Evaluating the quality of wetland impact assessment reports for coal mines in Mpumalanga

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Dissertation accepted in partial fulfilment of the requirements for the degree *Master of Environmental Management with Ecological Water Requirements* at the North-West University

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Graduation: July 2025

ACKNOWLEDGMENTS

The completion of this research was a journey enriched with support from invaluable individuals:

- Firstly, I thank God, for good health, sound mind, strength, and wisdom to complete this research.
- I sincerely appreciate the academic guidance, patience, and leadership of my supervisor, Dr. Jurie Moolman, for his continuous support throughout this research.
- I extend my gratitude to the staff within the faculty of Natural and Agricultural Sciences at the North-West University for their academic and administrative support.
- My heartfelt gratitude goes out to my dearest daughter (Ms. Mokgethwa Matlala) for her unwavering support and love through this journey.
- To my parents, (Mr and Mrs Matlala) and siblings, I am grateful for their continuous prayers and support.
- To my colleagues and fellow EAP's, I am grateful for the reports and knowledge shared.
- To Ms. Norma Boshoff, I am grateful for your assistance in language editing this dissertation.
- Lastly, to my employer, SRK Consulting (SA) (Pty) Ltd, for funding my studies.

"*This work is dedicated to those who strive to balance human progress,*

yet preserve our planet's natural heritage"

UNESCO World Heritage Centre

ABSTRACT

The wetlands are one of the most threatened ecosystems globally and locally, due to continuous anthropogenic activities such as mining, urbanisation, agriculture and industrial developments. With Mpumalanga having the majority of coal mining operations in South Africa, the wetlands in this area face a substantial risk of encroachments leading to loss of their ecological health, benefits, and integrity. The National Water Act (Act 36 of 1998) makes provision for competent authorities to authorise the use of water resources, requiring the need to undertake wetland impact assessments in support of water use license applications. The Wetland Impact Assessment (WIA) is considered a specialist study which allows for competent authorities to make informed decisions on the authorisation of water use, however, the quality of WIA reports has been questioned by scholars in recent times. The aim of this research was to evaluate the report quality of Wetland Impact Assessments undertaken for coal mines in Mpumalanga. The evaluation sample consisted of n=15 wetland assessment reports which were evaluated against a tailored review package.

The results showed excellent work done in certain review areas, but also inadequacies in other review areas. The foundational review areas performed very well, this included the introduction of project and purpose of the report, baseline description of the study area, and report referencing. Other areas showed satisfactory results where there was some omission of information yet not significant and this includes; the specialist expertise discussion, legislative framework and the adequacy of information review areas. Even though there are well performing areas, it was noted that other review areas were rated unsatisfactory, and these include; inclusion of a detailed impact assessment (mainly impacts associated with the preconstruction phase of a development), and the determination of wetland buffer zone. In addition, the methodology, discussion of results, conclusions, and recommendation review areas showed moderate quality scores.

To overcome the outlined inadequacies, it is recommended that a checklist outlining all the requirements of a wetland report be developed to support the existing legislative report requirements. The list will include legislative requirements of the report, detailed impact assessment with inclusion of significance of impact before and after mitigation, provision of buffer maps as per the guidelines, discussion of rehabilitation measures, offset strategy requirements where wetlands are likely to be destroyed and detailed monitoring plans. Through implementation of the outlined recommendations, it is believed competent authorities will be able to make informed decisions before the issuance of authorisations to water users and ensure the protection of wetland ecosystems.

Keywords: quality, wetlands, wetland impact assessment, coal mines, Mpumalanga, evaluation

ABBREVIATIONS AND ACRONYMS

CA	Competent Authority
CBA	Critical Biodiversity Area
DFFE	Department of Forestry, Fisheries and the Environment
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EA	Environmental Authorisation
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EAP	Environmental Assessment Practitioner
ELU	Existing Lawful Use
GA	General Authorisation
GIS	Geographic Information System
HGM	Hydro-geomorphic
NEMA	National Environmental Management Act (Act 107 of 1998)
NEMBA	National Environmental Management: Biodiversity Act (Act 10 of 2004)
NEPA	National Environmental Policy Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act (Act 36 of 1998)
NWAP	National Wetland Action Plan
PES	Present Ecological State
REC	Recommended Ecological Category
RSA	Republic of South Africa
SACNASP	South African Council for Natural Scientific Professions
SAHRIS	South African Heritage Resources Information System
SANBI	South African National Biodiversity Institute

SDGs	Sustainable Development Goals
SWSA	Strategic Water Source Area
WFD	Water Framework Directive
WIA	Wetland Impact Assessment
WRC	Water Research Commission
WUA	Water Use Authorisation
WUL	Water Use License
WULA	Water Use Licence Application

KEY DEFINITIONS

Development: Any activity which alters the existing land uses and changes the current environment, and may lead to significant impact on the receiving environment, is defined as development (Brundtland, 1985).

Ecological Importance and Sensitivity (EIS): is a term referring to the evaluation of the ecological significance and vulnerability of wetland ecosystems (Macfarlane *et al.,* 2020).

Environment: The physical, ecological, archaeological, aesthetic, cultural, economic, institutional, human health, biodiversity and social aspect of the surroundings of a person. It is made up of (i) earth's atmosphere, land and water, (ii) plants, animals and micro-organisms, further includes any interrelations between (i) and (ii) (National Environmental Management Act, Act 107 of 1998).

Environmental Impact Assessment: The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made (National Environmental Management Act, Act 107 of 1998).

Environmental Assessment Practitioner: A professional who is independent, registered and qualified to conduct environmental assessments, in addition, the practitioner manages, conducts, and reviews EIA's and related processes (National Environmental Management Act, Act 107 of 1998).

Overland sump: Refers to a type of water storage or collection system used in areas prone to surface runoff.

Present Ecological State (PES): is a term used to describe the current condition or health of a wetland ecosystem (Macfarlane *et al.,* 2020).

Watercourse: A river or spring, a natural channel that carries water regularly or intermittently, a wetland, lake, or dam that water flows into or out of, and any collection of water that the Minister declares to be a watercourse (National Water Act, Act 36 of 1998).

Water resource: A watercourse, surface water, estuary, or aquifer is considered a water resource (National Water Act, Act 36 of 1998).

Wet health: is a suite of tools developed to assess the present ecological state of wetland ecosystems (WRC, 2020).

Wetland: An intermediary zone between terrestrial and aquatic ecosystems, characterized by a water table that remains close to the surface or by periodic inundation with shallow water (National Water Act, Act 36 of 1998).

Wetland delineation: A process whereby wetland boundaries are mapped and defined using soil, vegetation, and hydrology (DWAF, 2005).

Wetland impact assessment: An evaluation process used to assess the potential impacts of proposed activities or developments on wetland ecosystems (Tekaligne, 2003).

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CHAPTER 1 INTRODUCTION

1.1 Background

Wetlands are important ecosystems that support a diverse and dynamic ecosystem of flora and fauna while providing essential ecological services such as carbon storage, water purification, flood regulation, and a host of biodiversity habitats (Balwan & Kour, 2021). Wetlands are a home to different environments such as marshes, and floodplains, which are differentiated by their unique hydrological characteristic features which occur either on a permanent, temporal, or seasonal cycle (Brinson, 1993). Having established the importance of wetlands, these systems are under continuous threat, not only from natural disasters such as floods, drought, fires, landslides, earthquakes, hurricanes, etc., but also anthropogenic activities such as agriculture, urbanization, extraction of mineral resources (mining related activities) and industrial processes (Ballut-Dajud *et al.,* 2022; Blann *et al.,* 2019; Kennish, 2002; Mengesha, 2017). All these listed anthropogenic activities cause harm to wetlands, and jeopardize the integrity and functionality of the systems, which may lead to habitat loss, degradation of water quality, and decline in biodiversity within the system (Kingsford *et al.,* 2016).

Globally, wetlands are acknowledged for their critical ecological importance and are safeguarded under international agreements such as the Ramsar Convention (1971), which emphasizes their preservation and sustainable use (Finlayson *et al.,* 2011). However, despite these protective measures, wetlands worldwide face a multitude of threats stemming from human activities (Xu *et al.,* 2019). Several case studies support this statement; firstly the Junk *et al.* (2005) paper on the Pantanal wetland in South America which highlights that the Pantanal wetland is one of the largest wetlands which sits at the centre of the continent of South America, and it is one of the wetlands within the continent which scores a high-level wetland-health status in terms of its ecological conditions. Even though it is considered to still be in good ecological condition, the wetland is threatened by increased human activities where large projects are undertaken within the catchment, the projects include a hydro-electric power generation reservoir and agro-industries. These developments have altered the Paraguay river tributaries by modifying the patterns of discharge and loads of sediments in the system, and with these modifications, the system is at risk of floods. The paper further details that the developments pose environmental risks such as loss of natural biodiversity (habitat), species diversity, and pollution. In addition, the paper concludes that the ecological conditions of the Pantanal wetlands are threatened due to increased developments within the catchment, which have economic benefit to the human population and further advise on sustainable development to ensure preservation of the wetland.

Secondly, Mengesha (2017) highlights the ecological importance and diversity of wetlands in Ethiopia by firstly: outlining the conditions of the wetland and also emphasizing the important roles played by wetlands, which include being a source of food, flood regulation and host to a variety of biodiversity resource such as coal. The paper further outlined the human induced threats to the Ethiopian wetlands, and this included: pollution through agricultural run-off, discharges from industrial activities and mining related pollution. Secondly: the destruction of the wetland habitat through urbanization, clearance of vegetation for agricultural activities and also infrastructure development. Thirdly: the overexploitation of the wetland resource through overgrazing, abstraction of water for irrigation and harvest of fuelwood. Fourthly: with disturbance of the resource, invasive species may host the area, and this leads to loss of biodiversity and functionality of the wetland. Lastly, climate change contributes to the vulnerability of wetlands in Ethiopia through altered rainfall patterns and increased temperatures. All the stated threats lead to the deterioration of wetland water quality, loss of biodiversity and alters the functionality of the wetlands.

Zorrilla-Miras *et al.* (2014) assessed contribution of land-use impacts on the decline of ecosystem services in the Doñana marshland and estuary located in Southwestern Spain (1918-2006). The researcher observed that intensive agriculture and illegal extraction of water have altered the natural and semi-natural wetland area by 70%, and the remaining 30% was protected for the provision of cultural services. With the alteration of the wetland area, the system has suffered habitat loss, loss of species diversity, and flood regulation. In addition, continuous loss of the wetland ecoservices may result in impacting the locals who use the system for cultural services.

In South Africa, wetlands are integral to the country's biodiversity and water resources (Rebelo *et al.,* 2019). They support unique flora and fauna and contribute significantly to water purification and regulation, flood control and groundwater recharge (Verhoeven *et al.,* 2006). However, South African wetlands are under considerable pressure due to agricultural expansion, urban development and industrial activities, including mining (Mangoro *et al.,* 2024). From data obtained by Adeeyo *et al.* (2022), 47,89% of wetlands are prone to threat because they have been reported to have low levels of protection and the South African Department of Forestry, fisheries and the Environment (DFFE), through the South African National Biodiversity Institute (SANBI) protects 28,17% of wetlands within the country. For the purpose of this research, the focus will be on wetlands which are impacted by coal mining and related activities in Mpumalanga. Mpumalanga is located in the eastern reaches of South Africa and it is renowned for its abundant natural resources, including substantial coal deposits and complex wetland ecosystems (Simpson *et al.,* 2019). Coal mining in Mpumalanga has experienced significant expansion over recent decades, driven by both domestic and international demand for energy resources (Nel *et al.,* 2023). This

association of rich biodiversity and intensive mining activities has sparked considerable debate and concern regarding the environmental sustainability of coal mining in the region, particularly its impact on the invaluable wetlands (Shongwe, 2018).

By definition, a wetland is considered to be a water resource (Fretwell *et al.,* 1996), and water resources are governed by policies and legislations globally (Rogers & Hall, 2003). These may include, but are not limited to, the African Convention on the Conservation of Nature and Natural Resources (1968), Ramsar Convention on Wetlands (1971), UNESCO World Heritage Convention (1972), Convention on Wetlands and Migratory Species (CMS) (1979), Convention on Biological Diversity (CBD) (1992), (which gave birth to legislation such as the National Environmental Management Act in South Africa), Water Framework Directive (WFD) of the European Union (2000) and the Sustainable Development Goals (SDGs) (Goal 6 – Clean Water and Sanitation and Goal 15 – Life on Land). South Africa is one of the most water stressed countries on the African Continent (Duse *et al*., 2003), and the National Water Act (Act 36 of 1998) (NWA), makes provision for the protection of water resources.

In an attempt to protect these water resources, such as wetlands, the NWA urges water users to apply for authorisation from the Department of Water and Sanitation (DWS) before they commence with activities which are likely to impact wetlands (Lemine, 2008). In terms of the NWA there are five permissible water use authorisations namely: Schedule 1, which authorises the use of water mainly for domestic purposes; General Authorisation (GA) which allows for the use of water without a license, under specified conditions and within defined limits outlined in the General Authorisation Gazette and must be registered with DWS before commencement of activities. Existing Lawful Use (ELU) apply to any authorisation of water given by law, 2 years prior to the commencement of the NWA. A license is not required to continue with ELU until a competent authority requires the user to apply for a license. However a registration of the ELU authorisation must be done with DWS; a Water Use License (WUL), which requires the water user to apply for authorisation for activities outlined in section 21 of NWA. Lastly, section 22 of the NWA, details the permissible water use without a license under certain conditions but ensures the use of water does not impact the water resource or other users negatively. The main purpose of section 22 is to ensure that there is a balance between individual water use needs and sustainable water management.

Different water use authorisations each has an application process to follow. For the purpose of this research we focus on the full water use license as per section 21 of the NWA. The WUL application process is undertaken in line with its own requirements and procedures as prescribed in the application and appeals regulations (DWS, 2017). These regulations require the applicant to submit specialist studies in support of the application and may include studies such as hydro-

pedological assessments, aquatic impact assessments, hydrology assessments, water balance determination study, floodline determinations, stormwater management and wetland impact assessments (WIA). Wetland Impact Assessments aim to ensure that the identification of impacts likely to affect the water resource are assessed, discussed and mitigation measures are provided, in order to assist decision makers on the approval or rejection of a licence.

1.2 Problem statement and rationale for the study

The global and local concerns about wetlands use are rooted in the fundamental understandings of the critical ecological services that wetlands provide (Xu, *et al*., 2019). Even though wetlands provide many benefits, they are amongst the most threatened ecosystems globally (Bassi, *et al*., 2014). The loss of wetlands functionality may be due to challenges such as waste pollution, urbanization, over-abstraction of groundwater, poor storm water management practices, lack of policy enforcement and mining related activities (Barbier, 2011). Mining, especially coal mining and its related activities, are associated with geological features that are naturally linked to the presence of wetlands (Hayes, 2016). This is also the case for most coal mines in South Africa. Mpumalanga hosts 81% of South Africa's coal mines, and as stated in the background section of this paper, coal mines are associated with wetlands, thus this makes Mpumalanga wetlands prone to higher risks of impact (Centre for Environmental Rights, 2017; Majavu, 2023).

The South African government has adopted and implemented numerous policy-based instruments to mitigate mining related impacts on wetlands. One such instrument is water use licence authorisations which are supported by wetland impact assessments (Camden & Colloty, 2022). During the application process, a wetland specialist must be appointed to determine the significant impacts of the proposed development on wetlands and suggest mitigation measures to reduce the significance of these impacts on the wetland. This specialist report forms the basis for the competent authority in deciding whether to authorise the water use or to reject the application (Alberts *et al*., 2020). This suggests that the quality and substance of these specialist assessment reports are crucial, as the decision-making relies extensively on the information provided to make an informed decision (Bond *et al*., 2016).

Over the recent past years, scholars have questioned the quality of specialist reports submitted for decision-making (Thiesing, 2001: Bond *et al*., 2016). However, literature also seems to suggest that only a few of these studies have been published specifically on the quality of wetland impact assessment reports which are submitted in support of policy-based implementation instruments such as environmental impact assessment and water use authorisations (Sandham *et al*., 2008). Therefore, this research aims to evaluate the quality of wetland impact assessment reports for coal mines in Mpumalanga.

1.3 Research aims and objectives

From the problem statement above, the aim of this research is:

- To evaluate the quality of wetland impact assessment reports for coal mines in Mpumalanga.

In setting out to achieve the aim of the research, the following three research objectives have been identified:

1. Objective 1: To develop a quality review package to assess the quality of wetland impact assessment reports for coal mines in Mpumalanga;
2. Objective 2: To analyse the quality of wetland impact assessment reports for coal mines in Mpumalanga using the developed quality review package; and
3. Objective 3: To make recommendations for improving the quality of wetland impact assessment reports.

1.4 Scope of the research

This research only included evaluating the quality of selected wetland impact assessment reports in support of water use licence applications. The review method implemented was a tailored review package adopted from the Lee and Colley review package (Lee & Colley, 1992; Lee *et al.,* 1999). The tailored review package was informed by relevant water use licence legislation, regulation and guideline documents. Insights from similar studies in related contexts also influenced the tailored review package, namely the research done by Sandham, *et al.* (2008), reviewing the quality of EIA reports for projects affecting wetlands; and research undertaken by Hallatt *et al*. (2015); Swanepoel *et al*. (2019); Wentzel *et al*. (2023), where the researchers were reviewing the quality of EIA reports in areas with rich biodiversity, and finally research done by Sandham *et al*. (2022), reviewing the quality of EIA reports in areas considered to be protected in Africa.

The research focussed mainly on the quality of wetland impact assessment reports undertaken for coal mines within Mpumalanga and did not consider any other types of reports for any other province within South Africa. A total of fifteen reports were included in the sample for evaluation. A description of the methodology associated with the development of the tailored review package and selection of the reports is included in Chapter 3 of this dissertation.

1.5 Assumptions and limitations

The following assumptions applied to this research:

- The availability of wetland impact assessment reports. It was assumed that there is a sufficient number of wetland impact assessment reports available about coal mines in Mpumalanga for analysis and evaluation. A sample of 15 reports was sourced using the website of the South African Heritage Resources Information System (SAHRIS) and reports provided by consultants, this ensured that a sufficient number of reports were evaluated.

- Accuracy of data. The assumption was made that the data contained within the wetland impact assessment reports is accurate and reflective of the actual conditions and potential impacts on wetlands resulting from coal mining activities.

The following limitations apply to this research:

- Single reviewer. The reports were reviewed by a researcher, who has 5 years' experience working as an EAP whereby exposure to wetland reports were extensive and has been exposed to field delineation of wetlands as an assistant. In addition, the researcher is a Registered EAP with EAPASA (Reg. No. 2020/1161) and also a Professional Natural Scientist with SACNASP (Reg. No. 121047).

- The researcher has no experience in using the Lee and Colley review package, but through peer review and validation from the assistance of the supervisor, we are confident that the results of the analysis are valid and a true reflection on the report quality.

- The researcher was unable to undertake any ground truthing in terms of the wetland delineation, yet the presence of delineation maps and the dates the specialist undertook the site visit, was used as an indication of ground truthing.

- The Wet health results/scores and ecosystem service determinations could not be recalculated to determine their accuracy, nevertheless the methodology to determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) was used and results obtained.

- The specialists' qualifications and expertise cannot be validated due to lack of public/free accessible databases, but the discussion of specialist details provided an indication of the specialists' expertise.

1.6 Structure and outline of the dissertation

The dissertation is structured around five chapters and includes:

Chapter 1: Introduction

This chapter focus on the introduction of the study, background, provision of the problem statement, the aim and objectives of the research, and the limitations and assumptions thereof.

Chapter 2: Literature review

This chapter provides an overview of literature related to the research topic. The literature review was done in sub-themes to ensure that all key concepts of the research's aim and objectives are addressed. The topics covered in this chapter include origin and purpose of wetland impact assessment (international and local instruments used), the relationship between coal mining and wetlands and an overview of wetland impact assessment (the process of undertaking a wetland impact assessment and gaps in knowledge in integration of WIA as a specialist report in South Africa).

Chapter 3: Methodology

This chapter provides a description of the research approach and the methodology implemented to gather data, analyse data, and how the results are presented.

Chapter 4: Results and discussion

The results obtained through the implementation of the said methodology are presented in this chapter and discussed in accordance with relevant literature.

Chapter 5: Conclusion and recommendations

This chapter draws conclusions based on the results obtained. It further provides recommendations to improve the quality of wetland impact assessment reports. The chapter also concludes with potential research topics which may be explored in the future.

CHAPTER 2 LITERATURE REVIEW

This chapter provides an overview of all key concepts and previous research related to the topic under investigation. Firstly, the relational use of the term “wetland impact assessment” and “wetland delineation” is discussed. Secondly, the origin and purpose of wetland impact assessment is explained. Thirdly, the relationship between coal mining and wetlands is explored. Lastly, the overview of wetland impact assessments and factors affecting the quality of these assessments, with inclusion of the discussion of previous research related to this research is considered.

2.1 Relational use of the terms “wetland impact assessment” and “wetland delineation”

Wetland impact assessment is defined as the process used to assess potential impacts a proposed development or any activities within a wetland boundary may have on the wetland biodiversity, health, water quality and ecosystem services (Tekaligne, 2003).

Wetland delineation is defined as a process whereby a wetland boundary is mapped out and defined using hydrology, soil, and vegetation indicators (DWAF, 2005).

These terms are widely used within the South African context. The NEMA EIA Regulations, 2014 (as amended) widely use the term “wetland impact assessment” whereas the WULA Regulations (GNR 267 of 2017) use the term “wetland delineation”. Even so one needs to delineate the boundary of a wetland unit before determining the extent of impact and determining buffer areas. Therefore, the term “wetland impact assessment” is used as an umbrella term which covers various aspects, such as identification of wetlands, delineating wetland boundaries, assessment of impacts, wetland functionality and integrity assessment and mitigation and management strategy implementation (Obele, 2010). In addition, the title of this research refers to the wetland impact assessment process, yet the review of reports was not only limited to the impact assessment reports, but also included the wetland delineation report requirements.

2.2 Origin and purpose of wetland impact assessment

The origin of wetland impact assessment is embedded in the broader development of environmental impact assessment (EIA), which emerged in the 1970s (Glasson & Therivel, 2013). Internationally, the EIA process was introduced in 1969 in the United States of America, through the adoption of the National Environmental Policy Act (NEPA) (Robinson, 1991). The EIA process was introduced with a purpose to systematically identify positive and negative impacts that a proposed development may have on the environment and include mitigation measures where

possible, and the process also explored alternatives (technological, site, off-sets, etc.) (Nita, *et al.,* 2022).

Local and international governments have adopted and implemented policies for managing impacts posed on wetlands by proposed developments. The following section focused on discussing both the global and local instruments which are adopted to manage impacts on wetlands caused by coal mining related activities.

2.2.1 International instruments for the management of wetlands

Coal mining is an internationally important industry that provides essential energy resources but often poses great environmental challenges, especially regarding wetland ecosystems (Garbellini, 2023). There are several international instruments which provide support to management of wetlands, including the Ramsar Convention (1971), which was signed in Ramsar, Iran and its main goal is the conservation and sustainability of wetlands, to ensure their future use through understanding their importance and the services they provide such as cultural, ecological, and economic significance (Bowman, 1995). Ramsar also has wetlands that are internationally recognised and are protected based on their unique ecosystem and biodiversity. The Verloren Vallei Nature Reserve is one of the areas listed as “protected areas” by Ramsar in Mpumalanga (Loock & Swanepoel, 2019). Secondly, the UNESCO World Heritage Convention is also one of the instruments which protects wetlands on the bases of their universal value (Meskell, 2013). Thirdly, the Convention on Biological Diversity (CBD), which was signed into legislation in South Africa in 1993 with the CBD’s core focus as conservation of biological diversity of wetlands (Secretariat of the Convention on Biological Diversity, 2001). Lastly, the Convention of International Trade in Endangered species (CITES), which focuses on the protection of endangered species from international trade, and this includes fauna likely hosted by wetlands (Ong, 1998).

There is integration of WIA’s into Water Use Authorisation applications for mining related projects from a global perspective. Wetland impact assessments are an integral component of water use authorisations, licences, permits, rights, consents etc, which are obtained for coal mining related projects internationally, aiming to assess and mitigate potential impacts on wetland ecosystems (Lemine, 2020). These assessments evaluate changes in hydrology, habitat loss, and water quality resulting from coal mining activities (Bedford & Preston, 1988). International studies emphasize the importance of integrating wetland considerations into coal mining licences, permits, rights etc, to ensure the sustainable management of natural resources and compliance with regulations (Garbellini, 2023; Webster, *et al.,* 2015). By incorporating WIA findings into

decision-making processes, regulatory authorities can balance economic development with wetland conservation objectives (Olorunfemi, 2017).

There are challenges and opportunities for integration of WIAs in some international projects requiring water use authorisations, licences, rights, permits, etc. These challenges include variations in regulatory frameworks, technical capacities and stakeholder engagement practices (Kabogo*, et al.,* 2017). International collaboration and knowledge exchange are crucial for addressing these challenges and promoting best practices in wetland impact assessment and management for coal mining (Darwall, *et al.,* 2018). By sharing experiences and lessons learned, countries can enhance their capacity to conduct WIAs effectively and achieve shared quality reports which are related to coal mining regions (Gardner & Finlayson, 2018).

In conclusion, WIAs play a vital role in supporting water use authorisation processes for coal mining projects worldwide. By integrating wetland considerations into decision-making frameworks, regulatory authorities can promote sustainable development practices that balance economic growth with wetland conservation. International integration and knowledge exchange are essential for overcoming challenges and advancing the science and practice of wetland impact assessment in coal mining areas.

2.2.2 South African instruments for the management of wetlands

South Africa boasts a rich diversity of wetlands, encompassing approximately 2.4% of its total land area (Mthiyane, 2020). These wetlands are classified into several types including estuarine, coastal, inland freshwater and mountain wetlands (Ollis *et al.,* 2012). Each type supports unique flora and fauna adapted to specific hydrological conditions and play a critical role in maintaining biodiversity, regulating water quality and quantity, mitigating floods and droughts, and for carbon storage (Hey *et al.,* 2012).

The management of wetlands in South Africa is primarily governed by, but not limited to, the following legislations and regulation: Environmental Impact Assessment Regulation of 2017, (as amended) as governed by the National Environmental Management Act (Act 107 of 1998), where the details and contents of specialist studies are outlined in Chapter 6 of the EIA regulations, where the National Environmental Management: Biodiversity Act (Act 10 of 2004) protects the biodiversity of a wetland ecosystem; and the National Water Act (Act 36 of 1998) which provides the requirements of authorisation for any development likely to impact a water resource. These Acts, regulations and policies provide the legal framework for the protection of wetland ecosystems and ensures that report quality meets an acceptable standard (Sinthumule, 2024).

The latest Environmental Impact Assessment Regulations (2014, as amended in 2017) do not provide a detailed guideline on delineating and assessing wetlands, however, it lists the content structure of Specialist Report. The contents are provided in Chapter 6 of the Regulations (Camden, & Colloty, 2022). The National Environmental Management: Biodiversity Act promotes the protection of wetland biodiversity (Lemine, 2021), and it requires environmental impact assessments (EIAs) for activities that may impact wetlands and promotes the establishment of protected areas and biodiversity stewardship initiatives (Lemine, 2018).

The National Water Act (Act of 1998), regulates water resources in South Africa, including those associated with wetlands (Mthiyane, 2020). It requires that water use licences are obtained for activities affecting wetlands and prescribes the contents of wetland delineation reports (Duse *et al*., 2003). The regulations regarding the procedural requirements for WULA and appeals (2017) gazetted by the Department of Water and Sanitation outline the contents of a wetland delineation report. This content includes: introduction of the project and purpose of the study, terms of reference of the study, the gaps in knowledge, discussion of study area (maps, coordinates, SG codes, etc.), specialist expertise, aims and objectives of the study, methodology of undertaking the delineation, results discussion of the delineation, impact assessment, conclusions and recommendations, and lastly the reference list of cited sources.

In support of the NWA, there are institutions in South Africa which promote the protection of wetlands through guidelines and methods. Firstly, the SANBI Wetland Classification System provides a mechanism of how different wetland ecosystems can be classified. This system classifies wetlands as: valley-bottoms (channelled and unchanneled), depression wetland (pan), seepage wetland, and floodplains. Secondly, the Department of Water Affairs (DWAF) (2005/2008) provides a wetland assessment criterion, for field assessment and identification; and provides a national wetland classification system. Lastly, the Water Research Commission (WRC) has developed a Version 2.0 WET-Health tool (2020), which is used to determine the present ecological state, ecological importance and sensitivity, and determine the wetland offset hectare equivalent value. With all these tools combined, a specialist produces a wetland report which will be used as a base for protection of a wetland environment from any encroachment or disturbance and if a disturbance cannot be avoided, mitigation measures are provided, which may also include an offset study (Macfarlane, *et al.,* 2014).

In addition to the outlined legislation and regulations for the management of wetlands, there are policies and guidelines which aim for the protection of wetlands, namely: the National Wetland Action Plan (NWAP) which was developed under the auspices of the Department of Forestry, Fisheries and the Environment (DFFE) and provides strategic guidance for wetland conservation and management. It aims to improve coordination amongst stakeholders and enhance knowledge

sharing on wetland issues (Malan & Day, 2005). Secondly, an analysis of the provincial policies in South Africa. Provinces have developed their own policies and guidelines tailored to local wetland contexts. For instance, the Western Cape Provincial Wetland Conservation Policy emphasizes the protection of unique wetland ecosystems in the region through targeted management and conservation efforts (Berliner & Desmet, 2007). Lastly, there are wetland management strategies which are implemented by local municipalities and conservation authorities. These strategies integrate local stakeholder participation, scientific research, and adaptive management practices to address local wetland issues effectively (Grygoruk & Rannow, 2017). Coal mines are associated mostly with wetlands (Newton *et al*., 2020); and the following section further discusses the interrelation between coal mining and wetlands.

2.3 Coal mining and wetlands

Wetlands are among the most productive ecosystems on earth, providing ecosystem services (Xu, *et al.,* 2020). These services include trapping of sediments, maintenance of biodiversity, controlling of erosion, carbon storage, removal of nitrate and phosphate, assimilation of toxins, floods control, cultural and spiritual attributes, education and research, food cultivation, tourism (aesthetics) regulation of channels and water supply (Kotze, *et al.,* 2022). However, with their great benefits, they are increasingly threatened by anthropogenic activities, including coal mining (Newton *et al.,* 2020). Coal seams are commonly found in areas that are wetlands or that the formation of coal seams is often linked to wetland environments (This refers to the geological process, where peat, which forms in wetland conditions (such as bogs or swamps), eventually transforms into coal over millions of years under specific pressure and temperature conditions). The association suggests that wetlands play a significant role in the creation of coal seams. With the knowledge of coal seams being linked to wetland rich environments, coal mining operations pose significant environmental challenges in wetland areas, including habitat destruction, water pollution, and disruption of hydrological processes (Takarz & Dulin, 1994). Figure 2-1 below shows how mining related water may come in contact with natural surface water and there is a clear indication that there will be loss of certain ecosystem services which were provided by the wetlands within this area before the commencement of mining activities. Understanding and addressing these challenges are essential for minimizing the negative impacts of coal mining on wetland ecosystems and promoting resource management practices which are discussed below.

Figure 2-1: (Top left): Main inflow channel from the conveyor system to the overland sump. (Top right): View of the inflow channel into the overland sump showing coal fines and sediment buildup. (Middle left): Close-up of sediment accumulation in the sump. (Middle right): Seepage visible below the wall of the overland sump. (Bottom left): White residue on the soil about 100 meters downslope from the overland sump. (Bottom Right) View of the Krapfontein clean water dam, located around 330 meters downslope from the overland sump. (Source: Wetland Consulting Services (Pty) Ltd., 2019)

- **Habitat destruction:** Coal mining activities often involve the clearing of vegetation and excavation of land, resulting in the destruction of wetland habitats (Scanes, 2018). This loss of habitat can have devastating consequences for the flora and fauna that depend on wetlands for survival, leading to declines in biodiversity and ecosystem function (Shongwe, 2018; Newton *et al.*, 2020). Implementing measures such as habitat restoration and conservation offsets can help mitigate the impacts of habitat destruction caused by coal mining operations (Kujala *et al.,* 2015).

- **Water pollution:** Coal mining can result in the release of various pollutants into wetland ecosystems, including heavy metals, sediment and toxic chemicals (Rai, 2008). These pollutants can contaminate surface water and groundwater, affecting water quality and posing risks to aquatic organisms and human health (Bi *et al.,* 2007; Sheoran & Sheoran, 2006). Implementing thorough water management practices, such as the installation of sedimentation ponds and the use of advanced treatment technologies, can help reduce the risk of water pollution from coal mining activities (Qu & Fan, 2010; Shi *et al.,* 2021; Younger & Wolkersdorfer, 2004).

- **Hydrological processes of wetlands:** Coal mining operations can disrupt the natural hydrological processes of wetland ecosystems, leading to changes in water flow patterns, groundwater recharge rates, and wetland hydroperiods (Jiang & Chui, 2022; Volik, *et al.,* 2020; Wescoat, 2017; Younger, 2004). These alterations can have far-reaching consequences for wetland vegetation, wildlife habitat and ecosystem stability. Implementing hydrological monitoring programs and employing sustainable land-use planning techniques can help minimize the disruption of hydrological processes caused by coal mining activities (Euliss, *et al.,* 2008; Volik, *et al.,* 2020; Yang, *et al.,* 2015).

- **Cumulative impacts on wetlands:** In addition to direct environmental impacts, coal mining activities can also contribute to cumulative impacts on wetland ecosystems when combined with other stressors such as urbanization, agriculture and climate change (Newton *et al*., 2020; Xiong *et al.,* 2023). Understanding the cumulative effects of multiple stressors is essential for developing effective management strategies that safeguard wetland health and resilience in the face of increasing anthropogenic pressures (Hemond & Benoit, 1988; Khelifa *et al.,* 2022; Ostrowski *et al*., 2021).

2.4 An overview of wetland impact assessments (WIA)

A WIA is considered to be a systematic assessment of impacts that a project or development may have on a wetland ecosystem (Acreman & Miller, 2007). In line with mining activities, the wetlands

are impacted through the alteration of the topography and development of new gradients in water quality and hydrology (Knutsen, 2014). Whether a development is taking place inside a wetland or in the catchment area surrounding one, it will influence the wetland according to its kind and scale, and each of the wetland services will be affected and may even disappear entirely (Kotze, *et al.,* 2020).

Wetland impact assessment has objectives that are followed to ensure a professionally written and investigated report. This includes, but is not limited to, the following (Phillips & Madlokazi, 2011):

- Identify and characterize the wetlands present within or near the project area.
- Evaluate the potential direct and indirect impacts of the proposed project on wetland resources.
- Assess the significance of these impacts on wetland functions and values.
- Propose measures to avoid, minimize or mitigate adverse impacts on wetlands.
- Ensure compliance with relevant environmental regulations and permit requirements.

The WIA usually involves first undertaking a desktop assessment of the study area, through the use of spatial databases (such as Google Earth, aerial photographs), National Freshwater Ecosystem Priority Areas (NFEPA databases – Figure 2-3), and existing literature. The desktop study is followed by a field survey to ground-truth the wetland boundaries, vegetation types, hydrological patterns and wildlife habitat (Rountree *et al*., 2007).

Based on the findings of the assessment, recommendations are made to minimize or mitigate adverse impacts on wetlands. This could involve adjusting project designs, implementing best management practices during construction, compensating for lost wetland functions through restoration or creation of new wetlands (wetland offset strategy), or obtaining permits and approvals from competent authorities (Rountree *et al*., 2007).

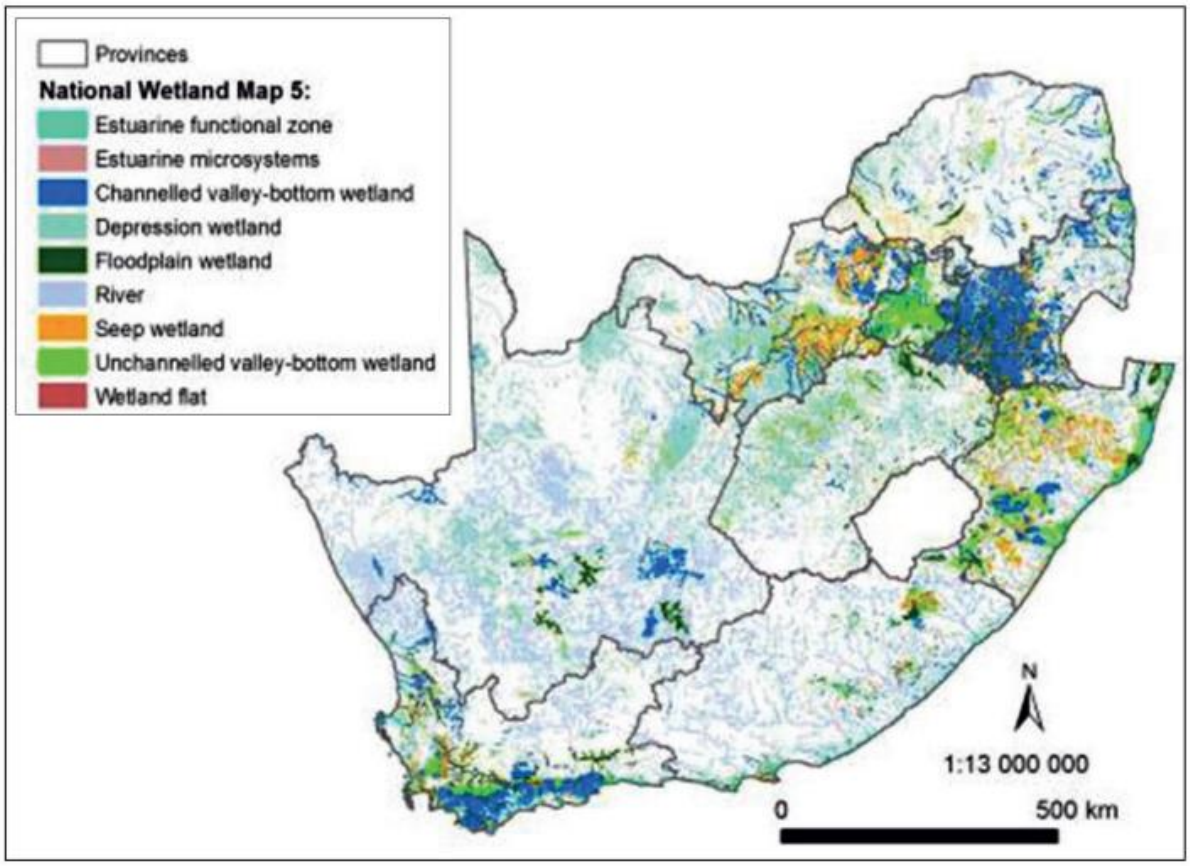

Figure 2-2: Inland wetland and estuarine ecosystems of South Africa (Source: Van Deventer *et al*., 2020)

2.4.1 Processes of undertaking a wetland impact assessment

Wetland impact assessments are often required as part of the environmental review process for diverse types of projects, including infrastructure development, land use planning, agriculture, and mining (Jones *et al.,* 2009). They are essential tools which aim to balance the needs of human activities with the preservation and protection of wetland ecosystems (Hák, *et al.,* 2016). Wetland impact assessment reports play a significant role in the water use application process, ensuring that proposed projects are evaluated comprehensively for their potential impacts on wetland ecosystems (Sandham *et al.,* 2008). During the WULA process, the incorporation of WIAs is to provide competent authorities with a detailed assessment of impacts associated with a proposed development, therefore, to ensure protection to wetland ecosystems there is a need to ensure these impact reports are of good quality, to avoid loss of ecosystem services (Alberts *et al*., 2020; Bond *et al.,* 2016; De Villiers, *et al.,* 2008).

Undertaking a wetland impact assessment involves a systematic evaluation of potential effects of proposed activities on wetland ecosystems (Preston & Bedford, 1988). The process begins with a baseline study, where a comprehensive baseline assessment of biophysical characteristics, ecological functions, and socio-economic values of the wetland are undertaken, utilizing spatial data such as the NFEPA (WRC, 2011/2021) (Van Staden, 2023). A site verification is undertaking where the existence of wetlands is confirmed and the wetland boundary is delineated using the practical field book by WRC/DWAF (2005). Following a site visit, a report is compiled which will detail an impact identification (which identifies direct and indirect impacts, considering cumulative effects), and a predictive modelling and risk assessment is undertaken (DFFE, 2020). Based on these findings, mitigation measures are proposed to avoid, minimize, or compensate for impacts, supported by monitoring and adaptive management plans. The assessment culminates in a detailed report that informs decision-makers and stakeholders, to recommend sustainable management practices that safeguard wetland biodiversity and ecosystem services (DFFE, 2020).

2.4.2 Knowledge gaps on the inclusion of wetland impact assessment

Within the South African context, there are numerous research studies which have assessed the quality of EIA reports associated with impacts on sensitive environments and receptors (i.e. biodiversity and wetlands) (Sandham *et al.,* 2018, Hallatt *et al*., 2015, and Swanepoel *et al*., 2019). At the time of writing, very little research was observed to have been done for analysing specialist studies (Wentzel *et al*., 2023), however evaluating wetland impact assessments research undertaken within the context of WULAs could not be found. Research studies undertaken by Hallatt *et al*. (2015); and Swanepoel *et al*. (2019) focused on quality of environmental impact assessment reports with input from biodiversity assessments, whereas Sandham *et al.* (2008) assessed the quality of environmental impact assessment where developments may have negative impacts on wetlands. All these examples adopted and implemented a tailored Lee and Colley review package of 1999, which was designed to achieve their objectives. The structure of the review package consists of four hierarchical levels namely, Level 4 (overall assessment), Level 3 (review areas), Level 2 (review categories), and Level 1 (sub-categories). Each level is evaluated with performance ratings ranging from "A" (very well done/satisfactory) to "F" (unsatisfactory). The evaluation uses symbols (A-F) to indicate performance, where A is well performed and there are no important tasks left incomplete, B is generally satisfactory and complete, with only minor omissions and inadequacies, C is considered to be just satisfactory despite omissions and/or inadequacies, D rating shows that parts are well attempted but considered unsatisfactory because of omissions or inadequacies, E is noted as Not satisfactory, due to significant omissions or inadequacies, F rating is noted as Not satisfactory, since important

task(s) are poorly done or not attempted. Lastly, is the rating Not Applicable (N/A) where the review topic is not applicable or is irrelevant in the context of the report. A more detailed discussion on the Lee and Colley Review package is provided in Chapter 3 section 3.4 below.

Through the use of the tailored Lee and Colley Review Package, Hallatt *et al.* (2015) it was discovered that the results showed differential performance where review areas including public engagement, monitoring plans, poor choice of season to gather data, and site alternative assessment performed unsatisfactory. Whereas areas such as baseline assessment (incorporating ecosystem process), and impact assessment showed satisfactory results and these results confirmed international trends. Swanepoel *et al*. (2019), observed that the review areas rated unsatisfactory included alternatives, public participation, impact assessment, monitoring plans, and impact management, and satisfactory rated areas include specialist expertise and collection of baseline data, Wentzel *et al.* (2023) noted that satisfactory rated review areas included site baseline description and clear biodiversity reference and unsatisfactory rated areas were poor public participation, lack of legal legislative framework, no site-specific monitoring plans and wrong choice of season for field data collection. Sandham *et al*. (2008) observed that review areas with satisfactory rating included specialist expertise, adequacy of information, impact assessment and baseline description, and the area which rated unsatisfactory was results discussion, and the study further recommended the use of a quality checklist to improve reports. This checklist could potentially be included in future legislation for standardized EIA assessments, particularly for wetlands.

Specialist studies are undertaken to support competent authorities in their decision making on licences, authorisations, permits, etc., and the quality of these reports were questioned (Bond *et al*., 2016; Thiesing, 2001). The specialist assessments often focus on the adequacy of field surveys, data collection methods, and impact prediction models. To support this statement, Rebelo *et al.,* (2009) highlight the importance of incorporating remote sensing techniques and Geographic Information Systems (GIS) to enhance the accuracy and efficiency of wetland mapping and delineation in WIA reports. Similarly, Garbellini (2023) and Brown *et al.* (2021) emphasize the need for standardized protocols and best practices in wetland assessment to ensure consistency and reliability across different mining projects.

The inclusion of WIA is important, particularly for projects that involve water extraction, diversion, or discharge activities (Calmeyer & Muruven, 2015). The Department of Water and Sanitation (DWS) requires applicants to assess the potential impacts of their water use activities on wetland ecosystems and demonstrate compliance with relevant water resource management principles and legislation (Malherbe, *et al.,* 2020). Wetland impact assessment reports provide valuable information to support WUL applications, facilitating the identification of appropriate water

allocation and usage practices that minimize adverse effects on wetlands and ensure long-term water security (Moolman, *et al*., 2022; Nkutha, 2022). The WUL process is followed if a development triggers a listed notice in terms of Section 21, water uses (NWA, 1998). In addition to the water uses applied for GNR 704, it is intended to safeguard water resources and make sure they are adhering to the regulations. To prevent pollution, the legislation lays out precise conditions that mining companies and related activities must comply with.

In addressing the regulatory compliance, one key aspect of reviewing WIA reports in the mining sector is evaluating their compliance with regulatory requirements and environmental standards. Several studies have investigated the extent to which WIA reports align with legislative frameworks and guidelines for wetland conservation and management. For instance, research by Houdet and Chikozho (2015) examines the degree of adherence to EIA regulations and mitigation measures in WIA reports for mining projects in a specific region. By identifying gaps and inconsistencies in regulatory compliance, these studies provide valuable insights for improving the effectiveness of WIA reports in ensuring legal compliance and environmental protection. In assessing the predictive accuracy and long-term monitoring, which is another critical aspect of evaluating WIA reports, anticipating wetland impacts and their effectiveness in long-term monitoring and adaptive management is of the essence. Few studies have examined the reliability of impact predictions made in WIA reports and the extent to which mitigation measures have been successful in minimizing adverse effects on wetlands over time. Research by Kgare (2022) evaluated case studies to assess the accuracy of impact predictions and the efficacy of mitigation strategies implemented in response to mining-related wetland impacts, looking at the Victor Khanye Local Municipality in the Mpumalanga Province. These studies underscore the importance of incorporating monitoring and adaptive management components into WIA reports to enhance their effectiveness in addressing long-term environmental impacts.

In every legislation or policy, there are challenges and opportunities. Despite the regulatory framework in place, challenges persist in the effective implementation of WIA reports in EIA and WUL processes in South Africa. These challenges include limited capacity for wetland assessment and monitoring, inadequate enforcement of environmental regulations and insufficient consideration of cumulative impacts on wetland ecosystems (Ma, *et al.,* 2015; Malekmohammadi, *et al*., 2014; Maltby, *et al.,* 2013). Addressing these challenges requires collaborative efforts among government agencies, industry stakeholders and civil society to strengthen institutional capacity, improve compliance with environmental laws and promote ecosystem-based approaches to water resource management (Roy, *et al.,* 2011; Wardrop, *et al.,* 2013).

2.5 Conclusion

In conclusion, the reviewed literature highlights the importance of strong methodological approaches, regulatory compliance, and long-term monitoring in evaluating WIA reports in the mining sector. By critically assessing the strengths and limitations of existing WIA practices, researchers and practitioners can identify opportunities for enhancing the effectiveness of wetland impact assessment and management in the context of mining activities. Continued research efforts and interdisciplinary collaborations are essential for developing evidence-based strategies to minimize the adverse impacts of mining on wetland ecosystems.

CHAPTER 3 METHODOLOGY

This chapter will provide an overview of the methodology employed to gather data regarding the quality of wetland impact assessment reports. The primary aim of the study is to assess the quality of wetland impact assessment reports in coal mines within Mpumalanga. The chapter provides the research approach, overview of the study area, selection of wetland impact assessment reports, overview of the tailored review package and development of the review package for assessing the wetland impact assessment reports.

3.1 Research approach

There are different approaches a researcher may adopt to achieve the aim of the research. Amongst others they are qualitative, quantitative and mixed method approaches (Creswell & Creswell, 2018). To achieve the set aim and objectives of the research a qualitative approach will be implemented, which entails the gathering, analysing, and understanding of data that cannot be easily converted into numerical values (Smith & Davies, 2010). The selected research approach will be supported by the evaluation of documented information by implementing a tailor-made review package based on the concept provided by Lee and Colley (1991).

It is now commonly acknowledged that when evaluating the quality of reports, the qualitative research approach is used (Mays & Pope, 2000). The primary difficulties with this strategy are twofold. First, choosing appropriate cases, and then, appropriately generalizing the findings. Conclusions drawn from a statistical survey approach should not be overly generalized in order to preserve external validity. Instead, the study adheres to a theory known as “replication logic” (Yin, 2003), which contends that findings should be expected to repeat in the context of South Africa under comparable circumstances.

Selecting the right research method is crucial for obtaining reliable results. For this research, the document analysis method has been proposed. Bowen (2009) states that document analysis provides a systematic approach to evaluate documents to derive meaning from them. This method is suitable for the study, as it involves a thorough examination and analysis of different wetland impact assessment reports.

3.2 Overview of the study area

The study was narrowed to focus on wetland impact assessment reports undertaken for coal mines within Mpumalanga. There are approximately 130 mines in Mpumalanga of which fifty are operational coal mines and collieries, making Mpumalanga the province with the highest number of active coal mines in South Africa (XMP Consulting, 2017) (Figure 3-1).

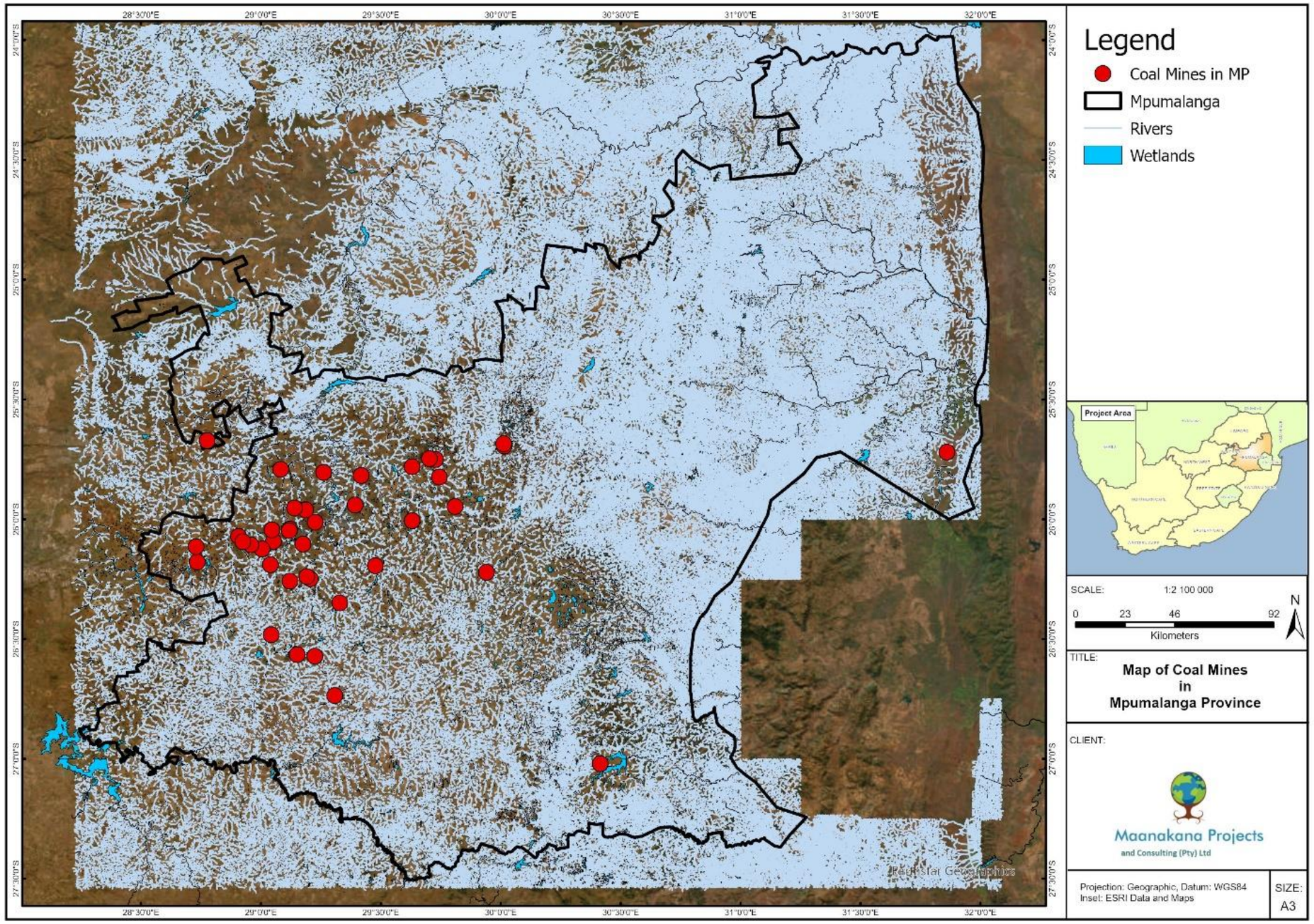

Figure 3-1: Distribution of coal mines (red dots) in relation to rivers and wetlands (blue pattens) in Mpumalanga

3.3 Selection criteria for wetland impact assessment reports

There is no centralized database containing a completed number of wetland impact assessments undertaken for coal mines in Mpumalanga, making it impossible to identify a representative sample. The method followed in selecting the wetland impact assessment reports used in the evaluation is explained below. The criteria applied in selecting the wetland impact assessment reports:

- Only reports for coal mining related development.
- Only wetland impact assessment reports for projects which were undertaken to support water use licence applications as per the NWA (1998).
- Wetland impact assessment reports associated with successfully completed WULA (issued WUL).
- Wetland assessment report for projects undertaken post 2017, following the promulgation of the WULA regulations (GNR. 267).

A total of fifteen reports were selected for evaluation which seems to be an appropriate number considering similar research, (Sandham *et al.,* 2008; Hallatt *et al.,* 2015; Swanepoel *et al*., 2019; Wentzel *et al.,* 2023). Lastly, these reports were sourced from online servers such as SAHRIS, mining companies and consulting companies. Table 3-1 below details the wetland impact assessment reports included in the sample.

Table 3-1: Summary of the sampled reports

ID	Project name	Company	Year commenced
A	Development of an Underground Coal Mine and Associated Infrastructure, near Hendrina, Mpumalanga Province: Wetland Assessment Report	Digby Wells and Associates (South Africa) (Pty) Ltd	2017
B	Wetland Specialist Report Isibonelo Colliery Wetland Baseline Assessment and Application of the GN509 Risk Assessment for Various Existing Activities	Wetland Consulting Services (Pty) Ltd	2019
C	Proposed Exxaro Leeuwpan Mine Expansion, Delmas, Putfontein AH, Mpumalanga Province.	Limosella Consulting (Pty) Ltd	2019
D	Dorstfontein West Coal Mine Expansion: wetland impact assessment	WaterMakers	2020

ID	Project name	Company	Year commenced
E	Proposed Mining Rights Application for Vogelfontein Colliery, Farm Vogelfontein 245 IS, Mpumalanga Province	Limosella Consulting (Pty) Ltd	2021
F	Wetland Impact Assessment for the Belfast Expansion Project – *Exxaro Coal Mpumalanga (Pty) Ltd*	Golder Associates Africa (Pty) Ltd	2021
G	Wetland Delineation and Water Use Risk Assessment for a Proposed Vent Shaft at Seriti New Denmark Colliery	WCS Scientific (Pty) Ltd	2019
H	N'komati Anthracite: Wetland Delineation & Impact Assessment	WCS Scientific (Pty) Ltd	2023
I	Bokgoni Colliery: Wetland Delineation and Water Use Risk Assessment Report for the proposed Dragline Walkway Crossing	Wetland Consulting Services (Pty) Ltd	2020
J	Dorstfontein West Coal Mine Expansion: Wetland Impact Assessment	WaterMakers	2019
K	Wetlands Impact Assessment for the Proposed Water Treatment Plant at the Klipspruit Colliery, Mpumalanga Province	Digby Wells Environmental	2018
L	Wetland Assessment Report for the Oifanslaagte extension project (North block), Mpumalanga Province	Sazi Environmental Consulting	2023
M	N'komati anthracite: wetland delineation & impact assessment	WCS Scientific (Pty) Ltd	2023
N	Wetland Assessment and Delineation report for the proposed mining areas within Wesselton II, in the Ermelo District, Mpumalanga Province	Sazi Environmental Consulting	2021
O	Wetland Specialist Report: Stuart South Colliery	Wetland Consulting Services (Pty) Ltd	2018

3.4 Overview of tailored quality review packages

Internationally, and even in South Africa, review packages are frequently used to analyse or assess the quality of environmental impact assessment reports to a certain criterion (Bond *et al*., 2016; Lee *et al*., 1999; Sandham *et al*., 2008; Sandham *et al.,* 2020).

Through a review of the literature, it is evident that several studies have been conducted on the evaluation of the quality of Biodiversity Impact Assessment Reports (BIAs), through the adoption of a tailored Lee and Colley Review Package (Hallatt *et al*., 2015; Swanepoel *et al*., 2019; Wentzel *et al*., 2023), which is widely used to evaluate the quality of Environmental Impact Assessment Reports. A general environmental impact assessment report quality review package has previously been created for South Africa, based on the Lee and Colley package (Sandham & Pretorius, 2008). However, it is acknowledged that this general package must be modified to examine the quality of environmental impact assessment reports in particular industries, in line with wetlands and water management. From literature review, in the context of South Africa, research was done which focused on the quality of EIA for projects which have a potential to impact wetlands and the research was undertaken by Sandham *et al.* (2008). The paper assessed four reports, the overall analyses of the reports showed both satisfactory and unsatisfactory results and further recommended that EIA practitioners and authorities should utilize a quality review checklist alongside existing guidelines to enhance project reports, particularly for those impacting wetlands. This approach can be promulgated into future legislation, to ensure a standardized assessment of wetlands EIA practice, enhancing report quality and addressing crucial aspects.

3.4.1 Overview of the review package structure

The general approach involved listing review areas, categories, and sub-categories sequentially. Performance scores were assigned to each level in an ascending order as outlined in Figure 3-2 below. From the hierarchy, level 4 details the overall assessment of the wetland Impact assessment report; level 3 details the assessment of review areas; level 2 details the assessment of review categories and level 1 is the assessment of review sub-categories (Lee *et al*., 1999). Evaluating the quality of various assessment tasks, (sub-categories, categories, and areas), is part of the quality review process starting with the lowest level of classifications (sub-categories). Then, using these assessments as a foundation, the reviewer gradually advances from one level to the next, applying increasingly sophisticated criteria to larger tasks and procedures in the process, completing the report's overall assessment. Using a standard criteria of assessment symbols (A- N/A), the reviewer records the evaluation from applying each criterion on a collation sheet (Table 3-2) (Sandham *et al*., 2008). To prevent reviewers from using rudimentary arithmetic aggregation to obtain assessments at the higher levels of the assessment hierarchy, alphabetic letters are used as symbols instead of numerals (Swanepoel *et al*., 2019). At each level in the review hierarchy, the symbols A through C symbolize generally satisfactory performance (A: very satisfactory, B: satisfactory, and C: just satisfactory), while the symbols D through F indicate

generally unsatisfactory performance (Sandham *et al*., 2008). Detailed key performance indicators were specified within each level and compiled for analysis.

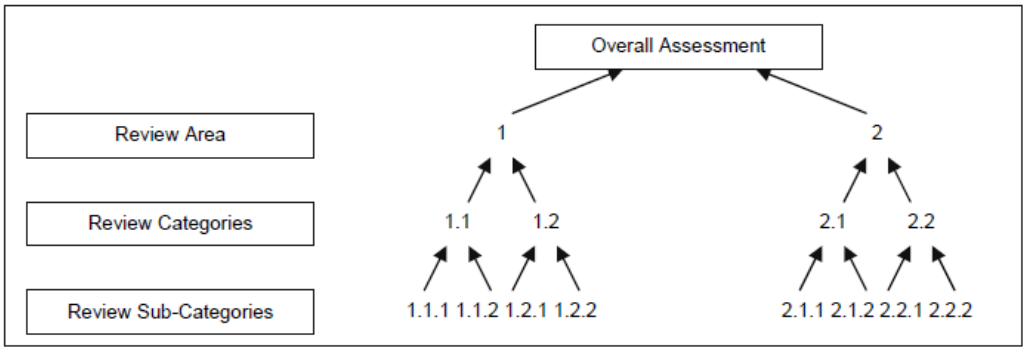

Figure 3-2: The Hierarchical structure of the Lee and Colley (1992) EIR review package

Table 3-2: List of assessment symbols (adapted from Lee et al., 1999)

Symbol	Explanation
A	Generally well performed, no important tasks left incomplete
B	Generally satisfactory and complete, only minor omissions and inadequacies
C	Can be considered just satisfactory despite omissions and/or inadequacies
D	Parts are well attempted but must, as a whole, be considered just unsatisfactory because of omissions or inadequacies
E	Not satisfactory, significant omissions or inadequacies
F	Not satisfactory, important task(s) poorly done or not attempted
N/A	Not applicable. The review topic is not applicable or irrelevant in the context of this report

3.5 Development of a tailored review package for the review of wetland impact assessment reports

The Lee Colley review package has been used with a primary focus on assessing the quality of environmental impact reports, particularly in the context of applications within the United Kingdom (Barker & Wood, 1999; Lee & Colley, 1991; Lee & Dancey, 1993), and it has been applied successfully in EIA review and Biodiversity input into EIA in South Africa (Hallatt *et al*., 2015; Swanepoel *et al*., 2019; Wentzel *et al*., 2023). Specialist studies are included in the WULA reports for decision-making, and these reports must adhere to specified legal requirements. Previous research has been done to evaluate the quality of EIA reports (Hallatt *et al*., 2015; Swanepoel *et*

al., 2019; Wentzel *et al*., 2023), and the Lee Colley review package method was adapted. For the purpose of this research, which aims to evaluate the quality of WIAs, changes were made to the generic Lee and Colley package at the review area and category level to incorporate wetland related content. This study made changes to the generic Lee and Colley review package in their research to tailor it specifically for evaluating Wetland Impact Assessments (WIAs). The original Lee and Colley package was designed for general Environmental Impact Assessments (EIAs) and needed modifications to better address wetland-related content and issues. These changes were applied at the review areas and category levels to ensure the evaluation process accounted for the unique aspects and legal requirements associated with wetland management. By adapting the package, the study could more effectively assess the quality of WIAs, ensuring that they met the specific needs and legal standards for wetland-related projects.

To determine the review areas and categories for this study's review package, the South African legislative guidelines in line with water use application mainly the National Water Act and its associated regulations was used. This includes; the regulations regarding the procedural requirements for water use licence applications and appeals (Department of Water and Sanitation, 2017), the practical field procedure for identification and delineation of wetlands riparian areas (DWAF, 2005), the SANBI wetland classification system series 22 (Ollis, *et al.,* 2013), Version 2.0 Wet-Health (Macfarlane, *et al.,* 2020), the wetland ecosystem services scoring document (Kotze, *et al.,* 2020), the Macfarlane, *et al.* (2014) preliminary guideline document on the determination of buffer zones for rivers, wetlands, and estuaries, and lastly, the south African best practice guideline for wetland offsets (Macfarlane, *et al.,* 2014). Based on these guidelines the new review areas and categories were developed (see Annexure A). The review package provides for three tiers from the overall assessment, which is the first being the review area, second review category and third the review subcategory, for the purpose of this research, only three tiers were used, which is the overview assessment, the review areas and review category levels, e.g. from the overall assessment of WIAs, there's Review area 2: Specialist expertise and the area categories were 2.1 Qualifications, expertise and experience, 2.2 Details of specialist, 2.3 Declaration of independence, and 2.4 Validity of information. Table 3-3 below shows an abbreviated comparativeness of the adapted review package alongside the original Lee and Colley review package.

Table 3-3: Comparativeness of the tailored review package with the original Lee and Colley review package.

Review Area	Lee and Colley Review Package	Adapted Review Package
Report introduction	√	√

Review Area	Lee and Colley Review Package	Adapted Review Package
Specialist expertise	√	√
Adequacy of report information	√	√
Baseline site description	√	√
Result discussion	√	√
Impact assessment discussions	√	√
Conclusions and recommendations	√	√

Included into the adapted Package

Review Area	Lee and Colley Review Package	Adapted Review Package	Comments
Legislative framework	**X**	√	It is assumed that the original Lee and Colley framework assumed that EIA processes were conducted within an existing legal and regulatory context, and there was no need to include a dedicated review area to assess whether the legislative framework was adequately addressed. For the tailored package, this area was included because, in South Africa, compliance with legal frameworks (e.g., NWA 1998, GN R267) is critical to the WUL application process, warranting a dedicated review area.
Methodology	**X**	√	Wetland assessments involve technical, scientific methods (e.g., WET-EcoServices, EcoStatus, WET-Health) that must be evaluated in detail. A separate methodology area ensured scientific credibility.
Study area buffer	**X**	√	In South Africa, buffer zone requirements are legislated and ecologically vital in wetland protection. Assessing this component is key to compliance and sustainability in WULs, justifying having this review area
References	**X**	√	Wetland reports act as scientific reports, and through referencing other documents, ensures clarity, credibility, and continuity of knowledge.

This Chapter addressed the development of a quality review package tailored to assess the quality of wetland impact assessment (WIA) reports for coal mines in Mpumalanga. In achieving **Objective 1**, the study successfully provided an overview of a structured review package by incorporating wetland-specific criteria into the existing Lee and Colley framework. The refined review package included review areas and categories relevant to wetlands, ensuring its applicability to assessing WIAs was further discussed in Section 3.4. Regarding **Objective 2**, the developed quality review package was applied to analyse existing literature. The two-tiered approach, comprising review areas and review categories, allowed for a comprehensive assessment of specialist expertise, report validity, and compliance with regulatory standards (DWAF, 2005; Ollis *et al*., 2013; Macfarlane *et al*., 2020). This ensured that the analysis provided a clear understanding of the strengths and weaknesses of the assessed reports.

CHAPTER 4 RESULTS AND DISCUSSION

4.1 Introduction

This chapter provides results of the quality review undertaken on the fifteen (n=15) wetland impact assessment reports compiled to support applications for water use licences in coal mining related projects in Mpumalanga. As outlined in this research, the results have been analysed to achieve the research set objectives, develop quality review packages to assess the quality of WIA reports, analyse the quality of WIA reports, and make recommendations for improving the quality of WIA reports. The methodology outlined in Chapter 3 was used to review the reports.

4.2 Results discussion for the overall wetland impact assessment reports

Firstly an analysis and discussion of the overall quality results for the sampled (n=15) wetland impact assessment reports using the results from the collation sheet (Annexure B). The majority (88%) of the reports have an overall rating of satisfactory (Rated A-C), whereas 12% depict a rating of not satisfactory (rating D-F) (Figure 4-1). Table 4-1 shows the summary percentage of the reports following the use of the tailor-made review package. Table 4-2 below classed the review areas into satisfactory (A-C%) versus unsatisfactory rating (D-F%).

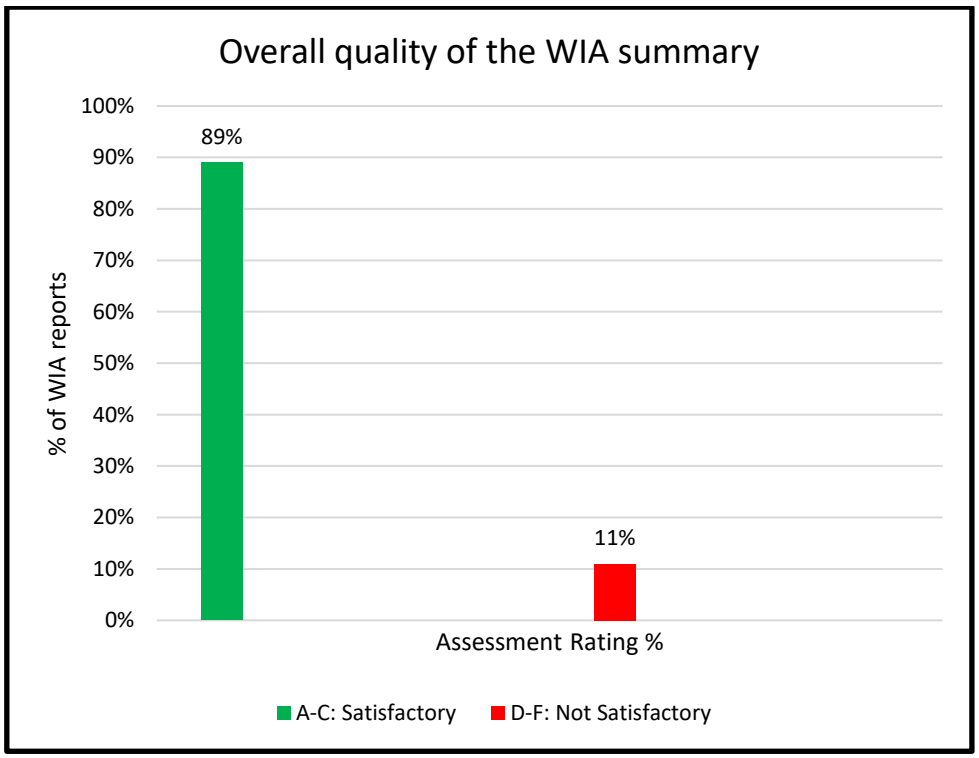

Figure 4-1: The overall wetland impact assessment report quality ratings

Table 4-1: The overall rating percentage of review areas for the WIA reports

No. Review Area	Review Area	Rating %						
		A	B	C	D	E	F	N/A
1	Report Introduction	100	0	0	0	0	0	0
2	Specialist Expertise	93	7	0	0	0	0	0
3	Adequacy of report information	75	4	0	0	0	3	18
4	Legislative Framework	64	18	2	10	3	3	0
5	Baseline site description	92	0	8	0	0	0	0
6	Methodology	91	7	0	0	0	0	2
7	Result Discussion	98	0	1	1	0	0	0
8	Impact assessment discussions	59	2	6	5	4	24	0
9	Study Area Buffer	60	10	3	4	0	23	0
10	Conclusions and recommendations	64	9	16	0	0	11	0
11	References	100	0	0	0	0	0	0

Table 4-2: Overview of the review area results shown in percentages, with overall satisfactory highlighted in green and unsatisfactory percentages highlighted in red

Review Area	Rating %							A-B%	B-C%	A-C% Satisfactory	C-D%	D-E%	E-F%	D-F% Unsatisfactory
	A	B	C	D	E	F	N/A							
1. Report Introduction	100	0	0	0	0	0	0	100	0	100	0	0	0	0
2. Specialist Expertise	93	7	0	0	0	0	0	100	7	100	0	0	0	0
3. Adequacy of report information	75	4	0	0	0	3	18	79	4	97	0	0	3	3
4. Legislative Framework	64	18	2	10	3	3	0	82	20	77	12	13	6	23
5. Baseline site description	92	0	8	0	0	0	0	92	8	93	8	0	0	7
6. Methodology	91	7	0	0	0	0	2	98	7	100	0	0	0	0
7. Result Discussion	98	0	1	1	0	0	0	98	1	97	2	1	0	3
8. Impact assessment discussions	59	2	6	5	4	24	0	61	8	59	11	9	28	41
9. Study Area Buffer	60	10	3	4	0	24	0	70	13	70	7	4	24	30

Review Area	Rating %							A-B%	B-C%	A-C% Satisfactory	C-D%	D-E%	E-F%	D-F% Unsatisfactory
	A	B	C	D	E	F	N/A							
10. Conclusions and recommendations	64	9	16	0	0	11	0	73	25	78	16	0	11	22
11. References	100	0	0	0	0	0	0	100	0	100	0	0	0	0

4.3 Results discussion of the 11 review areas

In this section the results and findings from analysing the 11 review areas with their review categories for the wetland impact assessment reports are presented (Figure 4-2). A more detailed discussion of the review areas is provided in the following sub-sections.

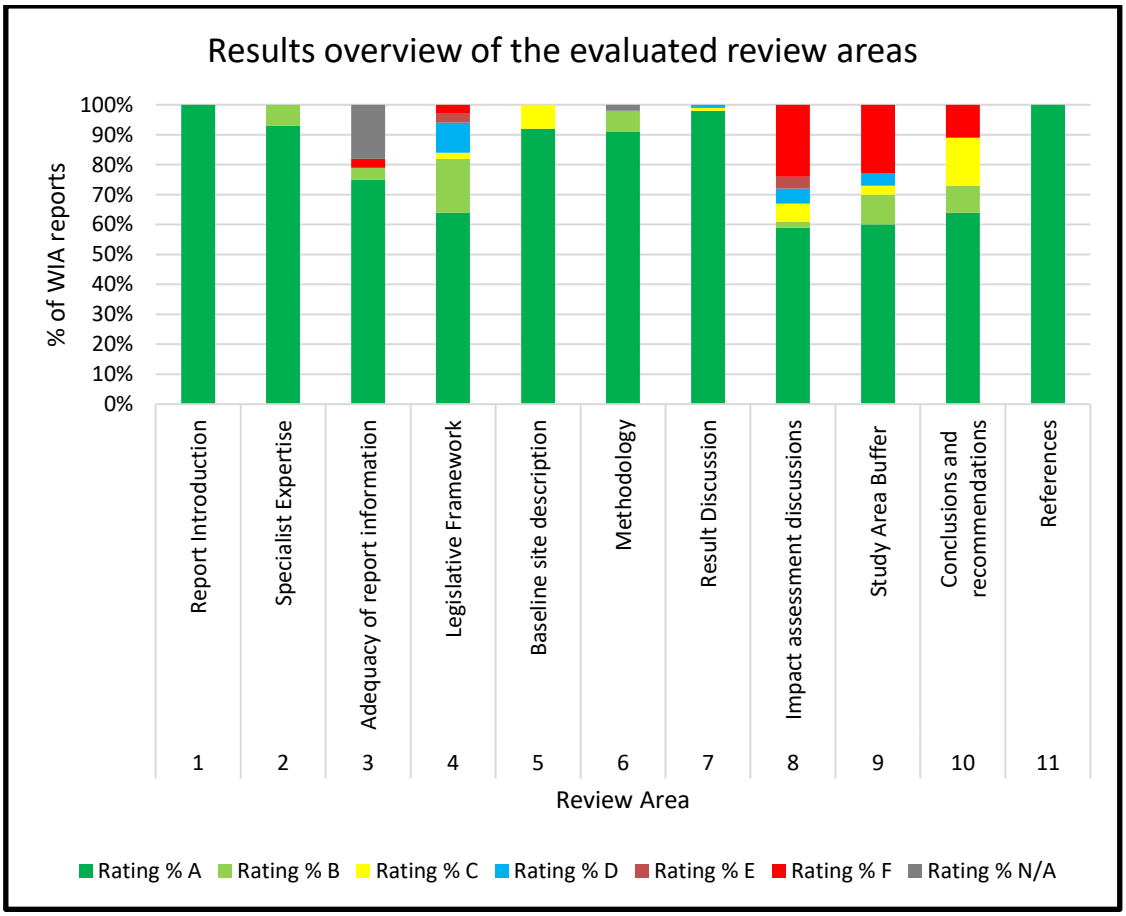

Figure 4-2: Results of the 11 review areas

4.3.1 Review area 1: Report introduction

This review area focuses on determining if the wetland assessment report contained a detailed introduction of the projects and also the purpose of conducting the study. The results shows that all the n=15 (100%) (Figure 4-3) reports did provide an introduction of the project and the purpose of undertaking that wetland assessment and Rating A (well done). These results are compared to the reports of Hallatt *et al*. (2015); Sandham *et al.* (2008); Swanepoel *et al*. (2019) and Wentzel *et al*. (2023). Of the reports, over 50% were rated satisfactory (A-C), except for the reports reviewed by Wentzel *et al*. (2023) which 63% of the reports were rated unsatisfactory (D-F) (Annexure C). It can be noted that this area was rated satisfactory because a report introduction section is a basic requirement in most reports, since it sets out the scope, purpose and basic information of the discussed topic.

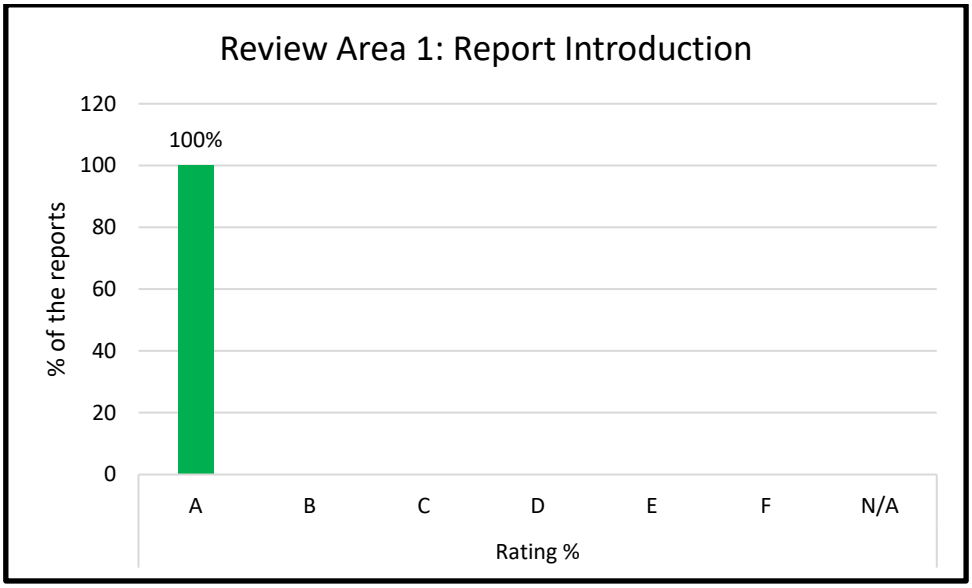

Figure 4-3: Results for Review area 1

4.3.2 Review area 2: Specialist expertise

Review area 2 focus on the expertise of the specialist who undertook the wetland assessment. The analysis assessed if the specialist has a relevant natural science qualification, is registered with the South African Council of Natural Scientific Professions (SACNASP) as a Professional Natural Scientist (Pr.Sci.Nat.), and the validity of their registration can be confirmed from the SACNASP website. In addition, the analysis looked at whether the report contained a signed declaration of independence by the specialist. The results from the analysis show that 93% of the reports are well performed (A rating) without any omission of important tasks, and 7% showed a satisfactory rating (B) (Figure 4-4). For this review area all the analysed reports by other scholars listed in Section 4.3.1, the report compiler's expertise a rating of satisfactory was received except

Wentzel *et al.* (2023) where 62% of the reports were rated unsatisfactory (D-F)(Annexture C). 100% of the analysed reports were rated satisfactory (A-C) in this review area, and this can be explained by the fact that all specialists in South Africa are required to register with the South African Council for Natural Scientific Professions (SACNASP). Through this registration process, individuals must meet specific academic and professional qualifications to be recognized as professional natural scientists. This ensures that wetland assessments are conducted by competent specialists with the necessary expertise in natural sciences, thereby maintaining the credibility and scientific rigor of environmental reports. In addition, the requirement for a signed declaration of independence further reinforces the objectivity and ethical responsibility of specialists in conducting assessments without bias or external influence.

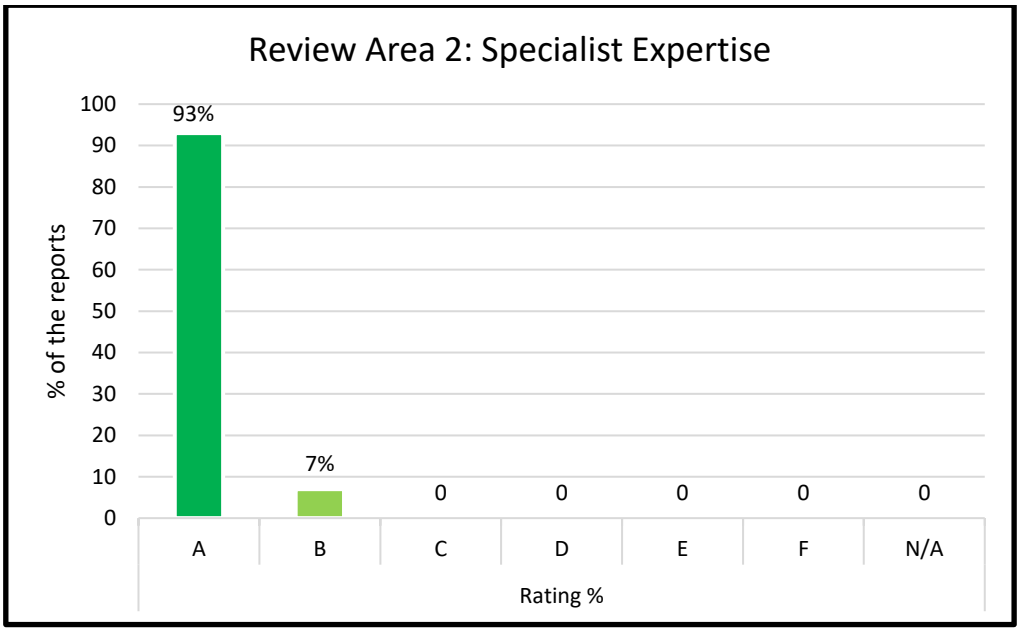

Figure 4-4: Results for Review area 2

4.3.3 Review area 3: Adequacy of report information

Review area 3 analysed whether the reports contained the terms of reference for the study, if aims and objectives of the study are outlined, any gaps in knowledge, level of confidence regarding the assessment, provision of limitations and assumptions, and lastly assessment of site alternatives. From the results, 75% of the reports were rated A (well done), and 4% shows satisfactory (B rating). In addition, 3% of the reports rated unsatisfactory (F), and there is a 18% rating of not applicable (Figure 4-5), this was from the “site alternative assessment”, since in most cases specialists are provided with a site alternative by either their client or proponent or the Environmental Assessment Practitioner (EAP). For this review area the reports showed a variety of ratings, with the current research scoring over 75% on satisfactory ratings, the Sandham *et al.* (2008) report showed 100% satisfactory rating (A-C); Hallatt *et al*. (2015) rated satisfactory (A-C)

that was 89% of the analysed reports and 11% unsatisfactory (D-F) for this review area. Swanepoel *et al.* (2019), of the reports, about 46% rated unsatisfactory (D-F) in this area and 54% of the reports were satisfactory, and Wentzel *et al.* (2023) had 56% rated satisfactory, and 44% rated unsatisfactory (D-F). Lastly Wentzel *et al.* (2023) had a moderate rating with 56% being rated satisfactory (A-C) and 44% being unsatisfactory (D-F) (Annexture C). The analysis results showed that over 75% of the reports rated satisfactory (A-C) this could have been due to that most specialist report writing requires that one outlines their reports objectives and gaps in knowledge which speaks to the report purpose and scope. In addition, it is noted that this review area was rated satisfactory because it is connected to the introduction review area, which typically includes key components such as the terms of reference, study aims, and objectives, making it a standard requirement in professional reporting.

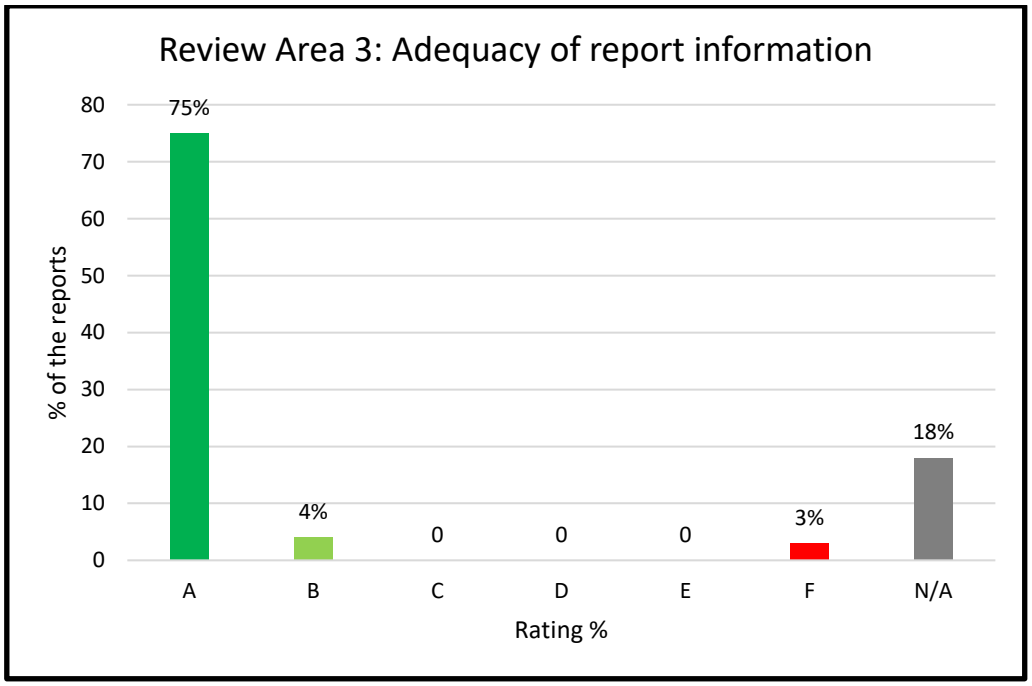

Figure 4-5: Results for Review area 3

4.3.4 Review area 4: Legislative framework

Review area 4 analysed the legislative requirements of a wetland assessment report. In the literature review and introduction section, it has been discussed that for the purpose of this study the NWA and its associated regulations are used as a baseline. In this review area, the description of legal framework (national, provincial, and local) within the reports, discussion of related policies and guidelines in relation to wetland assessments was analysed, and mainly the procedural requirements were included in the report. The results show that 64% of the reports were well done (A), 18% rated at B (satisfactory), 2% was satisfactory despite omissions (C), 10% of the reports rated D, where certain parts were attempted but there were more omissions making them

unsatisfactory, 6% of the reports were rated unsatisfactory (E-F) where there was no discussion of legal framework (Figure 4-6). Sandham *et al.* (2008) did not have this review area in their analysis, however Hallatt *et al*. (2015); Swanepoel *et al*. (2019) and Wentzel *et al*. (2023), did analyse this area and their analyses showed an unsatisfactory rating (D-F). The satisfactory performance of most reports in this review area indicates that a majority of specialists understand the importance of incorporating the legislative requirements for wetland assessments. However, the omission of key documents, such as the "Procedural Requirements for Water Use Licence Applications and Appeals Regulations (GNR.267) of 2017" by other specialists, points to a gap in awareness or application of current legal guidelines. This regulation is crucial as it outlines the necessary procedural steps and requirements for wetland delineation reports, particularly in the context of water use licensing. The omission of this document could be due to several factors, including the fact that it is primarily used by Environmental Assessment Practitioners (EAPs) when applying for water use permits or licenses as it outlines specialist studies "terms of reference". This lack familiarity with certain regulatory frameworks might result from the fact that many specialists do not regularly deal with water use permits or the associated procedural guidelines, especially if their work focuses primarily on ecological assessments rather than the regulatory compliance aspects of development projects. Additionally, although the document is publicly available, some specialists may not be actively engaged with the latest updates to regulations or may not recognize the full scope of documents that need to be referenced in the reports.

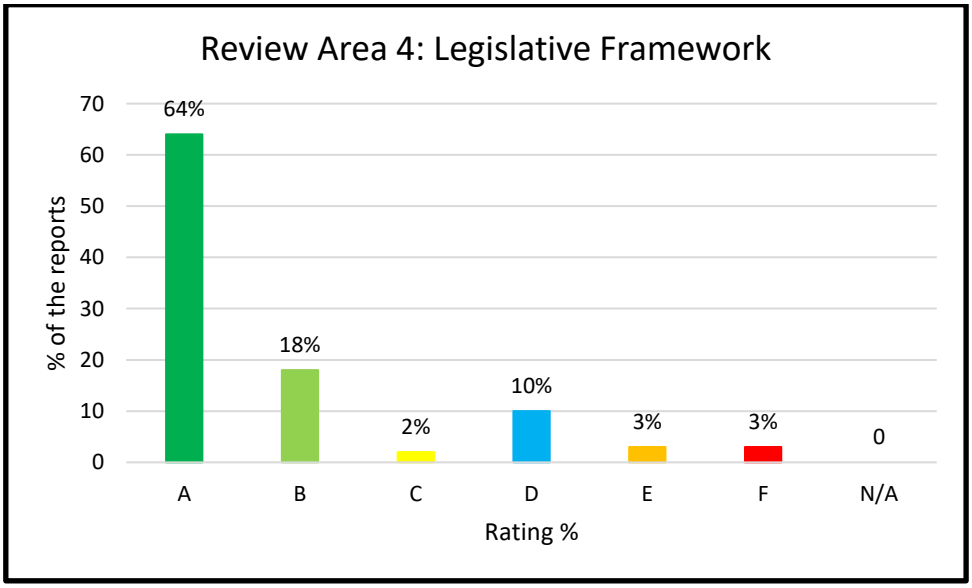

Figure 4-6: Results for Review area 4

4.3.5 Review area 5: Baseline site description

Review area 5, the baseline description of the study site was analysed, and the main component was to analyse whether the report made provision for the location of the study (this included

coordinates, nearest town, municipalities, SG codes – where possible, etc.), provision of maps, and photographs. The area further analysed the project description in relation to wetlands, and lastly it looked at characteristics of the affected environment (geology, climate, topography, soils, etc.). The results show that 92% of the reports performed well (A) showing that they did provide a baseline description of the site; 8% of the reports rated C which was satisfactory with some omissions which are within acceptable limit (Figure 4-7). Reports by Hallatt *et al*. (2015); Sandham *et al.* (2008); Swanepoel *et al.* (2019) and Wentzel *et al.* (2023) for the baseline site description rated as satisfactory (reports rating above 90%). It is noted that this review area rated satisfactory because most specialists understand the fundamental importance of including key baseline details such as the location of the study, coordinates, maps, photographs, and environmental characteristics like geology, climate, topography, and soils. These elements serve as the foundation for any environmental study, providing essential context for the reader. By clearly outlining where the study took place, including specific geographic references such as coordinates and proximity to nearby towns and municipalities, the report enables the reader to understand the spatial scope of the assessment. The inclusion of maps and photographs also aid in better comprehension and making the report more accessible and informative for readers who may not be familiar with the site, and this showed the understanding that specialists had of the study area. Moreover, this level of detail was essential for establishing a sound foundation for impact assessments.

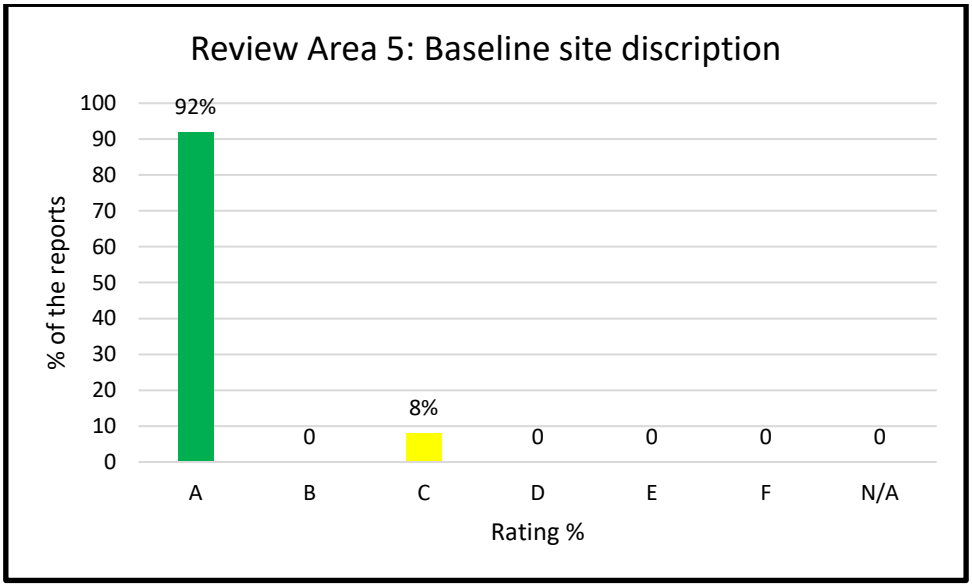

Figure 4-7: Results for Review area 5

4.3.6 Review area 6: Methodology

In review area 6, the main analysis was the methodology used in undertaking the study. In alignment with the National Water Act, the supporting documents outline what methodologies should be included in the reports, this included: desktop wetland identification, field wetland delineation using the DWAF (2005) field survey guidelines, determination of the wetland health services, integrity and WET-Health using the Kotze *et al.* (2020) document, determination of PES (Macfarlane *et al.,* 2020), and EIS (Kotze *et al.,* 2020), and provision of impact assessment methodology with criteria used to assess the impacts anticipated. The results show that 91% of the reports rated A (well done - satisfactory), 7% were rated satisfactory (B), and 2% were rated not applicable (N/A) since the determination of ecological classification and description was not part of the report's scope (Figure 4-8). All the discussed previous studies did not have this area in their review areas. Methodology of a study in a report is a fundamental part, therefore it is noted that this review area was rated satisfactory since the majority of the reports (91%) adhered to the prescribed methodologies outlined in the National Water Act and supporting documents. This indicates that researchers followed standardized procedures such as desktop wetland identification, field delineation, wetland health and integrity assessments, PES, and EIS determinations. The adherence to these established guidelines ensures consistency, scientific rigor, and credibility in these assessments.

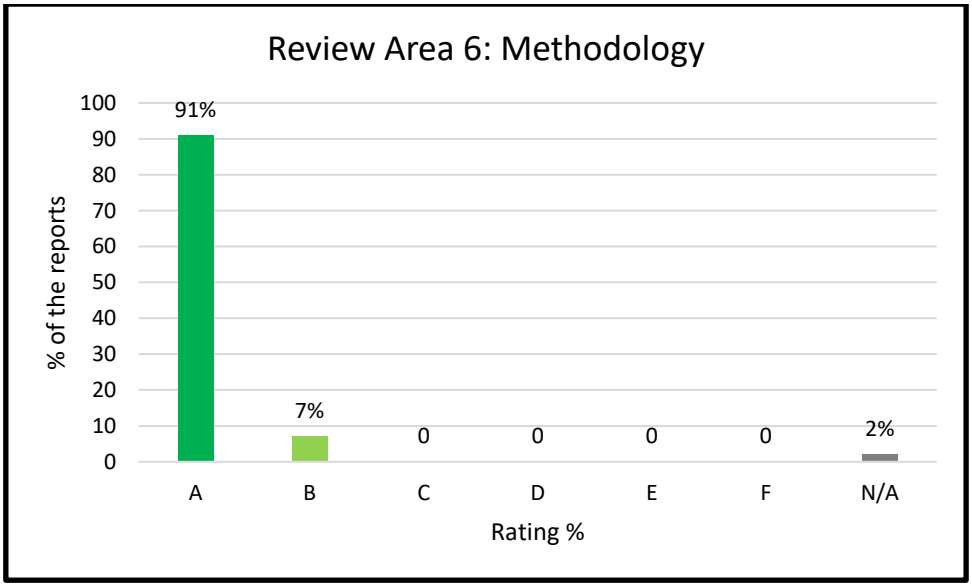

Figure 4-8: Results for Review area 6

4.3.7 Review area 7: Results discussion

Findings of the study are discussed in Review area 7. In this area, an analysis of whether the report had undertaken the site delineation (provision of a map), included the description of wetland

units and provided their setting, discussion of the wetland soils, discussion of the wetland functionality, provision of PES score and EIS assessment, and lastly a discussion of the site's water resources (these discuss rivers, NFEPA, catchments, etc.). The results show that 98% of the reports are well done (rating A), 1% rated satisfactory with slight omissions (C), and 1% rated as attempted but unsatisfactory (D) as some information was omitted and this included the discussion of wetland soils (Figure 4-9). Only Sandham *et al*., (2008) had this review area in their package, and the results are slightly different since this research scored 99% satisfactory rating (A-C) whereas their study sits at 75% satisfactory rating (A-C). The WIA is an investigative study, therefore results are to be provided within the report. Therefore, it is noted that this area performed satisfactorily since the majority of the reports (98%) comprehensively. This high rating suggests that report authors prioritized providing detailed and robust analyses in their reports, ensuring that the findings were well-documented and aligned with best practices in wetland assessments.

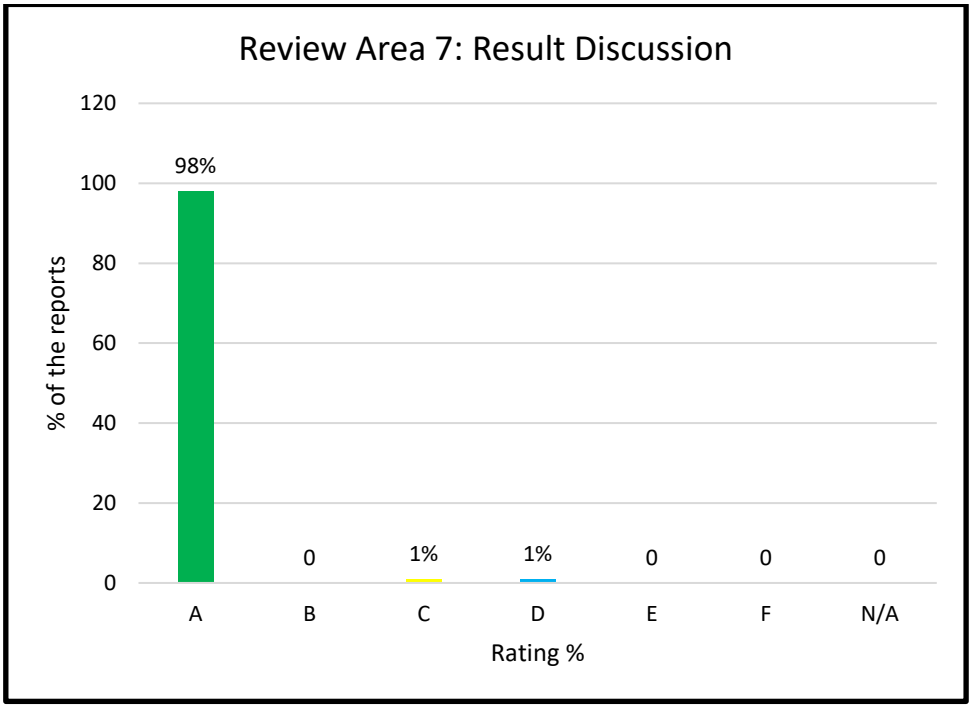

Figure 4-9: Results for Review area 7

4.3.8 Review area 8: Impact assessment discussion

Review area 8 provides a discussion of results of the impact assessment. In this section, the study's impact assessment discussion is analysed, and it included; impact discussion and significance rating for the pre-construction phase, construction phase, operational phase, closure phase, rehabilitation measures and monitoring plan. The results shows that 59% of the reports were rated A (well done), 2% rated satisfactory (B), 6% rated satisfactory with slight omission of information(C), 5% of the reports rated D (there was an attempt, but it is considered inadequate),

4% rated E (unsatisfactory), and 24% reports were rated F (unsatisfactory) (Figure 4-10). The unsatisfactory rating was mainly on reports not having assessed the pre-construction phase impacts, since only n=2 reports assessed those impacts. The not applicable rating was because of reports which were done for expansion of existing mining activities and there was no new supporting infrastructure to be constructed. In addition, the monitoring plans or programs in the reports were not detailed, only n=3 reports provided a detailed plan. In this review area the other scholars' showed a variety of analysis, the current study rated 67% (A-C) satisfactory and 31% unsatisfactory, Sandham *et al.,* (2008) rated this review area following the review of their 4 reports as Satisfactory (100% rating of A-C), Hallatt *et al*. (2015) rated this area as satisfactory because 84% were rated A-C and only 16% of the reports were unsatisfactory (D-F), Swanepoel *et al.,* (2019) rated this area as the most unsatisfactory since 69% rated D-F, and only 31% rated satisfactory (A-C) Lastly Wentzel *et al.,* (2023) rated this area to have 56% of reports as satisfactory (A-C) and 44% unsatisfactory (D-F). Based on the results, it is believed that specialists did not assess the pre-construction activities because this phase is often overlooked not only in specialist studies but also in environmental impact assessments, especially when projects involve the expansion of existing mining activities rather than new developments because main focus is on construction activities, even though lack of proper site demarcation and placement of signages to avoid sensitive areas may results in harm to sensitive environments. Many reports may have focused primarily on construction and operational phases, assuming that pre-construction impacts were minimal or already addressed in prior assessments. Additionally, there may be a lack of clear regulatory requirements or guidelines emphasizing the need to assess pre-construction impacts in detail. The results also showed that monitoring plans were generally not well-discussed, this could be due to resource constraints or a lack of emphasis on long-term environmental oversight in some reports. This aligns with findings from previous studies, where impact assessment quality varied significantly, highlighting the need for improved consistency in addressing all project phases comprehensively.

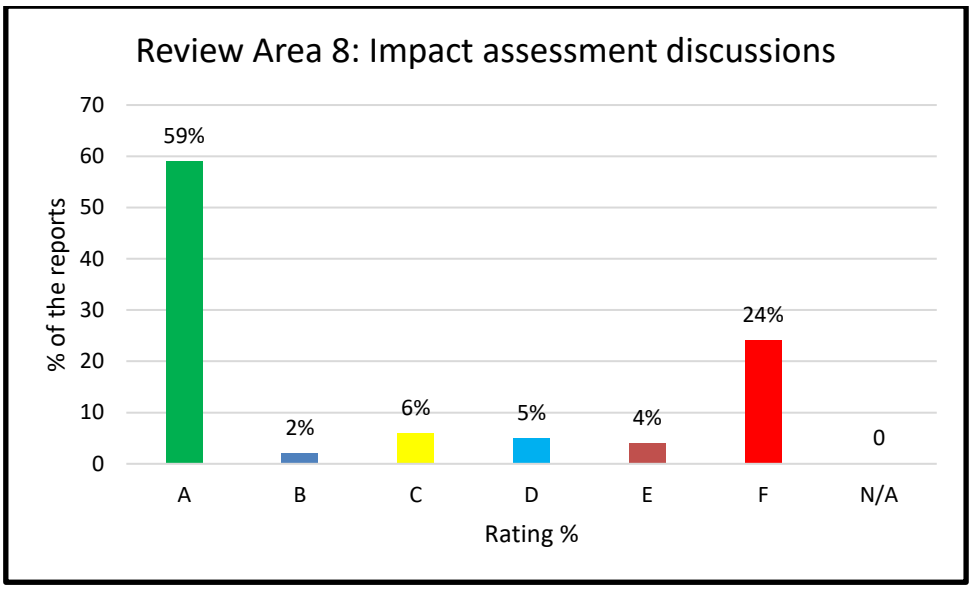

Figure 4-10: Results for Review area 8

4.3.9 Review area 9: Study area buffer

Review area 9 analysed the delineated or assessed study area buffers. The review was aimed at analysing if the reports contained an area or zone of safety in order to preserve the wetland integrity and avoid encroachment by development activities. The buffer zone differs per area and proposed activity undertaken, yet to achieve the objectives of this review area, there was a need to see the buffer map showing the zone from the outer edge of the delineated wetlands, and also look at whether the report has made use of the buffer zone determination document by Macfarlane *et.al.* (2017). The analysed results shows that 60% of the reports were rated A (well done), 10% were satisfactory (B), 3% rated C (satisfactory with minimal omissions), 4% of the reports rated D (a task was attempted but there is more omissions of required information), and 23% of the reports rated unsatisfactory (F) (Figure 4-11). The previously discussed studies did not have this review area in their package. Based on the results, it is believed that specialists did not provide a buffer area discussion because some specialists might have assumed that general environmental management measures would be sufficient to protect wetlands without explicitly delineating buffer zones. The variation in buffer zone requirements based on site conditions and project types may have also contributed to inconsistencies in reporting, with some specialists possibly omitting this aspect due to uncertainty in applying standardized buffer guidelines. Furthermore, the lower inclusion of buffer maps and references to the Macfarlane *et.al.* (2017) document suggests that either the methodology was not well integrated into practice, or there was a lack of access to updated guidelines during report preparation.

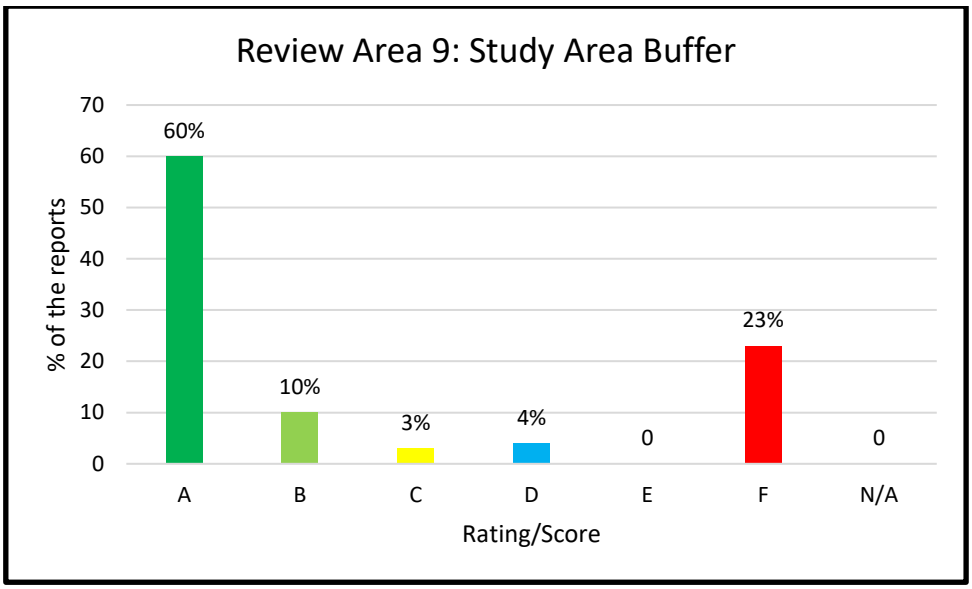

Figure 4-11: Results for Review area 9

4.3.10 Review area 10: Conclusions and recommendations

In Review area 10, the evaluation analysed whether the reports provided a conclusion statement and recommendations to the competent authorities or not. The section analysed whether the reports provided key management actions summary, the opinions of the specialist and finally, if the report made mention of off-set strategy requirements where wetlands are likely to be destructed. The results show that 64% of the reports are well done (A) in this section, 9% is satisfactory (B), 16% is satisfactory with minimal omissions of essential information (C), and 11% of the reports rated unsatisfactory (F) (Figure 4-12), where the specialist did not mention any requirements for an offset. As a highlight in this section all reports provided summaries of key management actions and also the specialist provided recommendations. The rating was low due to the lack of discussion on the off-set strategy requirements. Sandham *et al*., (2008) did not review this area, however the reports of Hallatt *et al*., (2015), Swanepoel *et al.,* (2019) and Wentzel *et al,* (2023) did and rated the reports as satisfactory (A-C). Some specialists did not include wetland offset strategies, this might have been because specialists deemed that the proposed development activities would not cause significant wetland destruction, and therefore, an offset strategy was deemed unnecessary. If the impact was perceived as manageable through mitigation measures, offset requirements may have been overlooked. In addition, specialists may not have consistently applied wetland offset strategies due to varying interpretations of offset guidelines or a lack of clear methodology for determining offsets as regulation enforcement is not in place.

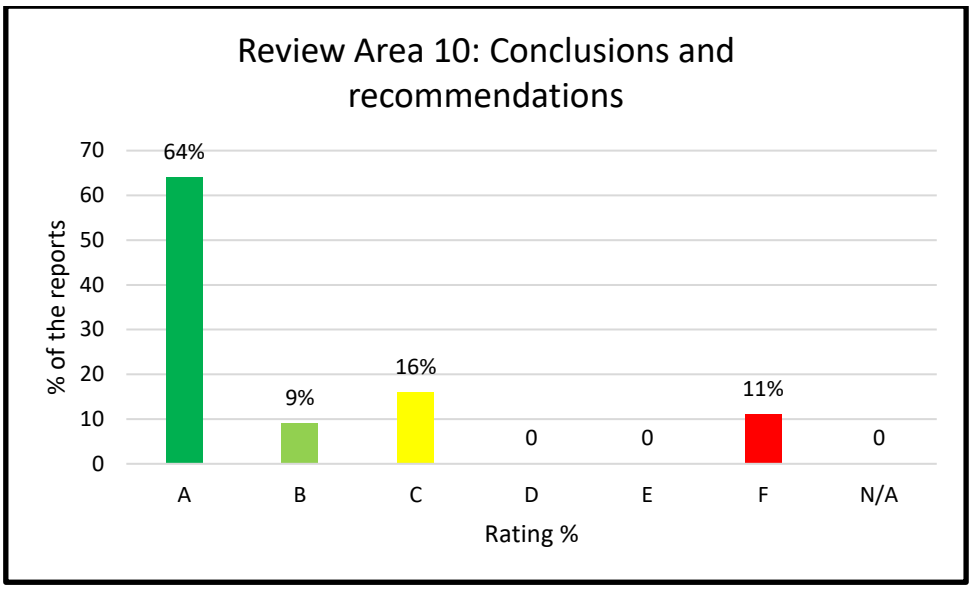

Figure 4-12: Results for Review area 10

4.3.11 Review area 11: References

Review area 11 was the last assessed area, and the analysis was to determine whether the reports contained a reference list of the cited documents. The results show that all the assessed reports (n=15) were rated 100% (A) (Figure 4-13), showing that they all contained a reference list. All the other previous studies did not have this review area in their package. It is believed that proper citation of sources is a fundamental requirement in scientific reporting. Adhering to citation standards ensures credibility, transparency, and traceability of the information used in the assessment. Given that these reports rely on established methodologies, legislative frameworks (such as the National Water Act), and previous studies, it is expected that authors would reference these sources to support their findings.

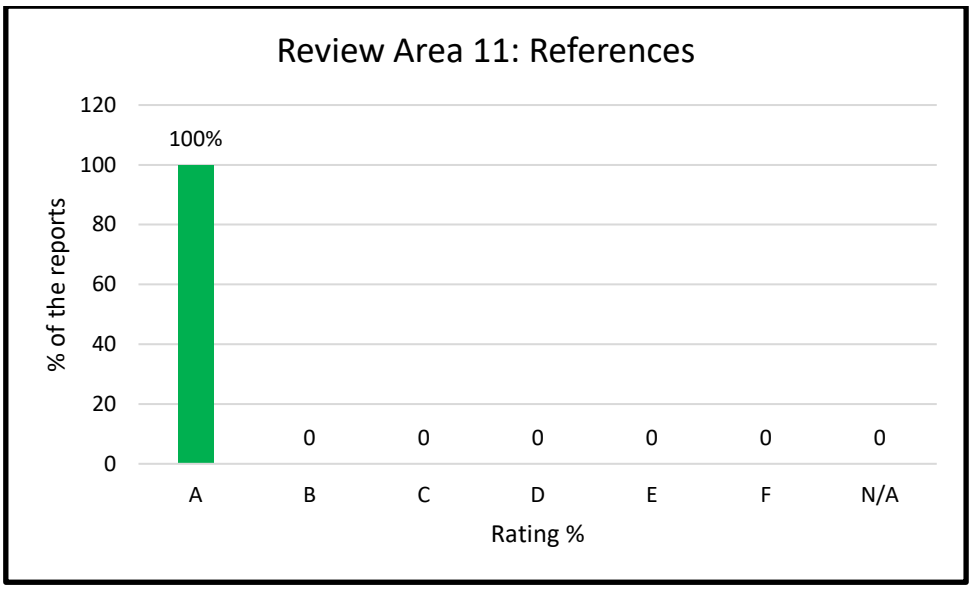

Figure 4-13: Results for Review area 11

4.4 Review area results summary

The quality review of the wetland impact assessment reports revealed varying levels of compliance across different review areas. Overall, the foundational components of the reports demonstrated strong adherence to reporting standards. Specifically, the report introduction (Review Area 1) and references (Review Area 11) received the highest ratings, indicating comprehensive background information and appropriate citation of sources. These findings suggest that most reports met basic reporting expectations by clearly outlining the scope of the study and referencing relevant literature and regulatory documents. Several review areas performed satisfactorily, demonstrating an acceptable level of quality. These included specialist expertise (Review Area 2), adequacy of report information (Review Area 3), methodology (Review Area 6), and results discussion (Review Area 7). The high ratings in these areas suggest that most reports were compiled by qualified specialists, provided essential project details, employed appropriate methodologies, and presented findings in a structured manner. The adherence to standardized methodologies, particularly those outlined in the National Water Act and supporting documentation, further reinforced the reliability of these assessments. However, notable unsatisfactory results were observed in key areas related to impact assessment and wetland buffer determination. The impact assessment discussion (Review Area 8) exhibited inconsistencies, particularly in the evaluation of pre-construction phase impacts and the adequacy of proposed rehabilitation measures. This omission suggests a gap in the comprehensive assessment of potential environmental impacts across all project phases. Similarly, the study area buffer (Review Area 9) was frequently underdeveloped, with many reports failing to provide a clear delineation of wetland buffer zones or reference established buffer determination

methodologies. These shortcomings highlight the need for enhanced guidance on assessing and mitigating potential environmental impacts, particularly in sensitive wetland ecosystems.

Moderate performance was noted in other key areas, including baseline site description (Review Area 5), legislative framework discussion (Review Area 4), conclusions and recommendations (Review Area 10). While these sections generally provided relevant information, inconsistencies were noted in the level of detail and comprehensiveness. For instance, some reports did not adequately discuss environmental characteristics relevant to the project site, while others omitted crucial regulatory references or failed to include offset strategies for wetland disturbances. These gaps indicate the need for greater standardization in the reporting of legislative and environmental baseline information.

4.5 Conclusion

In summary, while the reviewed wetland impact assessment reports demonstrated strong performance in foundational reporting areas, unsatisfactory ratings in impact assessment discussions and wetland buffer determinations remain areas of concern. Addressing these gaps through improved methodological guidance and regulatory enforcement could enhance the overall quality and reliability of wetland impact assessments in coal mining-related projects. Detailed recommendations are provided in Section 5.1.3.

Objective 3 was addressed by identifying gaps in WIA reports and proposing improvements to enhance their quality which are discussed in detail in Section 5.1.3. By aligning the review criteria with best practice guidelines and regulatory frameworks (Kotze *et al*., 2020; Macfarlane *et al*., 2014), the research provides actionable recommendations to improve the quality of WIA reports associated with WULs for coal mining projects.

CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The aim of this research was to evaluate the quality of wetland impact assessment reports for coal mines in Mpumalanga. A total of 15 reports were selected and evaluated using a tailored review package. This review package was informed by relevant South African legislation, guidelines and policies. The following section provides an overview of the three objectives of the research, a summary of key findings, conclusions of the completed evaluation and discussions of the results and concludes with recommendations on improving the quality of WIA reports.

5.1.1 Objective 1: Development of a quality review package to assess the quality of wetland impact assessment reports

A tailored review package was developed using Lee and Colley (1999) as a base structure. For the purpose of this research, the relevant WULA documents, legislation, policies and standards were relied on in order to develop a tailored quality review package. This review package was also informed by section 6 of the WULA Regulation (GNR 267) of 207 to ensure that all review areas are covered, and the evaluation can be undertaken on the selected reports. Key Review areas were designed using the South African regulations related to the water use licence application process namely, the Procedural Requirements for Water Use Licence Applications and Appeals Regulations (GNR.267) of 2017, the WET-Health, functionality, and Integrity assessments documents (Kotze *et al.,* 2020; Macfarlane *et al*., 2020, 2009, 2020), the Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands, and Estuaries document (Macfarlane *et.al.,* 2017), the Classification System for Wetlands cation System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis*, et al.,* 2013) and the practical field procedure for identification and delineation of wetlands riparian areas (DWAF, 2005).

The tailored review package consisted of a total of eleven (11) review areas, including the report introduction, specialist expertise, information adequacy, legislative framework, description of baseline data, report methodology, discussion of results, impact assessment, buffer determination, conclusion and recommendation and reference lists (see Annexure A). This tailored review package was used to evaluate the n=15 selected wetland impact assessment reports (see Objective 2).

5.1.2 Objective 2: Evaluation of wetland impact assessment reports using a tailored review package

The developed review package (see Objective 1) was used to evaluate the 15 selected wetland impact assessment reports with the aim to determine their quality. The evaluation results indicated variation in results, whereby some review areas have performed very well, others have performed poorly, and other areas of report have moderate results. Inadequacies of these reviewed reports were observed through this research, whereby some subcategories scored poorly in the reports and this includes the impact analysis of the pre-construction phase, rehabilitation measures, closure phase impact analysis, wetland offset strategy measures, monitoring plans and wetland buffer zone determination. The monitoring plans lacked detailed discussion where monitoring coordinates were not provided, responsible individuals and the frequency of monitoring were not provided. Highest scores from the evaluation were from the reference list review category, and other areas include discussion of the project introduction, purpose of the study, and specialist expertise (qualifications, experience, and details of specialist). Terms of reference of the study were well defined including gaps in knowledge, assumptions and limitations, description of the baseline environment (location, geology, soils, topography, water resource, etc.), the specialist declaration of independence and discussion of results. The moderately performing review category areas include: discussion of construction and operational phase impact analysis, aims and objectives of the study, conclusion and recommendations and legislative framework of the study. Lastly, the assessment of site alternatives was considered as not applicable for most reports since the specialists were not provided with other sites to assess, yet it was noted that the No-Go alternative (maintenance of status quo), was not discussed. In conclusion, although most review areas are within acceptable levels, it is clear that there is a need for improvement to ensure better quality reports are produced and competent authorities make well informed decisions on issuing licences, permits, or authorisations. Based on these evaluation results, recommendations have been made to improve the overall quality of wetland impact assessment reports (see Objective 3).

5.1.3 Objective 3: Recommendations to improve the quality of wetland impact assessment reports

Following the completion of the evaluation, the following recommendations are proposed:

- **Legislative framework:** There should be a detailed inclusion of legal frameworks for reports where national, provincial, and local acts, laws, policies, guidelines, etc are applicable. For reports undertaken post 2017, they will make provision for the GNR 267, Section 6 which outlines the requirements of a wetland report. In addition, development of a regulated

legislation checklist may assist report assessors to confirm compliance or inclusion of legislative requirements in the wetland assessment reports.

- **Impact analysis:** Impacts in the reports were analysed in detail for the construction and operational phase of the development, yet there was less discussion of impacts associated with the development for the pre-construction phase. It is recommended that impacts associated with the pre-construction phase of the development be assessed and significance ratings be provided with mitigation measures.

- **Rehabilitation measures:** It is recommended that the rehabilitation measures be provided in detail in the reports.

- **Offset strategy:** It is noted that wetland offset strategy requirements were not listed in detail in the wetland impact assessment, but it is recommended that where developments are likely to impact wetland, the recommendation of the offset strategy be discussed in the reports.

- **Buffer zone:** Wetland buffer zones are discussed in the reports but most of the reports lacked legislative discussion and buffer maps showing the sensitivity of the site and areas of avoidance, therefore it is recommended that detailed buffer maps and discussions be provided in the reports.

- **Monitoring plan:** There was a notable gap in the monitoring plans provided in the reports and it is recommended that detailed monitoring requirements be outlined. This includes monitoring location (coordinates), frequency of monitoring, seasons of monitoring, provision of monitoring targets and indicators, significance of ratings, responsible individual to monitor and the auditing reports requirements.

In summary, creation of a standardized checklist which ensures all areas of reports requirements are covered will assist assessors in ensuring they make informed decisions, which enhance/improve the protection of environments.

5.2 Areas of future research

During this dissertation, it was noted that there is a need for future research in this field, The research evaluated the overview reports, where only the requirements of report content were analysed. The research did not do any intrusive evaluation through ground-truthing the data, reviewing the results discussion accuracy, ensuring that the reference used in the text report is similar to the reference list, confirmation of the delineated wetlands (their presence on site), classification of wetland unit and their setting, WET-health (PES and EIS) determination accuracy,

and determination of relevant buffer zone parameters. In addition, only the SACNASP affiliation certifications were validated, but the specialist qualifications could not be validated since there is no public or free database where qualifications can be validated. The Managed Integrity Evaluation (MIE) qualification verification has a cost fee, and the POPI act applies. Based on the above mentioned there is an opportunity for further studies in this field.

5.3 Conclusion

The analysis has shown both unsatisfactory and well performing reports and further detailed recommendations to ensure better quality of reports in the future. The use of the tailored review package has allowed this study to evaluate the reports and provide results analysis with a rating from satisfactory (rating of A-C), and unsatisfactory (rating of D-F). The well performing review areas are the baseline discussion of the report which included the project introduction, reference lists, and specialist expertise, and the unsatisfactory performing review areas are the buffer determination, impact analysis, (preconstruction impact analysis, and monitoring plan requirements) and offset strategy discussions. In addition to the unsatisfactory and satisfactory rated areas, there were areas which rated moderately and this included the legislative framework, conclusions and recommendations. Based on these results there are detailed recommendations provided in section 5.1.3. In conclusion the three objectives outlined in the study were achieved.

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Annexure A: Review areas

Review topic		Rating	Reviewer's comment
Review area 1: Report introduction			
1.1	Was a detailed introduction of the project provided?		
1.2	Was the purpose of conducting the wetland study outlined?		
Review area 2: Specialist expertise			
2.1	Is there a clear indication of relevant qualifications (SACNASP registered, relevant natural science qualification), expertise, and experience of the specialist who conducted the study?		
2.2	Does the wetland impact report contain the details of the specialist who undertook the study?		
2.3	Was the declaration of independence provided by the specialist?		
2.4	Was the specialist's information validated (confirmation of SACNASP reference number)?		
Review area 3: Adequacy of report information			
3.1	Are the terms of reference outlined in the report and to what degree has the specialist fulfilled all the requirements outlined in the ToR for input into the report?		
3.2	Was the aims and objectives of the study been outlined in the report?		
3.3	Were any knowledge gaps, or low levels of confidence regarding the assessment outlined in the report?		
3.4	Were study assumptions and limitations outlined?		
3.5	Were any site alternatives assessed in the report?		
Review area 4: Legislative framework			
4.1	Was the legal context of the study in line with wetlands described in the study (in the South African context)?		

4.2	Were the Policy and planning context of project discussed (on national, provincial and local levels)?		
4.3	Were the standards and guidelines in relation to wetlands discussed (NWA, 1998; the Procedural Requirements for Water Use Licence Applications and Appeals, Regulations – GNR.267)?		
4.4	Were there indications that the study will support policy, plans and programmes?		
Review area 5: Baseline site description			
5.1	Has the description of the study area been provided (coordinates, nearest town, SG codes, municipalities, etc.)?		
5.2	Were the locality map, plans and photographs been provided?		
5.3	Has the project description been outlined, and has the relation to the wetlands on site been outlined?		
5.4	Were the characteristics of affected environment (geology, climate, topography, soils, etc.) been discussed?		
Review area 6: Methodology			
6.1	Was the wetland identification and mapping methodology outlined (desktop assessment, and presence of field photographs)?		
6.2	Was the wetland delineated using the wetland and riparian habitat delineation document (DWAF (2005))? (Field survey: determine outer edge using the 4 indicators (terrain, vegetation, soil wetness and redoximorphic features))		
6.3	Was the wetland functional assessment discussed as per the WET-EcoServices tool (Kotze *et al*., 2020)? – Were the ecosystem services (cultural benefits (cultural/heritage, education and research, recreation and tourism), provisioning benefits (provision of cultivated foods, harvestable resources, water for human use, and maintenance of biodiversity), regulating and support benefits (flood attenuation, regulation of streamflow, and storage of carbon), and water quality enhancement (sediment trapping, phosphate nitrate and toxicant assimilations, and erosion control) discussed?		

6.4	Was the ecological integrity of the wetlands determined using the Eco Classification and EcoStatus determination (Kleynhans, *et al*., 2008 or Kotze *et al*., 2020)?		
6.5	Was the present ecological state of wetlands determined using the WET-Health tool (Macfarlane *et al*., 2008, 2009, or 2020)?		
6.6	Were the ecological importance and sensitivity of wetlands determined using the WET-EcoServices, (Kotze *et al*, 2020)?		
6.7	Were the ecological classification and description outlined where the wetlands were classified according to HGM (hydrogeomorphic) type (level 4A classification level) using the National Wetland Classification System (SANBI document)?		
6.8	Was the impact assessment approach and methodology discussed?		
6.9	Were the criteria used to assess impacts discussed in detail in the report?		
Review area 7: Result discussion			
7.1	Was the wetland delineated (delineation map)?		
7.2	Was the wetland unit identified?		
7.3	Was the wetland unit setting discussed?		
7.4	Were the wetland soils discussed in the report?		
7.5	Was the description of wetland type (as outlined in the SANBI wetland classification report) provided?		
7.6	Was the general functional description of wetland types provided?		
7.7	Was the wetland ecological functional assessment determined?		
7.8	Was the ecological health assessment of the area provided?		
7.9	Was the PES assessment of the wetland areas provided?		
7.10	Was the EIS assessment of the wetland areas provided?		
7.11	Was the study area water resource (rivers, quaternary catchment, FEPA, etc.) description discussed?		

Review area 8: Impact assessment discussions			
8.1	Were impacts analysed for the preconstruction phase, and significance rating provided?		
8.2	Were the impacts analysed for the construction phase and significance rating provided?		
8.3	Were the impacts analysed for the operational phase and significance rating provided?		
8.4	Were impacts analysed for the closure phase and significance rating provided?		
8.5	Were rehabilitation measures provided?		
8.6	Was mitigation of positive and negative impacts provided, rating before and after mitigation?		
8.7	Was the monitoring programme provided and does it address the following: the exact questions to be asked, the frequency, and season of monitoring, responsible individuals to undertake monitoring, monitoring targets and indicators, significance ratings, and requirements for auditing and reporting?		
Review area 9: Study area buffer			
9.1	Was the buffer zone discussed using the preliminary guideline for the determination of buffer zones for rivers, wetlands, and estuaries document by Macfarlane et*.al.,* (2017)?		
9.2	Was a buffer map provided?		
Review area 10: Conclusions and recommendations			
10.1	Was the summary of key management actions outlined?		
10.2	Has the specialist opinion been provided?		
10.3	Were the wetland off-set requirements outlined?		
Review area 11: References			
11.10	Was the reference list provided?		

Annexure B: Collation Sheet

List of reports		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Year report was compiled		2017	2019	2019	2020	2021	2021	2019	2023	2020	2019	2018	2023	2023	2021	2018
Review area 1: Report Introduction																
1.1	Introduction to project	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
1.2	Purpose of the study	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Review area 2: Specialist expertise																
2.1	Qualifications, expertise and experience	A	A	A	B	A	A	A	A	A	A	A	A	A	A	A
2.2	Details of specialist	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
2.3	Declaration of independence	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
2.4	Validity of information	B	A	A	A	B	A	A	A	A	A	B	A	A	A	A
Review area 3: Adequacy of report information																
3.1	Terms of reference	A	A	A	A	A	F	A	A	A	A	A	A	A	A	A
3.2	Aims and objectives	A	A	C	C	C	F	A	A	A	C	B	A	A	B	A
3.3	Gaps in knowledge	A	A	B	A	A	F	A	A	A	A	A	A	A	A	A
3.4	Assumptions and limitations	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
3.5	Assessment of site alternatives	N/A	N/A	N/A	N/A	A	A	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	A
Review area 4: Legislative framework																
4.1	Description of legal framework	A	B	A	B	A	A	A	A	B	B	A	A	A	A	B
4.2	Policy and planning context of project	A	B	A	B	A	A	A	A	B	B	A	A	A	A	B
4.3	Inclusion of standards and guidelines	F	A	A	D	A	F	A	A	A	D	D	D	A	D	D
4.4	Support of policy, plans and programmes	A	A	A	E	A	A	A	A	C	E	A	A	A	A	B

Review area 5: Baseline site description																
5.1	Description of the study area	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
5.2	Locality map, plans and photographs	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
5.3	Project description	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
5.4	Characteristics of affected environment (geology, climate, topography, soils, etc.)	A	C	A	A	A	A	A	A	C	A	C	A	C	A	C
Review area 6: Methodology																
6.1	Wetland identification and mapping	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6.2	Wetland delineation methodology	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6.3	Wetland functional assessment	A	A	A	A	B	A	A	A	B	A	A	A	A	A	B
6.4	Determining the ecological integrity of the wetlands	A	N/A	A	A	B	A	A	A	B	A	A	A	A	A	B
6.5	Determining the present ecological state of wetlands	A	A	A	A	B	A	A	A	A	A	A	A	A	A	B
6.6	Determining the ecological importance and sensitivity of wetlands	A	A	A	A	B	A	A	A	A	A	A	A	A	A	B
6.7	Ecological classification and description	A	N/A	A	A	A	A	A	A	A	A	A	A	A	A	A
6.8	Impact assessment approach and methodology	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6.9	Criteria used to assess impacts	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Review area 7: Result discussion																
7.1	Wetland delineation results discussion	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.2	Wetland unit identification	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.3	Wetland unit setting	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.4	Wetland soils	A	D	A	A	A	A	A	A	C	A	B	A	A	A	A

7.5	Description of wetland type	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.6	General functional description of wetland types	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.7	Wetland ecological functional assessment	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.8	The ecological health assessment of the area	A	N/A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.9	The PES assessment of the wetland areas	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.10	The EIS assessment of the wetland areas	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
7.11	Study area water resource (rivers, quaternary catchment, FEPA, etc.)	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Review area 8: Impact assessment discussions																
8.1	Impact analysis – preconstruction phase	F	A	F	F	F	F	F	F	F	F	F	F	F	A	F
8.2	Impact analysis – construction phase	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
8.3	Impact analysis – operational phase	A	A	A	A	A	A	A	A	A	A	A	A	A	F	A
8.4	Impact analysis – closure phase	A	A	F	A	F	C	A	A	A	A	A	F	A	F	A
8.5	Rehabilitation plan	A	E	F	D	F	A	A	A	A	D	A	F	A	F	A
8.6	Mitigation of positive and negative impacts	A	E	A	A	A	A	F	A	A	A	A	C	A	C	A
8.7	Monitoring programme	A	C	E	D	E	B	C	B	D	D	C	F	A	F	A
Review area 9: Study area buffer																
9.1	Description of buffer zone	A	B	A	B	A	A	A	A	D	B	A	A	A	A	A
9.2	Buffer map	F	C	A	F	A	F	F	A	F	F	A	A	A	A	F
Review area 10: Conclusions and recommendations																

10.1	Summary of key management actions	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
10.2	Specialist opinion	A	A	B	A	A	A	A	A	B	A	A	A	A	A	A
10.3	Wetland off-set requirements	C	B	C	C	C	A	F	F	F	C	B	C	F	C	F
Review area 11: References																
11.1	Reference list	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A

Annexure C: COMPARISON OF RATING BETWEEN THE CURRENT RESEARCH AND PREVIOUS STUDIES

Review area		Current study	Previously done reports			
			Sandham *et al*. (2008)	**Hallatt *et al*. (2015)**	**Swanepoel *et al*. (2019)**	**Wentzel *et al*. (2023)**
1.	Report introduction	A=100%	A=75%, B=25%	A=4%, B=27%, C=27%, D=38%, E=4%	B=31%, C=46%, D=8%, E=15%	A-C=37%, D-F=63%
2.	Specialist expertise	A=93%, B=7%	A=50%, B=50%	A=46%, B=34%, C=12%, D=8%	A=8%, B=69%, C=23%	A-C=38%, D-F=62%
3.	Adequacy of report information	A=75%, B=4%, F=3%, N/A=18%	A=50%, B=50%	A=4%, B=35%, C=50%, D=11%	A=8%, B=19%, C=27%, D=38%, E=8%	A-C=56%, D-F=44%
4.	Legislative framework	A=64%, B=18%, C=2%, D=10%, E=3%, F=3%	N/A	B=4%, C=31%, D=27%, E=23% F=15%	A=8%, B=23%, C=46%, D=19%, F=4%	A-C=0%, D-F=100%
5.	Baseline site description	A=92%, C=8%, D=2%	B=100%	A=46%, B=42%, C=12%	A=62%, B=23%, C=15%	A-C=94%, D-F=6%
6.	Methodology	A=91%, B=7%, N/A=2%	N/A	N/A	N/A	N/A
7.	Result discussion	A=98%, C=1%, D=1%	A=25%, B=50%, D=25%	N/A	N/A	N/A

Review area		Current study	Previously done reports			
			Sandham *et al*. (2008)	**Hallatt *et al*. (2015)**	**Swanepoel *et al*. (2019)**	**Wentzel *et al*. (2023)**
8.	Impact assessment discussions	A=59%, B=2%, C=6%, D=5%, E=4%, F=24%	B=50% C=50%	B=19%, C=65%, D=12%, E=4%	B=4%, C=27%, D=46%, E=19% F=4%	A-C=56%, D-F=44%
9.	Study area buffer	A=60%, B=10%, C=3%, D=4%, F=23%	N/A	N/A	N/A	N/A
10.	Conclusions and recommendations	A=64%, B=9%, C=16%, F=11%	N/A	A=31%, B=38%, C=4%, D=23%, E=4%	A=19%, B=27%, C=35%, D=8%, E=4%, F=8%	A-C=87%, D-F=13%
11.	References	A=100%	N/A	N/A	N/A	N/A
Overall Rating		88% satisfactory, and 12% unsatisfactory	91% satisfactory, and 9% unsatisfactory	73% satisfactory (A-C) and 27% unsatisfactory (D-F)	81% satisfactory (A-C) and 19% unsatisfactory (D-F)	63% satisfactorily and 37% unsatisfactory