APPENDIX M: CLIMATE CHANGE STUDY

Specialist Climate Change Impact Assessment

Jindal Melmoth Iron Ore Project

Prepared by Promethium Carbon for:

SLR

27 October 2022

Executive Summary

This report presents the climate change impact assessment conducted by Promethium Carbon (appointed by SLR Consulting) for the Jindal Melmoth Iron Ore Project located in Melmoth, KwaZulu Natal. The assessment was conducted in accordance with the environmental authorisation process, and in the context of the Thabametsi Case judgement.

Promethium's assessment covered the impact of the proposed project on climate change and the project's resilience to climate change across both the construction and operational phases of the project.

The assessment of the project's impact on climate change was based on the project's greenhouse gas (GHG) emissions, as calculated according to SANS 14064:2021 Part 1 and the Regulations and Technical Guidelines published by the Department of Forestry, Fisheries, and the Environment (DFFE).

The assessment of the project's resilience to climate change was guided by the DFFE's Framework for Climate Change Vulnerability Assessments and the Equator Principles. The project's vulnerability was assessed across core operations, value chain (upstream and downstream), and the broader social and environmental context.

This report also addresses possible mitigation and adaptation measures that could be considered by the proposed project developer as recommendations to reduce GHG emissions and improve the project's resilience to climate change.

The impact of the project on climate change was assessed in the context of both GHG emissions from the project, as well as the potential positive impact the project can have through the avoidance of emissions. The project will emit 326 $ktCO_2e$ during the construction phase, 19 850 $ktCO_2e$/year during the operational phase and 496 100 $ktCO_2e$ over its lifetime. The iron ore processing related emissions form a significant portion of these emissions, therefore the higher emission factor was selected to be conservative. Should the iron ore be processed in a plant indicative of the global average which includes new build plants in developed countries such as Europe, the emissions from downstream processing could decrease by approximately 40%.

The iron and steel industry are already and will continue to play a critical role in the global transition to a low-carbon economy. The World Bank predicts a steel demand of 2.5 billion tonnes under a 2°C scenario, driven by the growth in demand for components used in renewable energy technologies. The global economy will not be able to move to a lower GHG emissions scenario without a substantial increase in renewable energy infrastructure development which will require steel. The Project will therefore have a positive net climate change impact.

Climate projections for the KwaZulu Natal province indicate an annual average ambient temperature increase, with overall variability in precipitation. The drought risk prediction for the Mthonjaneni Local Municipality is however low. Central parts of the municipality are also predicted to experience floods due to rainfall variability. In the summer months particularly, the municipality is susceptible to hail, thunderstorms, and heavy rainfall. There will be an increase in the number of extreme hot days with an average annual temperature increase of at least 1.7 °C to 2.0 °C from the baseline period (1961-1990).

Promethium Carbon has not identified any fatal flaws with respect to the CCIA for this project and we do not propose any special conditions with respect to the authorisation of this project. In accordance with our findings, we therefore advise that the proposed Jindal Melmoth Iron Ore Project should receive environmental authorization.

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Key Terms and Definitions[1,2]

Adaptive capacity	Adaptive capacity is a set of factors which determine the capacity of a system to generate and implement adaptation measures. These factors relate largely to available resources of human systems and their socio-economic, structural, institutional, and technological characteristics and capacities.
Climate change[3]	The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as: '*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*. The UNFCCC thus makes a distinction between climate change attributable to human activities altering the atmospheric composition and climate variability attributable to natural causes.
Climate change impacts	The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure. Impacts may be referred to as consequences or outcomes and can be adverse or beneficial.
Climate change vulnerability	The degree to which a system is susceptible to and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.

[1] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[2] IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.

[3] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

Climate resilience	Focuses on the ability to adapt to disturbances and events caused by climate change and investigates future climate-related risks which may pose new challenges for traditional risk management.
Climate variability	Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).
Exposure	Exposure is directly linked to climate parameters, that is, the character, magnitude, and rate of change and variation in the climate. Typical exposure factors include temperature, precipitation, evapotranspiration, and climatic water balance, as well as extreme events such as heavy rain and meteorological drought. Exposure is the contact between one or more biological, psychosocial, chemical, or physical; stressors, including stressors affected by climate change.
Extreme weather[4]	Is unexpected, unusual, or unforeseen weather and differs significantly to the usual weather pattern, such as droughts, floods, extreme rainfall, and storms.
Greenhouse Gas (GHG)	Greenhouse gasses (GHGs) are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and by clouds. This property causes the greenhouse effect. The Kyoto Protocol deals with the following greenhouses gases, carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), Sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).
Sensitivity	Sensitivity determines the degree to which a system is adversely or beneficially affected by a given climate change exposure and is a function of the natural and socio-economic context of a particular site.

[4] GIZ. 2014. The vulnerability sourcebook. Gesellschaft für Internationale Zusammenarbeit, Bonn, Germany.

Social vulnerability drivers[5]

Social vulnerability is defined as a dynamic state of societies comprising exposure, sensitivity and adaptive capacity. It is characterised by high levels of dependence on natural resources for livelihoods and economic development, combined with increasing environmental degradation, which can both increase exposure (e.g. wetland destruction) and reduce adaptive capacity (e.g. declining river flows constraining water provision). Examples of social vulnerability drivers include poverty, low awareness and inability to migrate.

SSP 2
Shared Socioeconomic Pathway 2

This is the "Middle of the Road" or medium pathway, which extrapolates the past and current global development into the future. In this scenario, there is a certain cooperation between states, but it is barely expanded. Global population growth is moderate, levelling off in the second half of the century. Environmental systems are facing a certain degradation.[6] This scenario is equivalent to RCP 4.5 in the IPCC's Fifth Assessment Report (AR5).

SSP 5
Shared Socioeconomic Pathway 5

This is the "Fossil-fuelled Development" scenario. In the scenario, global markets are increasingly integrated, leading to innovations and technological progress. The social and economic development is based on an intensified exploitation of fossil fuel resources with a high percentage of coal and an energy-intensive lifestyle worldwide. The world economy is growing and local environmental problems such as air pollution are being tackled successfully. This scenario is equivalent to RCP 8.5 in the IPCC's Fifth Assessment Report (AR5).

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5 Tucker, J., Daoud, M., Oates, N. et al. Reg Environ Change (2015) 15: 783. https://doi.org/10.1007/s10113-014-0741-6.

6 Böttinger, M and D. Kasang. 2021. The SSP Scenarios. Deutsches Klimarechenzentrum, Hamburg, Germany. Available at: https://www.dkrz.de/en/communication/climate-simulations/cmip6-en/the-ssp-scenarios.

Declaration of Independence

The authors of this report do hereby declare their independence as consultants appointed by SLR Consulting to undertake a Climate Change Impact Assessment as part of the Jindal Melmoth Iron Ore Project. Other than fair remuneration for the work performed the specialists have no personal, financial business or other interests in the project activity. The objectivity of the specialists is not compromised by any circumstances and the views expressed within this report are their own.

Robbie Louw

Kenneth Slabbert

Megan Schulze

Indiana Mann

Shannon Murray

Details of the Specialist Team

Promethium Carbon is a South African climate change and carbon advisory company based in Johannesburg. The company has been active in the climate change and carbon management space since 2004.

Promethium Carbon's climate change impact studies include an estimation of the carbon footprint of the activity or group of activities, as well as the vulnerability of the activity/ies to climate change. Promethium Carbon has calculated greenhouse gas inventories for over 60 entities and is proficient in applying the requirements of ISO/SANS 14064-1 and the Greenhouse Gas Protocol's accounting standards, as well as South Africa's Greenhouse Gas Reporting Guidelines. Promethium Carbon has also assisted around 40 clients develop climate change risk assessments, which includes the compilation of climate change specialist reports. Promethium Carbon's assessments include thorough analysis of historical and projected weather data specific to the region in which the client operates. Promethium Carbon's assessment of vulnerability goes beyond core operations to include impacts within the supply chain and broader network of the Melmoth Jindal Iron Ore Project.

Robbie Louw is the founder and director of Promethium Carbon. He has over 18 years of experience in the climate change industry. Robbie holds both a BCom Honours Degree in Economics as well as a BSc degree in Chemical Engineering. Robbie has significant experience with regards to climate change mitigation and adaptation. Robbie's chemical engineering background combined with his extensive experience in climate change has led to him leading several projects related to climate change risk and vulnerability, energy development and developing climate change mitigation and adaptation alternatives. His experience over a period of 35 years covers the chemical, mining, minerals process and energy fields, in which he was involved in R&D, project, operational and management levels. Robbie is currently a member of The Southern African Institute of Mining and Metallurgy and the Institute of Directors in South Africa (IoDSA). In addition, Robbie is also a member of the Technical Working Group of the Climate Disclosure Standards Board (CDSB). Robbie's experience in climate change includes, but is not limited to:

- Climate change risk and vulnerability assessments for large mining houses;
- Extensive experience in preparing carbon footprints. The team under his leadership has performed carbon footprint calculations for major international corporations operating complex businesses in multiple jurisdictions and continents;
- Carbon and climate strategy development for major international corporations;
- Climate change impact assessments for various companies and projects;
- Climate change scenario planning and analysis, particularly in terms of the recommendations of the Taskforce on Climate-related Financial Disclosure; and
- In depth understanding of South Africa's climate change regulations and carbon tax requirements.

Kenneth Slabbert is a Climate Change Advisor who holds a Masters in Mechanical Engineering specialising in energy management. He has four years of experience in climate change mitigation and energy management. Kenneth's experience includes carbon footprint calculations and reporting, carbon tax calculations, climate change impact assessments, energy management, CDP responses and carbon credit project documentation.

Megan Schulze is a Climate Change Advisor who holds a Postgraduate Diploma in Sustainable Development. Her postgraduate studies focused on a transdisciplinary range of sustainable development issues including, but not limited to, sustainable food systems, renewable energy policy, corporate governance, complexity theory and systems thinking and sustainable cities. Part of her postgraduate studies involved a short course in Carbon Footprint calculations, as well as a one month internship at Promethium Carbon in 2019. Over the past two years at Promethium Carbon, Megan has gained valuable experience in a range of topics. Some of the projects she has been involved in include:

- GHG Reporting;
- Carbon Footprints;
- CDP Climate and CDP Water disclosure reporting;
- Climate Change Risk and Vulnerability Assessments;
- Climate Change Impact Assessments;
- The Task Force on Climate-Related Financial Disclosures gap analysis;
- Policy development; and
- CDM and VCS Projects, including landfill gas flaring projects.

Indiana Mann is a Climate Change Advisor who holds an honours degree in Atmospheric Science. Her postgraduate studies focused on the impact meteorological conditions have on pollen distribution. With her background in Environmental and Geographical Science and Atmospheric Science, Indiana has knowledge in climate modelling, climate change risk and vulnerability assessments and climate change policies. The projects in which she has been active include:

- Climate Change Risk and Vulnerability Assessment;
- Climate Change Impact Assessments;
- The Task Force on Climate-Related Financial Disclosures reports; and
- Handling of weather data for necessary reports.

Shannon Murray is a climate change advisor who commenced her employment with Promethium Carbon in October 2021. She completed her BA Degree in Sign Language, as well as her LLB degree through the University of the Witwatersrand. Furthermore, Shannon obtained course certificates through the Wits Mandela Institute in Energy Law, Environmental and Sustainable Development Law, Land and Water Law and International Environmental Law. Shannon was admitted as an attorney in November 2019 and practised as such for a small commercial litigation firm until September 2021. In the short period of time that Shannon has been employed with Promethium Carbon, she has done extensive research in relation to the climate change field and has formed part of various teams within the company. She has gained experience in:

- The legal aspects of carbon credit purchase agreements;
- Developing a socio-economic development project list, with climate change project funding benefits, for a global mining company;
- Developing a climate change target for a listed pharmaceutical company; and
- Performing an eligibility assessment for a carbon credit project, including the legal aspects of the carbon credit transaction.

Report structure and reference in terms of NEMA Regulations (2014), Appendix 6

NEMA Regulations (2014) (as amended) - Appendix 6	Relevant section in report
Details of the specialist who prepared the report	Page xi-xii
The expertise of that person to compile a specialist report including a curriculum vitae	Page xi-xii
A declaration that the person is independent in a form as may be specified by the competent authority	Page x
An indication of the scope of, and the purpose for which, the report was prepared	Section 2, sub-section 2.2
An indication of the quality and age of base data used for the specialist report	Sub-section 4.1.2 and 4.2.2
A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5 and 6
The duration date and season of the site investigation and the relevance of the season to the outcome of the assessment	No site investigation took place as this was a desktop study that relied on requested information
A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 4
Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternative	Section 7
An identification of any areas to be avoided, including buffers	This is not relevant in terms of the climate change impact assessment. However, this report does make mention of the impacts of climate change on sensitive areas surrounding the Jindal Melmoth Iron Ore Project
A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	This is not relevant in terms of the climate change impact study. However, this report does define the boundaries for which the project's impact on climate change, as well as the project's vulnerability to climate change was determined
A description of any assumptions made and any uncertainties or gaps in knowledge	Sub-section 4.1.5 and 4.2.4
A description of the findings and potential implications of such findings on the impact of the proposed activity or activities	Section 5, 6 and 7
Any mitigation measures for inclusion in the EMPr	Section 8
Any conditions for inclusion in the environmental authorisation	N/A

Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 9
A reasoned opinion as to whether the proposed activity or portions thereof should be authorised and regarding the acceptability of the proposed activity or activities	Section 9
A description of any consultation process that was undertaken during preparing the specialist report	N/A
A summary and copies of any comments received during any consultation process and where applicable all responses thereto	N/A
Any other information requested by the competent authority	N/A

1 Introduction

Promethium Carbon has been appointed by SLR Consulting (South Africa) (Pty) Ltd (SLR Consulting) to undertake a climate change impact assessment (CCIA) as part of the Environmental Impact Assessment (EIA) for the mining right application of the proposed Jindal Melmoth Iron Ore Project (hereafter, referred to as the Jindal Project). The Project's mining right application includes an application for two prospecting areas (North and South Blocks), as well as the development of open pit iron ore mining operations and a processing plant in Melmoth, KwaZulu-Natal (KZN). The mine is anticipated to be developed within Jindal's proposed prospecting right area, which is located approximately 25 kilometres southeast of Melmoth, and falls within the jurisdiction of the Mthonjaneni Local Municipality and King Cetshwayo District Municipality, as indicated in Figure 1 below.

The Project will include the following components, as per the scope of work provided:

- An open pit mining operation;
- A processing plant for milling and magnetic separation of iron ore concentrate;
- A waste rock dump for disposal of waste rock;
- Associated infrastructure; and
- A tailings storage facility (to be applied for under a separate Environmental Authorisation process).

Jindal Iron Ore (Pty) Ltd (Jindal) holds two Prospecting Rights over the Project site (North and South Block). The North (PR 10644) and South (PR 10652) blocks have a total combined extent of 20 170 hectares. Jindal's intent with this mining right application is to consolidate the prospecting rights for the North and South blocks into a single mining right. The mining right application will consider the entire extent of the two prospecting right blocks, but with a specific focus on the area for Phase 1 of the Jindal Project.

Phase 1 of the Jindal Project will consist of an open cast pit mining operation to be developed in the southeast area of the South Block. Waste rock stripped from the pit will be disposed on a waste rock dump within the mining right application area. Run of mine ore will be hauled to a primary processing plant for crushing, milling and magnetic separation. The plant will produce iron ore concentrate and tailings, which will be transported to the Richards Bay Port via either rail or pipeline, from there, it will be exported. Prospecting will be undertaken in the North and South blocks in parallel with the Phase 1 mining.

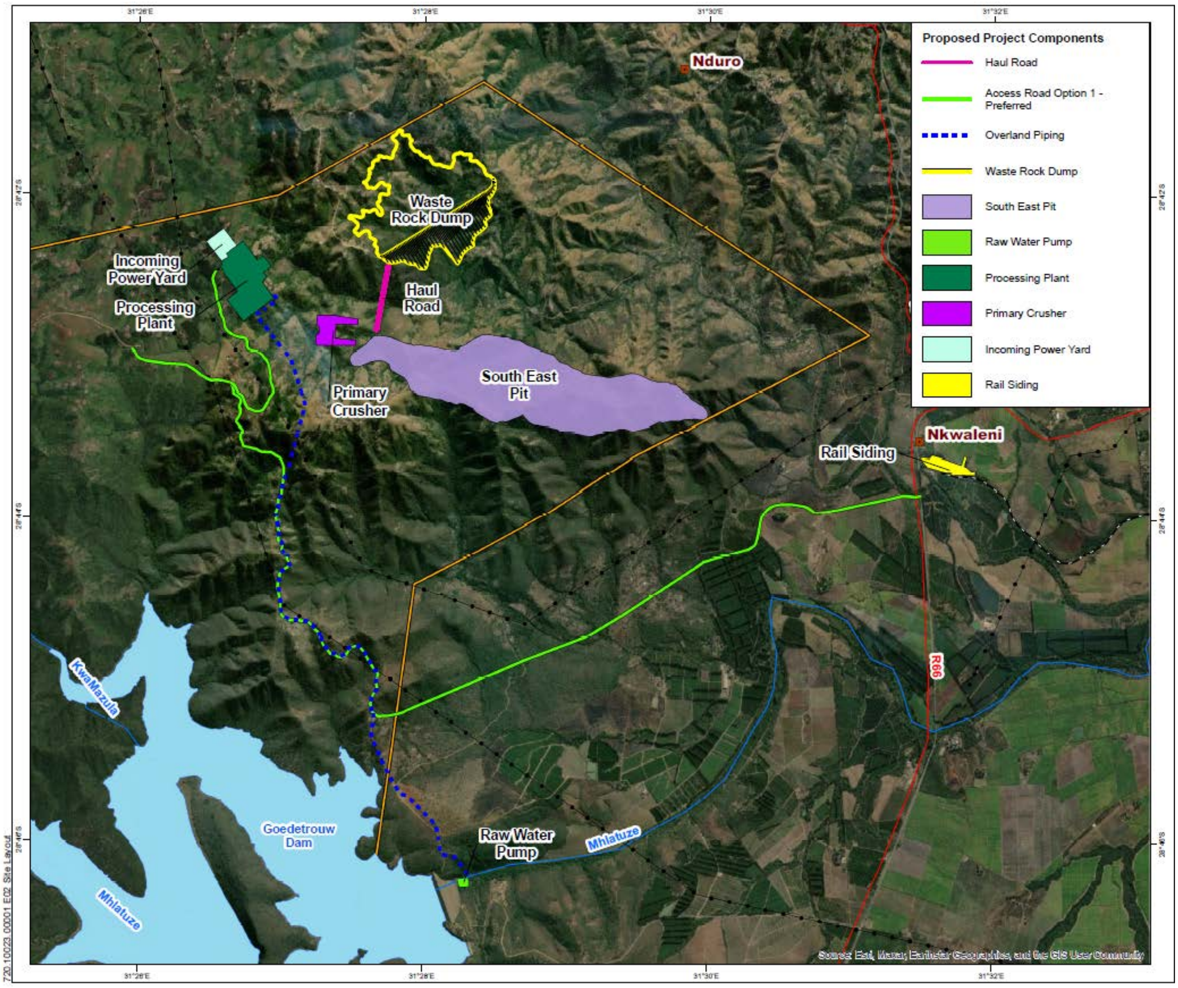

Figure 1: Jindal Project site location.

There are three key aspects covered in this CCIA, namely:

- An assessment of the Jindal Project's potential contribution to climate change through the emission of greenhouse gases (GHGs). These include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). These gasses are collectively referred to throughout this report as carbon dioxide equivalent (CO_2e);
- An assessment of the Jindal Project's resilience to climate change impacts; and
- Mitigation or adaptation options that could be adopted to minimise the impact on/by climate change.

2 Background to Climate Change Impact Assessments

This report will inform and assist Jindal in developing a climate change strategy for the Jindal Project, which is aligned to the company's environmental management goals. In this context, the impacts of the project on climate change and the climate change impacts on the project, must therefore be considered.

2.1 The Legal Precedent for Climate Change Impact Assessments in South Africa

2.1.1 Thabametsi Case

The Thabametsi case judgment[7] set the legal precedent for South African CCIAs, which has made provision for the inclusion of climate change in the specialist assessments. The environmental authorisation of the proposed Thabametsi coal-fired power station was appealed by Earthlife on the basis that the Chief Director of the Department of Environmental Affairs[8], who initially granted Thabametsi an environmental authorisation, and the Minister for Environment Forestry and Fisheries (now the Department of Forestry, Fisheries and the Environment "DFFE"), were obliged to consider the climate change impacts of the power station before granting an Environmental Authorisation, and that they failed to do so[9].

The court found that:

"[…] the legislative and policy scheme and framework overwhelming support the conclusion that an assessment of climate change impacts and mitigating measures will be relevant factors in the environmental authorisation process, and that consideration of such will best be accomplished by means of a professionally researched climate change impact report."[10]

Before the legal precedent set by the Thabametsi case, there was no express provision stipulating that climate change is a relevant factor to be considered as part of an Environmental Impact Assessment (EIA) in South Africa. For this reason - and given the lack of domestic guidelines to assess the climate change impacts of a specific activity - it was necessary to not only consider the principles of NEMA, but to also consider international best practice and international laws which inform CCIAs.

2.1.2 Constitutional Court's Decision to Dismiss New Coal Mining Operations – Uthaka Energy

In November 2021, the Constitutional Court dismissed an application by Uthaka Energy (Pty) Ltd for leave to appeal an interdict that was granted in the Pretoria High Court in March the same year.

The company was interdicted from starting any mining activities and operations at its proposed coal mine. The Constitutional Court's decision to pause the development of the new coal mining

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7 Earthlife Africa Johannesburg v Minister of Environmental Affairs and Others (65662/16) [2017] ZAGPPHC 58; [2017] 2 All SA 519 (GP) (8 March 2017) (saflii.org).

8 Following the announcement of the sixth administration in 2019, forestry and fisheries functions were amalgamated into the Department of Environmental Affairs, which became known as the Department of Environment, Forestry and Fisheries (DEFF). On 1 April 2021, the DEFF was renamed to the Department of Forestry, Fisheries and the Environment (DFFE).

9 Despite the court victory in March 2017, after reconsideration of the climate change impacts of the plant, the Minister again upheld Thabametsi's environmental authorisation, on the basis that the 2010 Integrated Resource Plan for Electricity (IRP) called for new coal-fired power capacity and had already assessed climate impacts. However, due to its large environmental footprint, funding for the project was pulled and on 19 November 2020, the court ordered that the environmental authorisation be set aside.

10 *Ibid*, See par 91 of the Judgement.

operations, was in part based on the fact that the impacts that coal mining has on Strategic Water Source Areas[11] and on global warming, is irrefutable, the impacts must be considered, and ultimately, Africa (in this case South Africa) needs to build resilience to climate change, and not add to it.

The circumstances of the Uthaka Project are very different to those of the Jindal Project, but the case is worth mentioning in terms of what a Court considers as the necessary procedure for implementation of a project that has adverse effects on the environment, and subsequently, the impacts of climate change.

The interdict that was granted in the Pretoria High Court in March 2021, confirms the fundamental importance of fair and transparent decision making, which was not taken by the then Ministers in granting the environmental authorisations. Therefore, in the context of the Jindal Project, an open and transparent process must be followed when obtaining the necessary environmental authorisations, failing which, the consequences may be dire in terms of being interdicted from commencing project activities.

2.1.3 Purpose of the Climate Change Impact Assessment

An EIA must be conducted before project development can commence, as per the relevant regulations. The EIA process is in accordance with the requirements of the 2014 EIA regulations promulgated in terms of the *National Environmental Management Act* (NEMA), 1998 (Act No 107 of 1998). As part of the specialist requirements under NEMA regulations 12(1) for the EIA, Promethium Carbon will undertake a CCIA for the Jindal Project. As such, the analysis presented in this CCIA is aligned with the principles of NEMA. In addition, the Thabametsi case judgement has resulted in the legal precedent for South African CCIAs.

Climate change is generally considered to be covered within existing environmental law frameworks, since climate change impacts the environment and societies living in certain environments. South Africa's overarching environmental law framework is founded in NEMA. The *Environmental Impact Assessment (EIA) Regulations of 2017* (which were promulgated under NEMA), were predominantly drafted to govern activities which have an impact on the environment within the Republic of South Africa. Therefore, applying NEMA's principles to a global phenomenon, such as climate change, presents a challenge.

The Jindal Project, during the operation phase, is likely to release GHG emissions relating to the combustion of diesel. This will contribute towards GHGs that will contribute towards climate change. The Jindal Project will also contribute towards the national GHG emissions inventory.

[11] In 2018, the Water Research Commission (WRC) updated the definition of "Strategic Water Source Areas" (SWSA), to include groundwater, and now defines SWSA's as:
"*areas of land that either:*
(a) supply a disproportionate (i.e. relatively large) quantity of mean annual surface water runoff in relation to their size and so are considered nationally important; or
(b) have high groundwater recharge and where the groundwater forms a nationally important resource; or
(c) areas that meet both criteria (a) and (b)".
In short, SWSA's are considered to be of national importance for the water security of South Africa.

During the scoping phase of the project, it was recommended that a CCIA be undertaken for these reasons. Therefore, the purpose of the CCIA would be to quantify and incorporate the impact of climate change during the EIA phase of the project.

2.2 Scope of the Climate Change Impact Assessment

Considering the guidance from the Thabametsi judgement, CCIAs cover the following:

- The **impact of the project** on climate change:
  - A greenhouse gas (GHG) inventory for the construction, operational and decommissioning phases of the project;
  - An analysis of the GHG inventory regarding the impact of the project on climate change;
  - A description of the existing climate conditions of the local area;
  - An impact assessment of the project, which includes the cumulative impacts of climate change in relation to the project; and
  - Mitigation and adaptation measures to minimise the impacts of the proposed project on climate change.

- The **impacts of climate change** on the project:
  - Impacts on core operations – likely exposure to climate change, sensitivity to such and vulnerability assessment;
  - Impacts on the upstream value chain;
  - Assessment of climate change related impacts on the local natural environment, surrounding communities, local ambient air quality, and human health, and any associated implications for the project;
  - Assessment of potential climate change adaptation measures; and
  - Assessment of the impacts of transitional risks.

- The **resilience of the project** in terms of climate change:
  - An analysis of the climate change impacts for the region in which the project will be located;
  - The processes and associated infrastructure of the proposed project that could be affected by climate change, and the potential magnitude of the impacts; and
  - Mitigation and adaptation measures to minimise the impacts of climate change on the proposed project.

The analysis of climate change risks includes both physical and transitional risks. The scope of inclusion of these risks are set out in the table below:

Table 1: Coverage of risks in the CCIA

	Risk	Included/excluded
Physical risks	Risks such as extreme weather events, storms, droughts, etc.	Included in the CCIA as it can significantly impact on the resilience of the project to climate change in the core

		operations, value chain, natural environment, and social environment.
Transitional risks	Risks such as regulation, carbon pricing, and stranded asset risks	These risks are excluded from the CCIA as they represent commercial risks to the owner of the project rather than environmental and societal risks that are governed in the context of NEMA.

2.3 Description of Project Activities and Associated Infrastructure

In 2021, Jindal appointed SLR Consulting as the independent Environmental Assessment Practitioner to undertake the environmental regulatory processes for the Jindal Melmoth Iron Ore Project, or Jindal Project. Development of the mine and mining infrastructure will be phased, with mining currently only proposed to be undertaken in the south-eastern section of the South block where the iron ore resource has been defined through previous prospecting. Infrastructure would be developed to support this mining operation. Jindal's intent with the mining right application is to consolidate the two Prospecting Rights for the North and South blocks into a single mining right, as well as the development of Phase 1 of the Jindal Melmoth Iron Ore Project.

Phase 1 of the Jindal Project will comprise of an open pit, processing plant, waste rock dump, tailing storage facility and associated infrastructure, as seen in Figure 2 below. Mining activities and infrastructure will only be undertaken/developed in portions of the mining right area and some infrastructure may be located outside of the area. The iron ore concentrate would be transported to the Richards Bay Port, either by rail or pipeline. The concentrate will be exported, as there are limited local markets. Approximately 500 million tonnes of ore are expected to be mined from the pit over its lifetime of approximately 25 years.

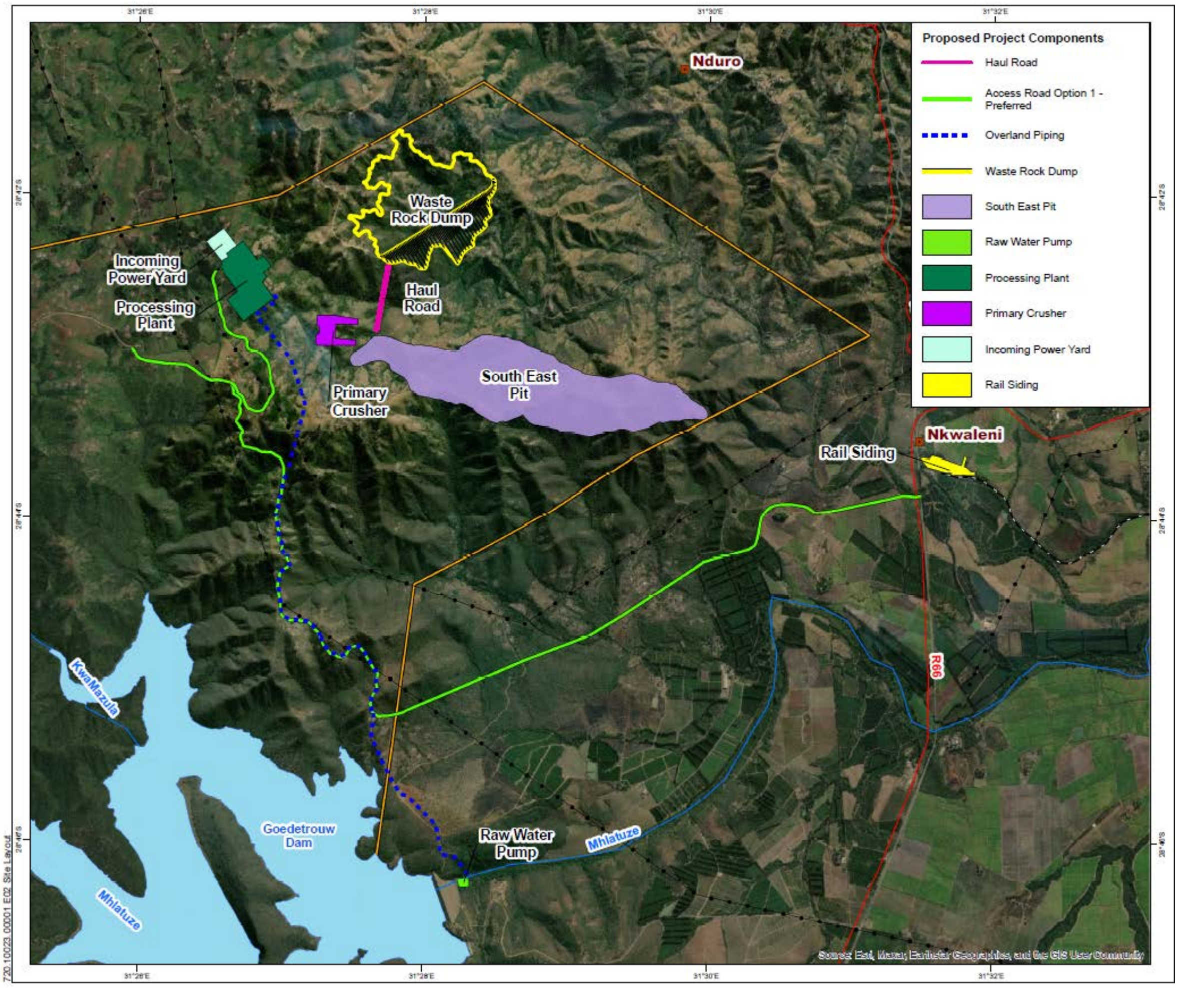

Figure 2: Jindal Project site layout.

Waste rock will be stripped from the pit at a ratio of approximately 0.5 tonnes of waste rock per 1 tonne of ore. The waste rock will be disposed of on a waste rock dump proposed within the mining right area. Drilling and blasting techniques will be used to excavate the iron ore at a rate of 32 million tonnes per annum (mtpa), which will then be loaded onto trucks and transported to the run-of-mine ore stockpile area, where it will be stored and subsequently transferred to the processing plant for milling and magnetic separation. The processing plant will produce iron ore concentrate and a tailings slurry. Approximately 7.5 mtpa of iron ore concentrate, consisting of 67% iron (Fe), will be transported to the Richards Bay Port via, either rail or pipeline for exportation. The tailings will be disposed of to a tailings storage facility.

Associated infrastructure to support the mine will include access and haul roads, electrical transmission lines and sub-stations, raw water abstraction and pipelines, stormwater management infrastructure, tailings pipelines, concentrate pipelines, offices, change houses, workshops, and perimeter fencing (amongst others). Some of the infrastructure required for the mine (e.g., the access road, pipelines, and tailings storage facility), may be located outside of the mining right area. While the access road and water supply pipelines are part of this application, certain other infrastructure will be subject to separate application, assessment, and approval processes, as required by the applicable legislation.

2.4 Broader context of climate risks

Climate change results in different types of risks, such as social/environmental risks and commercial risks. Commercial risks are market-related risks, while social and environmental-related risks are externalities which are not typically priced into commercial risks. In the context of NEMA, commercial risks are not relevant, however, the inclusion of externalities must be considered. Externalities refer to the cost or benefit that is imposed onto a third party that is not incorporated into the final cost[12].

2.4.1 Social and Environmental Externalities

The Jindal Project could contribute to social and environmental externalities. Steel production, which requires mined iron ore, is one of the most energy-consuming and CO_2 emitting industrial activities[13] globally. As such, the Jindal Project could result in increasing GHG emissions which would also have the associated cost of air pollution in the region, which is considered an externality.

2.4.2 Transition to a low-carbon economy

Considering the high GHG emissions associated with iron ore mining and steel production, iron and steel will play a big part in the transition to a low-carbon economy and the shift from a 4-degree scenario to a 2-degree scenario. The Jindal Project will generate emissions throughout the life of the project; however, iron ore is considered a necessary and vital component of a low-carbon economy. As such, the Jindal Project becomes an enabler for moving from a 4°C to a 2°C world.

3 Climate Change Context

The climate change context of the Project considers the projected climatic changes in terms of the GHG emissions, as well as the carbon budgets.

3.1 Projected Climatic Changes

GHG emissions from all sources accumulate in the atmosphere and contribute to global climate change. One of the main GHGs is carbon dioxide (CO_2). Like all GHGs, CO_2 contributes to climate change by trapping heat in the atmosphere. The greater the concentration of GHGs, the greater the warming effect.

As a result of the continuous emissions of GHGs, it is highly likely that a warming of global average temperatures will exceed 1.5°C above pre-industrial levels by 2100. In addition, heavy precipitation events will become more intense and frequent. The irreversible melting of the ice sheets will be initiated, resulting in harmful sea level rise. Furthermore, tropical cyclones and wind speeds are likely to increase globally. These climatic changes increase the possibility of irreversible changes in the way the planet, and in turn, human societies and economies will function.

12 https://boycewire.com/externalities-definition/.
13 https://www.mckinsey.com/business-functions/sustainability/our-insights/climate-risk-and-decarbonization-what-every-mining-ceo-needs-to-know.

Based on the most recent climate change projections for the Southern African region[14], South Africa is warming at twice the global rate of temperature increase. Temperatures could increase by up to 3°C, to more than 7°C (Figure 3). Extreme weather events, such as droughts, storms and floods, are likely to become more intense, frequent, and unpredictable. Water stress will increase. The western parts of the country are projected to become hotter and drier, and the eastern parts wetter[15].

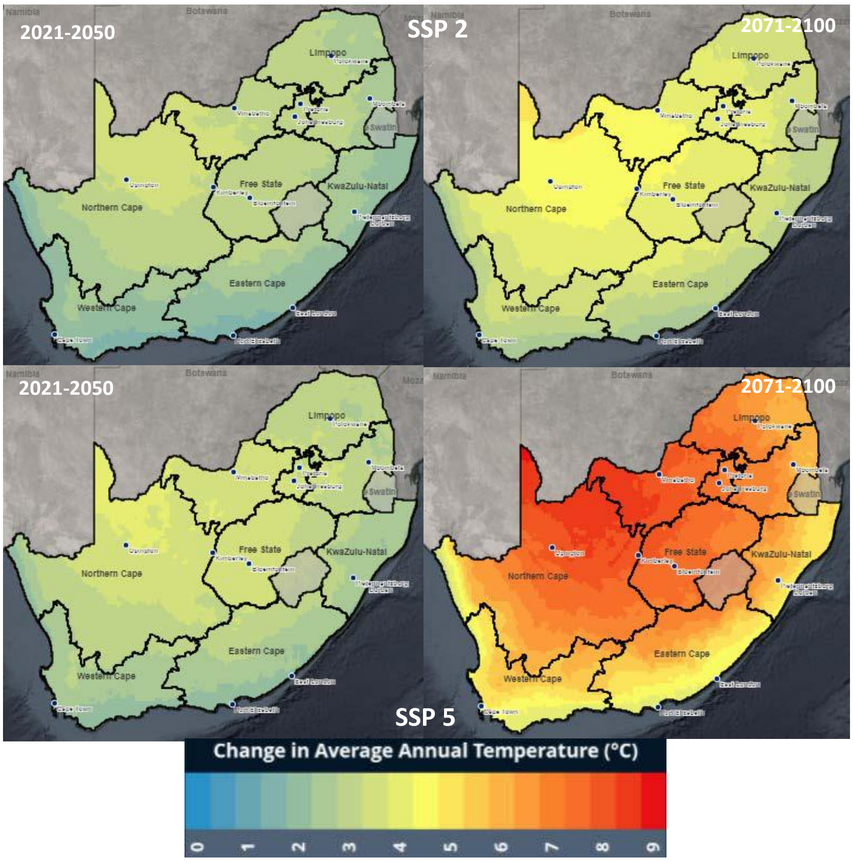

Figure 3: Projected change in average annual temperatures (90th percentile) for the Shared Socio-economic Pathway (SSP) 2 (previously RCP 4.5) and Shared Socio-economic Pathway 5 (previously RCP 8.5)[16]

To collectively prevent changes in the natural system to the extent that they can no longer support socio-economic activities, as we know them, we need to understand how much more GHGs the global community can afford to emit. This can be done through carbon budgets.

[14] Engelbrecht, F., Le Roux, A., Arnold, K. & Malherbe, J. 2019. Green Book. Detailed projections of future climate change over South Africa. Pretoria: CSIR. Available at: https://pta-gis-2-web1.csir.co.za/portal/apps/GBCascade/index.html?appid=b161b2f892194ed5938374fe2192e537 .

[15] Republic of South Africa. 2021. First Nationally Determined Contribution under the Paris Agreement (Updated September 2021). Republic of South Africa, Pretoria.

[16] Engelbrecht, F., Le Roux, A., Arnold, K. & Malherbe, J. 2019. Green Book. Detailed projections of future climate change over South Africa. Pretoria: CSIR. Available at: https://pta-gis-2-web1.csir.co.za/portal/apps/GBCascade/index.html?appid=b161b2f892194ed5938374fe2192e537.

3.2 Carbon Budgets

A carbon budget can be defined as the allocation of a quantity of GHGs that can be emitted over a specified period that would result in limiting global warming to a given level[17,18,19].

This specialist CCIA is a legal requirement for environmental authorisation of the proposed Jindal Project. Therefore, the guiding principle for the carbon budget will be the emission limits laid out by South Africa's Nationally Determined Contribution[20] (NDC), updated in 2021. Table 2 shows the target emissions for the low and high emissions scenarios, as given in the 2021 NDC.

Table 2: Targeted annual emissions for South Africa, according to the 2021 NDC

	2020	2025	2030	2050	Cumulative Emissions
Low Emission Scenario	398 $MtCO_2e/y$	398 $MtCO_2e/y$	350 $MtCO_2e/y$	0 $MtCO_2e/y$	7 758 $MtCO_2e$
High Emission Scenario	510 $MtCO_2e/y$	510 $MtCO_2e/y$	420 $MtCO_2e/y$	0 $MtCO_2e/y$	9 585 $MtCO_2e$

Thus, the cumulative emissions from 2020 to 2050 across the low and high emissions scenarios are 7 758 $MtCO_2e$ and 9 585 $MtCO_2e$, respectively. These scenarios will be selected as the low and high emission carbon budgets for South Africa. The low emission carbon budget will be used as a conservative estimate of a carbon budget against which to measure the impact of the Jindal Project.

4 Approach and Methodology

The methodology used for this CCIA was informed by:

(i) The nature of climate change;
(ii) The project development timeframes;
(iii) The long-term climate impacts anticipated for the Project and its surrounding areas; and
(iv) Historical and projected precipitation data at the Project.

The climate-related impacts and vulnerabilities relevant to the Project and surrounding areas will be considered throughout this CCIA.

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[17] WWF. 2012. Understanding carbon budgets. WWF-SA, Cape Town, South Africa. Available at: http://awsassets.wwf.org.za/downloads/understanding_carbon_budgets_final_nov_2014.pdf.
[18] Sacket, P, Steffen, W. and K. Jesson. 2018. What is a carbon budget? ACT Climate Change Council, Dickson, Australia. Available at: https://www.environment.act.gov.au/__data/assets/pdf_file/0006/1297707/What-is-a-Carbon-Budget.pdf.
[19] IPCC. 2021. Climate Change 2021 – The Physical Science Basis. Summary for Policy Makers. Intergovernmental Panel on Climate Change, Geneva, Switzerland.
[20] Republic of South Africa (2021). *South Africa – First Nationally Determined Contribution Under the Paris Agreement.*

4.1 Project Impact on Climate Change

The Jindal Project's impact on climate change will be determined by developing a projected GHG inventory for the project across its lifetime. This process is described further below.

4.1.1 GHG Inventory

The basic premise of calculating a GHG inventory is to determine the relevant activities and the emissions associated with these activities. The product of these is then the GHG inventory. The basic structure is shown in the equation below.

$$Emissions = Activity\ data \times Emission\ Factor$$

The following section provides more details regarding this process.

4.1.1.1 Standards used

At the time of writing this report, South African laws (most are considered under the umbrella of the National Environmental Management Act – or NEMA), do not yet provide adequate guidelines for CCIAs[21]. Thus, this report makes use of globally accepted international best practice and is guided by the Thabametsi Judgement (as discussed in the background section above).

The GHG inventory, for the proposed Jindal Project, has been guided by the following reference documents for this CCIA:

- *SANS 14064:2021 Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals* [22];
- The Greenhouse Gas Protocol's *A Corporate Accounting and Reporting Standard (Revised Edition)*[23];
- The Department of Environmental Affairs' *Technical Guidelines for Monitoring, Reporting and Verification of Greenhouse Gas Emissions by Industry*[24];
- The Department of Forestry, Fisheries and the Environment's *Technical Guidelines for the Validation and Verification of Greenhouse Gas Emissions*[25];
- The 2006 Intergovernmental Panel on Climate Change (IPCC) *Guidelines for National Greenhouse Gas Inventories*[26]*;* and

21 South Africa's Department of Forestry Fisheries and the Environment is in the process of providing further guidelines for Climate Change Impact Assessments. However, these guidelines were not taken into consideration, as these guidelines are only a draft and have not yet been published.

22 Standards South Africa, 2021, *SANS 14064-1:2021 Greenhouse Gases Part 1: Specification with guidance at the organisational level for the quantification and reporting of greenhouse gas emissions and removals*, Pretoria.

23 Greenhouse Gas Protocol, 2015, *A Corporate Accounting and Reporting Standard: Revised Edition.*

24 Department of Environmental Affairs, 2016, *Technical Guidelines for Monitoring, Reporting and Verification of GHG Emissions by Industry.*

25 The Department of Forestry, Fisheries and the Environment ,2021, *Technical Guidelines for the Validation and Verification of Greenhouse Gas Emissions.*

26 IPCC, 2006. *IPCC Guidelines for National Greenhouse Gas Inventories*, [Online] Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/ [Accessed on 05/04/2022].

- The Intergovernmental Panel on Climate Change (IPCC) *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 4*[27].

The main guiding document used, in the calculation of the impact of the project on climate change, is the *SANS 14064:2021 Part 1*. This document sets out principles summarised in Table 3, that guide the GHG inventory development process. It requires that emissions be categorised into the following groups:

- **Category 1** – Direct GHG emissions and removals;
- **Category 2** – Indirect GHG emissions from imported energy;
- **Category 3** – Indirect GHG emissions from transportation;
- **Category 4** – Indirect GHG emissions from products used by an organization;
- **Category 5** – Indirect GHG emissions associated with the use of products from the organization; and
- **Category 6** – Indirect GHG emissions from other sources.

Table 3: ISO/SANS 14064-1 principles for carbon footprints

Relevance	Selecting all the greenhouse gas sources, sinks, reservoirs, data, and methodologies that are appropriate.
Completeness	Including all the greenhouse gas emissions and removals relevant to the proposed project.
Consistency	Enable meaningful comparisons to be made with other greenhouse gas related information.
Accuracy	Reducing bias and uncertainties as far as is practical.
Transparency	Disclosing sufficient and appropriate greenhouse gas related information to allow intended users to make decisions with reasonable confidence.

The calculation of the GHG inventory for the proposed Jindal Project, follows the general steps stipulated here:

- Boundaries of the analysis are set;
- GHG sources inside the boundary are identified;
- The significance of each of the emission sources is determined;
- Quantification method is established; and
- GHG emissions inventory is calculated.

Note that traditionally, GHG reporting has been done in line with the 2006 version of SANS14064-1, which classified emissions in 3 emission scopes. The relationship between the traditional emission scopes and the latest version of the standard is shown in Table 4 below:

[27] IPCC, 2019. *Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.*

Table 4: GHG reporting for both standards ISO 14064-1:2021 and ISO 14064-1:2006.

SANS 14064-1:2021		ISO 14064-1:2006	
Category	**Description**	**Category**	**Description**
1	Direct GHG emissions and removals	Scope 1	
2	Indirect GHG emissions from imported energy	Scope 2	Energy indirect emissions
		Scope 3 Category 3	Fuel- And Energy-Related Activities
3	Indirect GHG emissions from transportation	Scope 3 Category 4	Upstream Transportation and Distribution
		Scope 3 Category 6	Business Travel
		Scope 3 Category 7	Employee Commuting
		Scope 3 Category 9	Downstream Transportation and Distribution
4	Indirect GHG emissions from products used by organization	Scope 3 Category 1	Purchased Goods and Services
		Scope 3 Category 2	Capital Goods
5	Indirect GHG emissions associated with the use of products from the organization	Scope 3 Category 10	Processing of Sold Products
		Scope 3 Category 11	Use of Sold Products
		Scope 3 Category 12	End-Of-Life Treatment of Sold Products
6	Indirect GHG emissions from other sources	Scope 3 Category 5	Waste Generated in Operations
		Scope 3 Category 8	Upstream Leased Assets
		Scope 3 Category 13	Downstream Leased Assets
		Scope 3 Category 14	Franchises
		Scope 3 Category 15	Investments

4.1.1.2 Significance Criteria for Inclusion of Indirect Emissions

The boundary of the GHG Inventory for the Jindal Project is established in accordance with SANS 14064-1:2021 standard. The standard outlines the process as identifying emission sources at the operation and its value chain. All direct emission sources are included in the boundary, while indirect emission sources are identified through a significance assessment.

The direct emission sources included in the boundary for both construction and operation phases are the combustion of fuel in stationary and mobile mining equipment.

The indirect emission sources are assessed based on the following significance criteria.

Table 5: Jindal Project-defined and explained criteria.

Criteria	Description	Explanation
Magnitude	The indirect emissions or removals that are assumed to be quantitatively substantial.	Include based on Magnitude when the value of the indirect emission is **more than 1%** of the total estimated GHG inventory of the company unless it is explicitly excluded by another criterion. Exclude all indirect emissions when the value of the emission is **less than 1%** of the total estimated GHG inventory of the company unless explicitly included by another criterion.
Level of influence	The extent to which the organization has the ability to monitor and reduce emissions and removals (e.g., energy efficiency, eco-design, customer engagement, terms of reference).	Include based on Influence when the level of influence is considered **high.** Exclude based on Influence when the level of influence is considered **zero.**
Risk or opportunity	The indirect emissions or removals that contribute to the organization's exposure to risk (e.g., climate-related risks such as financial, regulatory, supply chain, product and customer, litigation, reputational risks) or its opportunity for business (e.g., new market, new business model).	Include based on Risk or Opportunity when risk or opportunity is climate-related and is considered **high.** Exclude based on Risk or Opportunity when climate-related risk or opportunity is considered **zero.**
Sector-specific guidance	The GHG emissions deemed as significant by the business sector, as provided by sector-specific guidance.	Include based on Sector-specific guidance when such is **available.**
Outsourcing	The indirect emissions and removals resulting from outsourced activities that are typically core business activities.	Include based on Outsourcing when the value of the indirect emission is **more than 1%** of the total estimated GHG inventory of the company. Exclude based on Outsourcing when the value of the indirect emission is **less than 1%** of the total estimated GHG inventory of the company.
Employee engagement	The indirect emissions that could motivate employees to reduce energy use or that federate team spirit around climate change (e.g., energy conservation incentives, carpooling).	Include based on Employee Engagement when the impact on emissions of employee engagement is considered **high.** Exclude based on Employee Engagement when the impact of

		employee engagement on emissions is considered **zero.**

The indirect emission sources relevant to the Jindal Project were assessed by Promethium Carbon in Table 6. Promethium Carbon used Table 5 to assess the significance of the Jindal Project's indirect GHG emissions. Emissions were included or excluded as per the stipulated explanation (Table 5).

Based on Promethium's assessment, the following indirect GHG emissions were included in the Jindal Project's GHG inventory calculation as per ISO 14064-1:2018 / SANS 14064: 2021

Table 6: Significance criteria and related definition for Jindal Project's indirect emissions.

Emission source	Significance criteria						Inclusion in the GHG inventory boundary
	Magnitude	Level of influence	Risk or opportunity	Sector-specific guidance	Outsourcing	Employee engagement	
Generation of purchased electricity	**High** – forms 10% of the overall inventory	**High** – can influence these emissions by generating own renewables up to 100MW or PPA's with renewable independent power producers	**High** - risk of energy security and supply disruptions from climate change related events	N/A	N/A	**Low** – some change in these emissions could come from engaging with employees on responsible energy consumption	**Include**
	Include because it forms more than 1% of the total GHG inventory	Include because influence is high	Include because climate-related risk is high			Do not include or exclude because rating is low	
Production of fuel used in operation	**Low** – forms less than 1% of the overall inventory	**High** – can switch suppliers of fuels to lower emission sources	**High** - risk of energy security and supply disruptions from climate change related events	N/A	N/A	**Low** – some change in these emissions could come from engaging with employees on responsible energy consumption	**Include**

Emission source	Significance criteria						Inclusion in the GHG inventory boundary
	Magnitude	Level of influence	Risk or opportunity	Sector-specific guidance	Outsourcing	Employee engagement	
	Exclude it, unless included elsewhere	Include because influence is high	Include because climate-related risk is high			Do not include or exclude because rating is low	
Waste generated in operation	**Low** – forms less than 1% of the overall inventory	**Medium** – can be influenced by operational changes	**Low** - there is some risk in disruptions to wastewater treatment due to climate change related events	N/A	N/A	Low – some change in these emissions could come from engaging with employees on responsible disposal of general waste.	**Exclude**
	Exclude because it forms less than 1% of the total GHG inventory	Do not include or exclude because rating is low	Do not include or exclude because rating is low				

Emission source	Significance criteria						Inclusion in the GHG inventory boundary
	Magnitude	Level of influence	Risk or opportunity	Sector-specific guidance	Outsourcing	Employee engagement	
Employee commuting	**Low** – forms less than 1% of the overall inventory	**Medium** – can influence emissions through employee engagement programmes	**Low** - there is some risk in disruptions to employee commuting due to climate change related events	N/A	N/A	**High** – these emissions could be changed through ride sharing, public transport and other employee engagement programmes	**Include**
	Exclude because it forms less than 1% of the total GHG inventory	Do not include or exclude because rating is medium	Do not include or exclude because rating is low			Include because the impact of employee engagement on emissions is high	
Production of purchased goods - water	**Low** – forms less than 1% of the overall inventory	**Low** – there is minimal influence over the emissions associated with purchased water	**High** – there is significant risk of water security due to climate change events such as flooding or droughts	N/A	N/A	**Low** – most of the water consumption is for mining processes. There is, therefore, little impact from employee engagement on the quantity of water produced	**Include**

Emission source	Significance criteria						Inclusion in the GHG inventory boundary
	Magnitude	Level of influence	Risk or opportunity	Sector-specific guidance	Outsourcing	Employee engagement	
	Exclude because it forms less than 1% of the total GHG inventory	Do not include or exclude because rating is low	Include because climate-related risk is high			Do not include or exclude because rating is low	
Production of purchased goods - cement	**Low** – forms less than 1% of the overall inventory	**Low** – there is minimal influence over the emissions associated with cement production due to the unmitigable emissions in the production process	**High** – there is some risk in disruptions to the production of cement due to climate change related events, based on Carbon Tax pass-through	N/A	N/A	N/A	**Include**
	Exclude because it forms less than 1% of the total GHG inventory	Do not include or exclude because rating is low	Include because climate-related risk is high				

Emission source	Significance criteria						Inclusion in the GHG inventory boundary
	Magnitude	Level of influence	Risk or opportunity	Sector-specific guidance	Outsourcing	Employee engagement	
Processing of sold product (iron ore concentrate)	**High** – forms more than 1% of the overall inventory	**High** – Iron ore concentrate sent to Jindal owned steel mill in India. Jindal therefore has operational control over the emissions during the smelting process.	**Medium** – disruption to global markets for steel based on events that could be attributed to climate change	N/A	N/A	**High** – the emissions from smelting the concentrate could be outsourced to a third party thus shifting the control of the emissions outside the Jindal Group.	**Include**
	Include because it forms more than 1% of the total GHG inventory	Include because influence is high	Do not include or exclude because rating is medium				

4.1.1.3 GHG Inventory Development

The direct, upstream, and downstream emissions for the construction and operational stages of the Jindal Project are calculated based on the procedures below considering the boundary above. The emissions for the decommissioning stage are considered insignificant in the context of the overall project and are therefore not calculated in this GHG Inventory.

The direct emissions relate to onsite emissions during construction and operation (such as combustion of fuels). The upstream emissions relate to the sourcing of materials consumed during construction and operation (such as material manufacture and transport emissions). The downstream emissions relate to the end of life of materials and the use of sold products (such as waste management activities and steel manufacture).

These emissions are given in CO_2 equivalents (CO_2e). A CO_2 equivalent is when the emissions of other GHGs are equated to an equivalent amount of CO_2 using the 100-year global warming potential (GWP) of that gas. The GWP of any GHG is the amount of heat absorbed, per mass unit of a GHG, divided by the amount of heat an equivalent mass of CO_2 would absorb over the specified period.

The construction- and operation-related emissions are calculated using the equation as described in the beginning of Section 4.1.1. The generic *Activity Data, Emission factor and Emission* terms are replaced with specific parameters to describe the emissions under consideration.

During construction and operation, the Category 1 emissions are from stationary and mobile combustion of diesel. These emissions can be calculated as followed:

$$Cat1_D = (Diesel_x \times EF_{SD})$$

Where:

- $Cat1_D$ represents the direct emissions during the construction and operation phase of the Jindal project, measured in tCO_2e/year;
- x represents the phase that is being accounted for. i.e., construction or operation phase;
- $Diesel_{Dx}$ represents the total combustion of diesel during the construction or operation phase of the Jindal project, measured in litres/year;
- EF_{SD} represents the emission factor of stationary combustion of diesel, measured in tCO_2e/l;

During the construction phase, generators were used at the site and therefore, electricity consumed is only accounted for during the operation phase of the project. This is to avoid double counting emissions, as the production related emissions for the electricity in construction is accounted for under Category 1 emissions. Therefore, the Category 2 emissions during the operation were calculated as:

$$Cat2_{Elec} = (\text{Electricity}_x \times EF_{Elect})$$

Where:

- $Cat2_{Elec}$ represents the Category 2 emissions during the operation phase of the Jindal project, measured in tCO_2e/year;
- Elect_x represents the electricity consumed in year *x* at the Jindal Project, measured in MWh/year; and
- EF_{Elect} represents the grid emission factor for electricity, measured in tCO_2e/MWh.

The indirect emissions (Category 3 – 6) will account for the purchased goods and services, fuel and energy related activities, upstream and downstream transportation and distribution, use of sold products and waste generated. The main calculation that was used for these emissions is:

$$Scope3_{IDE} = (Act_x \times EF_{Act})$$

Where:

- $Scope3_{IDE}$ represents the total indirect emissions during the construction and operation phase of the Jindal Project, measured in tCO_2e/year;
- x represents the phase that is being accounted for. i.e., construction or operation phase;
- Act_x represents the activity data occurring at the Jindal Project for a specific phase x, measured in Unit of Measurement/year. The Unit of Measurement depends on the activity, for example, tonnes of purchased material or distance transported; and
- EF_{Act} represents the emission factor of that activity data, measured according to the activity measurement.

4.1.2 Data used

4.1.2.1 Activity Data

The data used throughout this assessment was obtained from various sources. For the calculation of the GHG inventory for the CCIA, the main information was obtained from the data sheets sent by the client. The data provided is summarised in the table below.

Table 7: Activity data used in the GHG inventory

Construction Phase	Quantity	Data Source
Diesel	180 000 litres	Project Developer
Concrete	100 000m^3	Project Developer
Construction waste generated	100 tonnes/month	Project Developer
Construction waste - distance transported	25 km	Project Developer
Municipal waste	120 tonnes/year	Project Developer
Water	29 200 000 litres/year	Project Developer
Length of construction phase	3 years	Project Developer
Operation Phase	**Quantity**	**Data Source**
Electricity purchased	1 274 519 MWh/year	Project Developer
Diesel purchased	180 000 litres/year	Assumption based on energy intensity of similar

		operations in South African
Water purchased	12 000 Ml/year	Project Developer
Rock mined	48 000 000 tonnes/year	Project Developer
Ore sold	7 2000 000 tonnes/year	Project Developer
Employees – mine management and admin	48 people	Project Developer
Employees – mine operators etc	284 people	Project Developer
Mine life	25 years	Project Developer

4.1.2.2 Emission Factors

The emission and conversion factors applied in the calculation of the Project's GHG inventory, are aligned with the following principles:

- derived from a recognised origin;
- appropriate for the GHG source concerned;
- current at the time of quantification;
- take account of quantification uncertainty and are calculated in a manner intended to yield accurate and reproducible results; and
- consistent with the intended use of the carbon footprint.

The main sources of the emissions and conversion factors used in this GHG inventory are the South African Technical Guidelines[28], the IPCC 2006 Guidelines[29] and the DEFRA 2021[30] emission factor sheet.

Specifically, the emission factors to calculate category 1 emissions were taken from the South African Technical Guidelines. This reference was used as the primary reference for emission factors because they are approved by the DFFE.

The emission factors (and other conversion factors) used in this CCIA are presented in Table 8 below.

Table 8: Emission and conversion factors used for the GHG inventory

Emission factor	Value	Unit	Source
Direct Emission Factors			
Diesel Stationary Combustion	0.0028	tonne CO_2e/litre	South African Technical Guidelines TG-2016.1
Diesel Mobile Combustion	0.083	tonne CO_2e/GJ	South African Technical Guidelines TG-2016.1

28 Department of Environmental Affairs, 2017, *Technical Guidelines for Monitoring Reporting and Verification of Greenhouse Gas Emissions by Industry.*

29 IPCC. 2006. Climate Change 2006 – The Physical Science Basis. Summary for Policy Makers. Intergovernmental Panel on Climate Change, Geneva, Switzerland.

30 DEFRA, 2021, UK Government GHG Conversion Factors for Company Reporting.

Fuel energy intensity	0.0259	GJ/tonne	Assumption using similar iron ore company annual reports
Fossil fuel energy consumption	6 650 000.0	GJ	Assumption using similar iron ore company annual reports
Rock mined	256 300 000.0	tonne	Assumption using similar iron ore company annual reports
Energy indirect Emission Factors			
South Africa - Grid	0.952	tCO_2e/MWh	Calculated
Other Indirect Emission Factors			
Water	1.400	tonne CO_2e/Million litres	Rand Water annual report 2017[31]
Diesel production	0.00063	tonne CO_2e/litre	DEFRA 2021[32]
South Africa - Transmission and distribution losses	0.12541	tCO_2e/MWh	Calculated
Waste landfilled	1.01633	tonne CO_2e/tonne	Friedrich & Trois, 2013. - Current and future greenhouse gas (GHG) emissions from the management of municipal solid waste in the eThekwini Municipality e South Africa[33]
Average petrol car	0.00022	tonne CO_2e/passenger. km	DEFRA 2021
Heavy Goods Vehicle	0.00011	tonne CO_2e/t.km	DEFRA 2021
Bus	70%	%	Assumption
Minibus taxi	30%	%	Assumption
Bus	0.0001	tonne CO_2e/passenger. km	DEFRA 2021[34]
Average car	0.0002	tonne CO_2e/passenger. km	DEFRA 2021
Minibus taxi	0.0000	tonne CO_2e/passenger. km	Toyota Quantum specifications[35]
Heavy Goods Vehicle	0.0009	tonne CO_2e/km	DEFRA 2021
Distance to India	4 679.0000	nautical miles	ports.com
Distance to India	8 665.5080	km	

31 Rand Water, 2017, Annual Report.
32 DEFRA, 2021, UK Government GHG Conversion Factors for Company Reporting.
33 Friedrich & Trois, 2013, Current and future greenhouse gas (GHG) emissions from the management of municipal solid waste in the eThekwini Municipality e South Africa.
34 DEFRA, 2021, UK Government GHG Conversion Factors for Company Reporting.
35 Toyota, 2014, Toyota Quantum 2.7 GL 14-seater bus specifications.

Cargo ship	0.0000	tonne CO_2e/tonne.km	DEFRA 2021
Iron Ore smelting	1.4000	tonne CO_2e/tonne	https://www.iea.org/reports/iron-and-steel
Conversions and Assumptions			
Average workdays per month	22	days	Assumption
Global Warming Potential of CH_4	23	$kgCO_2e/kgCH_4$	SA Technical Guidelines Annexure H
Global Warming Potential of N_2O	296	$kgCO_2e/kgN_2O$	SA Technical Guidelines Annexure H
Diesel Calorific Value	38	MJ/litre	SA Technical Guidelines Annexure D
Convert GJ to MWh	0.277778	MWh/GJ	
Nautical mile to km	1.852	km/nautical mile	Conversion

4.1.3 Environmental Impacts of GHG Emissions

The EIA reporting requirements listed in Table 9 below, set out the criteria to describe and assess local environmental impact. However, climate change is a global phenomenon, thus, the criteria are only partially applicable as they are inadequate to fully quantify the impact. Despite this, these criteria are currently the only criteria available to measure the impact of the project on climate change.

Table 9: EIA Criteria.

Nature	A description of what causes the effect, what will be affected and how it will be affected. *In the case of climate change assessments, the nature of the impact is the contribution of the Project to global anthropogenic climate change.*
Intensity (I)	The intensity is the magnitude of the environmental impact under consideration. These impacts can be positive or negative and range from negligible change to severe irreversible change. The environmental impact assessment reporting requirements were developed to describe and assess environmental impacts, however GHG emissions that have a global impact has yet to be described. For this reason, a materiality threshold was defined to quantify the intensity of the impacts. South Africa's carbon budget is described in section 3.2 above.
Extent (E)	An indication of whether the impact will be local (limited to the immediate area or site of development), regional, national, or international. Part of the site is considered very low, the whole property - low, affecting immediate neighbours - medium, local area - high and regional/national - very high. *In the case of climate change assessments, the extent is always global, and thus, very high is allocated to all projects that contribute to global anthropogenic climate change.*
Duration (D)	An indication of the lifetime of the impact. Impacts are quantified as follows: less than a year – very low, between 1 and 5 years – low, between 5 and 10 years – medium, between 10 and 20 years – high and longer than 20 years – very high. *In the case of this project, the impact will end at the end of the project life. Therefore, a high rating is allocated.*

Probability (P)	An indication of the likelihood of the impact occurring. The scale of probability ranges from unlikely to definite. The IPCC has reported that it is 95 percent certain that man-made emissions are the main cause of current observed climate change[36]. *Thus, a definite probability is allocated to all projects that contribute to global anthropogenic climate change.*
Consequence (C)	The consequence of the impacts is a function of the intensity, extent and duration, and assesses the overall consequence of the impacts.
Significance (S)	The significance of the impacts is calculated as :S=C x P

4.1.4 Determining the Intensity of the Project Impact on Climate Change

4.1.4.1 Determination of the Low Impact Level for GHG Impact Rating

The DFFE has published the draft *National Guideline for the Consideration of Climate Change Implications in Applications for Environmental Authorisations, Atmospheric emissions Licenses and Waste Management Licenses* in January 2021. One of the guidelines for when a specialist climate change impact assessment is necessary, is when the activity breaches one of the thresholds stipulated in the *National Greenhouse Gas Reporting Regulations*. Thus, the low impact level was taken as the combustion of coal at a capacity of 10 $MW_{thermal}$ at a 100% utilisation.

$$Upper\ limit\ \text{Low} = 10\ MW_{thermal} \times \frac{31\,536\,000\ s}{year} \times \frac{1\ TJ}{1\,000\,000\ MJ} \times EF_{coal}$$

The emission factor for coal is taken as "Other Bituminous Coal" from Table A.1 of the Technical Guidelines[37]. This equates to approximately 30 000 tCO_2e/year. Thus, emissions less than 30 000 tCO_2/y will be considered to have a ***Low*** impact.

4.1.4.2 Determination of the Very High and High Impact Level for GHG Impact Rating

The lower limit for the ***Very High*** impact category was calculated to be the annual emissions of a new coal fire power station. The size of the hypothetical power station was equivalent to the average capacity of the Eskom coal-fired fleet, namely 2 900 MW[38]. The annual emissions were calculated using an efficiency taken from the 2017 EPRI Report[39] for new coal-fired power stations and the current availability of the Eskom fleet. The annual emissions calculated, and thus the limit between the ***High*** and ***Very High*** impact categories, was 15 000 000 tCO_2e/year.

The lower limit for the ***High*** impact category was then taken as an order of magnitude less than the lower limit for the ***Very High*** impact category discussed above.

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36 IPCC, 2014: 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, 151 pp.

37 Department of Environmental Affairs, 2017, *Technical Guidelines for Monitoring Reporting and Verification of Greenhouse Gas Emissions by Industry*.

38 Calculated from Eskom's 2021 IAR.

39 Electric Power Research Institute (2017). *Power Generation Technology Data for Integrated Resource Plan of South Africa*.

4.1.4.3 Summary of Impact Levels

Table 10.combines the above calculations into one impact table. This is used to assess the magnitude of the impact of a project on climate change. It also compares the thresholds to the low emission NDC carbon budget of 7 758 Mt CO_2e.

This assessment only considers emissions in the GHG inventory that occur within the boundary of South Africa. This ensures consistency in the impact assessment, as the climate change impact assessment is a South African legal process. There is therefore no jurisdiction over emissions from international sources within this process. This also allows the emissions to be compared to the NDC, which only considers the South African national GHG inventory.

Table 10: Impact category thresholds used to determine the magnitude of the impact of the project on climate change.

GHG impact rating as a % of SA's carbon budget	Amount of GHG emissions		Relative to Low Emission NDC Carbon Budget	
	Lower limit (tCO_2e)	Upper limit (tCO_2e)	Lower limit (tCO_2e)	Upper limit (tCO_2e)
Low	-	30 000	0.000000%	0.00039%
Medium	30 001	1 500 000	0.00039%	0.019%
High	1 500 001	15 000 000	0.019%	0.193%
Very High	15 000 001	+	> 0.193%	

4.1.5 Limitations and Assumptions

This CCIA makes use of data obtained during a desktop review for the development of this GHG inventory and associated impact assessment. Certain assumptions were made to ensure the development of the most accurate and extensive GHG inventory and the associated impact assessment. These assumptions were made considering the significant boundary set out by the EIA reporting requirements. The assumptions are the following:

- It was assumed that the following aspects of the Jindal Project will contribute immaterially towards the GHG footprint of the project during the operational phase:
  - Purchase of capital goods, such as vehicles; and
  - Business travel.
- It was assumed that the decommissioning of the plant will contribute immaterially towards the GHG inventory when compared to the operational phase.

The above assumptions were determined by applying the significance criteria in the SANS14064 (2021) standard, namely the magnitude and level of influence criteria.

4.2 Project Vulnerability to Climate Change

The impacts of climate change are likely to result in increased climate-related vulnerabilities for the Jindal Project. Climate change management should, therefore, not be limited to emission reductions (mitigation) but should also take into consideration measures for increasing the resilience of the Jindal Project (adaptation) in the face of climate change impacts. Identifying impacts of climate change on the Jindal Project will be considered in this assessment.

4.2.1 International Best Practice

Due to the current lack of local regulations regarding CCIAs in South Africa, specifically with regards to unpacking and quantifying vulnerability to climate change, international best practice is used in this assessment. In this regard, this report makes use of globally accepted international best practice, including:

- International Council on Mining and Minerals (ICMM): Adapting to climate change[40];
- Framework for Climate Change Vulnerability Assessments[41];
- International Finance Corporation (IFC) performance standards[42];
- European Bank for Reconstruction and Development (EBRD) principles; and
- The Equator Principles[43].

The abovementioned documents were used to develop a rating system (indicated in Section 4.1.4 of this report), to which the current project is benchmarked. This enables us to adequately assess climate change impacts considering available baselines and relevant information.

4.2.1.1 Key Areas of Impact

Climate change could potentially pose threats to the key processes of the development and implementation of the Jindal Project. Climate change could disrupt several main areas, such as the core operations, the natural environment, the value chain, and the social context of the area surrounding the Project. Consequently, climate change impacts within these areas are focused on the following four areas:

1. **Core operations** - The core operations relate to the activities taking place on site, which are essential to the operations of the facility. These are operations that are performed by the Project and that its management has complete control over. These activities are centred on processes related to mining and mineral beneficiation. The impacts of climate change on site operations will be considered in this regard;
2. **Value chain (upstream and downstream)**- The value chain relates to the goods and services the Jindal Project requires to operate. These are operations that are related to the Project, but its management does not have control over. These include activities of suppliers, customers, government, and the greater economic market;
3. **Social environment (surrounding/impacted communities)** - This includes the people that are both directly and indirectly affected by the Project, such as employees, surrounding

40 International Council on Mining and Minerals, 2013, *Adapting to a changing climate: implications for the mining and metals industry*. ICMM.
41 GIZ. 2014. The vulnerability sourcebook. Gesellschaft für Internationale Zusammenarbeit, Bonn, Germany.
42 International Finance Corporation, 2012, *Performance Standards*, [Online] Available at: https://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/Sustainability-At-IFC/Policies-Standards/Performance-Standards [Accessed on 30/03/2022].
43 The Equator Principles Association, 2020, *Equator Principles EP4*, [Online] Available at: https://equator-principles.com/about/ [Accessed on 30/03/2022].

industry and local communities. The social context of this assessment refers to the communities/settlements (both urban and rural) that would be impacted, both directly and indirectly, by climate change. The social context is important, as it contributes to the Jindal Project in the form of labour and service provision. In addition, the social context could also impact on the operations and construction of the Project from a social volatility and vulnerability perspective. Social tensions, safety, poverty and/or inequality could, therefore, impact on productivity at the Project; and

4. **Broader environmental risks** - This is related to the natural environment directly surrounding the operations of the Project. These include the Project's operations, as well as those of surrounding industries and the livelihoods of the local communities. The natural environment relates to natural assets and environmental ecosystems that deliver valuable services to people, such as water and climate regulation, soil formation and disaster risk reduction. The natural environment plays an important role in terms of supplying key ecological services and resources to the Jindal Project.

The resilience and vulnerability assessment conducted for this CCIA considers the four key aforementioned areas[44] related to the Jindal Project that could be vulnerable to climate change impacts. For widescale considerations of the impacts of climate change, all four of the abovementioned aspects could be impacted by climate change and the Jindal Project.

4.2.2 Data used

This vulnerability assessment refers to various data sources in the process of determining the critical vulnerability factors faced by the Jindal Project. These sources are explained in the table below.

Table 11: Climate change related tools used throughout this CCIA

Tools and Data	Explanation of use
The World Resources Institute (WRI) Water Aqueduct Tool[45]	This tool provides insight into the areas that experience different vulnerabilities to water stress, globally. On a regional level, these identified water-stressed zones are anticipated to impact on the operations and sustainability of various industrial activities, including that of the Project.
The GreenBook Tool[46]	The GreenBook provides a municipal overview of climate-related changes anticipated for 2050 in comparison to present-day climatic conditions. In addition, this tool looks specifically at South African municipalities and indicates the increasing vulnerabilities of certain regions and the associated economic, health and environmental impacts of these changing vulnerabilities.

[44] International Council on Mining and Minerals, 2013, *Adapting to a changing climate: implications for the mining and metals industry*. ICMM.

[45] Wri.org. 2021. Aqueduct Water Risk Atlas. [online] Available at: https://www.wri.org/applications/aqueduct/water-risk-atlas/.

[46] Greenbook.co.za. 2021. Green Book l Adapting settlements for the future. [online] Available at: https://greenbook.co.za/.

Meteoblue Historical Data	Meteoblue provides historical climate data for the Melmoth area. The parameters include daily temperature and rainfall data from 1985 to 2021. Such information was then used to make projections of climate conditions at the Jindal Project site.
Local demographic factors	Local demographics were used to earmark particularly vulnerable communities, which may be impacted more severely by climate change and/or the presence of the Project within the region.

These tools were used in conjunction with the information sheet received from the client and considering the specialist's background and understanding of climate-related impacts posed on the Jindal Project.

4.2.3 Determining project vulnerability and resilience

The overall vulnerability of the Jindal Project, and its surrounds to climate change impacts, can be determined by identifying the exposure, vulnerability, and adaptive capacity of the region in which the Project lies. The IPCC Sixth Assessment Report (2021)[47] defines vulnerability as: "*the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt*"[48]. This definition aligns with the method for determining the Project's climate-related vulnerability, proposed in Figure 4 below.

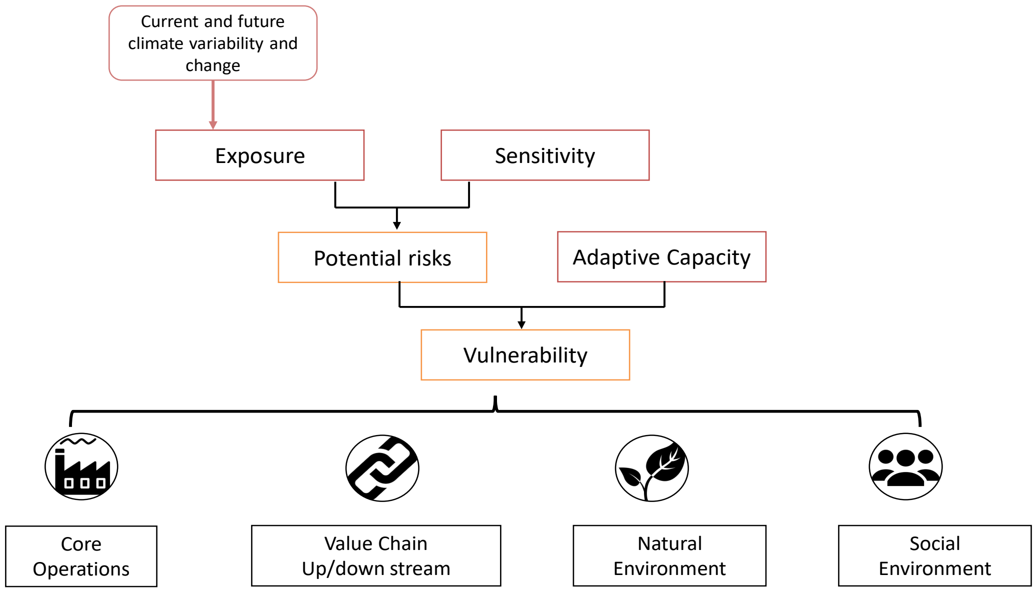

Figure 4: Interrelations of Exposure, Sensitivity and Adaptive Capacity, which makes up the basis of the vulnerability assessment

[47] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[48] IPCC, 2021, *Data Distribution Centre Glossary: Vulnerability*, IPCC [Website] Available at: https://www.ipcc-data.org/guidelines/pages/glossary/glossary_uv.html [Accessed on 16/03/2022].

Figure 4 indicates the vulnerability of the core operations of the Jindal Project, the value chain of the Project, as well as the social and natural environments surrounding the Project. The diagram also illustrates how climate change impacts and variability could result in changes in the exposure levels experienced in this region.

The vulnerability assessment is conducted considering the impact of climate change on the region's exposure. Thereafter, the overall vulnerability is determined using project exposure, sensitivity, and the current-day adaptive capacity.

4.2.4 Limitations and Assumptions

The Project's vulnerability to climate change is assessed within this CCIA through an analysis of available datasets.

Climate projections at finer scales, such as at a municipal level, are much more challenging to project as opposed to a subcontinental or continental scale. As a result, there are levels of uncertainty at much finer scales. Therefore, while confidence is growing in global climate models, there is a much greater appreciation of uncertainties involved in downscaling global models to illustrate climate projections at a local scale[49]. This is particularly relevant for rainfall projections where different climate change models are used. As such the latest climate change scenarios and projections were used in this climate change assessment.

This uncertainty should be noted by the project developers, since the impacts of climate change may result in decreased investment value over time and possible increases in costs of maintenance.

The assessment of the vulnerability of the project to climate change is subject to further limitations, namely:

- Only impacts on the direct value chain were assessed;
- No modelling of climate change impacts was conducted; and
- Only impacts occurring during the lifetime of the project were considered.

5 Status Quo and Projected Climatic Changes

5.1 Mining Location and Climate

Two main sources of data, namely the province of KwaZulu-Natal and site-specific data relating to the Mthonjaneni Local Municipality within which the Jindal Project is situated, were analysed for climate forecasting. Based on the Greenbook and the data obtained, the historical weather data trends were used to forecast/foresee weather changes. These historical and projected weather trends are stipulated in the sections below.

It is important to note that climate change projections such as those included in the Greenbook, can in some instances indicate findings that appear contradictory, particularly with respect to

[49] Bourne, A, P. deAbreu, C. Donatti, S. Scorgie, and S. Holness. 2015. A Climate Change Vulnerability Assessment for the Namakwa District, South Africa: The 2015 revision. Conservation South Africa, Cape Town.

rainfall. Most climate change models predict increasing variability of rainfall. This means that rainfall will be erratic. Periods of drought but then also periods of intense rainfall, are both plausible scenarios.

5.1.1 Regional Climate Change Considerations

The Jindal Project is situated within the KwaZulu-Natal province of South Africa. The climate change projections for the Project within KwaZulu-Natal indicate that annual average ambient temperatures are likely to increase by 1-2˚C in the near future. Furthermore, it is identified that KwaZulu-Natal will be exposed to more extreme rainfall events and an increase of extreme hot days by +30 days per annum. Such changes are likely to influence the province's risks to floods and fires in the future[50] (Figure 5). Such climatic changes would impact on the Jindal Project in terms of its core operations, value chain and broader socio-economic and natural environment.

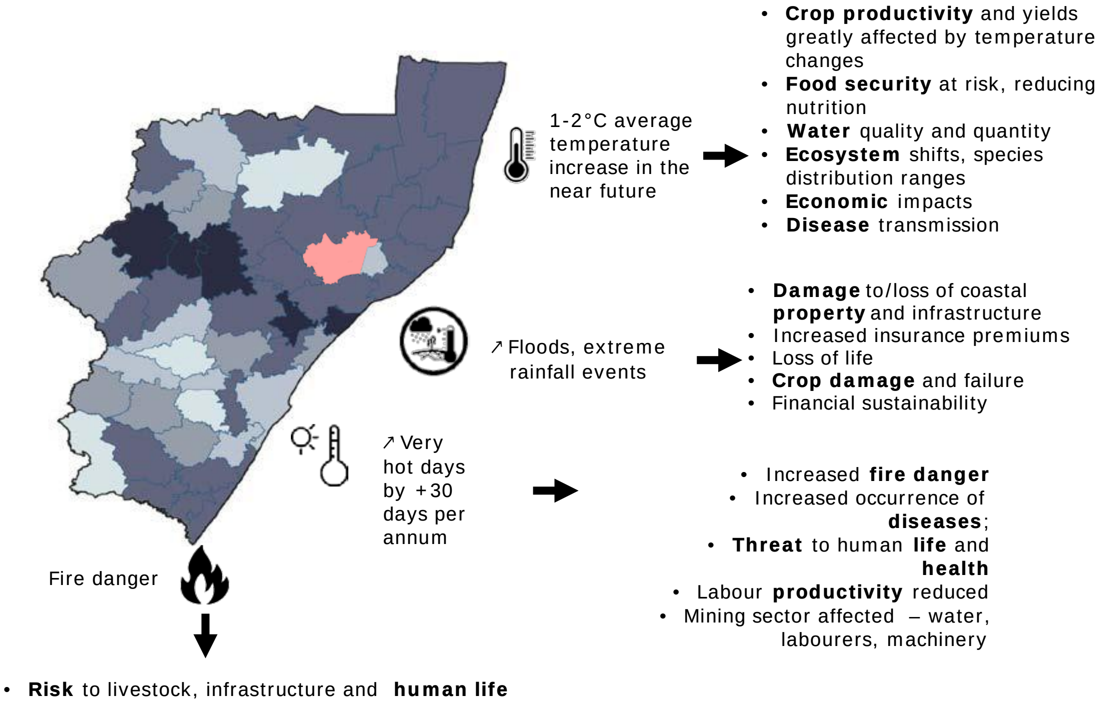

Figure 5: Climatic conditions predicted in KwaZulu-Natal province in terms of Mthonjaneni Local Municipality (SSP5)

The current and future changes in climate for the Jindal Project, are summarised in the below table.

[50] Mambo, J. and Faccer, K., 2017. South African Risk and Vulnerability Atlas: understanding the social & environmental implications of global change.

Table 12: Current and future climate projections for the Jindal Project within the Mthonjaneni Local Municipality

Climate change impact	Current	SSP 2	SSP 5
		The projected change for the period 2021 to 2050, relative to the baseline period (1961 to 1990).	
Temperature	Average annual temperature between 17-20 ˚C.	Average annual temperature increases by between 1.73°C to 2.02°C	Average annual temperature increases by between 2.09°C to 2.31°C
Very Hot Days (>35°C)[51,52]	The number of hot days (>35˚C) is seen to be between 1 to 8 days.	Potential increase of 3.00 days to 8.66 days	The average increase in the number of very hot days could increase between 2.88 days to 14.80 days
Rainfall	Average of between 1100mm to 1700 mm of rainfall experienced.	Average annual rainfall may decrease by 6.03mm or increase by 85.49mm	Average annual rainfall may increase between by 121.38mm to 183.88mm
Extreme Rainfall Days[53]	*Information is not available for the baseline*	The region could experience a change of 0.48 days fewer extreme rainfall days or up to 2.06 days more.	The region could experience a change of 1.00 to 2.68 more extreme rainfall days.
Flood Risk[54]	Very low to medium risks in the South and West regions, while the North and East regions have medium-high to very high risks.	*Information is not available for the SSP 2 scenario*	High risk in central part of the region.
Drought Risk [54,55]	Drought tendencies are increasing throughout, with the North region having the highest tendencies.	*Information is not available for the SSP 2 scenario*	Low risk in central part of the region.
Fire Risk [54]	Likely within the central region of Mthonjaneni municipality	*Information is not available for the SSP 2 scenario*	High risk in central part of the region

Climatic projections for the Jindal Project suggest that the Mthonjaneni Local Municipality could experience an increase in average annual temperatures of at least 1.7°C to 2.0°C from the baseline period (1961-1990). It is further projected that annual average rainfall volumes would become more variable, and it is likely that there will be an overall increase in rainfall. It is also seen that the

51 Very hot days: the number of days (per 8 x 8 km grid point) where the maximum temperature exceeds 35°C.
52 Heat wave days: where temperature exceeds maximum temperature of the warmest month of the year by 5°C for a period of 3 or more consecutive days.
53 20mm of rain occurring within 24 hours over the 8 x 8 km grid point.
54 Flood, drought and fire risk data were modelled for the RCP 8.5 scenario only (see greenbook.co.za), therefore no RCP 4.5 data could be included in this analysis. Floods, drought and fires are the most destructive and have the greatest environmental and social impact. RCP 8.5 scenario was selected to give a good indication of how climate change would precipitate as a function of the current conditions under these three aspects. Providing a current and worst-case scenario will help to provide a more conservative approach upon which actions can be based.
55 Number of cases exceeding near-normal per decade for the period 1995-2024 relative to 1986-2005 baseline period, under the low mitigation scenario.

Mthonjaneni Local Municipality will experience an increase in extreme hot days for both SSP2 and SSP5. Hence, the changes in temperature and the increased variability in rainfall volumes and extreme hot days, increases the flood and fire risk for the central part of the region within the SSP5 projection.

The main climate change impacts at the Mthonjaneni Local Municipality are **increased temperature** and extreme **hot days**, increased **rainfall variability** and high risks to **floods** and **fires** in central parts of the region. The climate in the area is thus likely to become hotter and wetter.

5.1.2 Weather Trends and Projections

This analysis is based on the following datasets:

- Meteoblue's Weather Data for the Jindal Project; and
- World Resources Institute's (WRI) Aqueduct tool.

5.1.2.1 Rainfall data

Historical rainfall data from 1985 to 2021 for the Jindal Project was obtained from Meteoblue. The parameters analysed are *average annual rainfall*, *total days over average annual rainfall*, *total consecutive rainfall days over average*, and *total rainfall days*, such graphs can be seen in Figure 6 below.

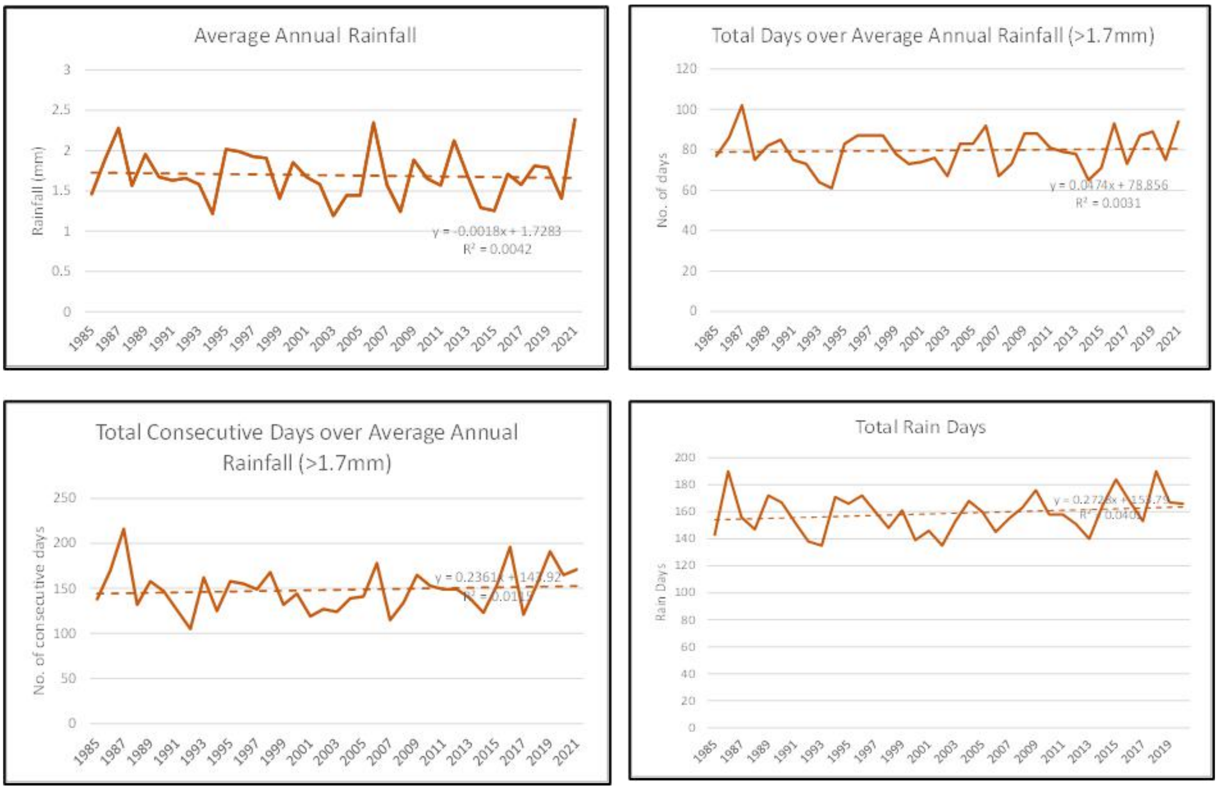

Figure 6: Historical precipitation data from 1985 to 2021 for the Jindal Project.

It is seen in the figure above that the total days over the average annual rainfall[56], total consecutive rainfall days over the average rainfall, and total rainfall days are showing an upward trend. Such trend showcases that the amount of precipitation that has been above average, and the amount of rainfall days experienced, has increased from 1985 to 2021. The medium-term data above is not statistically significant, however, if we investigate longer-term data such as the Greenbook (Table 12), it is identified that the local municipality and project area is at risk to floods in the future. Such data is significant information for this Project, as numerous operations are sensitive to water availability and therefore should be considered.

5.1.2.2 Temperature data

Historical temperature data from 1985 to 2021 for the Jindal Project was obtained from Meteoblue. The parameters analysed are *average annual temperature*, *maximum temperature, total number of uncomfortable days (Discomfort Index>90)* and *total consecutive uncomfortable days,* such graphs can be seen in Figure 7.

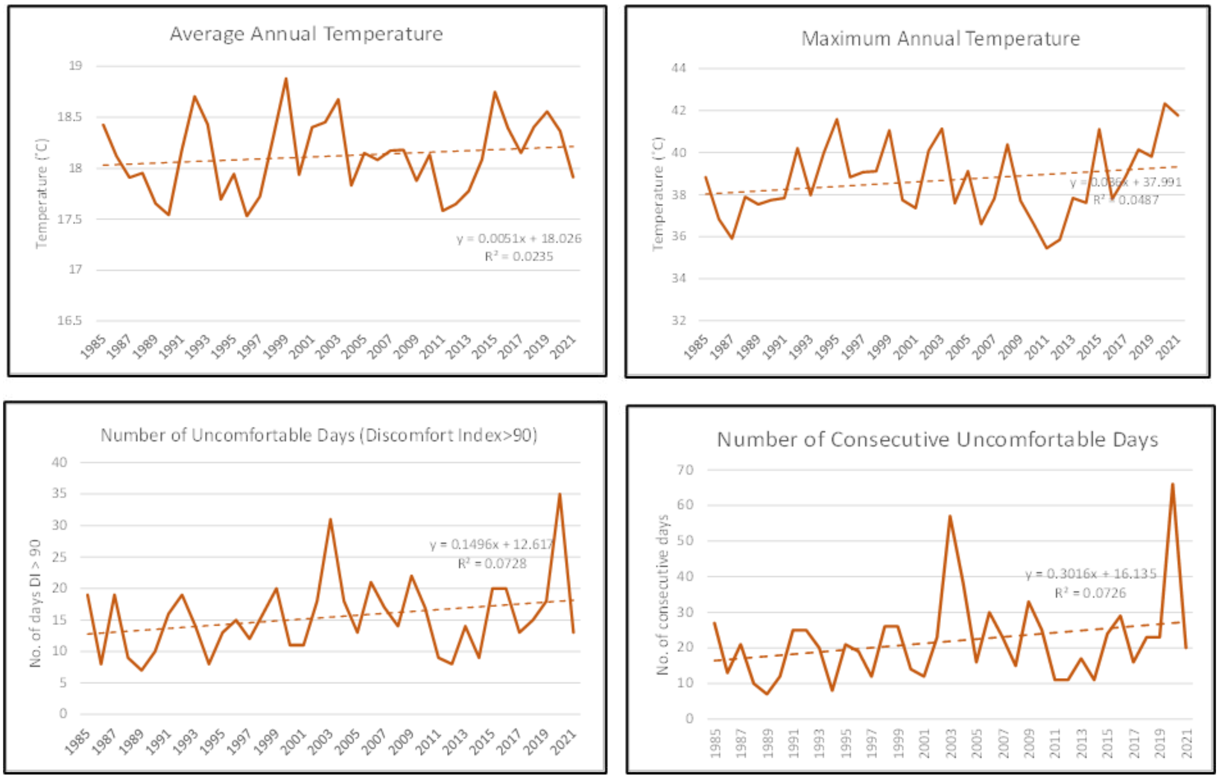

Figure 7: Historical temperature data from 1985 to 2021 for the Jindal Project.

From the figure above it is identified that the historical temperature parameters show upward trends from 1985 to 2021. Such trends reveal that the temperature from 1985 to 2021 has increased over time, with the uncomfortable days increasing significantly. It is therefore evident that the area within which the Project will be located has become hotter and such changes could increase the risks to droughts and/or fires in the future.

[56] Total number of days that had a recorded amount of rainfall over the average (1.7mm).

5.1.3 Projected Climate Change

5.1.3.1 Rainfall

For rainfall projection, information depicted in Table 12 will be used. According to the table, it is seen that that average annual rainfall may decrease by 6mm or increase by 85 mm for SSP 2 and increase between 121 to 183 mm for SSP 5. Furthermore, the municipality is predicted a change of 0.48 fewer extreme rainfall days or up to 2 days more for SSP 2, and a change of 1 to 2.6 more extreme rainfall days for SSP 5. As for flood risks, it is seen that there is a high risk at central part of the municipality. Hence, the project area is likely to become wetter in the future. According to the Mthonjaneni Disaster Risk Management Plan, the municipality is susceptible to numerous forms of natural disasters. For instance, in summer, hailstorms, thunderstorms, heavy rains and floods are all common[57].

5.1.3.2 Temperature

Like the rainfall projection above, information depicted in Table 12 will be used for temperature projections. According to the table, it is seen that the extreme hot days will increase between 3 to 8 days for SSP 2 and 3 to 15 days for SSP 5. Furthermore, it is seen that average annual temperature will increase by at least 1.7°C to 2.0°C from the baseline period (1961-1990). As for the drought risk of the region, it is projected that central parts of the municipality show a low risk to droughts.

5.1.3.3 Water Stress

By use of the World Resources Institute's Aqueduct tool, the water stress in the Melmoth region can be analysed. The site is located 25 km southeast of Melmoth, within the Mthonjaneni Local Municipality, in KZN. Projected change in water stress shows how development and/or climate change are expected to affect water stress, which is the ratio of water use to supply. The "business as usual" scenario (SSP2 RCP8.5) represents a world with stable economic development and steadily rising global GHG emissions. The projected increase in water stress is "low -medium", suggesting that there is a 10-20% possibility that water stress will increase by 2030.

[57] Mthonjaneni Local Municipality, 2019. Mthonjaneni Disaster Risk Management Plan.

Figure 8: Projected change of water stress for the Jindal Project.

Such information is further supported by the figures below. According to the figures below, the Jindal Project site is within an area that is exposed to "low-medium" water stress conditions by 2040, as well as within a water-stress hot spot area.

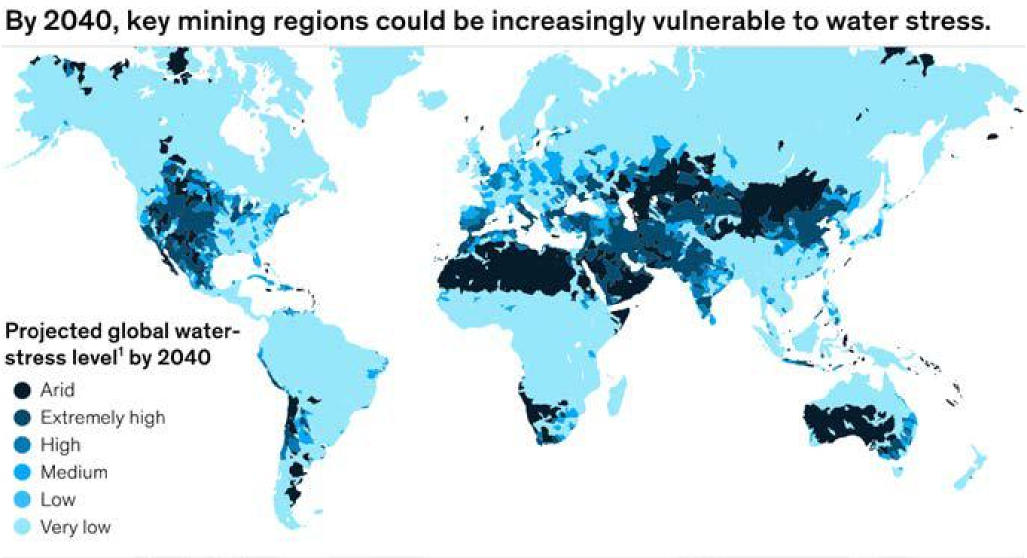

Figure 9: Global water stress.[58]

58 Delevingne, L., Glazener, W., Grégoir, L. and Henderson, K., 2020. Climate risk and decarbonization: What every mining CEO needs to know. Report McKinsey & Company.

Figure 10: Global water stress projections and hot spots.[59]

The projected change in seasonal variability of water, based on the Aqueduct tool, is shown in Figure 11 below. Currently, the WRI Aqueduct Tool indicates that seasonal variability in the Project area is considered "Medium-High". According to the WRI, seasonal variability measures the average within-year variability of available water supply, including both renewable surface and groundwater supplies. Higher values indicate wider variations of available water supply within a year.

The projected change in seasonal variability of water moves from "Medium-high" to "Low-medium" in 2030 under a "business-as-usual" scenario. Lower values indicate narrower variations of available water supply within a year. This indicates that seasonal variability[60] may become less extreme in 2030. Please note that Figure 8 and Figure 11 are not related to one another. Figure 8 indicates projected change in water stress while Figure 11 indicates seasonal variability of water availability for the project area.

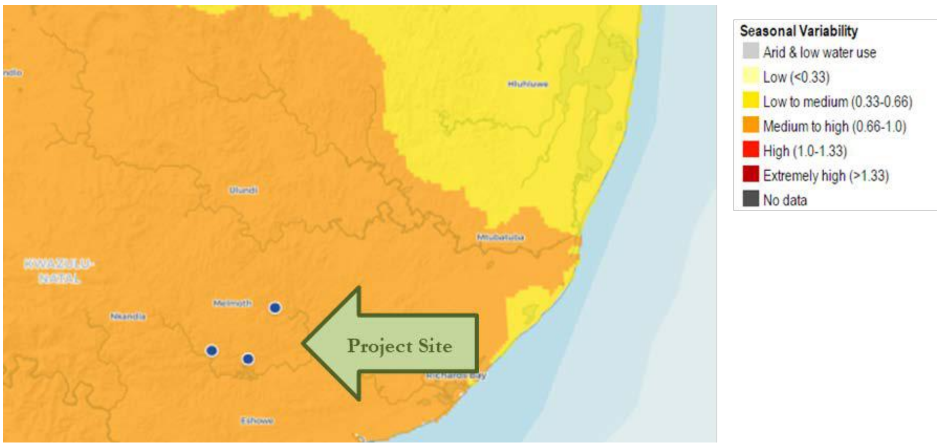

Figure 11: Seasonal variability at the Jindal Project.

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59 Delevingne, L., Glazener, W., Grégoir, L. and Henderson, K., 2020. Climate risk and decarbonization: What every mining CEO needs to know. Report McKinsey & Company.

60 Seasonal variability is an indicator of the variability between months of the year. Increasing seasonal variability may indicate wetter wet months and drier dry months, and higher likelihood of droughts or wet periods.

6 Project Impact on Climate Change

This section outlines the Jindal Project's impact on climate change. The GHG inventory will be assessed in accordance with the methodology described in section 4. The boundary of this assessment includes the construction and operation of the iron ore mine, as well as the downstream transport and processing of the iron ore concentrate. The emissions from the decomissioning phase are deemed immaterial in the context of the overall inventory and have therefore been excluded from the calculations.

6.1 Project Greenhouse Gas Inventory

The GHG inventory for the Jindal Project was developed in accordance with the SANS 14064-1:2021 standard, as well as the GHG Protocol (ISO 14064-1 (2006)), as described in Section 4.1.1 above. For the purposes of this assessment, the GHG inventory according to SANS14064 will be considered.

The boundaries of the analysis were set, as indicated above. This analysis took into consideration the relevant emissions from core operations, as well as upstream and downstream emissions.

Table 13 summarises the calculated emissions for the Jindal Project for the direct emissions and significant indirect emissions. The key GHG emission sources are the consumption of electricity during operation and the processing of the sold concentrate during the steel production process.

The table below is presented in terms of the SANS14064 (2021) standard. The emissions are presented in accordance with the GHG Protocol in Appendix A for completeness.

The emissions from processing the iron ore contributes 91% of the overall emissions. These emissions are calculated making use of the emission intensity published by Jindal's operations in India. This intensity is significantly higher than the global average for steel production. As such, the downstream emissions from the project could change significantly, should the steel be produced elsewhere. The higher emission factor has been selected to be conservative in the estimate of the downstream emissions. Should the iron ore be processed in a plant indicative of the global average which includes new build plants in developed countries such as Europe, the emissions from downstream processing could decrease by approximately 40%.

Table 13: Construction and operation emissions for the Jindal Project – SANS14064-1 (2021).

Emission category	Emission source	Construction phase	Operation phase	Total over life of project (25 years)
Category 1: Direct GHG emissions and removals)	Diesel Combustion	1 530 tCO_2e	103 029 tCO_2e	2 575 722 tCO_2e
Category 2: Indirect GHG emissions from imported energy	Electricity		1 213 978 tCO_2e	30 349 453 tCO_2e
	Fuel & energy related emissions not included in category 1 and 2	340 tCO_2e	159 855 tCO_2e	3 996 375 tCO_2e
Category 3: Indirect GHG emissions from transportation	Waste generated in operations	444 tCO_2e		
	Employee commuting		546 tCO_2e	13 659 tCO_2e
	Downstream transportation and distribution		220 804 tCO_2e	5 520 102 tCO_2e
Category 4: Indirect GHG emissions from products used by organization	Purchased goods and services	323 568 tCO_2e		
Category 5: Indirect GHG emissions from use of products sold by organization	Processing of sold product		18 144 000 tCO_2e	453 600 000 tCO_2e
Total indirect emissions		**324 531 tCO_2e**	**19 739 184 tCO_2e**	**493 479 589 tCO_2e**
Total emissions		**325 881 tCO_2e**	**19 842 212 tCO_2e**	**496 055 311 tCO_2e**

6.2 Project contribution to climate change

6.2.1 Transitioning to a 2-degree scenario

Iron and steel will play a vital role in the transition to a low-carbon economy. According to World Bank, global cumulative demand for steel under a 4-degree scenario is approximately 1.5 billion tonnes. This means that an additional 1.5 billion tonnes of steel up to 2050 is required. Under a 2-degree scenario, this demand increases to 2.5 billion tonnes, an additional 1 billion tonnes of steel[61], approximately 67% increase from the 4-degree scenario. The global increase in demand for iron and steel will be partially driven by the growth in demand for components used in renewable energy technologies. An increase in steel production is required for the transition to a low-carbon economy. This is highlighted by Figure 12 below from the World Bank report.

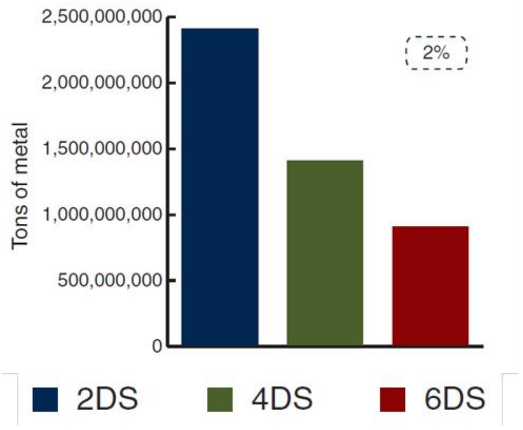

Figure 12: Global demand for steel.

A second World Bank report further investigates this global increase in demand for minerals and metals specifically in the energy sector[62]. In Figure 13 below, the increase across the different minerals is shown. Iron, a key component in steel production, is projected to have an increase in demand of up to 219% in the energy sector, depending on the scenario.

[61] World Bank. 2017. *The Growing Role of Minerals and Metals for a Low Carbon Future.*

[62] World Bank. 2020. *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition*

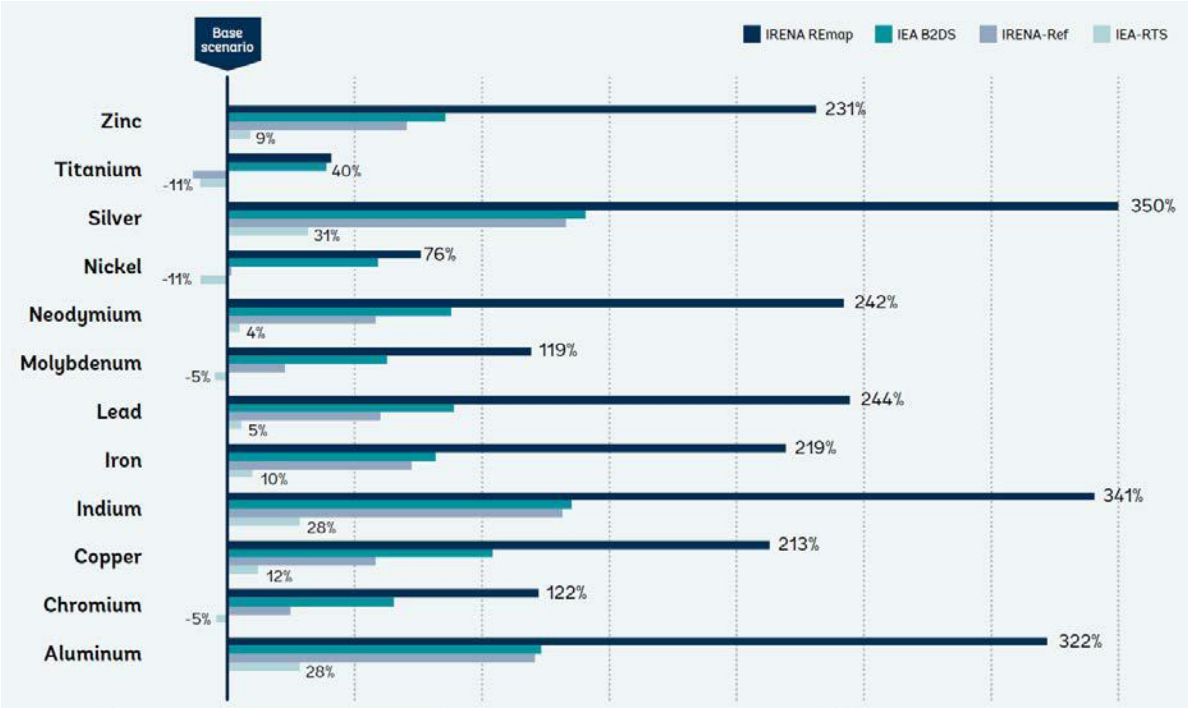

Figure 13: Global mineral demand increase.

The 6th Assessment Report from the IPCC[63] estimates the annual emissions for various scenarios. Based on these scenarios, there is a difference of 20GtCO_2 per annum by 2050 between SSP4.5 and SSP2.6. The IPCC 6th Assessment Report additionally projects the cumulative emissions as shown in Figure 14. Using this figure, the cumulative emissions under a 2-degree and 4-degree scenario were estimated. The difference between these two figures is approximately 4 200 GtCO_2. This results in approximately 4 128 tCO_2 abated/tonne steel. Using a stochiometric analysis to obtain the amount of iron ore required to create steel, the abatement can be converted to tonnes of iron ore. A stochiometric ratio of 0.66 tonnes of steel from each tonne of iron ore results in approximately 2 743 tCO_2 potentially abated by the economy for every tonne of iron ore mined.

The above value was calculated by obtaining the difference between the projected cumulative emissions under 2-degree and 4-degree scenarios, presented in Figure 14 below. The resulting emissions abatement was divided by the 1 billion tonnes of cumulative steel demand to obtain 4 200 tCO_2 abatement per tonne of steel produced. This was then multiplied by 0.66 tonnes steel/tonne iron to yield the 2 743 tCO_2 potential abatement per tonne of iron ore mined.

The above abatement figure does not consider the emissions to produce steel. Should the global average emission factor be used, the emission abatement will decrease by 1.4 tCO_2e/tonne steel, while if the Jindal emission factor is used, it will decrease by 2.52 tCO_2e/tonne steel. This reduction is immaterial in the context of the potential abatement, forming only 0.03% of the overall potential.

63 IPCC. 2022. *6th Assessment Report, Working Group I, Summary for Policy Makers.*

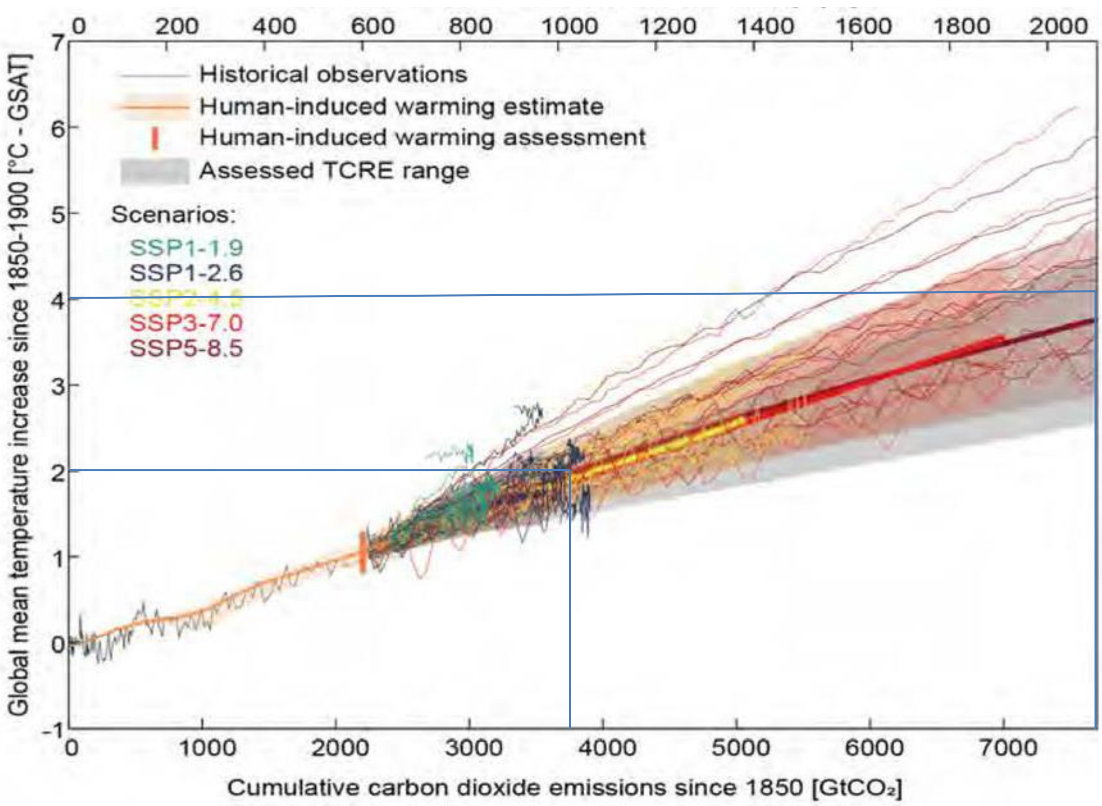

Figure 14: Projected global cumulative emissions.[64]

The proposed Jindal Project will lead to direct emissions emitted within the boundary of South Africa as well as indirect emissions emitted nationally and internationally. Section 6.2.3 discusses these emissions in the terms of the impact of the proposed project within the context of the environmental authorisation process.

6.2.2 Causal Chain

The iron ore, and subsequent steel, from Jindal is an enabler for moving the global economy to a 2-degree scenario (Figure 15). The global economy will not be able to move to a lower GHG emissions scenario without a substantial increase in renewable energy infrastructure development, which will require steel.

The Project will therefore have a positive net climate change impact and is assigned an intensity of low-positive, as the project could result in 2 743 tCO_2e abated by the economy for every tonne of iron produced. The mine itself will only emit 0.18 tCO_2e/tonne ore, which is immaterial when compared to the potential abatement. The lifetime emissions of the project forms 0.01% of the emissions that could be abated through its potential contribution to the transition to a low-carbon economy.

[64] IPCC. 2021. Climate Change 2021 "The Physical Science Basis Working Group I contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change"

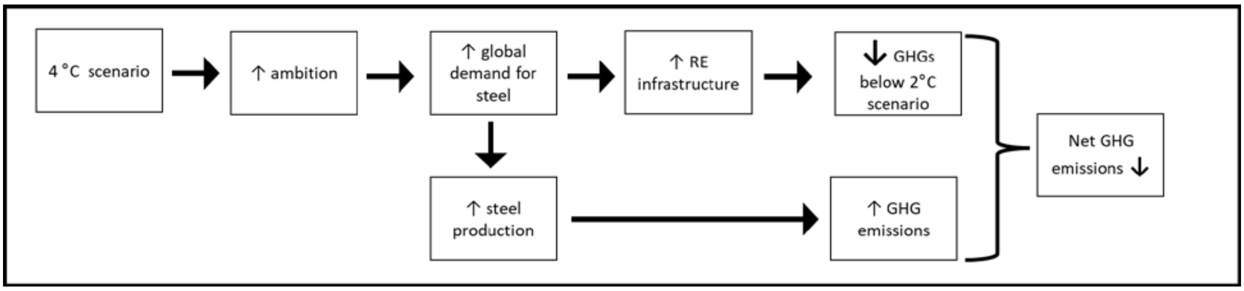

Figure 15: A causal chain for steel production.

6.2.3 Assessment Criteria

The proposed Jindal Project has a significance score of Low negative for construction and High positive operation. The score is calculated based on the methodology described in Section 4. The project therefore has an overall **positive High** climate change impact.

Table 14: Climate Change Impacts of the Jindal Project – construction.

Nature: The proposed Jindal Project is an iron ore mine that will consume diesel for the construction of its operations. The combustion of this diesel results in direct GHG emissions from the project. The manufacturing and transport of purchased fuels and materials also leads to GHG emissions. These emissions are indirect emissions for the project. The emissions considered for this impact assessment are those that occur within the boundary of South Africa. This includes all direct and indirect GHG emissions associated with the project construction. The direct and indirect emissions occurring within South Africa from the Jindal Project construction amounts to approximately 325 thousand tCO_2e/year.		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Low positive	Low positive
Duration	Long term – High	Long term – High
Extent	International – Very high	International – Very high
Consequence	High positive	High positive
Probability	Definite	Definite
Significance	Low negative	Low negative
Mitigation: There are several non binding proposals for mitigation of these emissions, such as fuel additives in diesel vehicles or regular service intervals to ensure optimal vehicle efficiency. The impact of these mitigation measures could marginally reduce the energy emissions of the construction phase.		

Table 15: Climate Change Impacts of the Jindal Project – operation.

Nature: The proposed Jindal Project is an iron ore mine that will consume diesel for its onsite operations. The combustion of this diesel results in direct GHG emissions from the project. The project also consumes electricity, which leads to GHG emissions in its production.

The manufacturing and transport of purchased fuels and materials also leads to GHG emissions as well as the processing of the sold product. These emissions are indirect emissions for the project. The emissions considered for this impact assessment are those that occur within the boundary of South Africa. This includes all direct and indirect GHG emissions associated with the project. As a result, the emissions from the transport and processing of the concentrate are excluded from the assessment despite these emissions forming a significant portion of the overall GHG inventory. These emissions are excluded as the transport occurs in international waters and the processing is most likely to occur in India. The direct and indirect emissions occurring within South Africa from the Jindal Project amounts to approximately 1.5 million tCO_2e/year. The emissions from the project should be considered in the context of the significant positive impact the project can have in the transition to a 2-degree scenario. This transition could result in approximately 2 700 tCO_2e abated/ tonne of iron ore mined.		
Criteria	**Without Mitigation**	**With Mitigation**
Intensity	Low positive	Low positive
Duration	Long term – High	Long term – High
Extent	International – Very high	International – Very high
Consequence	High positive	High positive
Probability	Definite	Definite
Significance	High positive	High positive
Mitigation: Based on the exclusion of the processing emissions related to the iron ore, a much larger portion of the emissions can be mitigated, as they are predominantly energy based. There are several mitigation opportunities for these emissions, such as, renewable energy or fuel switches in mobile machinery. Additionally, a switch to electric vehicles could be considered at the mining operation. The impact of these mitigation measures could significantly reduce the energy emissions of the overall project.		

7 Project Vulnerability to Climate Change

Vulnerability is defined as the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes[65]. The physical risks of climate change, such as water stress, precipitation, and heat, must be evaluated at a localised, asset-specific level. The map presented below indicates the fire risk, flood risk, increased extreme rainfall and extreme hot days[66] for the Mthonjaneni Local Municipality, within which the Jindal Project is located. The trends displayed in the map indicate that the Mthonjaneni Local Municipality is exposed to numerous climate change risks such as fire and flood risks, specifically

65 IPCC, 2022: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.

66 Extreme hot days are defined as summertime temperatures that are much hotter and/or humid than average (https://www.cdc.gov/disasters/extremeheat/heat_guide.html).

in the central region of the municipality, as well as an increase in extreme rainfall events and hot days.

The King Cetshwayo District Municipality's Climate Change Response Plan (2018)[67], further reported that the district is prone to climate-related hazards, prioritized hazards include severe storms (wind, hail, snow, lightning, fog), fire hazards, floods, and drought. Rainfall variations within the Mthonjaneni Local Municipality is also likely to cause an increase in the number of rainfall days[68]. The increase in the number of rainfall days may likely result in flooding events across the district. The risks mentioned above must therefore be considered within the context of the project and within the context of the vulnerability of the local municipality.

According to the information provided by the Greenbook and Mthonjaneni disaster risk management plan, the map presented below summarises the risks associated with Mthonjaneni Local Municipality within which the Jindal Project is located. It is anticipated that Mthonjaneni Local Municipality region of KwaZulu-Natal will experience increased temperatures and decreased rainfall volumes, with increase rainfall variability[69]. Such events will inevitably increase the municipalities risk to floods and fires.

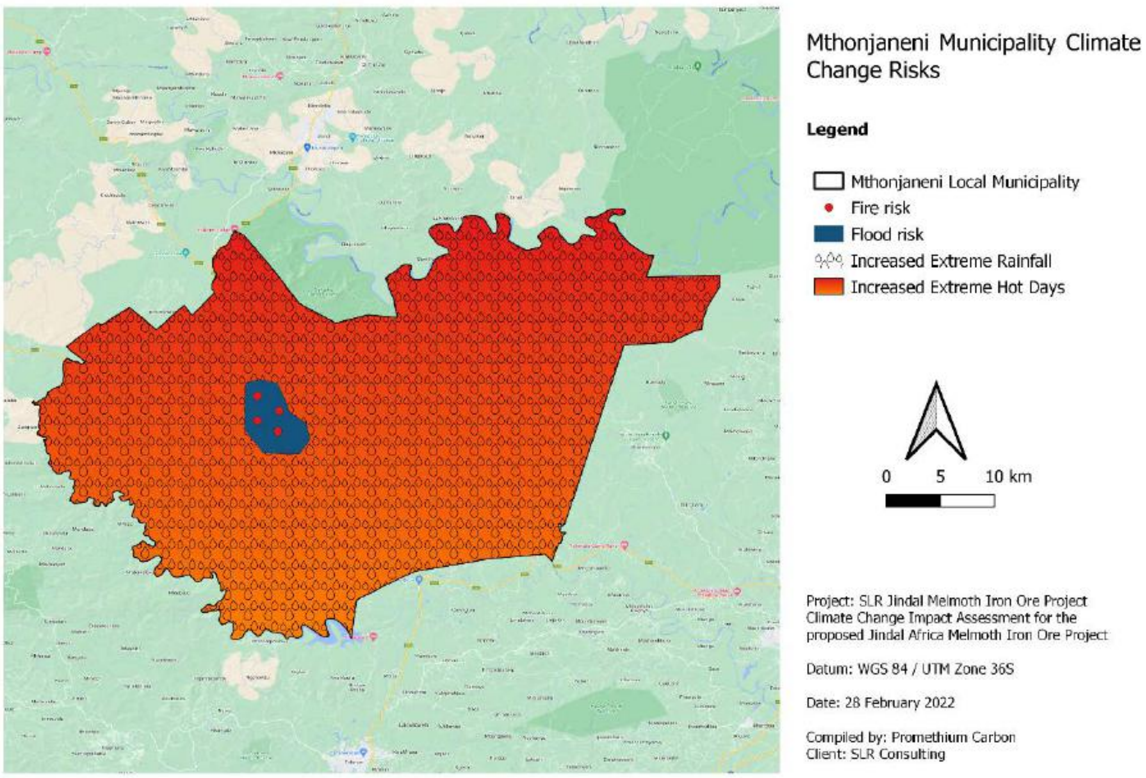

Figure 16: Mthonjaneni Local Municipality fire, drought, extreme hot days, and flood risks.

67 Available at: https://letsrespondtoolkit.org/municipalities/kwazulu-natal/king-cetshwayo/.
68 https://letsrespondtoolkit.org/municipalities/kwazulu-natal/king-cetshwayo/.
69 Green Book Tool, *Mthonjaneni Local Municipality: Current status*, [Website] Available at: https://riskprofiles.greenbook.co.za/ [accessed on 31/03/2022].

Such implications will inevitably have impacts on the Project's core operations, value chain and broader network and will be discussed in the section below.

7.1 Core operations

The Jindal Project's core operations could be impacted by climate change in two main ways, namely, (i) the physical impacts on the mining infrastructure and (ii) the impact on labourers.

7.1.1 Physical Risks

Such risks relate to the direct impacts climate change conditions may have on several sectors of society and the environment. With relevance to the Jindal Project, the physical risks considered include the impacts temperature and rainfall will have on the project, the work force, and the surrounding local community. The Jindal Project will be an open-cast mine, and as a result the risk of dust needs to be considered in respect to climate change. Such implications will impact not only the mine operations, but the surrounding environments and communities will be affected as well.

7.1.1.1 Temperature

It is expected that the Mthonjaneni Local Municipality will experience an increase in average temperature, as well as an increase in the frequency of hot days. The GreenBook tool indicates that by 2050, the average temperature will increase by between 1.7°C to 2.0°C under the SSP 2 (RCP 4.5) scenario and between 2.10°C to 2.3°C under an SSP 5 (RCP 8.5) scenario. The number of very hot days is also predicted to increase by up to 8 days under SSP2. Typical risks associated with the relationship between increased temperatures and mining, include the following:

- The increased annual temperatures and an increased frequency in the number of hot days/ heatwaves, will result in equipment thresholds being exceeded more frequently.
- Temperature rise will affect physical plant machinery as well as equipment efficiencies. With increased temperatures, overheating of equipment is more likely, and equipment thresholds can be reached at a faster rate.
- In addition, the onsite offices will have increased energy demands for cooling and associated energy costs.

7.1.1.2 Rainfall

It is seen that there will be an increase in rainfall variability and high flood risks in specific regions of the Mthonjaneni Local Municipality. As a result of the location of the Jindal Project, the operations will most likely be water sensitive. For example, the mining transportation, infrastructure, buildings, and facilities are likely to be negatively impacted by increased rainfall and flood risks, i.e., unregulated discharge of the mine water. Therefore, change in rainfall patterns and availability has the potential to impact the operations and production at the Jindal Project.

7.1.2 Labour and working conditions

In terms of the project's workforce, the existing hot and dry environment, coupled with expected increase in the number of extreme hot days, could have a negative impact on the health of employees, particularly for individuals working outside who are exposed to extreme heat. Heat stress is a major occupational health risk and can directly impact labour productivity and consequently, operations at the Jindal Project.

Since the Jindal Project is planned to be an open-pit mine, mine workers will be impacted by increasing ambient temperatures. Rising ambient temperatures increases exposure to heat and in turn heat stress, especially for outdoor workers. Heat stress at work resulting from (climate change-related) rising temperatures impacts workers' health, safety, productivity, and social well-being. Heat stress and discomfort felt by truck drivers and machine operators could lead to unforeseen incidents that could cause damage to equipment/or human injury. This could lead to high mortality rates, heat-related illnesses, increased injuries, more absenteeism, slow work pace, loss of productive capacity, and poor social well-being.

Furthermore, increased rainfall events and flood risks could create numerous safety hazards to arise at the project area. Such events could have extreme repercussions on the workforces safety and health, which will inevitably impact the productions and core operations at the Jindal project.

7.2 Value chain

Analysing the impact climate change will have on the Jindal Project's value chain allows for an understanding of how materials, equipment, and resources (upstream), and manufacturing, production, and distribution (downstream) process, will be affected.

The upstream value chain for the project will be impacted by climate change, as indicated for the main items used in the Project, in Table 16 below.

Table 16: Climate change impacts on the upstream value chain of the Jindal Project.

Item	Aspects affected by the impacts of climate change
Transport and storage of all goods	It is anticipated that diesel will also be used onsite for machinery and generators. Similarly, all equipment and other such goods will be transported to the project site. These items will make use of the established road networks in and around the Mthonjaneni Local municipality. In addition, water obtained from the municipality will be transported via existing municipal water distribution systems. *Extreme weather events* With increased seasonal variability, the Jindal Project may be exposed to periods of intense rainfall and flood risks. This could lead to limited road access to the project and cause delays in product deliveries to the Project site.
Concrete supply	Concrete will be mainly used for the construction and maintenance of the Jindal Project. The main risk associated with concrete production is the possible damaging of the concrete. Flood events could impact the foundation of the concrete and in extreme cases cause collapses. This is of concern since this region is currently, and anticipated, to experience increased rainfall. If a concrete producer is affected by increased water, this could disrupt the supply of concrete to the Project, which could delay construction and further operations.

7.2.1 Downstream value chain

Table 17: Climate change impacts on the downstream value chain of the Jindal Project.

Item	Aspects affected by the impacts of climate change
Distribution lines and substations	Various infrastructure is in place to support the mine, this could include road access, transmission lines and sub-stations, raw water abstraction and pipelines, and so forth. *Increasing daily temperatures* Hotter ambient temperatures often decreases the efficiency of electric components like substations, and will impact the performance of kV distribution lines, causing increases in transmission and distribution losses. *Increased rainfall/flood risks* Heavy rainfall and extreme events would likely cause the pylons and poles to be increasingly susceptible to uprooting and toppling, resulting in a disruption of electricity supply to consumers.
Road access for maintenance and services	*Extreme weather events* There are several roads and gravel roads available to access the site. However, with increased rainfall events and flood risks, road access to the location could get disrupted and could affect the transportation of ore to the Richards Bay port, as well as impact the maintenance workers health and work productivity.

7.3 Broader Social Context

Promethium understands that a social specialist study will be undertaken as part of the EA process and will include a Social Impact Assessment. This CCIA will therefore not provide details with respect to demographics, inequality, education, employment, household income or service delivery for the local municipality.

We do however note the following key points that should be considered with respect to climate change and the broader local community:

- With respect to the demographic profile, women are generally considered to be more vulnerable to climate change than their male counterparts, as women generally head up the household whilst males leave to urban centres, as a result, firewood and water collection is often a women's primary responsibility;
- A high unemployment rate points to existing socio-economic vulnerabilities. High levels of poverty, low-income distribution and low education levels all contribute to vulnerability. Social vulnerability from climate change will result in further inequalities and reduced capacity to cope with climate shocks; and
- A local community that is largely younger than 15 or older than 65 indicates a higher dependency ratio. Increased economic strain on households can lead to increased vulnerability to climate change impacts.

7.4 Broader Environmental Context

In addition to this specialist CCIA, other specialist studies have been conducted for the Jindal Project, specifically:

- Geology;
- Hydrogeology;
- Hydrology;
- Terrestrial Biodiversity;
- Aquatic Biodiversity; and
- Soils and Agricultural Potential.

This CCIA will therefore not provide additional details with respect to the above-mentioned disciplines.

We do however note the following key points that should be considered with respect to climate change and the broader environmental context:

- Climate change will affect natural ecosystems, reducing their ability to withstand impacts. The continued loss of biodiversity and degradation of ecosystems, and impacts to water resources weakens their ability to provide essential services.
- According to the South African National Biodiversity Institute's summary, it is identified that there are approximately 312 wetlands present within Mthonjaneni Local Municipality, with 3 of these wetlands being found within the South Block site[70]. Wetlands have important regulatory functions in that they moderate floods. They allow for attenuation of flood peaks thus reducing the risks to people and infrastructure. In addition, wetlands improve water quality though filtration and detoxification. Climate change will negatively impact wetlands and their ability to provide essential services.

8 Project Mitigation and Adaptation Measures

Mitigation and adaptation measures will need to be addressed in terms of both the measures the proposed Jindal Project must take to reduce its *impact on climate change*, as well as the measures needed to improve the *resilience of the project to climate change*. These are discussed further below.

8.1 Measures to reduce the impact of the Project on Climate Change

There are a few measures that could potentially mitigate the impact the project has on climate change, by reducing the direct and energy indirect emission intensity of the mine. These options are focused on the energy consumption processes of the Jindal Project. Some potential options are:

- **Decarbonisation of the electricity supply:** This could come in several forms, such as the decarbonisation of the grid emission factor as new renewable energy comes online in

70 Golder Associates, 2015. Iron Ore Mine near Melmoth. KZN operated by Jindal Mining KZN (Pty) Ltd.

the national grid system. Alternatively, some decarbonisation could be achieved through the installation of on-site renewable energy for own use.

- **Electrification of the fleet:** This option could mitigate emissions by electrifying the mine vehicle fleet and reducing the fuel consumption in mobile machinery. The electrification could be combined with renewable energy for further mitigation.

8.2 Adaptation Measures to Increase the Project's Resilience to Climate Change

As described in Section 7 of this report, climate change impacts are likely to influence the proposed Jindal Project, as well as the surrounding communities and broader natural environment. Despite changing climate conditions, options exist to improve the resiliency of mining assets to certain physical climate change impacts. Adaptation measures to be considered in the development of the Jindal Project include:

- To improve resiliency, reduce the water intensity of the Jindal Project's mining processes. Jindal can also consider recycling used water and reduce water loss from evaporation, leaks, and waste. Mining companies can prevent evaporation by putting covers on small and medium dams. Jindal could also consider natural capital, like wetland areas, to improve groundwater drainage.
- To address high-water concerns, companies can adopt flood-proof mine designs that improve drainage and pumping techniques. They can adapt roads (such as by using hard metal or crusted rock for speed drying) or build sheeted haul roads. They can also use conveying methods that don't rely on trucking (such as by creating a full in-pit crushing and conveying system).

9 Opinion of the Project

The assessment of the climate change impact of this project has been done on the impact of the project on climate change, the resilience of the project to climate change, as well as the options for mitigation of the impacts.

The impact of the project on climate change was assessed in the context of both GHG emissions from the project, as well as the potential positive impact the project will have for the transition to a low-carbon economy.

The project will emit 326 $ktCO_2e$ during the construction phase, 19 850 $ktCO_2e$/year during the operational phase and 496 100 $ktCO_2e$ over its lifetime. The iron ore processing related emissions form a significant portion of these emissions, therefore the higher emission factor was selected to be conservative. Should the iron ore be processed in a plant indicative of the global average which includes new build plants in developed countries such as Europe, the emissions from downstream processing could decrease by approximately 40%.

The global economy will not be able to move to a lower GHG emissions scenario (or 2°C scenario) without a substantial increase in renewable energy infrastructure development, which will require steel. The Project will therefore have a positive net climate change impact.

In accordance with the findings of this CCIA, we advise that the proposed Jindal Melmoth Iron Ore Project should not be refused environmental authorisation on the basis of climate change related issues.

Appendix A GHG Emissions according the GHG Protocol

Table 18: Construction and operation emissions for the Jindal Project (GHG Protocol).

Emission category	Emission source	Construction phase	Operation phase	Total over life of project (25 years)
Scope 1: Direct emissions	Diesel (Combustion)	1 530 tCO_2e	103 029 tCO_2e	2 575 722 tCO_2e
	Total direct emissions	1 530 tCO_2e	103 029 tCO_2e	2 575 722 tCO_2e
Scope 2: Indirect GHG emissions from imported energy	Electricity		1 213 978 tCO_2e	30 349 453 tCO_2e
Scope 3: Other Indirect emission	Category 1: Purchased Goods and Services	323 568 tCO_2e		
	Category 3: Fuel- And Energy-Related Activities	340 tCO_2e	159 855 tCO_2e	3 996 375 tCO_2e
	Category 5: Waste Generated in Operations	444 tCO_2e		
	Category 9: Downstream Transportation and Distribution		220 804 tCO_2e	5 520 102 tCO_2e
	Category 11: Use of Sold Products		18 144 000 tCO_2e	453 600 000 tCO_2e
	Total Scope 3 emissions	324 351 tCO_2e	18 525 205 tCO_2e	463 130 136 tCO_2e
Total Indirect Emissions		**324 351 tCO_2e**	**19 739 184 tCO_2e**	**493 479 589 tCO_2e**
Total Emissions		**325 881 tCO_2e**	**19 842 212 tCO_2e**	**496 055 311 tCO_2e**