis and the assessment of impacts relating to defence as part of this Strategic Environmental Assessment (SEA) is similar to that undertaken for the 2016 Electricity Grid Infrastructure (EGI) SEA (DEA, 2016[1]) considering the similar linear nature of the projects.

The subsequent sections are therefore predominantly based on the Defence Assessment (Part 3, Chapter 7: Defence of the 2016 EGI SEA Report) undertaken as part of the 2016 EGI SEA (DEA, 2016). The latter was desktop based and focused mainly on the interpretation of existing data. This assessment has also been supplemented with information gathered from discussions and meetings with the Department of Defence (DoD), ARMSCOR, South African Air Force (SAAF), South African Navy, South African Military Health Service (SAMHS), and the South African National Defence Force (SANDF).

The SANDF uses an extensive system of military airspace and land assets in order to prepare and train combat-ready forces. Furthermore, it also operates radar systems designed to protect the sovereignty of the national borders and to detect threats to national security. The SANDF falls under the DoD and comprises four armed services, namely: Army, Air Force, Navy and Military Health Service.

The various defence features to be taken into consideration when locating gas pipelines are listed in Table 1 below.

4.2.5.2 Sensitivity Analysis and Mapping

In accordance with discussions with the military, DoD, ARMSCOR, SAAF, South African Navy, SAMHS, and the SANDF, areas of interest were mapped and appropriately buffered as shown in Table 1. The sensitivity map (Map 1) was delineated according to these criteria. Most of the sensitivity features noted in Table 1 below are military areas, where access is limited, and have been highlighted as a result of the potential impact of gas pipelines on these features.

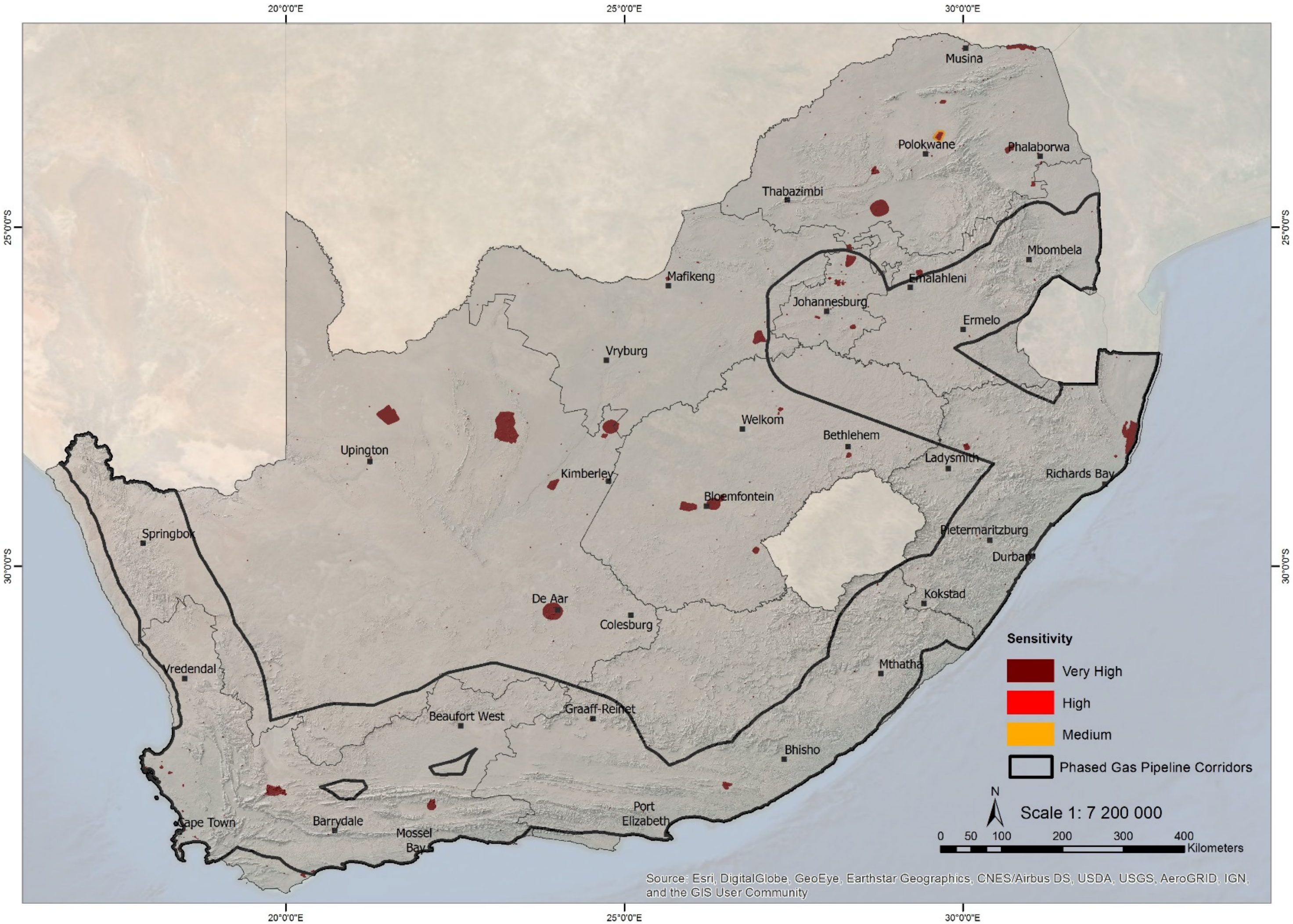
It should be noted that all of the sites that were highlighted by the abovementioned authorities have been included in this assessment, where shapefiles were available. However, were shapefiles were not available (i.e. for the Hell's Gate Military Training Area, Hopefield Weapons Range, Tooth Rock Weapons Range, and Overberg Test Range), the co-ordinates provided by the DoD were used and the areas were mapped according to the ERF and farm portions.

[1] Department of Environmental Affairs, 2016. Strategic Environmental Assessment for Electricity Grid Infrastructure in South Africa. CSIR Report Number: CSIR/02100/EMS/ER/2016/0006/B. Stellenbosch.

Table 1: Defence Sensitivity Criteria

Sensitivity Feature	Data Source	Sensitivity Mapping Application
Forward Airfields	SANDF, 2017	Very High – 1 km buffer
Air Force Bases -including air force training ranges	SANDF, 2017	Very High – 1 km buffer
High Sites	SANDF, 2017	Very High – 1 km buffer
Operational Military Bases	SANDF, 2017	Very High – 1 km buffer
Military Training Areas	SANDF, 2017	Very High – 2 km buffer
Bombing Ranges	SANDF, 2017	Very High – 1 km buffer High – 2 km buffer Medium – 5 km buffer
Shooting Ranges	SANDF, 2017	Very High - 1 km buffer
Border Posts	SANDF, 2017	Very High – 1 km buffer
Ammunition Depot	SANDF, 2017	Very High - 10 km
All Other DoD features (including Naval Bases, Housing, Offices etc.)	SANDF, 2017	Very High – 1 km buffer

Map 1/...



Map 1: Defence Sensitivity Map for the Phased Gas Pipeline Development in the Proposed Corridors

4.2.5.3 Impact Description

Impacts of gas pipelines on defence activities could result from interference with surveillance radars and communication systems. The nature of gas pipeline infrastructure may lead to the blocking and cluttering of surveillance and communication signals. Any interference with SANDF surveillance radar would compromise the safeguarding of coastlines, national borders, military airspace or other militarily sensitive areas. In addition, certain defence features, such as bombing ranges and military training facilities, may have an impact on the below ground gas pipeline (in terms of ground vibrations and shock waves).

Correspondence with the SANDF has led to the identification of 15 possible sites of significance that coincide with the draft refined corridors and could pose a risk to gas pipeline infrastructure in their immediate vicinity. These 15 sites are all accompanied by either 1) a weapons range; 2) an ammunition stockpiling facility; or 3) both. All of these sites, excluding one, are military facilities. In addition, three of the identified sites are no longer in use but may still be contaminated with unexploded ordnance despite rigorous clean-up before the military vacated these sites, which means that it would still be of significance to the sensitivity survey.

The SANDF have identified safety footprints of the heaviest calibre weapons in use, stockpiled or fired at each of the 15 above-mentioned sites. Small arms ranges are also of concern, particularly at sites where tracer rounds are used (as this can have a similar or worse outcome on the pipeline and surrounding area than an artillery round). All such ranges, military or civilian, are accredited by law, by the SA Police Service (SAPS). A register of all such SAPS-accredited small arms shooting ranges is available online. Tracer rounds would be allowed as part of this accreditation, and for purposes of sensitivity analysis, it must be assumed therefore, that such munitions are in use at each of these ranges, and could hold risk to any gas pipeline infrastructure in the vicinity.

There are other military facilities that coincide with the proposed draft refined gas pipeline corridors, but these were deemed benign in terms of their possible impact on gas pipeline infrastructure in the vicinity. The latter sites will however emerge in future site specific assessments when particular phases of the pipeline are planned for actual construction.

The Seismicity Assessment study conducted as part of the Gas Pipeline SEA (included in Appendix C.2 of the Gas Pipeline SEA Report) mentions that seismicity in South Africa arises from both natural sources (e.g. plate tectonic forces, buoyant uplift of the continent after erosion) and human-induced sources (e.g. rock failure caused by mining-induced stresses, slip on faults causes by changes in load and pore fluid pressure during the filling of reservoirs, and vibrations produced by blasting for open pit mining, civil excavation and the disposal of expired munitions). The report further notes that ground vibrations produced by the disposal of expired munitions have been investigated by Grobbelaar (2017). Ground vibrations may also be produced by blasting in open pit mines and for civil excavations (e.g. road cuttings), and the disposal of expired military explosives. The effect of these blasts is local. Intensities strong enough to cause damage to sensitive structures are usually limited to distances of tens to hundreds of meters, or at most a kilometre or two from the source. Expired munitions are usually detonated on the surface, so relatively little energy is transmitted into the earth and little damage done. However, the shock wave travelling through the air may cause alarm, discomfort, and in some cases damage. The Seismicity Assessment includes additional information provided by the Council for Geoscience in terms of measurements of the ground motion produced by military explosives detonated on surface and their effects on buildings (B Manzunzu, pers. Comm., 2018).

4.2.5.4 Interpretation of the Sensitivity Map

Proponents intending to develop gas pipeline within high and very high sensitivity areas must ensure that the proposed development will not have an unacceptable negative impact on defence activities.

The Obstacle Evaluation Committee (OEC), under the chairmanship of the Senior Staff Officer Air Traffic Management of the Air Force, is responsible for streamlining and coordinating the approvals for the construction of potential aviation obstacles in the vicinity of military areas of interest. The OEC consists of members from both the Air Force and the South African Civil Aviation Authority (SACAA), and is mandated to make final recommendations to the Deputy Chief of the Air Force regarding the approval of obstacles that might affect Air Force activities. Due to the complexity of impacts potentially posed by obstacles on aviation, surveillance, communication, and other military activities, all proposed gas pipeline infrastructure must be evaluated by this committee. Even in instances where the distance from the nearest area of military interest may seem far enough for it not to have an impact, there is still potential for interference with communication, surveillance, or other military services.

The sensitivity map illustrated in this section (Map 1) does not indicate where development can or cannot proceed. Instead, the main objective of this section is to identify high risk areas for development in the context of defence features. This way, developers are able to plan to avoid sensitive defence related features at the earliest stage of development planning, and in so doing, minimise the risk of project delays or increased project costs as a result of the potential interference of the proposed development with defence services.

Table 2/…

Table 2: Interpretation of Defence Sensitivity Map

<table>
<tr><th>Sensitivity Class</th><th>Interpretation</th><th>Recommendations at project level</th></tr>
<tr><td>Very High
(dark red)</td><td>In Very High sensitivity areas there is a high likelihood for significant negative impacts on the defence installation. In-depth assessment of the potential impacts and mitigation measures is likely to be required before development can be considered in these areas.</td><td rowspan="2">The proponent must request a comment in writing from the OEC and/or from the SACAA, which may include inputs from the OEC confirming no unacceptable impact on military areas of interest.

Inputs from the OEC/SACAA, if provided within prescribed timeframes in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended, will be considered by the relevant competent authority for decision making. If no inputs are provided by the OEC within the prescribed timeframes, then the EAP must provide evidence of engagement with the relevant officials at the OEC and timeous requests for inputs.</td></tr>
<tr><td>High
(red)</td><td>In High sensitivity areas there is potential for negative impacts on the defence installation that can potentially be mitigated. Further assessment may be required to investigate potential impacts and mitigation measures.</td></tr>
<tr><td>Medium
(orange)</td><td>In Medium sensitivity areas there is a low potential for negative impacts on the defence installation, and if there are impacts there is a high likelihood of mitigation. Further assessment of the potential impacts may not be required.</td><td rowspan="2">No additional requirements</td></tr>
<tr><td>Low
(green)</td><td>No significant impacts are expected in low sensitivity areas. It is unlikely for further assessment and mitigation measures to be required.</td></tr>
</table>

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.6

Civil Aviation

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MAPS

ABBREVIATIONS

EGI	Electricity Grid Infrastructure
SAAF	South African Air Force
SACAA	South African Civil Aviation Authority
SACAR	South African Civil Aviation Regulations
SACATS	South African Civil Aviation Technical Standards
SEA	Strategic Environmental Assessment

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.6 Civil Aviation

4.2.6.1 Introduction and Scope

This chapter covers the potential impacts on civil aviation associated with the development of gas pipelines within the proposed corridors. The approach to the sensitivity analysis and the assessment of impacts relating to civil aviation as part of this Strategic Environmental Assessment (SEA) is similar to that undertaken for the 2016 Electricity Grid Infrastructure (EGI) SEA (DEA, 2016[1]) considering the similar linear nature of the projects.

The subsequent sections are therefore predominantly based on the Civil Aviation Assessment (Part 3, Chapter 6: Civil Aviation of the 2016 EGI SEA Report) undertaken as part of the 2016 EGI SEA (DEA, 2016). This study was desktop based and focused mainly on the interpretation of existing data.

Civil aviation is governed by the Civil Aviation Act (Act 13 of 2009) and the South African Civil Aviation Authority (SACAA) is mandated with controlling, promoting, regulating, supporting, developing, enforcing and continuously improving levels of safety and security throughout the civil aviation industry. All proposed developments or activities in South Africa that potentially could affect civil aviation must thus be assessed by SACAA in terms of the South African Civil Aviation Regulations (SACARs) and South African Civil Aviation Technical Standards (SACATS) in order to ensure aviation safety. The Obstacle Evaluation Committee (OEC) which consists of members from both the SACAA and South African Air Force (SAAF) fulfils the role of streamlining and coordinating the assessment and approval of proposed developments or activities that have the potential to affect civil aviation, military aviation, or military areas of interest. The OEC is chaired by the Senior Staff Officer Air Traffic Management of the Air Force. With both being national and international priorities, the OEC is responsible for facilitating the coexistence of aviation and gas pipeline development, without compromising aviation safety.

The various civil aviation features to be taken into consideration when locating gas pipelines are listed in Table 1 below. It is anticipated that other features identified in the Defence Assessment (Part 4.2.5 of the Gas Pipeline SEA Report) are not applicable in the case of civil aviation.

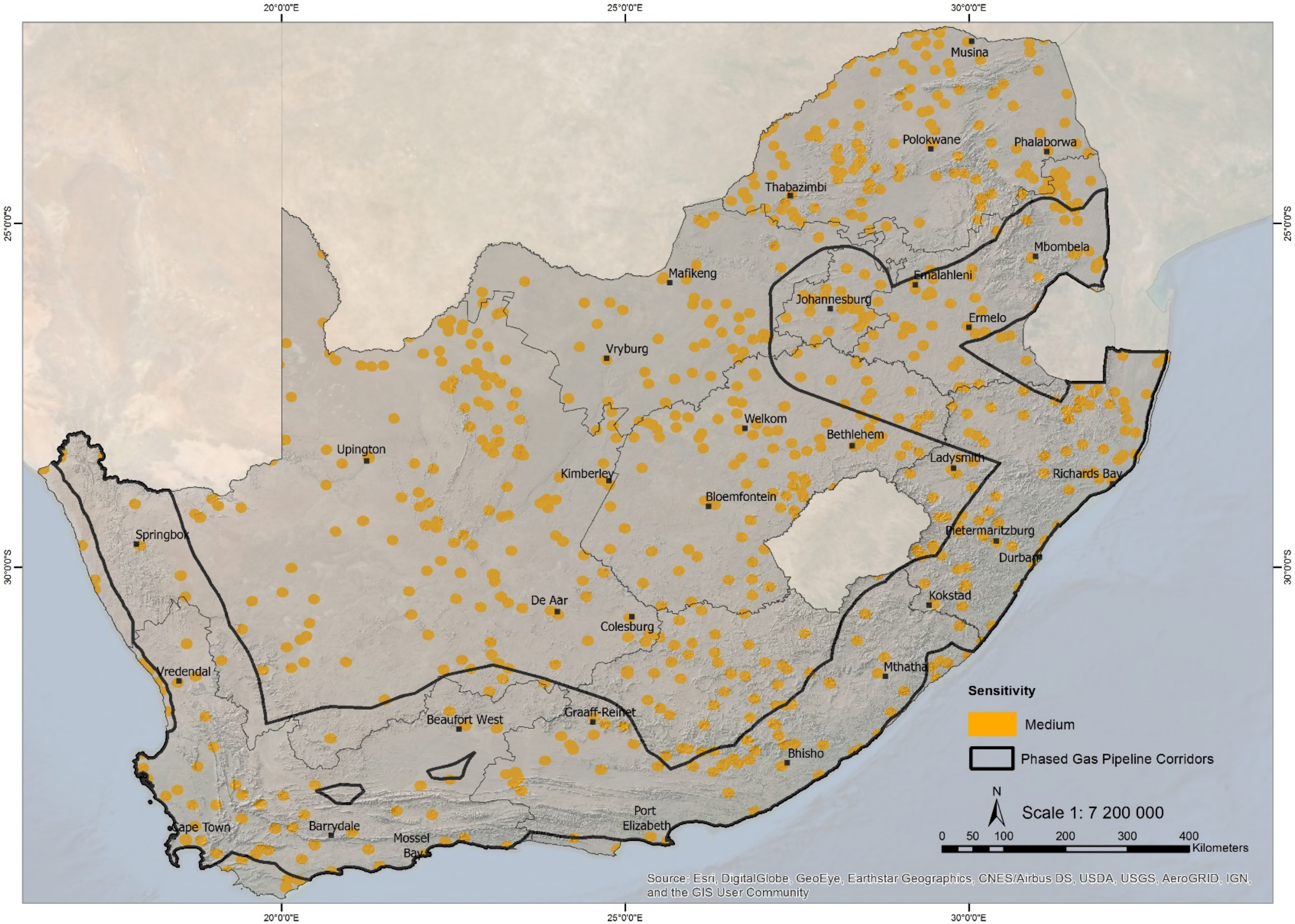
4.2.6.2 Sensitivity Analysis and Mapping

Based on the sensitivities defined in Table 1, areas of interest were mapped and appropriately buffered. The sensitivity map (Map 1) was delineated according to these criteria.

Table 1: Civil Aviation Sensitivity Criteria

Sensitivity Feature	Data Source	Sensitivity Mapping Application
Major Airports	SACAA	Medium – 8 km buffer
Other Civil Aviation Aerodromes (Small Aerodromes)	SACAA	Medium – 8 km buffer

[1] Department of Environmental Affairs, 2016. Strategic Environmental Assessment for Electricity Grid Infrastructure in South Africa. CSIR Report Number: CSIR/02100/EMS/ER/2016/0006/B. Stellenbosch.



Map 1: Civil Aviation Sensitivity Map for the Phased Gas Pipeline Development in the Proposed Draft Refined Corridors

4.2.6.3 Impact Description

Regulation 19.01.30 (3) of the Civil Aviation Regulations (2011) states that “buildings or other objects which will constitute an obstruction or potential hazard to aircraft moving in the navigable air space in the vicinity of an aerodrome, or navigation aid, or which will adversely affect the performance of the radio navigation or instrument landing systems, must not be erected or allowed to come into existence without the prior approval of the Director” of the SACAA.

The Civil Aviation Act (Act 13 of 2009) refers to an “obstacle” as “all fixed or mobile objects (whether temporary or permanent) or parts thereof, that are located on an area intended for the surface movement of aircraft; or extend above a defined surface intended to protect aircraft in flight; or stand outside those defined surfaces and that have been assessed as being a hazard to air navigation”.

This is also linked to Regulation 91.01.10 (1) of the Civil Aviation Regulations (2011), which states that "No person shall, through any act or omission endanger the safety of an aircraft or person therein, or cause or permit an aircraft to endanger the safety of any person or property".

Therefore, it is a requirement in terms of the Civil Aviation Regulations (2011) to submit an application for approval to the SACAA for any development that includes obstacles that could pose a hazard to aviation.

In South Africa, all structures taller than 15 metres above ground level must be assessed and registered as potential obstacles to aviation in the Electronic Terrain and Obstacle Database (eTOD). The impact of gas pipelines on civil aviation tends to be limited because the infrastructure will be constructed below-ground, with the exception of pigging stations, pipeline markers and block valves. These are not expected to have excessive heights that could significantly impact on major airports and other civil aviation aerodromes. However, cranes may be used during the construction phase.

4.2.6.4 Interpretation of the Sensitivity Map

The OEC is mandated to make final recommendations to the Deputy Chief of the Air Force regarding the approval of obstacles that might affect Air Force activities. Due to the complexity of impacts potentially posed by all obstacles on aviation, surveillance, communication, and other military activities, all proposed gas pipeline infrastructure must be evaluated by this committee.

Therefore. without being able to guarantee that any development will not be found to have an unacceptable impact on civil aviation features without confirmation by OEC, the sensitivity map illustrated in this section (Map 1) does not indicate where development can or cannot proceed. Instead, the main objective of this section is to identify high risk areas for development in the context of civil aviation features. This way, developers are able to plan to avoid sensitive civil aviation related features at the earliest stage of development planning, and in so doing, minimise the risk of a negative decision, project delays or increased project costs as a result of the potential interference of the proposed development with civil aviation services.

Table 2: Interpretation of Civil Aviation Sensitivity Maps

<table>
<tr><th>Sensitivity Class</th><th>Interpretation</th><th>Recommendations at project level</th></tr>
<tr><td>Very High
(dark red)</td><td>In Very High sensitivity areas there is a high likelihood for significant negative impacts on the civil aviation installation. In-depth assessment of the potential impacts and mitigation measures is likely to be required before development can be considered in these areas.</td><td rowspan="2">Proponents intending to develop gas pipeline anywhere in South Africa that triggers the need for an environmental assessment process must ensure that the proposed development will not have an unacceptable negative impact on civil aviation activities. In order to do so, the proponent must request a comment in writing from the OEC and/or from the SACAA, which may include inputs from the OEC confirming no unacceptable impact on civil aviation areas of interest.

Inputs from the OEC/SACAA, if provided within prescribed timeframes in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended, will be considered by the relevant competent authority for decision making. If no inputs are provided by the OEC within the prescribed timeframes, then the EAP must provide evidence of engagement with the relevant officials at the OEC and timeous requests for inputs.</td></tr>
<tr><td>High
(red)</td><td>In High sensitivity areas there is potential for negative impacts on the civil aviation installation that can potentially be mitigated. Further assessment may be required to investigate potential impacts and mitigation measures.</td></tr>
<tr><td>Medium
(orange)</td><td>In Medium sensitivity areas there is a low potential for negative impacts on the civil aviation installation, and if there are impacts there is a high likelihood of mitigation. Further assessment of the potential impacts may not be required.</td><td rowspan="2">No further requirements</td></tr>
<tr><td>Low
(green)</td><td>No significant impacts are expected in low sensitivity areas. It is unlikely for further assessment and mitigation measures to be required.</td></tr>
</table>

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.7

Heritage

CONTENTS

TABLES

MAPS

ABBREVIATIONS

CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
ECPHRA	Eastern Cape Provincial Heritage Resources Authority
EIA	Environmental Impact Assessment
EGI	Electricity Grid Infrastructure
HWC	Heritage Western Cape
MSDF	Municipal Spatial Development Framework
NEMA	National Environmental Management Act (Act 107 of 1998)
NHRA	National Heritage Resources Act (Act 25 of 1999)
PHRA	Provincial Heritage Resources Authority
SAHRA	South African Heritage Resources Agency
SAHRIS	South African Heritage Resources Information System
SAPAD	South African Protected Areas Database
SEA	Strategic Environmental Assessment

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.7 Heritage

4.2.7.1 Introduction and Scope

This chapter covers the potential impacts on heritage, associated with the development of a phased gas pipeline within the proposed corridors. The approach to the sensitivity analysis and the assessment of impacts relating to heritage as part of this Strategic Environmental Assessment (SEA) is similar to that undertaken for the 2016 Electricity Grid Infrastructure (EGI) SEA (DEA, 2016[1]) considering the similar linear nature of the projects.

The subsequent sections are therefore predominantly based on the Heritage Assessment (Appendix C.4 of the 2016 EGI SEA Report) undertaken as part of the 2016 EGI SEA (DEA, 2016). This study was desktop based and focused mainly on the interpretation of existing data.

Information for this assessment was mainly sourced from the latest heritage resources dataset (December 2018) provided by South African Heritage Resources Agency (SAHRA). Further consultations with relevant authorities such as the SAHRA was undertaken to confirm applicable buffers and sensitivities. A meeting was held with SAHRA and Department of Environmental Affairs (DEA) in May 2019 to discuss heritage related aspects of the SEAs commissioned by the DEA, such as data usage and SAHRA's requirements.

4.2.7.2 Approach: Data Sources, Legislation, Assumptions and Limitations

The main source of information is data on heritage sites provided by SAHRA in February 2019. This data includes national and provincial data, as well as local data up to December 2018. The list of updated data used in this current Gas Pipeline SEA is indicated in Table 1 below. Assumptions and limitations applicable to this assessment are provided in Table 2.

Table 1: Heritage Datasets

Data title	Source and date of publication	Data Description
Mapped Heritage Features	SAHRA, 2018	Heritage sites and features curated by SAHRA
World Heritage Sites and related buffer zones	South African Protected Areas Database (SAPAD) - Q4, 2017	World Heritage sites
Geological Features and Substrates of Palaeontological Importance, Geology Layer	Council for Geosciences, 2014	Specific geological types of potential heritage importance

Table 2: Assumptions and limitations

Limitation	Included in the scope of this study	Excluded from the scope of this study	Assumption
Data availability	Latest dataset provided by SAHRA was used (data up to December 2018) but a large amount of published and	Field verification of datasets and outcomes, and extensive local expert consultation. The study	Data provided by SAHRA comprises the majority of the data potentially available.

[1] Department of Environmental Affairs, 2016. Strategic Environmental Assessment for Electricity Grid Infrastructure in South Africa. CSIR Report Number: CSIR/02100/EMS/ER/2016/0006/B. Stellenbosch.

Limitation	Included in the scope of this study	Excluded from the scope of this study	Assumption
	unpublished data has not been included.	area widely scattered.	
Unavailability of the palaeosensitivity map to include in the sensitivity analysis	-	Further field assessment and/or desktop work to verify and correct the sensitivity levels described	The palaeosensitivity map contains the most updated information and currently needs to be accessed online.

The relevant regulatory instruments are listed in Table 3 below.

Table 3: Applicable Legislation for the Heritage Assessment

Instrument	Key Objective	Feature
International Instrument		
UNESCO Convention on the Protection of World Cultural and Natural Heritage, 1972 (applicable in all corridors)	Protection of natural and cultural heritage sites which demonstrate importance for all the people of the world.	Declared World Heritage Sites: • Fossil Hominid Sites of South Africa (also known as the Cradle of Humankind) • Vredefort Dome • Cape Floral Region Protected Areas[2]
National Instrument		
National Heritage Resources Act 25 of 1999 (applicable in all corridors)	Identification, management, protection, conservation and promotion of the national heritage resources within the country	All heritage sites except for World Heritage Sites
National Environmental Management: Protected Areas Act 57 of 2003	Protection and conservation of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascape	World Heritage Sites
Integrated Coastal Management Act 24 of 2008	Promotion, conservation and sustainable development of the coastal environment	Heritage sites within 1 km of the coastline
National Environmental Management Act 107 of 1998, as amended (NEMA)	Environmental governance within the country	Heritage sites identified during the environmental process
Provincial Instrument		
KwaZulu-Natal Heritage Act 4 of 2008 and KwaZulu-Natal Amafa and Research Institute Act (Act 5 of 2018) (Applicable to the relevant sections of the Phase 3, 4 and 7 corridors).	Conservation, protection and administration of both the physical and the living or intangible heritage resources of the Province of KwaZulu-Natal	Heritage sites falling within the boundaries of KZN

[2]The Cape Floral Region Protected Areas is declared as a 'natural' heritage site by UNESCO but it is not subjected to the same treatment as other heritage sites in South Africa by Heritage Western Cape and SAHRA.

The National Heritage Resources Act (Act 25 of 1999) (NHRA) is considered most relevant, as it protects many heritage resources as follows:

- Section 34: structures older than 60 years;
- Section 35: palaeontological, prehistoric and historical material (including ruins) more than 100 years old;
- Section 36: graves and human remains older than 60 years and located outside of a formal cemetery administered by a local authority; and
- Section 37: public monuments and memorials.

Section 38 (1) of the NHRA states the following:

- "Subject to the provisions of subsections (7), (8) and (9), any person who intends to undertake a development categorised as:
    - (a) the construction of a road, wall, power line, **pipeline**, canal or other similar form of linear development or barrier exceeding 300m in length;
    - (b) the construction of a bridge or similar structure exceeding 50 m in length;
    - (c) any development or other activity which will change the character of a site — (i) exceeding 5 000 m^2 in extent; or (ii) involving three or more existing erven or subdivisions thereof; or (iii) involving three or more erven or divisions thereof which have been consolidated within the past five years; or (iv) the costs of which will exceed a sum set in terms of regulations by SAHRA or a provincial heritage resources authority;
    - (d) the re-zoning of a site exceeding 10 000 m^2 in extent; or
    - (e) any other category of development provided for in regulations by SAHRA or a provincial heritage resources authority; must at the very earliest stages of initiating such a development, notify the responsible heritage resources authority and furnish it with details regarding the location, nature and extent of the proposed development."

Section 38 (2a) states that if there is reason to believe that heritage resources will be affected then an impact assessment report must be submitted by the Applicant to the relevant Heritage Authority. This is usually the case for gas pipeline development. Therefore, since a specific HIA will be required prior to development of the gas pipeline on a project specific basis, a dedicated HIA was not undertaken at this SEA level. Instead, a review of existing literature captured for the previous SEAs, as well as a general sensitivity analysis has been undertaken for this current SEA.

Grading of sites is necessary for heritage management as it is a legal requirement towards the formal protection of sites and informs the requirements for the management of generally protected sites. Any heritage site which is part of the national estate as defined in Section 3 of the NHRA should be graded according to its significance. In South Africa, grading has three associated components, namely the geographical range of a site's significance (international, national, provincial/regional or local), the level of significance (High, Medium or Low) and the heritage authority with the delegated powers to manage the site. The grading of heritage sites which form part of the national estate is specified in Section 7 of the NHRA as follows:

- (a) Grade I: Heritage resources with qualities so exceptional that they are of special national significance;
- (b) Grade II: Heritage resources which, although forming part of the national estate, can be considered to have special qualities which make them significant within the context of a province or a region; and
- (c) Grade III: Other heritage resources worthy of conservation.

Grade III sites have three subcategories according to their level of local significance. IIIa (high), IIIb (medium) and IIIc (low). These sites are significant at the local level and the type of mitigation allowed at these sites varies from destruction (IIIc) or extensive mitigation (IIIb) to general avoidance and minimal modification (IIIa). Grade IIIa sites are of such a high local significance that they should be protected and retained. Grade IIIb sites are heritage resources rated with medium local significance. They should preferably be retained where possible, but, where developments cannot be realigned or moved, mitigation is normally allowed. Grade IIIc sites are of low local significance. These resources must be recorded satisfactorily before destruction is allowed.

SAHRA is the national authority and manages Grade I sites only; and Provincial Heritage Resources Authorities (PHRAs) manage Grade II and Grade III sites. Only one municipality, the City of Cape Town Metropolitan Municipality, has obtained limited powers to manage Grade III resources from Heritage Western Cape (HWC). As part of the review of the Draft SEA Report, SAHRA noted that the HWC, Eastern Cape Provincial Heritage Resources Authority (ECPHRA) and Amafa KwaZulu-Natal have been assessed as competent to perform functions in terms of Sections 8, 26, 27-30, and 34-37 of the NHRA. SAHRA further indicated that the Northern Cape, North West, Gauteng, Limpopo, Mpumalanga and the Free State PHRAs are only competent to provide permits for heritage resources as per Section 34 of the NHRA, or under Section 27 (only for sites defined as structures as per Section 34). For sites managed under Section 27, if the site is defined as an archaeological or palaeontological site, or a meteorite (Section 35), or as a burial ground and grave (Section 36), these sites are managed and permitted by SAHRA.

The majority of the Provincial Heritage Sites were declared as National Monuments under the National Monuments Act of 1969. These sites are mainly buildings located within the urban edge of various towns and cities across the country.

There are two useful guides which explain the grading process in more detail:

- the HWC Short Guide to and Policy Statement on Grading issued in 2012[3]; and
- the SAHRA Minimum Standards for Archaeological and Palaeontological Impact Assessments issued in 2007[4] (It is noted that these Minimum Standards are currently being updated by SAHRA, and thus the requirements of an HIA process may change).

The 2012 Minimum Standards on Palaeontological Components of Heritage Impact Assessments is also considered useful in terms of the above.

Refer to Section 5 of the 2016 Heritage Assessment Report (DEA, 2016) for a detailed description of the study methodology, assumptions and limitations undertaken as part of the 2016 EGI SEA. It must be noted that detailed sensitivity analysis was not undertaken as part of this current SEA given that, regardless of the sensitivity of the site, the developer will be required to carry out, at least, a Phase 1 HIA.

The list of data used in this current Gas Pipeline SEA is indicated in Table 1.

4.2.7.3 Impact Description and Mitigation

The information presented in this section is based on the 2016 Heritage Assessment Report (DEA, 2016). It is acknowledged that the activities relating to gas pipeline and EGI construction may differ, however both gas pipelines and power lines are linear infrastructure. Both infrastructural components require surface clearing, as well as trenching and infilling for the pipeline installation and pylon bases. These specific activities may impact on heritage features in a similar way. Gas pipelines and power lines however may impact the greater landscape in a different way. The findings of the 2016 Heritage Assessment Report (DEA, 2016) for EGI are still considered relevant for this Gas Pipeline SEA.

The integrity and significance of heritage resources can be jeopardized in two ways i.e. by natural forces such as erosion or anthropogenic forces such as development activities. Gas pipeline developments have

[3]https://www.westerncape.gov.za/other/2012/9/grading_guide_&_policy_version_5_app_30_may_2012.pdf
[4] http://www.sahra.org.za/sahris/sites/default/files/website/articledocs/ASG2-2%20SAHRA%20A%26PIAs%20MIN%20STDS%20Ph1-2%2016May07.pdf

the potential to impact on heritage resources through physical disturbance during construction or by changing the wider landscape context.

Physical impacts to heritage resources in the context of gas pipeline development can take the form of excavations for pipelines, pigging stations, block valves and in some cases new roads. The potential physical impacts are greatly dependent on the micro-siting of the infrastructure. Although it is possible to identify and protect known and above ground heritage resources (e.g. cultural sites and historical structures), it is more challenging to assess the potential impacts on unknown and underground heritage resources (e.g. the potential presence of fossils or middens). Even at a project level it is difficult to identify and confirm such heritage resources prior to excavation.

4.2.7.4 Sensitivity Analysis and Mapping

Given the diverse nature of impacts presented by gas pipelines to heritage resources, heritage sensitivity inside the Gas Pipeline Corridors was delineated according to two heritage categories, namely: 1) Palaeontological and 2) Non-Palaeontological (referring to archaeology and other heritage resources e.g. graves). The heritage features that would be impacted by gas pipeline development and their relative sensitivities are indicated in Table 4.

Palaeontological resource sensitivity was largely inferred through the use of geological maps depicting formations likely to contain fossils. Features taken into consideration to create the four-tier sensitivity palaeontological map are:

- Palaeontological sites with buffers as indicated below; and
- South African Heritage Resources Information System (SAHRIS) palaeosensitvity map consisting of a range of six sensitivity levels and related recommendations.

The occurrence of Non-Palaeontological resources is much less predictable and cannot be discounted through desktop assessment alone, unless the area has already undergone a detailed HIA (however it is acknowledged that an HIA previously conducted in an area may not have identified all heritage resources present, and over time erosion may uncover subsurface heritage resources that were not present during the previous HIA etc.). Features taken into consideration to create the four-tier sensitivity map are:

- The heritage sites (excluding palaeontological sites) as provided by SAHRA (December, 2018).

Natural features such as rivers, wetlands and pans; as well as Koppies, mountainous areas and coastlines are often foci of prehistoric and historic settlement and may therefore contain important heritage resources. These natural features, although potentially important location for heritage resources, have not been included in this sensitivity map given that the proposed sensitivity zones (buffers) around those natural features were found to be of similar magnitude (and often smaller) than those set as part of the environmental sensitivity analysis.

On 9 May 2018, the SAHRA provided the following feedback with regards to sensitivity zones for heritage sites to be used for the Gas Pipeline SEA mapping exercise. The feedback from SAHRA serves as guidance for the delineation of the Gas Pipeline SEA project with regards to sensitivity zones surrounding heritage resources, and does not constitute a legal exclusion zone as per Sections 27, 28, 29, 31, 34, 35, 36 and 37 of the NHRA. In addition, the recommended buffer zones noted below only apply to heritage resources under the jurisdiction of SAHRA. SAHRA has recommended that guidance on sensitivity buffer zones for heritage resources that fall under the jurisdiction of the PHRAs must be sought from the relevant PHRAs.

The proposed sensitivity zones for heritage resources apply to:

- officially graded heritage resources as per Section 7 of the NHRA;
- officially declared sites as per Section 27 of the NHRA; and

- sites provided a field rating as per the 2007 SAHRA Minimum Standards: Archaeological and Palaeontological components of Impact Assessments.

The proposed sensitivity zones around identified heritage resources, as recommended by SAHRA, are as follows:

- Grade 1: 2 km from either the official point or official boundary of the site;
- Grade 2: 1 km from either the official point or official boundary of the site;
- Grade 3a: 150 m from the provided point;
- Grade 3b: 100 m from the provided point;
- Grade 3c: 50 m from the provided point; and
- Ungraded/no field rating provided: 100 m from the provided point.

According to SAHRA, the above sensitivity zones do not exclude development occurring within those areas however, should development be planned to occur in the area, more intensive mitigation measures may be necessary. Depending on the sensitivity of the heritage resources, the development in or near the proposed buffer zones will be subject to footprint amendments based on the findings of a HIA.

SAHRA noted that the various heritage site taxonomy i.e. archaeological sites, palaeontological sites, built environment sites, burial grounds and monuments, underwater heritage sites, were not used to further separate the categories of heritage, as the variable involved with the sites are too large to employ at the current high-level mapping exercise.

The Gas Pipeline Corridors were mapped separately for Palaeontological sensitivity and Non-Palaeontological sensitivity. The two mapping outputs were then integrated into a combined mapping output, by retaining the highest sensitivity rating between the two sensitivity maps for all areas within the corridors. The combined sensitivity map (Map 1) is symbolic of overall heritage sensitivity inside of each Gas Pipeline Corridor.

Sensitivity maps (Palaeontological resources and non-palaeontological resources) were produced for the corridors according to the criteria set out in Table 4 to classify heritage sensitivity spatially into four tiers namely, Very High, High, Medium and Low.

From a heritage perspective, Grade 1, 2, and 3 sites have been considered as sites that have a mapped heritage feature present, and these areas will be avoided during gas pipeline design, construction and maintenance.

During the review of the Draft SEA Report, SAHRA noted that the Melkbosstrand/Blouberg Area in terms of the Battle of Blaauwberg and Koeberg Archaeological Zone as identified in the finer scale City of Cape Town Municipal Spatial Development Framework (MSDF) and Blaauwberg District Plan must be mentioned and acknowledged in the SEA Report. According to the Blaauwberg District Plan, the "Blaauwberg Hill and surrounds have high heritage significance in terms of the Battle of Blaauwberg (1806)" (City of Cape Town, 2012; Page 86[5]). Both these sites have been demarcated as cultural and recreational resource zones in the District Plan (City of Cape Town, 2012).

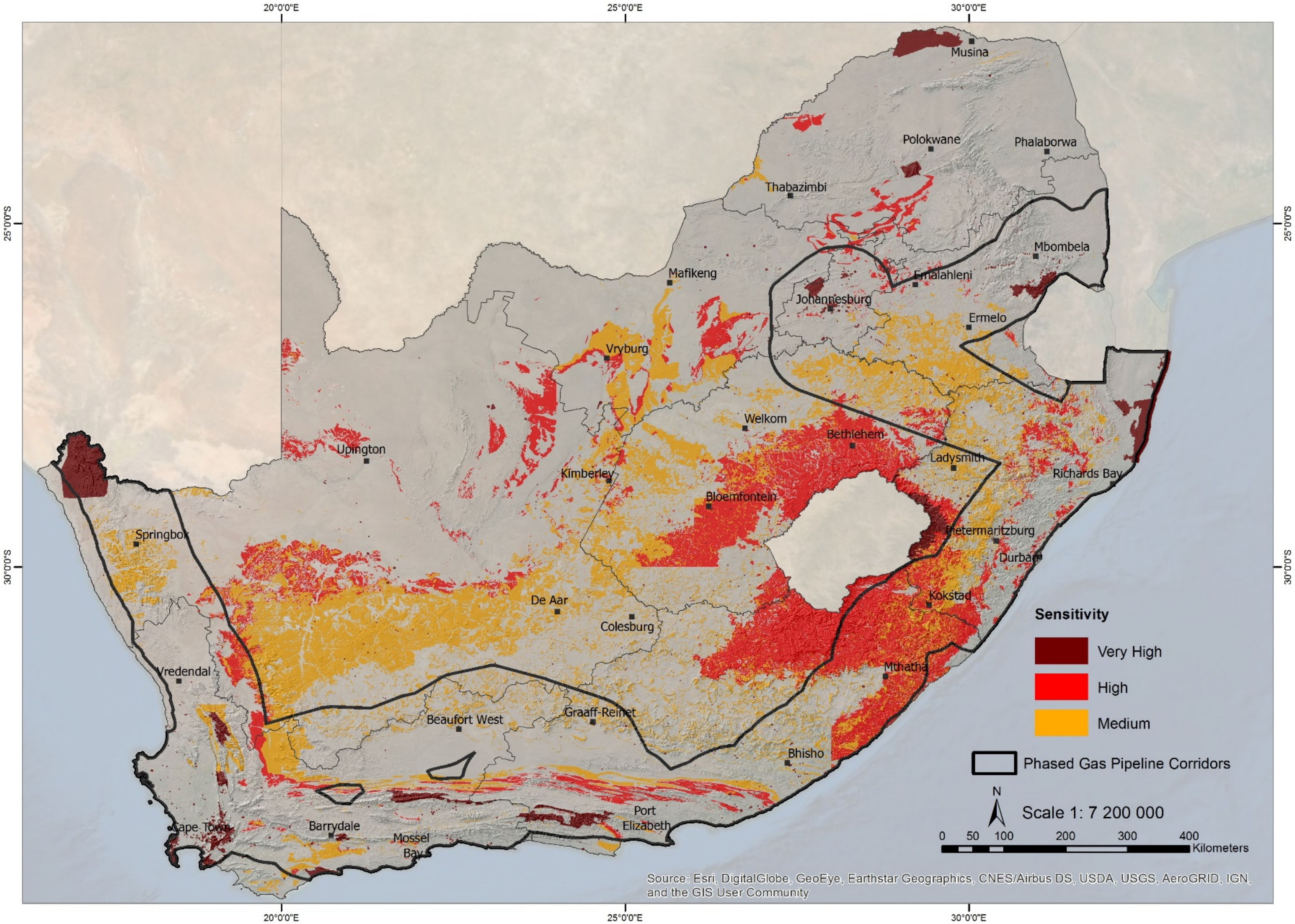
[5] City of Cape Town (2012). Blaauwberg District Plan. Accessed online (October 2019): http://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/Blaauwberg_District_Plan_Technical_Report.pdf

Table 4: Summary of sensitive heritage (including palaeontology) features, datasets and process of preparing data, and sensitivity assignment

Sensitivity Feature	Data Source and Date of Publications	Data Preparation and Processing	Sensitivity
World Heritage Sites and related buffer zones	SAPAD - Q4, 2017	Union between World heritage sites[6] as part of SAHRA, 2018 layer and SAPAD - Q4, 2017 Buffer and core areas used as is in the data set.	Very High - within defined buffer zone
Grade I sites	Mapped Heritage Features, SAHRA, 2018	As extracted from the SAHRA, 2018 Layer	Very high – 2 km buffer
Grade II sites	Mapped Heritage Features, SAHRA, 2018		Very high – 1 km buffer
Grade IIIa sites	Mapped Heritage Features, SAHRA, 2018		High – 150 m buffer
Grade IIIb sites	Mapped Heritage Features, SAHRA, 2018		High – 100 m buffer
Grade IIIc sites	Mapped Heritage Features, SAHRA, 2018		High – 50 m buffer
Ungraded sites	Mapped Heritage Features, SAHRA, 2018		Very High – 100m buffer
Battlefields (Grade IIIb)	Mapped Heritage Features, SAHRA, 2018		Very high – 5 km buffer
SAHRIS PalaeoSensitivity map - Formations of very high sensitivity (red)	SAHRIS PalaeoSensitivity Map	This map was not made available to the Project Team at the time of completion of this SEA Process. It should be noted that the information is currently only available online (via the SAHRIS website). The DEA and SAHRA are in the process of obtaining the datasets from the Council for Geosciences.	Very High
SAHRIS PalaeoSensitivity map - Formations of high sensitivity (orange/yellow)			High
SAHRIS PalaeoSensitivity map - Formations of moderate and unknown sensitivity (Green/white)			Medium
SAHRIS PalaeoSensitivity map - Formations of low (blue)			Low
Palaeontological Substrate and Heritage Resources: High Sensitivity Areas: • ADELAIDE • KOEGAS • SCHMIDTSDRIF • ASBESTOS HILLS • KUIBIS • SCHWARZRAND	Geology – Known to potentially have Palaeontological features from previous assessments, Council for	As extracted from geology layer	High

[6] It is understood that World Heritage Sites are managed by the DEA and not SAHRA, except, when a National Heritage Site has been declared a World Heritage Site, in which case both entities are responsible for the co-ordination of the management of these sites.

Sensitivity Feature			Data Source and Date of Publications	Data Preparation and Processing	Sensitivity
• BOEGOEBERG DAM • BOTHAVILLE • BRULSAND • CAMPBELL RAND • CLARENS • DRAKENSBERG • DWYKA • ECCA	• MATSAP • MOLTENO • PRINCE ALBERT • RIETGAT • ELLIOT • ENON • GHAAP	• STALHOEK • SULTANAOORD • TARKASTAD • VRYBURG • WHITEHILL • WITTEBERG • KAMEELDOORNS	Geosciences, 2014		
Palaeontological Substrate and Heritage Resources: Medium Sensitivity Areas:			Geology – Known to potentially have Palaeontological features from previous assessments, Council for Geosciences, 2014	As extracted from geology layer	Medium
• ACHAB • ALLANRIDGE • BIDOUW • BREDASDORP • CERES • CONCORDIA GRANITE • DWYKA • FORT BROWN • GESELSKAPBANK • GLADKOP • GRAHAMSTOWN • HARTEBEEST PAN • GRANITE	• KOOKFONTEIN • KORRIDOR • MESKLIP GNEISS • MODDERFONTEIN • GRANITE/GNEISS • NAAB • NABABEEP GNEISS • HOOGOOR • KALAHARI • KAMIESKROON GNEISS • KAROO DOLERITE • KHURISBERG • KONKYP GNEISS	• NAKANAS • NARDOUW • NUWEFONTEIN • GRANITE • RIETBERG GRANITE • SKOORSTEENBERG • STINKFONTEIN • STYGER KRAAL • SYENITE • TABLE MOUNTAIN • TIERBERG • VOLKSRUST • WATERFORD			



Map 1: Heritage (Palaeontology and non-palaeontology) sensitivity map for Gas Pipeline Development in the corridors (Data Sources: Council for Geosciences, 2014; SAHRA, 2018; and DEA (SAPAD), 2017).

4.2.7.5 Interpretation of Sensitivity Maps

The four-tier sensitivity map (Map 1) identified the presence of known heritage resources and the areas in which the likelihood of longer and more expensive HIAs involving mitigation of heritage resources is higher. It should be noted that a HIA is required when it is anticipated that there will be impacts on significant heritage resources for a particular development proposal. Given the large size of South Africa, most HIAs incorporate a heritage survey but the two activities are not necessarily synonymous. All HIAs must include a field based survey in line with the requirements of Section 38 (3) of SAHRA. A Heritage Scoping Assessment Report or Heritage Desktop Assessment may or may not contain a field survey. The four-tier sensitivity map does not account for areas already thoroughly surveyed (either through research or during HIAs). Depending on the development proposal, a HIA may or may not be required in these areas (DEA, 2016). It is understood that all development proposals that undergo a NEMA Environmental Authorisation Process will require an assessment of the impacts to heritage resources is undertaken (i.e. Section 24 (4) (b) (ii) of NEMA and Section 38 (8) of the NHRA). Here below is a short summary of the explanation of the combined four-tier sensitivity map.

Table 5: Interpretation of Heritage Sensitivity Maps

Sensitivity Class	Interpretation	Implementation and additional assessments at project level (*)	Permit requirements (if any)
Very High	This category includes • Grade I and II Heritage sites; • World, National and Provincial Heritage Sites with their related buffer zones, i.e. a buffer zone of 2 km and 1 km implemented around these sites respectively. World Heritage Sites have their own defined buffer zones; • The proposed site is located on areas of Very High sensitivity as indicated by the SAHRIS palaeontological sensitivity map (red areas). These areas are formally protected areas under the NHRA and the World Heritage Convention Act (Act No. 49 of 1999) and should be avoided.	Areas of very high sensitivity are areas which are formally protected under the NHRA and the World Heritage Convention. An Archaeological/Palaeontological Impact Assessment must be undertaken within these areas and their prescribed buffer zones. Areas of very high palaeosensitivity require a PIA during the design phase, inclusive of a field assessment.	Permit required under Section 27 of NHRA from: • SAHRA for any possible impact on Grade I National Heritage Sites; and • PHRAs for impact on Grade II Provincial Heritage Sites. Additional permit from the Management Authority of the Fossil Hominid Sites of South Africa. Additional permit from SANParks, where required.
High	High sensitivity represents areas which are or have the potential to be highly sensitive in terms of heritage resources because either: • Previous assessment of the area has identified palaeontological/archaeological	A general avoidance strategy should be taken but mitigation might be allowed under certain circumstances if avoidance is not possible. It is expected that HIAs or PIAs will then be required for proposed	Note no permits are required for surveys. For sites of significance identified during future surveys, permits under

Sensitivity Class	Interpretation	Implementation and additional assessments at project level (*)	Permit requirements (if any)
	heritage resources which are classified as being of high significance; or • The proposed site is located on areas of High sensitivity as indicated by the SAHRIS palaeontological sensitivity map (orange/yellow areas); or • There is a high probability of encountering a significant heritage resource; or • There is the potential to include cultural heritage resources which will require conservation or lengthy mitigation.	developments in these areas and that some sites may be identified which will require mitigation, thereby increasing costs and lengthening the timeframes of the applications. PIA: Desktop study during design phase. Walk through orange areas of selected route and report before excavation activities (by respective specialist).	Section 35 of the NHRA will normally be required from the relevant heritage authority if impacts are envisaged[7].
	Sites of high significance: IIIa sites with 150m buffer zone.		For significant sites already recorded or identified during future surveys, permits will normally be required from the relevant heritage authority if impacts are envisaged.
Medium	Medium sensitivity represents areas which are, or have the potential to be, sensitive to development in terms of heritage resources because either: • Previous assessment of the area has identified heritage resources which are considered to be of medium significance; or • The proposed site is located on areas of moderate and unknown sensitivity in the SAHRIS palaeontological sensitivity map (green/white areas); or • There is a moderate probability of encountering significant heritage resources.	It is expected that HIA/PIA will be required for proposed developments in these areas and that some sites may be identified which will require mitigation, thereby increasing costs and lengthening the timeframes of the applications. However, such sites are expected to be less sensitive or extensive than in high sensitivity areas. Areas of moderate and unknown palaeontological sensitivity will require desktop studies during the design phase.	Note no permits are required for surveys. For sites of significance identified during future surveys, permits under Section 35 of the NHRA will normally be required from the relevant heritage authority if impacts are envisaged.

[7]See previous footnote about HWC's process for handling the permitting process under Section 38 of the NHRA. Note that Heritage Western Cape currently does not require 'permits' for generally protected heritage resources under the NHRA when developments trigger Section 38 of the NHRA. Instead, a work plan is required which is very similar to a permitting process.

Sensitivity Class	Interpretation	Implementation and additional assessments at project level (*)	Permit requirements (if any)
	Sites of medium significance: IIIb sites with 100m buffer zone.		For significant sites already recorded or identified during future surveys, permits will normally be required from the relevant heritage authority if impacts are envisaged.
Low	Low sensitivity represents areas which are not likely to be sensitive to development in terms of heritage resources because either: • Previous assessment has revealed the area to contain no resources or resources of low significance; or • The proposed site is located on formations of low sensitivity in the SAHRIS palaeontological sensitivity map (blue areas); or • There is a low probability of encountering significant heritage resources.	For sites known to contain no resources, no further assessment is necessary for the proposed development in these areas. In areas where there is a low chance of finding heritage material of significance (the majority of the lowlands and areas already fully assessed), a HIA is required but it is expected that no material of significance requiring extensive mitigation will be identified. In areas of low palaeontological sensitivity, a palaeontological chance find procedure should be requested to be included in the EMPr and reviewed by a specialist. Where Grade IIIc sites occur and these sites have generally been recorded sufficiently and are of low significance – no further mitigation is normally required for these sites.	For sites of significance identified during future surveys, permits will normally be required from the relevant heritage authority if impacts are envisaged.
	Sites of low significance: IIIc sites with 50 m buffer zone.		No permit is required for development to proceed in these areas.

(*) NOTE: Motivating for exemption from a PIA/HIA - A PIA/HIA may not be required if such motivation is included in the initial notification prepared by a competent heritage specialist. In order to motivate for a PIA/HIA not to be required the inputs from a heritage specialist is required as part of the notification. Site visits to inform the notification may also be necessary to motivate for a PIA/HIA not to be required, and are up to the discretion of the specialist providing input to the notification. In most cases, it will be sufficient for only the heritage specialist preparing the notification to visit the site before an exemption from further assessment can be motivated. If exemption from further assessment is motivated, the notification must contain proposed mitigation measures for inclusion in the EMPr.

4.2.7.6 Conclusions and General Recommendations

The following general recommendations for the management of heritage resources have been identified, and additional detail will be provided in the EMPr:

- In general, important heritage sites that are small in spatial extent need to be protected through implementation of buffers, as noted above.
- Where significant heritage resources are known to occur or have been identified in an HIA, Environmental Control Officers (ECOs) will need to be appointed and need to be trained by an archaeologist or palaeontologist, depending on the nature of the finds, to identify any sub-surface heritage resources during construction, in order to prevent loss of highly significant palaeontological, archaeological and palaeoanthropological resources.
- Carry out general monitoring of excavations for potential fossils, artefacts and material of heritage importance. Monitoring of excavations, especially in highly sensitive fossil areas, will prevent loss of data and greatly contribute to the scientific understanding of these heritage resources.
- In general, following the routes of existing linear infrastructure servitudes (where possible) will reduce cultural landscape impacts to a degree (however the findings of all relevant specialist studies need to be taken into consideration in order to determine if potential cumulative impacts are acceptable).
- Shell middens and artefact scatters have scientific value and should be avoided during gas pipeline and associated infrastructure construction. Rock art sites, historic farmhouse complexes, and built environment and historic sites are much more visually sensitive and should be buffered. Such buffering will ensure protection of the sites and their contexts.
- Structures older than 60 years and not located in formal towns, such as farmsteads and the trees surrounding farm houses, and the surrounding homesteads are an integral part of the South Africa's colonial rural landscape. These historical landscapes will also require assessment and possible buffering.
- Identify, demarcate and prevent impact to all known sensitive heritage features on site.
- All work must cease immediately, if any human remains and/or other archaeological, palaeontological and historical material are uncovered. Such material, if exposed, must be reported to the nearest museum, archaeologist/ palaeontologist (or the South African Police Services), so that a systematic and professional investigation can be undertaken. Sufficient time should be allowed to remove/collect such material before development recommences.
- During the construction phase, consultation with affected and surrounding communities will be important in terms of grave finds and management of heritage sites. It is also important to consult with affected communities during the planning stage to identify the location of any informal burial grounds. In this regard, preliminary consultation with the affected communities regarding any heritage resource close to and within the gas pipeline servitude must be undertaken and included in the HIA.

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.8

Climate Change

CONTENTS

TABLES

FIGURES

ABBREVIATIONS

CSIR	Council for Scientific and Industrial Research
FHI	Flood Hazard Index
IPCC	Intergovernmental Panel on Climate Change
MSL	Mean Sea Level
NCA	National Coastal Assessment
RCP	Representative Concentration Pathways
SLR	Sea Level Rise
WMO	World Meteorological Organisation

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.8 Climate Change

4.2.8.1 Introduction and Scope

It is estimated that devastating impacts of weather-induced natural hazards – such as flooding, heatwaves, droughts, coastal flooding, wildfires and storms – will continue intensifying. According to the Intergovernmental Panel on Climate Change (IPCC) (2007), climate change will cause low-lying coastal areas to be inundated, thereby resulting in potential impacts on coastal infrastructure (Boko et al., 2007 in Council for Scientific and Industrial Research (CSIR), 2011). Satellite data indicates that the sea level rise from 1993 to 2006 was 3.3±0.4 mm per year (Theron, 2011 in CSIR, 2011). It is predicted that even with the stabilisation of greenhouse gas concentrations, sea level rise will continue to occur (IPPC, 2007 in CSIR, 2011).

When considering the development of linear infrastructure, it is important to understand the impact of climate change on the intensity and magnitude of these hazards, as this may ultimately affect the location and the design of such infrastructure. From an operational perspective, a drier climate is not a concern for a gas pipeline. However, if the climate gets wetter, buoyancy issues would prevail, requiring additional design measures (e.g. concrete weights or saddles) to address the constraint and prevent it from floating. Floating may induce bending stresses with the potential to cause fatigue on the pipeline increasing the risk of failure to the pipeline. If the air temperature increases or decreases within a few degrees Celsius (and not in the extreme), it is unlikely that this will affect the soil temperature at the depth of the pipeline and is not likely to be a concern to the gas pipeline.

The Cape Nature Disaster Management team confirmed that given the depth of the pipeline between 1 - 2 m underground, veld fires or controlled burning for crops would not pose a risk as the soil below ground returns to normal temperatures from about 10 cm below ground level. Root fires may have a different impact, however, deep rooted vegetation will not be allowed to establish above the pipeline within the registered servitude. In addition, forest areas will be avoided for the development of the pipeline.

This section is essentially based on information extracted from the Green Book compiled by the CSIR between 2016 and 2019 (CSIR, 2019). The Green Book seeks to "*facilitate the integration of climate change adaptation into local government planning instruments and processes, in support of the development of climate resilient cities and settlements*". As such, a number of projects were undertaken to investigate the anticipated impact that a changing climate and growing urban population will have on the settlements and key resources of South Africa.

While it is acknowledged that the Green Book's main function is to assist local municipalities in integrating climate change adaptation measures into their planning processes; for the purpose of this study, information from the online tool is used to identify high risks areas in terms of extreme rainfall events, inland flooding and coastal flooding when developing a gas pipeline network. This information is therefore only to be used <u>as a guideline</u> for the identification of high risks areas. Projections on drought and fire risks have been included in Appendix A of this chapter for information purposes only.

Climate change projections are usually evaluated under four different mitigation scenarios (known as the Representative Concentration Pathways (RCP)). The projections presented in the Green Book are for the following two mitigation scenarios, namely:

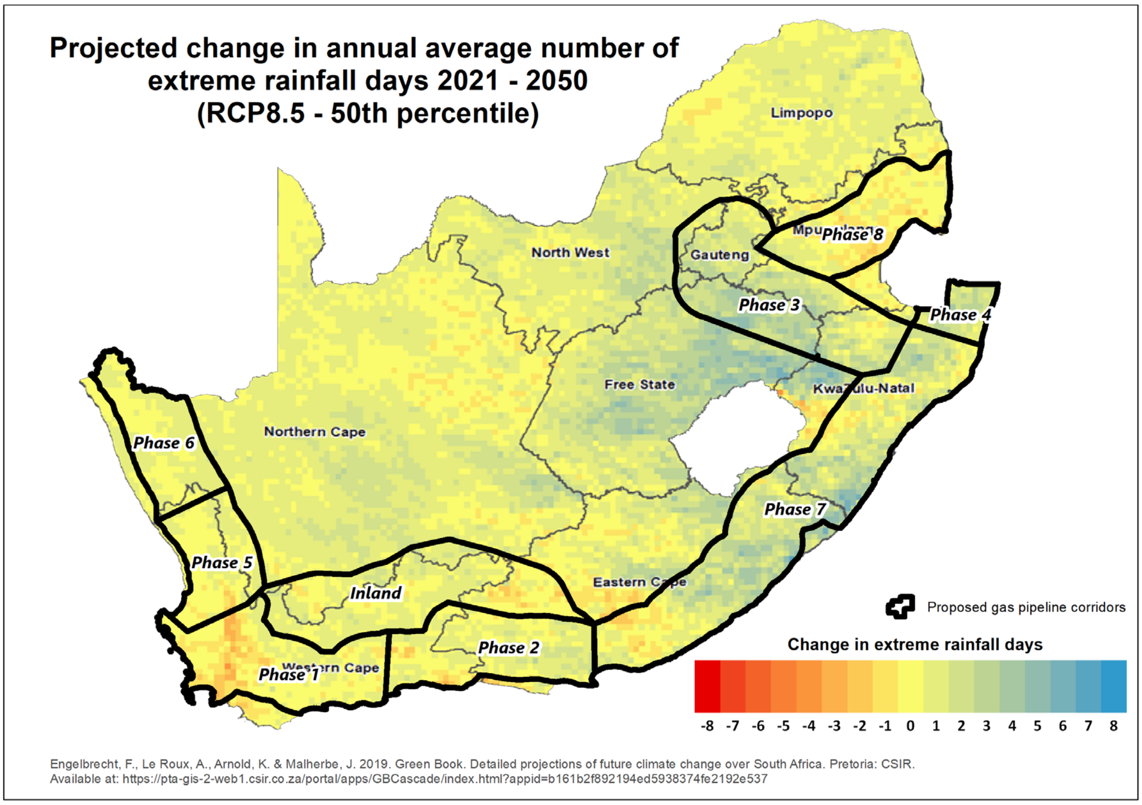
1. RCP 8.5 – where low mitigation is implemented (worst case scenario); and
2. RCP 4.5 – where high mitigation is implemented.

The following sections depict the projected change in the magnitude of the hazards identified above in relation to the location of the proposed gas pipeline corridors.

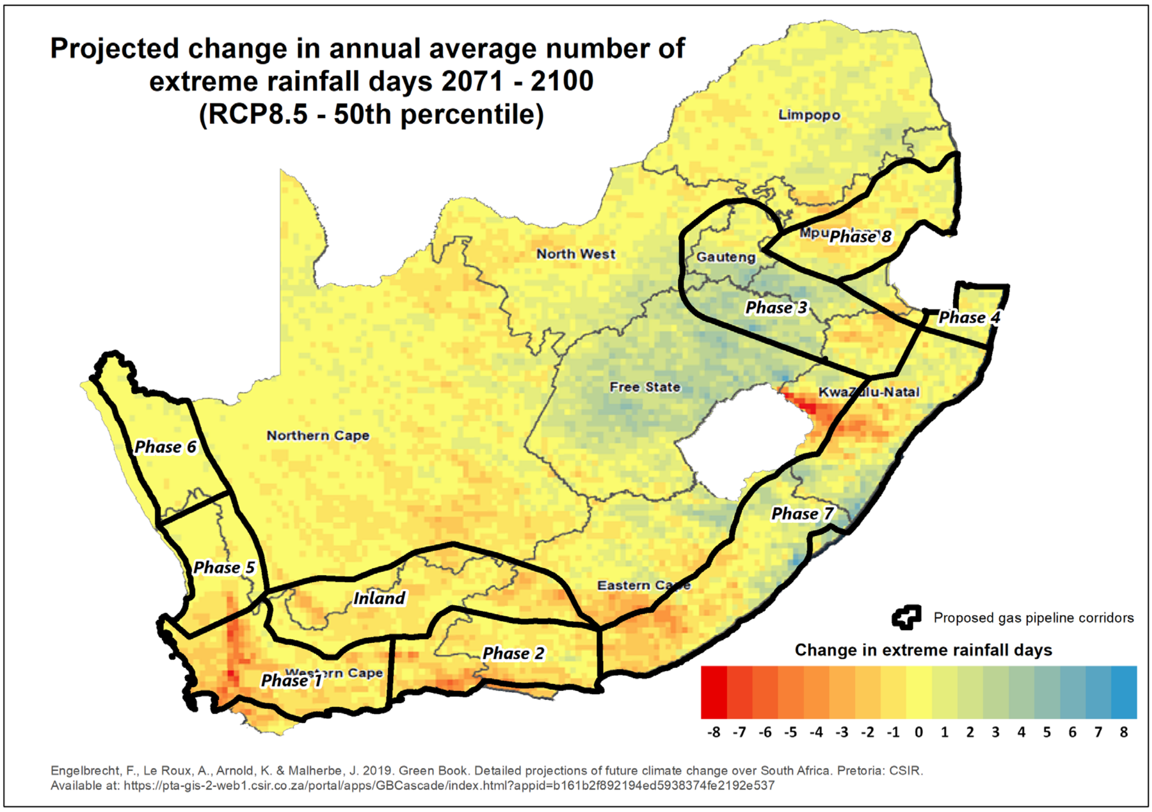
4.2.8.2 Extreme rainfall days

The following section is extracted from the Green Book (Engelbrecht et al., 2019).

Figures 1a and b show the projected change in the annual average of extreme rainfall days by 2050 and 2100 respectively, under an RCP 8.5 low mitigation (worst case) scenario (Engelbrecht et al., 2019). An extreme rainfall event (including severe thunderstorms and lightning) is defined as 20 mm of rain occurring within 24 hours over an area of 64 square kilometres (Engelbrecht et al., 2019). A value above 1 shows an increase in the annual average of extreme rainfall days. Most of the country shows some level of increase in extreme rainfall days, while some provinces (in particular Western Cape, Eastern Cape and Mpumalanga) are anticipated to experience a decrease in extreme rainfall days in some areas. There is however a general tendency towards a decrease in the annual average of extreme rainfall days for most provinces (with the exception of the Free State and Gauteng, and its surroundings) by 2100 (Figure 1b).



a)



b)

Figure 1: Projected change in annual average number of extreme rainfall days (50th percentile[1]): 2021-2050 (a) and 2071-2100 (b).

Based on Figure 1 above, the following can be established:

- Most of the proposed gas pipeline corridors will experience a slight increase in annual average number of extreme rainfall days in the short term (2021-2050);
- Small areas in Phase 1, Phase 7 (in the Eastern Cape) and Phase 8 are expected to experience a decrease in annual average number of extreme rainfall days until 2050;
- Some areas in Phase 1 (Western Cape), Phase 2 (Western and Eastern Cape), and Phase 7 (Eastern Cape and KwaZulu-Natal) will experience a decrease in the annual average of extreme rainfall days in the long-term (2071-2100).

4.2.8.3 Floods

The following section is extracted from the Green Book (Le Maitre et al., 2019).

Inland flooding, caused by surface water, consists of flash flooding as well as river and groundwater flooding. Le Maitre et al. (2019) developed a Flood Hazard Index (FHI) based on the catchment characteristics and design rainfall, and averaged at the quinary catchment level. As depicted on Figure 2, the FHI at a national level is rated as medium for the majority of the country. Namaqualand, the Kalahari, parts of the Karoo, the Limpopo valley and the Zululand coast have been shown to display low to very low FHI, while some areas in KwaZulu-Natal and the Eastern Cape display a very high FHI.

[1] 50th percentile: A percentile is a statistical measure to indicate the value below which a given percentage of observations in a group of observations falls. For example, the 50th percentile is the value below which 50% of the observations fall.

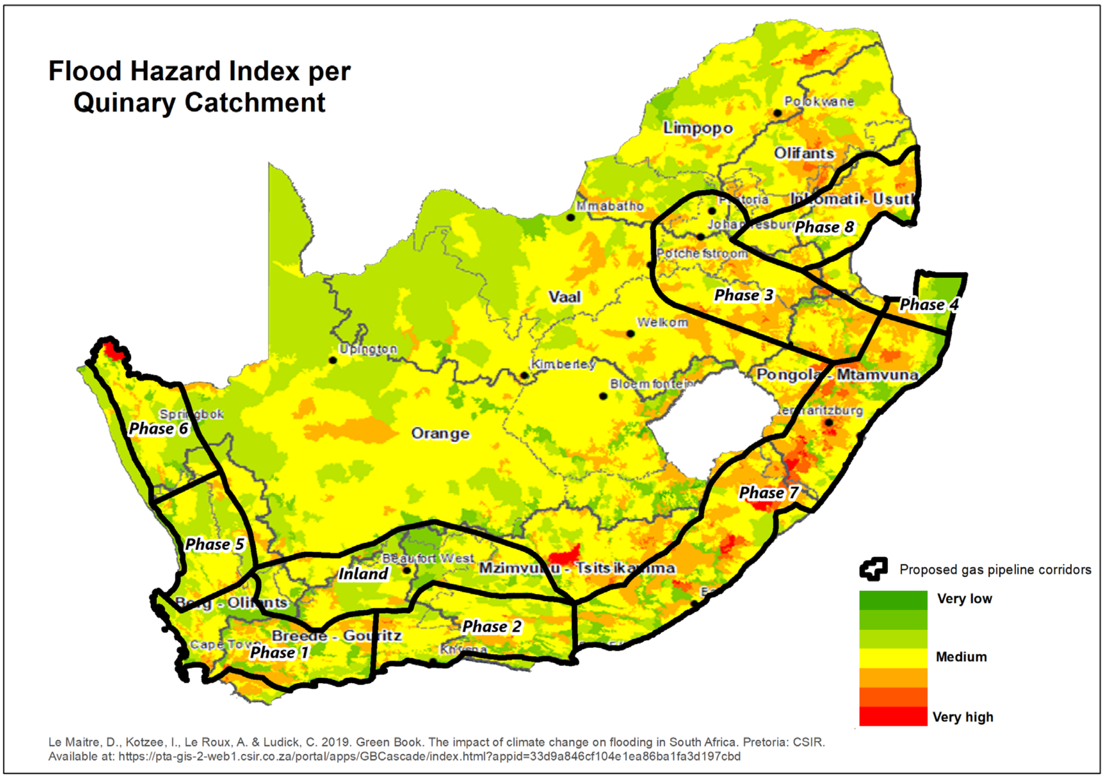


Figure 2: Mean Flood Hazard Index per Quinary Catchment in relation to the gas pipeline corridors (Le Maitre et al.; 2019).

It must be noted that this flooding assessment only provides an overview of relative flood hazards and risks for a range of settlements in South Africa and a more detailed assessment will be required at project level once a specific route has been identified.

4.2.8.4 Coastal Flooding

The following section is extracted from the National Coastal Assessment Draft Report (CSIR, 2018).

Coastlines are expected to be influenced by climate change in a number of different impacts. Sea level rise will cause flooding of low-lying coastal areas, especially where there are no structures in place for protection of these areas (IPCC-5, 2013). Storm surges and wave run up will also influence coastal flooding as a result of increased storm frequency and intensity for parts of the South African coast. In addition, more intense wave action is expected to have a greater impact on coastal sediment dynamics, which is likely to lead to increased rates of coastal erosion (and local sedimentation) (Lück-Vogel et al., 2019).

Coastal flooding and erosion are, while not the only threats, the most significant abiotic threats to coastal environments. An estimation of the physical coastal vulnerability (combining flood and erosion risks) was determined as part of the National Coastal Assessment (NCA) undertaken by the CSIR in 2018. Table 1 lists the parameters that were used to determine coastal flood risks and erosion risks. Risks were classified in five risk classes ranging from 1 (very low) to 5 (very high).

> *Note 1: Quantified wave run-up (including storm related wave run-up and other extreme inshore water level components) were omitted from the flood risk analysis due to the lack of suitable data at higher resolution.*

Table 1: Parameters used for flood, erosion and comprehensive physical hazard risk analysis. Source: NCA (CSIR, 2018).

<table>
<tr><th></th><th>Aspect</th><th>Input Parameter</th><th>Details</th></tr>
<tr><td rowspan="7">Physical hazard risk assessment</td><td rowspan="2">Flood risk</td><td>Elevation (topography)</td><td>Risk classes based on LiDAR and SUDEM data.</td></tr>
<tr><td>Distance to coast</td><td>Euclidian distance calculated from National_Coast_Types shape file, and reclassified into risk classes.</td></tr>
<tr><td rowspan="5">Erosion risk</td><td>Geomorphology</td><td>Risk classes based on coast attributes in National_Coast_Types.shp, which were then projected inland.</td></tr>
<tr><td>Ground Cover</td><td>Risk classes based on SA Land Cover 2013-14 data.</td></tr>
<tr><td>Bathy slope</td><td>Parameter calculated based on Bruun's rule using nautical chart contours (slopes) as proxy for SLR vulnerability, which were then projected to the nearshore inland and classified into risk classes.</td></tr>
<tr><td>Coastal protective structures</td><td>Structures digitised from Google Earth, projected inland and classified into risk classes.</td></tr>
<tr><td>Foredune volume</td><td>Calculated from LiDAR and SUDEM data and highest astronomical tide (HAT, as base level) per province, and classified into risk classes.</td></tr>
</table>

Note 2: Flooding through extreme water levels in the hinterland, e.g. through excessive rainfall and river flooding were not assessed at this stage, not were the potential flood risks through Tsunamis, land subsidence or landslides.

Tables 2 and 3 illustrate the risk classes used for elevation above sea level and distance from the coast respectively.

Table 2: Hazard risk categories for elevation above sea level

	Hazard Risk				
	Very low	Low	Medium	High	Very high
	1	2	3	4	5
Elevation (above MSL)	**>20 – 30 m**	**>10 – 20 m**	**>5 – 10 m**	**>3 – 5 m**	**0 – 3 m**

Accepted sea level rise (SLR) scenarios provided by IPCC-5 (2013) show an expected rise between 0.55 and 1.2 m globally by 2100. The areas expected to be affected by SLR are therefore located in the "very high" risk class. In the final flood hazard class, SLR affected areas could be occurring in the very high to medium risk class.

Table 3: Hazard risk categories for distance from coast

	Hazard Risk				
	Very low	Low	Medium	High	Very high
	1	2	3	4	5
Distance from coast	**>1,000 m**	**>200 – 1,000 m**	**>50 – 200 m**	**>20 – 50 m**	**0 – 20 m**

Based on Tables 2 and 3, it is assumed that areas higher than 10 m above Mean Sea Level and further than 200 m from the coast are generally safe (low risks) from ocean-borne flooding.

An example of coastal flooding risk for Strand (False Bay, Cape Town) is depicted in Figure 3a.

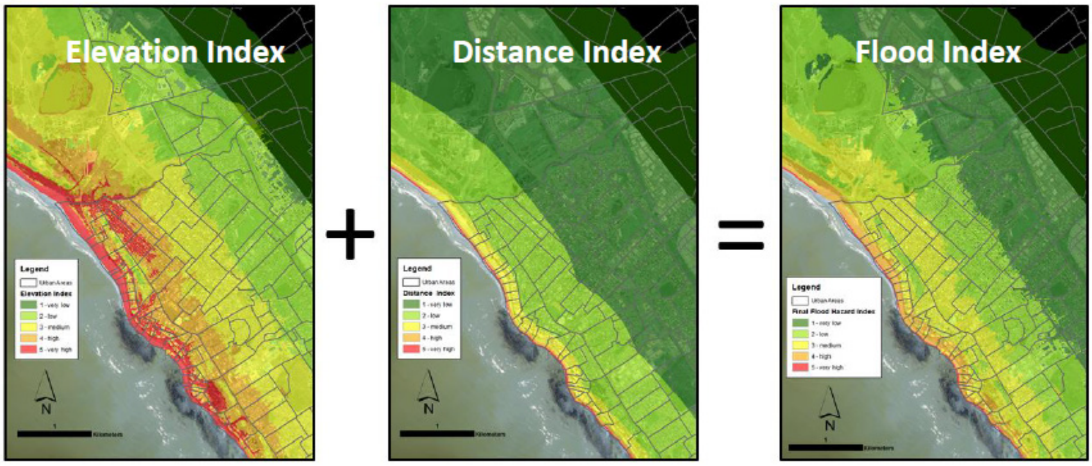


Figure 3a: Final flood risk index for Strand (False Bay, Cape Town). Source: NCA (CSIR, 2018).

The physical coastal vulnerability of an area is based on the coastal flooding risk and erosion risks. An example of physical coastal vulnerability risk for Strand (False Bay, Cape Town) is depicted in Figure 3b.

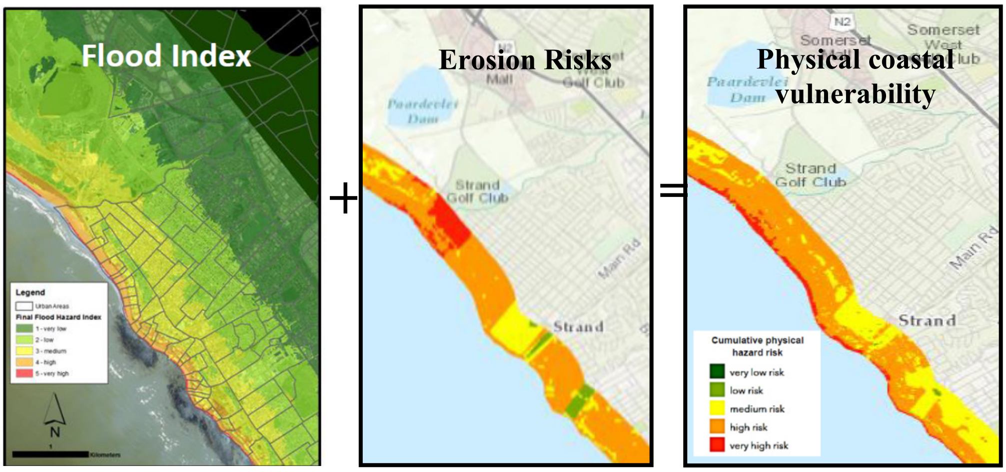


Figure 3b: Physical coastal vulnerability risk for Strand (False Bay, Cape Town). Source: NCA (CSIR, 2018).

The final gas pipeline corridors considered in this study have been set back by a minimum of 1 km from the coast due to engineering constraints. Therefore, it is not expected that the final corridors would be exposed to coastal flooding or coastal erosion.

4.2.8.5 Conclusion

Given the above and an increase population pressure on coastal urban areas (see urban projections in the Green Book, Le Roux et al. 2018), coastal development and management will have to be particularly aware of the hazards and potential risks arising therefrom.

The information presented above, as provided by the Green Book (CSIR, 2019) are based on all the assumptions noted in the tool. It is assumed that municipalities will use the Adaptation Actions Tool to adapt to the impacts of climate change, reduce exposure to hazards, and exploit opportunities for sustainable development (CSIR, 2019). Such measures fall within the mandate of the municipality, and as such, the related climate change adaptation and hazard reduction requirements for potential gas pipeline developments will be discussed with the project developer and affected municipalities on a project specific basis.

Therefore, it is important that during the project specific stage, the project developers consider climate change models developed at the time in order to plan for the infrastructure correctly and that additional assessments relating to climate change impacts be undertaken.

4.2.8.6 References

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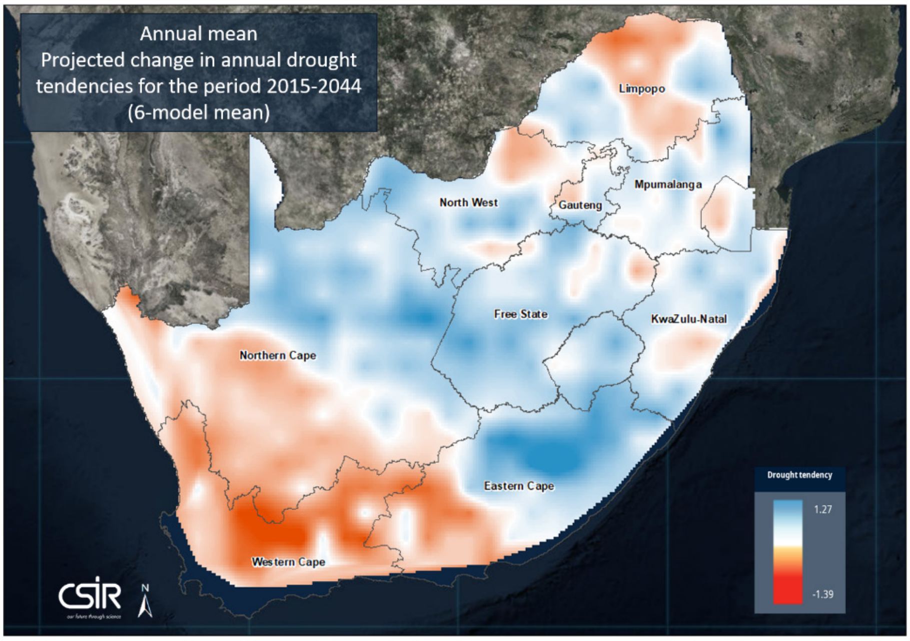
APPENDIX A

Drought

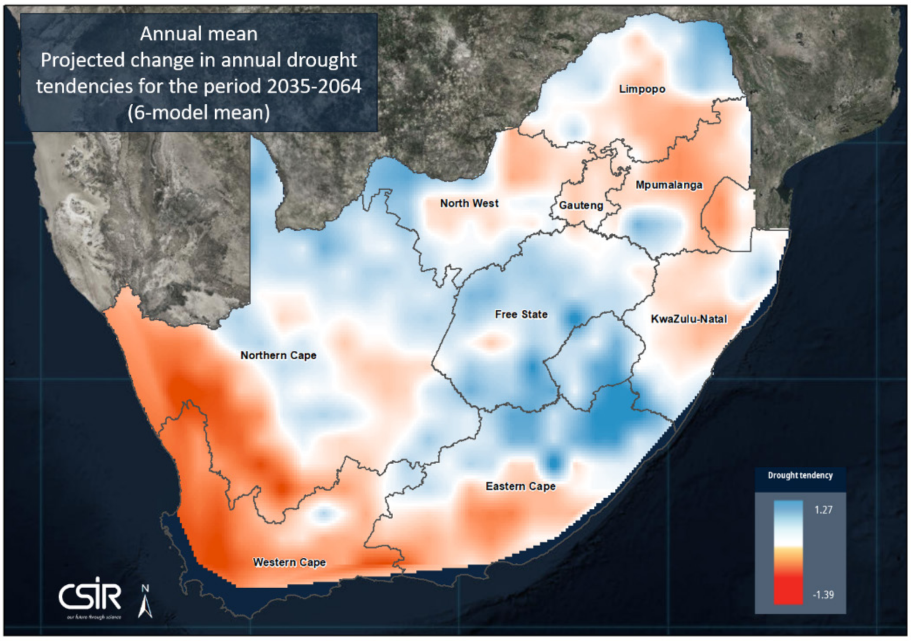
Possible future changes in the state of drought (and flood) over South Africa under the low mitigation scenario (RCP 8.5) were estimated using the 6 climate projections in terms of SPI[2] (Beraki et al., 2019). Figures 4 a) and b) show the projected change in the drought (flood) tendency (i.e. number of cases exceeding near-normal per decade) over South Africa for the period 2015-2044 and 2035-2064 relative to the 1986-2005 baseline period. A negative value is indicative of an increase in drought tendencies per 10 years (more frequent than baseline). The annual mean was used as it represents the contribution of all the different climate regimes of South Africa (such as winter, summer and year-round rainfall regions).

According to projections, the south-western interior and parts of Limpopo are anticipated to be drier during the period of 2015-2044, which will mainly affect Phases 1, 2, 5, 6, Inland and the southern part of Phase 7 of the Gas Pipeline Corridors. During the period of 2035-2064, a high likelihood of increased conditions of drought are projected to occur within the presence of a drastic increase in maximum temperature and very hot days (i.e. becoming even hotter and drier).



a)

[2] SPI = Standardised Precipitation Index which is recommended by the World Meteorological Organisation (WMO) and is also acknowledged as a universal meteorological drought index by the Lincoln Declaration on Drought, to characterise the extent, severity, duration and time evolution of drought (flooding) over South Africa



b)

Figure 4: Projected change in annual mean drought tendency (6-model mean) for the period 2015-2044 (a) and 2035-2064 (b)

Fire risks

As previously mentioned however, veld fires or controlled burning for crops would not pose a risk to the proposed underground pipeline. This information is therefore included for information purposes only. The number of high fire danger days (Figure 5) is relatively low in most parts of the country, with the exception of the arid north-western parts of South Africa which depicts a very high number of high fire danger days (between 140 and 220 days).

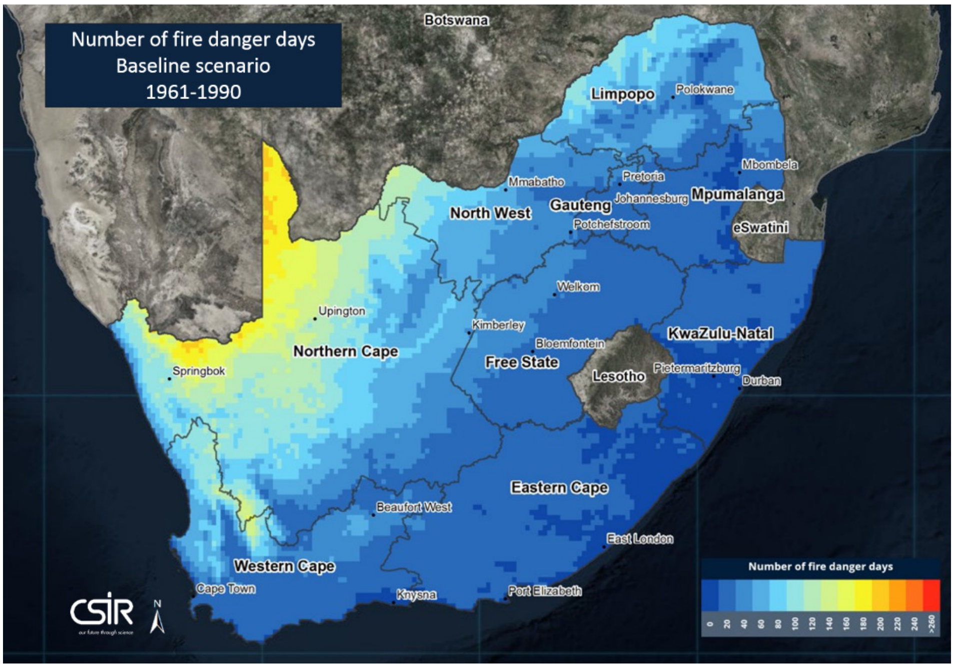


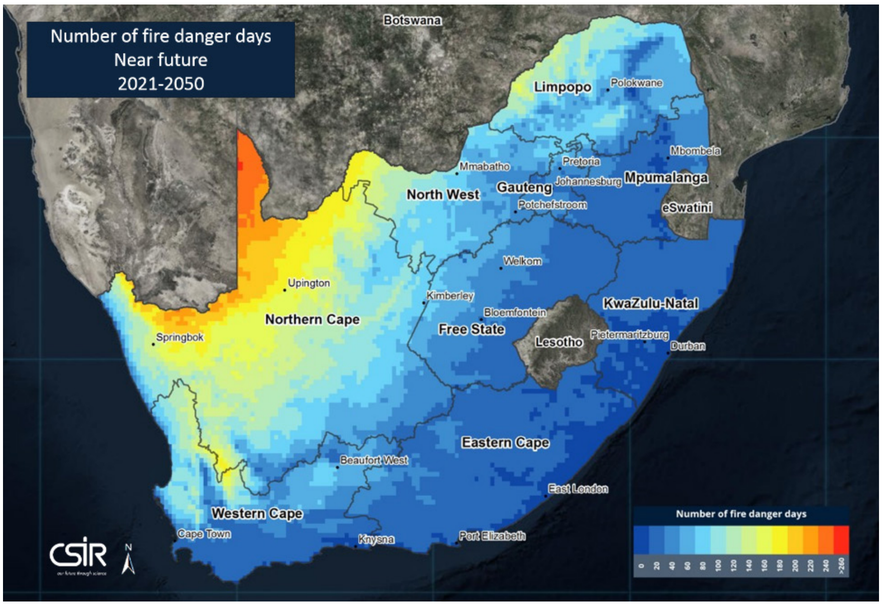
Figure 5: Number of high fire danger days - Baseline scenario (1961-1990)

It must however be noted that these calculations are based just on the climatic conditions and do not take the availability of fuel into account. For example, as shown in Table 4 below, most of the Northern Cape is covered by Karoo shrublands, which almost never experience fires. In contrast, there is a strip extending from the northern part of the Northern Cape through to Limpopo, that experienced 50 to 100 high fire danger days. This section comprises arid woodland and sweet grassland where fires can occur after growing seasons that have higher than normal rainfall. Sweet grassland and arid woodland require high rainfall to produce sufficient grass fuel for fires but when they do accumulate fuels, the fires can be extensive and the authorities need to be prepared for such fires. Sour grassland and moist woodland are areas where fires can occur annually and the grasses require fires every 2 to 5 years to regenerate themselves (Forsyth et al., 2019).

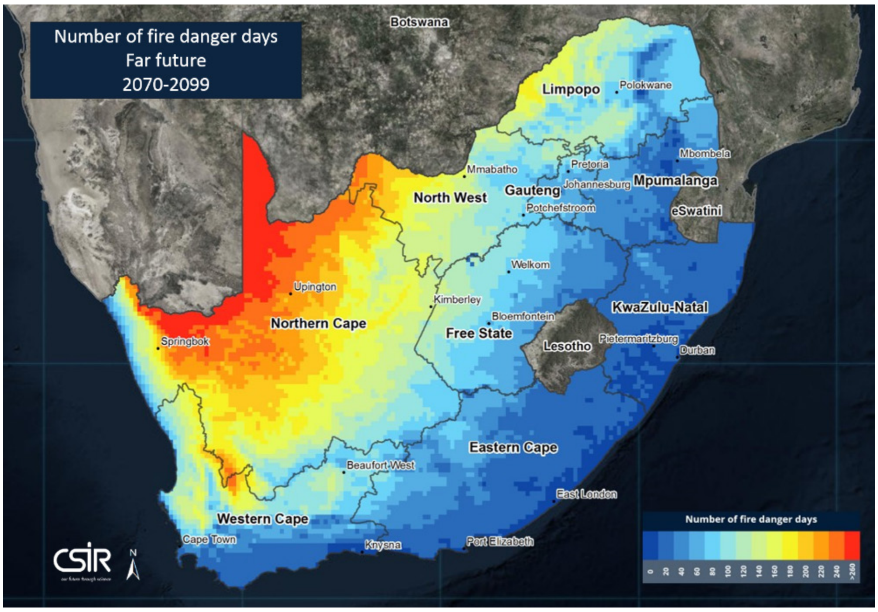
Table 4: Fire ecotype

Fire Ecotype	Fire sensitivity (values in the table are percentages of the column total)		
	Fire dependent	Fire independent	Fire sensitive
Arid Woodland	19.69%	0%	0%
Coastal Grassland	4.46%	0%	0%
Fynbos	11.14%	0%	0%
Moist Woodland	20.21%	0%	0%
Renosterveld	3.94%	0%	0%
Sparse Arid Woodland	0.3%	0%	0%
Sour Grassland	27.71%	0%	0%
Sweet Grassland	12.56%	0%	0%
Thicket	0%	35.43%	0%
Nama Karoo	0%	37.22%	0%
Succulent Karoo	0%	27.35%	0%
Grassy Nama Karoo	0%	0%	80.77%
Forest	0%	0%	19.23%
Water bodies	0%	0%	0%
Total number	**1346**	**223**	**26**

The projections for both the near future and the far future show a southward and eastward expansion of the occurrence of >25 high fire danger days per year and a contraction in the areas experiencing 0-25 days per year (Figure 6). There is also a large increase between the near and far future, which emphasises the importance of effective action to mitigate climate change. The most marked shifts in the future are projected to be in the Free State, Western and Eastern Cape, North West and Limpopo provinces.



a)



b)

Figure 6: Number of high fire danger days – a) Near future (2021-2050) and b) Far future (2070-2099)

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa

PART 4

Specialist Assessments

Part 4.2.9

Mining

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ABBREVIATIONS

CGS	Council for Geosciences
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
EGI	Electricity Grid Infrastructure
GDP	Gross Domestic Product
MPRDA	Mineral and Petroleum Resources Development Act (Act 28 of 2002, as amended)
REDZ	Renewable Energy Development Zones
SEA	Strategic Environmental Assessment

PART 4. SPECIALIST ASSESSMENTS

Part 4.2.9 Mining

4.2.9.1 Introduction and Scope

This chapter covers the potential impacts of the development of a phased gas pipeline within the proposed corridors on mining operations as well as the impact of mining on potential gas pipeline infrastructure (i.e. engineering constraint).

With access to some of the world's largest mineral reserves, the mining industry in South Africa has been, and still is, a major contributor to national economic growth and job creation (Map 1). In a media statement[1] issued on 3 September 2019, the National Department of Mineral Resources (DMR) (now operating as the Department of Minerals and Energy) noted that the mining sector increased by 14.4% and contributed 1.0% point to the Gross Domestic Product (GDP) in the second quarter, with iron ore, manganese and coal mainly contributing to the growth. Mining in South Africa is governed by the Mineral and Petroleum Resources Development Act (MPRDA) (Act 28 of 2002, as amended). The DMR serves as the Competent Authority.

The subsequent sections of this report are predominantly based on the Mining Scoping Level Assessment undertaken as part of the 2015 Phase 1 Renewable Energy Development Zones (REDZ) Strategic Environmental Assessment (SEA) (Department of Environmental Affairs (DEA), 2015[2]), which was desktop based and focused mainly on the interpretation of existing data.

4.2.9.2 Relevant Legislation

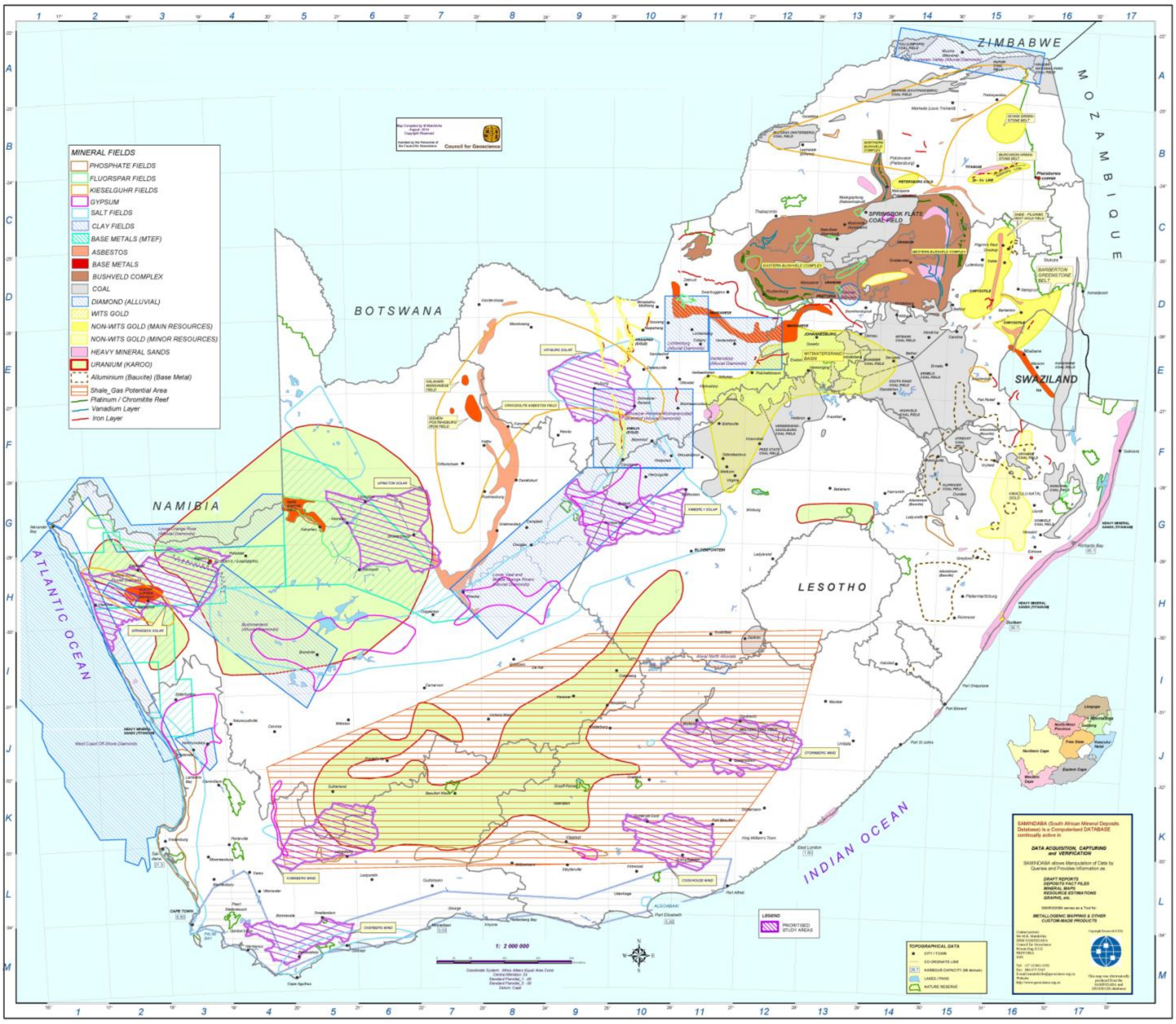
The MPRDA stipulates that mineral and petroleum resources are the common heritage of all the people of South Africa and that the State is the custodian thereof for the benefit of all South Africans. Some of the objectives of the MPRDA are to:

- recognise the internationally accepted right of the State to exercise sovereignty over all the mineral and petroleum resources within the Republic;
- promote equitable access to the nation's mineral and petroleum resources to all the people of South Africa;
- promote economic growth from mineral and petroleum resources development in the Republic;
- provide for security of tenure in respect of prospecting, exploration, mining and production operations;
- give effect to section 24 of the Constitution by ensuring that the nation's mineral and petroleum resources are developed in an orderly and ecologically sustainable manner while promoting justifiable social and economic development; and
- ensure that holders of mining and production rights contribute towards the socio-economic development of the areas in which they are operating.

Chapter 4 of the MPRDA deals with the regulation of minerals and the environment, and details the processes to follow for applications for reconnaissance permits, prospecting rights, mining rights, mining permits, and retention permits, as well as communications with Interested and Affected Parties. Chapter 6 of the MPRDA separately deals with petroleum exploration and production, and it makes provision for two permits (i.e. reconnaissance permits and technical co-operation permits) and two rights (exploration rights and production rights).

[1] Department of Mineral Resources, 2019. Media Statement: Mining Strongest Performer in the Second Quarter. Accessed 4 September 2019 [online]: https://www.dmr.gov.za/news-room/post/1813

[2] Department of Environmental Affairs, 2015. Strategic Environmental Assessment for wind and solar photovoltaic energy in South Africa. CSIR Report Number: CSIR/CAS/EMS/ER/2015/0001/B. Stellenbosch.



Map 1: Mineral and Petroleum Resource Potential Areas (Council for Geosciences (CGS), 2014)

4.2.9.3 Assumptions, Limitations and Data Sources

During the data gathering process, difficulties were experienced in sourcing, accessing, and interpreting datasets on mining. To ensure data processing accuracy and a true allocation of constraint levels, the location of existing mines and their status in terms of whether they are active, dormant or abandoned was imperative. The assumptions and limitations applicable to this study are listed in Table 1.

Table 1: Assumptions and Limitations to the Mining Study

Limitation	Included in the Scope of this Study	Excluded from the Scope of this Study	Assumption
Resource availability	Only existing, published datasets used with limited desktop verification	Field verification of datasets and outcomes, and extensive local and authority expert consultation	Reasonable accuracy of the data layers used, and a detailed desktop assessment was undertaken to refine the datasets used using ArcGIS 10.4. Field verification and interaction with the Competent Authorities (i.e. DMR) will take place on a site-by-site basis prior to development.

The list of data used for the Mining Study as part of the Gas Pipeline SEA is indicated in Table 2.

Table 2: Mining Data used in the Gas Pipeline SEA as part of the Engineering Constraints Analysis

<table>
<tr><th>Dataset</th><th>Source and Date of Publication</th><th>Data Description</th><th>Data Preparation and Processing</th></tr>
<tr><td>Mineral Data: Active and Abandoned/Dormant Mines in South Africa</td><td>CGS (Sourced directly by the DEA), 2012</td><td>The data delineates active and abandoned mines in point format per point locality. This includes all mineral commodities and range from small quarries and diggings to large open cast and underground mines, as well as shafts, adits, etc. The dataset includes:

▪ Mine, Continuously Producing;
▪ Mine, Intermittently Producing;
▪ Mine, Dormant;
▪ Mine, Abandoned; and
▪ Deposit, Exploited.</td><td rowspan="2">When rights are granted to either prospect or mine, they are based on an area or lease footprint. To convert the Active and Dormant/Abandoned mines point shapefile to a spatial footprint, the data was overlaid with the DMR 2019 dataset.

All the areas where mining rights have been withdrawn were removed from the final mining layer.

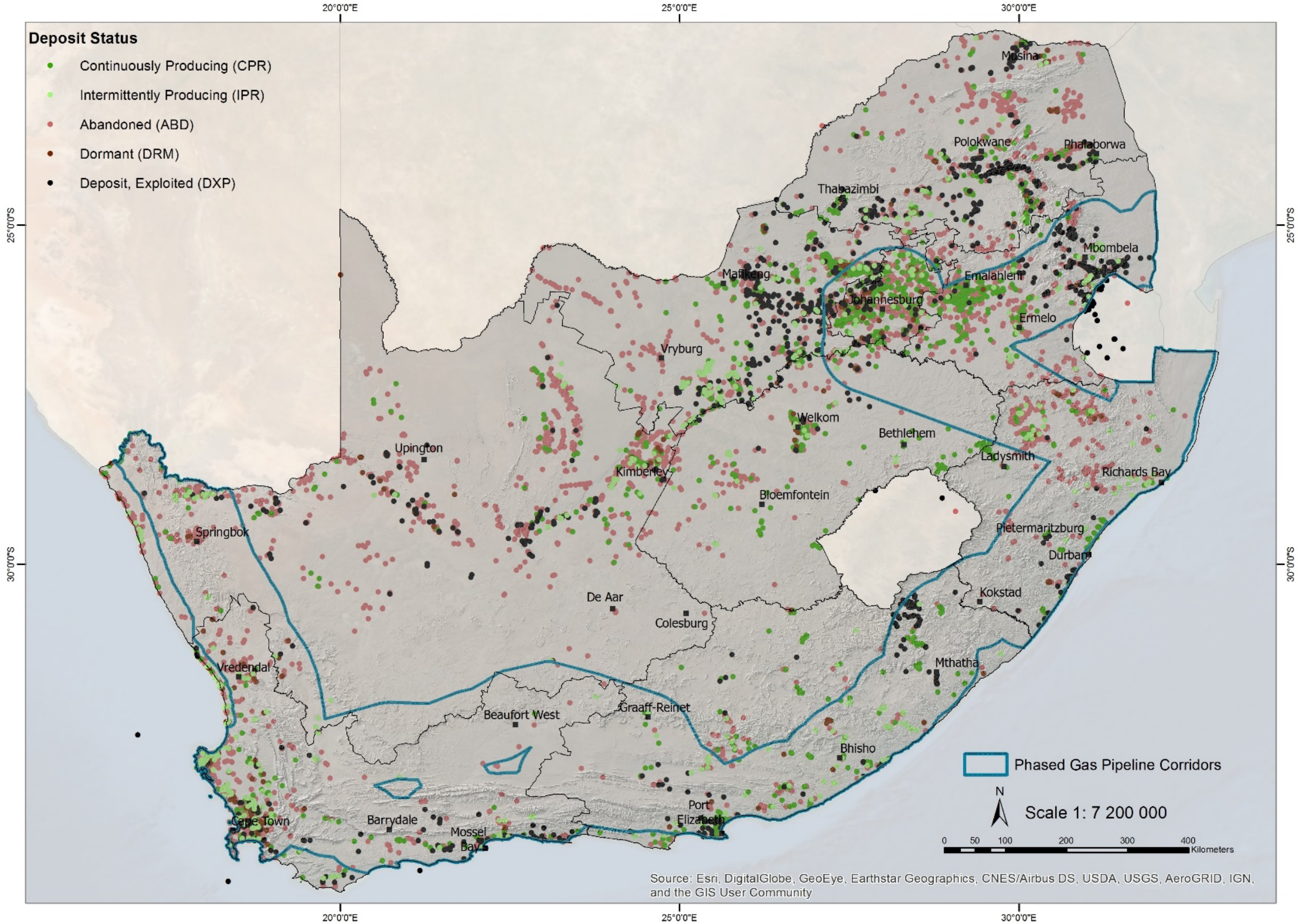
Further refinement was undertaken for the few areas where the leased footprint was too extensive. The mining lease areas with extensive footprints were refined by digitizing the actual operational area using Google Earth and ESRI base map imagery.

In addition, all active mining areas that fall within the Protected Areas were removed from the final layer.</td></tr>
<tr><td>Application Commodity: Mining Application Types</td><td>DMR, 2019</td><td>The data delineates mined minerals in polygon format per lease footprint. The dataset includes:

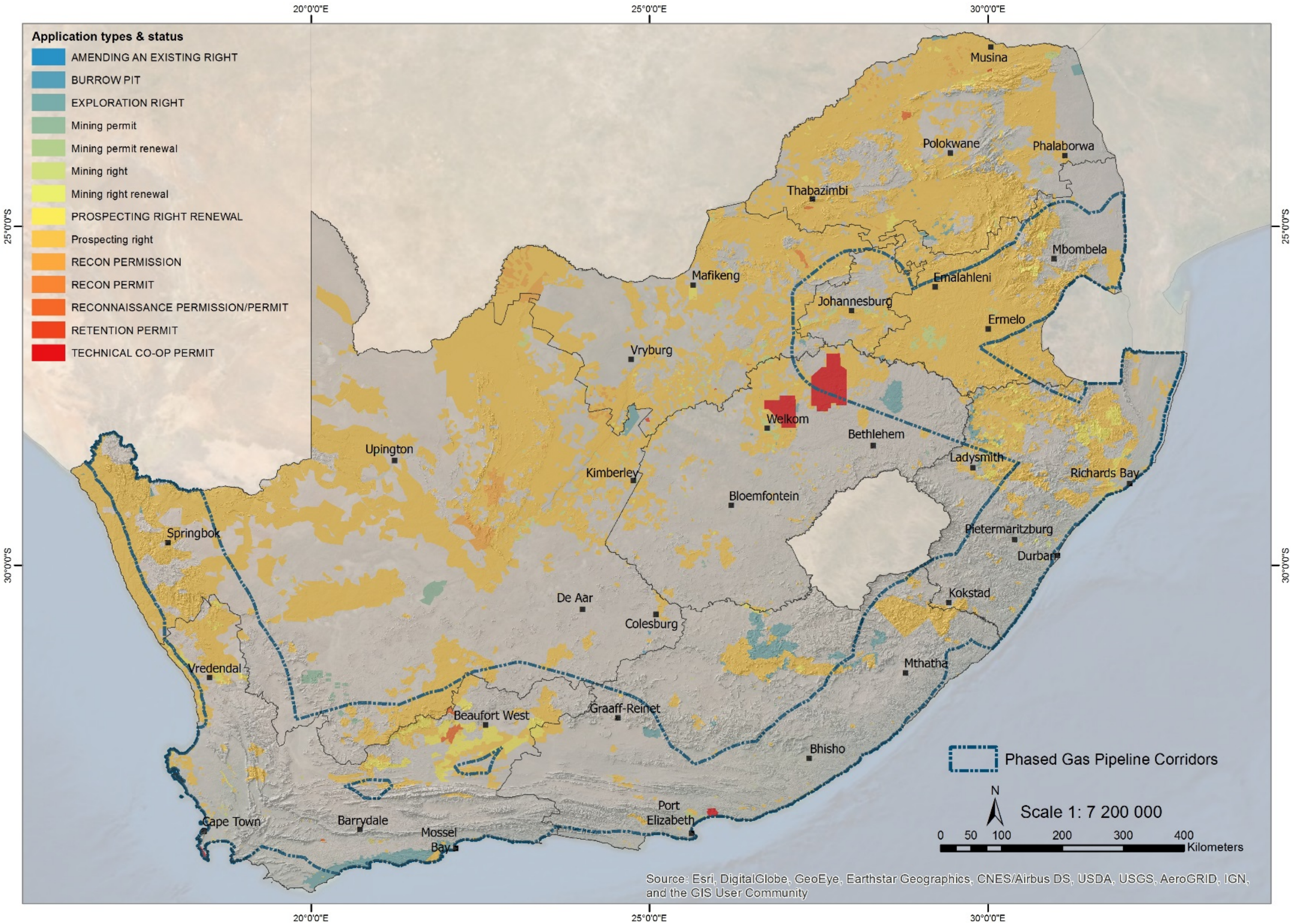
▪ Amending an existing right;
▪ Burrow pit;
▪ Exploration right;
▪ Mining permit;
▪ Mining permit renewal;
▪ Mining right;
▪ Mining right renewal;
▪ Prospecting right;
▪ Prospecting right renewal;
▪ Reconnaissance permission/permit;
▪ Retention permit; and
▪ Technical co-operation permit.</td></tr>
</table>

As indicated in Table 2, the two datasets represent different spatial information; and were sourced at different stages of the SEA Process. This influenced how the data was used, processed and analysed in the SEA. As a result, there was a need for the data to be refined and manipulated into a single layer that combined the two datasets to reflect up-to-date mining activities in the country. The data included in the CGS 2012 and DMR 2019 datasets are illustrated in Maps 2 and 3, respectively.

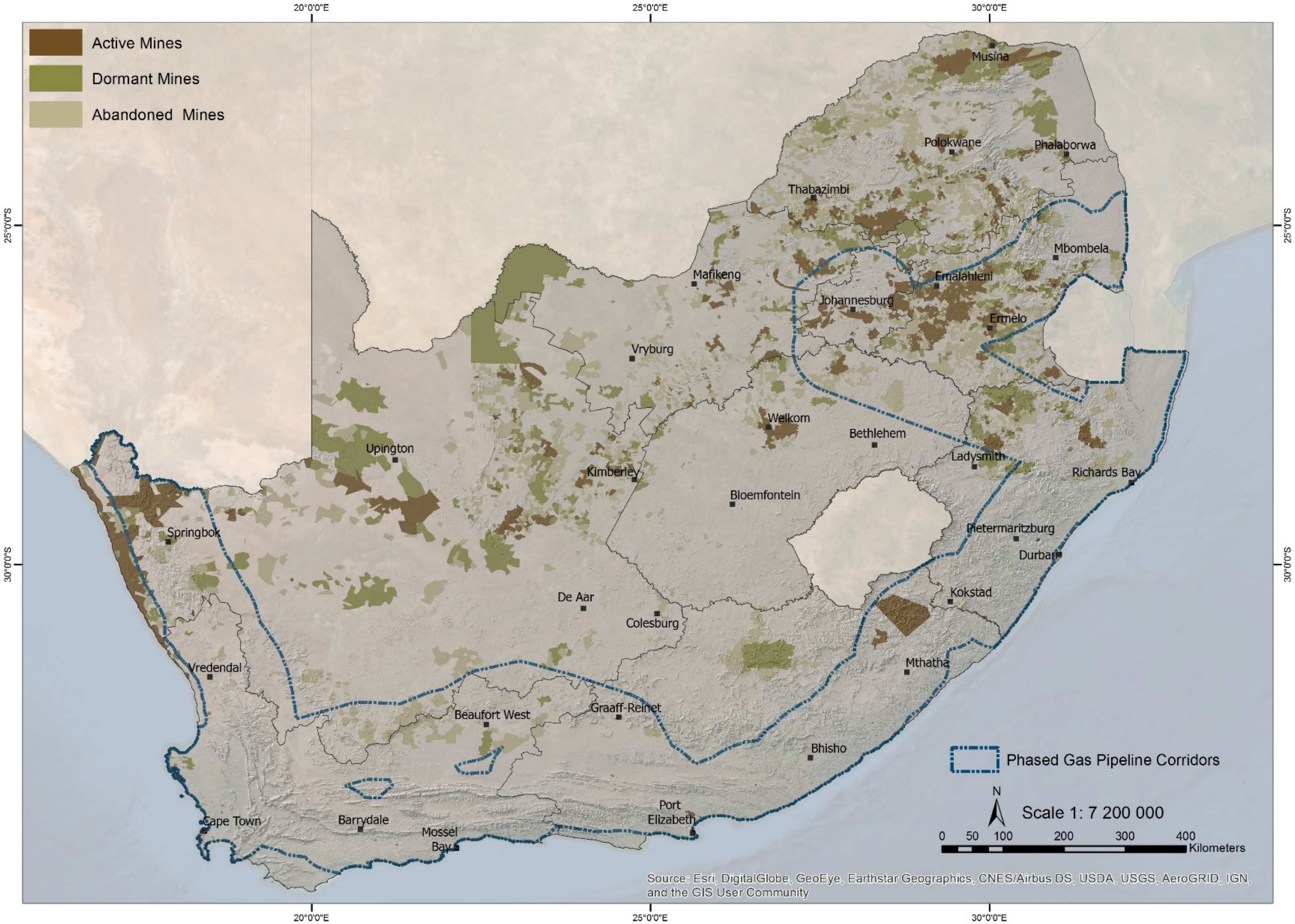
Map 4 illustrates the final refined mining feature layer used in this SEA.



Map 2: Active, Dormant and Abandoned Mines in South Africa, including a) Mine, Continuously Producing; b) Mine, Intermittently Producing; c) Mine, Dormant; d) Mine, Abandoned; and e) Deposit, Exploited. Sourced from the CGS, 2012.



Map 3: Various Mining Application Types in South Africa (e.g. Mining Rights, Mining Permits, and Prospecting Rights etc.). Sourced from the DMR, 2019.



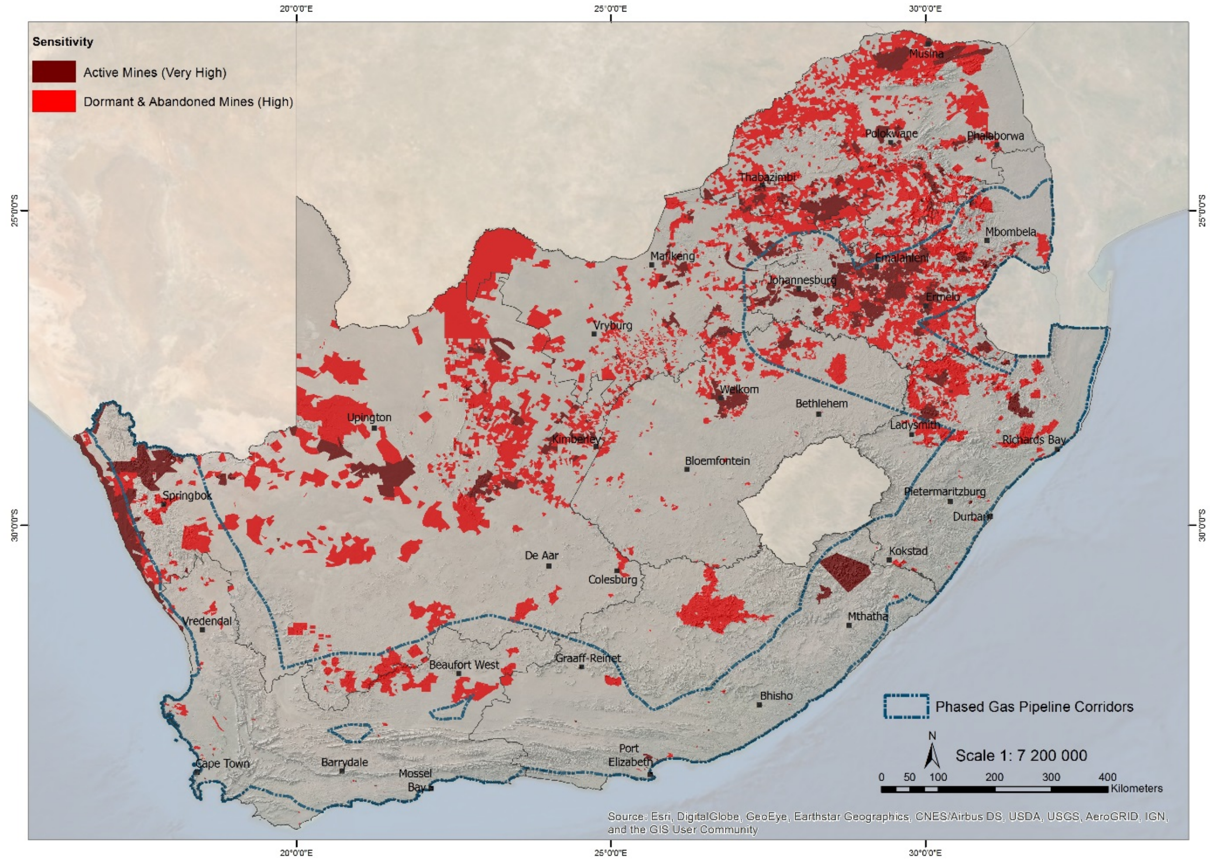
Map 4: Final Refined Mining Layer used in the Gas Pipeline SEA.

4.2.9.4 Sensitivity Analysis

A sensitivity map (Map 5) was produced for the Gas Pipeline corridors according to the criteria set out in Table 3 to classify mining sensitivity spatially into four tiers namely, Very High, High, Medium and Low. From an engineering constraints perspective, active mining areas have been allocated a Very High sensitivity, whereas Dormant and Abandoned Mining Areas have been allocated a High sensitivity. Background on the rational for these sensitivity allocations are provided in Section 4.2.9.5.

Table 3: Summary of the Engineering Constraints Analysis for the Mining Datasets

Sensitivity Feature	Data Source + Date of Publications	Sensitivity
Active Mining Areas	CGS (Sourced directly by the DEA), 2012; and DMR, 2019 refined into one layer.	Very High
Dormant and Abandoned Mining Areas		High



Map 5: Combined Mining Sensitivity Map for the Gas Pipeline SEA.

As illustrated in Map 5, active mining areas mainly occur in the Phase 6, Phase 3 and Rompco Pipeline (Phase 8) Gas Pipeline Corridors. An active mining area is also located towards the west of Kokstad in the Phase 7 Gas Pipeline Corridor. The above is also evident for dormant and abandoned mining areas, with many found in the Inland Gas Pipeline Corridor via the Karoo as well.

4.2.9.5 Impact Description and Mitigation

4.2.9.5.1 Impact of Mining on Gas Pipeline Infrastructure

From an engineering constraints perspective, abandoned and dormant mining areas and underground mining areas should be avoided when planning routes for gas pipelines. Similarly, open cast and sand mining are both an engineering constraint for the construction and operation of gas transmission pipelines, and should therefore be avoided as well.

These areas should be avoided for several reasons, with the main reason being safety of the pipeline, and the surrounding communities. Underground mining will lead to instability, subsidence, sinking and sinkholes, which are unfavourable and unsafe for a gas pipeline. Abandoned and dormant mining areas are also considered a hazard due to potential instability and uncertainties. Open cast and sand mining are also not conducive to gas pipeline development, as the pipelines will be routed below-ground to a depth of approximately 1 m to the top of the pipeline. Open cast and sand mining operations exceed these depths, and as such will lead to potential damage to the pipeline.

Any damage to the gas pipeline due to mining activities may result in product releases that may lead to incidents that constitute a risk to the surrounding environment, mining operations and personnel, and proximal settlements. Health and safety risks associated with potential leaks, fires and impact on other critical infrastructure are described in detail in the Settlement Planning, Disaster Management and related Social Impacts Assessment chapter of the Gas Pipeline SEA Report (i.e. Appendix C.3).

However, from a demand perspective, future planned mining areas were also considered as a pull factor as such mining operations could potentially require gas as an energy source. In addition, future coal mining areas could present an opportunity in terms of coal-bed methane (i.e. a potential source of gas). There is potential to route gas pipelines close enough to future mining areas, however a suitable case-specific buffer between the mining operations and the gas pipeline would need to be determined to ensure that there is no risk to the infrastructure, and surrounding environment and communities. In addition, the gas pipeline must be stringently designed in order to protect it from mining operations, including ripple effects/shakings from blasting.

Linked to the above, the Mine Health and Safety Act (Act 29 of 1999, as amended) and its regulations, specify various requirements to ensure that hazards are identified and the risk to health and safety is eliminated, controlled and minimised. This includes various safety buffer zones that need to be respected with regards to mining and surrounding infrastructure.

With regards to mining areas that are being decommissioned and rehabilitated, there are a number of diamond-mining areas in the Northern Cape that are scheduled for such activities. The suitability of areas that have been previously mined for diamonds and earmarked for rehabilitation will be based on the demand for gas in that area at the time, as well as the environmental sensitivity of the rehabilitated area, considering that rehabilitation may entail the re-introduction of endangered species.

4.2.9.5.2 Impact of Gas Pipeline Infrastructure on Mining

The impact of gas pipeline infrastructure on mining operations is closely linked to the impact described in the preceding section.

Section 53 of the MPRDA notes that approval of the Minister of Mineral Resources is required for any land surface use that may be contrary to the objectives of the MPRDA. Such an application is required for all land uses other than:

- those within an approved town-planning scheme which has applied for and obtained approval from the Minister;
- farming and related land uses; or
- other land uses identified by the Minister as not requiring approval.

With a project lifespan of approximately 50 - 70 years (assuming steel pipelines and dependent on the relevant maintenance plan) and the likelihood of extension, gas pipeline developments are considered to have the potential for preventing access to below ground mineral resources, and hence require approval in terms of Section 53 of the MPRDA. The consideration of Section 53 applications for gas pipeline projects are complex and case specific. Furthermore, the presence of below ground mineral resources at a specific site can only be confirmed through exploration, and without such certainty, it is challenging to justify the prevention of gas pipeline development on such a site by refusing a Section 53 application.

With the foregoing complexities requiring consideration when evaluating the potential impacts of proposed gas pipeline developments on mining, the following principles are important:

- It is vital that mining impacts are considered on a project specific scale. The Project Developer must contact the relevant Competent Authority (e.g. DMR) during the pipeline route planning stage in order to confirm the mining areas based on the latest available information, and to discuss applicable constraints and sensitivities. This will inform the pipeline route selection process, and will ensure that the safety of the gas pipeline infrastructure, and surrounding mining operations and communities are taken into consideration and factored into the design.
- There is potential for land use integration, which could be mutually beneficial for mining. The potential for such benefits may be dependent on the type of mining (e.g. surface or underground), the mining life cycle phase (e.g. exploration or rehabilitation), and several other case specific factors. Due to these case specific factors influencing potential benefits, every application will be dependent on the agreement that can be reached between the mining and gas pipeline operators and must be considered on its own merit.
- It is difficult to justify the sterilisation of land for gas pipeline development based on mining sensitivities without some degree of certainty that there are indeed below ground mineral resources that can be affected. Furthermore, where an exploration or mining right has either lapsed or the relevant activities have not started within the stipulated timeframes, such unused rights do not justify the sterilisation of land for other land uses contributing to the national economy, such as gas pipeline development.

Strategic Environmental Assessment for the Development of a Phased Gas Pipeline Network in South Africa



PART 5

Final Corridors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ABBREVIATIONS

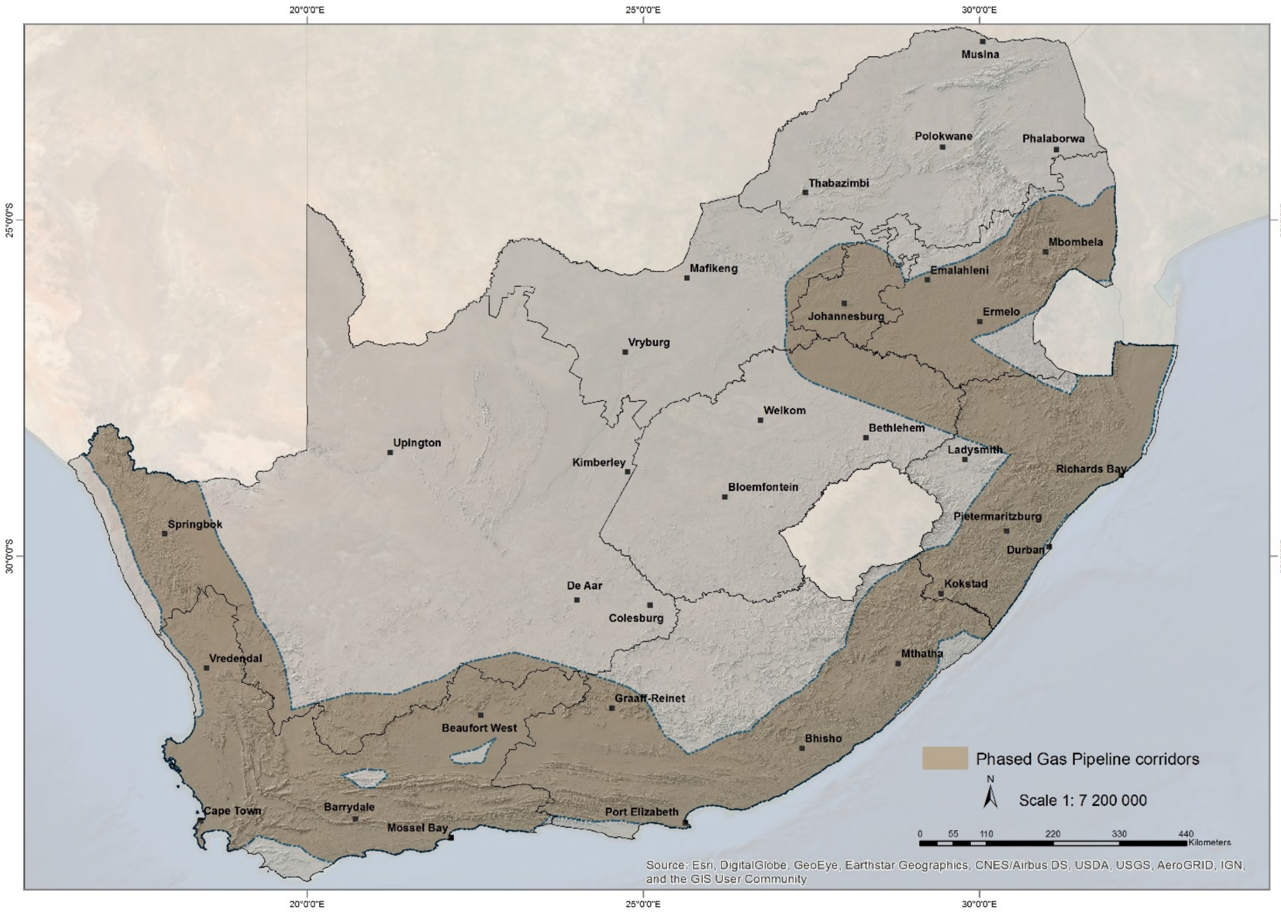
DAFF	Department of Agriculture, Forestry and Fisheries
DM	District Municipality
DTI	Department of Trade and Industry
EGI	Electricity Grid Infrastructure
ERG	Expert Reference Group
IDP	Integrated Development Plan
IDZ	Industrial Development Zone
IOCB	Indian Ocean Coastal Belt
KCAAA	Karoo Central Astronomy Advantage Area
LM	Local Municipality
MM	Metropolitan Municipality
NERSA	National Energy Regulator of South Africa
NFI	National Forest Inventory
PSC	Project Steering Committee
REDZ	Renewable Energy Development Zones
SANParks	South African National Parks
SAOGA	South African Oil and Gas Association
SACAD	South African Conservation Areas Database
SAPAD	South African Protected Areas Database
SAPVIA	South African Photovoltaic Industry Association
SASTELA	Southern Africa Solar Thermal and Electricity Association
SAWEA	South African Wind Energy Association
SDF	Spatial Development Framework
SEZ	Special Economic Zone
SEA	Strategic Environmental Assessment
SIP	Strategic Infrastructure Projects
SKA	Square Kilometer Array
SWSA	Strategic Water Source Area

PART 5. FINAL CORRIDORS

5.1 Introduction

This chapter (i.e. Part 5) of the Gas Pipeline Strategic Environmental Assessment (SEA) Report provides a detailed description on the process followed and analysis undertaken to refine and identify the **Final 100 km wide Gas Pipeline Corridors**, which is an outcome of the **Final Pinch Point Analysis**. The **Final 100 km wide Gas Pipeline Corridors** will be recommended for gazetting and adoption.

As discussed in Part 3 of the Gas Pipeline SEA Report, 125 km wide corridors were identified following the completion of the **Draft Pinch Point Analysis** in Task 3 of Phase 2 of the SEA Process. These Draft Refined 125 km wide corridors were identified based on the best available data at the time, and were delineated based on environmental sensitivities and engineering constraints that were rated as **Very High** sensitivity following the Negative Wall to Wall mapping exercise (undertaken as part Task 2 of Phase 2 of the SEA Process). The Draft Refined 125 km wide corridors (Map 1) were thereafter assessed by the Specialists during Task 4 of Phase 2 of the SEA Process.



Map 1: Draft Refined 125 km wide Gas Pipeline Corridors identified during the Draft Pinch Point Analysis and assessed by the Specialists.

5.2 Final Pinch Point Analysis Methodology

As indicated in Figure 1, the **Final Pinch Point Analysis** considered the following main aspects in order to refine the Draft Refined 125 km wide Gas Pipeline Corridors and to identify the **Final 100 km wide Gas Pipeline Corridors:**

- Findings of the Spatial Energy Demand Mapping;
- Findings of the Specialist Assessments;
- Outcome of the Updated Negative Wall to Wall Mapping; and
- Recommendations from stakeholders (as applicable).

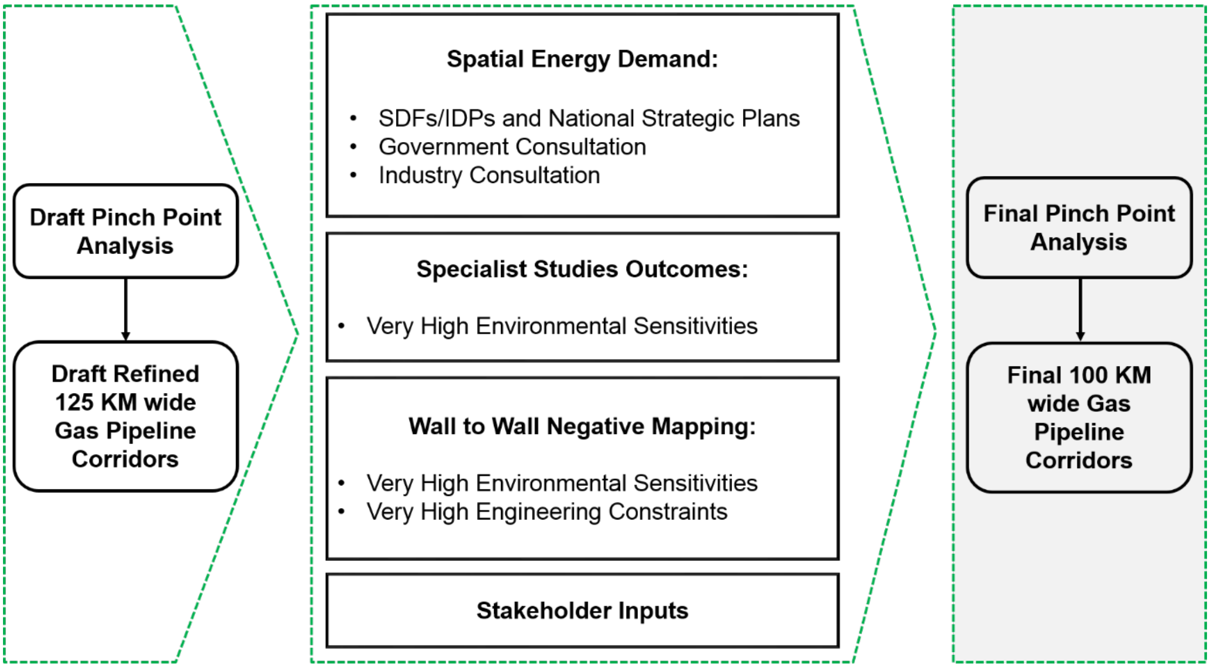


Figure 1: Factors considered in the Final Pinch Point Analysis

The **first step** of the Final Pinch Point Analysis included the refinement of the gas pipeline corridors from 125 km wide to 100 km wide based on the **Demand Mapping**, in order to ensure that the corridors are placed where there is the biggest demand potential for gas pipelines. These corridors are referred to as the "100 km wide Demand Mapping Corridors". The Demand Mapping Process identified and considered various demand factors and opportunities for gas, also referred to as Pull Factors. Refer to Section 5.3 of this chapter for additional details.

The **second step** of the Final Pinch Point Analysis including the shifting of the 100 km wide Demand Mapping Corridors, where necessary, based on the presence of environmental sensitivities and engineering constraints that were rated as **Very High** sensitivity (i.e. pinch points). These **Very High** sensitivity areas included updated sensitivities and data stemming from the Specialist Assessments (undertaken as part of Task 4 of Phase 2 of the SEA Process) and from the Negative Wall to Wall mapping exercise that was updated as necessary (undertaken as part Task 2 of Phase 2 of the SEA Process). Refer to Section 5.4 of this chapter for additional details.

The Final Pinch Point Analysis also took into consideration the relevant recommendations made by stakeholders, where applicable. It should be noted that the recommendations from stakeholders were based on input received during the various Project Steering Committee (PSC), Expert Reference Group (ERG), Sector Specific, Focus Group, Authority Meetings, as well as Public Information Sharing Sessions held throughout the SEA Process, as well as during the Stakeholder Review of the Draft SEA Report (between April 2019 and June 2019).

The **last step** of the Final Pinch Point Analysis included the finalisation and demarcation of the **Final 100 km wide Gas Pipeline Corridors**, based on the various factors discussed above, and illustrated in Figure 1. The overall methodology adopted for the Final Pinch Point Analysis is illustrated in Figure 2.

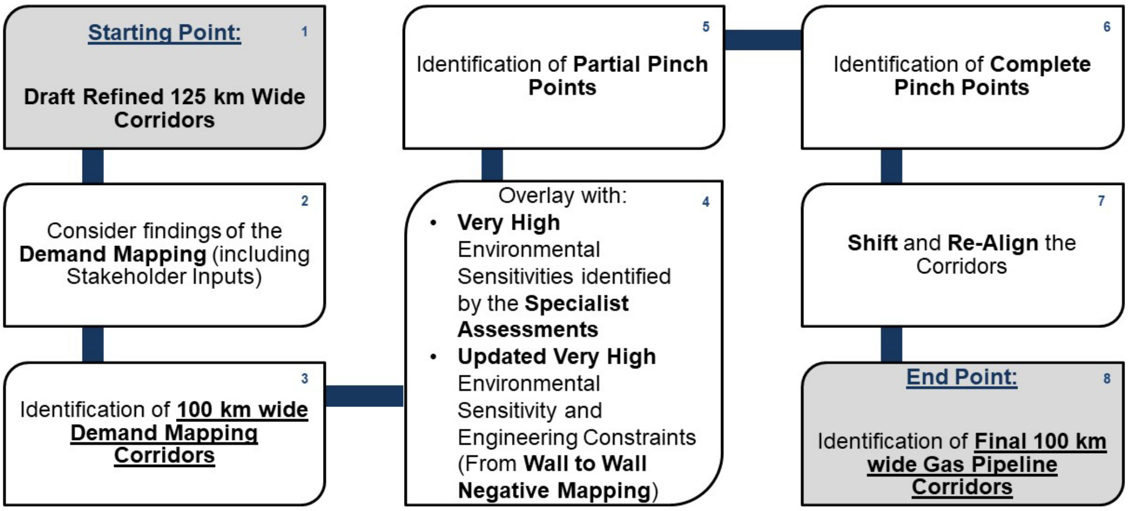


Figure 2: Process of the Final Pinch Point Analysis

5.3 Step 1: Opportunities (Demand) Mapping Process

The Demand Mapping Process was undertaken during Phase 2 of the SEA Process, and it involved identifying and mapping any existing and future energy intensive developments and activities within and close to the Draft Refined Corridors. The aim of this process was to determine where investment into the development of gas transmission pipeline infrastructure might be best utilised. Utilisation in the context of this study refers to the productive 'use' of gas transmission pipeline infrastructure. Gas transmission pipeline infrastructure supports the transfer of gas away from where it is sourced and the delivery of such gas to where it is needed for potential power generation, consumption and other applicable usage.

The process considered key strategic geographical areas set aside for specifically targeted economic activities through national policy, plans and programmes. In particular, the mapping exercise considered Special Economic Zones (SEZs) identified by the Department of Trade and Industry (DTI) as incentivised sector-specific industrial development areas under the SEZ Act (2012). Consideration was also given to existing Industrial Development Zones (IDZ) and the spatial distribution of the relevant Strategic Infrastructure Projects (SIPs). The establishment and promotion of SEZs are at the centre of national industrial policy. These zones include the existing IDZs at Coega, East London, Richards Bay and Saldanha, as well as Atlantis, as well as other proposed SEZs. Other energy intensive developments include areas for industrial expansion as well as priority mining areas (i.e. areas set aside for either existing or future mining activity operations). Data for the Demand Mapping Process was obtained from the following sources, which are described in further detail in the following sub-sections:

- Review of provincial and municipal Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs);
- Review of national scale strategic development plans (e.g. SEZs, IDZs, and SIPs);
- Provincial and Municipal Feedback Exercises;
- Industry Feedback Exercises; and
- Feedback received during various meetings held during the SEA Process, including the Authority and Public Outreach Sessions.

5.3.1 Review of Spatial Development Frameworks, Integrated Development Plans and National Plans

A detailed review of SDFs of provincial and district municipalities located inside of the Draft Refined 125 km wide corridors was undertaken. The review involved mapping areas illustrated within relevant SDFs as being set aside either for future mining related activity, industrial expansion, transport developments, agriculture, tourism or for urban expansion. A number of the SDFs were not considered suitable for the purposes of this exercise, either because they were older than 5 years or did not contain spatial information concerning plans for industrial expansion and/or mining. Where required, the relevant IDPs of municipalities were also considered. In addition, national strategic plans, such as the National SDF, and National Gazetted Electricity Grid Infrastructure (EGI) Corridors were also considered.

5.3.2 Provincial and Municipal Feedback Exercise

A dedicated consultation process was initiated in May 2018 until April 2019 with the affected Provincial Government Departments and District Municipalities indicated in Table 1. During this exercise, feedback was requested from these authorities on the details and spatial representation of provincial and municipal future energy intensive activities, such as industrial development and potential mining/agricultural operations. Table 1 provides a list of the Provinces and District Municipalities that were consulted with. To facilitate the feedback process, the planning departments of each affected Province and District Municipality were provided with the following:

- A cover letter to the Provincial Planning Department requesting the above feedback;
- A 20 km x 20 km grid map of the province and feedback form to provide the requested feedback;
- A cover letter to the District Municipality Planning Department requesting the above feedback; and
- A 20 km x 20 km grid map of the District Municipality and feedback form to provide the requested feedback.

An example of the abovementioned letters to the Provincial and District Municipality Planning Departments, as well as the grid map and feedback form is included in Appendix A of the Gas Pipeline SEA Report.

The italised font in Table 1 provides an indication of which Province and District Municipality submitted feedback. The Provinces and Municipalities were requested to shade the relevant cell of the grid map provided and allocate a grid cell number (if not provided) based on the location of the planned energy intensive activity they have identified. An example of the feedback received from the Saldanha Bay Local Municipality, West Coast District Municipality, and uMkhanyakude District Municipality is provided in Figure 3.

It is important to note that feedback was received via this feedback exercise, as well as during the various discussions and meetings held throughout the SEA Process. Specifically, a considerable amount of information was received from stakeholders during focus group, sector specific, ERG, PSC and Authority Meetings.

Table 1: List of Provinces and Municipalities that formed part of the Provincial and Municipal Feedback Exercise. Note that in this table, "DM" refers to District Municipality and "MM" refers to Metropolitan Municipality; and that all ***italised*** font is an indication that feedback was received from these Provinces and Municipalities.

Planning Departments	
Provinces	*Mpumalanga; Western Cape; Eastern Cape; KwaZulu-Natal; Free State; Gauteng; Northern Cape; and North-West*
Metropolitan and District Municipalities	**Western Cape:** *Overberg DM; West Coast DM; Garden Route DM; Saldanha Bay Municipality; City of Cape Town;* Cape Wineland DM; and Central Karoo DM
	Eastern Cape: *Sarah Baartman DM; OR Tambo DM; Buffalo City MM; Nelson Mandela Bay MM; Chris Hani DM;* Joe Gqabi DM; Alfred Nzo DM; and Amathole DM
	KwaZulu-Natal: *Ugu DM; eThekwini Municipality; Ilembe DM; King Cetshwayo DM; Umkhanyakude DM; Amajuba DM; City of uMhlathuze; Harry Gwala DM; Zululand DM; UMgungundlovu DM; uThukela DM; and Umzinyathi DM*
	Gauteng: *Ekurhuleni MM; City of Johannesburg MM;* City of Tshwane MM; West Rand DM; and Sedibeng DM
	Mpumalanga: *Gert Sibande DM*; Ehlanzeni DM; and Nkangala DM
	North-West: Bojanala DM and Dr Kenneth Kaunda DM
	Free State Fezile Dabi DM; and Thabo Mofutsanyane DM
	Northern Cape: *Namakwa DM; and Pixley Ka Seme DM*

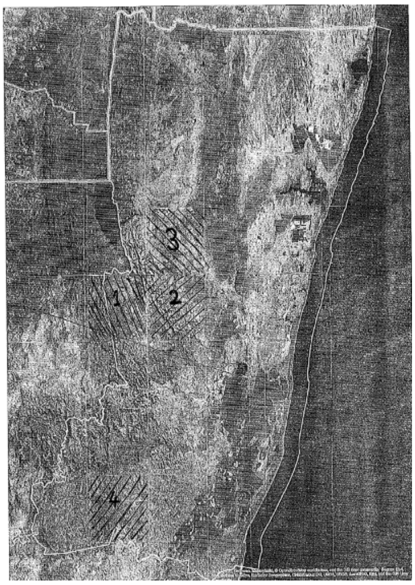
SANBI
South African National Biodiversity Institute

CSIR

SECTION 2:

PLEASE PROVIDE DETAILS ON ANY KEY PROVINCIAL/DISTRICT MUNICPALITY AREAS EARMARKED FOR DEVELOPMENT THAT COULD INFLUENCE THE FINAL LOCATION OF THE CORRIDORS IN SUPPORT OF THESE AREAS.

GRID CELL REFERENCE NUMBER	SECTOR	ACTIVITY	COMMENTS
1	ENERGY	BIOMASS	Establishment of a 6-5 MW Biomass plant in the MKHUZE AREA
2	Aviation	Airport	Development of the Mkhuze Regional Airport as catalyst for new investments & dev. of Mkuze
3	Agriculture	Processing	Intensive development of high-value agriculture & ~~dev~~ processing thereof @ Mathathini
4	Mining	Mining	proposed expansion of an existing Somkhele mine (Anthracite) in Mtubatuba



A) uMkhanyakude District Municipality

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SECTION 2:

PLEASE PROVIDE DETAILS ON ANY KEY PROVINCIAL/DISTRICT MUNICPALITY AREAS EARMARKED FOR DEVELOPMENT THAT COULD INFLUENCE THE FINAL LOCATION OF THE CORRIDORS IN SUPPORT OF THESE AREAS.

GRID CELL REFERENCE NUMBER	SECTOR	ACTIVITY	COMMENTS
81, 101	TRANSPORT	MAJOR ROADS	Interchange on TR85/1 intersection with R27
"	"	"	Extention of TR85/1 to Langebaanweg R45
81	INDUSTRIAL	LIGHT + HEAVY INDUSTRIES	Saldanha Bay Besaansklip industrial development area.
100	MINING	MINING	Elandsfontein mining area.

B) Saldanha Bay Local Municipality

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South African National Biodiversity Institute

public enterprises

Eskom

CSIR

SECTION 2:

PLEASE PROVIDE DETAILS ON ANY KEY PROVINCIAL/DISTRICT MUNICPALITY AREAS EARMARKED FOR DEVELOPMENT THAT COULD INFLUENCE THE FINAL LOCATION OF THE CORRIDORS IN SUPPORT OF THESE AREAS.

GRID CELL REFERENCE NUMBER	SECTOR	ACTIVITY	COMMENTS
1	Industrial	Heavy Industry	Saldanha IDZ
2	Mining	Mining	Mineral Sand Mining i.e. Namakwa Sands + Tormin

C) West Coast District Municipality

Figure 3: Examples of completed feedback forms and annotated maps (as applicable) received from A) uMkhanyakude District Municipality; B) Saldanha Bay Local Municipality; and C) West Coast District Municipality.

5.3.3 Industry Feedback Exercise

An Industry Feedback exercise was also commissioned in May 2018 to seek feedback from major energy users and industry stakeholders in terms of:

- Future energy demand (gas) to support development plans of major gas users in South Africa up to 2040 (i.e. future/planned energy intensive activities).

These stakeholders were issued a cover letter requesting the above feedback, as well as a Bulk User Feedback Form. Examples of these documents and forms are included in Appendix A of the Gas Pipeline SEA Report. Table 2 provides a list of the major energy users and industry stakeholders that were consulted with during this exercise. The italised font in Table 2 provides an indication of where feedback was received, either through this exercise process or discussions and meetings held throughout the SEA Process.

Table 2: List of Major Energy Users and Industry Stakeholders that formed part of the Industry Feedback Exercise. Note that all *italised* font in this table is an indication that feedback was received from these stakeholders.

Major Energy Users and Industry Stakeholders
Business Unity South Africa; Chamber of Mines; Energy Intensive User Group of Southern Africa; South African Photovoltaic Industry Association (SAPVIA); South African Oil and Gas Association (SAOGA); Transnet; National Energy Regulator of South Africa (NERSA); Saldanha Bay IDZ; Coega IDZ; Richards Bay IDZ; Eskom; iGas; PetroSA; South African Wind Energy Association (SAWEA); Southern Africa Solar Thermal and Electricity Association (SASTELA); Council for Mineral Technology; Industrial Development Corporation; National Business Initiative; Business Leadership South Africa; South African Chamber of Commerce and Industry; National Development Agency; and Alexkor

5.3.4 Consolidation of the Demand Mapping

All of the relevant information and data received from the sources above were reviewed, packaged, and digitised (where required). The Demand Mapping was initially undertaken at a 20 km by 20 km grid cell scale. However, where actual proposed and planned development boundaries were sourced from stakeholders, these were used instead of the grid system. The datasets used in the demand mapping is detailed in Appendix 5.1 of this chapter.

These features were used as pull factors to ensure that areas of high demand were considered in the corridor refinement. The following categories of data were mapped into separate layers and assessed as part of the Final Pinch Point Analysis:

- <u>Agriculture</u>: This includes agricultural potential, commercial intensive agriculture, agriculture support programmes, existing areas, cooperative agricultural areas, agricultural hubs, farmer production support units, agri-park locations and areas of agricultural significance (Refer to Map 2);
- <u>Industry</u>: This includes industrial areas that exist and are planned, SEZs, IDZs, Aquaculture Development Zones, economic opportunities for different sectors, and rural enterprise hubs (Refer to Map 3);
- <u>Mining Areas</u>: This includes existing mining areas, priority mining areas, mining focus areas, coalfields, some mining rights (Refer to Map 4); and
- <u>Potential and Existing Markets:</u> This includes mixed industry, heavy industry and light industry that would potentially use gas, as well as potential gas to power markets. This was also largely informed by the Gas Opportunities Analysis study, which is included in Appendix 1 of Part 1 of the Gas Pipeline SEA Report (Refer to Map 5).

All the above demand factors and categories were thereafter combined to provide an overall spatial representation of the various demand for gas within the Draft Refined 125 km wide corridors (Map 6). This facilitated the refinement and identification of the <u>100 km wide Demand Mapping Corridors</u>.

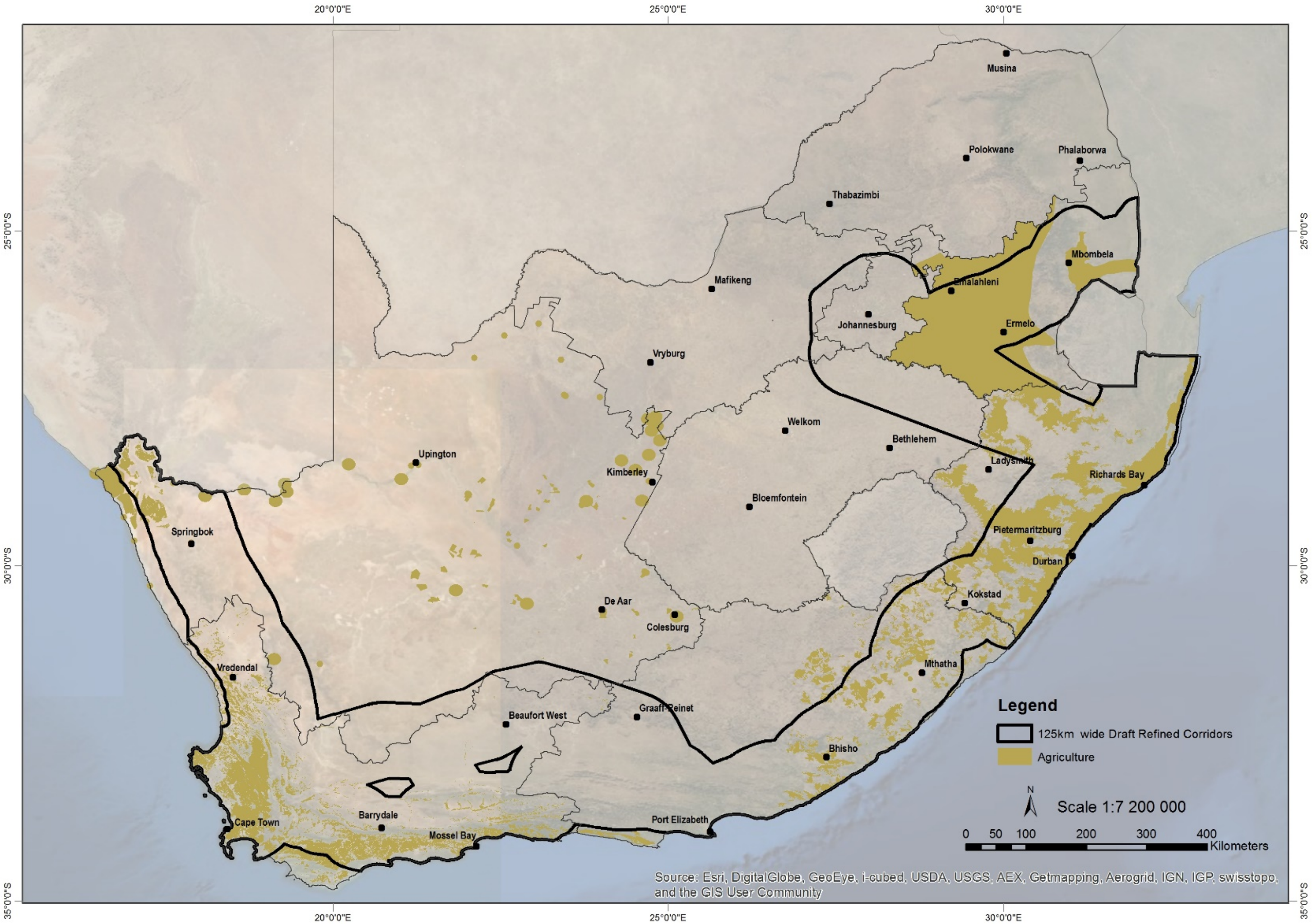
The refinement focused on ensuring that the areas with the maximum amount of overlap of demand layers were selected and included in the 100 km wide Demand Mapping Corridors initially. Additionally, the demand mapping corridor refinement ensured that the potential gas development at the proposed Boegoebaai Port and IDZ in the Northern Cape were catered for, as well as the areas and boundaries of the Coega and Saldanha Bay IDZs.

It must be noted that the Ports of Durban, Port Elizabeth and Cape Town are not included in the corridors based on the respective Ports of Richards Bay, Ngqura and Saldanha being more likely landing points for potential gas, which were included in the corridors since the inception of the SEA. The following have been considered in the demand mapping for the proposed gas transmission corridors:

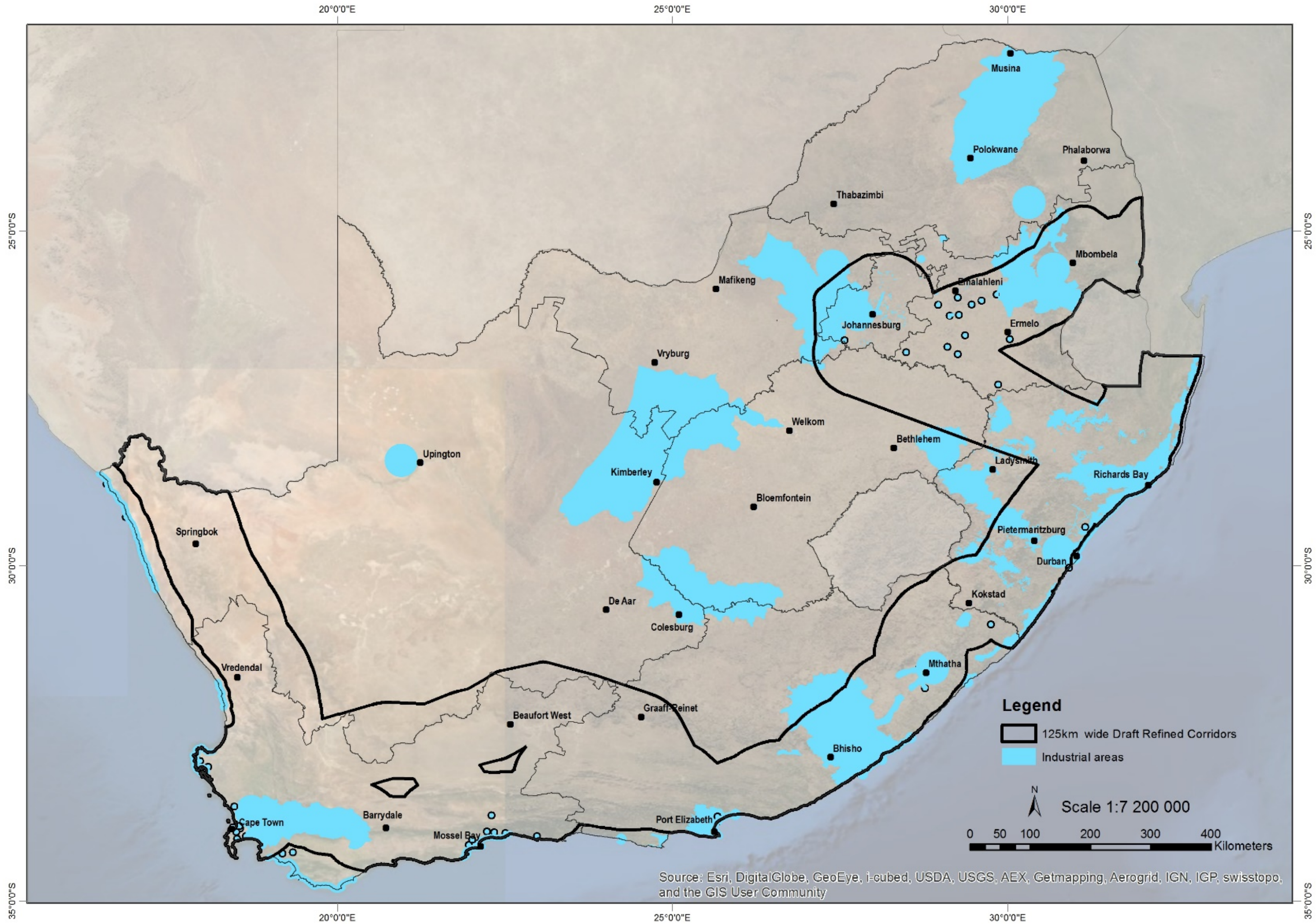
- Ports of Mossel Bay and East London;
- Platinum Valley SEZ in the North West Province[1];
- Upington SEZ in the Northern Cape[1];
- Nkomazi SEZ and Secunda SEZ located in Mpumalanga;
- Umtata SEZ located in the Eastern Cape.

The 100 km wide Demand Mapping Corridors are presented in Map 6.

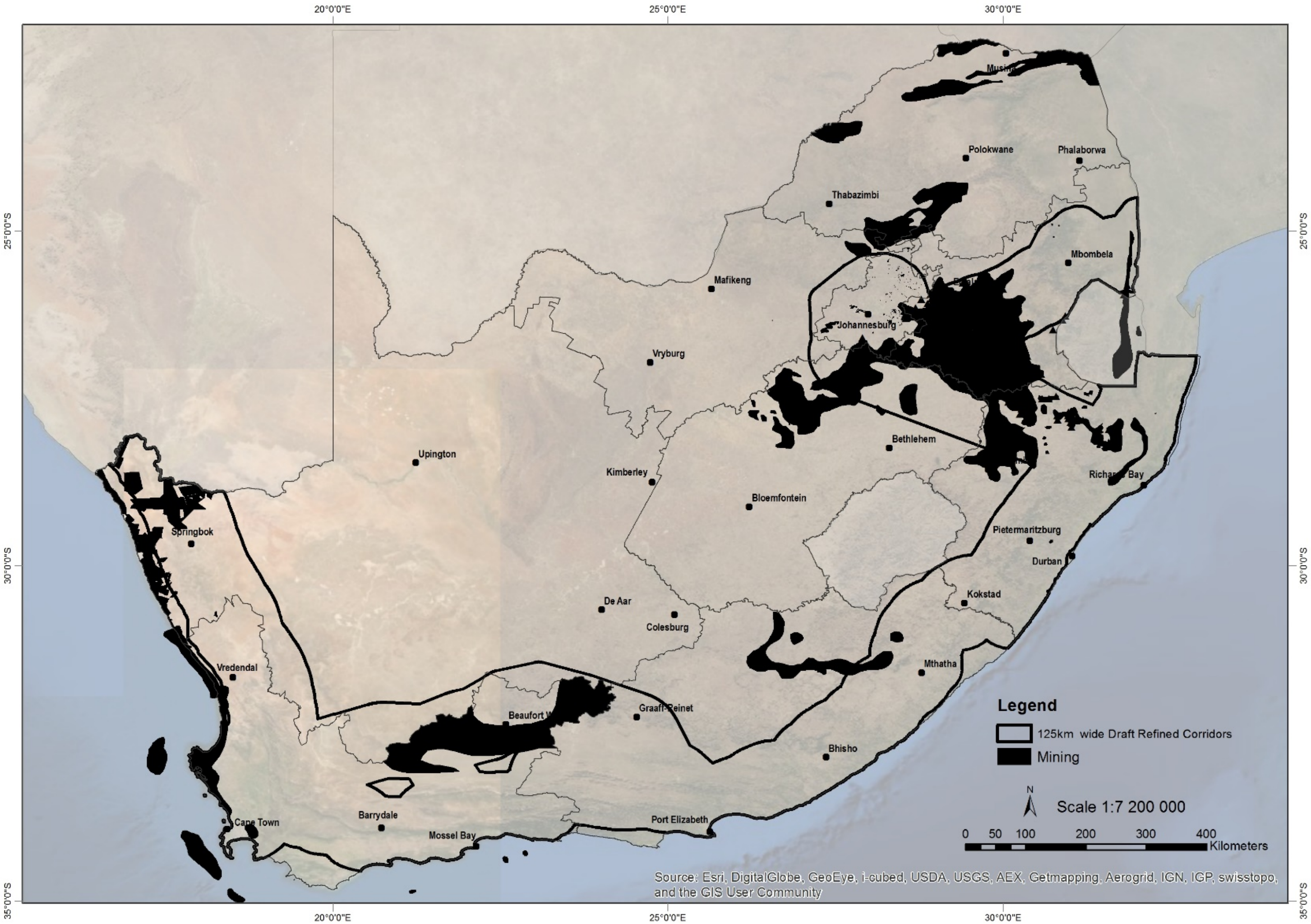
[1] Note that these SEZs are located far from the Draft Initial corridors and could therefore not be taken into consideration in the corridor refinement process.



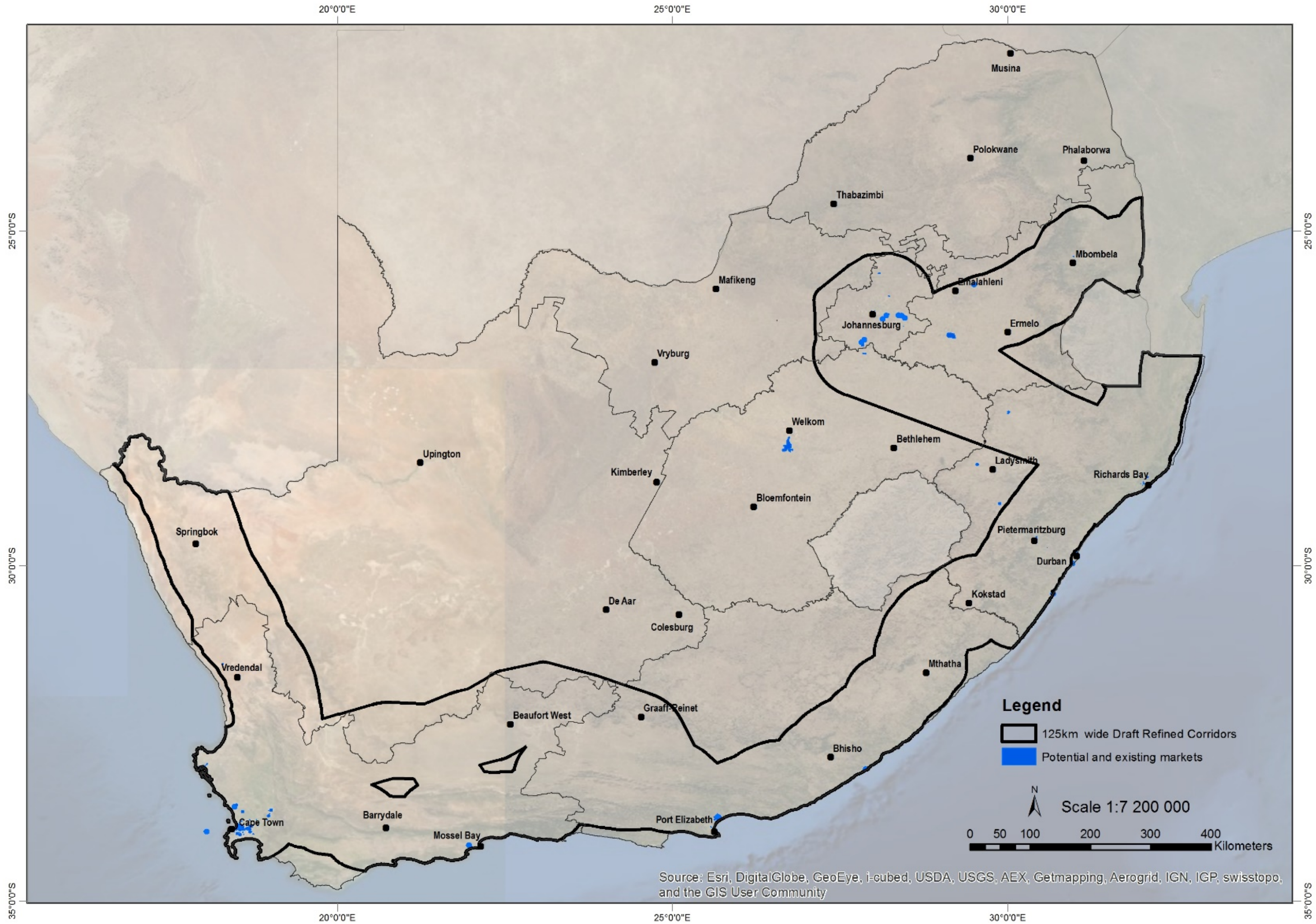
Map 2: Agricultural Areas captured in the Demand Mapping in relation to the Draft Refined 125 km wide Gas Pipeline Corridors.



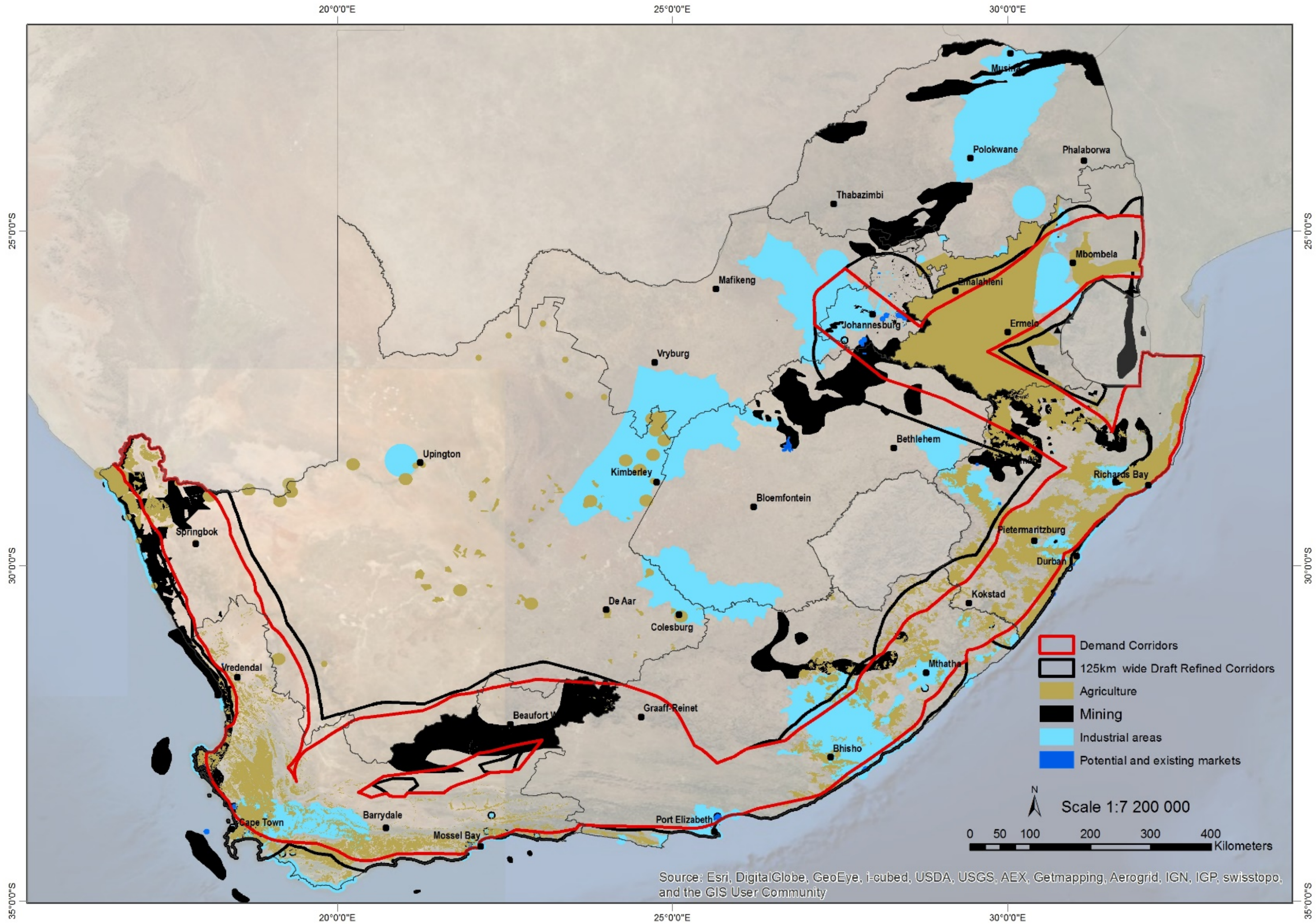
Map 3: Industrial Areas captured in the Demand Mapping in relation to the Draft Refined 125 km wide Gas Pipeline Corridors.



Map 4: Mining Areas captured in the Demand Mapping in relation to the Draft Refined 125 km wide Gas Pipeline Corridors.



Map 5: Potential and Existing Markets for Gas to Power captured in the Demand Mapping in relation to the Draft Refined 125 km wide Gas Pipeline Corridors.



Map 6: Refined 100 km wide Demand Mapping Corridors shown in red based on all the Demand Mapping features.

5.4 Step 2: Updated Environmental Sensitivities and Engineering Constraints Criteria

For this step of the Final Pinch Point Analysis, all engineering constraints and environmental sensitivities that were allocated a **Very High** sensitivity were used to identify and locate both potential and partial pinch points within the 100 km wide Demand Mapping Corridors. Pinch points or bottle necks are defined, for the purposes of this exercise, as areas within the 100 km wide Demand Mapping Corridors where at least 80 % of the 100 km wide corridor is covered by **Very High** sensitivity features.

5.4.1 Updated Environmental Sensitivities

Very High sensitivity environmental data for this exercise was derived from the following two sources:

- Specialist Assessments; and
- Updated Wall to Wall Negative Mapping.

5.4.1.1 Data from Specialist Assessments

Areas identified as Very High sensitivity were extracted from the following Specialist Assessments:

- Integrated Biodiversity and Ecology Assessment (Terrestrial and Aquatic Ecosystems, and Species) – Appendix C.1 of the Gas Pipeline SEA Report;
- Avifauna (Appendix C.1.8 of the Gas Pipeline SEA Report) and Bats (Appendix C.1.9 of the Gas Pipeline SEA Report) Impacts;
- Seismicity Assessment (Appendix C.2 of the Gas Pipeline SEA Report); and
- Settlement Planning, Disaster Management and related Social Impacts Report (Appendix C.3 of the Gas Pipeline SEA Report).

Furthermore, the Specialist Assessments were released to stakeholders for a comment period extending from 25 April 2019 to 24 June 2019 via the project website. Following this review period, where applicable, stakeholder comments were taken into consideration in the refinement of the draft refined corridors.

5.4.1.2 Data from Updated Wall to Wall Negative Mapping

Following the stakeholder consultation, sensitivities of features for themes that did not require further verification and refinement from the specialists were extracted from the Wall to Wall mapping spreadsheet (as contained in Part 3 of this SEA Report, Table 2) and updated, where applicable. This included, for example, defence, civil aviation, heritage (including archaeology and palaeontology), agriculture, the Square Kilometer Array (SKA), the Karoo Central Astronomy Advantage Area (KCAAA), Natural Forests and Strategic Water Source Areas (SWSAs). This updated list is presented in Table 3.

Very High sensitive features were then extracted from this updated list shown in Table 3 and was used for the Final Pinch Point Analysis (Refer to Table 4).

Table 3: Features and Datasets used to inform the Final Pinch Point Analysis – Updated Wall to Wall Negative Mapping – Environmental Sensitivity

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer
Protected Areas	South African Protected Areas Database (SAPAD) - Q4, 2018, South African National Parks (SANParks) and Provincial	National Parks	Very High	feature
		Nature Reserves	Very High	feature
		World Heritage Sites (Core)	Very High	feature
		Mountain Catchment Areas	High	feature
		Protected Environments	High	feature
		Forest Nature Reserve	Very High	feature
		Forest Wilderness Area	Very High	feature
		Special Nature Reserve	Very High	feature
Protected Areas Buffers	SAPAD - Q4, 2018 and South African Conservation Areas Database (SACAD) - Q1, 2017	10 KM buffer around National Parks or buffers received from SANParks	High	feature
		Buffer around World Heritage Sites (Buffers are Site Specific)	High	feature
Conservation Areas	SACAD - Q1, 2017 (DEA); Provincial Game Farm Data	Biosphere reserves (Buffer area of the biosphere reserve, core areas are already protected)	Medium	feature
		Botanical gardens	Medium	feature
		Ramsar Sites (not already protected)	Very High	feature
	UNESCO website / SAHRA	UNESCO tentative sites	High	feature
National Protected Areas Expansion Strategy	Priority Areas For Protected Area Expansion, 2017 (including updated Northern Cape priorities) DEA	Protected Areas Expansion Priority Areas (Primary)	High	feature
Stewardship sites	Provincial stewardship data	Stewardship sites	High	feature
Natural Forests	National Forest Inventory (NFI), sourced 2016, Department of Agriculture, Forestry and Fisheries (DAFF)	National Forest Inventory	Very High	1km (High)
Strategic Water Source Areas (SWSAs) - Surface and Groundwater	Council for Scientific and Industrial Research (CSIR). April 2018	Swsas (Natural Areas)	High	feature
Land Cover	National Land Cover 2013/2014, DEA Habitat Modification Layer (improved Land Cover) SANBI 2017	Natural Areas	Low	feature
		Modified Areas	Low	feature
		Old Fields (Mapped From Imagery)	Low	feature
Agricultural Land Capability	Land Capability Layer, 2016, DAFF	Land capability features with values ranging from 11-15	Very High	feature
		Land capability features with values ranging from 8-10	High	feature
		Land capability features class 6 to 7	Medium	feature
		Land capability features class 1 to 5	Low	feature
Field Crop Boundaries	Field Crop Boundaries, 2017, DAFF	Irrigated Areas (Pivot Agriculture)	Very High	feature
		Shadenet	Very High	feature
		Viticulture	Very High	feature
		Horticulture	Very High	feature
		Other cultivated areas	High	feature
Coastline	Coastline, 2015, SANBI and	Buffered coastline	Very High	1km

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer
	Department of Rural Development and Land Reform			
Karoo Central Astronomy Advantage Area (KCAAA)	KCAAA Footprint, obtained via CSIR (2017)	Karoo Central Astronomy Advantage Area	Medium	feature
Square Kilometre Array (SKA) Area	SKA core area, 2017, from SKA via CSIR	SKA study area	Very High	Feature
		SKA telescopes with 20km buffer	Very High	0-20km
Defence	Defence data, 2017, South African National Defence Force	Forward Airfield	Very High	1 km
		Air Force Bases	Very High	1 km
		High Sites	Very High	1 km
		Operational Military Bases	Very High	1 km
		Military Training Areas	Very High	2km
		Bombing Ranges	Very High	1km
			High	2km
			Medium	5km
		Shooting ranges	Very High	1km
		Border Posts	Very High	1km
		Ammunition Depots	Very High	10 km
		All Other DoD features (Including Naval Bases, Housing, Offices etc.)	Very High	1km
Airports (major, landing strips, small aerodromes)	REDZs 1 SEA dataset and EGI SEA dataset, 2017	Major Airports	Medium	8km
		Other civil aviation aerodromes (small aerodromes)	Medium	8km
Paleontological heritage resources	Geological features and substrates of Palaeontological Importance, Geology Layer, 2014, Council for Geosciences	High sensitivity areas: • Adelaide • Asbestos Hills • Boegoeberg Dam • Bothaville • Brulsand • Campbell Rand • Clarens • Drakensberg • Dwyka • Ecca • Elliot • Enon • Ghaap • Kameeldoorns • Koegas • Kuibis • Matsap • Molteno • Prince Albert • Rietgat • Schmidtsdrif • Schwarzrand • Stalhoek • Sultanaoord • Tarkastad • Vryburg • Whitehill • Witteberg	High	feature

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer
		Medium sensitivity areas: • Achab • Allanridge • Bidouw • Bredasdorp • Ceres • Concordia Granite • Dwyka • Fort Brown • Geselskapbank • Gladkop • Grahamstown • Hartebeest Pan Granite • Hoogoor • Kalahari • Kamieskroon Gneiss • Karoo Dolerite • Khurisberg • Konkyp Gneiss • Kookfontein • Korridor • Mesklip Gneiss • Modderfontein • Granite/Gneiss • Naab • Nababeep Gneiss • Nakanas • Nardouw • Nuwefontein Granite • Rietberg Granite • Skoorsteenberg • Stinkfontein • Styger Kraal Syenite • Table Mountain • Tierberg • Volksrust • Waterford	Medium	feature
Heritage	Mapped heritage features, SAHRA, 2018	World Heritage Sites (Core)	Very High	feature
		World Heritage Sites (Buffer)	High	feature
		Grade I sites	Very High	2km
		Grade II sites	Very High	1km
		Grade IIIa sites	High	150m
		Grade IIIb sites	High	100m
		Grade IIIc sites	High	50m
		Ungraded	Very High	100m
		Battlefields (Grade IIIb)	Very High	5 km
Visual	Modelled from digital elevation model, 2015, NGI	Slopes > 25% or 1:4	Medium	feature
	NFEPA 2011	Major River	N/A	N/A
	NGI, 2016	Coastal zones	N/A	1-4 km
	Provincial data sets on Game farms and Private reserves (2014-2017); SACAD Q2, 2017, DEA	Private reserves and game farms	High	0-2.5 km
			Medium	2.5-5 km
			Low	5-10 km
			Low	>10 km
	Location of the South African Large Telescope (SALT), sourced from the CSIR, 2017	SALT	Very High	0-25 km

Feature Category/Factor	Source/Dataset	Features	Mapping Sensitivity	Feature/Buffer
	Mapped heritage features, SAHRA, 2015	Heritage feature: Grade I sites	Medium	2km
		Heritage feature: Grade II sites	Medium	1km
		Heritage feature: Grade IIIa sites	Medium	150m
		Heritage feature: Grade IIIb sites	Medium	100m
		Heritage feature: Grade IIIc sites	Medium	50m
	Location of towns, AfriGIS Towns – 2017	Town, villages and settlements outside large urban areas	Very High	0-500 m
			High	500 m - 1 km
			Medium	1 km-2 km
	NGI, Roads 2016	National roads and scenic routes	N/A	N/A
			N/A	N/A
			N/A	N/A
	Western Cape Department of Transport, 2013, sourced from the CSIR	Western Cape Routes	N/A	N/A
Major towns	Location of towns, AfriGIS Towns – 2017	Towns, villages and settlements and urban areas	Very High	5km
Urban areas and high density rural settlements	Eskom SPOT Building Count, 2013 (100 m x 100 m grid cell resolution).	Grid cells containing ≥ 3 dwellings	Very High	1km

5.4.1.3 Environmental Sensitivity Map for the Final Pinch Point Analysis

The features and datasets used to prepare the Environmental Sensitivity Map for the Final Pinch Point Analysis is included in Table 4 – these include the Very high sensitive features extracted from Table 3 as well as the Very High features identified through the specialist assessments. Map 7 shows the spatial footprint of the Very High sensitivity data from an environmental perspective within the 100 km wide Demand Mapping Corridors.

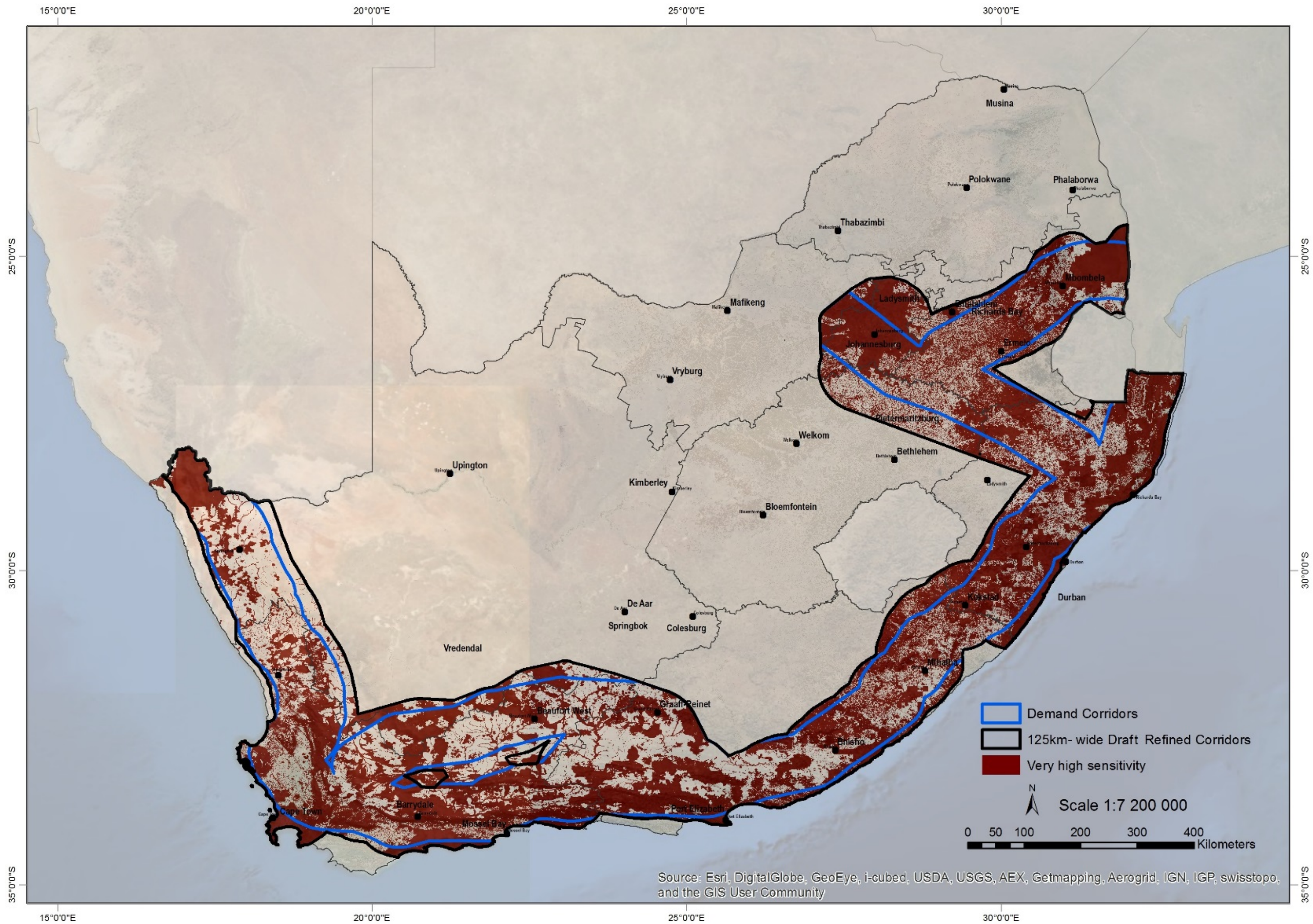
It must be re-iterated that High, Medium and Low sensitivity areas were not considered in the Final Pinch Point Analysis, based on the reasoning provided in Part 3 of the SEA Report.

Table 4: Features and datasets used to prepare the Environmental Sensitivity Map for the Final Pinch Point Analysis

Factor to include	Source	Features	Mapping Sensitivity	Feature/Buffer
Source Of Dataset: Updated Wall To Wall Environmental Sensitivities				
Protected Areas	South African Protected Areas Database (SAPAD) - Q4, 2018, South African National Parks (SANParks) and Provincial	National Parks	Very High	feature
		Nature Reserves	Very High	feature
		World Heritage Sites (Core)	Very High	feature
		Forest Nature Reserve	Very High	feature
		Forest Wilderness Area	Very High	feature
		Special Nature Reserve	Very High	feature
Natural Forests	National Forest Inventory (NFI), sourced 2016, Department of Agriculture, Forestry and Fisheries (DAFF)	National Forest Inventory	Very High	1km (High)
Agricultural Land Capability	Land Capability Layer, 2016, DAFF	Land capability features with values ranging from 11-15	Very High	feature
Field Crop Boundaries	Field Crop Boundaries, 2017, DAFF	Irrigated Areas (Pivot Agriculture)	Very High	feature
		Shadenet	Very High	feature
		Viticulture	Very High	feature
		Horticulture	Very High	feature
Coastline	Coastline, 2015, SANBI and Department of Rural Development and Land Reform	Buffered coastline	Very High	1km
Square Kilometre Array (SKA) Area	SKA core area, 2017, from SKA via CSIR	SKA study area	Very High	Feature
		SKA telescopes with 20km buffer	Very High	0-20km

Factor to include	Source	Features	Mapping Sensitivity	Feature/Buffer
Defence	Defence Data, 2017, South African National Defence Force	Forward Airfield	Very High	1 km
		Air Force Bases	Very High	1 km
		High Sites	Very High	1 km
		Operational Military Bases	Very High	1 km
		Military Training Areas	Very High	2 km
		Bombing Ranges	Very High	1 km
		Shooting ranges	Very High	1 km
		Border Posts	Very High	1 km
		Ammunition Depots	Very High	10 km
		All Other DoD features (Including Naval Bases, Housing, Offices etc.)	Very High	1 km
Heritage	Mapped Heritage Features, SAHRA, 2018	World Heritage Sites (Core)	Very High	feature
		Grade I sites	Very High	2 km
		Grade II sites	Very High	1 km
		Ungraded	Very High	100 m
		Battlefields (Grade IIIb)	Very High	5 km
Source of Dataset: Specialist Assessments Outputs				
Nama and Succulent Karoo, and Desert Biome	Specialist studies	Sensitive features for the Nama and Succulent Karoo; and Desert Biomes	Very High	feature
Fynbos Biome	Specialist studies	Sensitive features for the Fynbos Biome	Very High	feature
Albany Thicket Biome	Specialist studies	Sensitive features for the Albany Thicket Biome	Very High	feature
Indian Ocean Coastal Belt (IOCB) Biome	Specialist studies	Sensitive features for the IOCB Biome	Very High	feature
Grassland Biome	Specialist studies	Sensitive features for the Grassland Biome	Very High	feature
Savanna Biome	Specialist studies	Sensitive features for the Savanna Biome	Very High	feature
Estuaries	Specialist studies	Sensitive features for estuaries	Very High	feature
Rivers and wetlands	Specialist studies (Masked with Land Cover (Non-Natural classes were masked	Sensitive features for rivers and	Very High	feature

Factor to include	Source	Features	Mapping Sensitivity	Feature/Buffer
	only))	wetlands		
Bats	Specialist studies (Masked with Land Cover (Non-Natural classes were masked only))	Sensitive features for bats	Very High	feature
Birds	Specialist studies	Sensitive features for birds	Very High	feature
Settlement Planning	Specialist studies	Areas of Very High sensitivity for planning	Very High	feature



Map 7: Very High Sensitivity Environmental Features in relation to the 100 km wide Demand Mapping Corridors.

5.4.2 Updated Engineering Constraints

Very High sensitivity data identified in the Engineering Constraints was also included in this step of the Final Pinch Point Analysis. This includes, but is not limited to, data relating to slopes, coastline, estuaries, gully erosion, railway lines, mining and dams.

Major planned road and railway infrastructure has also been considered as a pull factor for gas pipeline development considering their linear nature. However, this has been considered based on the buffers allocated in the Engineering Constraints Analysis, as depicted in Table 5. As previously noted, the gas pipeline needs to be at least 5 – 10 km away from railway lines and electricity transmission lines due to an induced current that may be created within the pipeline that could lead to corrosion as a result of the proximity to these structures. Furthermore, the Provincial Departments of Transport, as well as the South African National Roads Agency Limited (SANRAL) have specific requirements and buffers for the development of infrastructure within road servitudes. Hence, these are considered as pull factors, within reason.

An updated list of the datasets used, as well as their corresponding sensitivities are included in Table 5 and has been spatially mapped in Map 8. Very High sensitive features were then extracted from this updated dataset contained in Table 5 for use in the Final Pinch Point Analysis (refer to Table 6). Map 9 shows a map of only the Very High sensitivity engineering features within the 100 km wide Demand Mapping Corridors.

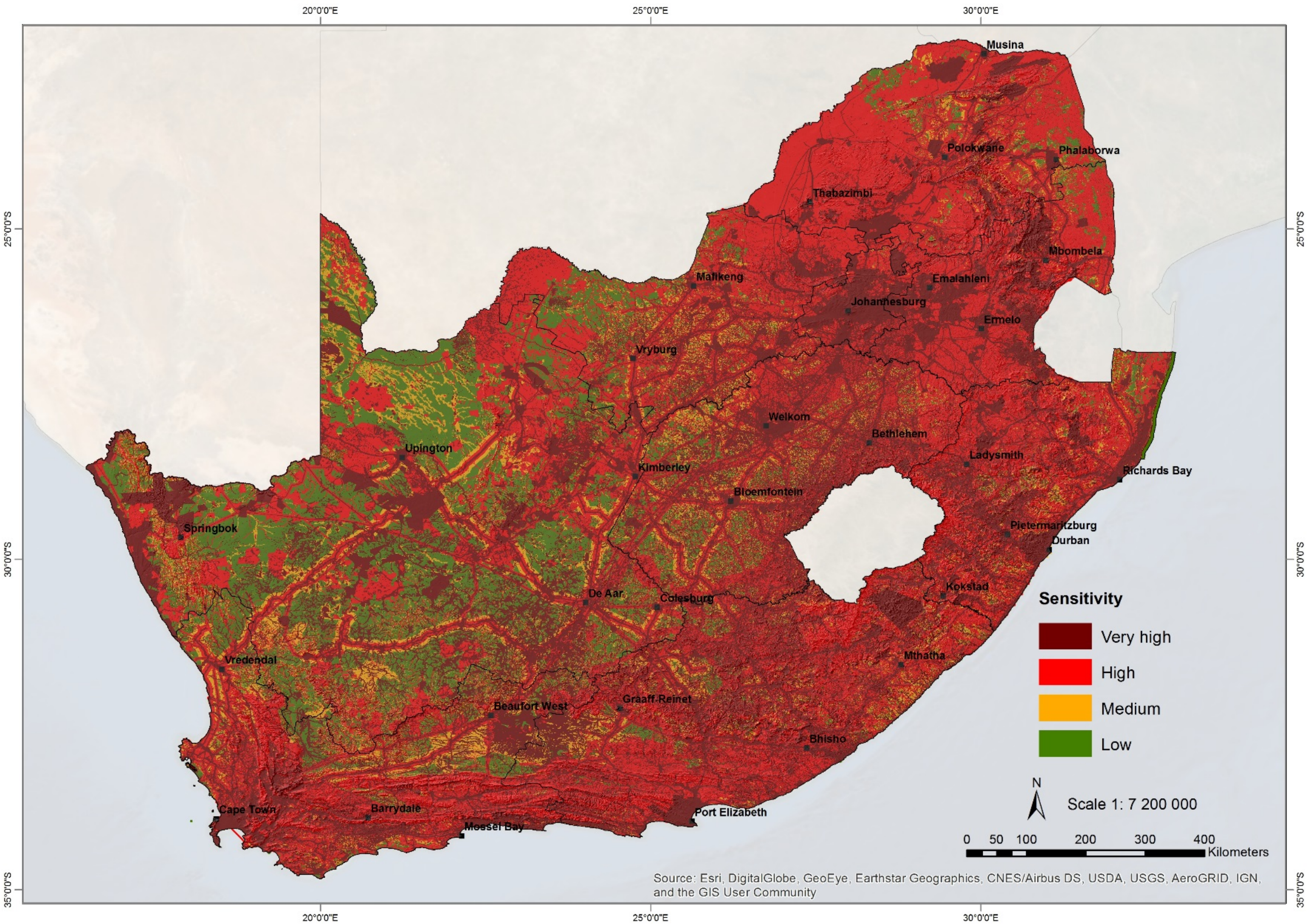
5.4.3 Consolidation of the Environmental Sensitivities and Engineering Constraints

The Very High sensitivity features for both the engineering and environmental features within the 100 km wide Demand Mapping Corridors were then overlaid to identify where partial and complete pinch points are located. The combined engineering and environmental features are indicated in Map 10.

Table 5: Features and Datasets used to prepare the Updated Draft Engineering Constraints Wall to Wall Map to inform the Final Pinch Point Analysis

Factor to include	Source	Features	Mapping Sensitivity
Coastline (including Estuaries)	SANBI 2004	Coastline & Estuaries	Very High
Slope	25m NGI DEM	>45∘	Very High
		25-45∘	High
		15-25∘	Medium
		0-15∘	Low
Access/Roads	NGI Roads Layer 2018	Roads – 90 m from feature	High
		Roads - > 90 m from feature	Low
Geology	Council for Geoscience, 1997	Dolomite, Limestone and other Calcrete	High
		Dolomite restricted to Gauteng and Mpumalanga	Very high
Seismicity	Seismic Hazard in South Africa 2011; Council for Geoscience Report Number: 2011-0061)	Generally confined to Cape Fold Belt region of Southern Cape	High
Gully Erosion	DAFF Gully Erosion	Footprint of erosion/gully > 500 m^2	Very High
Soil Erosion	ARC, J le Roux, 2014	Distribution of Sheet and Rill erosion in South Africa	High
Soil Erodibility	DAFF Soil Erosion Hazard Classes - South Africa and Lesotho, 2010	Hazard Class - High	High
		Hazard Class - Medium	Medium
		Hazard Class - Low	Low
Settlements	AfriGIS Towns Layer	Towns, villages and settlement spatial footprints	Very high
Railway Lines (All Railways)	DRDLR Topo, 2006 - Transnet	0 - 1 km around railways	Very High
		1 - 5 km around railways	High
		5-10 km around railways	Medium
Industrial Areas	DEA 2013/2014 Land Cover	Existing industrial areas	Low
Industrial Expansion	SDFs, IDPs, Consultation with Authorities	Planned industrial activities	Low
Mining	DMR, 2018 (SAMRAD Mining Applications)	(Retention Permit, Reconnaissance Permission/Permit, Recon Permission, Prospecting Right, Prospecting Right Renewal, Mining Right, Mining Permit, Mining Right Renewal, Exploration Right, Burrow Pit, Amending An Existing Right)	Very High
Mining	Transnet	Undermining. Localised areas in northern KwaZulu-Natal and Mpumalanga associated with old coal mine working	High
Major dams	DWA Dams Data	Dams	Very High
Wetlands	Wetland Data 2017	All Wetlands	Medium
Rivers, Drainage Lines & Estuaries	NFEPA River Data 2010 and NGI Mapped River Footprint Estuaries - National Biodiversity Assessment (NBA) 2017/18	Width > 500m	Very high
		Width Between 10 and 500 m	High
		Width <10m	Medium
Rivers	NBA 2018 (South African Inventory of Inland Aquatic Ecosystems),	Valley Bottom including Stream (Excluding	Very High

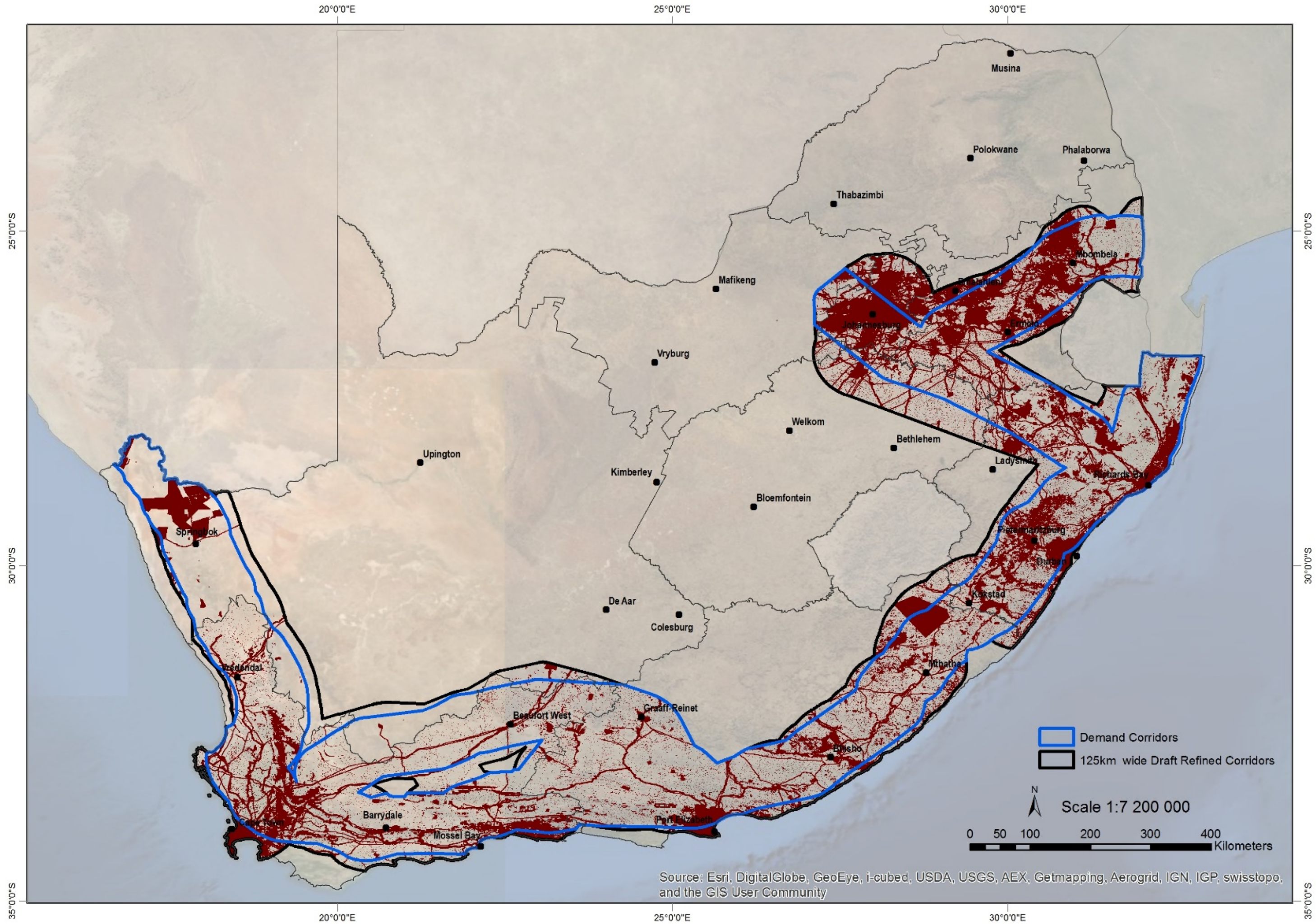
Factor to include	Source	Features	Mapping Sensitivity
		Northern Cape)	
WULA Agreements	NFEPA River and Wetland Data 2010	Rivers and Wetlands buffered by 500 m	High
Water Stressed Catchments	South African Risk And Vulnerability Atlas, 2009	Water Stressed Catchments	Medium
Natural Forests	Department of Agriculture, Forestry and Fisheries, 2017. NFI	Natural forests	Very High
Forestry Potential (Eastern Cape)	EC Parks and Tourism Agency 2014	Potential Areas for forestry	Medium
Thicket	Albany Thicket, SANBI Vegetation Map, 2017	National	High
Sugar Cane	KZN Land Cover 2011 [Sugar cane farming and emerging farming data]	Sugar Cane Farm Boundaries	High
Commercial Forestry	Data on Commercial Forestry provided by DAFF in June 2016	DAFF Commercial Forests	Very high
Field Crop Boundaries (Pivot >500 m radius)	Agriculture Field Crop Boundary Data 2016	All	N/A
Field Crop Boundaries (Vineyards And Orchards)	Agriculture Field Crop Boundary Data 2016	All	High
Field Crop - Short term	Agriculture Field Crop Boundary Data 2016	All	Medium
Field Crop - Long term	Agriculture Field Crop Boundary Data 2016	All	Very High
High Incidence for Lightning Strikes	Eskom, July 2014	Highest 10% risk areas	Low
High Incidence for Fire	Eskom, November 2016 (2002-2017)	Highest 10% risk areas	High
High Incidence for Wind	Eskom, July 2014	Highest 10% risk areas	Low
High Incidence for Flooding	Eskom, 2015 (Sourced in 2018)	Highest 10% risk areas	Medium
High Incidence for Snow Conditions	Eskom, July 2014	Highest 10% risk areas	N/A
High Incidence for Pollution	Eskom, July 2014	Highest 10% risk areas	N/A
Electrical Transmission Cables (Voltages Above 60 kV)	DRDLR Topo, 2006 - Transnet	0 - 1 Km	Very High
		1 - 5 km	High
		5 - 10 km	Medium
		> 10 km	Low
Electrical Transmission Cables (Voltages Below 60 kV)	DRDLR Topo, 2006 - Transnet	0 - 1 Km	High
		1 - 5 km	Medium
		5 - 10 km	Low
Pipelines	iGas, 2017 (Rompco Gas Pipeline) Transnet, 2018 (Future and Existing Gas and Fuel Pipelines)	Gas and Fuel Pipelines (feature)	Medium
Water Pipelines	DWS, 2017 (Bulk Infrastructure)	Existing and Future Bulk Water Pipelines and Infrastructure	Medium



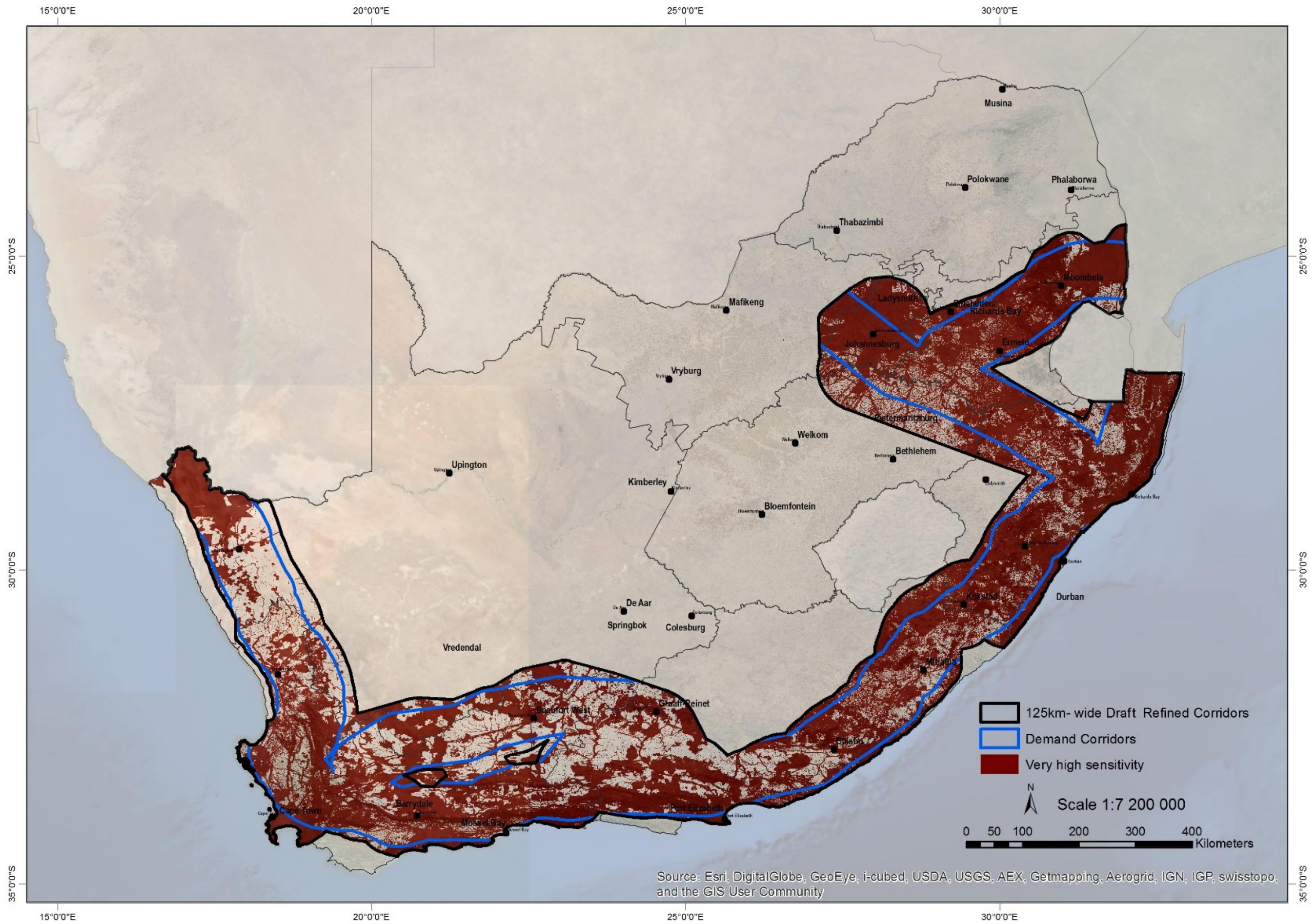
Map 8: Updated Draft Engineering Constraints Wall to Wall Map

Table 6: Features and datasets used to prepare the Engineering Constraints Map for the Final Pinch Point Analysis

Factor to include	Source	Features	Mapping Sensitivity	Sensitivity
Coastline (including Estuaries)	SANBI 2004	Coastline & Estuaries	Very High	1 km
Slope	25m NGI DEM	>45°	Very High	feature
Geology	Council for Geoscience, 1997	Dolomite restricted to Gauteng and Mpumalanga	Very high	Feature
Gully Erosion	DAFF Gully Erosion Datasets	Footprint of erosion/gully > 500 m^2	Very High	feature
Settlements	AfriGIS Towns Layer	Towns, villages and settlement spatial footprints	Very high	feature
Railway Lines (All Railways)	DRDLR Topo, 2006 - Transnet	0 - 1 km	Very High	1 km
Mining	DMR, 2018 (SAMRAD Mining Applications)	(Retention Permit, Reconnaissance Permission/Permit, Recon Permission, Prospecting Right, Prospecting Right Renewal, Mining Right, Mining Permit, Mining Right Renewal, Exploration Right, Burrow Pit, Amending An Existing Right)	Very High	feature
Major dams	DWA Dams Data	Dams	Very High	feature
Rivers, Drainage Lines & Estuaries	NFEPA River Data 2010 and NGI Mapped River Footprint Estuaries - National Biodiversity Assessment (NBA) 2017/18	Width > 500m	Very high	feature
Rivers	NBA 2018 (South African Inventory of Inland Aquatic Ecosystems)	Valley Bottom including Stream (Excluding Northern Cape)	Very High	feature
Natural Forests	Department of Agriculture, Forestry and Fisheries, 2017. NFI	Natural forests	Very High	50 m buffer
Commercial Forestry	Data on Commercial Forestry provided by DAFF in June 2016	DAFF Commercial Forests	Very high	50 m buffer
Field Crop Boundaries - Long term	Agriculture Field Crop Boundary Data 2016	All	Very High	feature
Field Crop Boundaries-Shadenet	Agriculture Field Crop Boundary Data 2016	All	Very High	feature
Electrical Transmission Cables (Voltages Above 60 kV)	DRDLR Topo, 2006 - Transnet	0 - 1 Km	Very High	< 1 km
Albany Thicket	Specialist study	Thicket features	Very High	feature
Seismicity	Specialist study	Seismicity areas	Very High	feature



Map 9: Very High Sensitivity Engineering Features in relation to the 100 km wide Demand Mapping Corridors.



Map 10: Combined Very High Sensitivity Environmental and Engineering Features in relation to the 100 km wide Demand Mapping Corridors.

5.5 Identification of Pinch Points

The following four pinch points were identified based on the **Very High** Environmental Sensitivities and Engineering Constraints:

- Pinch Point 1: South African and Namibian Border;
- Pinch Point 2: West Coast;
- Pinch Point 3: Northern KwaZulu-Natal; and
- Pinch Point 4: Gauteng.

These pinch points are further described below.

5.5.1 Pinch Point 1: South African and Namibian Border

A pinch point was identified within the Phase 6 gas pipeline corridor at the extreme northern extent bordering Namibia. It covers the entire extent of the corridor in this specific location, as illustrated in Map 11, and the corridor itself cannot be shifted due to the Namibian border and the Orange River. Currently at this pinch point, the Draft Refined Gas Pipeline Corridors are already less than 100 km wide because of the border constraints. The main constraints influencing the pinch point are the Richtersveld National Park and World Heritage Site, as well as Critical Biodiversity Areas (CBAs). In addition, this area also contains the Orange River Mouth Nature Reserve (including a Ramsar wetland) and the Nababieps Provincial Nature Reserves (refer to Succulent and Nama Karoo, and Desert Biomes Assessment (Appendix C.1.4 of the Gas Pipeline SEA Report)).

Based on the above, the pinch point itself could not be resolved during the Final Pinch Point Analysis. Therefore, the best solution would be to ground truth the area for the relevant environmental sensitivities during the project specific stage, and to potentially determine engineering solutions for avoidance where required or to minimise the potential impact. CBAs in the Northern Cape are often not irreplaceable, therefore the possibilities of minimising potential impact is highly likely.

5.5.2 Pinch Point 2: West Coast

The pinch point identified in the Phase 5 Gas Pipeline Corridor (Map 12) was resolved during the Final Pinch Point Analysis by shifting the corridor slightly to the west to ensure that the extent of Very High sensitivity area within the corridor is reduced. The main constraints influencing the pinch point include the following:

- Knersvlakte and Oorlogskloof Nature Reserves as identified in the Succulent and Nama Karoo, and Desert Biomes Assessment (Appendix C.1.4 of the Gas Pipeline SEA Report). The Knersvlakte is considered especially sensitive due to the exceptional levels of endemism which characterise this area as well as its arid nature and associated difficulty in effectively rehabilitating disturbed areas;
- Very High sensitivity aquatic quinaries based on the Wetland and Rivers Assessment (Appendix C.1.7 of the Gas Pipeline SEA Report);
- Avifaunal nests and Important Bird Areas (IBAs) as identified in the Avifauna Assessment (Appendix C.1.8 of the Gas Pipeline SEA Report);
- CBAs as identified in the Fynbos Biome Assessment (Appendix C.1.1 of the Gas Pipeline SEA Report);
- World Heritage Site (Part 4.2.7 of the Gas Pipeline SEA Report); and
- Very High sensitivity areas from the Seismicity Assessment (Appendix C.2 of the Gas Pipeline SEA Report).

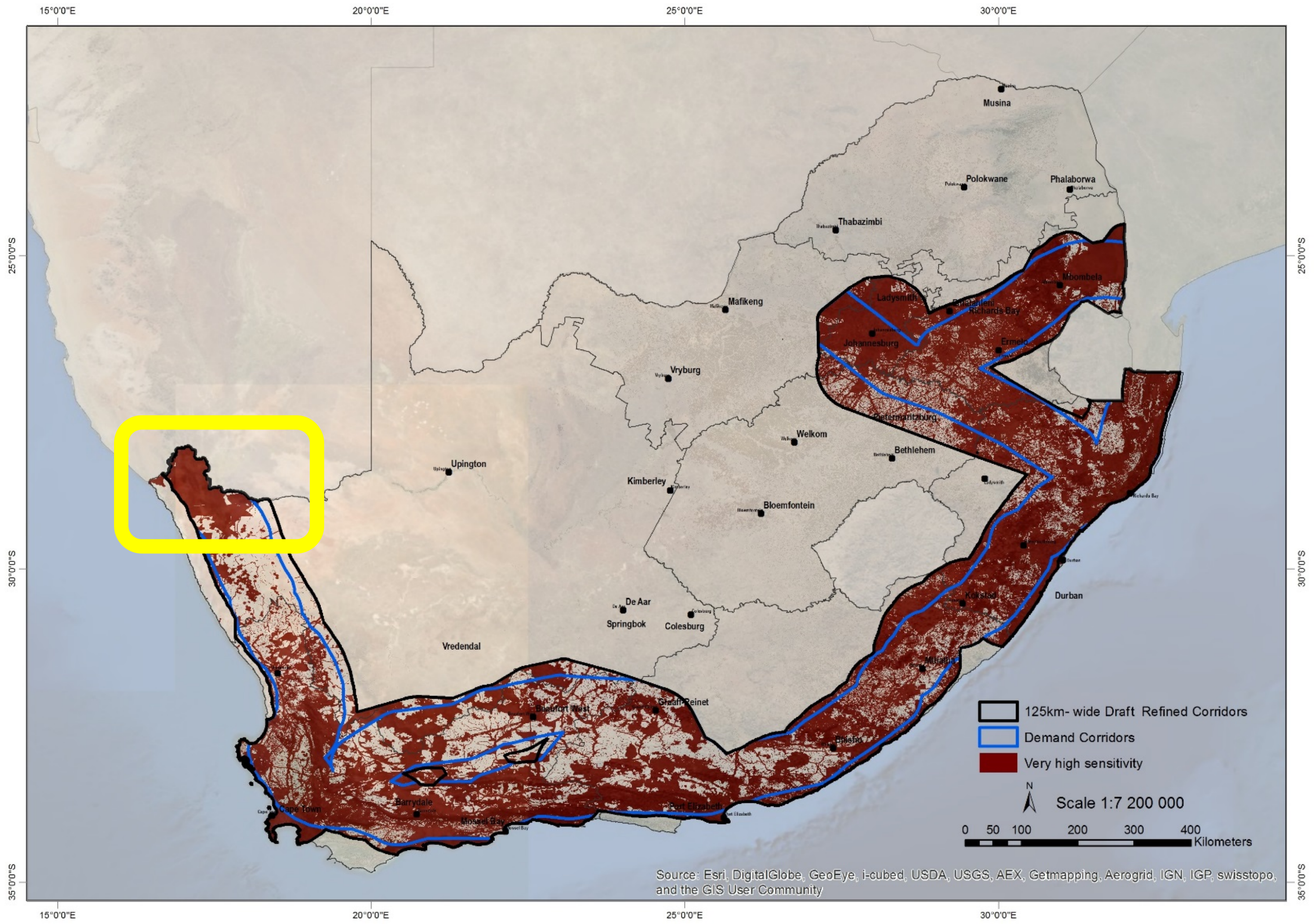
5.5.3 Pinch Point 3: Northern KwaZulu-Natal

The pinch point caused in the Phase 4 Gas Pipeline Corridor (Map 13) was resolved in the Final Pinch Point Analysis by shifting the corridor to the left to ensure that the extent of Very High sensitivity area within the corridor is reduced. It must be however noted that shifting of the northern section of the corridor is limited due to the Swaziland border. The main constraints influencing the pinch point include the following:

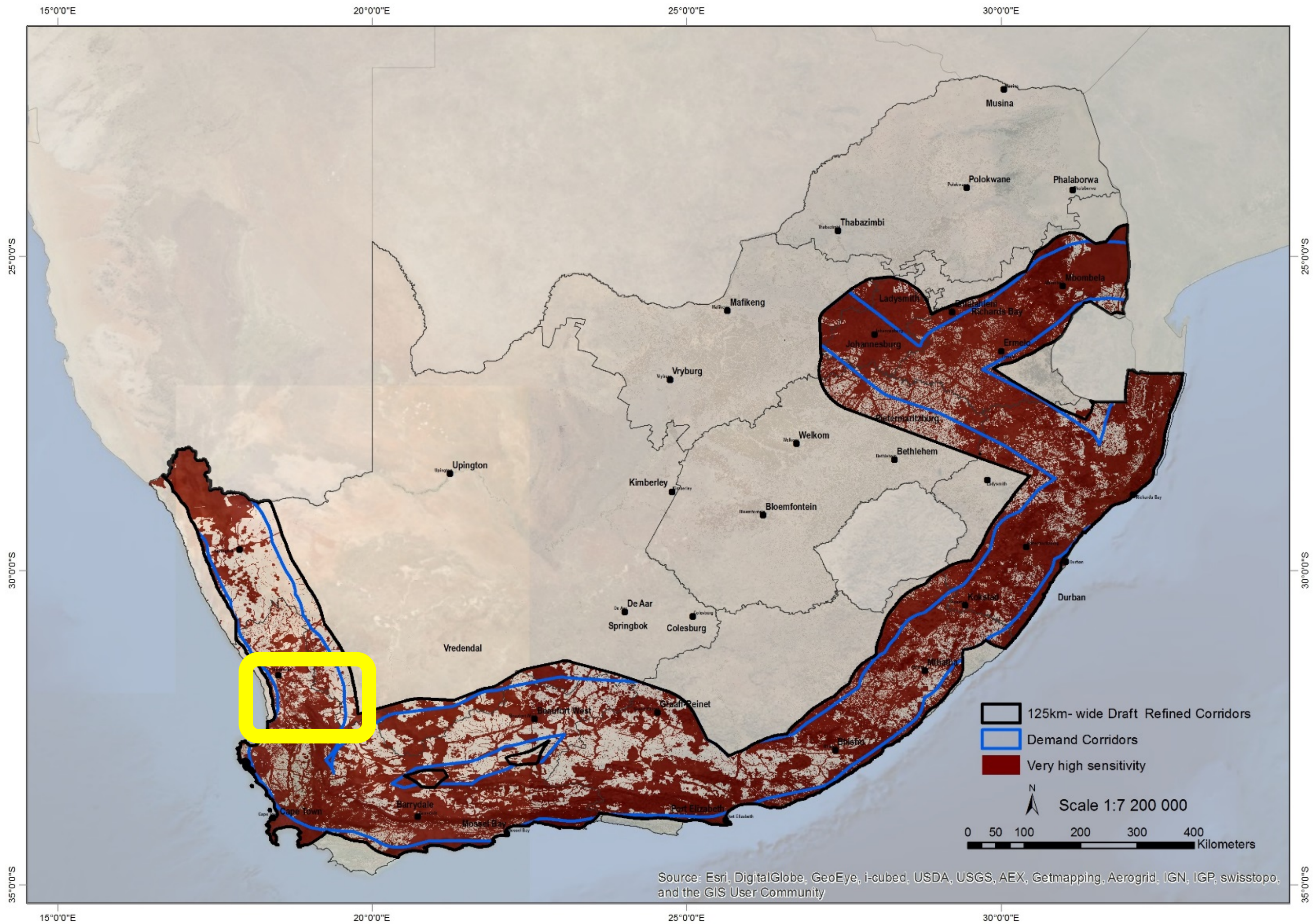
- Lake Sibayi Fresh water reserve;
- iSimangaliso National Park;
- Hluluwe-uMfolozi Nature Reserve;
- Tembe Elephant Park;
- Silezi, Mkuzi and Ndume Nature Reserves;
- Very High sensitivity freshwater quinaries based on the Wetland and Rivers Assessment (Appendix C.1.7 of the Gas Pipeline SEA Report);
- Estuaries;
- Nesting and habitat sites for birds;
- Ecoregions for bats; and
- Areas of Very High sensitivity identified in the for the Indian Ocean Coastal Belt Biome Assessment (Appendix C.1.3 of the Gas Pipeline SEA Report);
- World Heritage Sites;
- Ungraded Heritage Sites;
- Forests;
- Coastline;
- Towns; and
- Major dams.

5.5.4 Pinch Point 4: Gauteng

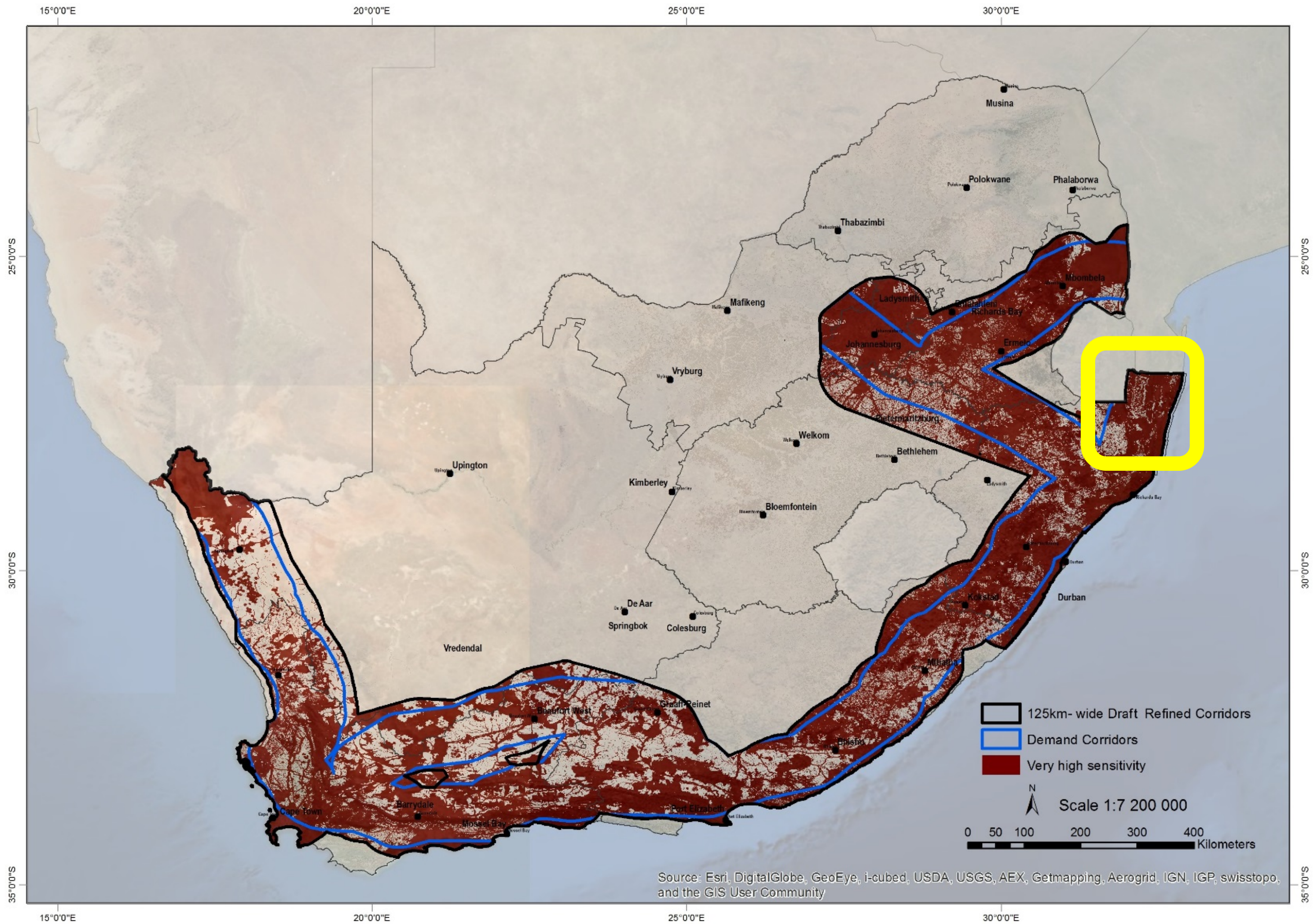
The pinch point caused in the Phase 3 Gas Pipeline Corridor (Map 14) was also resolved in the Final Pinch Point Analysis by shifting the corridor to ensure that the extent of Very High sensitivity area within the corridor is reduced. The main constraints influencing the pinch point, includes the extent of towns, active mining sites, dams, Suikerbosrand Nature Reserve, Olifantsvlei Nature Reserve and the Vaaldam Nature Reserve.



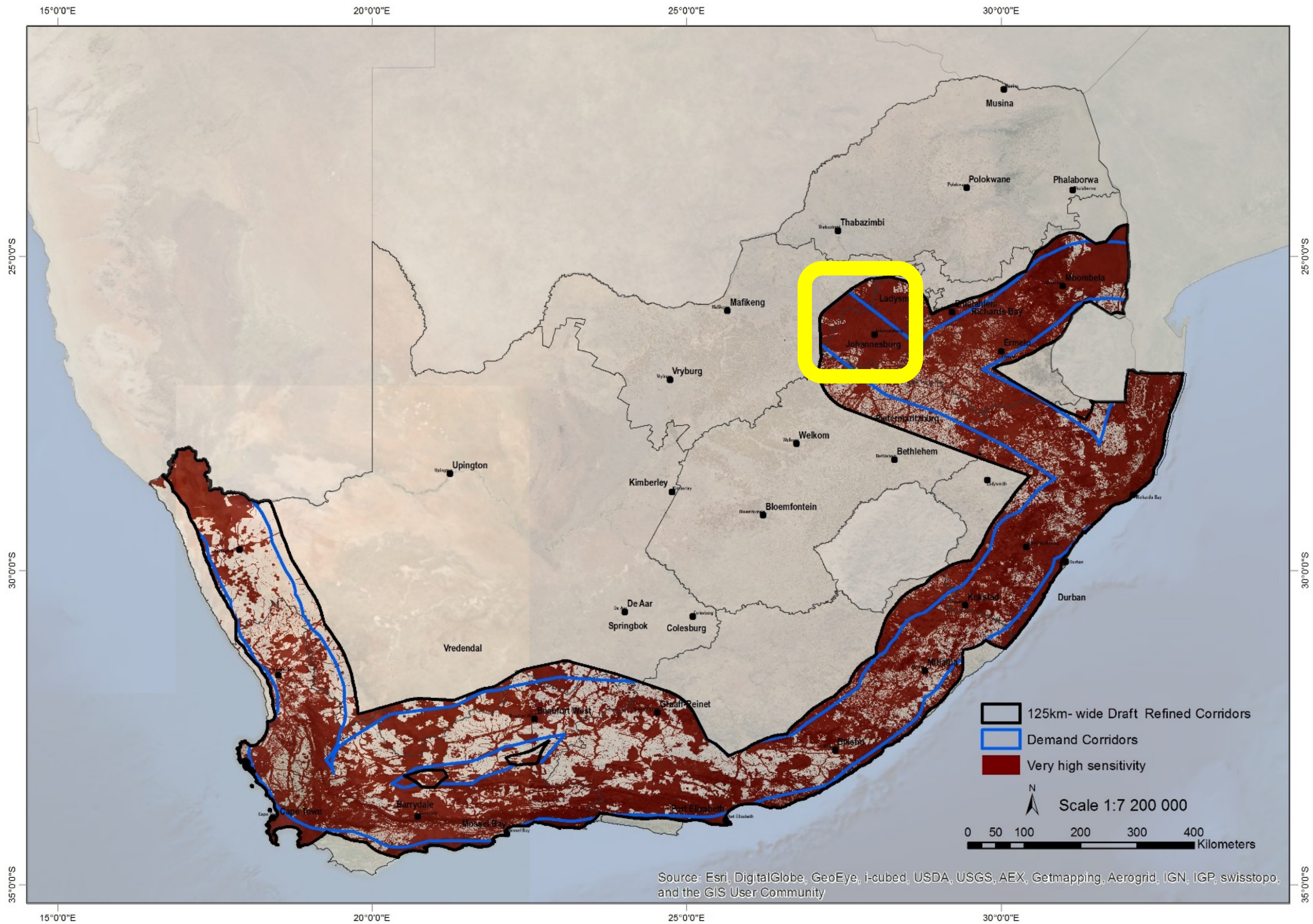
Map 11: Location of the Pinch Point at the South African and Namibian Border in the Gas Pipeline Phase 6 Corridor in relation to the 100 km wide Demand Mapping Corridors (in blue) and Draft Refined 125 km wide Corridors (in black).



Map 12: Location of the Pinch Point along the West Coast in the Gas Pipeline Phase 5 Corridor in relation to the 100 km wide Demand Mapping Corridors (in blue) and Draft Refined 125 km wide Corridors (in black).



Map 13: Location of the Pinch Point in Northern KwaZulu-Natal in the Gas Pipeline Phase 4 Corridor in relation to the 100 km wide Demand Mapping Corridors (in blue) and Draft Refined 125 km wide Corridors (in black).



Map 14: Location of the Pinch Point in Gauteng in the Gas Pipeline Phase 3 Corridor in relation to the 100 km wide Demand Mapping Corridors (in blue) and Draft Refined 125 km wide Corridors (in black).

5.6 Step 3: Identification of Final Gas Pipeline Corridors

Based on the pinch points identified above in Section 5.5, the 100 km wide Demand Mapping Corridors were shifted and re-aligned in order to identify the **Final 100 km wide Gas Pipeline Corridors.** To summarise, the 100 km wide Demand Mapping Corridors were shifted in three main places to resolve the pinch points identified:

- Pinch Point 2: West Coast: Both the coastal and inland extremities of the Phase 5 corridor in this vicinity were shifted to the east;
- Pinch Point 3: Northern KwaZulu-Natal: The inland extremity of the Phase 4 corridor in this vicinity was shifted to the west. The coastal extremity was also shifted very slightly in this vicinity; and
- Pinch Point 4: Gauteng: Both extremities of the Phase 3 corridor were shifted to the south-west.

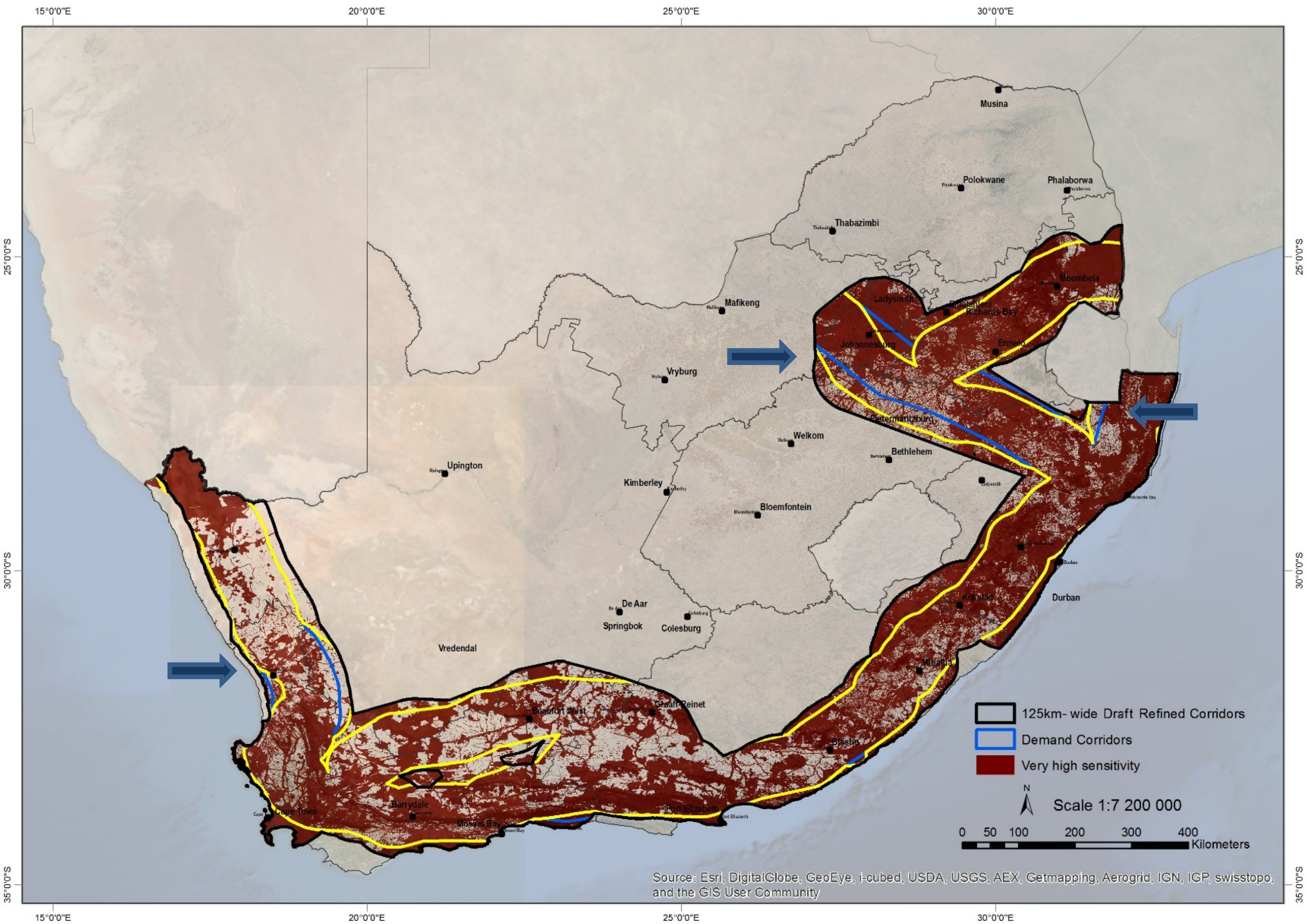
Map 15 provides an illustration of the **Final 100 km wide Gas Pipeline Corridors** shown in yellow, the 100 km wide Demand Mapping Corridors shown in blue, and the Draft Refined 125 km Corridors shown in black, which have been overlaid on the Very High environmental and engineering sensitivity features. Map 15 also shows the main areas at which the corridors were shifted in order to identify the Final 100 km wide Gas Pipeline Corridors.

Map 16 illustrates the **Final 100 km wide Gas Pipeline Corridors** that have been identified following the Final Pinch Point Analysis, which will be recommended for gazetting. Map 17 provides the same information, however with additional context in terms of Provinces, District Municipalities, key towns and National Roads.

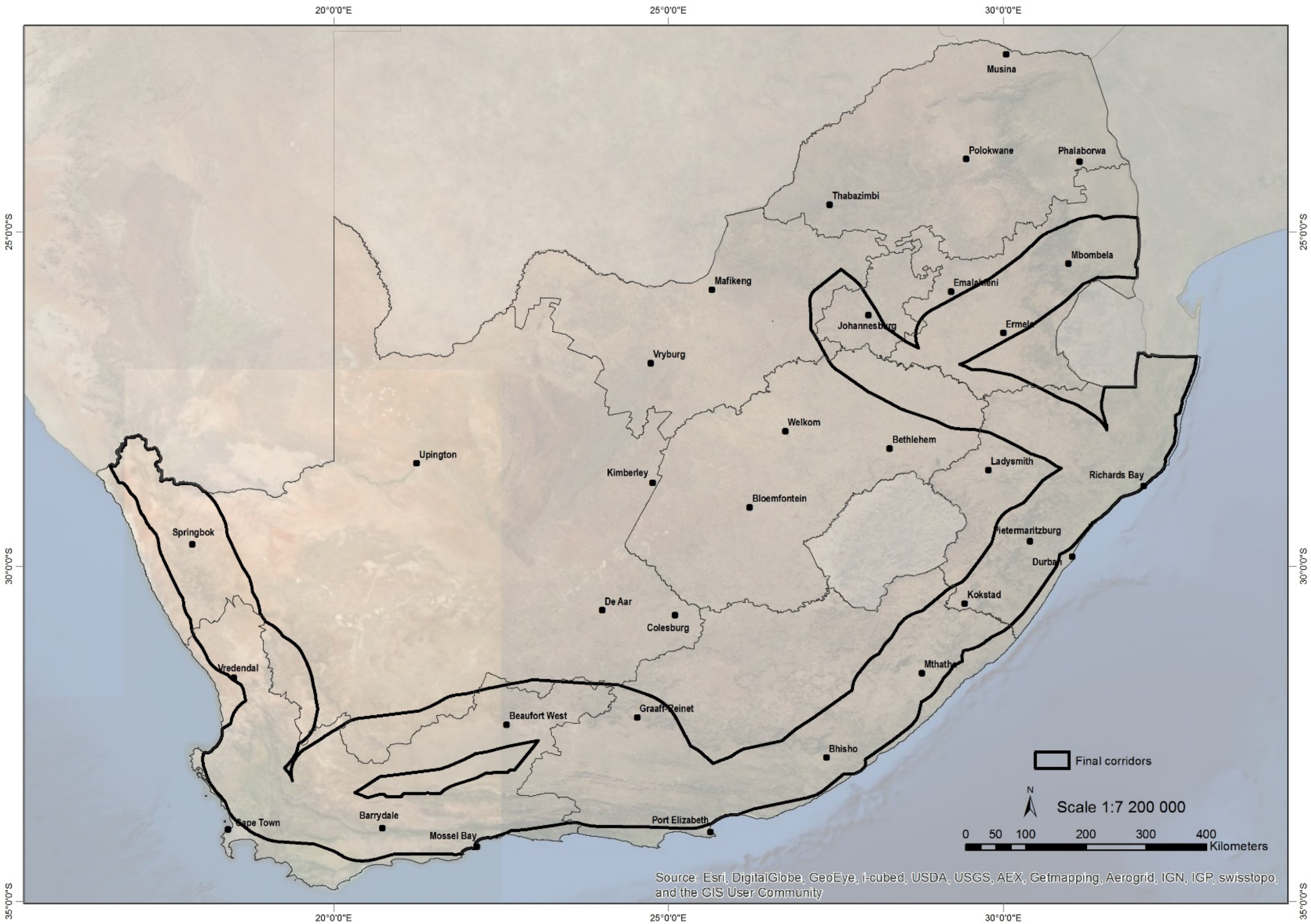
5.7 Conclusion

Maps 18 and 19 respectively illustrate the Environmental Sensitivity and Engineering Constraints of the **Final 100 km wide Gas Pipeline Corridors**.

This serves as the concluding point of the SEA Process. The next step in Phase 3 of the SEA is to gazette the outputs of the SEA, which will be undertaken by the DEA. The main output of the SEA is the proposed streamlining of the Environmental Assessment Process within the Gas Pipeline Corridors (once gazetted) to a Basic Assessment Process and reduced decision-making timeframe. In addition, other Decision-Support Outputs include the Generic Environmental Management Programme for Gas Pipelines and Heritage Protocol, which will be gazetted for comment prior to being gazetted for implementation. Stakeholders are encouraged to review these documents when they are made available for comment.

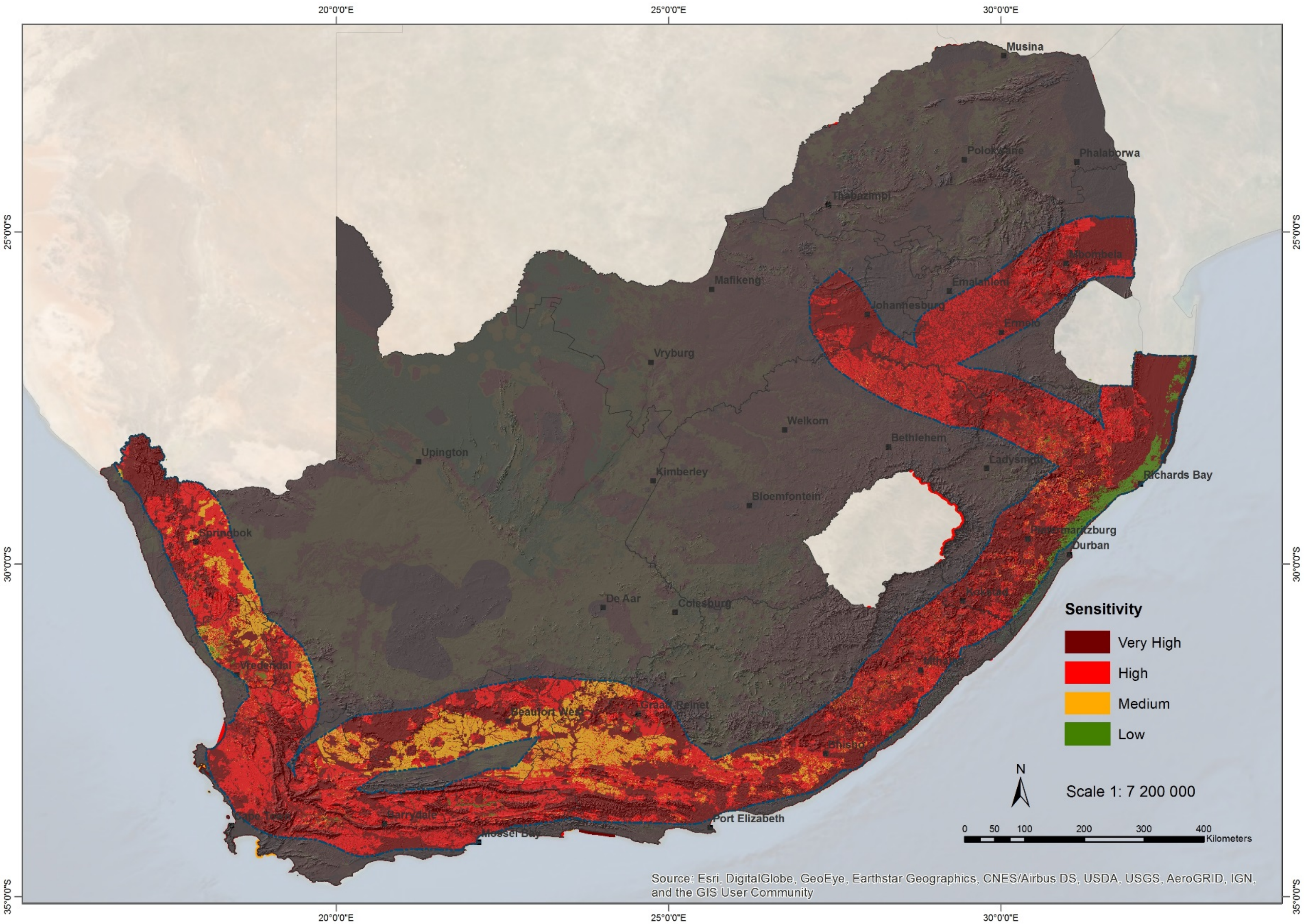


Map 15: Final 100 km wide Gas Pipeline Corridors (yellow), the 100 km wide Demand Mapping Corridors (blue), and the Draft Refined 125 km Corridors (black), overlaid on the Very High environmental and engineering sensitivity features. The arrows indicate the areas that were shifted.

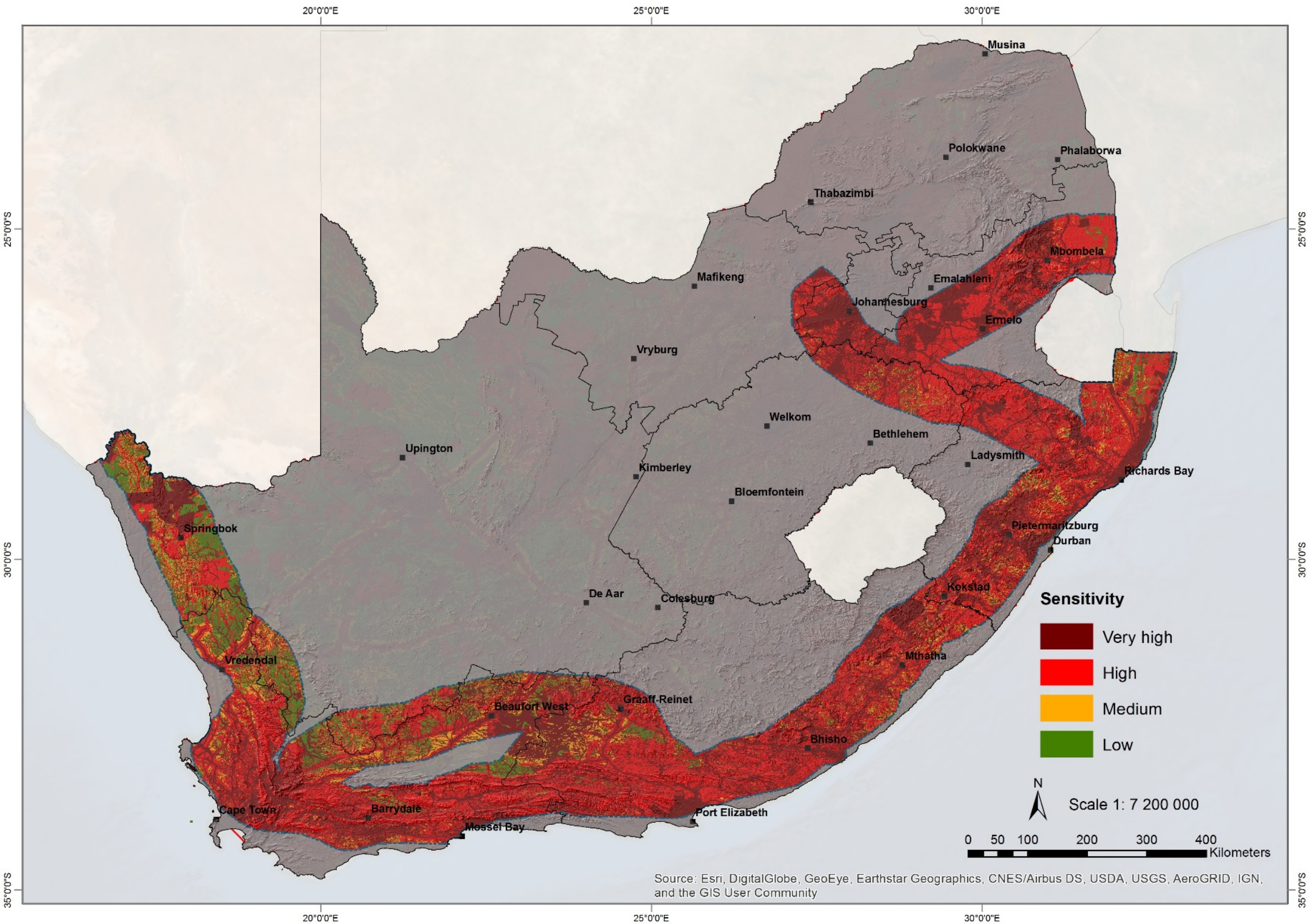


Map 16: Final 100 km wide Gas Pipeline Corridors identified for Gazetting.

Map 17: Final 100 km wide Gas Pipeline Corridors identified for Gazetting, in relation to Provinces, District Municipalities, key towns and National Roads.



Map 18: Environmental Sensitivity of the Final 100 km wide Gas Pipeline Corridors for Gazetting.



Map 19: Engineering Constraints of the Final 100 km wide Gas Pipeline Corridors for Gazetting.

Appendix 5.1 – List of features used in the Demand Mapping Exercise

Feature mapped	Source and date	Scale	Additional notes
Agriculture			
Agri-parks sites	DRDLR, June 2018	Eastern Cape Province	
Agricultural areas	Eastern Cape Provincial Spatial Development Framework (PSDF), June 2018	Eastern Cape Province	Includes Agri-Parks.
Agricultural areas	Eden District Spatial Development Framework (SDF) Municipality, June 2018	Eden District Municipality	
Agricultural areas	Saldanha LM Feedback	Saldanha Local Municipality	
Agricultural areas	OR Tambo District Municipality, June 2018	O R Tambo District Municipality	2018/19 Municipal Budget and Benchmark Engagement OR Tambo District Municipality
Agricultural areas	City of Johannesburg SDF, June 2018	City of Johannesburg Municipality	
Agricultural areas	City of Ekurhuleni, June 2018	City of Ekurhuleni Municipality	
Agricultural areas	eThekwini Municipality Draft SDF, June 2018	eThekwini Municipality	
Agricultural areas	uThungulu (King Cetshwayo) – Umlalazi Local Municipality	King Cetshwayo District Municipality	
Agricultural areas	Gert Sibande District Municipality, June 2018	Gert Sibande District Municipality	
Agricultural areas	City of Cape Town SDF, September 2018	City of Cape Town Municipality	
Commercial farming, agriculture areas	Gert Sibande District Municipality, September 2018	Gert Sibande District Municipality	
Agricultural areas	KZN Department of Co-operative Governance and Traditional Affairs (COGTA), September 2018	KZN District Municipalities	Including data for the Ugu District Municipality, Umzinyathi District Municipality, Uthukela District Municipality, Amajuba District Municipality, Zululand District Municipality, Umkhanyakude District Municipality, King Cetshwayo District Municipality, City of uMhlathuze Local Municipality, Ilembe District Municipality, Harry Gwala District Municipality, eThekwini Municipality, Umdoni Local Municipality
Agri-parks, agricultural potential	Eastern Cape Province, February 2019	Eastern Cape Province	From Agri-Park Commodity Report ORTDM 301115
Potential Wildlife Zone	Northern Cape Province CPA project business proposal, December 2018	Richtersveld	
Agricultural areas	PSDF COGTA, February 2019	KwaZulu-Natal Province	
AgriHubs and farmer production support units	Northern Cape Province, February 2019	Northern Cape Province	
Mega Agri-Parks	Northern Cape Province, February 2019	Northern Cape Province	Includes Agri-Parks for, Frances Baard, John Taolo,

Feature mapped	Source and date	Scale	Additional notes
			Namakwa, Pixley ka Seme and Mgcawu Districts
Agricultural areas	Draft Mpumalanga PSDF, February 2019	Mpumalanga Province	
Industry			
Areas earmarked for development	DEADP PSDF, June 2018	Western Cape Province	
Industrial areas	Eastern Cape PSDF, June 2018	Eastern Cape Province	Includes open gas cycle turbines and SEZs
Key Infrastructure considerations	Eastern Cape PSDF, June 2018	Eastern Cape Province	Includes PSDF nodes, for industrial sectors and rural enterprise development hubs
Industrial areas	Eden District Municipality SDF, June 2018	Eden District Municipality	
Industrial areas	City of Cape Town, June 2018	City of Cape Town Municipality	Based on the built environment performance plan
Industrial areas	Saldanha LM Feedback	Saldanha Local Municipality	
Future activities	Sarah Baartman District Municipality, June 2018	Sarah Baartman District Municipality	
Industrial areas	OR Tambo District Municipality, June 2018	O R Tambo District Municipality	2018/19 Municipal Budget and Benchmark Engagement OR Tambo District Municipality
Industrial areas	City of Johannesburg SDF, June 2018	City of Johannesburg Municipality	
Industrial areas	City of Ekurhuleni, June 2018	City of Ekurhuleni Municipality	
Industrial areas	eThekwini Municipality Draft SDF, June 2018	eThekwini Municipality	
Proposed key developments	Namakwa District Municipality, June 2018	Namakwa District Municipality	
Proposed projects	Pixley Ka Seme District Municipality, June 2018	Pixley Ka Seme District Municipality	
Industrial areas	uThungulu (King Cetshwayo) – Umlalazi LM	King Cetshwayo District Municipality	
Proposed developments	Namakwa District Municipality, June 2018	Namakwa District Municipality	
Industrial areas	Gert Sibande District Municipality, June 2018	Gert Sibande District Municipality	
Industrial areas	City of Cape Town SDF, September 2018	City of Cape Town Municipality	
Proposed Projects	Pixley Ka Seme District Municipality, September 2018	Pixley Ka Seme District Municipality	
Proposed development	Free State Province, September 2018	Free State Province	
Industrial areas	Gert Sibande District Municipality SDF, September 2018	Gert Sibande District Municipality	
Industrial areas	KZN COGTA September 2018	KZN District Municipalities	Including data for the Ugu District Municipality, Umzinyathi District Municipality, Uthukela District Municipality, Amajuba District Municipality, Zululand District Municipality, Umkhanyakude District Municipality, King Cetshwayo District Municipality, City of uMhlathuze Local Municipality, Ilembe District Municipality, Harry Gwala District Municipality, eThekwini Municipality, Umdoni Local Municipality
Industrial Development Zone (IDZ)	Saldanha Bay, September 2018	Saldanha Bay	
Draft Aquaculture Development Zones	Aquaculture SEA, January 2019	National	

Feature mapped	Source and date	Scale	Additional notes
Special Economic Zone	Northern Cape Department, January 2019	Upington	
Department of Transport structure and services	KwaZulu-Natal Department of Transport, January 2019	KwaZulu-Natal Province	
Proposed Strategic Economic Zone for North West	North West, November 2018	North-West Province	
Approved Strategic Economic Zone for Nkomazi SEZ and Secunda SEZ	Nkomazi Local Municipality, February 2019	Nkomazi Local Municipality	
Dimbaza Industrial Development Areas	ECSECC	Eastern Cape Province	
Industrial Development Zone	Richards Bay, February 2019	Richards Bay	Includes phases 1A-F and 2A
Mining Impacts in the Richtersveld	Northern Cape Province CPA project business proposal, December 2018	Richtersveld	
Planned regional investments	Northern Cape Province CPA project business proposal, December 2018	Northern Cape	
Industrial areas	PSDF COGTA, February 2019	KwaZulu-Natal Province	
Industrial areas, economic hub growth points	Draft Mpumalanga PSDF, February 2019	Mpumalanga Province	
Industry	Sunbird energy approved project area	Sunbird Energy, May-19	Western Cape, Local scale
Mining			
Mining areas	Eastern Cape PSDF, June 2018	Eastern Cape Province	
Mining areas	Eden District SDF Municipality, June 2018	Eden District Municipality	
Mining areas	Gauteng SDFs	Gauteng	Includes mining belt development areas, priority mining areas
Mining areas	OR Tambo District Municipality, June 2018	O R Tambo District Municipality	2018/19 Municipal Budget and Benchmark Engagement OR Tambo District Municipality
Mining areas	City of Johannesburg SDF, June 2018	City of Johannesburg Municipality	
Mining areas	City of Ekurhuleni, June 2018	City of Ekurhuleni Municipality	
Mining areas	eThekwini Municipality Draft SDF, June 2018	eThekwini Municipality	
Mining areas	uThungulu (King Cetshwayo) – Umlalazi LM	King Cetshwayo District Municipality	
Mining areas	Gert Sibande District Municipality, June 2018	Gert Sibande District Municipality	
Mining areas	City of Cape Town SDF, September 2018	City of Cape Town Municipality	
Mining focus areas, mining areas	Gert Sibande District Municipality, September 2018	Gert Sibande District Municipality	
Mining areas	KZN COGTA September 2018	KZN District Municipalities	Including data for the Ugu District Municipality, Umzinyathi District Municipality, Uthukela District Municipality, Amajuba District Municipality, Zululand District Municipality, Umkhanyakude District Municipality, eThekwini Municipality, Umdoni Local Municipality King Cetshwayo District Municipality, City of uMhlathuze Local Municipality, Ilembe District Municipality, Harry Gwala

Feature mapped	Source and date	Scale	Additional notes
			District Municipality, eThekwini Municipality, Umdoni Local Municipality
Mining areas	PSDF COGTA, February 2019	KwaZulu-Natal Province	
SAMRAD Applications	DMR, February 2019	National	
Mining Applications Types	DMR, February 2019	National	
Mining areas	Draft Mpumalanga PSDF, February 2019	Mpumalanga Province	
Mining areas	Western Cape	Western Cape	Key mining areas
Potential and existing markets			
Industrial areas	West Coast District Municipality, June 2018	West Coast District Municipality	
Proposed Developments and Gas Plan	Coega Development Corporation, June 2018	Eastern Cape	Proposed Developments and Gas Plan
Gas pipeline network	Overberg District Municipality, June 2018	Overberg District Municipality	
Pipeline Corridors	Transnet, July 2018/ August 2018	National	
Gas network	Saldanha Bay IDZ, July 2018 / August 2018	Saldanha Bay	
Recommissioned power stations	Gert Sibande District Municipality, September 2018	Gert Sibande District Municipality	
Existing and potential gas markets	Gas Opportunities Analysis		Includes mining potential gas markets, Industry potential markets and towns for potential gas power