Seriti Power - New Largo Wetland Mitigation, Rehabilitation and Offset Strategy

For:

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Reference: W2024_75

DOCUMENT SUMMARY DATA

PROJECT:	**New Largo Coal Wetland Mitigation and Offset Strategy**
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DATE: October 2024	DATE: October 2024	DATE:

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DATE	No.	DESCRIPTION OF REVISION OR AMENDMENT	INITIAL

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ABBREVIATIONS

BMP	Best Management Practice
CBA	Critical Biodiversity Area
CEMP	Construction Environmental Management Plan
CVB	Channelled Valley Bottom
DFFE	Department of Forestry, Fisheries and Environment
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
ESA	Ecological Support Area
EWT	Endangered Wildlife Trust
FEPA	Freshwater Ecosystem Priority Area
HGM	Hydro-geomorphic
ha-eq	Hectare-equivalent
IS	Wetland Importance and Sensitivity
MBSP	Mpumalanga Biodiversity Sector Plan
MRA	Mining Right Area
NEMA	National Environmental Management Act (Act No. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Area project
NGI	National Geo-spatial Institute
NWA	National Water Act (Act No. 36 of 1998)
P & G	Preliminary and General charges
PES	Present Ecological State
REC	Recommended Ecological Class
SANBI	South African National Biodiversity Institute
TDS	Total Dissolved Solids
UVB	Unchannelled Valley Bottom
WCS	Wetland Consulting Services (Pty.) Ltd.
WQ	Water Quality
WRC	Water Research Commission
WUL	Water Use Licence

EXECUTIVE SUMMARY

Wetland Consulting Services (Pty.) Ltd. (WCS) has been appointed by WSP Group Africa (Pty.) Ltd. (WSP), on behalf of Seriti Power (Pty.) Ltd. (Seriti), to develop a wetland mitigation, rehabilitation and offset strategy for the New Largo coal mine. This strategy is required to compensate for wetlands affected by mining activities at the site and has been in development since 2016. This report provides the latest update to the strategy, reflecting recent changes to the mine plan, and will be used to support the water use license application for mining through Honingkrantz Pan, associated with Pit A, which was not originally authorised under the National Water Act.

A water use licence (WUL) (04/B20G/ACFGIJ/2538) was granted in 2015 authorising the New Largo Coal (Pty.) Ltd. to mine some of the wetlands and pans based on a mine plan which was approved at the time. This approval excluded the mining of Honingkrantz Pan but included the mining of a number of other pans (referred to as Pan 2 (New Largo pan), and Pans 3, 5 and 6). The 2024 mine plan includes adjustments to the New Largo mine plan which now include the mining of Honingkrantz Pan but excludes the mining of Pan 2 (New Largo pan) and Pans 3, 5 and 6, as well as a number of wetland areas that would have been lost or indirectly affected according to the previous mine plan. Even though there are exclusions of wetlands in the 2024 mine plan, there are still wetlands that will remain impacted, particularly the loss of Honingkrantz Pan, and hence the strategy requires revision and updates.

The strategy aims to explore and address the offset opportunities for Honingkrantz Pan as well as the other directly and indirectly impacted wetlands, ensuring that all offset requirements for the New Largo coal mine are met. The strategy includes a targeted pan offset approach to try to achieve a 'like-for-like' compensation specifically for the loss of Honingkrantz Pan. Honingkrantz Pan was highlighted due to feedback from the Department of Water and Sanitation (DWS) that offset opportunities for it had not been fully explored. The updated strategy aims to ensure that "like for like" pan offsets are thoroughly investigated to maximise functional and ecosystem conservation gains. The goal of the wetland mitigation, rehabilitation and offset strategy is to compensate for losses by rehabilitating and protecting targeted wetlands within the New Largo Mining Right Area (MRA) and in offsite areas where there is a specific focus on pans.

Over the past number of years, WCS has carried out extensive work in the New Largo MRA (WCS, 2014; 2016; 2020; 2022). This work has included, for example, compiling and updating baseline data on wetland ecological integrity and importance and sensitivity, modelling of wetland flow drivers and assessing the impact on these from proposed mining activities, compiling a draft preliminary wetland reserve determination study, and developing wetland mitigation, rehabilitation and management strategies. The aim has been to develop ecological specifications to ensure wetlands' continued functionality and their ability to provide ecosystem services under various mining and development scenarios.

The objectives of the updated strategy are twofold: (1) to reflect recent mine plan revisions which include the proposed mining of Honingkrantz Pan, and the avoidance of a number of other wetlands including pans, previously authorised to be mined, and (2) through proactive rehabilitation, management and protection measures, mitigate the hectare equivalent losses as far as reasonably possible, associated with mining activities, including both current and historic mining.

In summary, the scope of this study included: Determining the condition and identifying potential catchment and pan basin rehabilitation opportunities and estimates of possible wetland hectare equivalent gains of the two offsite pans (known as Pans 7 and 8) identified during previous work as potential target wetlands for inclusion in the strategy; Determining the uniqueness of the pans initially considered in the proposed strategy by undertaking a study focusing on the branchiopods; Getting clarity on whether or not the required clean water release flows can be provided and the areas proposed for the releases are suitable to supplement the required flow losses to the wetlands selected given the new water balance based on the revised mine plan; Updating the wetland offset hectare equivalent calculations based on the findings of the various studies and the ability of Seriti to mitigate the key risks to the wetland offset strategy; Liaising with Seriti and other specialists on the WSP team related to the proposed rehabilitation opportunity at New Largo Pan to develop a possible rehabilitation strategy for the pan; Calculating the direct and indirect wetland offset requirements as a result of the revised mine plan; Assessing the wetland offset opportunities and feasibility, and evaluating the potential offset gains; and Developing an updated wetland mitigation, rehabilitation, and offset strategy guided by the DWS & SANBI (2016) wetland offset guidelines.

Included in the strategy are: Category 1 Wetlands, being wetland areas that are not affected by the proposed mining activities within the New Largo Mining Right Area (MRA); Category 2 Wetlands, being wetland areas that are partially affected by the proposed mining activities as a result of the loss of catchment area and water inputs; Category 3 Wetlands, being the remaining pan cluster within the MRA (New Largo Pan and the southern pan cluster); and Category 4 Wetlands, being the offsite Pans which initially only included Pans 7 and 8. Due to land tenure issues, Pan 8 had to be excluded from the study which was then expanded to include additional pans within Seriti's Surface Right Areas (SRA). This included considering pans in Kriel and Middleburg Mine Services (MMS) – Boschmanskrans Section (BMK) SRA, and at Dispatch Rider.

A key aspect of the work done was related to New Largo pan (Pan 2) which forms part of the Category 3 Wetlands indicated above. It has been affected by historical underground as well as sand mining and the pumping of previously polluted water originating from the underground void into the pan. This resulted in an elevated full supply level and water quality changes in the pan which persisted for decades. The resulting historical disturbance has translated into significant landuse changes in the pan, its associated seep and in the pan catchment. The changes all affect the state of the pan and associated seep, accounting for the degraded condition associated with these. The lack of hatching success of invertebrates as indicated in the results of the egg bank study further support the findings related to historical disturbance of this pan. This provided a good opportunity for rehabilitation intervention to try to improve the condition of the pan and its seep. Despite the poor state of the pan, flamingos were observed feeding on the pan when it had surface water in early 2024.

Despite the good opportunity for rehabilitation of the pan, a concern exists related to the risk of future pillar and possible overburden failure in the pan basin and catchment due to underground stability issues. Another challenge has to do with safety issues related to implementing the proposed rehabilitation interventions in the degraded seep around the pan and in the catchment. In order to understand these risks, a stability assessment was undertaken by Saxum Mining (Saxum Mining & Trading CC, August 2024, Rev. 02) which indicated that tailored methods would be required in order address the risks associated with the implementation of the proposed rehabilitation. After a considerable team effort between the various specialists to come up with a method to address the rehabilitation implementation risks associated with either pillar or overburden failure, a method statement was developed by WSP in consultation with the wetland specialists (WSP Memo, September 2024). It was concluded that rehabilitation is possible if the implementation is done in accordance with the methods proposed by WSP. Long-term monitoring will be required to monitor the area for any pillar or overburden failure in the future and Seriti will have to address such in the pan basin or catchment in the future should it pose a risk to the pan.

The other Category 3 Wetlands include the southern Pan Cluster within the Seriti MRA and include Pans 3, 5, and 6, which now form part of the onsite wetland offset strategy following revisions to the mine plan. These pans were previously authorised for mining but have since been excluded for mining by Seriti and are now available for offset consideration. Rehabilitation efforts focus on the portions of the pans and their catchment areas within Seriti's Mining and Surface Rights Area which for Pans 3 and 5 include approximately half of the pan basins and their associated seeps and catchment areas.

A key aspect of any like-for-like offset is determining like-for-like attributes. One attribute that was identified as requiring additional work was how similar or different (unique) the pans are from a conservation or biodiversity perspective. It was envisaged that this would help clarify some of the debate as to whether or not Honingkrantz Pan is unique from a biodiversity or conservation perspective. It would also allow a comparison with the other pans being considered as possible suitable candidates for offsetting the loss of Honingkrantz Pan. In order to address the above, an invertebrate study, using an egg bank viability assessment was undertaken by Ecology International. The study aimed to assess the uniqueness of these pans by analysing the branchiopod taxa thereby providing further insights into the ecological differences and distinctiveness of the pans under consideration as part of this study.

The results of the study showed that hatching success varied greatly amongst the pans assessed, with New Largo Pan showing no hatching success and Pan 5 and Pan 6 showing very limited hatching success. Available data and literature suggest that anthropogenic disturbances have affected the viability of egg banks in these pans. Sediment salt retention, likely caused by mining activities, appears to be a significant factor for New Largo Pan. For Pan 6, agricultural activities within the pan's basin likely contributed to the reduced egg bank viability. The results showed that Pan 7, which exhibited the highest diversity and abundance of branchiopod nauplii, stood out as the most unique pan among those assessed, demonstrating high ecological importance. Consequently, Pan 7 has been included in the offset strategy, with recommendations to further enhance and preserve its ecological value. Although Honingkrantz Pan did not exhibit ecological uniqueness compared to the others, the principle of protecting well-functioning systems before they degrade was strongly emphasised and recommended in this case.

In terms of the Category 4 Wetlands indicated above, two offsite pans (Pan 7 and Pan 8) were initially identified for inclusion in the offset strategy. During the course of this study Pan 8 was excluded due to complications with multiple landowners, making land tenure and rehabilitation efforts challenging. In contrast, Pan 7, with a single landowner, has been successfully included in the strategy, with an agreement in place to include it as part of the offset. To replace Pan 8 and try to achieve more like-for-like hectare equivalent gains to offset the loss of Honingkrantz Pan, Seriti and the study team identified seven additional pans within Seriti's surface rights areas, including four Dispatch Rider Pans, two Kriel Pans, and one MMS-BMK Pan. Since all these pans are located on Seriti Surface Rights Areas, these pans offer better control for offset activities and long-term management and stewardship, aimed at trying to achieve a "like-for-like" pan offsets for the project.

A conceptual hydropedological assessment was also conducted for New Largo Pan (Pan 2) and Pan 7 in order to better understand the flow drivers to these pans and to be able to provide hydrological context for the proposed rehabilitation strategy. Hydrological response units were determined for the pans and the various impacts to the pan catchments were described. New Largo Pan (Pan 2) receives water from rainfall, surface runoff, interflow, and no groundwater return flow, but loses water through evaporation, evapotranspiration, and groundwater percolation. Historical impacts, such as sand mining, underground mining, and invasive alien trees, have significantly altered its hydrology. The pan often dries up annually as water outflows exceed inflows over long periods. Alien trees reduce water input, while there are risks subsidence and water loss. Rehabilitation efforts, including alien tree removal, conversion of cultivated fields to semi-natural grassland, and infilling of old sand mined areas with suitable topsoil and sandy interflow sub-soils in certain areas to facilitate the recreation of seep conditions along the slopes leading to the pan. This is expected to convert some of the surface runoff flow drivers into interflow which will help support more regulated water inputs to the pan and is expected to improve water retention and help restore the pan to a more natural, seasonal state. An important consideration would be the installation of a clay liner below the infill areas to safeguard against water losses which may arise in future due to crack formation from pillar failure related subsidence.

Pan 7 covers 20.1% of the catchment, more than New Largo Pan, suggesting less frequent inundation. Two cross-sections show how soil types and hillslope hydrology work together. Invasive trees reduce groundwater recharge, particularly in upper slopes, affecting water flow into the pan. Interflow and surface runoff contribute water, with seasonal groundwater fluctuations playing a role. Key impacts include invasive trees, small-scale sand mining, housing, and farm tracks. Alien trees like Wattle and Eucalyptus have the biggest effect, reducing water inflow to the pan. Sand mining and housing have minor, localised impacts on the overall hydrology.

Four wetland types occur within the Mining Right Area (MRA), including Channelled and Unchannelled valley bottoms, Seeps and Depressions (pans). Drainage lines and springs also occur, some of latter of which support wetland habitats. These wetlands are influenced by a variety of land uses that have altered their condition including but not necessarily limited to previous underground and sand mining and agriculture, especially the cultivation of dryland crops and livestock grazing which has impacted the wetlands. This is particularly seen in the hillslope seepage wetlands (Seeps), leading to vegetation loss, soil disturbance, and water quality degradation. Pastures, though less impactful than crop cultivation have also altered habitat quality and affected the wetland biodiversity by replacing natural mesic grassland with pasture monocultures. In some areas overgrazing of the natural grasslands has also degraded the general ecosystem, affecting both the wetlands and the associated catchments. As a result of the above landuse and other impacts on site the Present Ecological Sate (PES) ranges from severely degraded (PES Category E) to largely natural (PES Category B) with most wetlands (76%) being largely modified (PES Category D) or moderately modified (14% in PES Category C).

From an ecological importance and sensitivity perspective the wetlands lie within a Critical Biodiversity Areas (CBAs), identified as "Irreplaceable," and Ecological Support Areas (ESAs), according to the Mpumalanga Biodiversity Sector Plan. Parts of the area are within Vulnerable vegetation types (Eastern Highveld Grassland and Rand Highveld Grassland) and several wetlands, including the Honingkrantz Pan, are classified as Freshwater Ecosystem Priority Areas (FEPAs) due to their role in water quality maintenance and biodiversity support. The wetlands provide habitat for rare and endangered species, such as Greater and Lesser Flamingos and Blue Cranes, particularly observed around the Honingkrantz Pan with the former also seen in some of the offset pans including New Largo Pan and Pan 7. The Importance and Sensitivity (IS) assessment indicated that most wetlands within the MRA are of Moderate IS, though several larger seeps and the pans scored High.

The strategy follows the DWS & SANBI (2016) guidelines for calculating the wetland offset requirements. The assessment determined that mining activities would result in the loss of approximately 138.19 hectare-equivalent (ha-eq) for water resources and 905.73 ha-eq for ecosystem conservation. These losses include both direct and indirect impacts on wetlands. Direct losses refer to the wetlands that will be mined through while indirect losses involve wetlands that will remain but will experience changes in their drivers and flow inputs due to mining activities, particularly from the reduction of catchment areas.

To mitigate indirect losses, flows from the catchment of affected wetlands will be supplemented with clean water from existing and proposed water treatment facilities. Additionally, the rehabilitation of opencast pits will create new catchment areas that will need to support flow back to the wetlands. These will need to be integrated into the mine's closure plans. This combined approach is aimed at ensuring that both direct and indirect impacts are addressed as part of the overall wetland management and mitigation strategy. From the 2016 mitigation and offset strategy to the current 2024 strategy, there has been a 58% reduction in water resources and ecosystem services requirements and a 48% increase in ecosystem conservation targets. These changes are directly tied to revisions in the mine plan, which have reduced the mining footprint and, consequently, the pressure on the water resources. The increase in conservation targets is attributed to the updated threat status of various wetland types as highlighted in the 2018 National Biodiversity Assessment.

To try to mitigate the remaining wetland losses, the offset strategy aims for a 'No Net Loss' or even a 'Net Gain' in functional outcomes. Through rehabilitation, conservation, and protection of targeted wetlands, the offset strategy anticipates achieving:

- A Net Gain of 8.07 ha-eq for Water Resources and Ecosystem Services.
- A Net Gain of 74.22 ha-eq for Ecosystem Conservation.

These gains are projected to be realised during the operational phase of mining, assuming successful implementation of the rehabilitation measures. The strategy focuses on functional offsets which are more difficult to achieve but crucial for maintaining ecosystem services while also contributing to broader ecosystem conservation.

From a pan like-for-like perspective, the offset for the Honingkrantz Pan has been calculated at 45.78 ha-eq for Water Resources and Ecosystem Services and 132.60 ha-eq for Ecosystem Conservation. To compensate for these losses, the Category 3 (remaining onsite pans) and Category 4 (offsite pans) wetland rehabilitation is expected to contribute approximately 37.95 ha-eq for Water Resources and 418.93 ha-eq for Ecosystem Conservation. Overall, the strategy achieves 83 % of the "like-for-like" water resources and ecosystem services offset target and a positive net gain towards contributing to the ecosystem conservation targets for the pans. An important aspect to mention here is that only those pans and sections of the pans and pan catchments where the land-tenure is secured, through direct surface rights ownership by Seriti or via an agreement with the landowner, have been included in the calculation of the estimated gains.

In conclusion, the revised offset strategy strives to balance wetland losses with targeted rehabilitation and conservation efforts. This also serves to preserve both the hydrological and biodiversity value of the remaining wetlands within the New Largo MRA. Although the strategy does not fully achieve the 'like for like' offset targets, its contribution to ecosystem functioning remains significant. The gains in terms of biodiversity are still valuable, particular through the creation of ecological corridors, which help prevent habitat isolation and promote species movement.

Additional benefits of the rehabilitation proposed which are not necessarily captured in the hectare equivalent calculations include for example, the improvement of habitat quality and likely benefits for biota. Improved habitat quality in New Largo Pan for example is likely to provide opportunities for additional biota to establish or colonise the re-established habitats. These opportunities will not exist in the future without active rehabilitation intervention in the system. It is expected that the rehabilitation measures proposed in the wetland systems in general will support the long-term viability of the broader ecosystem in an otherwise transforming landscape, thereby enhancing overall biodiversity support and resilience in the area during and post-mining.

In addition, in order to ensure no net loss of wetland hectare equivalents during mining, the strategy must be implemented in parallel with mining operations. A phased approach to the implementation of the strategy has been proposed starting with Phase 1 which includes the Category 1 Wetland Offsets, followed by Phase 2 which includes the Category 3 Wetland Offsets and Additional Pans (off-site Kriel and MMS-BMK Pans), followed by Phase 3, which includes the Category 4 Wetland Offsets and Dispatch Rider Pans, and lastly Phase 4, which includes the Category 2 Wetland Offset. The phased implementation considers various factors, including land control (ownership), ease of implementation, additional work requirements, and expected gains, among others. Moreover, there is an opportunity to align this phased approach with the staged development of the New Largo coal mine. As the development footprint of the mine expands and affects wetlands, the rollout of the wetland offset strategy, and the realisations of gains are extended to compensate for the anticipated impacts.

Risks, especially related to the New Largo Pan and the other onsite pan offsets, including stability risks, must be managed through appropriate monitoring and management measures. A practical schedule will need to be agreed upon between Seriti and relevant authorities for the ongoing monitoring and audit of the offsets. The strategy also provides guidance in the form of a general wetland management plan for the wetlands targeted and as well as timing for implementation. Both these will require further input and revision should the offset strategy be approved and taken forward for detailed design and implementation.

1. BACKGROUND AND SCOPE OF WORK

Wetland Consulting Services (Pty.) Ltd. (WCS) has been appointed by WSP Group Africa (Pty.) Ltd. (WSP), on behalf of Seriti Power (Pty.) Ltd. (Seriti), to develop a wetland mitigation and offset strategy for the New Largo Coal Mine. This strategy is required to compensate for wetlands affected by mining activities at the site and has been in development since 2016. This report provides the latest update to the strategy, reflecting recent changes to the mine plan, and will be used to support the water use license application for mining through Honingkrantz Pan, associated with Pit A, which was not originally authorised under the National Water Act.

Over the past number of years, WCS has carried out extensive work in the New Largo Mining Right Area (MRA) (WCS, 2014; 2016; 2020; 2022). This work has included, for example, compiling and updating baseline data on wetland ecological integrity and importance and sensitivity, modelling of wetland flow drivers and assessing the impact on these from proposed mining activities, compiling a draft preliminary wetland reserve determination study, and developing wetland mitigation, rehabilitation and management strategies. The aim has been to develop ecological specifications to ensure wetlands' continued functionality and their ability to provide ecosystem services under various mining and development scenarios.

In addition, WCS has continuously refined the wetland mitigation, rehabilitation, and management strategy to address and compensate for the wetland losses caused by mining activities and proposed changes to the mine plan. These ongoing efforts have culminated in the current updates to the strategy, which are designed to meet regulatory requirements while addressing the evolving scope of mining operations. This body of work, developed over more than a decade, serves as the foundation for the latest strategy updates.

The objectives of the updated strategy are twofold: (1) to reflect recent mine plan revisions which include the proposed mining of Honingkrantz Pan, and the avoidance of a number of other wetlands including pans, previously authorised to be mined, and (2) through proactive rehabilitation, management and protection measures, mitigate the hectare equivalent losses as far as reasonably possible, associated with mining activities, including both current and historic mining. In response to these changes, WCS has been requested to revise and update the strategy accordingly.

The scope of this study included the following:

- Determining the condition of the two offsite pans (known as Pans 7 and 8) identified during previous work as potential target wetlands for inclusion in the strategy. This included undertaking a condition assessment of the two offset pans (PES and IS), including landcover class mapping of the catchments and determining the hydrological flow drivers based by conducting a hydropedological study of the pans. Also included was identifying potential catchment and pan basin rehabilitation opportunities and estimates of possible wetland hectare equivalent gains compared with the high-level estimates derived from the previous desktop assessment.

- Determining the uniqueness of the pans considered in the proposed strategy by undertaking a study focusing on the branchiopods to determine the differences in these between the pans and the uniqueness of the pans.
- As part of this study, it was considered important to get clarity on whether or not the required clean water release flows which form part of the proposed strategy can be provided given the new water balance based on the revised mine plan. In addition, more clarity was required related to the location of the release nodes and whether or not the areas proposed for the releases are suitable to supplement the required flow losses to the wetlands selected.
- Updating of the wetland offset hectare equivalent calculations based on the findings of the various studies and the ability of Seriti to mitigate the key risks to the wetland offset strategy. It was envisaged that hectare equivalent calculations would need to be updated to align with the risk mitigation methods proposed.
- Liaise with Seriti and other specialists on the WSP team related to the proposed rehabilitation opportunity at New Largo Pan to develop a possible rehabilitation strategy for the pan.
- Calculation of offset requirements (which includes the determination of direct and indirect offset requirements) as a result of the revised mine plan.
- Assessments of offset opportunities, feasibility, and evaluation of potential offset gains.
- Development of an updated wetland mitigation, rehabilitation, and offset strategy guided by the DWS & SANBI (2016) wetland offset guidelines.

As part of the study, the following mitigation and offset categories were considered in the revised strategy:

- Category 1: Wetland areas that are not affected by the proposed mining activities within the New Largo Mining Right Area (MRA).
- Category 2: Wetland areas that are partially affected by the proposed mining activities as a result of the loss of catchment area and water inputs. This includes the identification and evaluation of available potential water inputs to mitigate water loss.
- Category 3: Remaining pan cluster within the MRA (New Largo Pan and the southern pan cluster).
- Category 4: Offsite Pans. These initially only included Pans 7 and 8 identified previously at a desktop level, but due to land tenure issues associated with Pan 8 which had to be excluded, was expanded to include additional pans within Seriti's Surface Right Areas (SRA). This included considering pans in Kriel and Middleburg Mine Services (MMS) – Boschmanskrans Section (BMK) SRA, and at Dispatch Rider.

2. DETAILS OF SPECIALIST

2.1 Details of the Specialist Who Prepared the Report

Project Consultancy	Wetland Consulting Services (Pty.) Ltd.
Company Registration	1998/17216/07
Professional Affiliation	South African Council for Natural Scientific Professions (SACNASP) 400083
Contact Person	Mr. Bhuti Dlamini
Postal Address	P O Box 72295, Lynnwood Ridge, 0040

2.2 Expertise of the Specialist

2.2.1 Qualifications of the Specialist

Bhuti Dlamini holds the following degrees:

- Bachelor of Science, Hydrology major: University of KwaZulu-Natal (Pietermaritzburg)
- Bachelor of Science Honours in Water Resources (University of Pretoria)
- Master of Science in Environmental Sciences (University of the Witwatersrand)

Bhuti Dlamini holds a Professional Registration with SACNASP since 2016 – 400083/16 and is registered in the field of Water Resources Sciences

2.2.2 Past Experience of the Specialist

Bhuti Dlamini has been working in the field of Wetland Ecology and Water Resources Management for a period of 21 years. He has worked as a regulator in various government Departments including the Department of Water and Sanitation and the Gauteng Department of Agriculture Conservation and Environment, In seventeen years of this experience he has worked as a Specialist Wetland Consultant with Wetland Consulting Services (Pty.) Ltd. He also has substantial experience in wetland rehabilitation and has been involved in providing specialist ecological input into the planning projects for various projects including Working for Wetlands. In addition, he has been involved and conducting wetland specialist studies and producing a number of specialist baseline and impact assessment reports in support of various legislations' requirements. In recent years (past four years) he has been actively involved in developing wetland offset planning and mitigation strategies for different mining houses in the Mpumalanga Province. His experience in wetland ecology and water resources management extends to various provinces in South Africa including Gauteng, KwaZulu Natal, Eastern Cape, Mpumalanga, Northwest, Northern Cape and Limpopo Provinces where he has provided various specialist studies and inputs to various developmental activities as per relevant legislations' requirements. Bhuti is a registered Professional Natural Scientist (Pr. Sci. Nat) with SACNASP in the fields of Water Resources Sciences.

2.3 *Details of the Specialist Who assisted in Preparation of the Report (CVs – Appendix 9)*

Project Consultancy	Wetland Consulting Services (Pty.) Ltd.
Company Registration	1998/17216/07
Professional Affiliation	South African Council for Natural Scientific Professions (SACNASP) 116815/17
Contact Person	Mr. Johannes Hachmann
Postal Address	P O Box 72295, Lynnwood Ridge, 0040

2.4 *Expertise of the Specialist*

2.4.1 *Qualification of the Specialist*

Johannes Hachmann holds the following degrees:

- BSc [Environmental Natural Science] - Albert Ludwig University Freiburg, Germany.
- MSc [Hydrology] - Free University Amsterdam, Netherlands

Johannes Hachmann holds a Professional Registration with SACNASP since 2017 – 116815/17. He is registered in the field of Water Resource Science.

2.4.2 *Experience of the Specialist*

Johannes Hachmann, Hydrologist, has a professional working experience of 10 years working for Wetland Consulting Services (Pty) Ltd.

DECLARATION OF INDEPENDENCE

Declaration - Independent Specialist Consultant

I, Bhuti Dlamini (Pr. Sci. Nat.), representing Wetland Consulting Services (Pty.) Ltd., in my capacity as a Director and Wetland & Water Resources Scientist declare that we:

- Act as independent specialist consultants, in this application, in the field of wetland and riparian ecology.
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006.
- Have, and will have, no vested interest in the proposed activity proceeding.
- Have no, and will not engage in, conflicting interests in the undertaking of the activity.
- Undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006; and
- Will provide the competent authority with access to all the information at our disposal regarding the application, whether such information is favourable to the applicant or not.

Wetland Consulting Services (Pty) Ltd

Name of Company

Bhuti Dlamini

Name of Specialist Consultant

Signature of Specialist Consultant

Date: 14 October 2024

3. METHODOLOGY AND APPROACH

3.1 Wetland Delineation and Typing

The National Water Act, Act 36 of 1998, defines wetlands as follows:

Wetland

"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."

The presence of wetlands in the landscape can be linked to the presence of both surface water and perched groundwater. Wetland types are differentiated based on their hydro-geomorphic (HGM) characteristics, i.e. on the position of the wetland in the landscape, as well as the way in which water moves into, through and out of the wetland systems. A schematic diagram of how these wetland systems are positioned in the landscape is given in the Figure 1 below.

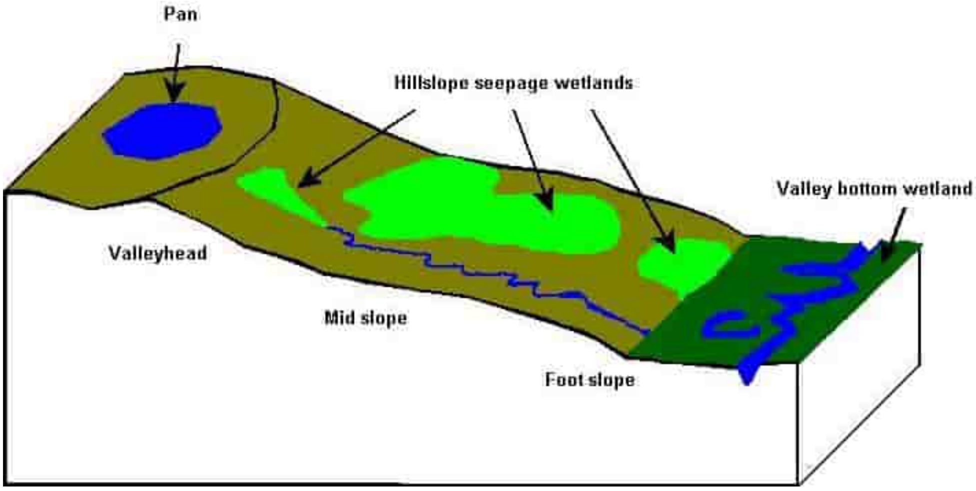


Figure 1. Diagram illustrating the position of the various wetland types within the landscape

For the purpose of this study, existing wetland information (including delineation and typing) was used. The wetland information was collated from previous wetland work as captured in various reports (WCS, 2014; 2016; 2020; 2022).

The methodology and approach used in these studies included the use of 1:50 000 topographic maps, 1:10 000 black and white orthophotos at the time and more recently Basemap (Esri, DigitalGlobe, Earthstar Geographics, CNES/Airbus DS, GeoEye, USDA FSA, USGS, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community), to generate digital base maps of the study area onto which the wetland boundaries were delineated using ArcGIS 10.2. A desktop delineation of suspected wetlands and riparian zones was undertaken by identifying rivers and wetness signatures from the digital base maps. All identified areas suspected of being wetlands or riparian zones were then further investigated in the field.

Wetlands were identified and delineated according to the delineation procedure as set out by the "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*" document, as described by DWAF (2005) and Kotze and Marneweck (1999). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

For the purposes of delineating the actual wetland boundaries use is made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within 50cm of the soil surface for an area to be classified as a wetland (*A practical field procedure for identification and delineation of wetlands and riparian areas*, DWAF).

The delineated wetlands were then classified using a hydro-geomorphic classification system based on the system proposed by Brinson (1993), and most recently modified for use in South African conditions by Ollis *et al*. (2013). As part of this current study, as far as reasonably possible, where there was evidence of changes on site as a result of landuse changes over the passage of time since the initial surveys, and/or where updated and higher resolution imagery indicated potential over-or under-estimation of previously captured wetland boundaries, and where field verification of these was possible, the delineation was updated to reflect the current situation on site.

3.2 Wetland Present Ecological State (PES)

A tool for assessing the PES of wetlands was first developed in 1999 (DWAF, 1999a). Following this WET-Health was developed (Macfarlane, Kotze, Ellery, Walters, Koopman, Goodman, and Goge, 2007), and more recently updated (Macfarlane, Ollis and Kotze, 2020). WET-Health uses indicators based on geomorphology, hydrology, and vegetation for assessing the PES of wetland systems. It was primarily developed to assess wetland conditions in linear systems where the wetland is linked to a drainage line. It has since been applied extensively in wetland assessments including for rehabilitation studies where the intention is to help understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite the damage, it is perhaps healthy enough not to require intervention.

An updated PES assessment was previously undertaken for the wetlands within the New Largo MRA utilising the WET-Health Version 2 Level 1B assessment methodology (MacFarlane, *et al*., 2020), which determines the PES of a wetland based on land use within the wetland, a 200m buffer around the wetland, and within its catchment. For the purpose of this assessment, land use was mapped based on the latest available Google Earth imagery and supported by field observations.

The results of the PES assessments are reflected in the placement of each wetland unit into a category based on the assessment scores. A description of the PES categories is provided in Table 1 below.

Table 1. The scoring system used for the PES assessment (after Macfarlane et. al., 2007).

Combined impact score	PES Category	Description
0-0.9	A	Unmodified, natural.
1-1.9	B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.
2-3.9	C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact
4-5.9	D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.
6-7.9	E	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognisable.
8 - 10	F	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.

3.3 Importance and Sensitivity of wetlands (IS)

Use was made of the Importance and Sensitivity (IS) assessment tool developed by Rountree, Malan and Weston (2013). The IS tool allows the determination of wetland importance and sensitivity for each of the following criteria:

- Ecological Importance and Sensitivity (EIS) – considers the presence of Red Data species, populations of unique species, the importance for migration, breeding and feeding sites for species, the protection status of the wetland and vegetation type/s present, the diversity of habitat types, the regional context of the ecological integrity of the wetland, and the sensitivity of the wetland to changes in hydrology and water quality.
- Hydro-functional importance – considers the ecosystem services the wetland provides in terms of flood attenuation, stream-flow regulation water quality enhancement, sediment trapping, phosphate, nitrate and toxicant assimilation, erosion control, and carbon storage; and
- Direct human benefit importance - considers the subsistence uses and cultural benefits of the wetland system.

As this assessment was undertaken at a desktop level, a number of the criteria that inform the overall score for each wetland had to be informed by available desktop information and datasets. On the basis of this assessment, each of the criteria above is scored on a scale from 0 to 4 and assigned a category according to that indicated in Table 2. The overall IS of the wetland is derived from the highest of the three main criteria (EIS, hydro-functional importance, or direct human benefit importance).

Table 2. The scoring system used for the IS assessment (Modified from DWAF, 1999 and used in Rountree, Malan and Weston (2013)).

Ecological Importance and Sensitivity Categories	Range of IS Scores
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal Wetlands that are not considered to be ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

Considerations that informed the IS assessment included:

- The location of part of the study area within a vegetation type (Eastern Highveld Grassland) that is considered extensively transformed and threatened, having been classed as ***Vulnerable.***
- The location of part of the study area within a vegetation type (Rand Highveld Grassland) that is considered extensively transformed and threatened, having been classed as ***Vulnerable.***
- According to the national wetland map (Van Deventer *et al*., 2019), generated as part of the latest National Biodiversity Assessment (NBA, 2018) the relevant wetland ecosystem types present within the study area, and their threat status and protection levels are as follows:
  - Mesic Highveld Grassland Bioregion (Valley-bottom): Critically Endangered and Not Protected.
  - Mesic Highveld Grassland Bioregion (Seep): Critically Endangered and Poorly Protected; and
  - Mesic Highveld Grassland Bioregion (Depression): Least Concern and Poorly Protected.
- The designation of various sections of the study area as Critical Biodiversity Areas, including portions of wetlands delineated, as a “Critical Biodiversity Area – Irreplaceable” and Ecological Support Areas (ESA) Wetlands and Wetlands Clusters according to the Mpumalanga Biodiversity Sector Plan (2019 Datasets).

- The capacity of the wetlands and different wetland types to support rare, endangered, or protected fauna and flora. For example, Greater and Lesser Flamingos and Blue cranes were previously observed within, and within the vicinity of, the Honingkrantz Pan.

The valley bottom wetlands and several of the seeps draining towards the Saalklapsruit and Wilge Rivers in the east and west respectively and Honingkrantz Pan are classified as Freshwater Ecosystem Priority Areas (FEPA's). The functional value of the different wetland types, particularly their capacity to improve water quality, in light of the disturbed nature of the area in general and anticipated deterioration in water quality over time as the area develops further, should be recognised.

3.4 Recommended Ecological Category (REC)

The Recommended Ecological Category (REC) of each wetland HGM unit was determined using the approach outlined in the Manual for the Rapid Ecological Reserve Determination of Wetlands (Version 2.0) (Rountree *et al*., 2013).

The REC is determined by the Present Ecological State of the water resource and the Importance and Sensitivity of the water resource. The guidelines as per Table 3 apply.

Table 3. Criteria used in determining the REC

PES	IS	REC (Rountree *et al*. 2013)	REC (Barbara Weston pers. comm. 2017)
A, B, C or D	Very High	At least 1 category higher (if feasible)	1 category higher (if feasible)
A, B, C or D	High	At least 1 category higher (If feasible)	0.5 category higher (if feasible)
A, B, C or D	Moderate	Current PES (unless improvement feasible)	Current PES
A, B, C or D	Low/Marginal	Current PES (unless improvement feasible)	Current PES
E or F	Any category	D (or higher if feasible)	D (or higher if feasible)
A or B (but improvement not possible)	Any category		Best Attainable State (BAS) or maintain PES

3.5 Development of a Wetland Mitigation and Rehabilitation Strategy

3.5.1 Rehabilitation Planning

The rehabilitation strategy, which serves as a precursor to a rehabilitation plan, comprises a description of the types of measures to be investigated. A subsequent rehabilitation plan entails detailed and complimentary input from a suitably qualified environmental engineer and a wetland ecologist. The wetland ecologist is responsible for identifying problems underlying the hydrological, geomorphological, and vegetative integrity of the habitat on the site and deciding on appropriate measures to address these. The engineer is responsible for designing appropriate earthen, gabion and/or concrete interventions to achieve the objectives outlined by the wetland ecologist. A conceptual rehabilitation plan for the suitable candidate wetlands is provided in this report, which goes as far as identifying the problems underlying the wetland integrity. In addition, the potential functional improvement in the wetlands has been calculated using the DWS and SANBI (2016) wetland offset calculator. Further information regarding the determination of functional gains and their place within the context of wetland offsetting is provided in the following sections.

3.5.2 Rational behind Compensatory Hectare Equivalents

Offsetting the residual loss resulting from wetlands that are removed from the landscape may take the form of one of the following:

- Onsite mitigation: the rehabilitation of wetlands that lie within the boundary of the development, but have been excluded from the development footprint, in order to ensure hectare equivalent gains.
- Offsite mitigation: the identification of suitable wetland habitat outside the boundaries of the development, and the implementation of rehabilitation measures that result in an additional gain in hectare equivalents in order to try to meet any deficit in terms of hectare equivalent targets.
- The creation of new wetlands on previously terrestrial/non-wetland areas; and/or the reintroduction of wetlands to the post-development landscape. These wetlands may be within previously existing wetland habitats, but the catchment drivers and topography would have been completely transformed. The wetlands are therefore constructed to be compatible with the new landscape. The authorities (particular the DWS) are reluctant to persue this option due to the risk associated with it including failure and cost implications.

The underlying principle is that the hectare equivalents gained by these measures should ideally offset those removed by the development. According to our current understanding, the offset target is separated into three components, namely:

- Water resource & ecosystem service target (functional target), which represents the wetland functional area (hectare equivalents) that is required to ensure a no net loss of wetland functioning. This employs a risk of failure multiplier and the temporal risk multiplier.
- Ecosystem conservation target, which incorporates aspects associated with the protection and threat status of the wetlands affected to ensure a certain level of protection pertaining to the threat status of the affected wetlands.
- Species of conservation concern target, which assesses the residual impacts on species of conservation concern. This assessment requires an appropriate species impact measure to be selected and applied to score the potential impact of the planned development. It is aimed at ensuring measures are put in place as part of an offset strategy to compensate for any loss (including loss of habitat) associated with species of conservation concern to ensure the protection of such species, and where possible improve the survival and persistence of these species.

3.5.3 Calculation of Hectare Equivalents

A hectare equivalent (ha-eq.) is a quantitative expression of the ecological integrity of a wetland HGM unit. It represents the common currency that enables the wetland functional area restored or rehabilitated to the landscape by restoration, rehabilitation, and artificial creation to be compared to that removed from the landscape by development (see DWS and SANBI, 2016). In the case of the New Largo Coal target wetlands, rehabilitation and protection were taken into consideration in calculating the potential functional gains associated with the rehabilitation strategy. Rehabilitation and averted loss can be defined as follows (taken from DWS and SANBI, 2016):

- Rehabilitation: Rehabilitation results in an improvement in wetland condition, function, and associated biodiversity. Rehabilitation involves the manipulation of the physical, chemical, or biological characteristics of a degraded wetland system in order to repair or improve wetland integrity and associated ecosystem services. It could involve actions such as blocking drainage canals, removing artificial obstructions to flow, assisting the regeneration of the natural vegetation and/ or clearing invasive alien species on the wetland site or in its buffer zone or catchment. By improving the condition of a wetland system and its biodiversity, a positive contribution is made towards the goal of no net loss. Where an offset is undertaken through rehabilitation, long-term protection and suitable management to maintain the full value of the offset wetland is required.
- Averted loss: In this guideline (SANBI & DWS, 2016), this term refers to physical activities which prevent the loss or degradation of an existing wetland system, its ecosystem services and its biodiversity, where there is a clearly demonstrated threat of decline in the system’s condition, ability to provide ecosystem services or contribute to overall water resource management objectives. This would apply in situations such as where active erosion in a wetland is stabilised to prevent an erosion gully from propagating further into the wetland, where excessive sediment inputs are prevented from entering a wetland through the stabilisation of erosion alongside the wetland or by creating structures to trap such sediment before reaching the wetland; or where there is significantly improved management of a wetland (e.g. long term improved management of the catchment, reduced grazing pressure or control of invasive alien species beyond the wetland and its buffer zone impacting on wetland ecosystem functioning). Long-term protection and suitable management to maintain the full value of the offset wetland are required.

To calculate hectare equivalents and the potential wetland functional gains, the revised DWS and SANBI wetland offset calculator was used, as detailed in the document entitled “Wetland Offsets: A Best Practice Guideline for South Africa” (DWS and SANBI, 2016). This study has focused on the functional and ecosystem conservation targets/gains and has not addressed the species conservation targets at this stage.

4. ASSUMPTIONS AND LIMITATIONS

This report has been prepared for the particular purpose outlined in the Background and Scope of Work above and no responsibility is accepted for the use of this report, in whole or in part, in any other context or for any other purpose.

Wetland boundaries reflect the ecological boundary where the interaction between water and plants influences the soils, but more importantly the plant communities. The depth to the water table where this begins to influence plant communities is approximately 50 centimetres. This boundary, based on plant species composition, can vary depending on antecedent rainfall conditions and can introduce a degree of variability in the wetland boundary between years and/or sampling periods. As part of the update, the wetland systems were verified by reviewing the most recent aerial imagery available generally at a scale of 1:5000 wherever possible and where the imagery was of sufficient resolution for this purpose. In some cases, adjustments were made to the mapping to align with the current situation onsite. Due to the extent of the area and the mapping scale used, the actual extent of the boundaries of these systems may be underestimated or overestimated in places. This may range from metres to tens of metres but generally is regarded as being of sufficient accuracy for the purposes of this level of study. In addition, for the purpose of this study only selected wetlands were revisited, and mainly to look at rehabilitation opportunities rather than for the purpose of updating any previous mapping.

In this study, the interventions are aimed at rehabilitation to try to improve wetland function in the targeted wetlands, and not at restoration.

It is necessary to distinguish between rehabilitation and restoration, the definitions being:

- Rehabilitation: the planned intervention in a system that aims at improving selected aspects within the system, recognising that some key ecological drivers cannot be altered.
- Restoration: the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning it to its historical or so-called 'pristine' state.

Where specific assumptions and limitations exist for each of the proposed offset categories, these are highlighted under each category section.

Although ecosystem conservation gains through rehabilitation were calculated, no buffer zones were taken into account when calculating the gains, as although it is recommended that a buffer zone be included surrounding all wetlands, it was not known whether buffering of all wetlands would be feasible given land ownership and future land use factors.

A number of important considerations and limitations apply to the PES assessment methodology utilised, namely:

- The PES assessment methodology is based on landcover/disturbance units mapped within the wetland, its buffer, and its catchment. Impacts to wetlands that are not associated with a specific landcover class, such as point source discharges of water or flow reduction due to groundwater abstraction, can therefore be underestimated or excluded from the Level 1B assessment.
- Landcover classes were mapped based on field observations where possible and supplemented with a review of aerial imagery.

- The Level 1B assessment is limited to 30 pre-defined landcover classes for wetlands (and 25 landcover classes for the 200m buffer zone and catchment). All landcover units mapped had to be allocated to these pre-defined landcover classes. Some interpretation is often required in order to be able to assign the landcover classes to those required in the Level 1B assessment. This may vary depending on individual interpretation of which cover class is considered best suited to a particular land-use or impact. It is recognised that this may affect the final PES outcome or results in some cases.
- The impact intensity scores ascribed to the landcover classes were generally used in the assessment as captured in the Level 1B assessment spreadsheets and not changed.
- Some unknowns also apply: For example, reference conditions of the wetlands are unknown, as no data are available on the affected wetlands prior to the onset of human-induced landuse changes within the wetlands and their catchments. Reference conditions are therefore based on experience gained from working on similar wetlands on the Mpumalanga Highveld. This limits the confidence somewhat with which the present ecological state (PES) is assigned.
- While the mapping of New Largo Pan was updated as part of this study to be able to better determine the rehabilitation opportunities and potential gains, because of the extensive disturbance around the pan, this was based on using a combination of historical and current imagery and some field verification. Safety risks associated with stability issues in and around the pan basin and associated seep and catchment precluded further field verification of the seep boundary following the initial site assessment conducted as part of this study. In addition, the pan full supply level, basin and seep boundary may change over time as the “new normal” flow inputs to the pan settle in following the stopping of pumping of underground mine water into the pan. This may take a few seasons to normalise, which together with the inherent variability in rainfall, may only be determined accurately in the future. The delineation is however considered adequate and accurate enough for the purpose of this study, including for developing sufficient understanding of the rehabilitation requirements and opportunities, and for estimating potential hectare equivalent gains that may be achievable from rehabilitating the associated wetlands and catchment. Should the rehabilitation of this pan be approved by the authorities and taken forward for detailed planning and implementation, then more detailed work will be required on site to refine the boundary delineations as well as focused rehabilitation areas. This would need to be aligned with safe access assessment for sections of the area where stability issues pose a higher risk. In addition, it is likely that the wetland boundaries will change over time with rehabilitation, especially with soil replacement and the alien tree removal that is proposed as part of the rehabilitation.

5. WETLAND OFFSETS IN SOUTH AFRICA

5.1 What are Wetland Offsets?

A useful and widely accepted definition of biodiversity offsets is provided by the Business and Biodiversity Offsets Programme (BBOP):

> "Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity." (BBOP, 2018).

Wetland offsets fall under the broader umbrella of biodiversity offsets, and from the definition above, the goal of wetland offsets can be said to achieve a measurable "**No Net Loss**" or "**Net Gain**" in conservation outcomes as a means of compensating for residual adverse impacts to wetlands.

5.2 Wetland Offsets in South Africa

Recognising the need for guidance and standardisation in the development of wetland and biodiversity offsets, several organisations and institutions have initiated processes to lead toward the formal adoption of policies and guidelines in this regard. The Minister of Environmental Affairs released a draft National Framework for Biodiversity Offsets for stakeholder comment in 2013 which provided national definitions and an understanding of key concepts relating to biodiversity offsets and was intended to provide authorities with a template to prepare specific guidelines on biodiversity offsets. The SANBI wetland offset guidelines (SANBI & DWS, 2016), which have undergone several iterations since their first release in 2012, form such a specific guideline proposing an approach and methodology to wetland offsets in South Africa. This document has been published by the Water Research Commission and is endorsed by the DWS as "*an official guideline to aid the development of appropriate wetland offsets in situations where an offset is required*".

The "**No Net Loss**" principle requires that the gains provided by an offset program equal or exceed the losses that have occurred as a result of the project impacts. There is thus a need for an accounting system to accurately quantify and calculate the losses and gains – in the SANBI Guidelines and this is achieved through the use of hectare equivalents. The gains provided by the offset should be equivalent to the losses in terms of type (e.g. wetland type or condition), time and space. What this means for wetland offsets is that generally, the following concepts apply:

- Offsets should be like for like (e.g. the loss of a pan would require a pan as offset, while offsetting a highly degraded wetland system to compensate for the loss of a pristine system would not generally be acceptable).
- Ideally, offset gains should materialise before, or at the same time, as wetland losses.

- All values of the lost wetland system should be targeted (e.g. if a wetland supports African Grass Owls and plays an important role in flow regulation, both these functions should be provided for in the offset target. This might require increasing the offset target area to cater for both functions).
- To ensure that "**No Net Loss**" is realised, an offset strategy needs to be accompanied by rehabilitation and enhancement of the target functions and values, as protection alone does not provide the gains that count towards "**No Net Loss**". Where offsets are done on a 1:1 basis (i.e. 1ha of a wetland is offset to compensate for the loss of 1ha of wetland), a net loss of 50 % would result, unless interventions are put in place to enhance the functions and values of the offset target.
- Offset multipliers are generally applied to take into account risks and uncertainties about the success or performance of planned offset measures.

The SANBI guidelines recognise five types of offsets:

Protection-based offset: Refers to the implementation of legal mechanisms (e.g. declaration of a Protected Environment or Nature Reserve under the National Environmental Management: Protected Areas Act, a legally binding conservation servitude, or a long-term Biodiversity Agreement under NEMA) and putting in place appropriate management structures and actions to ensure that conservation outcomes are secured and maintained in the long-term.

Averted loss offset: Refers to physical activities which prevent the loss or degradation of an existing wetland system and its biodiversity, where there is a clearly demonstrated threat of decline in the system's condition.

Rehabilitation/restoration offset: Refers to activities which result in an improvement in wetland condition, functions, and associated biodiversity. Rehabilitation/restoration involves the manipulation of the physical, chemical, and/or biological characteristics of a degraded wetland system in order to repair or improve wetland integrity and associated ecosystem services. By increasing the condition of a wetland system and its biodiversity, a positive contribution is made towards the goal of no net loss.

Wetland establishment: This involves the development (i.e. creation) of a new wetland system where none existed before by manipulating the physical, chemical, and/or biological characteristics of a specific site.

Direct compensation: Direct compensation involves directly compensating affected parties for the ecosystem services lost as a result of development activities. This is ideally done by providing an equivalent substitute form of asset or in some cases may take the form of monetary compensation. This form of offset action is generally most relevant to direct services.

The offset strategy developed for the New Largo Coal Extension Colliery Project incorporates two of the five offset types recognised by the SANBI guidelines, namely:

- Protection-based offset; and
- Rehabilitation/restoration offset.

5.3 Perceived value and limitation of the offset guidelines document and calculators as identified through ongoing applications - specialist review

5.3.1 Value of Offset Calculators:

- **Standardisation**: Provide uniform metrics for evaluating ecological impacts and offset gains, ensuring consistency across projects.
- **Comparability:** Facilitate comparison of impacts and offset measures across different ecosystems.
- **Quantitative Measurement:** Offer a quantitative approach to measure environmental losses and gains, objectifying ecological assessments.
- **Data-Driven Decisions**: Support decision-making with clear, measurable outcomes.
- **Transparency:** Establish clear criteria for evaluating impacts and offsets, promoting transparency.
- **Accountability**: Provide documented methodologies for review and audit.
- **Predictability:** Help anticipate the success or failure of offset strategies.
- **Communication:** Simplify complex data into understandable formats for stakeholders.
- **Engagement:** Facilitate informed discussions and negotiations among stakeholders.
- **Targeted Interventions:** Identify effective offset strategies by quantifying potential gains.
- **Long-Term Monitoring:** Set benchmarks for monitoring and assessing long-term outcomes.
- **Compliance**: Ensure development projects comply with environmental regulations and policies.

While the value and importance of offset calculators are acknowledged, it is crucial to incorporate assumptions and limitations into these tools to clearly understand their value and reach in evaluations. The current offset guidelines lack this essential aspect, leading to potential challenges and inaccuracies in their application. Some of the limitations noted through extensive use of the offset guidelines and associated calculators can be summarised as follows:

5.3.2 Limitations of Offset Guidelines and Calculators:

Generalisation Issues:

- One-Size-Fits-All Approach: The current guidelines often use a one-size-fits-all approach that may not account for the unique characteristics of different wetland types, such as depressions (pans), leading to inaccurate assessments.
- Oversimplification: Complex ecosystems are frequently reduced to basic metrics like area or species count, missing critical ecological interactions and services.

Qualitative Aspects:

- Neglected Qualitative Factors: Important aspects such as ecosystem resilience, connectivity, and long-term impacts of climate change are often overlooked, leading to incomplete evaluations.
- The specificity of the targets, without any margin of error built in makes successful evaluation difficult if you have different persons assessing the anticipated vs actual outcomes.

Variable Ecosystem Responses:

- Unpredictable Outcomes: The variability in ecological responses, particularly in dynamic systems like Depression (Pans) wetlands, is not always well represented, making predictions less reliable.
- Recovery Times: Differences in recovery times between impacted and offset areas are often inadequately addressed, leading to potential discrepancies in offset effectiveness.

Metrics and Benchmarks:

- Focus on Area Restoration: The emphasis on area restoration can neglect other crucial factors such as water timing, specific habitat needs, and the broader impacts of climate change.
- Simplistic Metrics: Relying on simplistic metrics like hectare equivalents can miss important ecological functions and interactions. To address this, the tool should incorporate a range of hectare equivalents rather than a single specific value. For example, instead of stating a gain of 10 ha-eq, the tool could provide a range, such as 10 ha-eq to 15 ha-eq, to account for variability and potential margins of error, allowing for more flexible and accurate comparisons by different users.

Implementation Challenges:

- Inflexibility: Current guidelines and calculators may lack the flexibility to accommodate different project types or ecosystems, leading to challenges in practical implementation.
- Incorporation of New Information: Changing conditions or new information may not be easily integrated into existing calculators, affecting their accuracy and relevance over time.

Summary:

The current offset guidelines and calculators, while valuable, have notable limitations that must be addressed to ensure their effective use. The generalisation and oversimplification of complex ecosystems, along with the neglect of qualitative factors and variable ecosystem responses, can lead to incomplete and inaccurate evaluations. To improve their application, it is essential to build in assumptions and limitations, allowing for a clearer understanding of the tools' reach and effectiveness. Addressing these limitations will enhance the reliability and accuracy of offset assessments, particularly for unique and dynamic ecosystems like Depression (Pan) wetlands.

Revision of the offset guidelines to highlight and address limitations should become a priority, in the same way that other wetland assessment tools have been revised or updated recently.

The following are some of the aspects that could be refined or adjusted to allow the tool to be more applicable to, and accurately representative of, a wider range of situations and wetlands.

- **Tailored Approach:** Adapt guidelines and calculators to the specific characteristics of different ecosystems and wetland types.
- **Beyond Basic Metrics:** Incorporate a broader range of ecological factors and qualitative aspects for a comprehensive evaluation of offset gains. Instead of specific hectare equivalents a lower and upper range should be built into the tool to allow flexibility and margin of error in comparison by different users. Habitat improvement and species diversity associated therewith is not always reflected in the landcover classes used to derive the PES. The added benefits of improving habitat and species diversity does not always translate into hectare equivalent changes especially in cases where the landcover classes do not reflect these. This is an area that should be considered in the further development of the existing assessment tools including the offset calculator.
- **Address Unique Ecosystems:** Refine calculators to better represent unique ecosystems and their specific functions and services.
- **Include Additional Factors:** Expand beyond area restoration to include water timing, habitat needs, and climate impacts.
- **Dynamic Tools**: Ensure tools are flexible to accommodate various project types and evolving conditions.
- **Incorporate New Data:** Regularly update calculators and guidelines to reflect new information and changing environmental conditions.

Summary:

The shortcomings in offset guidelines and calculators highlight the need for a more customised, holistic, and flexible approach. Current tools often oversimplify complex ecosystems and fail to adequately represent unique environments that may not be well considered under the broad umbrella of functionality. To improve effectiveness, guidelines should be adapted to specific ecosystem characteristics, include comprehensive metrics, and be regularly updated to incorporate new data and evolving conditions. This approach could enhance the accuracy and applicability of offset evaluations.

The offset guidelines and calculators offer significant value in standardising offset requirements, approaches and targets, and are a valuable and essential tool given the current state and ongoing loss and degradation of wetlands in South Africa. However, it must be acknowledged that the tool is not perfect and would benefit from revision and refinement, particularly in terms of the limitations highlighted above. Until such time as a revision of the guidelines and calculators is undertaken, it is important for the wetland specialists (and other relevant specialists) involved in any given project to use their experience and best, unbiased, scientific judgment to address perceived limitations of the tool when applicable and motivateable. In such situations, detailed records should be kept of any decision-making processes and the rationale for any deviation from the standard offset guideline and tool application. This is necessary to allow for the relevant authorities to make an informed decision and to ensure that the approach for future assessment and monitoring can effectively aligned with the initial offset approach.

6. DETERMINATION OF WETLAND OFFSET TARGETS

6.1 New Largo Wetlands

A field survey was undertaken over several days in August and September 2022 to collect additional input data for the various wetland assessment updates. Previous wetland delineations were used as the basis of this study (WCS, 2014; 2016 and 2020). Four wetland HGM types have been identified within the study area. These include:

- Channelled valley bottoms.
- Unchannelled valley bottoms
- Seeps.
- Depressions (pans).

Also recorded onsite are drainage lines - watercourses that act as preferential flow paths but support neither wetland habitat nor riparian habitat. Springs also occur, some of which support wetland habitat. In some cases, the wetland habitat occurs in excavations or small dams dug around the springs. A map of the wetlands associated with the Mining Rights Area (MRA) is shown in Figure 2 and the areas covered by each wetland HGM type are detailed in Table 4.

Table 4. Wetland types, other watercourses and the approximate total area of each within the study area.

Wetland HGM Classification	Wetland Area (Ha)	% of Total Wetland Area
Channelled Valley Bottom	108	5.86 %
Unchannelled Valley Bottom	198	10.78 %
Drainage line	3	0.15 %
Seep	1373	74.86 %
Depression (pan)	153	8.35 %
Grand Total	**1834**	**100 %**

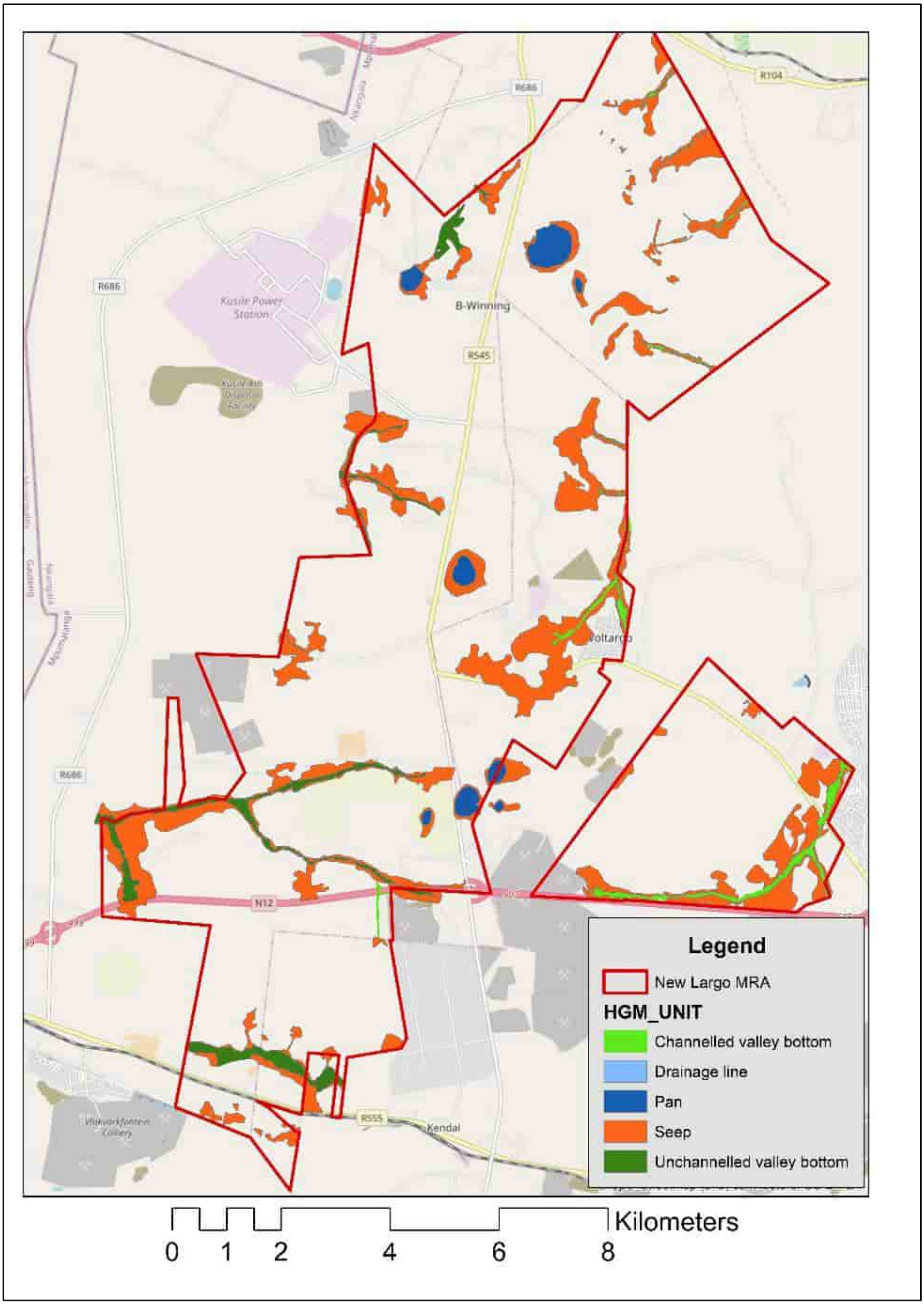


Figure 2. Distribution and HGM typing of wetlands within the study area.

6.2 Wetland Present Ecological State (PES)

The wetlands onsite exist within a mosaic of different land uses which affect the wetlands in a variety of ways. The land uses across the study area can be broadly grouped into the following categories:

- Past underground mining and associated surface infrastructure – Within the study area this is limited to past underground mining associated with the New Largo Colliery. The underground voids have resulted in limited decant of mine affected water into the wetlands at one active decant that the team is aware of at this stage. Rehabilitated material dumps are also present.
- Agriculture – On the surface, agriculture is the dominant land use across the wetlands and their catchments. This includes the cultivation of dryland crops, such as maize, and livestock grazing. Cultivation of annual crops can have a significant impact on wetlands, in particular seepage wetlands. As seepage wetlands are usually only temporarily to seasonally saturated, cultivated fields often extend into the wetland margins, causing a loss of wetland vegetation and disturbance of the soils. Cultivated lands in which appropriate soil conservation measures are not employed are also often a source of sediment, and due to reduced surface roughness can lead to an increase in surface relative to subsurface flows into and through affected wetlands. The use of herbicides, pesticides, and fertilisers leads to water quality deterioration in the receiving wetlands. Associated with agriculture in general, is the construction of earth dams within valley bottom wetlands, and occasionally, in seepage wetlands. Dams can have a significant impact on wetlands, as they impound flows, thereby reducing supply to the downstream wetlands, and at dam outlets cause flow concentration. The raised water level behind the dam wall creates a hydraulic head which, coupled with the excavation of the dam itself, creates conditions which facilitate headcut formation and channel erosion both up- and downstream of the dam.
- Pastures – Scattered amongst the cultivated fields are several areas that are planted with perennial pasture grasses and regularly mowed and baled. Pastures have a relatively low impact on wetland habitat relative to cultivation. The primary impact is reduced habitat quality and species diversity as the diversity of natural mesic grassland is replaced with a monoculture of pasture grass.
- Natural grassland – Natural grasslands, both primary and secondary, are relatively extensive within the wetlands and to a lesser extent, within their catchments. In most cases, available grassland is used to graze livestock, and depending on stocking densities, can have a negative impact on grassland if overgrazed. Secondary grassland, or semi-natural grassland, occurs in areas that have been cultivated in the past, but have been left fallow and, to a greater or lesser degree, have regenerated.

A summary of the PES results is shown in Table 5 and Figure 3.

Table 5. Summarised results of the PES assessment showing the percentage of each wetland type (in terms of extent) falling into each PES category, as well as the overall percentage per category (bottom row).

Wetland Type	PES B	PES C	PES D	PES E	TOTAL (%)
Channelled valley bottom	0 %	1 %	5 %	0 %	6 %
Depression	0 %	4 %	4 %	0 %	8 %
Drainage line	0 %	0 %	0 %	0 %	0 %
Seep	1 %	9 %	57 %	8 %	75 %
Unchannelled Valley Bottom	0 %	0 %	10 %	0 %	11 %
TOTAL	1 %	14 %	76 %	9 %	100 %

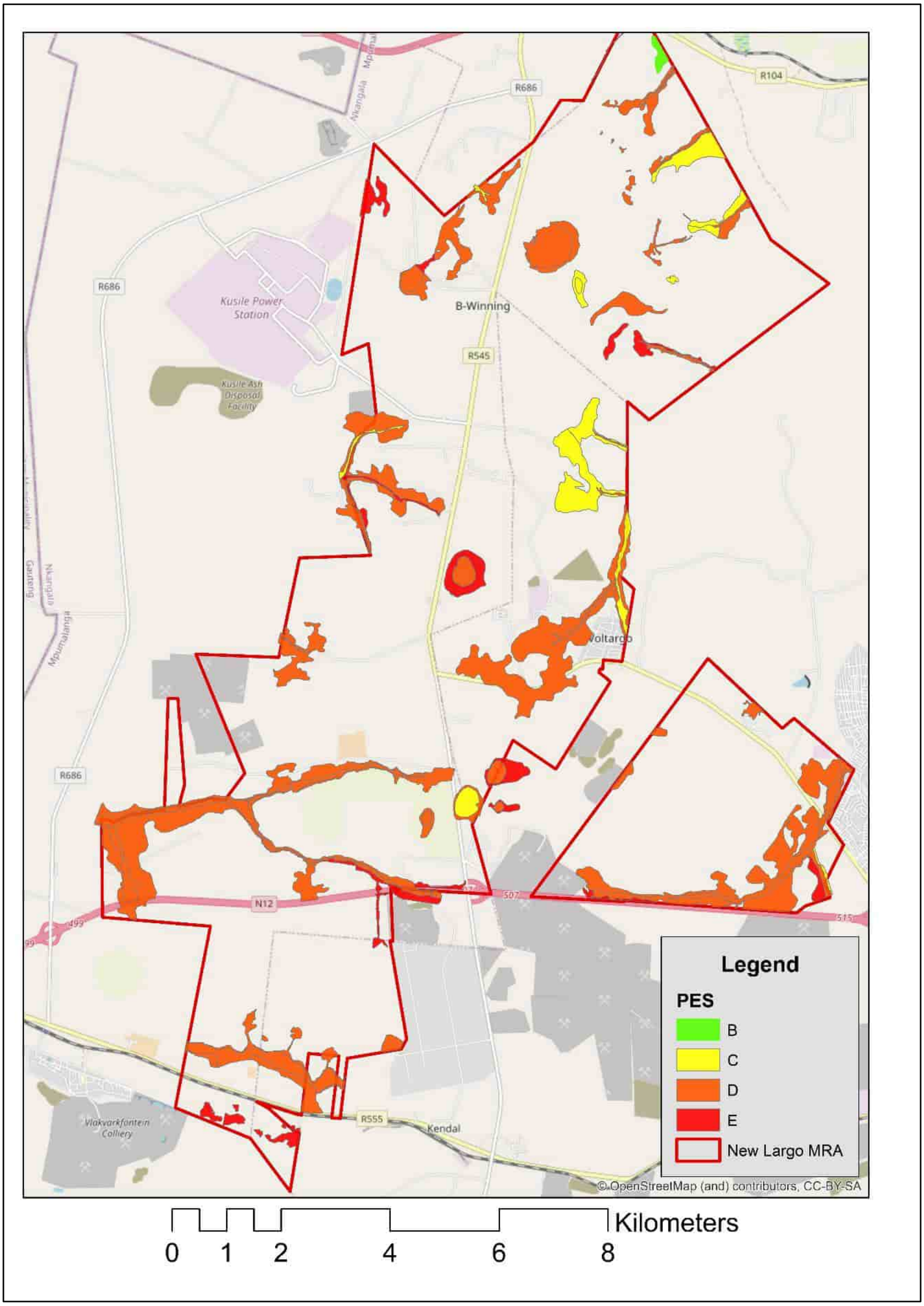


Figure 3. Map showing the PES assessment results for the wetlands within the New Largo Coal MRA.

6.3 *Wetland Importance and Sensitivity (IS)*

Based on the considerations indicated in the Methodology and Approach, it was found that the wetlands on site are mostly of Moderate IS (Table 6, Figure 5), though a number of the larger seeps and depressions are of High IS.

Table 6. Results of the IS assessment detailing the proportion of each wetland type falling into each category.

	HGM Unit					
IS Category	**Channelled Valley Bottom**	**Unchannelled Valley Bottom**	**Hillslope Seep**	**Depression**	**Drainage Line**	**Total Area (%)**
High	0.23 %	1.21 %	15.58 %	4.65 %	0.00 %	**22 %**
Moderate	5.34 %	9.56 %	44.15 %	3.70 %	0.00 %	**63 %**
Low/Marginal	0.29 %	0.00 %	15.13 %	0.00 %	0.15 %	**16 %**
Total Area (%)	5.86 %	10.78 %	74.86 %	8.35 %	0.15 %	**100 %**

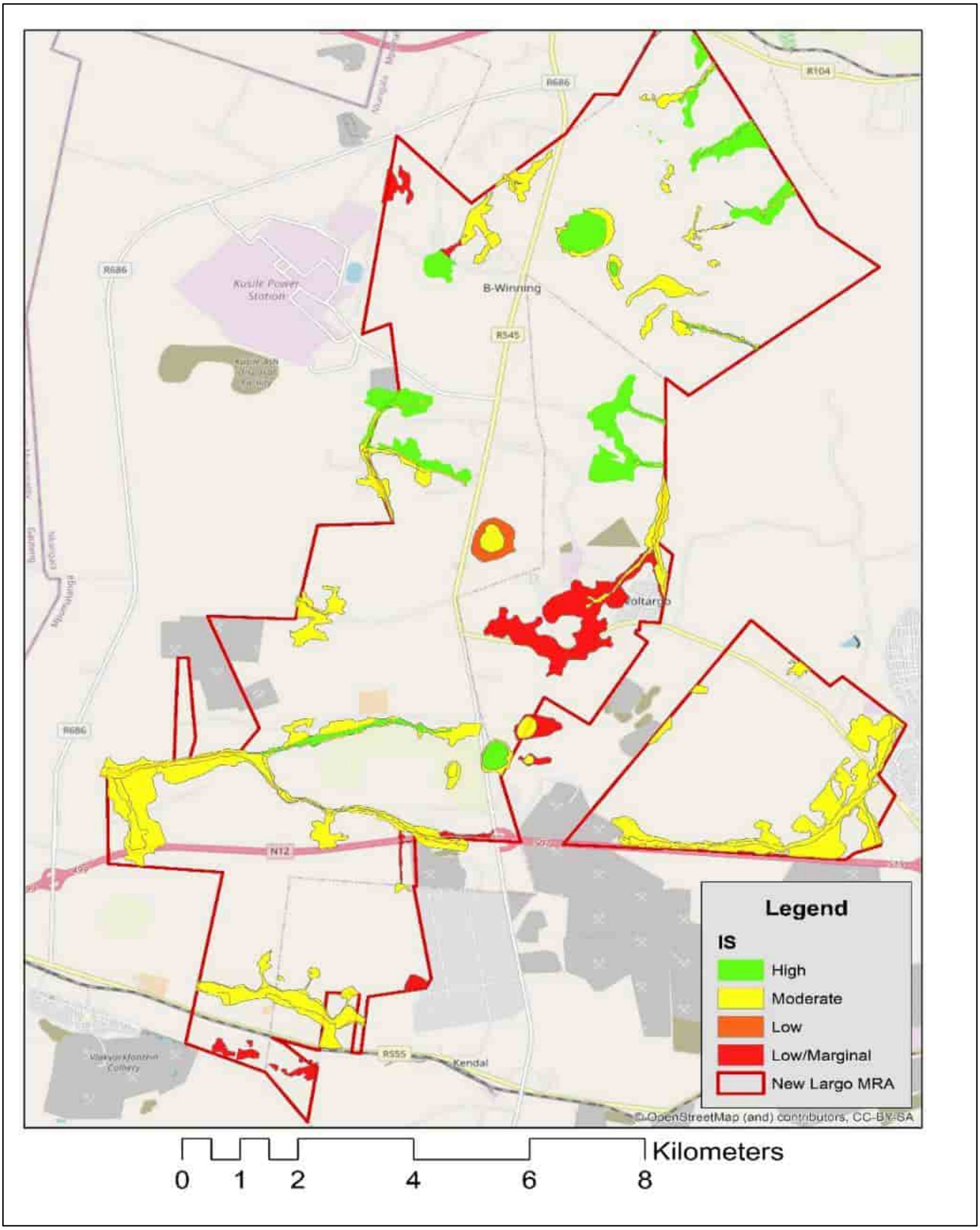


Figure 4. Map showing the importance and sensitivity (IS) of the wetlands within the study area.

6.4 Calculation of Wetland Offset Requirements

The SANBI & DWS (2016) wetland offset calculator was applied for the determination of the offset targets, using the updated wetland assessment data and the revised mine plan as input data. For the purpose of determining the required offset targets, direct wetland loss will occur in areas where wetlands will be completely lost within the footprints of mining and surface infrastructures. Indirect wetland loss refers to situations where the wetlands themselves will not be lost, but mining or infrastructure within the wetland catchment may affect the hydrology supporting the wetland by reducing flow inputs. The wetter a wetland's soils, the less water stress occurs. Conversely, if evapotranspiration or soil saturation is reduced, then this suggests water-limiting conditions and changes in the wetland-specific vegetation would be expected. Therefore, a reduction in the saturation of the wetland soils can lead to a deterioration in the wetland's condition and reduced functionality of the wetland. To quantify indirect losses, the losses were modelled using relative reductions of soil saturation and evapotranspiration of the affected wetlands resulting from the proposed mine plan, and these reductions equated to degrees of wetland degradation (lowering of the wetland PES category). Currently, there are no appropriate, scientifically developed, and tested methods to rate flow reduction of water balance components feeding wetlands or to relate this to a deterioration in wetland condition (PES). However, a suggested impact score rating for reduction of evapotranspiration and soil saturation is shown in Table 7 and was applied in determining the changes in wetland condition resulting from mining-related activities within various wetland catchments.

Table 7. Impact score on predicted wetland impacts based on average Soil Saturation Index (SSI) percentage reductions.

Severity	SSI reduction	Description	Estimated PES category reduction
No Impact	0-2.5 %	Where the reductions will not have a significant effect.	None
Low	2.5 – 5 %	Where the reductions will have a relatively small effect on the wetland integrity and functions; mitigation is unlikely to be required.	½
Low - Moderate	5 – 10 %	Where the reductions will likely have a negative effect on wetland integrity and functions; mitigation might be required.	1
Moderate	10 – 15 %	Where the reductions will definitely have a negative effect on wetland integrity and functions; mitigation is required.	1 ½
Moderate – High	15 – 22.5 %	Where the reductions will definitely have a negative effect on wetland integrity and functions; mitigation is required.	2
High	22.5 – 30 %	Where the reductions will definitely have a severe negative effect on wetland integrity and functions; mitigation is required.	2 ½
Very High	30 – 60 %	Where the impact will be severe and wetland integrity and functions are likely lost.	3
Non-Functional	> 60 %	Where the impacts are too severe for maintaining any functionality and the wetland can be regarded as lost.	4

A water use licence (WUL) (04/B20G/ACFGIJ/2538) was granted in 2015 authorising the New Largo Coal (Pty.) Ltd. to mine some of the wetlands and pans based on Mine Plan 7 which was approved at the time (Figure 5). This approval excluded the mining of Honingkrantz Pan but included the mining of a number of other pans (referred to as Pan 2 (New Largo pan), and Pans 3, 5 and 6). The 2024 mine plan includes adjustments to the New Largo mine plan which now include the mining of Honingkrantz Pan but excludes the mining of Pan 2 (New Largo pan) and Pans 3, 5 and 6, as well as a number of wetland areas that would have been lost or indirectly affected according to the previous mine plan. The change in the mine plan has led to a 45 % reduction in wetland areas impacted by mining, decreasing the direct loss from 325 hectares to 179.5 hectares. This reduction significantly minimises the wetland areas that would have been lost under the previous plan, reflecting a more environmentally considerate approach to mining operations. Figure 6 illustrated the 2024 mine plan in relation to the current wetland extent and shows those wetlands that are now proposed to be excluded from the mining activities and those that will remain directly impacted by mining activities. Even though there are exclusions of wetlands in the 2024 mine plan, there are still wetlands that will remain impacted, including Honingkrantz Pan which will be lost, and hence the strategy requires revision and updates. The extent of wetlands in relation to the proposed mining areas under the 2024 Mine Plan is indicated in Figure 6, while Figure 7 indicates direct and indirect wetland losses as a result of the proposed mining areas and associated infrastructure.

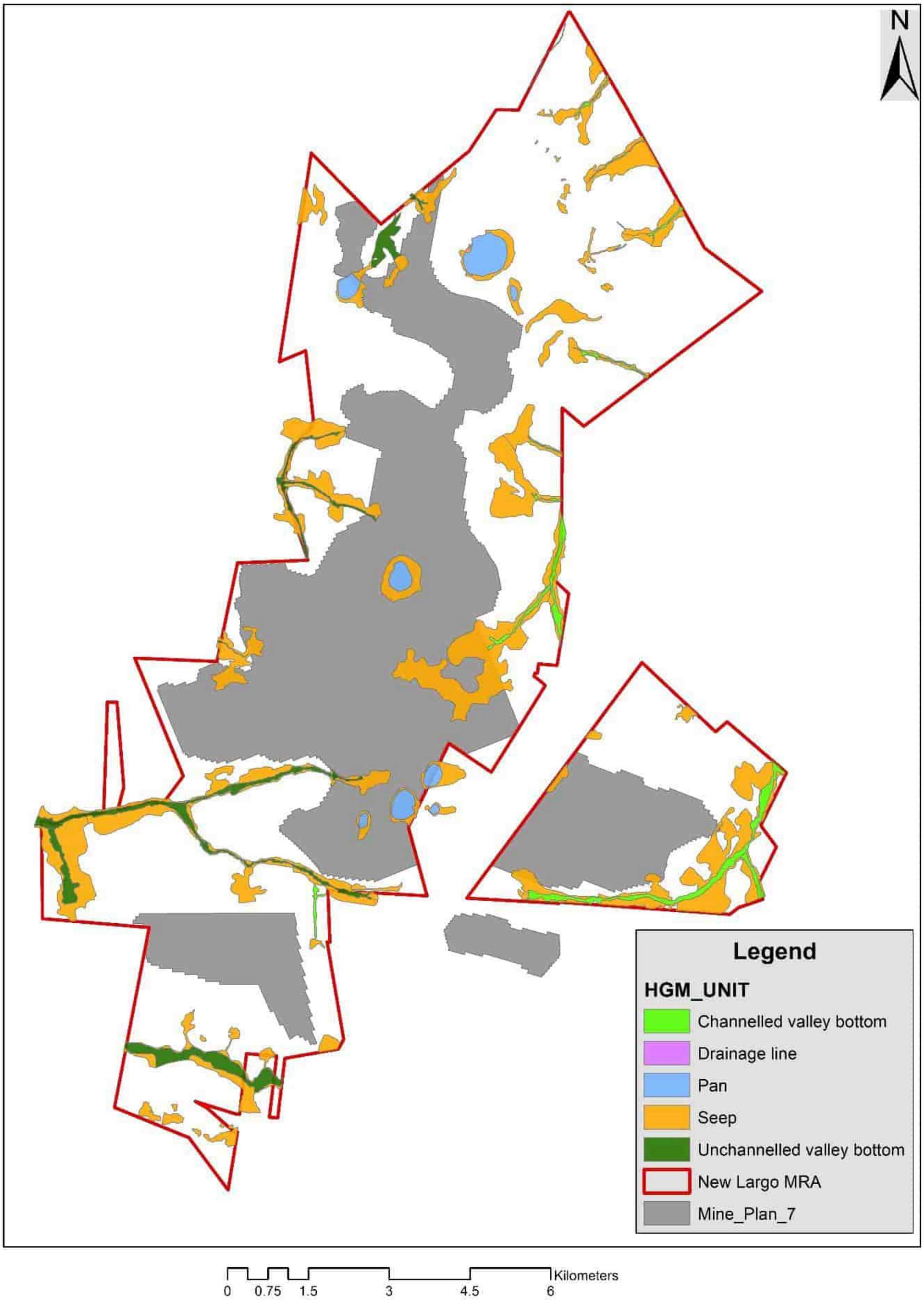


Figure 5. Approved mine plan as per existing WUL.

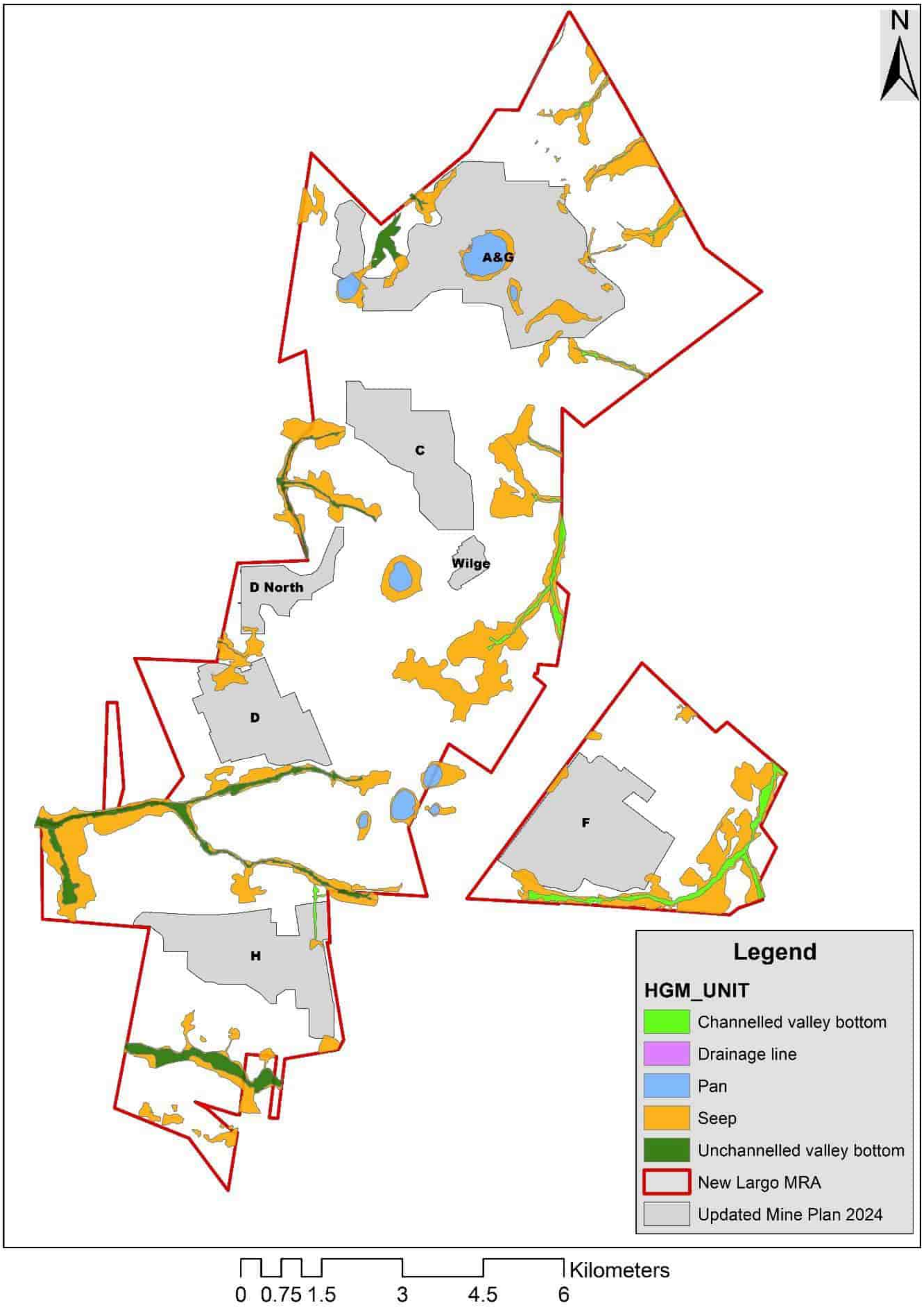


Figure 6. Map of the New Largo proposed mining areas (2024 Mine Plan) in relation to the wetlands.

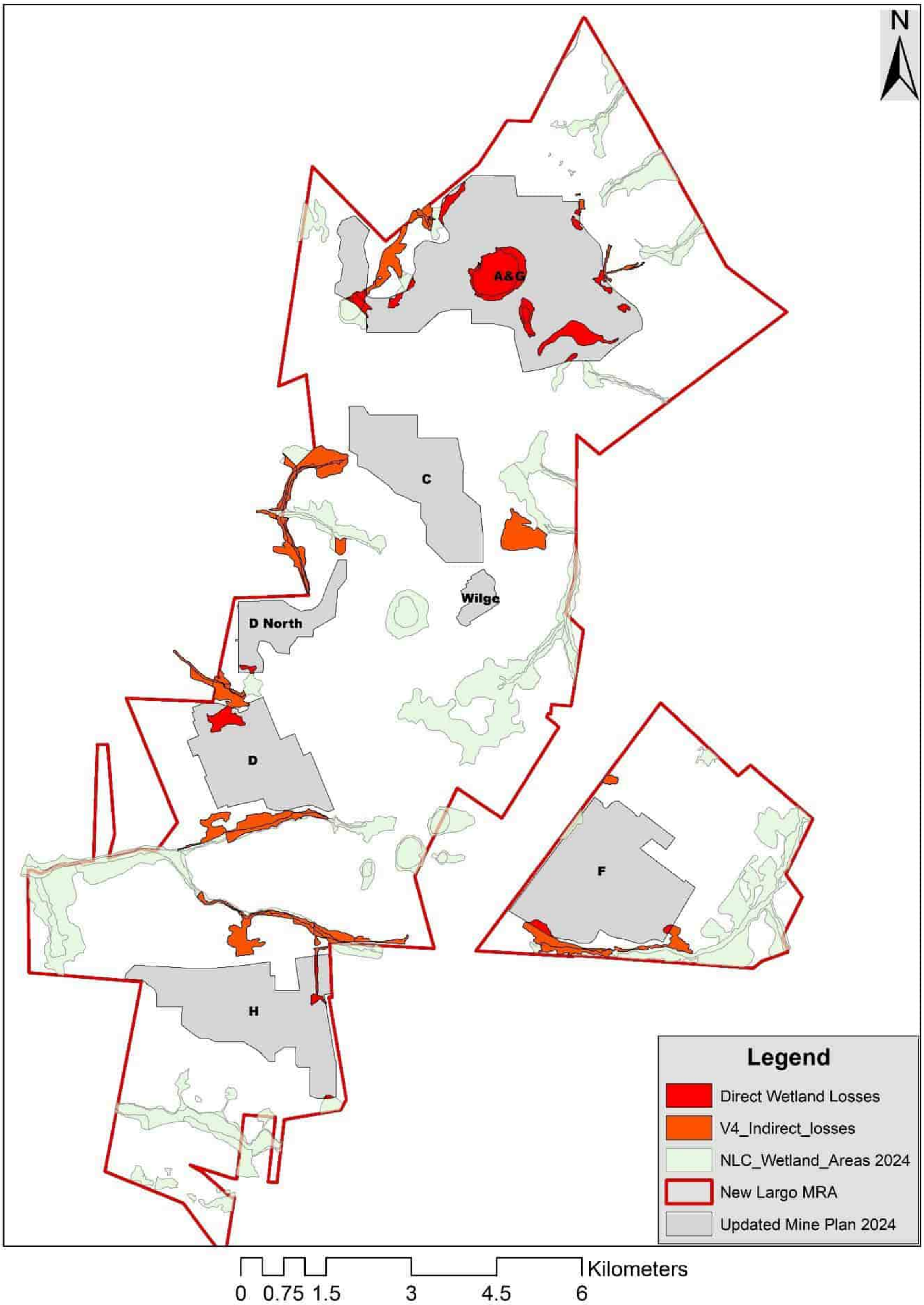


Figure 7. Map indicating expected direct and indirect wetland losses as a result of the proposed mining and associated infrastructure (2024 Mine Plan) within the New Largo MRA.

The wetland offset target calculations were revised based on the updated PES assessment (as detailed in the above section) and the current mine plan and are summarised in Table 8 (and Appendix 1). Table 9 indicates the specific offset requirements associated with the loss of the Honingkrantz Pan, extracted from the Table loss calculations. ***Honingkrantz pan has been highlighted because of the response received from the DWS that offset opportunities for the Honingkrantz Pan were not fully explored. It is therefore the intention of this integrated strategy to ensure that ''like for like'' in terms of pan offsets are fully explored in order to maximise the pan functional and ecosystem conservation gains in the updated strategy to try to meet the offset requirements for the Honingkrantz Pan***.

The goal of the wetland mitigation and offset strategy is to compensate for these losses through rehabilitation and protection of targeted wetlands remaining in the New Largo Coal MRA landscape and in an offsite area specifically targeting pans.

Table 8. Summary of the wetland offset requirements (direct and indirect losses).

Offset Requirements	***Functional Targets (ha-eq)***	***Ecosystem Conservation Contribution Targets (ha-eq)***
Requirements (Direct)	101.77	453.19
Requirements (Indirect)	36.42	452.54
Total Requirements	***138.19***	***905.73***

Table 9. Summary of both Water Resources and Ecoservices and the Ecosystem Conservation Targets/Requirements for the Honingkrantz Pan (extracted from the total requirements).

Honingkrantz Pan and associated seep	**Functional Offset targets (ha-eq)**	**Ecosystem Conservation Contribution targets (ha-eq)**
Requirements (Direct)	45.78	132.60
Total Requirements	***45.78***	***132.60***

7. WETLAND REHABILITATION AND OFFSET STRATEGY

7.1 Identification and Selection of Candidate Wetland Offsets

For the purpose of this work, ***onsite*** targeted wetlands (Figure 8) include wetlands remaining within the New Largo Mining Right Area (MRA) and ***offsite*** includes pan wetlands outside the MRA. The targeted wetlands for offset are separated into four categories as follows:

- **Category 1:** Wetland areas that are not affected by the proposed mining activities within the New Largo MRA.
- **Category 2:** Wetland areas that are partially affected by the proposed mining activities as a result of the loss of sections of the catchments and water inputs. This will include the identification and evaluation of available potential water inputs to mitigate water loss.
- **Category 3:** Remaining pan clusters within the MRA (New Largo Pan and Southern Pan clusters).
- **Category 4:** Offsite Pans (these include prioritised offsite Pan 7 and additional pan within the Seriti Surface right Areas – in Kriel and Middleburg Mine Services (MMS) – Boschmanskrans Section (BMK), and at Dispatch Rider. According to Seriti, the pans selected within the surface rights areas do not form part of any existing or proposed wetland offset associated with any of their existing mining operations and are thus available for inclusion in this wetland offset strategy.

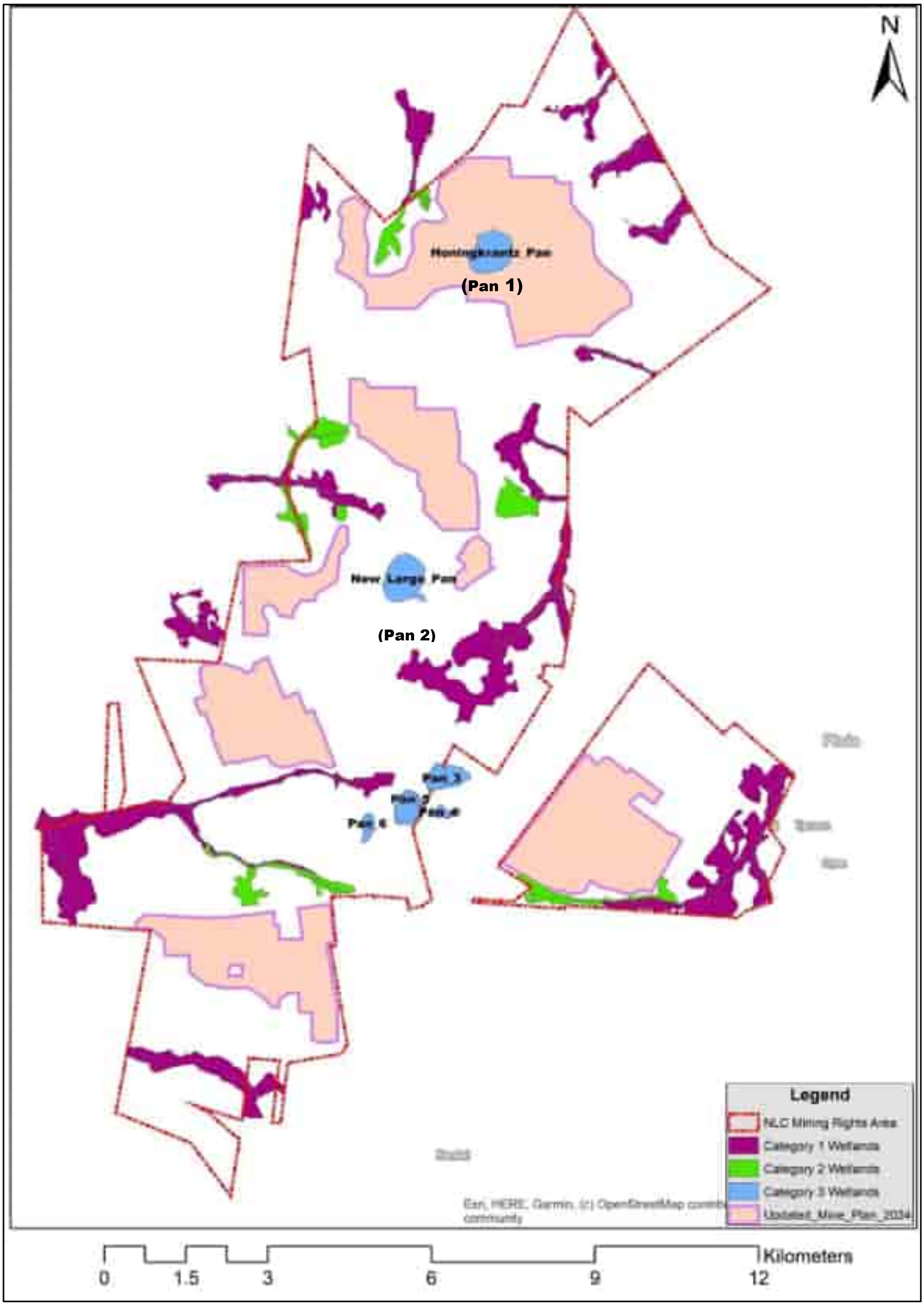


Figure 8. Location and extent of the onsite targeted offset wetlands. The pans indicated include the pan basin and seep wetlands associated with the pans.

7.1.1 Onsite Wetlands

7.1.1.1 Category 1 Wetlands

The Category 1 offset wetlands within the New Largo Mining Rights Area (MRA) are dispersed throughout the MRA and typically drain towards the west, north, or east. The hydrogeomorphic (HGM) types of wetlands in this category include channelled and unchannelled valley bottom wetlands, as well as seep wetlands. Additionally, drainage lines are part of the Category 1 wetlands. These wetlands and associated drainage lines collectively cover an area of approximately 1,224.24 hectares. Specific details regarding the various wetland types and the areas they occupy are provided in Table 10.

Table 10. Table illustrating type and extent of Category 1 wetlands.

HGM Units	Area (ha)	% Coverage
Seep	956.66	78.14 %
Channelled valley bottom	22,06	9.85 %
Drainage line	0.26	0.02 %
Unchannelled valley bottom	47.43	11.99 %
Total	1224.24	100 %

The Category 1 wetlands within the New Largo MRA were assessed to be moderately to seriously modified, with Present Ecological State (PES) categories ranging from C to E. The Importance and Sensitivity (IS) categories of these wetlands ranges from low/marginal to high, as shown in Figure 3 and Figure 4, and detailed in Appendix 2 (IS of Category 1 wetlands). Photographs depicting some of the observed impacts are included in Figure 9 to Figure 11. The primary goal of the rehabilitation strategy is to enhance the ecological condition of these wetlands, aiming for an improvement in both the PES score and category of each hydrological geomorphic (HGM) unit targeted for rehabilitation. This would help to restore functionality and improve the overall integrity of the wetland systems.

Figure 9. Photographs indicating some hydrological impacts within Category 1 wetlands (eroded channels, incisions, and headcut erosion).

Figure 10. Photographs indicating some geomorphological impacts within Category 1 wetlands (flow impoundment, infilling).

Figure 11. Photographs indicating some of the vegetation impacts within Category 1 wetlands (alien invasive vegetation – Black Wattle and Poplar trees).

7.1.1.2 Category 2 Wetlands

The location and extent of the Category 2 wetlands are illustrated in Figure 8. These offset wetlands are distributed throughout the New Largo Mining Rights Area (MRA) and consist of wetland systems that are located downslope of, or in close proximity to, the mine plan footprint. As such, they are anticipated to be indirectly impacted by the proposed mining project. The hydrogeomorphic (HGM) types in this category include channelled and unchannelled valley bottom wetlands, as well as seep wetlands. Collectively, the wetlands in Category 2 cover approximately 255.67 hectares. Detailed information regarding the specific wetland types and the areas they occupy can be found in Table 11.

Table 11. Table illustrating type and extent of Category 2 wetlands.

HGM Units	Area (ha)	% Coverage
Seep	186,18	73 %
Channelled valley bottom	22,06	9 %
Unchannelled valley bottom	47.43	19 %
Total	255.67	100 %

The assessment of the wetlands in Category 2 revealed that they are moderately to seriously modified, with Present Ecological State (PES) categories ranging from C to E. The Importance and Sensitivity (IS) categories for these wetlands ranges from low/marginal to high, as indicated in Figure 3 and Figure 4 and detailed in Table 12. Photographs illustrating some of the impacts identified in these wetlands are provided in Figure 12, highlighting the specific ecological challenges these systems face.

Table 12. The Wet-Health (Version2) Level 1B Assessment results including Importance and Sensitivity ratings of the Category 2 Wetlands.

WET_ID	HGM_UNIT	AREA (Ha)	IS	PES Category	PES %
CVB02	Channelled valley bottom	20,97	Moderate	D	44
CVB10	Channelled valley bottom	1,09	Low/Marginal	E	35
S32	Seep	7,62	Moderate	D	42
S34	Seep	8,35	Moderate	E	31
S35	Seep	22,23	Moderate	D	47
S39	Seep	36,27	High	C	56
S41	Seep	21,90	High	D	49
S42	Seep	12,31	High	D	58
S53	Seep	7,97	Moderate	D	60
S68	Seep	12,21	Moderate	D	43
S69	Seep	5,02	Moderate	E	34
S70	Seep	2,25	Moderate	E	37
S71	Seep	15,32	Moderate	E	38
S75	Seep	13,83	Moderate	D	51
S76	Seep	16,02	Moderate	E	39
S80	Seep	4,87	Moderate	D	40
UVB01	Unchannelled valley bottom	2,23	Moderate	C	64
UVB03	Unchannelled valley bottom	11,58	Moderate	D	48
UVB05	Unchannelled valley bottom	23,72	Moderate	D	49
UVB06	Unchannelled valley bottom	4,30	Moderate	C	60
UVB09	Unchannelled valley bottom	5,61	Moderate	D	54
TOTAL		**255,67**			

Figure 12. Photographs indicating several of the current impacts in Category 2 wetland systems that will be indirectly impacted by the mining activities onsite (alien invasive vegetation, erosion, flow impediments (pipes), livestock trampling, and headcut erosion).

7.1.1.3 Category 3 Wetlands

The Category 3 offset wetlands focus on five pan wetlands and adjacent seep wetlands, primarily located south of the New Largo MRA (see Figure 8). These pans, positioned along the south-eastern boundary of the New Largo MRA, at the watershed dividing westward and eastward draining catchments, are endorheic (internally draining systems). Covering approximately 132.44 hectares (as shown in Table 13), these wetlands have been strategically selected for the offset plan to help achieve a like-for-like offset for the anticipated loss of Honingkrantz Pan to the north, due to the proposed mining activities. The proximity of these pan wetlands to Honingkrantz Pan also aligns with the offset guidelines, which prioritise locating offsets as close to the impacted area as possible.

Table 13. Table illustrating type and extent of Category 3 wetlands.

WET ID	HGM Type	Area (ha)	% Coverage
P2	Depression	31,20	24 %
P3	Depression	10,80	8 %
P5	Depression	19,10	14 %

WET ID	HGM Type	Area (ha)	% Coverage
P6	Depression	3,70	3 %
S02	Seep	34.14	26 %
S03	Seep	18,30	14 %
S05	Seep	8,80	7 %
S06	Seep	6,40	5 %
TOTAL		**132.44**	**100 %**

The wetlands were assessed as Moderate to Seriously Modified, falling within PES categories C to F, with an Importance and Sensitivity (IS) categories ranging from Low/Marginal to High, as indicated in Figure 3 and Figure 4 and Table 14. Photographs showing some of the impacts identified in these wetlands are provided in Figure 13.

Figure 13. Infilling (old railway line traversing the seep of Pan 5 and running through the centre of Pan 3).

Table 14. The Wet-Health (Version2) Level 1B Assessment results including Importance and Sensitivity ratings of the Category 3 Wetlands.

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %
P3	Depression	10.80	Moderate	E	28
P5	Depression	19.10	Moderate	C	61
P6	Depression	3.70	Low/Marginal	E	39
S3	Seep	18.30	Low/Marginal	F	7
S5	Seep	8.80	Moderate	E	37
S6	Seep	6.40	Moderate	E	40
P2	Depression	31.20	Moderate	D	57
S2	Seep	34.14	Low/Marginal	D	42
Total		**132.44**			

A key aspect of the work done was related to New Largo pan (Pan 2)._This pan is affected by historical underground as well as sand mining. Previously polluted water originating from the underground void was pumped into the pan resulting in an elevated full supply level and water quality changes in the pan which persisted for decades. Water quality analyses undertaken by WSP during this study indicated elevated salt levels in the pan, despite pumping having been stopped. This is likely because of the elevated salt concentrations in the sediments and along the edges of the pan due to the long-term pumping of contaminated underground water into the pan. This pumping has been stopped and the pan full supply level has returned, more or less, to pre-mining levels as was interpreted by comparing historical imagery of the pan to present day inundation levels. It is envisaged that the reset full supply level will persist into the future as the pan now receives natural flows from the catchment. The resulting historical disturbance has translated into significant landuse changes in the pan, its associated seep and in the pan catchment, as indicated in Figure 14. The changes all affect the PES of the pan and associated seep, accounting for the degraded PES categories associated with these. The lack of hatching success of invertebrates as indicated in the results of the egg bank study discussed in Section 7.1.4 below further support the findings related to historical disturbance of this pan. A soils study of the pan basin (Soil Advisory Services, August 2024), indicated that New Largo Pan consist of soils that range from black to greyish gleyed, with a texture varying from friable to firm, consisting of coarse sand, clay loam, and clay, with thicknesses between 35 to 100 cm before transitioning to hard rock. Surface salt precipitates were observed around the pan's perimeter. Chemically, the soils are neutral to slightly saline, primarily composed of quartz and kaolinite, and exhibit low potential for acid generation. Although total concentrations of certain metals are elevated, they remain below national baseline thresholds, and their low solubility minimises contaminant risks. Water-soluble potential contaminants of concern (PCoCs), particularly during the dry season, may impact the aquatic environment, with elevated levels of water-soluble zinc (Zn) likely resulting from pan water quality rather than inherent soil chemistry. Honingkrantz pan while not fully mimicking the functions of the New Largo Pan, has chemistry reflective of largely natural pan soils, with soluble Zn levels exceeding aquatic chronic acute values. Despite elevated PCoC levels, the Honingkrantz Pan functions effectively, indicating that soluble Zn levels in New Largo Pan soils likely have minimal impact on the aquatic ecosystem. Furthermore, based on the analysis, sediment from the Honingkrantz Pan can be utilised to seal the New Largo Pan basin if necessary, helping to address stability issues related to potential cracks and sinkholes. This provided a good opportunity for rehabilitation intervention to try to improve the condition of the pan and its seep. The specific rehabilitation proposed to try to address some of these aspects is expanded upon in Section 0 below. A few photos of some of the attributes and disturbances in New Largo pan are shown in Figure 15.

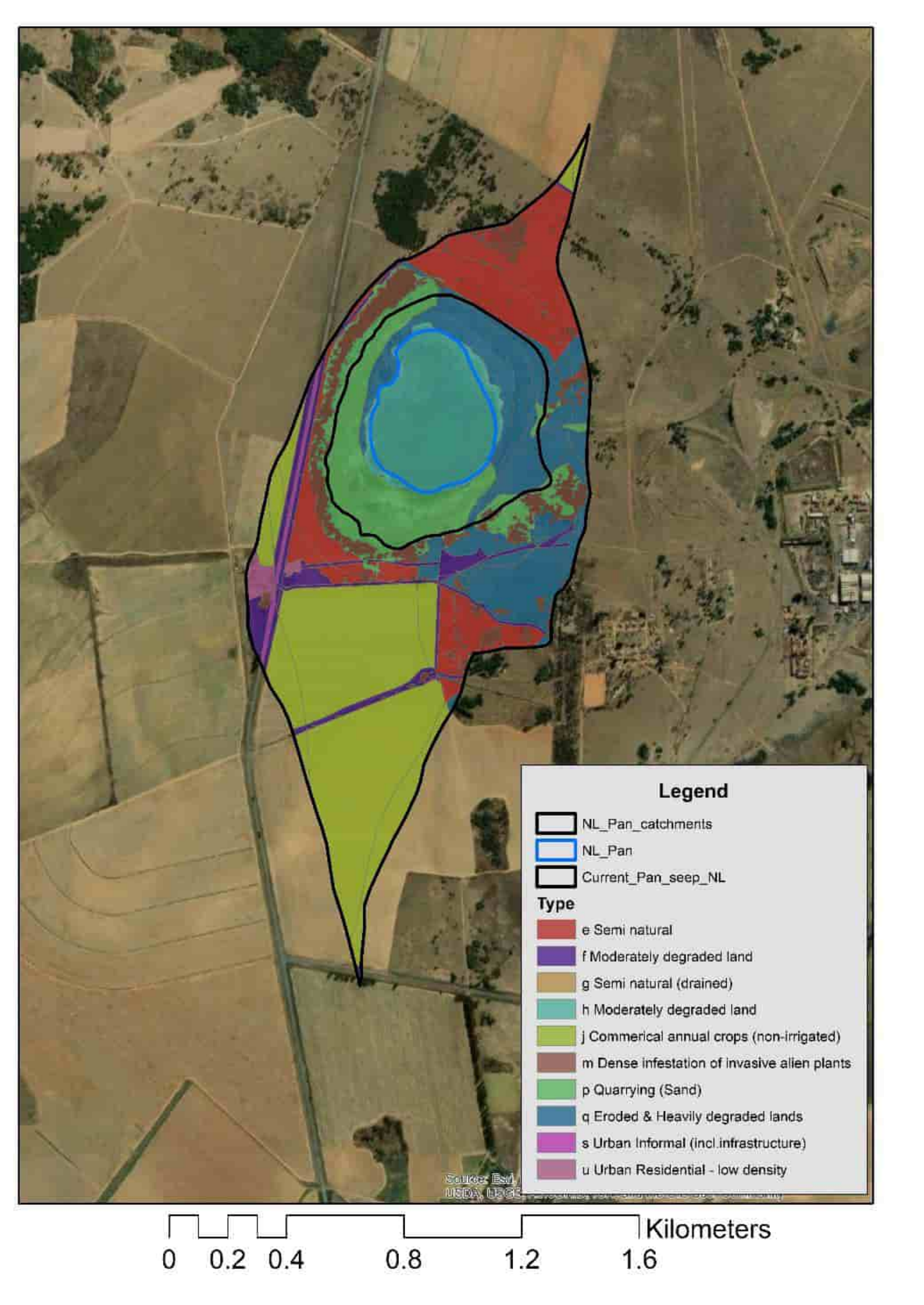


Figure 14. Current landuse associated with the New Largo pan

Figure 15. Old berms in the historically sand mined seep along the edge of the pan (top photo left). Historical full supply zone of the pan when underground mine water was being pumped into the pan (top photo right), Concentration of salts (salt crusting) in patches within the pan basin and historical seepage areas (middle photo left). Alien invasive trees along the edge of the historical seepage areas upslope of the edge of the pan basin (middle photo right). Historical trenching along the pan edge (bottom photo left). Despite the disturbance of the pan, flamingos were seen utilising the pan during the site visit (bottom photo right).

7.1.2 Offsite wetlands - Category 4 (Offsite Pans)

The site selection process for offsetting the loss of Honingkrantz Pan due to mining was conducted in accordance with the **SANBI & DWS (2016) Wetland Offset Site Selection Guidelines**. While onsite pans (Category 3) were initially considered, they could not fully meet the offset requirements for pan habitat losses. As a result, **offsite pans** (Category 4) had to be included in the strategy to compensate for the shortfall, ensuring that the offset targets for water resources and ecosystem conservation could be adequately achieved. This comprehensive process aimed to identify suitable wetlands by focusing on pans that shared key characteristics with Honingkrantz Pan. These characteristics included pan type, vegetation composition, support for similar bird species, pans larger than 10 hectares (to minimise the number of offset pans needed and avoid selecting numerous small pans), location outside the Mpumalanga Coal Fields (to secure the offset against future mining impacts), and proximity within the Wilge River Catchment (to ensure improvements and ecosystem gains within pan habitat are realised within the impacted catchment). Initially, nine pans were considered, but seven were excluded from further evaluation as they did not fully meet the selection criteria. Two pans (referred to as Pan 7 and Pan 8) were identified as fully meeting the criteria and were selected for further assessment and inclusion in the wetland offset plan.

Key Highlights of the Offset Selection Process

Selection Criteria: Pan wetlands with associated seep areas and which were similar to Honingkrantz Pan, and within the Wilge River Sub-Catchment, although not in its specific quaternary catchment, were considered. They needed to fall within the Eastern Highveld Grassland vegetation type.

Functional/Water Resources Perspective: The focus was on enhancing key regulating services rather than replicating the exact wetland. Offset location prioritises proximity to the impacted site, with preference given to local, quaternary, or tertiary catchments. The target sites had to be preferably located outside the coalfields to ensure the best chance for long-term protection. The pans had to be larger than 10 hectares.

Ecosystem Conservation Perspective: The pans needed to be located within a similar vegetation group, with similar threat status. Honingkrantz Pan, which falls within the Mesic Highveld Grassland Group 4 (Least Concern) category of wetlands, supports key bird species such as Greater flamingos and Blue cranes, criteria considered in selecting the offsite pans – providing suitable habitat for Red Data bird species.

Part of an existing Wetland Offset: The pans should not be part of an existing wetland offset strategy.

Outcome: Of the nine offsite pans assessed, only two (Pan 7 and Pan 8) (Figure 16) were found suitable for possible inclusion in the offset strategy.

7.1.3 Challenges with the Selected Offsite Pans

Subsequent to the above, Pan 8 which was initially considered as part of the wetland offset faces significant challenges due to its multiple surface landowners, making it difficult to reach agreements for implementing rehabilitation activities. For this reason, Seriti decided to exclude this pan from the offset strategy and instead, together with the study team, identified additional offsite pans to replace it. Conversely, Pan 7 has only one landowner, and agreements have already been established for its inclusion in the offset strategy as the first step in demarcating the area as a Conservation Area**.** The Pan 7 cluster includes Pan Basin (P07) and the Seep draining into the basin (S07).

The additional pans considered as replacements for Pan 8 are within Seriti surface right areas, ensuring better control over these areas as well as enabling control over the implementation of offset activities and securing long terms management and stewardship guided by monitoring. The additional areas include the **Dispatch Rider Pans, Kriel Pans** and a **MMS-BMK Pan**. In total, an additional seven pans are being considered as part of Category 4 pans to maximise the gains in terms of trying to achieve the “like-for-like” pan offset for this project.

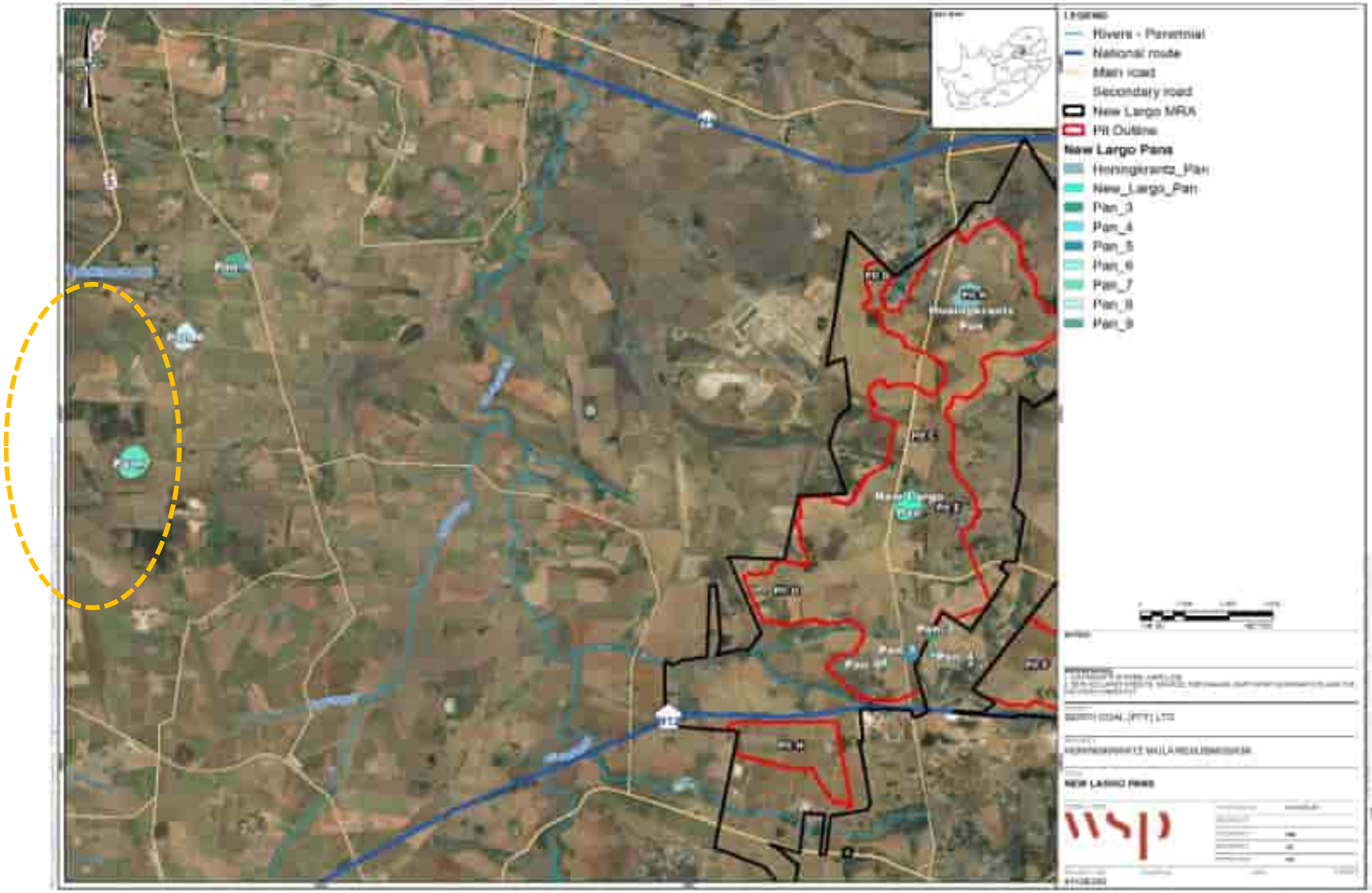


Figure 16. Location and extent of the selected on-and offsite pans targeted as offset wetlands (Source WSP, 2024). The offsite pans originally targeted are indicated in the area circled in the west.

Pan 7

The Pan basin currently exhibits favourable conditions, characterised by extensive open water areas, grassy terrain predominantly featuring a mixture of grasses and sedges. Patches of *Cyperaceae* including *Juncus* spp. occur along the edges of the pan basin. The basin provides an important habitat for flamingos, as evidenced by the observation of a large number of flamingos utilising the pan (Figure 17) at the time of the site visit.

Figure 17. Photographs of Pan 7.

The dominant vegetation within this wetland comprises grass-sedge meadows as well as *Imperata cylindrica* and *Seriphium plumosum along the edges of the pan*, alongside dense stands of *Helichrysum spp*. and *Verbena spp*. Despite its ecological significance, the seep wetland faces various challenges, including erosion, the encroachment of invasive alien species such as Poplar and *Eucalyptus* trees, (Figure 18) and the predominance of the black wattle *Acacia mearnsii*. in the surrounding catchment area. Human activities like cultivation, road construction, and excavation, especially near residential zones, further contribute to disturbances within the catchment (Table 15, attributes of Pan 7).

Figure 18. Photographs indicating Seep wetland associated with Pan 7.

There are existing opportunities for rehabilitation within both the seep wetland and its surrounding catchment area. Implementing rehabilitation efforts could help mitigate erosion, control invasive species, and enhance biodiversity. Additionally, measures to manage agricultural practices and minimise human-induced disturbances could contribute to the overall ecological health and resilience of the wetland ecosystem.

Table 15. Table summarising some of the key attributes of Pan 7 and the associated seep wetland and proposed rehabilitation interventions.

Wetland Name:	**Pan 7 Cluster**
Wetland Type & size (ha)	Pan wetland – 50.29 ha
	Seep wetland - 65.89 ha
	TOTAL - 116.18 ha
Upslope Catchment size:	183.9 ha
Present Ecological State:	Assessment Pan: B – largely natural.
	Assessment Seep: C – moderately modified.
Importance & Sensitivity:	Pan - High
	Seep - Moderate
Hectare equivalents:	Pan wetland – 43.3 ha-eq
	Seep wetland - 46.9 ha-eq
Rehabilitation Activities	Removal of alien invasive plants including weeds
	Removal of redundant infrastructure
	Stabilisation eroded areas
	infilling sloping and levelling of excavated areas
	Revegetation of disturbed areas
Land tenure	Land-owner agreement reached with Seriti on inclusion of the pan, associated seep and catchment as part of the offset strategy

The results of the PES assessment are summarised in Table 16 and Figure 19.

Table 16. The WET-Health (Version 2) Level 1B assessment results for Pan 7 and associated seeps.

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %
P07	Depression	50,29	High	B	86
S07	Seep	65,89	Moderate	C	71
Total		**116.18**			

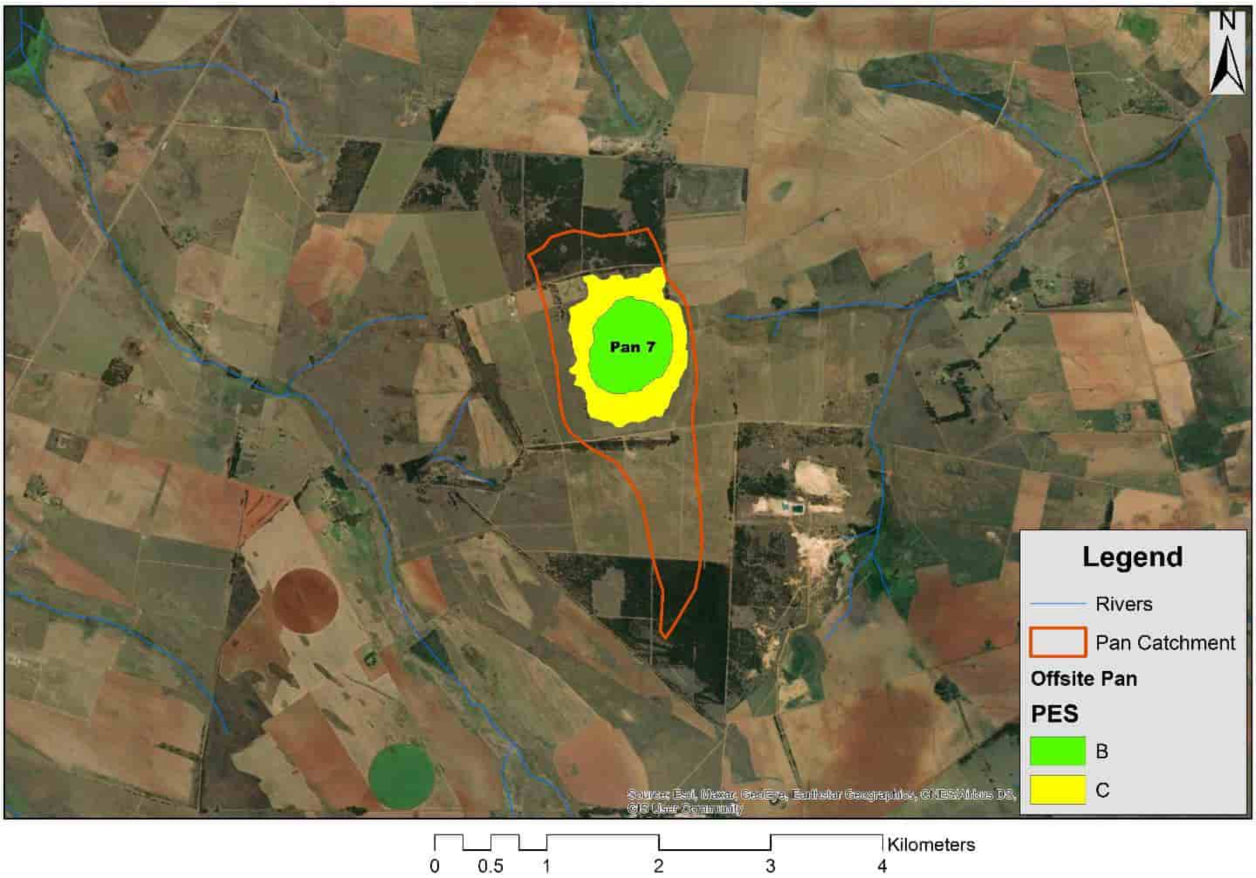


Figure 19. Map showing the results of the PES assessment of Pan 7 and its associated seep areas.

7.1.4 Uniqueness of the pans considered in the offset strategy

In an attempt to achieve a like-for-like offset for the potential loss of Honingkrantz Pan, the Wetland Mitigation and Offset Strategy was previously expanded to include 5 pans (Pan 2 to Pan 6) within the New Largo Mining Rights Area (MRA) - pans previously proposed to be mined - and two pans to the west on private land (Pan 7 and Pan 8). While Honingkrantz Pan as well as Pan 2 to Pan 6 formed part of a draft Wetland Reserve study conducted over 10 years ago, no recent detailed studies had been undertaken on these pans, and apart from a desktop assessment, no other studies had been undertaken on Pan 7 and Pan 8. In addition, no invertebrate studies had been undertaken on any of the pans previously. A key aspect of any like-for-like offset is determining like-for-like attributes. One attribute that was identified as requiring additional work was how similar or different (unique) the pans are from a conservation or biodiversity perspective. This would help clarify some of the debate as to whether or not Honingkrantz Pan is unique from a biodiversity or conservation perspective. It would also allow a comparison with the other pans being considered as possible suitable candidates for offsetting the loss of Honingkrantz Pan.

In order to address the above, an invertebrate study, using an egg bank viability assessment was undertaken by Ecology International (see Appendix 9). A total of nine pans were initially considered for the Egg Bank Viability Assessment study. Pan 9 was initially included for comparison as it was another large pan located in close proximity to Pans 7 and 8, but was later excluded due to land ownership issues. Pan 8 was included in the study but subsequently excluded from the wetland offset strategy due to land ownership issues. The study aimed to assess the uniqueness of these pans by analysing the branchiopod taxa thereby providing further insights into the ecological differences and distinctiveness of the pans under consideration as part of this study.

The findings are considered important in terms of supporting the offset strategy, particularly in terms of a like-for-like offset, and identifying similarities and differences between the pans from an ecological perspective.

The results of the study showed that hatching success varied greatly amongst the pans assessed, with New Largo Pan showing no hatching success and Pan 5 and Pan 6 showing very limited hatching success (Figure 20). The results showed that Pan 7 stood out as the most unique pan among those assessed, demonstrating high ecological importance. Consequently, Pan 7 has been included in the offset strategy, with recommendations to further enhance and preserve its ecological value. Although Honingkrantz Pan did not exhibit ecological uniqueness compared to the others, the principle of protecting well-functioning systems before they degrade was strongly emphasised and recommended in this case.

Pan 7 exhibited the highest diversity and abundance of branchiopod nauplii, with a significant peak in hatching success for *Branchiopoda (Anostraca*) observed on Day 7 of the inundation period—an outcome not seen in other pans. Many of the pans displayed similar temporal hatching patterns for *Branchiopoda (Anomopoda),* with an initial hatching phase followed by a second phase extending beyond the 30-day inundation period.
However, New Largo Pan and Pan 6 exhibited little to no hatching success, differentiating them from the others. Available data and literature suggest that anthropogenic disturbances have affected the viability of egg banks in these pans. Sediment salt retention, likely caused by mining activities, appears to be a significant factor for New Largo Pan. For Pan 6, agricultural activities within the pan's basin likely contributed to the reduced egg bank viability.

Except for Pan 6, all pans were sampled while inundated, leading to some sampling limitations. Despite these challenges, the study offers valuable insights into the health and viability of the egg banks across the pans and highlights the influence of human activities on these ecosystems. The findings emphasise the need for careful management and mitigation efforts to preserve the ecological integrity of these pans. Proposed rehabilitation activities, particularly in New Largo Pan, aim to improve ecological conditions and enhance the opportunities to try to get back some of the diversity and abundance of invertebrates, including some of the *Branchiopoda.*

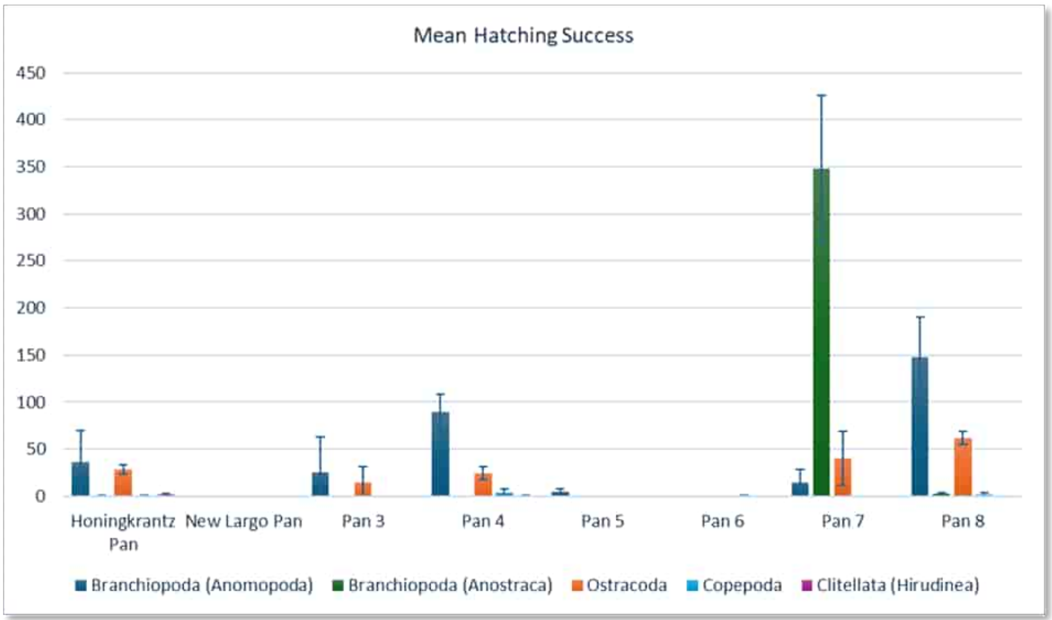


Figure 20. Mean hatching abundance for the pans assessed during the egg bank study.

7.1.5 Ecological integrity assessment of the additional selected pans

7.1.5.1 Dispatch Rider Pans

Depression and Seep wetlands are present onsite. Seep wetlands are typically sustained by subsurface interflow through the soil profile, with surface water only emerging during periods of complete saturation. Due to the widespread sandstone-derived soils in the study area, which generally promote interflow, Seep wetlands are extensive in both occurrence and extent. Most of the Seeps onsite are connected to the Depressions and drain towards the Depression basins.

Depression wetlands, also known as Pans, vary in size from 8 ha to 40 ha. These basins are typically characterised by a short, structured grass-sedge mosaic community, with patches of taller reed and grass species, such as *Typha capensis* and occasionally *Phragmites australis*, which are more commonly found along the basin edges. Hydrophilic plant species frequently encountered in the pan basins include *Leersia hexandra*, *Panicum repens*, *T. capensis*, *Agrostis lachnantha*, *Helichrysum aureonitens*, *Fuirena sp*., and *Eleocharis sp*. Standing water was present in several larger Pans, although open water habitat was only observed in Pan P3.

The Present Ecological State (PES) assessment revealed that most of the wetland habitat onsite is largely modified, classified under PES category D (Largely Modified). Approximately 43 % of the wetland habitat falls within PES category C (Moderately Modified) (Table 17 and Figure 21 and Photographs of some of land use impacts areas indicated in Figure 22 to Figure 24). The Pans and Seeps in the mining area have been significantly impacted by infrastructure related to current mining activities. Specifically, Pan P1 has been dissected by a haul road, conveyor belts, and powerlines, leading to a quarter of this Pan becoming isolated and experiencing a considerable reduction in functionality.

Table 17. The WET-Health (Version 2) Level 1B assessment results for the additional pans and associated seeps.

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %
P1	Depression	8,60	Low	D	59
P2	Depression	23,30	Moderate	C	78
P3	Depression	26,50	High	C	61
P4	Depression	7,70	Low	D	42
HS1	Seep	9,40	Moderate	D	54
HS2	Seep	21,50	Moderate	C	61
HS3	Seep	20,00	Moderate	D	41
Total		**117,00**			

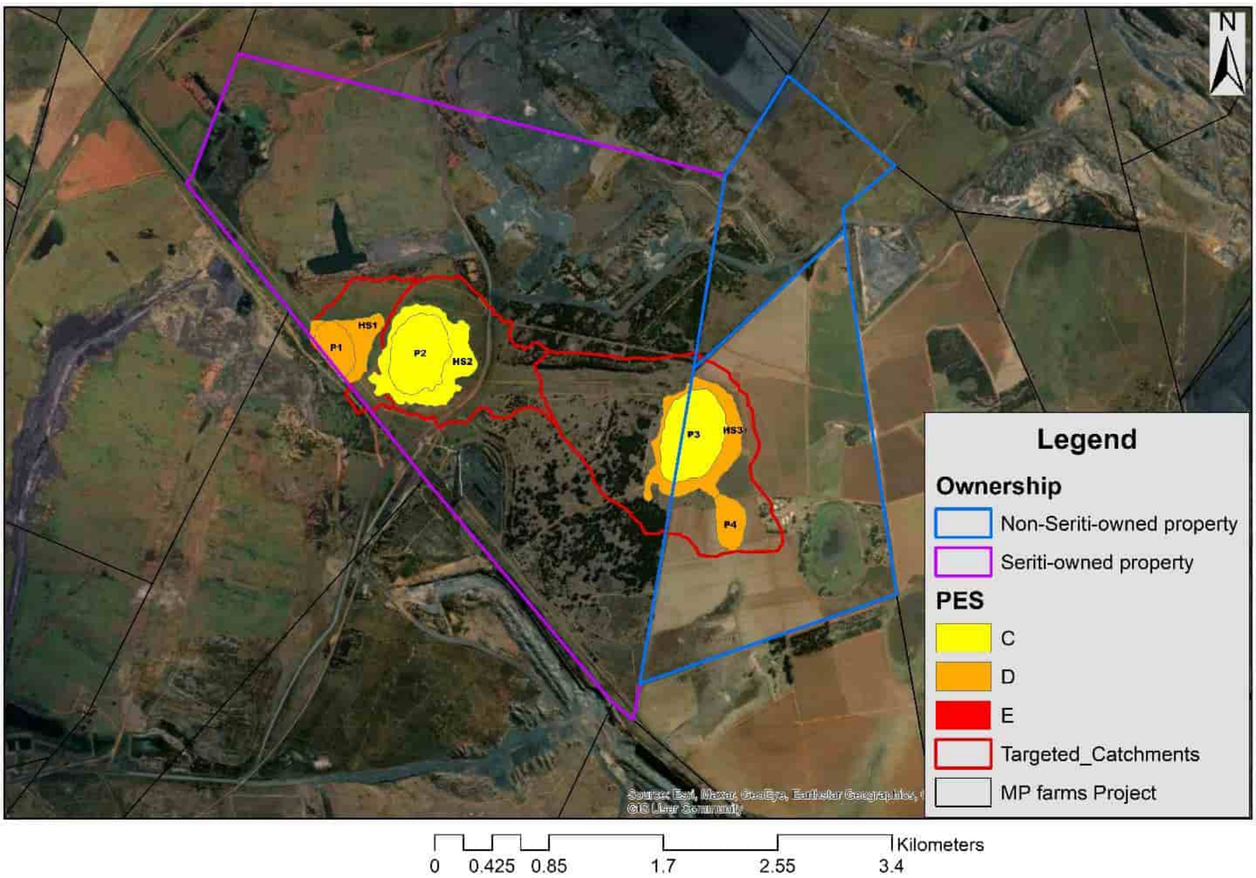


Figure 21. Map showing the results of the PES assessment of Dispatch Rider pans offsets and associated seep areas, the red outline catchment area extent of the areas targeted for the offset strategy and four pans within these catchment areas

Portions of Pan 3 (P3) and Pan 4 (P4) are situated on a property where Seriti holds prospecting rights but does not own the surface rights. As a result, while Seriti has exploration access, the company does not have full control over land use or activities related to surface rehabilitation or other interventions on that portion of the property.

Figure 22. Photographs of some of the land uses and impacts on Dispatch Rider wetlands (Pan 1 (P1))

Figure 23. Photographs of some of the land uses and impacts on Dispatch Rider wetlands – grazing within and around a Pan basin (P3), – trenching and excavation (apparently for a proposed shooting range) in the HS3 Seep around P3.

Figure 24. Photographs of some of the land uses and impacts on Dispatch Rider wetlands – overgrazing in HS4, Photograph F – infilling, excavation and alien invasive vegetation in HS5.

7.1.5.2 Kriel Pans

Two additional pans and associated wetland systems adjacent to the Kriel Power Station were assessed for potential contribution to the New Largo offset strategy shortfall. The wetlands, located on Seriti-owned land, comprise approximately 37 hectares of pan and seep wetlands and 131 hectares of catchments. The systems, designated as Kriel Pan and Seep 1 (KP01 & KS01) and Kriel Pan and Seep 2 (KP02 & KS02) (Figure 25), are proposed for rehabilitation to restore ecological function. Key activities include the conversion of cultivated fields to semi-natural grasslands, removal of alien vegetation such as Poplars, Black Wattle, and Blue gums, and remediation of excavated areas and dumped material through soil reshaping and revegetation. Access roads will be removed where unnecessary, and wildlife-friendly fencing will replace barbed wire to manage poaching and restrict livestock access. Photographs of land uses impacts are indicated in Figure 26).

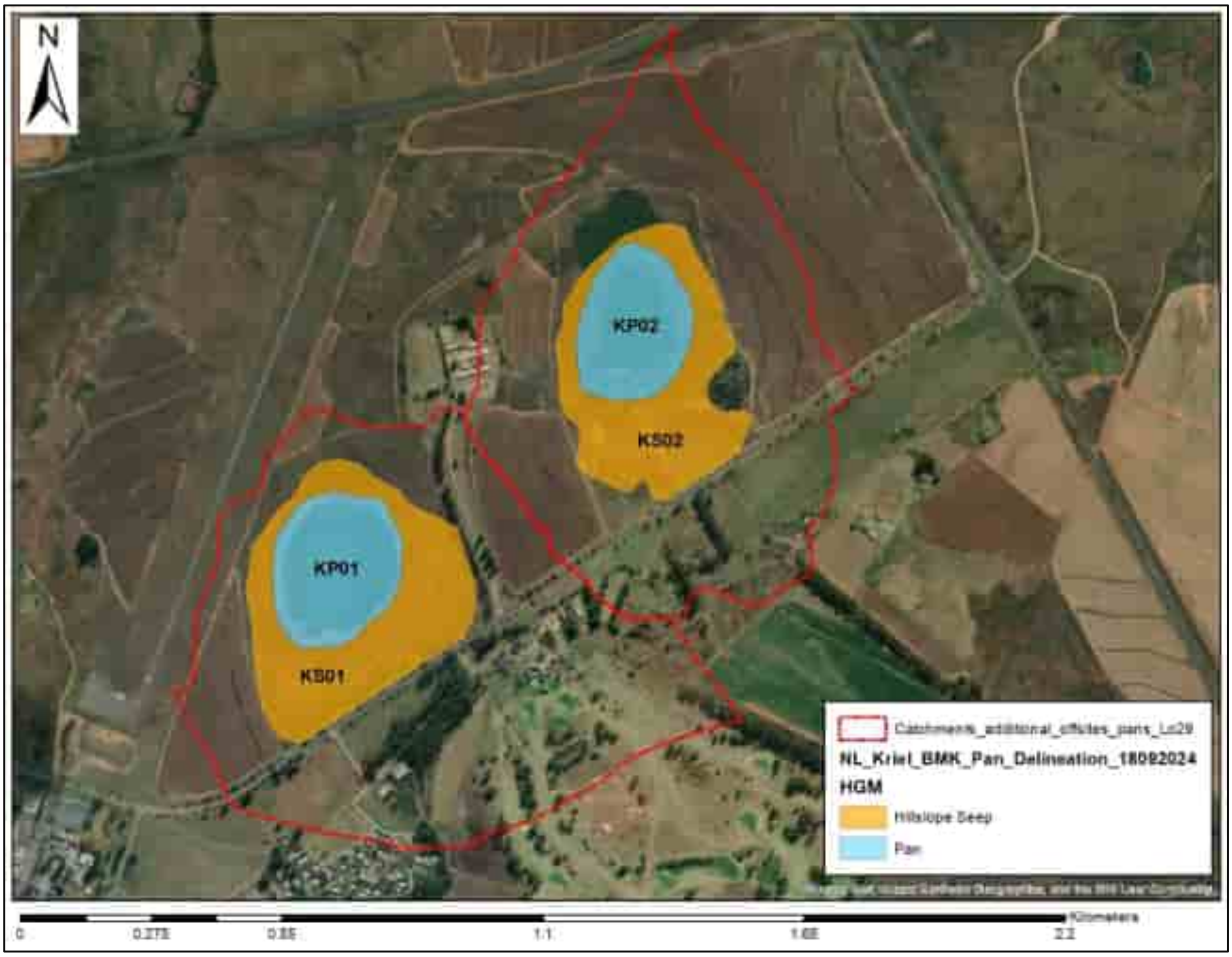


Figure 25. Map showing the two targeted pans next to Kriel Power Station, associated seep wetlands and their catchments.

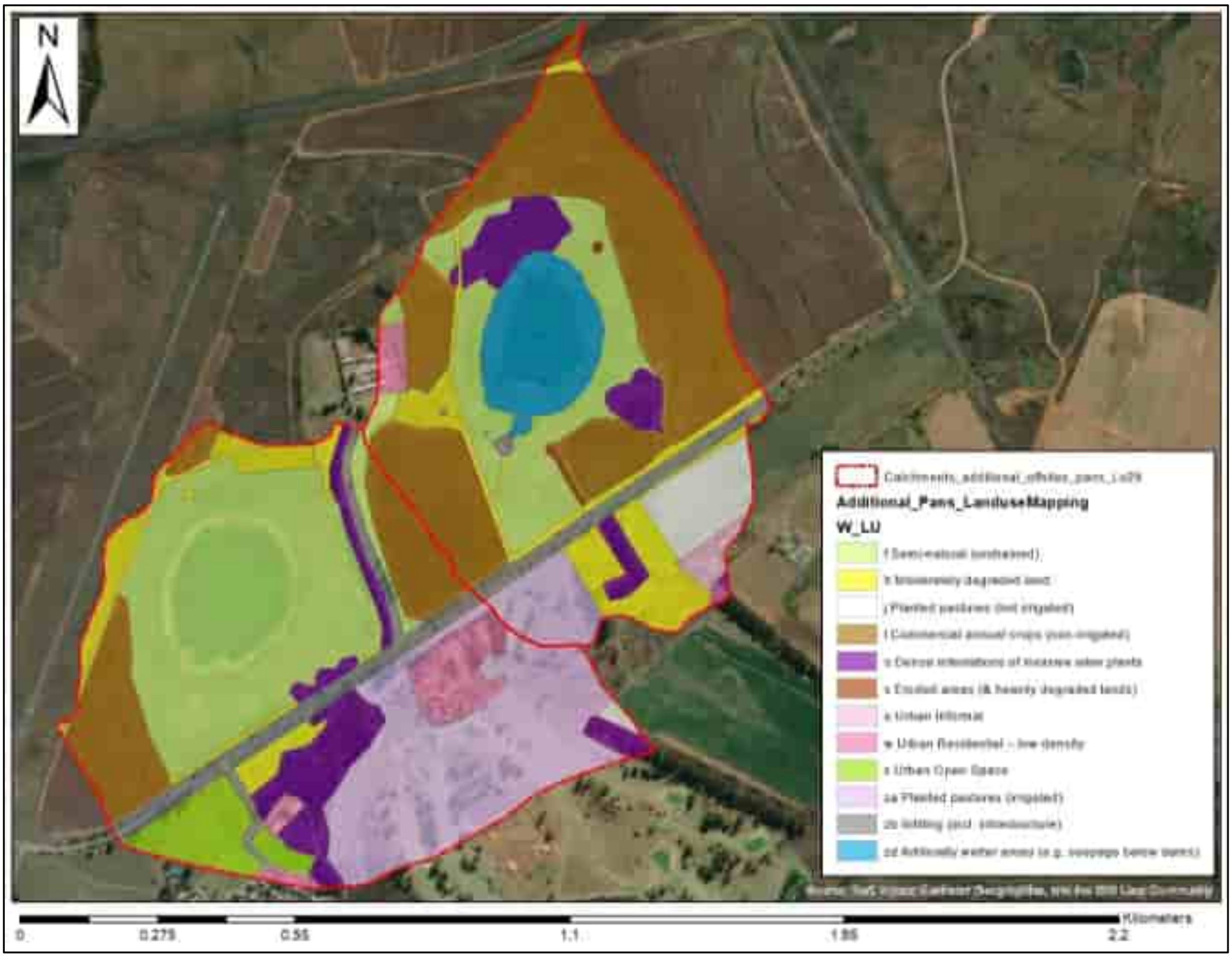


Figure 26. Map showing the land uses associated with targeted two Kriel pans next to Kriel Power Station

The Present Ecological State (PES) assessment of the Kriel wetland systems revealed that Kriel Pan 1 (KP01) is moderately modified, falling within PES Category C. In contrast, Kriel Seep 1 (KS01) is largely modified and assigned a PES Category D. Both Kriel Pan 2 (KP02) and Kriel Seep 2 (KS02) are also categorised as largely modified, with a PES Category D, indicating significant alterations in their ecological state (as shown in Table 18 and Figure 30, some of the impacts observed). These findings highlight the varying degrees of degradation across the wetland systems and inform the scope of the necessary rehabilitation interventions.

Figure 27. Photographs of some of the land uses and impacts on Kriel Pans and their associated seeps (alien invasive plants, incisions, infilling).

Table 18. The WET-Health (Version 2) Level 1B assessment results for the additional pans and associated seeps.

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %
KP01	Depression	7,24	High	C	74
KP02	Depression	6,31	High	D	47
KS01	Seep	12,51	Moderate	C	67
KS02	Seep	10.58	Moderate	C	58
Total		**36,63**			

7.1.5.3 MMS-BMK Pan

A single pan and associated seep wetland located within MMS, south of the BMK area (BMKP01 & BMKS01 also referred to as BMK Pan 3 in the Saxum Mining and Trading CC, August 2024 Report), were assessed as a potential contributor to the New Largo offset strategy. The wetlands, situated on Seriti-owned land, cover approximately 12 hectares, with a catchment area of around 31 hectares (Figure 28). Based on the site survey, several rehabilitation activities were proposed to restore ecological function. These include converting cultivated fields, which dominate the catchment, into semi-natural grasslands, and removing a small stand of Blue gums along the northern edge of the pan (Figure 29). Additionally, disturbed areas and dumped materials in the upper catchment will be removed, with the land reshaped and revegetated. Dirt access roads through the catchment will be realigned or removed where unnecessary, and the wetland will be enclosed with wildlife-friendly fencing to limit access to livestock and people, facilitating better management and conservation.

The Present Ecological State (PES) assessment for the wetland systems revealed that BMKP01 is moderately modified, classified under PES Category C, indicating a fair condition with some ecological functioning still intact. In contrast, BMKS01 is seriously modified, falling under PES Category E, which denotes significant degradation and a major loss of ecological integrity. These findings, as outlined in Table 19, highlight the need for targeted rehabilitation efforts, especially for BMKS01, to restore the wetland's functionality and improve its ecological state. Figure 30 shows photos of some of the land uses impacts recorded with the wetlands onsite.

Table 19. The WET-Health (Version 2) Level 1B assessment results for the additional pans and associated seeps.

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %
BMKP01	Depression	5,68	Moderate	C	67
BMKS01	Seep	5,89	Moderate	E	36
Total		**11,57**			

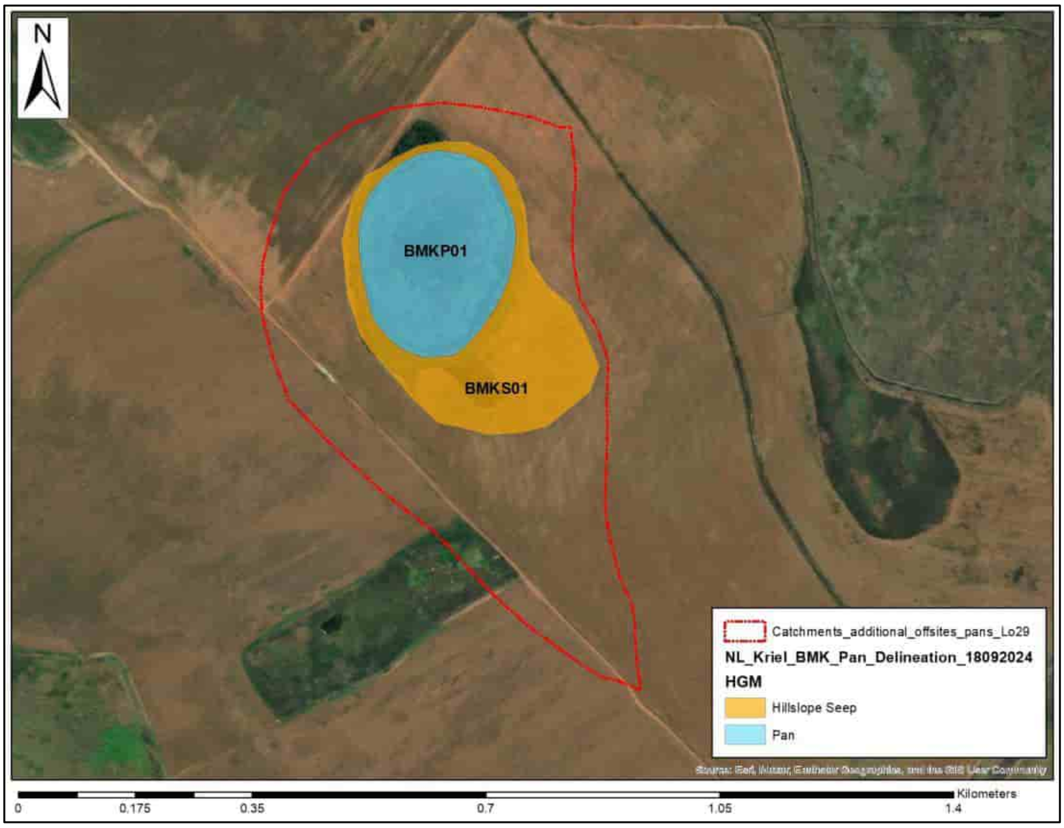


Figure 28. Map showing the targeted pan, associated seep wetland and its catchment - BMK pan

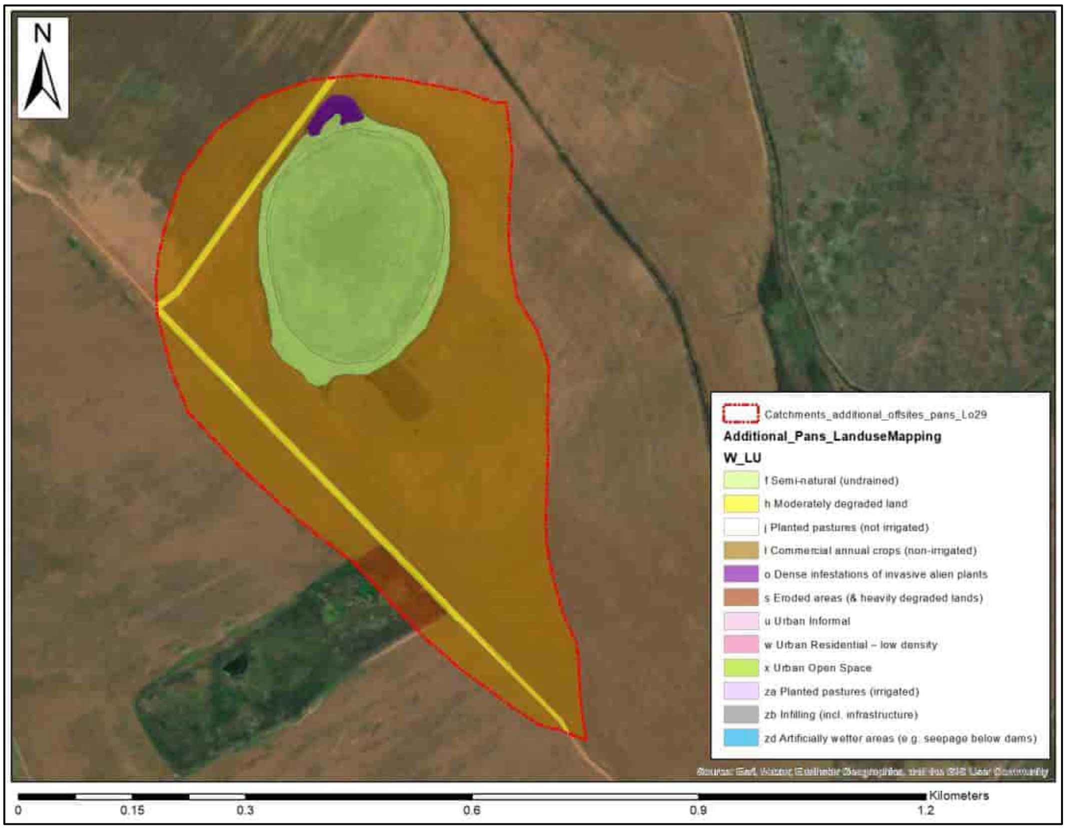


Figure 29. Map showing the land uses associated with targeted BMK pan and associated seep wetland.

Figure 30. Photographs of some of the land uses and impacts on BMK Pan and associated seep wetland (cultivation, infilling and alien invasive vegetation).

7.2 Hydropedological assessment

A hydropedological assessment was undertaken as part of this study aimed at identifying hydrological flow drivers to some of the offset pans. This assessment was necessary to identify existing impacts on natural hydrology of these pans and to guide rehabilitation measures to restore the pans a more natural state.

Initially, three pans were selected for this study: Pan 2 (New Largo Pan), Pan 7, and Pan 8. As mentioned earlier in this report, Pan 7 and Pan 8 were previously identified as the only two offsite pans targeted to fulfill the pan offset requirements. New Largo Pan was included to better understand the ecological drivers to support the development of a practical mitigation and rehabilitation strategy. However, out of the three pans, only two (Pan 2 and Pan 7) were assessed as Pan 8 was excluded due to complexities related to multiple land ownership. The remaining offsite offset pans at Kriel and MMS Boschmanskrans were added at a late stage of the study making it impossible to include a hydropedological assessment under the given timeframes for submission of this study. While a hydropedological assessment for these pans was not undertaken as part of this study, the inclusion of conceptual hydropedological studies for these pans is recommended in the next phase of the offset strategy. The following sections detail the findings of the hydropedological assessments for the two pans that were assessed to date.

7.2.1 New Largo Pan (Pan 2)

In the context of New Largo Pan, the various hillslopes were investigated to map and identify hydropedological response units and to develop a holistic hydrological understanding with emphasis of the pan's flow drivers. Three cross-sections were used to describe the hillslope hydrology from catchment divide to the pan basin. The locations of these transects are shown in Figure 31. The individual cross-sections are described in the Sections 7.2.1.1 to 7.2.1.3.

The pan basin covers approximately 11.1 % of the pan catchment. This portion is relatively small and would indicate that the pan receives a relatively large amount of flow from the catchment. This is in contrast to the field observations and comparison to other pans suggesting that the pan's hydrology is seasonal rather than more permanent.

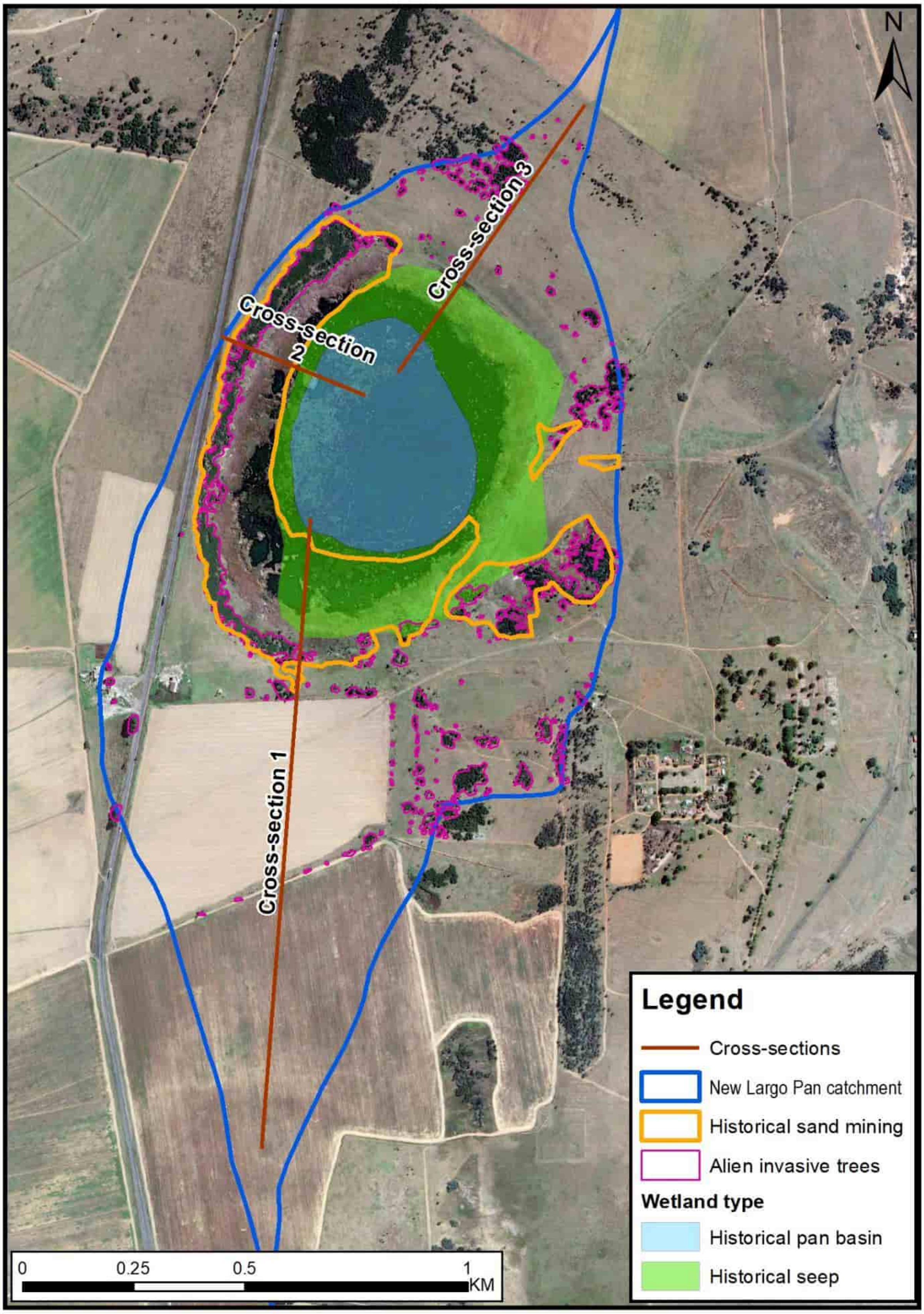


Figure 31. Map showing the locations of the cross-sections used for the hydropedological assessment in relation to the historical wetland extent (before sand mining impacts) and other current impacts within the pan catchment.

7.2.1.1 Cross-sections 1

The hillslope associated with this cross-section (see Figure 32) consists of relatively deep soils with high storage capacity in the upper reaches followed by interflow soils at the steeper parts of the slope. The interflow soil closer to the pan basin were mined out historically. Alien trees (predominantly black wattle trees) take up large amounts of interflow preventing this flow driver to contribute to the pan or seep wetland significantly. The soils within the extent of the historical seep wetland are mostly absent (due to sand mining) making these soils shallow-responsive. The pan basin edge along this cross-section was subjected to surface topography disturbances like berms and excavations for pumping sumps.

7.2.1.2 Cross-sections 2

This short cross section on the eastern portion of the catchment consists of deep recharge soils at the top followed by shallow soils (remnants of mined sand on bedrock) as shown in Figure 33. Historical imagery showed that the seep near the pan basin consisted of a relatively thin strip. The seep wetland along the pan basin was likely small due to the relatively short hillslope that does not allow for large amounts of interflow to be generated.

7.2.1.3 Cross-sections 3

The crest and upper portion of this hillslope consists of relatively shallow but well drained responsive soils. These soils contribute to recharging of the shallow perched groundwater on a seasonal basis. The steeper midslopes contain interflow soils that become shallower towards the edge of the pan basin. Historically no seep was visible on imagery. Currently the seep wetland is present along this hillslope within the interflow soils towards the footslopes. The pan basin appears to be relatively unimpacted with the expectation of the salt precipitates. It is likely that this slope is dominated by surface runoff during high intensity rainfall events due to the shallow nature of the soils. The interflow component from this northern portion of the catchment is likely small in comparison to the southern portion of the catchment.

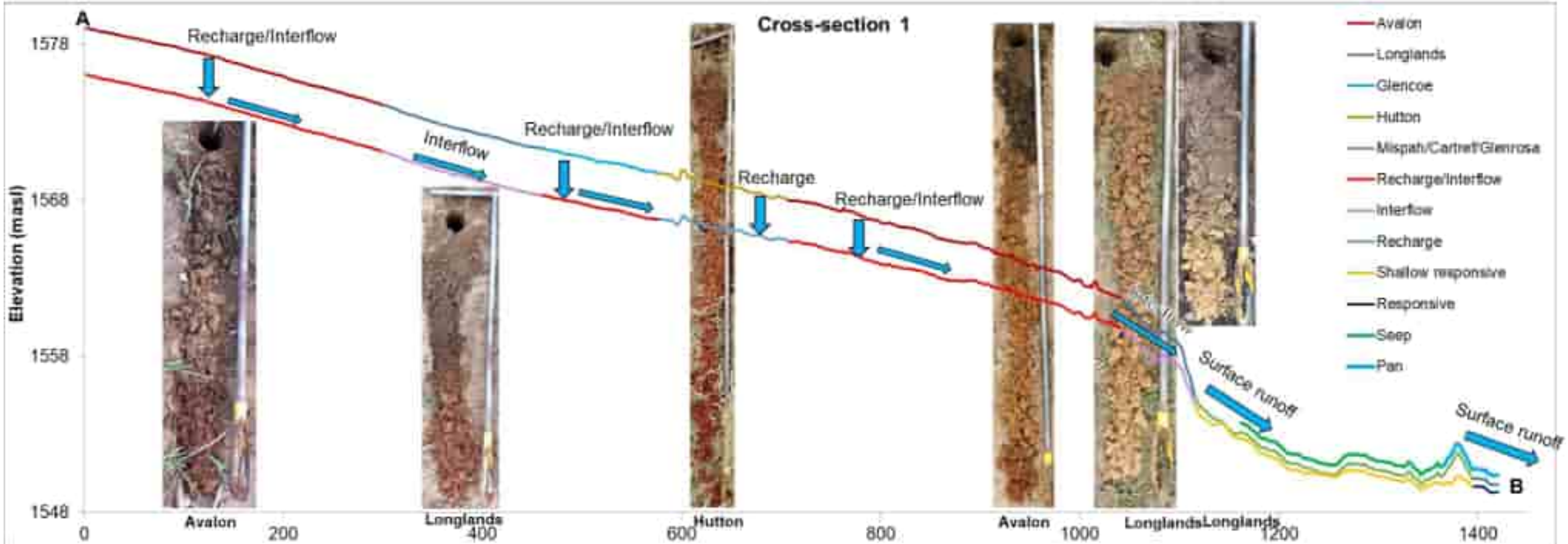


Figure 32. Cross-section 1 showing the surface topography (upper line), soil depths (difference between upper and lower line), soil forms (upper line), hydrological response units (lower line) and location of the historical seep and pan basin. Soil profile pictures are from the site-specific soil survey. Elevations are vertically exaggerated.

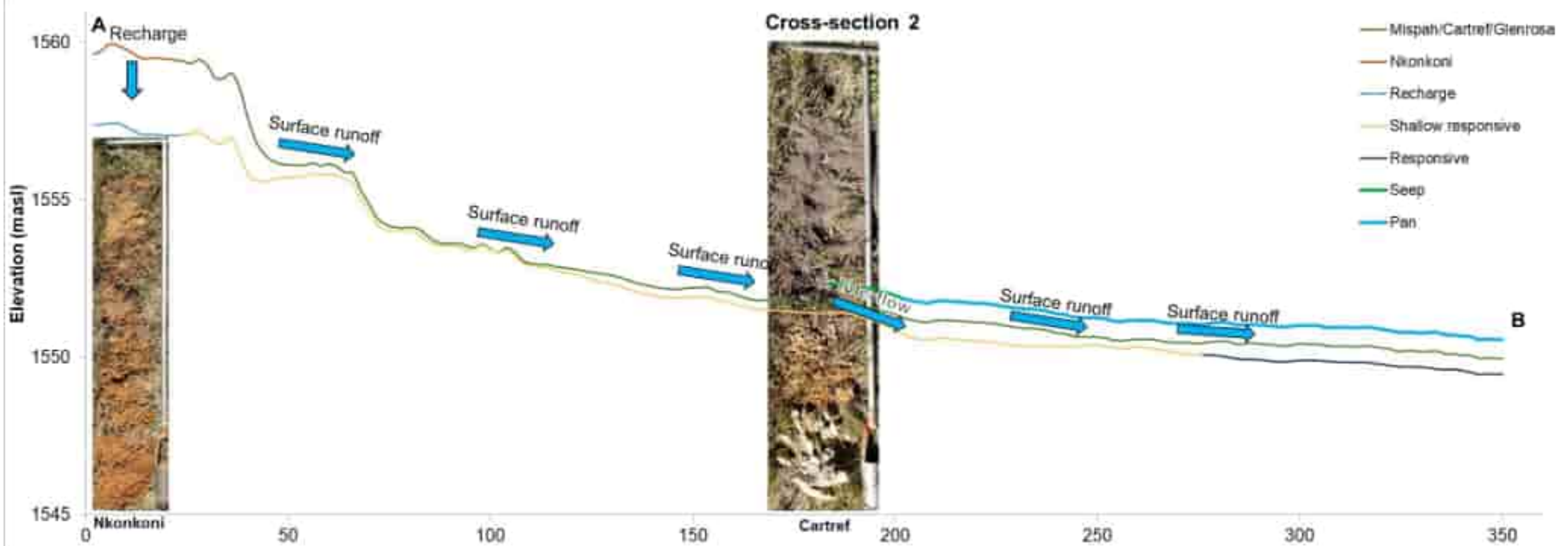


Figure 33. Cross-section 2 showing the surface topography (upper line), soil depths (difference between upper and lower line), soil forms (upper line), hydrological response units (lower line) and location of the historical seep and pan basin. Soil profile pictures are from the site-specific soil survey. Elevations are vertically exaggerated.

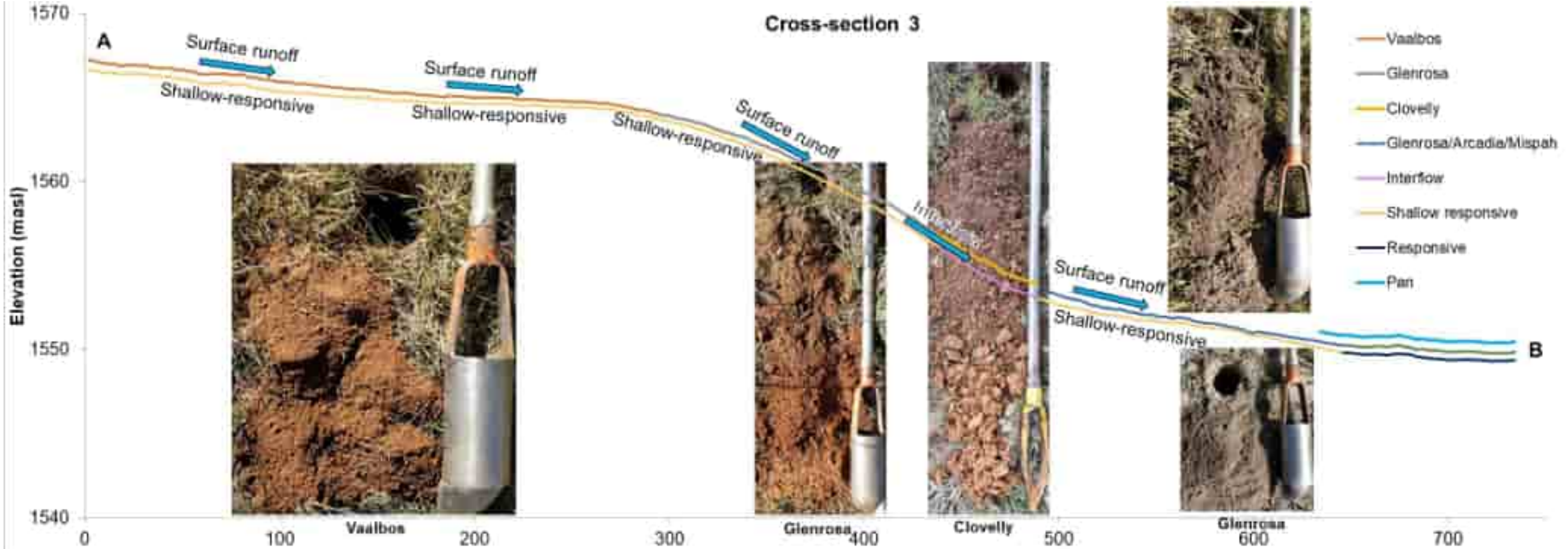


Figure 34. Cross-section 3 showing the surface topography (upper line), soil depths (difference between upper and lower line), soil forms (upper line), hydrological response units (lower line) and location of the historical seep and pan basin. Soil profile pictures are from the site-specific soil survey. Elevations are vertically exaggerated.

7.2.1.4 Hydrological Response Units

The hydrological response units identified within the pan catchment are shown in Figure 35. The southern portion of the pan catchment is dominated by deep recharge and deep interflow soils while the northern portion mainly consists of shallow responsive soils. The current wetland delineation is indicated as reference.

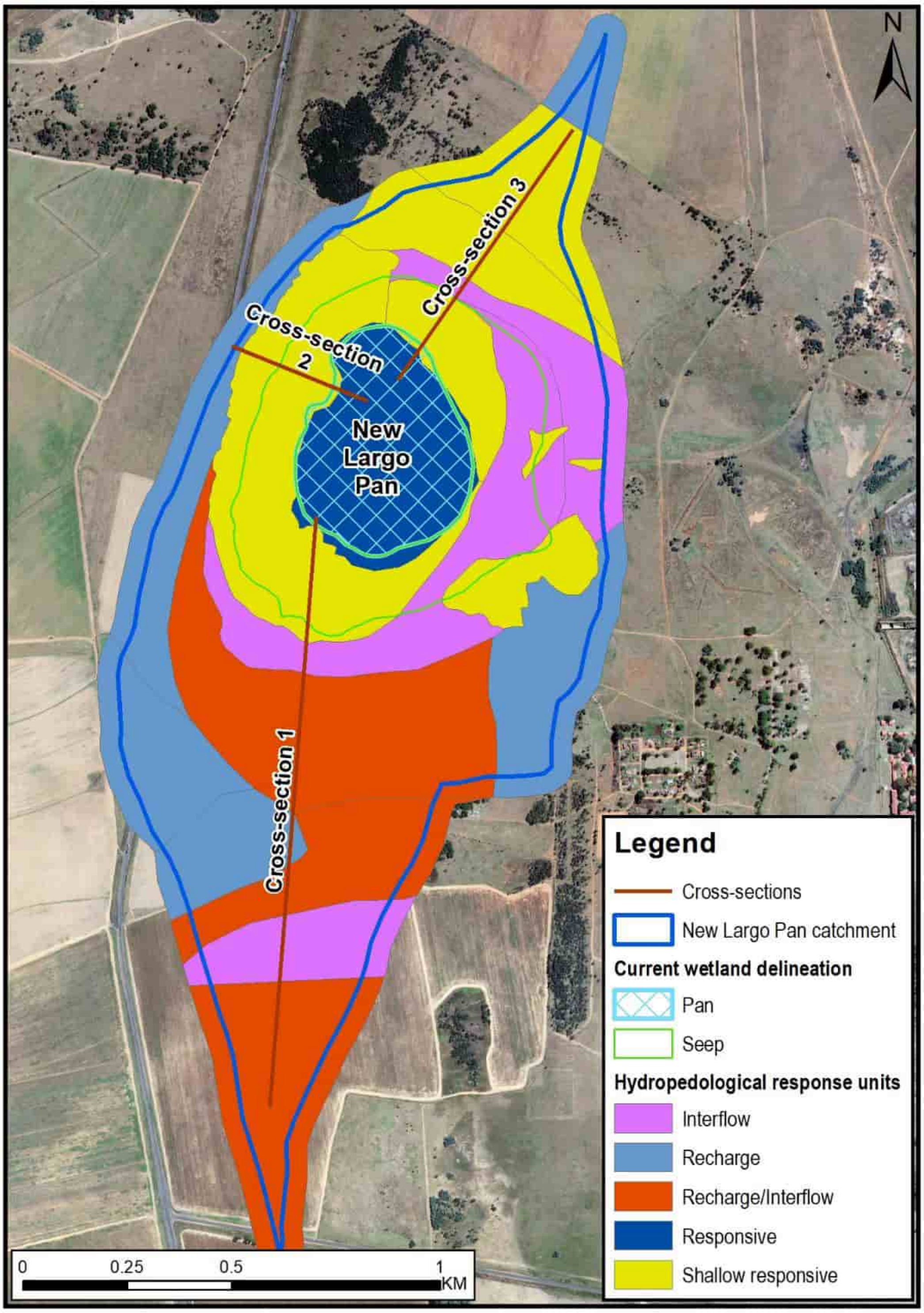


Figure 35. Map showing the hydrological response units for the New Largo Pan catchment in relation to the cross sections and the current wetland delineation.

7.2.1.5 Conceptual Hydrological Flow Diagram for New Largo Pan

New Largo Pan has different pathways of water entering and leaving the pan respectively (see Figure 37). The inflows are:

- Rainfall (directly into the pan basin).
- Surface runoff (from the pan catchment).
- Interflow (from the soils within the pan catchment).
- Groundwater as groundwater return flow.

The outflows from the pan water body are:

- Evaporation.
- Evapotranspiration.
- Groundwater percolation (Water percolating through the clay basin into below lying groundwater body (old underground workings).

The various flow drivers as well as water losses of the New Largo Pan can be summarised as follows:

- **Interflow**: This component occurs in various areas within the pan catchment typically close to the pan basin where the interflow daylight as seepage on surface within the seep wetlands. This component is not driven by groundwater but rather by seasonal shallow saturation within the interflow supporting soils.
- **Surface runoff**: Two different process generate and contribute surface runoff to the pan basin. Firstly, the shallow responsive soils consisting of a shallow soil profile over typically confined by shallow bedrock that do not have a large water holding capacity and therefore saturate relatively quickly during wet conditions. Once saturation within the shallow soil profile occurs no further rainfall can infiltrate resulting in surface runoff. The second occurrence of surface runoff is within the seep wetlands that are saturated during the wet season and are therefore unable to infiltrate any rainfall resulting in surface runoff.
- **Groundwater**: It is unlikely that the pan is in contact with any permanent groundwater body due to the extensive historical underground mining. Any groundwater percolation within the pan catchment will be lost to the pan basin as the groundwater levels are lower than the actual pan basin. It is unlikely that the groundwater levels will recover to the elevation of the pan basin as the underground workings are drained by a decant point to the west of the pan catchment that is significantly lower in elevation. The high conductivity of the historic underground mine shafts is likely to prevent water level recovery under the pan basin even during exceptionally wet conditions. Groundwater percolation from within the pan basin is likely limited to the outer edges of the pan basin as these are the only areas without a thick clay basin. The clay rich basin likely has a very low permeability preventing any significant amount of water to be lost to the below-lying groundwater.
- **Evaporation and Evapotranspiration**: These are the dominant forms of outflows from the pan basin. Vegetation occurs on the fringes of the pan basin while the inner basin is mostly free of vegetation. The majority of the outflows are therefore likely to be evaporation from the pan water body.

Monthly average rainfall and potential evapotranspiration for shallow open water bodies are shown in Figure 36. This graph highlights that the evaporation is higher than rainfall on any given month of the year. A pan water body therefore requires additional water input other than direct rainfall in order to allow for prolonged inundation. A conceptual water balance of the pan water body was developed based on the conceptual understanding of the pan. The relative contributions to the pan are summarised in Figure 39. The relative contributions to the pan under the current conditions are quantified in Table 20.

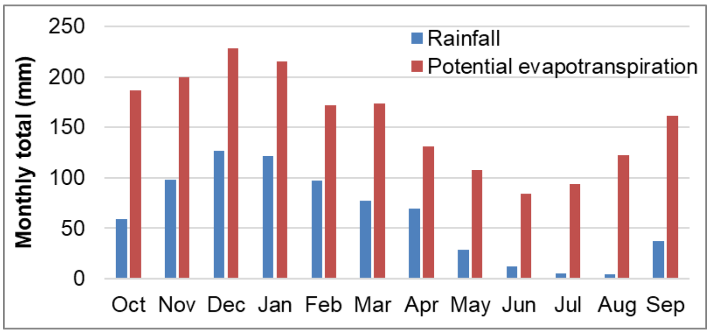


Figure 36. Graph showing the average monthly rainfall and potential evaporation totals for the region.

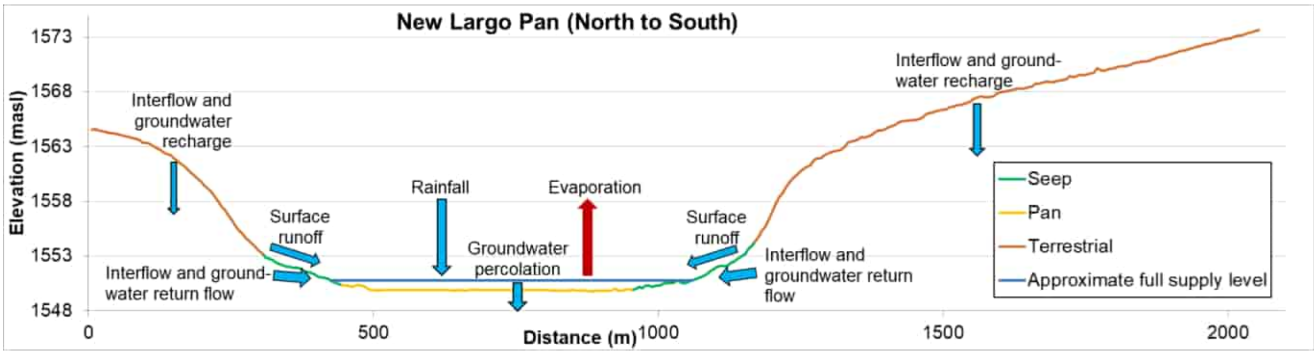


Figure 37. Conceptual hydrological flow diagram for New Largo Pan for a cross-sectional profile running from north to south within the pan catchment for all inflows and outflows under the current conditions. The wetland extent along the profile is a reflection of the current wetland extent.

7.2.1.6 Hydrological Impacts to New Largo Pan (Pan 2) Under the Current Conditions

Compared to a natural reference state there are several impacts within the pan catchment that occurred historically (either recently or in the past 100 years). The mitigation of these impacts is being discussed as part of the wetland mitigation strategy in Section 0. The impacts to the pan's hydrology compared to a natural reference state (in the order of their relative significance) are:

- Historical sand mining immediately outside the perimeter of the pan basin (See Figure 31) has led to the replacement of interflow soils with shallow-responsive soils.
- Historical underground mining of the #2 and #4 coal seam in 1987 and 1958 respectively and the associated risk of overburden cracking, sinkhole formation and subsidence potentially leading to increased linkages between surface water and the below-lying groundwater body. There is evidence of subsidence within the pan catchment (see Section 7.2.1.7). However, the current extent is limited

to a relatively small area within the catchment at the catchment divide. There is no evidence that any subsidence or sinkholes have formed close the pan basin at this stage and it was assumed that the pan's hydrology (apart from that affected by the historical impacts) is largely intact under the current conditions with the exception of the lowered groundwater table due to the historical underground mining.

- Alien invasive trees take up significantly more water than natural vegetation (Figure 31).
- High salinity (mostly sulphates) due to historical pumping of underground mining affected water into the pan basin affecting the water quality of the pan water body.
- Salt precipitates within the pan basin and immediately outside the pan basin due to salt precipitation following the drying out of the artificially high-water level due to historical pumping. These precipitates affect the pan water quality long term as they will be washed back into the smaller, present day pan basin during wet conditions.
- Berms and sumps within the edge of the pan basin as a result of the sand mining as well as pumping activities have disturbed water flow between the pan catchment and pan basin in some places.
- Agriculture within the pan catchment have altered the catchment's hydrology to a small degree.

A conceptual water balance for average conditions of the pan basin was established based on the region's specific average rainfall and evapotranspiration from Middleton et. al (2009) and based on estimates. The inflows and outflows of water balance components to New Largo Pan are listed in Table 20. It is important to note that the flows from the pan catchment to the pan were estimated and that these represent average rainfall amounts and average evaporation conditions. During higher or lower rainfall years most water balance components will likely be significantly different. Under average conditions the pan loses water faster than the inflows occur causing it to dry up at least once a year. During wetter conditions, it is possible that the pan will retain water throughout the dry season and into the following rainy season. Well established and mature alien/exotic trees within the interflow soils take up large amounts of water that would otherwise contribute to the pan under more natural conditions. The water uptake potential of these trees is likely larger than the evaporation that will occur from shallow water bodies and presented in Table 20. The removal of these trees will likely improve the water input to the pan significantly.

Table 20. Quantification of average water balance components for New Largo Pan.

Area	Flow direction	Component	Quantity (mm)	Percentage of rainfall	Source
Pan basin	Inflow	Rain	736.0	100	Middleton et. al, 2009
	Inflow	Interflow	257.6	35	Estimated
	Inflow	Surface runoff	331.2	45	Estimated
	Outflow	Evaporation (potential)	1 875.0	254.8	Middleton et. al, 2009
	Outflow	Groundwater percolation (loss)	0.0	0.0	Estimated
	Inflows	**Total**	**1 324.8**		
	Outflow (potential)	**Total**	**1 875.0**		
Pan catchment	Inflow	Rainfall	736.0	100	Middleton et. al, 2009
	Outflow to pan basin	Interflow	28.5	3.9	Estimated
	Outflow to pan basin	Surface runoff	36.6	5.0	Estimated
	Outflow groundwater	Groundwater percolation (loss)	110.4	15	Estimated
	Outflow	Evapotranspiration (potential)	1 650.0	224.2	Middleton et. al, 2009

The removal of the alien trees and the re-establishment of the mined-out soils (including placing a clay liner below the sandy soils) will result in a significant increase of the flow drivers from the catchment to the pan. It is likely that the pan will become more seasonal and carry water for longer which will likely be closer to it's natural state.

7.2.1.7 Potential Future Impacts to New Largo (Pan 2)

A risk assessment related to the probability of failure of pillars, probability of subsidence and the probability of sinkhole formation within the New Largo Pan basin was conducted by Saxum Mining (2024). Some areas within the pan catchment have already been subject to subsidence due to pillar failure caused by high extraction mining. The remaining pillars for the #2 and #4 coal seam that were mined in 1956 and 1987 respectively as well as the areas that have undergone subsidence are shown in Figure 38. The overall risk and likelihood of subsidence and sinkhole formation was rated as relatively high due the small pillar safety factors, shallow depth of underground mining as well as the poor competency of the overburden material. It is therefore likely that more subsidence and crack formation will occur in the future that will have an impact on the pan's hydrology. In the event of pillar failure within the pan catchment it is likely that interflow and potentially also surface runoff from the above lying areas will be intercepted and diverted to the groundwater body associated with the old underground workings. The magnitude of this water input loss depends on the location of crack formation or extent of the subsidence. The groundwater level below the pan basin is controlled by a decant point west of New Largo Pan which is significantly lower than the pan basin. Any groundwater recharge will therefore be lost to the pan. One mitigation measure to prevent water being lost to the underground workings is to construct a clay liner below the proposed soil infill areas. This will likely mitigate water loss in future cracks that may form due to pillar failure. The rehabilitation strategy is discussed in Section 0.

Failure within the pan basin could lead to loss of water within the pan itself or, if sufficient clay is available possible water pathways could self-seal. As can be seen in Figure 38 the pillar width within the pan basin is generally larger suggesting that a failure underneath the pan basin is less likely than the catchment.

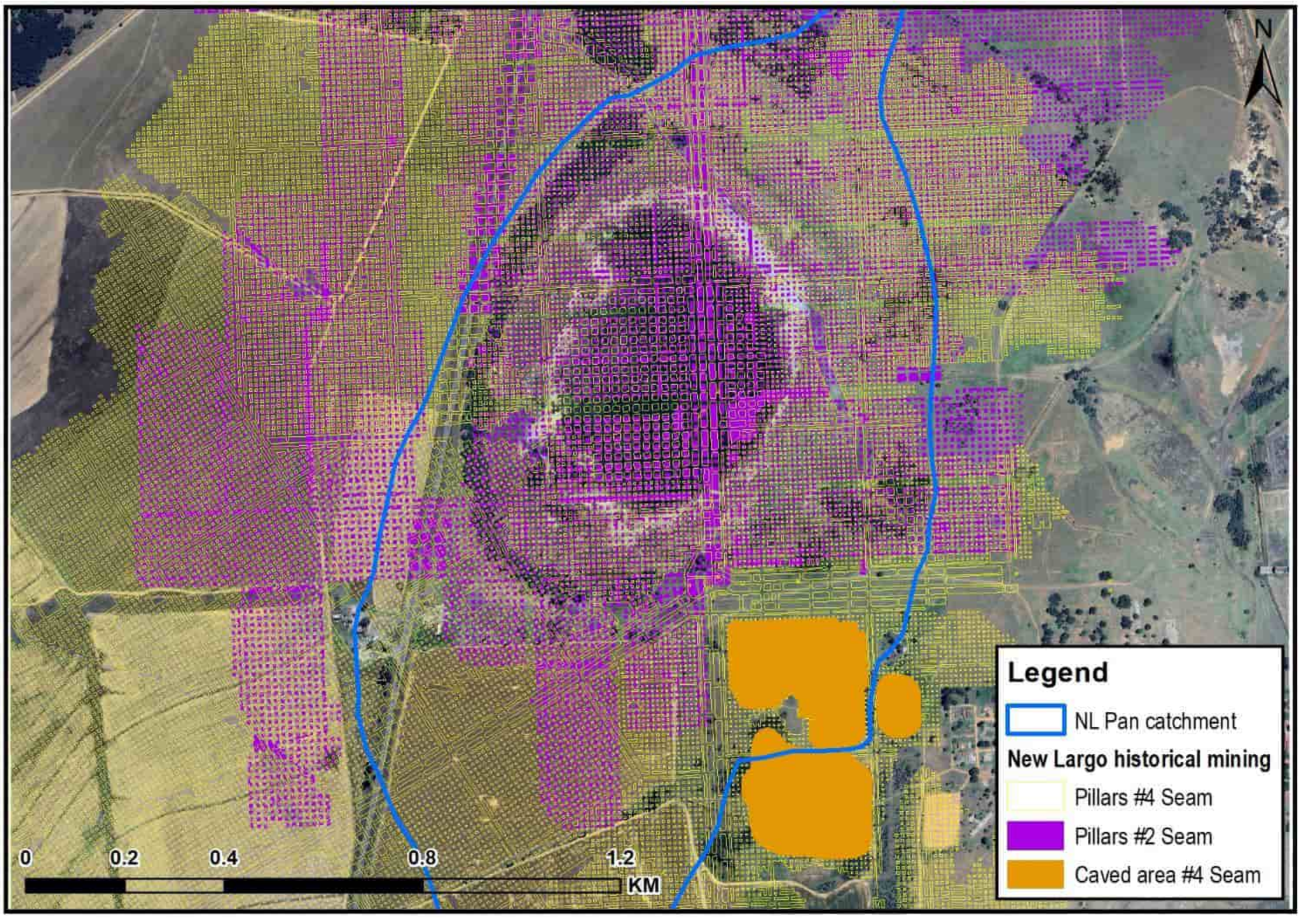


Figure 38. Map showing historically mined out pillars for the #2 and #4 seam respectively in relation to caved areas (land subsidence) and the pan catchment.

7.2.2 Pan 7

The pan basin of Pan 7 covers about 20.1 % of the pan catchment area. Compared to New Largo Pan this relative proportion is larger suggesting a less frequently inundated pan. Two cross-sectional profiles were created and used to describe the hillslope hydrology from catchment divide to the pan basin. The locations of these transects are shown in Figure 39. The individual cross-sections are described in the Sections 7.2.2.1 and 7.2.2.2 and describe the conceptual findings of the hydropedological assessment.

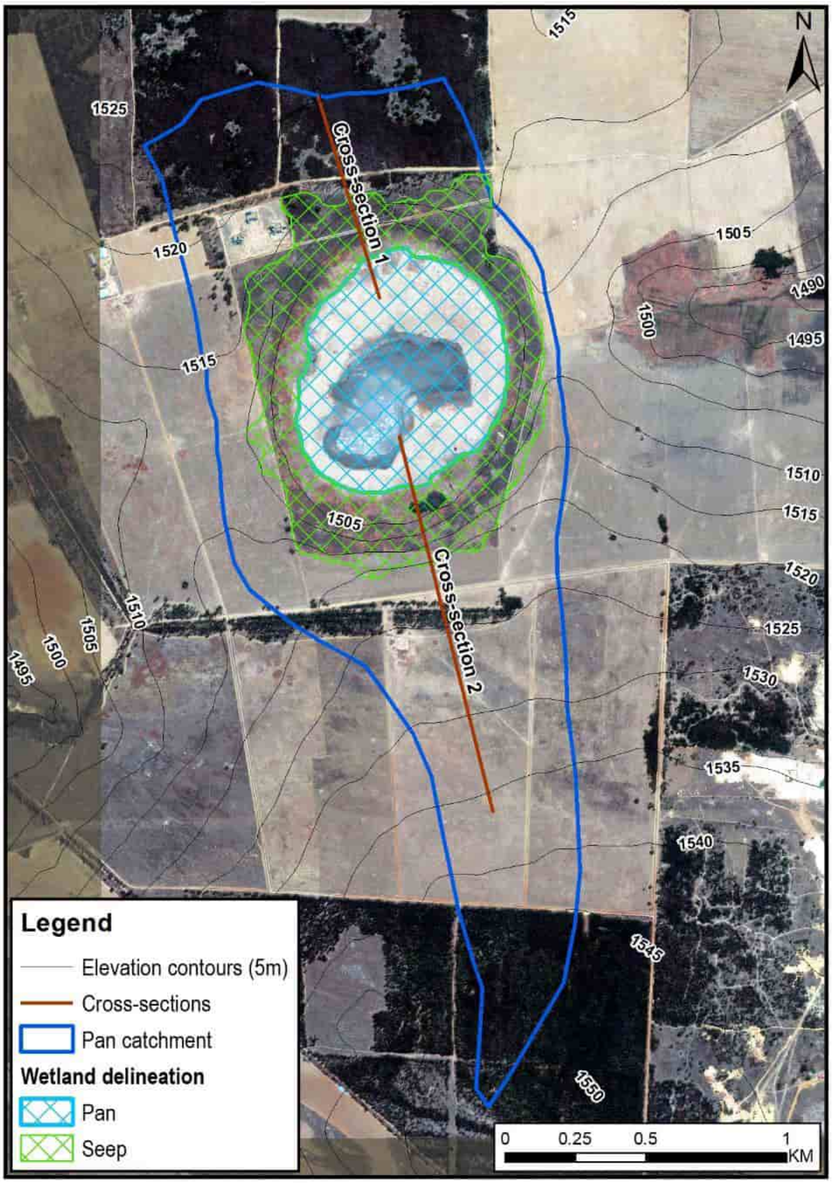


Figure 39. Map showing the locations of the cross-sections used for the hydropedological assessment in relation to the wetland extent.

7.2.2.1 Cross-sections 1

The hillslope associated with this cross-section (see Figure 40) consists of moderately deep soils that are slightly deeper in the interflow zone leading up to and within the seep wetlands. Mature alien trees take up large amounts of water within the pan catchment at the crest and upper slopes. The trees are reducing the groundwater recharge as well as recharge into the shallower perched interflow system. The interflow soils are followed by clay rich responsive soils at the pan basin. Here the interflow soils thin out towards the pan basin forcing interflow to daylight and contribute to the pan water body as surface runoff.

7.2.2.2 Cross-sections 2

This cross-section (Figure 41) represents the longest slope within the pan catchment. The upper slopes consist of a mosaic of deep sandy recharge/interflow soils and shallow rocky responsive soils. It is likely that the underlying bedrock is highly weathered and allows for groundwater recharge due to the sandy nature of the soils. Shallow soils will likely lead to surface runoff following high-intensity rainfall events. A steeper drop towards the pan basin is characterised by interflow soils such as Clovelly, Cartref, Kransfontein and Kroonstad. These soils have well developed eluviated soil horizons capable of conducting substantial amounts of water to the pan. It is also likely that these soils receive shallow perched groundwater indicated by a Poplar tree stand. These interflow soils become shallower towards the pan basin where they pinch out into Katspruit responsive soil.

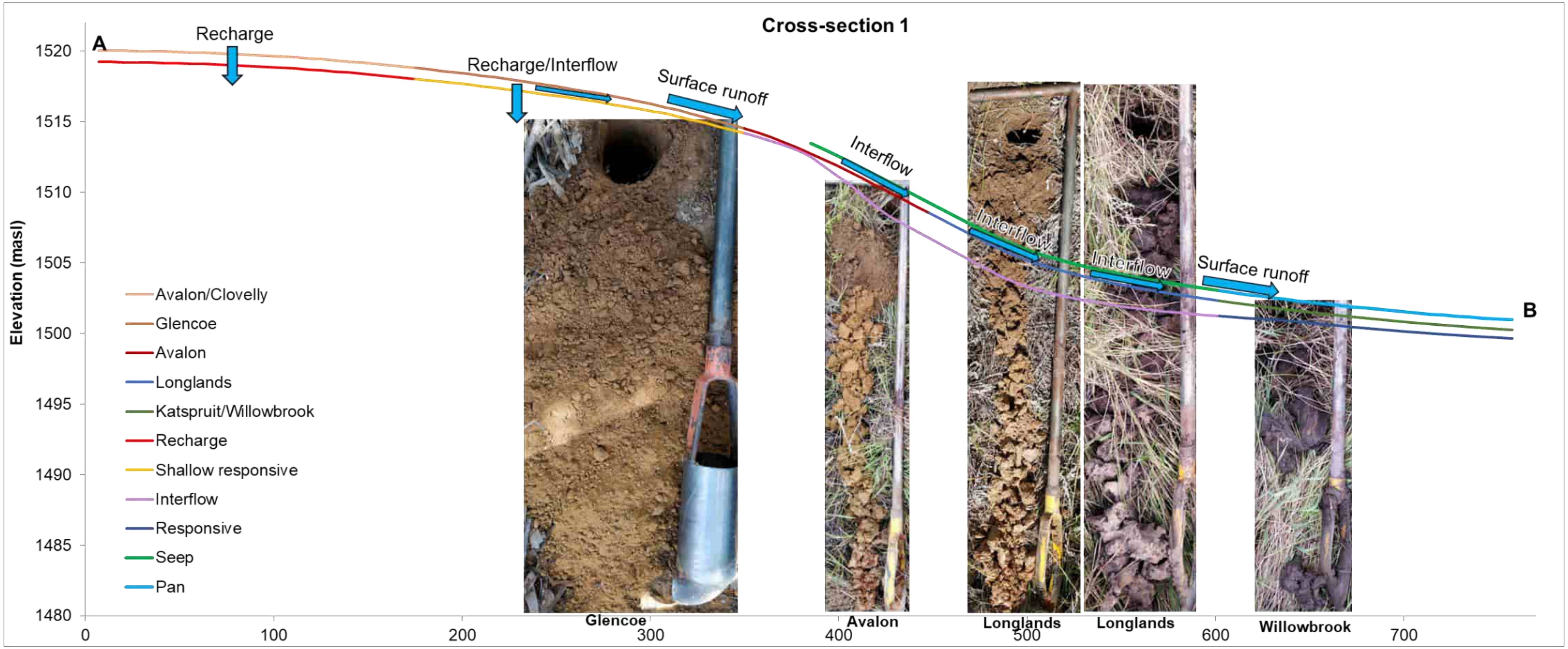


Figure 40. Cross-section 1 showing the surface topography (upper line), soil depths (difference between upper and lower line), soil forms (upper line), hydrological response units (lower line) and location of the seep and pan basin. Soil profile pictures are from site-specific soil survey. Elevations are vertically exaggerated.

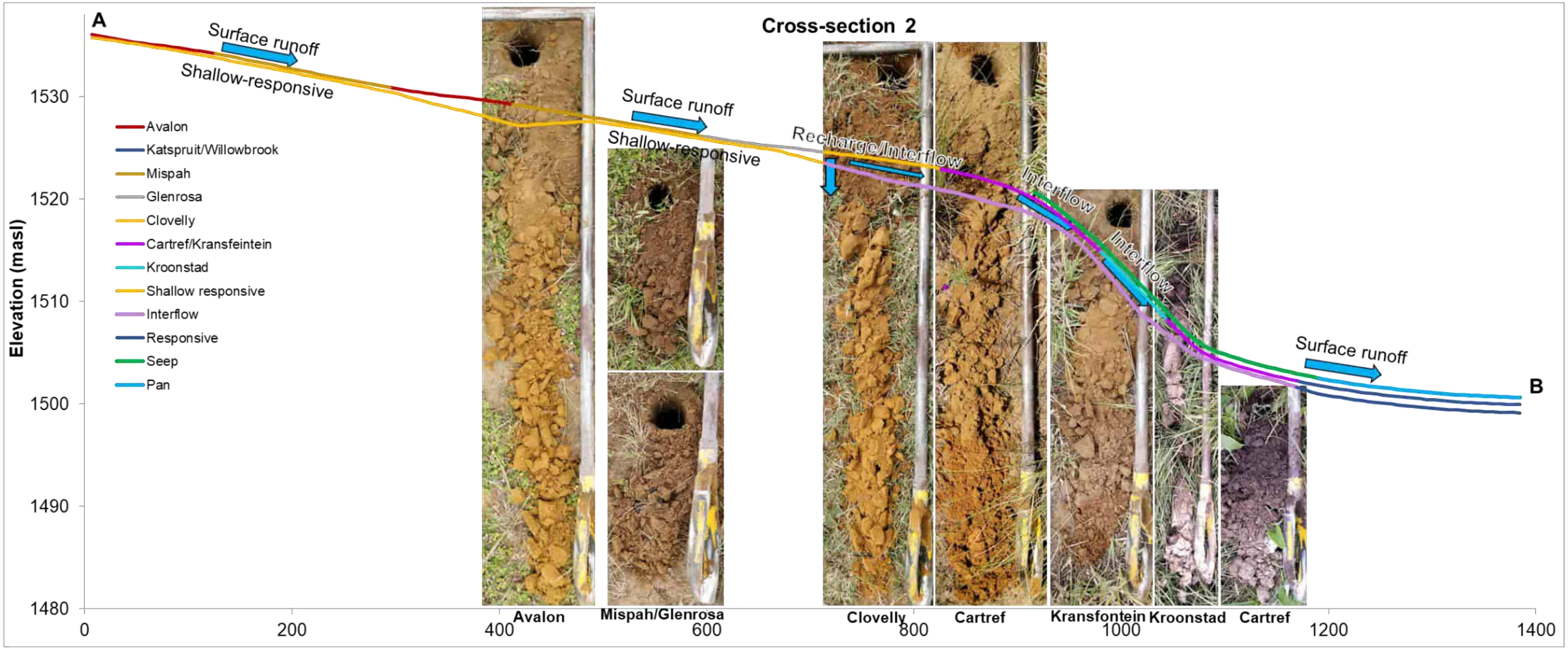


Figure 41. Cross-section 2 showing the surface topography (upper line), soil depths (difference between upper and lower line), soil forms (upper line), hydrological response units (lower line) and location of the seep and pan basin. Soil profile pictures are from site-specific soil survey. Elevations are vertically exaggerated.

7.2.2.3 Hydrological Response Units

The soils within the pan catchment were assessed to identify the main hydrological flow drivers and hydropedological response units. The majority of the soils were shallow responsive soils in the upper portions of the catchment. These soils are sandy in nature promoting recharge into the below lying weathered rock aquifer which is likely to be in contact with the pan basin. The shallow perched groundwater in the pan catchment likely fluctuates with the seasons contributing to the seepage in the interflow soils and associated seep wetland. The hydropedological response units are shown in Figure 42. The pan receives a combination of surface runoff, interflow as well as shallow perched groundwater during wet conditions.

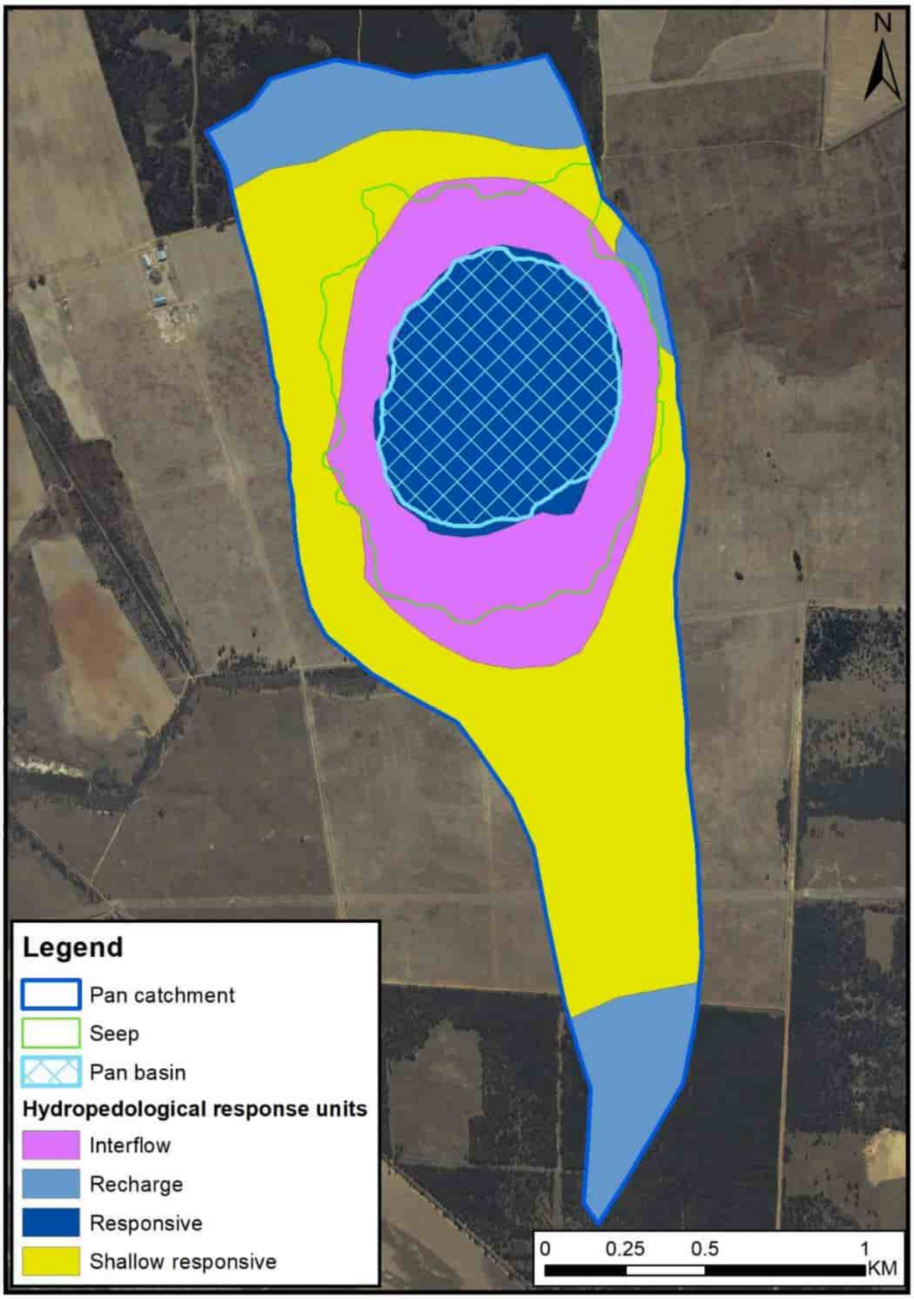


Figure 42. Map showing the hydrological response units for the Pan 7 catchment in relation the current wetland delineation.

7.2.2.4 Hydrological Impacts on Pan 7 Under the Current Conditions

The pan catchment shows a number of existing impacts that consist of:

- Alien invasive trees taking up significantly more water than natural vegetation (Figure 39).
- Small scale sand mining within the eluviated sandy portions of the interflow soils.
- Housing development that has transformed natural grassland into low density housing development.
- Small farm tracks that have altered semi-natural areas into bare soils or hardened surfaces.

The alien invasive trees such as Wattle, Eucalyptus and Poplar trees pose by far the most significant impact on the pan's hydrology. The trees reduce the groundwater recharge as well as interflow where trees are growing close to interflow soils. A substantial reduction in water contribution is to be expected from the forested portions of the catchment (northern and southern portion of the pan catchment) resulting in a reduction of interflow and groundwater return flows that are received by the pan basin. The sand mining in some portions of the interflow soils also have a negative impact on the pan's hydrology as they are likely causing interflow to daylight and collect in pools during the wet conditions. Due to the relatively small extent of the sand mining it is unlikely that this will have a significant impact on the overall hydrology of the pan. The housing development only covers a small portion of the pan basin whereby only the buildings seal surfaces. Lawn in between the building is unlikely having a significant impact on the hillslope hydrology.

8. WETLAND REHABILITATION OBJECTIVES AND CONCEPTUAL REHABILITATION INTERVENTION

Once suitable wetlands are identified for inclusion in the offset strategy, the next steps involve assessing the impacts or problems affecting these wetlands, such as erosion and alien vegetation, and understanding their effect on wetland conditions. Following this assessment, realistic rehabilitation objectives will need to be established to guide the selection of appropriate interventions. At this stage, suitable wetlands for inclusion into the New Largo offset strategy have been identified and the location and nature of the issues impacting wetland conditions have been identified, and broad rehabilitation objectives and strategies have been outlined. A detailed investigation into the proposed interventions will form the basis for a subsequent rehabilitation implementation plan, including the design of interventions and cost estimation, pending approval from the DWS and Seriti.

Wetlands within the New Largo MRA, which fall outside the current mine plan footprint, have been identified and targeted for inclusion in the offset strategy. Rehabilitation and protection of these wetlands, as detailed in the proposed offset strategy, will contribute to meeting the wetland offset requirements for the New Largo mining project. For wetlands categories 1, 2, 3 and 4, current impacts have been identified, rehabilitation objectives have been formulated to address these impacts, and a detailed rehabilitation strategy has been developed to achieve these objectives. A pan-specific rehabilitation strategy is detailed in Section 9. Various limitations and risks as well as proposed mitigation measures particular for the New Largo Pan, associated with the proposed offset rehabilitation projects have also been considered.

A summary of the impacts encountered within the target offset wetlands, the rehabilitation objectives for each impact type, and the broad rehabilitation strategy proposed is provided in Table 21. The rehabilitation objectives include:

- Improving wetland habitat.
- Enhancing the ecological integrity of wetlands.
- Augmenting the ecosystem services provided by wetlands.

Although the study did not extend to the design of specific physical rehabilitation interventions, it outlines the types of interventions proposed. These descriptions offer insights into the planned rehabilitation activities for the wetlands. More detailed rehabilitation interventions and designs will be developed should this mitigation and off-set strategy be approved.

Table 21. Nature of impacts identified in the target offset wetlands and proposed rehabilitation objectives and strategies to address the impacts.

IMPACT	IMPACT DESCRIPTION	PROPOSED REHABILITATION OBJECTIVE	PROPOSED REHABILITATION STRATEGY
Cultivated Fields	Cultivation along the wetland margins and extending into the wetland habitat. Areas of bare soil associated with cultivation form a hard crust which promotes surface runoff over infiltration. Cultivated fields extending into wetland habitats reduce wetland species diversity.	• Improve wetland habitat integrity, increase species diversity, biodiversity support capacity and aesthetics. • Improve infiltration of flows into the catchment and wetland soils.	• Pull back cultivation out of both the wetland boundaries and, if possible, implement a minimum 20-metre buffer around the wetlands. • Revegetate with indigenous plant species.
Alien Vegetation	Alien, invasive vegetation (such as *Eucalyptus* sp., *Acacia mearnsii*, *Populus × canescens*) with higher-than-average water demands encroach into wetland habitat, reducing flow to the wetlands and negatively affecting indigenous species diversity.	• Increase flows into and through the wetlands. • Improve indigenous species diversity.	• Remove stands of alien, invasive vegetation within wetlands and immediately upslope of wetlands. • Revegetate with indigenous plant species.
Dams[1]	Earthen farm dams cause flow impoundment behind the dam wall, and often, flow concentration at the outlet points. Impounding flows can lead to headcutting and channel erosion above and below the dam itself. Dams act as a focus point for livestock using them for drinking water, which leads to increased activity around the dams, trampling of vegetation and initiation or exacerbation of erosion.	• Improve wetland hydrology by removing impoundments to flow, encouraging diffuse flow through the wetland and limiting the opportunity for further headcutting and channel erosion. • Improve wetland vegetation component by reinstating a saturation regime across the wetland more similar to the natural condition.	• Removal of breached or damaged dams. • Re-engineering of certain dams to improve outflow points to encourage better distribution of flow and limit flow concentration.
Erosion Headcuts	Headcuts can form in wetlands as a result of flow concentration, livestock trampling or changes in the hydraulic head caused by impoundments at dams and road crossings. They form the starting point of channel incision through a wetland and have a major, negative impact on wetlands that are not naturally channelled.	Prevent further headcut migration in order to: • Improve the geomorphological health of the wetland. • Secure intact wetland habitat upstream. • Improve the erosion control eco-service provided by the wetland.	• Stabilisation of headcuts to prevent further migration of the headcut into intact areas of wetland.

[1] The implementation of the strategy tied to this impact will vary depending on the scale and purpose of the dams. Certain dams, particularly those categorised as large dams (Category 3), are extensively utilised for agricultural production. It's improbable that these larger dams can be integrated into the strategy. Instead, only small dams, specifically those aligning with the proposed implementation strategy, will likely be considered.

IMPACT	IMPACT DESCRIPTION	PROPOSED REHABILITATION OBJECTIVE	PROPOSED REHABILITATION STRATEGY
Erosion & Channel Incision	Channel erosion most often occurs as a result of flow concentration, such as below dams and linear infrastructure crossings, and is also a consequence of headcut migration. Channel incision and erosion lead to flow concentration and lowering of the water table in the wetland, which, in turn, can cause desiccation of wetland habitat as flows no longer spread across the entire wetland front.	• To deactivate all channels, thereby raising the water table. • To rewet desiccated wetland habitat, creating a mosaic of permanent, seasonal and temporary wetland habitat within the HGM unit	Placement of a series of biological weirs aimed at: • Raising the base-level of the channel, and in so doing raise the water table. • Promoting more frequent overbank topping of the channel. • Reshaping and revegetating eroded channels to improve bank stability.
Road Crossings and Culverts[2]	Road and other linear infrastructure crossings can have a similar impact on wetland hydrology as dams, causing flow impoundment upstream and flow concentration through culverts, leading to channel incision and changes in the natural saturation patterns across the wetland.	• Improve wetland hydrology by removing impoundments to flow, encouraging diffuse flow through the wetland and limiting the opportunity for further headcutting and channel erosion. • Improve wetland vegetation component by reinstating a saturation regime across the wetland more similar to the natural condition, and by converting infilled road crossings to natural vegetation	• Removal of farm tracks through the wetlands to limit impoundment and reinstate diffuse flow through the wetland and revegetate road crossing footprint. **OR** • Redesign road crossings and road culverts to allow more diffuse flow.
Trenches & Drains	Trenches have been dug for a variety of reasons, including to drain wetland areas to allow cultivation, to drain runoff away from roads quickly, or as security trenches to limit access to cultivated fields. They affect wetland hydrology by concentrating and impounding flows and diverting flows away from wetland areas which can lead to desiccation.	Deactivate all trenches and thereby: • Encourage diffuse flows into and through the wetlands, • Improve the distribution of flows across the entire wetland to rewet areas that have dried out; and promote wetland vegetation establishment	• Infill trenches with compacted material; and • Install plugs at regular intervals to prevent flow concentration.
Loss of Wetland Catchments and Water Inputs (Applicable to Category 2 Offset Wetlands Only)	Partially mining some of the wetland catchments will reduce flow inputs to the wetlands and may affect the degree of saturation within the receiving wetlands, as well as their resilience. A reduction in wetland functionality can also be expected as a consequence.	Maintain the wetland water balance and the hydrological drivers of the wetland systems by compensating for anticipated flow reductions through the discharge of additional flows. • Note: this should be considered as a mitigation measure rather than offset rehabilitation measure.	• Conveying treated excess water from the mine water balance, when it becomes available, via pipelines to strategic locations upstream of the affected wetlands and discharging it to supplement reduced natural flow inputs to the

[2] The proposed interventions will differ based on the scope and intended use of the roads. Therefore, the implementation of this strategy will be approached on a case-by-case basis.

IMPACT	IMPACT DESCRIPTION	PROPOSED REHABILITATION OBJECTIVE	PROPOSED REHABILITATION STRATEGY
			wetlands. The rehabilitation activities within the affected wetlands will require scheduling to align with periods during the life of the mine when excess water becomes available for use.
Redundant Infrastructure (old houses), infilled, excavated areas and diggings	Abandoned farmhouses, left partially demolished, create niches for additional impacts, including the proliferation of alien invasive vegetation. Infilling and excavated areas within the wetland areas can have a similar impact, while also affecting the geomorphology of the wetland.	• Increase flows into and through the wetlands. • Improve indigenous species diversity. • Improve hydrology and geomorphological characteristics of the wetlands	• Removal of redundant infrastructure and other associated impacts, including alien invasive vegetation, and other infilled materials. Levelling, shaping and revegetation of the disturbed areas

9. DEVELOPMENT OF A WETLAND OFFSET IMPLEMENTATION PLAN & EVALUATION OF POTENTIAL OFFSET GAINS

The wetland offset implementation strategy outlined in this section adopts a phased approach and establishes the framework for developing the wetland offset implementation plan should this strategy be approved. The phased implementation considers various factors, including land control (ownership), ease of implementation, additional work requirements, and expected gains, among others. Moreover, there's an opportunity to align this phased approach with the staged development of the New Largo coal mine. As the development footprint of the mine expands and affects wetlands, the rollout of the wetland offset strategy, and the realisations of gains are extended to compensate for the anticipated impacts. It is important to view the proposed phases as overlapping (Table 22), with certain components of different phases potentially occurring simultaneously.

Table 22. Proposed implementation plan phases and associated wetland categories.

Offset Phases	Wetland Offset Categories
Phase 1	Category 1 Wetland Offsets
Phase 2	Category 3 Wetland Offsets and Additional Pans (off-site Kriel and MMS-BMK Pans)
Phase 3	Category 4 Wetland Offsets and Dispatch Rider Pans
Phase 4	Category 2 Wetland Offset

9.1 Phase 1 – Category 1 Wetland Offsets

The initial phase of the wetland rehabilitation strategy will concentrate on the rehabilitation and protection of Category 1 Wetlands. These wetlands have been prioritised because they are situated on land owned by Seriti, allowing for rehabilitation and management actions to be executed directly under Seriti's control, thereby eliminating the need for negotiations with external landowners for consent and other permissions.

Implementing the proposed rehabilitation measures for the Category 1 Wetland offsets is expected to yield **97.76 hectare equivalents (ha-eq)** in gains for the water resources target and **516.07 ha-eq** for the ecosystem conservation target **(Appendix 2 - Offset gains)**. These gains represent 71 % of the water resources target (138.19 ha-eq) and 57 % of the ecosystem conservation target (905.73 ha-eq), respectively **(Appendix 1 – offset requirements)**. Given Seriti's full control over the wetlands, the likelihood of rehabilitation intervention failure is significantly lower, which suggests that the 0.66 risk multiplier typically applied in offset evaluation calculations may not be necessary in this context.

A key aim of the rehabilitation strategy and which will be applied to the Category 1 wetlands, will be to improve the condition of the wetlands, which should be reflected in an anticipated improvement in the PES score and category of each of the wetland HGM units within which rehabilitation is proposed. Rehabilitation activities will be undertaken in all targeted wetlands and therefore it is anticipated that improvements will occur in all wetlands where activities are undertaken.

Therefore, Phase 1 of the offset project will include the following key tasks:

- Full implementation of the detailed wetland rehabilitation and management interventions for Category 1 Wetland offset as outlined in this report.
- Engagement with the Department of Water and Sanitation (DWS) and other relevant authorities to keep stakeholders informed about the progress in implementing the offset strategy.
- Application for any authorisations required to conduct the rehabilitation and management interventions.

9.2 Phase 2 – Category 3 Wetland Offsets and Additional Pans (Kriel and MMS-BMK Pans)

In Phase 2 of the wetland offset strategy, the focus will shift to the rehabilitation of Category 3 Wetland Offsets. This category comprises of remaining pan habitat within the New Largo MRA as well as additional pan habitats identified within the Seriti surface rights area.

Similar to Phase 1 above, this category has been prioritised because it is situated on land owned by Seriti, allowing for rehabilitation and management actions to be executed directly under Seriti's control, thereby eliminating the need for negotiations with external landowners for consent and other permissions.

Implementing the proposed rehabilitation measures for the Category 3 Offset (which includes New Largo Pan – Pan 2, and the Southern Pan Cluster (Pans 3, 5 and 6) as well as additional off-site Pans at Kriel and MMS-BMK are expected to yield **33.59 ha-eq** in gains for the water resources and ecosystem services targets and **287.44 ha-eq** for the ecosystem conservation target **(Appendices 4 and 6)**. These gains represent **32.3 %** of the water resources target (103.9 ha-eq) and **43.8 %** of the ecosystem conservation target (656.3 ha-eq), respectively. Additionally, there is potential to enhance the hectare equivalent gains achieved through further protection and rehabilitation efforts for Wetland Cluster 3. This could involve measures such as designating the wetland system or specific farm portions as protected areas or pursuing other forms of formal protection. Implementing buffer zones and/or ecological corridors linking pans (onsite pans and Kriel pans), could also contribute to higher gains towards the ecosystem conservation target.

The proposed rehabilitation strategy for the remaining onsite pans (Category 3), is discussed further below.

9.2.1 New Largo Pan - Proposed Rehabilitation Strategy

The New Largo Pan is affected by historical underground mining, in that there is a stability risk in the pan's catchment and basin. Previously polluted water originating from the underground void was pumped into New Largo Pan. This resulted in an elevated full supply level and changes in water quality in the pan which persisted for decades. This has been stopped and the pan full supply level has returned, more or less, to pre-mining levels. Water quality analyses undertaken by WSP during the course of this study indicated elevated salt levels in the pan, despite pumping having been stopped. This is likely as a result of the elevated salt concentrations in the sediments and along the edges of the pan due to the long-term pumping of contaminated underground water into the pan. It is envisaged that the reduced full supply level will persist into the future as the pan now receives natural flows from the catchment. A concern was raised related to the risk of future subsidence in the pan basin and catchment and this risk remains due to underground stability issues. Another challenge had to do with safety issues related to implementing the proposed rehabilitation interventions in the degraded seep around the pan and in the catchment. In order to understand these risks, a stability assessment was undertaken by Saxum Mining (Saxum Mining & Trading CC, August 2024, Rev. 02). This indicated that tailored methods would be required in order address the risks associated with the implementation of the proposed rehabilitation. After a considerable team effort between the various specialists to come up with a method to address the rehabilitation implementation risks, a method statement was developed by WSP in consultation with the wetland specialists (WSP Memo, September 2024). It was concluded that rehabilitation is possible if the implementation is done in accordance with the methods proposed by WSP. In essence the main rehabilitation required as specified by the wetland specialist should include:

- Removal of alien invasive vegetation (gum trees and black wattle), roads, and cultivation from the pan catchment, and revegetation of all resulting disturbed areas with indigenous plant species.
- Infill of previously mined soils within the catchment.
- Rehab / remove pumping sump dams within the pan basin.
- Re-introduce plant species through pods and seeds from Honingkrantz pan.
- Withdraw the cultivated field within the pan catchment area.
- Dewater the pan water several times to reduce salinity in the pan basin.
- Removal of salt precipitates along the pan edge.
- Rehabilitate disturbed soils such as berms, trenches etc. both within the pan basin and the seeps adjacent to the basin.

A concept map showing the proposed interventions related to the New Largo Pan as described above is shown in Figure 44. A key aspect of the proposed rehabilitation of the pan is infilling the old sand mining areas where the seep was removed previously (see Figure 43). It is proposed that these areas be lined as indicated in the method statement by WSP and infilled with a suitable topsoil and sandy interflow sub-soils in certain areas to facilitate the recreation of seep conditions along the slopes leading to the pan. This is expected to convert some of the surface runoff flow drivers into interflow which will help support more regulated water inputs to the pan (see Section 7.2.1.6 for context). In order to better understand the infill requirements, cross sections of the sand mined areas along the edge of the pan were derived using recent LiDAR elevation data. Figure 45 shows surface topography slopes that were used to identify the edges of disturbed areas used as delineation of the soil infill areas. An important consideration would be the installation of a clay liner below the infill areas to safeguard against water losses which may arise in future due to crack formation from pillar failure related subsidence.

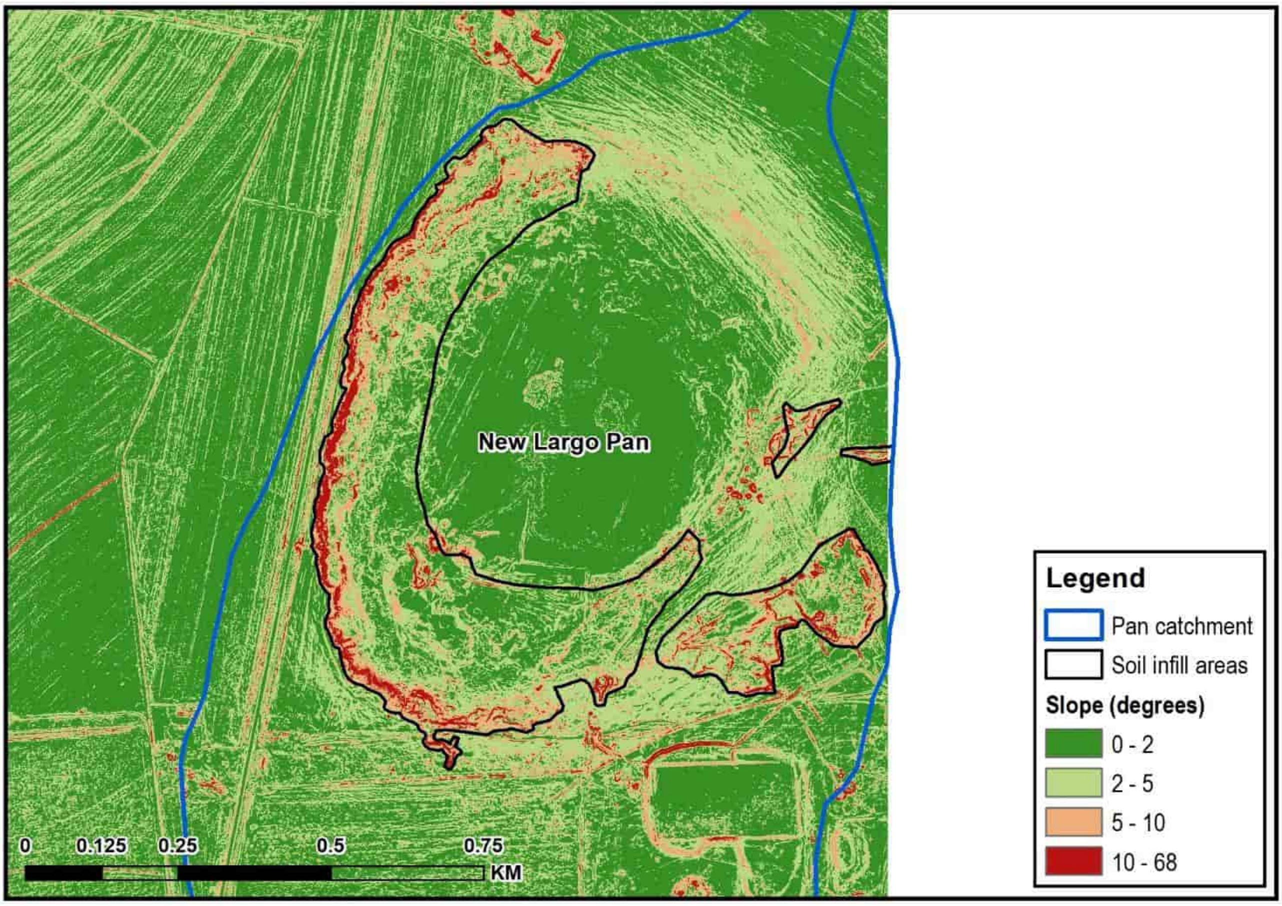


Figure 43. Map showing LiDAR derived slope highlighting historical disturbances such as sand mining used to identify and delineate of the proposed soil infill areas to be conducted to reinstate the seep wetland and to improve the pan's hydrology.

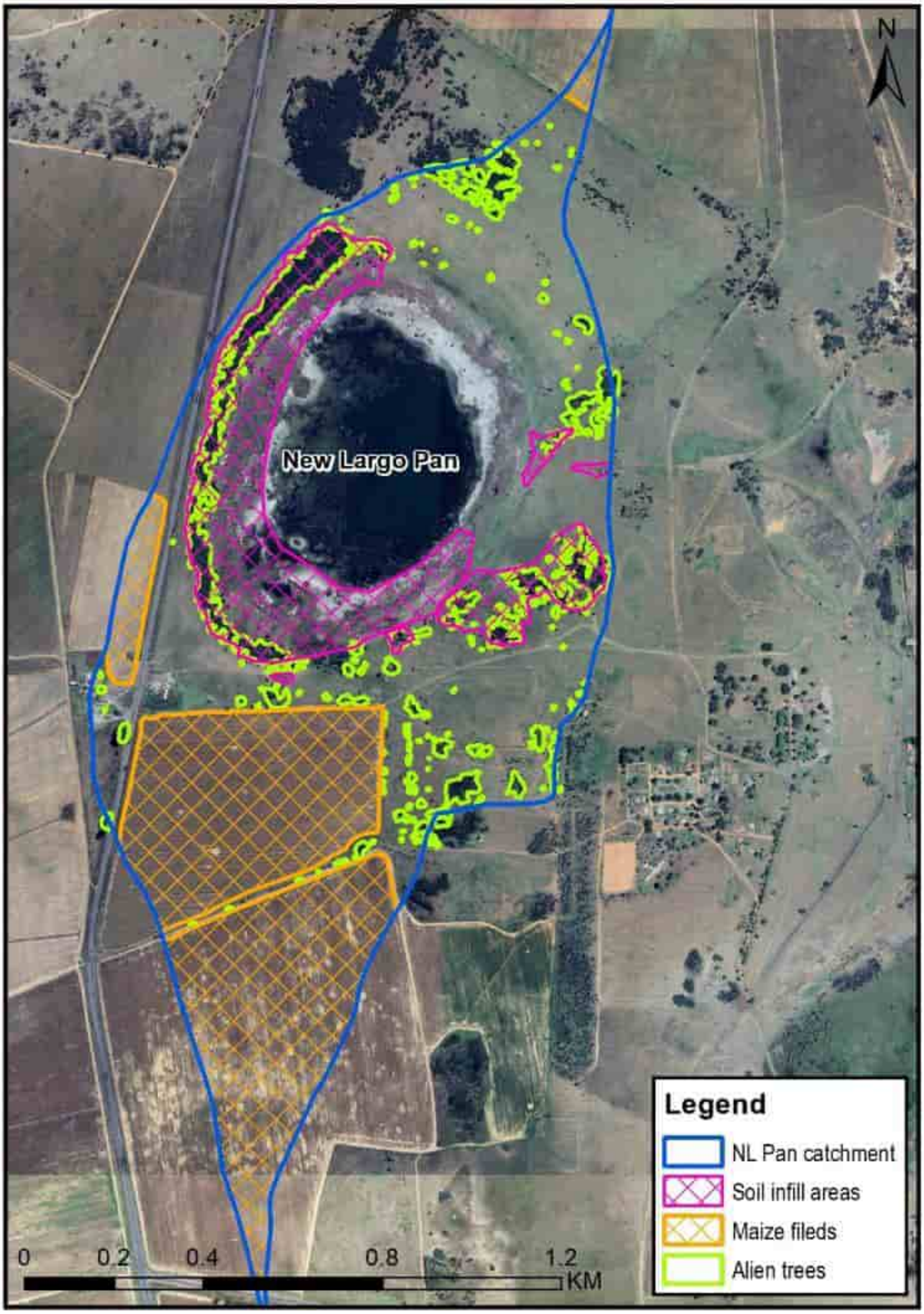


Figure 44. Map showing the proposed interventions for New Largo pan.

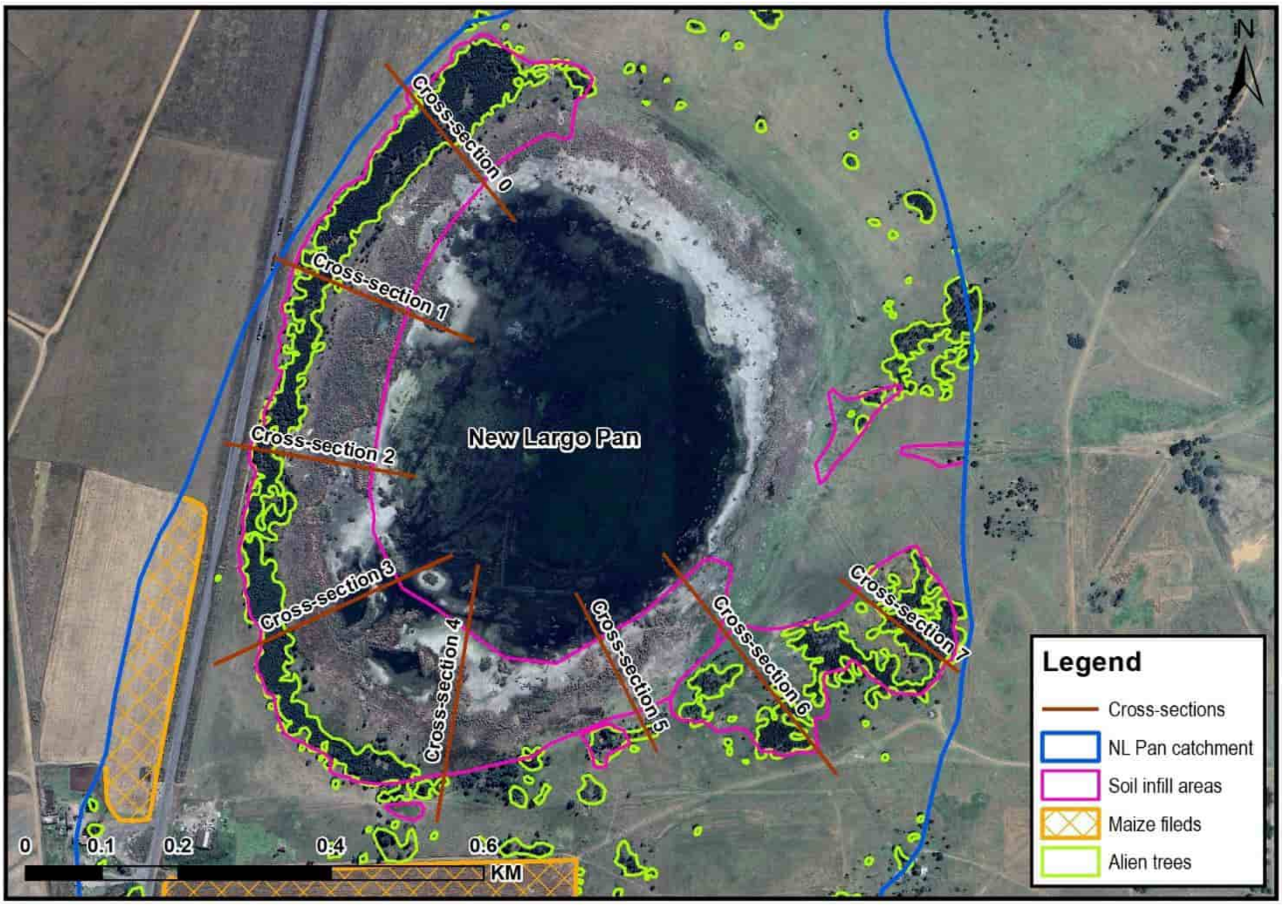
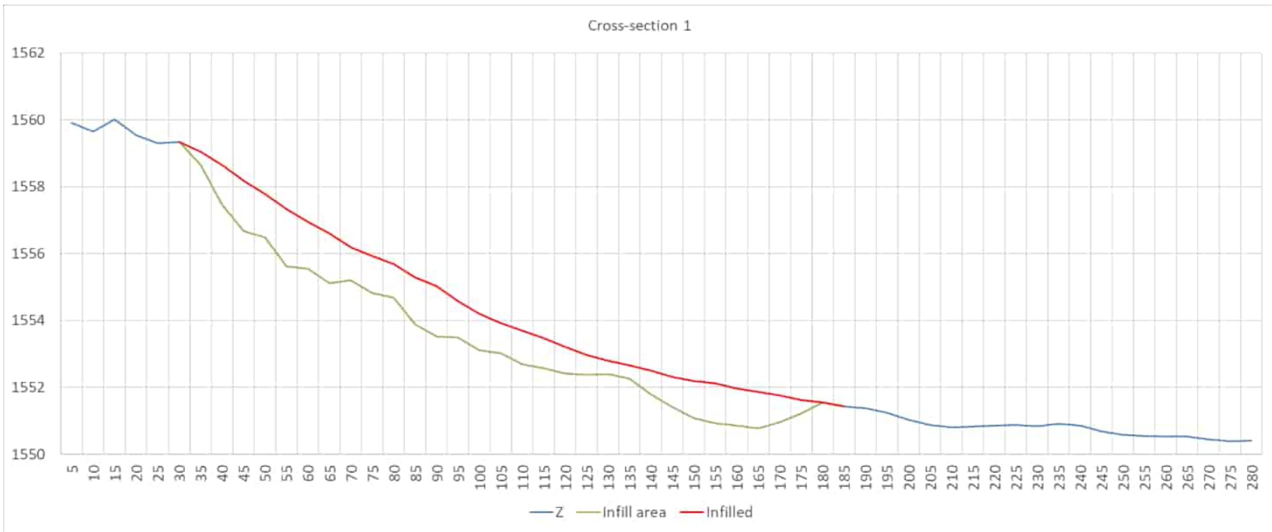


Figure 45. Map showing the cross-sections of the edges of the pan where infilling is required.


Cross-section 1
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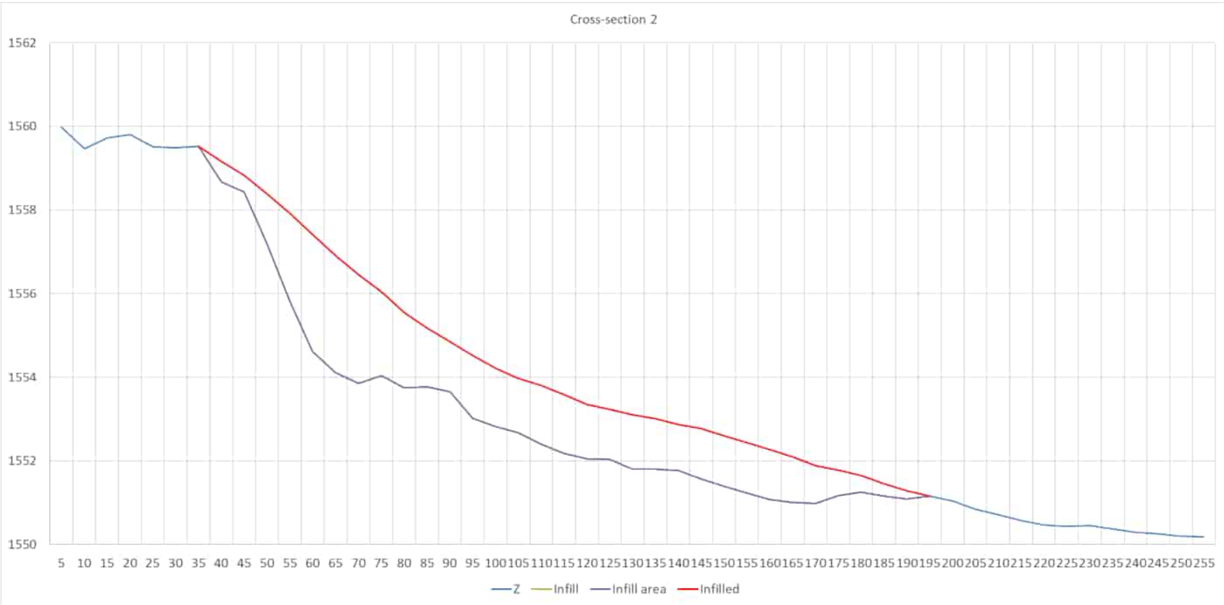
Cross-section 2
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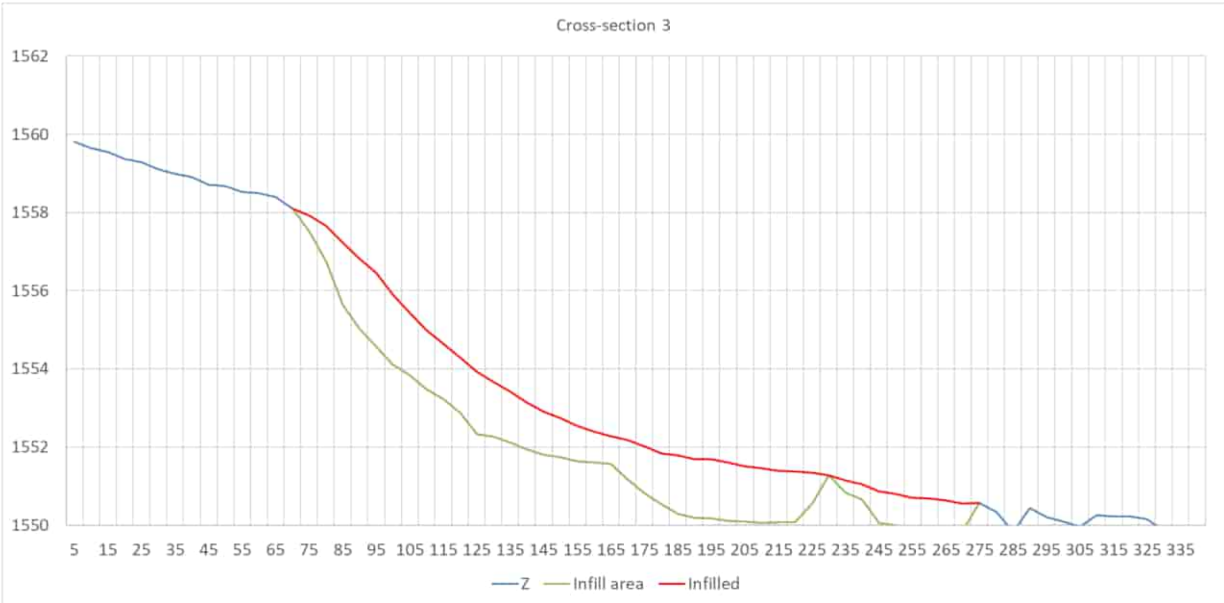
Cross-section 3
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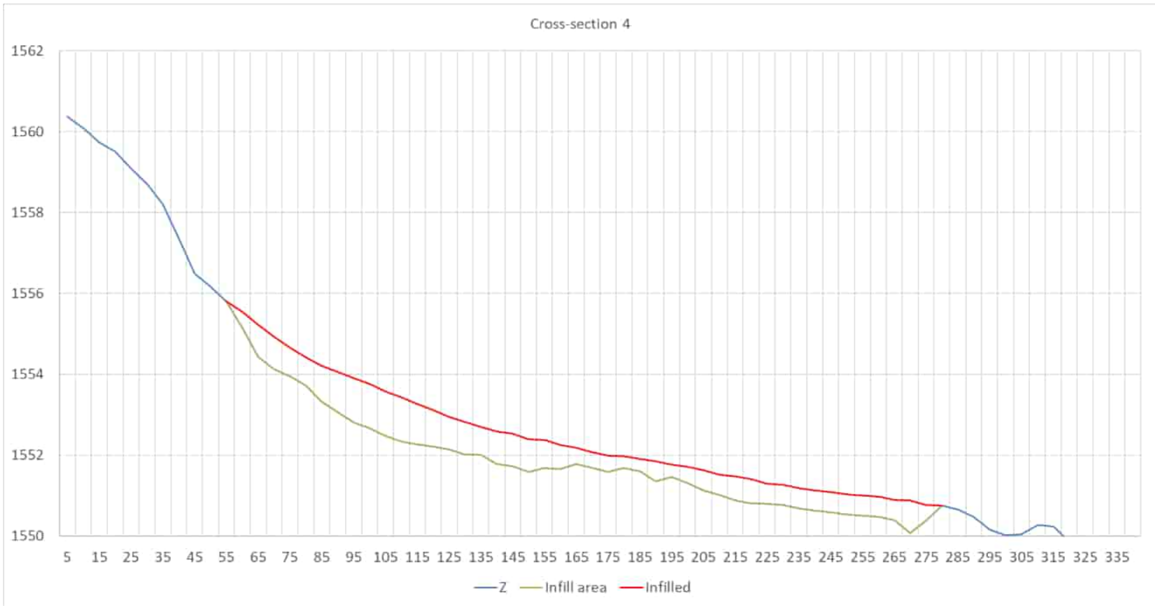
Cross-section 4
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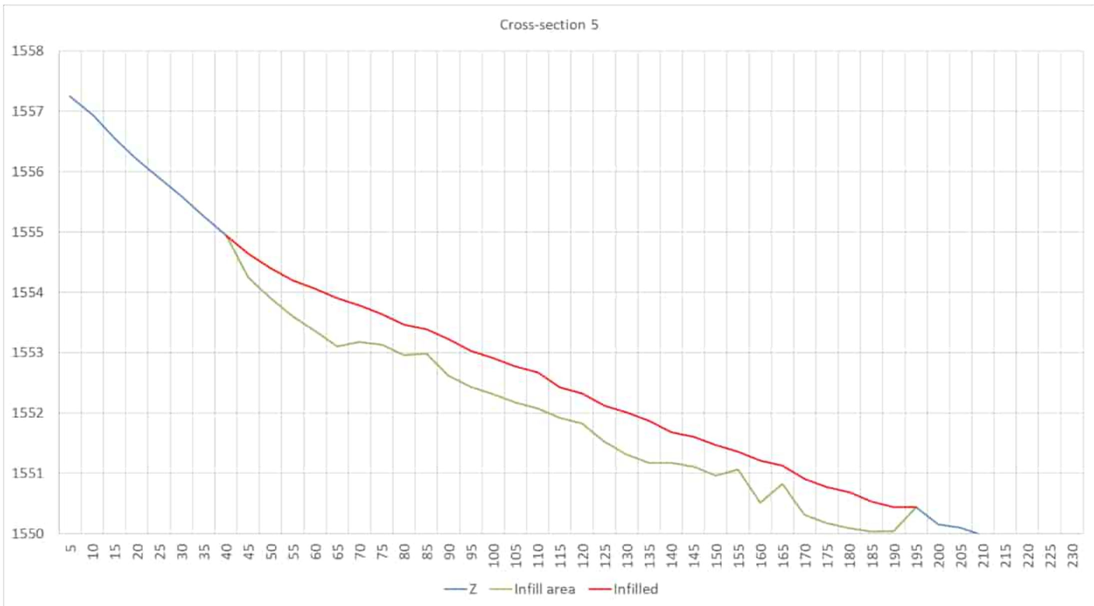
Cross-section 5
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5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230
Z
Infill area
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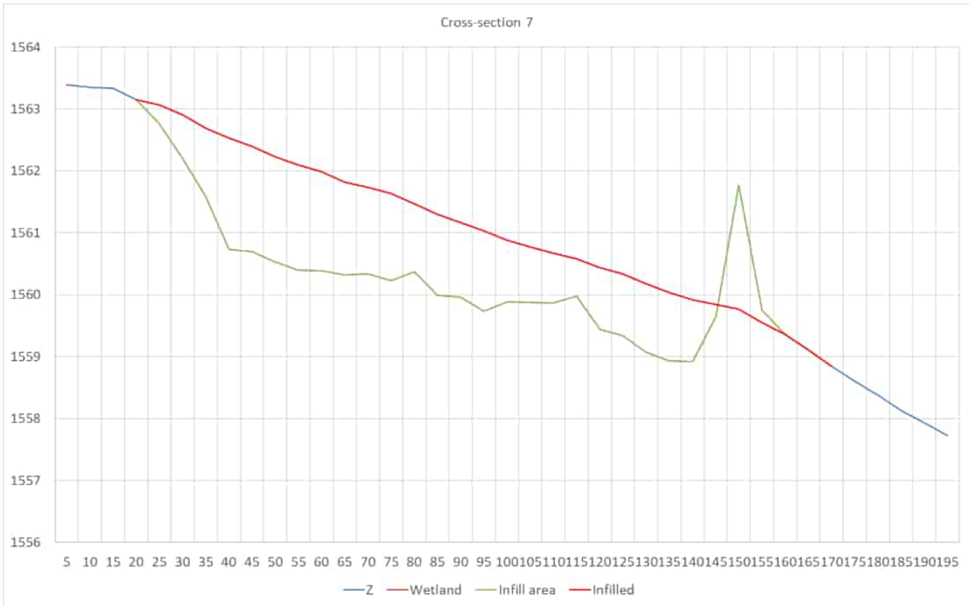


Figure 46. Cross sections as they relate to the figure above. Vertical axis is masl. and horizontal axis is distance in m.

9.2.1.1 Southern Pan Cluster (Pans 3, 5 and 6) - Proposed Rehabilitation Strategy

The following rehabilitation activities are proposed:

- Removal of railway infrastructure and material infill from within and around Pans 2 and 3.
- Removal of roads, redundant structures, and cultivation activities from within the pan catchments.
- Landscaping and revegetation of all disturbed areas within the pans and their catchments.
- Designation of the cluster of pans and their catchments as a conservation area, followed by appropriate management.

Rehabilitation activities are focused exclusively on the pans and catchment areas that fall within Seriti's Mining Rights. For Pans 3 and 5, this includes only half of the pan basin area, as well as the associated seep and catchment. Portions of these pans that extend beyond Seriti's Mining rights are not included in the rehabilitation efforts (Figure 47).

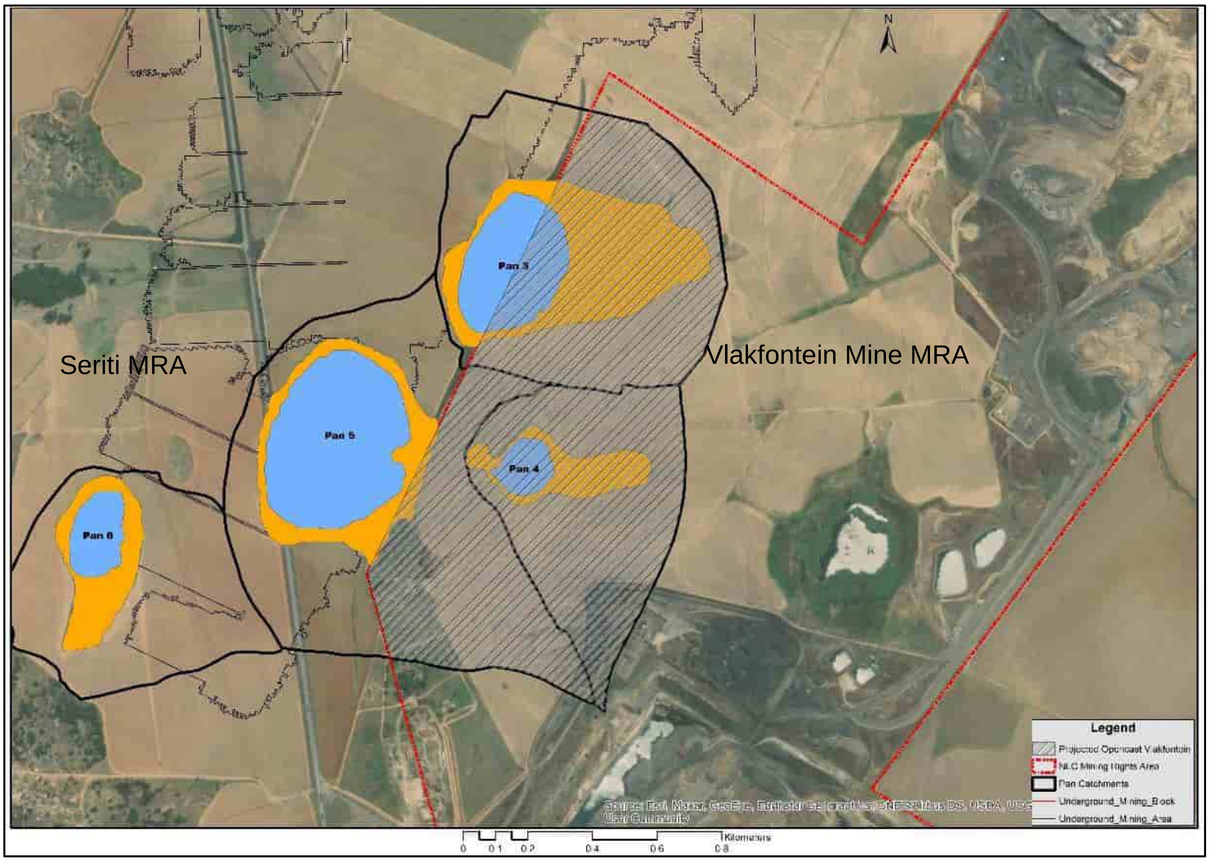


Figure 47. Portions of Pans and Their catchment targeted for rehabilitation activities for Southern Cluster Pans.

Kriel and MMS-BMK Pans - Proposed Rehabilitation Strategy. The impacts noted that need to be addressed as part of the rehabilitation of the pans include:

- Cultivation: Cultivated fields are present within all three pan catchments and extend into the seep wetlands surrounding the pans. The recommended rehabilitation includes removing all cultivation activities from both the wetlands and their entire catchments.
- Alien Vegetation: Alien vegetation, such as Poplars, Black Wattle, and Blue Gums, extends into one of the Kriel Pans as a large stand and exists in the immediate catchments of the other pans as isolated trees and small clusters. Rehabilitation efforts will involve removing all large stands of alien trees from the wetlands, as well as selective removal of isolated trees in the surrounding catchments.
- Excavations: Excavations are present in one or more of the pans. The recommended rehabilitation will involve infilling these excavations and reshaping them to restore the natural soil profile.
- Fencing: The Kriel pan basins are currently partially fenced with multi-strand barbed wire. Rehabilitation will include extending the fencing to encompass the seepage wetlands, fencing in the

BMK pan and seep, and replacing barbed wire (which poses a threat to wildlife) with smooth strand wire or a similar alternative. Extensive poaching using snares has been noted at one of the Kriel pans, and future management of this issue will be recommended.

- Primary Impacts: These are the most noticeable changes caused by various activities onsite which can be effectively addressed through rehabilitation.
- that can be addressed through rehabilitation, which can significantly contribute to offset gains.
- Sewage Treatment Plant: A sewage treatment plant was noted at one of the Kriel pans, which may be introducing poor-quality water inputs to the pan. Exploring options to remove this system and replace it with other onsite or alternative systems may be necessary to improve water quality in the affected pan over time. The offset gain that has been determined at this stage assumes the small sewage treatment plant will remain, and monitoring of water quality being discharged from the plant and in the pan is proposed to assess if any water quality impacts occur. If so these will need to be addressed or alternatively the sewage plant removed in order to secure the offset gains.

Therefore, Phase 2 of the offset project will include the following key tasks:

- Full implementation of the detailed wetland rehabilitation and management interventions for Category 3 Wetland Offsets as outlined in this report.
- This will include a specific rehabilitation method statement as complied for the New Largo Pan (WSP Memo, September 2024). Identification and establishment of appropriate buffer zones and ecological corridors for the targeted pan habitats especially for the Southern cluster pans and MMS-BMK Pan clusters.
- Exploration and, if feasible, implementation of formal protection measures for the pan clusters.
- Engagement with the Department of Water and Sanitation (DWS) and other relevant authorities to keep stakeholders informed about the progress in implementing the offset strategy.

9.3 Phase 3 – Category 4 Wetland Offsets and Dispatch Rider Pans

In Phase 3 of the wetland offset strategy, the focus will shift to the rehabilitation of the additional pan habitats, specifically offsite Pan 7 and the Dispatch Rider Pans. These wetlands (particularly Pan7) present unique challenges as they are not entirely situated on Seriti-owned land. Fortunately, a signed agreement already exists between the private landowner and Seriti for the inclusion of Pan 7 eliminating any land-tenure risks associated with Pan 7.

The focus for the Dispatch Rider pans will be on pans and seeps within the Seriti SRA and will eliminate the risk of conflicting land uses and possible resistance from neighbouring farms if the arrangement were to include private lands. **As indicated for the dispatch rider pans, the proposed way forward is to focus only on areas within Seriti's surface rights.** While the possibility of expanding this to the section of the catchment under the control of another private land owner exists, this has not been considered in the offset calculations presented below.

If the comprehensive rehabilitation and management measures outlined in this report are fully implemented, Pan 7 and portions of the pans and their catchment within Seriti's surface rights area at Dispatch Rider could achieve gains of **13.03 ha-eq** toward the water resources target, representing **9.4 %** of the target (138.19 ha-eq), and **253.52 ha-eq** toward the ecosystem conservation target, or **27.99 %** of the target (905.73 ha-eq) **(Appendix 5 – Option 3).**

The proposed rehabilitation strategy for the onsite remaining pans (Category 4) and Dispatch Rider Pans included the following:

Category 4 – Pan 7

- Removal of alien invasive plants including weeds
- Removal of redundant infrastructure
- Stabilisation eroded areas
- infilling sloping and levelling of excavated areas
- Revegetation of disturbed areas

Category 4 – Dispatch Rider Pans

- Removal of alien invasive plants including weeds
- Removal of redundant infrastructure
- Stabilisation eroded areas
- infilling sloping and levelling of excavated areas
- Revegetation of disturbed areas
- Control grazing and livestock trampling
- Creation of a vegetated/grassland corridor linking all four pans
- Possibly withdrawing agricultural activities within the catchments of the pans

Key tasks for Phase 3 of the offset project include:

- Implementing the wetland rehabilitation measures as outlined in this report, restricted to areas within Seriti's surface rights.
- Continuously engaging with the Department of Water and Sanitation (DWS) and other relevant authorities to ensure that all stakeholders are kept informed about the progress of the offset strategy.
- Application for any authorisations required to conduct the rehabilitation and management interventions.

9.4 Phase 4 – Category 2 Wetland Offset

In Phase 4 of the wetland offset strategy, the focus will shift to rehabilitating wetlands that have been partially impacted by onsite mining activities. To successfully claim offset gains, mitigation measures to address flow losses must first be implemented. Only after these measures are in place can further rehabilitation activities be undertaken to enhance the wetlands and allow offset gains to be claimed.

However, there will be delays in being able to implement the mitigation measures for one wetland, specifically the one requiring clean water discharge from the water treatment works. This will only occur at a later stage when the mine is fully operational. As a result, these wetlands are expected to be addressed last in the implementation hierarchy, depending on the availability of suitable water for supplementation.

Under the scenario where the full rehabilitation and management measures outlined in this report are implemented, Category 2 Wetland Offset could potentially achieve **11.18 ha-eq** of gains towards the water resources target (equivalent to **8.1 %** of the target of 138.19 ha-eq) and **44.94 ha-eq** towards the ecosystem conservation target (equivalent to **4.96 %** of the target of 905.73 ha-eq) (Appendix 3). In order to secure the long-term viability of this offset, it will be important to ensure that the post-mining landscape, through catchment re-instatement and suitable attenuation, is able to naturally supplement these flows post-mining so that there is not an ongoing requirement for flow supplementation. The design of this will need to form part of the detailed design stage of this phase, the details of which must be finalised together with the detailed design of the flow supplementation trenches and releases which form part of the operational stage of mining.

The mitigation and rehabilitation strategy for Category 2 wetlands, as detailed in Table 24, aims to improve wetland conditions by addressing current impacts and mitigating anticipated flow reductions associated with the mine plan. This will be achieved by discharging additional flows into the wetlands at strategic locations during operations, and through catchment re-instatement with appropriate attenuation post-mining.

The implementation of these measures should result in an anticipated improvement in the PES score and category of each wetland HGM unit where rehabilitation is proposed. A key component of the rehabilitation strategy for Category 2 wetlands will be the introduction of additional water to counteract the expected reduction in flow inputs due to catchment loss associated with the open cast mining activities.

Two areas are earmarked for water supplementation where water of suitable quality can be supplied to affected wetlands (see Figure 48). The North-Western (NW) area is located in the headwaters of the tributary south of Kusile Power Station and is located close to the proposed water treatment plant for Seriti's New Largo operations. The second area is located in the South-Eastern part of the study area south of Pit F where water can be brought in from the KPSX (Seriti's Klipspruit mining operations) water treatment plant. Table 23 below lists proposed infiltration trenches aimed at introducing interflow into the catchment soils upslope of affected wetland units. If interflow is being re-instated to affected wetlands, then the wetland flow losses are mitigated, and wetland interventions can be applied to these wetland units. The approximate locations of the various proposed infiltration trenches are shown in Figure 49 and Figure 50.

Table 23. Estimated volumes to be discharged into the infiltration trenches to mitigate impacts on Category 2 wetlands for the North-Western (NW) and the South-Eastern (SE) areas respectively (See Figure 48).

Trench_ID	WWBU	Supply Volume (ML/a)	Length – Infiltration trenches (m)	Area
49_A	49	14.55	546.2	NW
49_B	49	2.37	89.1	NW
49_C	49	2.54	95.4	NW
49_D	49	4.09	153.6	NW
50_A	50	1.84	190.4	NW
50_B	50	0.91	94.8	NW
50_C	50	3.62	375.4	NW
86_A	86	1.05	325.8	NW
89_A	89	2.07	125.2	NW
9091_A	90/91	17.88	365.3	NW
9091_B	90/91	16.79	343.1	NW
9091_C	90/91	5.84	119.3	NW
24_A	24	4.61	293.3	SE
24_B	24	6.15	391.0	SE
24_C	24	4.77	303.4	SE
24_D	24	2.46	156.5	SE
24_E	24	2.48	157.5	SE
28_A	28	2.10	208.7	SE
28_B	28	0.89	88.2	SE
28_C	28	1.63	161.8	SE
28_D	28	0.79	78.7	SE
28_E	28	1.04	103.0	SE
28_F	28	0.83	82.5	SE
28_G	28	6.43	637.8	SE
TOTAL		**107.7**	**5485.8**	

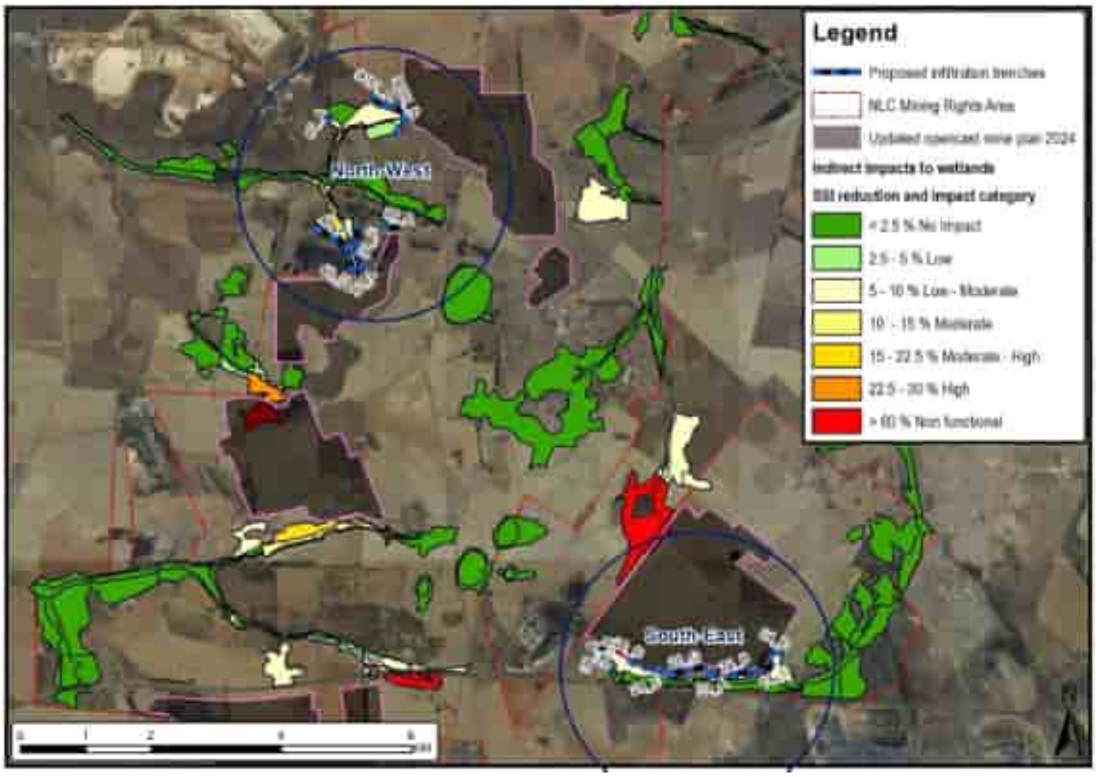


Figure 48. Map showing the two areas (North-West and South-East) targeted for water supplementation for indirectly affected wetlands along with water supplementation trenches.

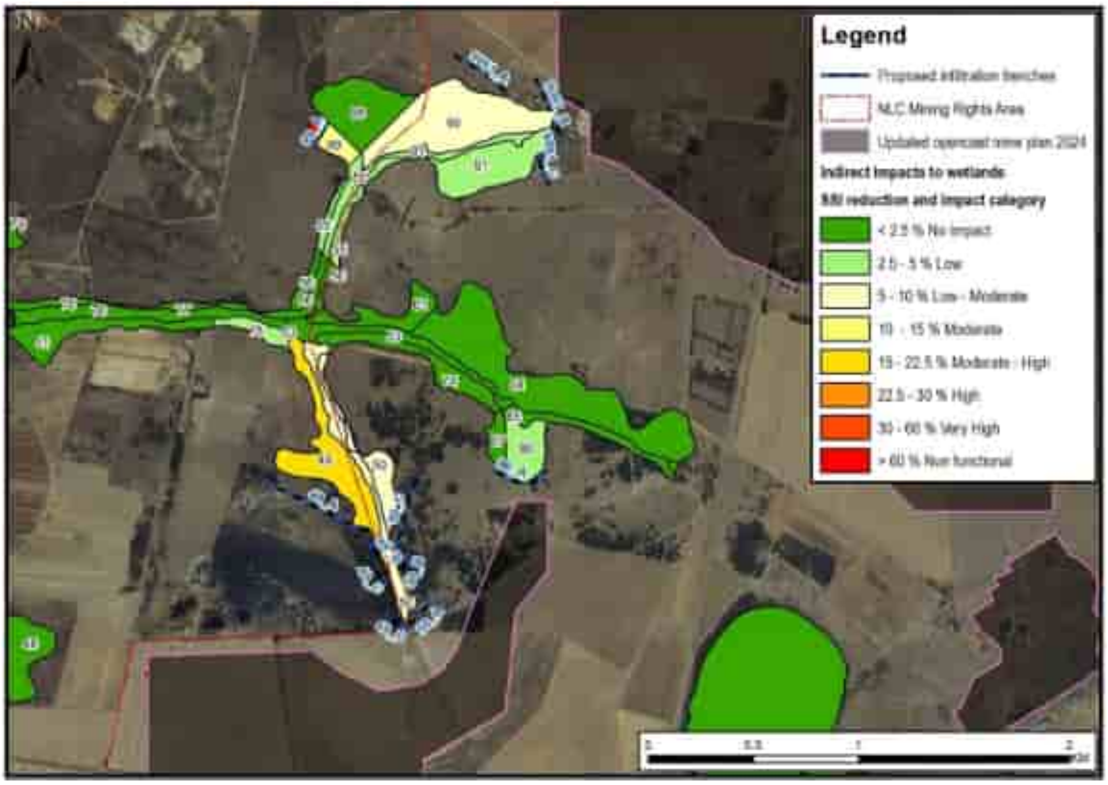


Figure 49. Map showing the location of the proposed infiltration trenches for the north-western area.

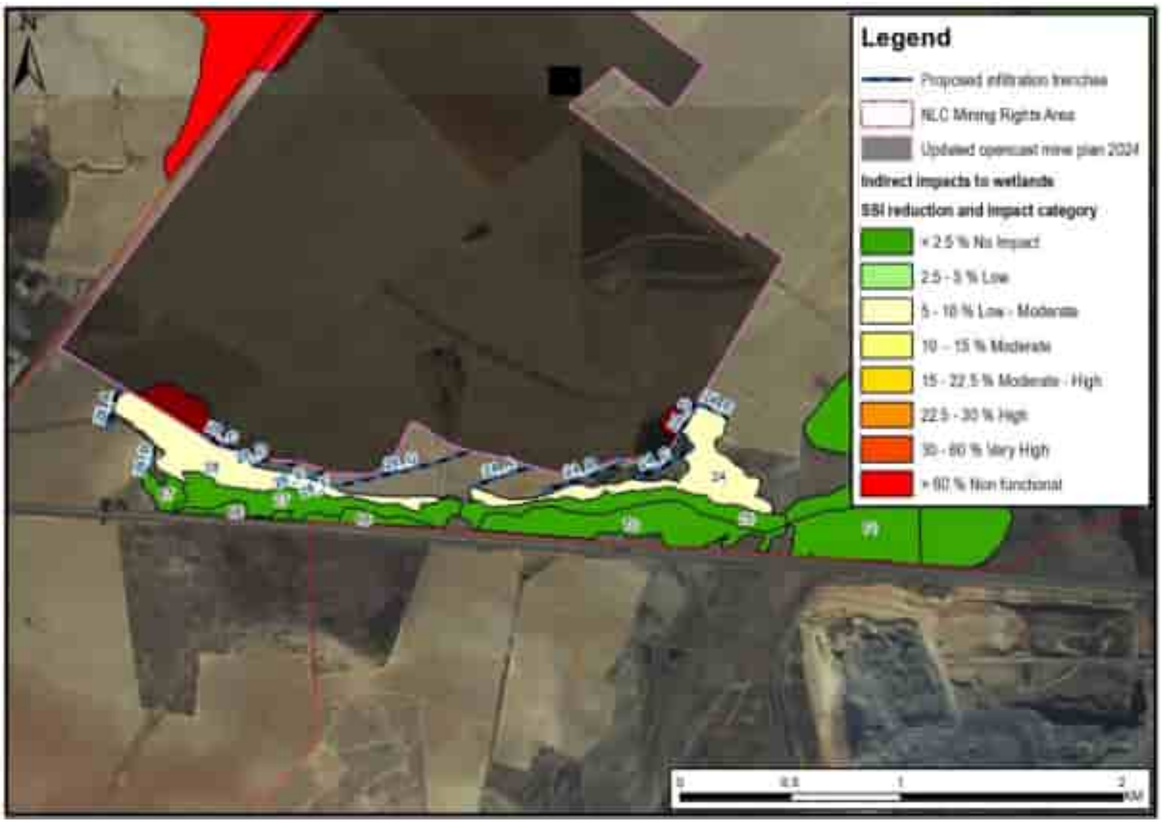


Figure 50. Map showing the location of the proposed infiltration trenches for the south-eastern area.

The offset project will include the following key tasks:

- Implement environmental flow discharges including water conveyance and transfer system to mitigate flow loss in wetlands as detailed in Table 23.
- Full implementation of the detailed wetland rehabilitation and management interventions for Category 2 Wetland Offsets as outlined in this report.
- Engagement with the Department of Water and Sanitation (DWS) and other relevant authorities to keep stakeholders informed about the progress in implementing the offset strategy.

9.5 Risks related to historical underground mining

Historical underground mining occurred underneath several of the targeted offset pans either within their catchment only or both within their catchment and basin. A risk assessment related to the probability of failure of pillars, probability of subsidence and the probability of sinkhole formation was conducted by Saxum Mining and Trading CC (August 2024 and September 2024) for all pans where historical mining occurred at least within their catchments:

- New largo Pan
- Pan 3 (Southern pan cluster)
- Pan 5 (Southern pan cluster)
- Pan 6 (Southern pan cluster)
- BMK Pan 3 (BMKPan01)
- Kriel Pan 1

- Kriel Pan 2

Seriti who holds the mining and surface rights for the Dispatch Rider pans has confirmed that no mining will take place underneath either the pan basins or pan catchments.

The relevance of a risk assessment of any form of failure related to historical underground mining lies within the long-term sustainability of the hydrology of the pans. In the event of pillar failure either sinkhole formation or subsidence is associated with breaks and crack formation of the overburden material typically consisting of sandstone, mudstone or shale. The failure related cracking will increase the vertical hydraulic conductivity allowing surface water related flow drivers to drain (increased groundwater percolation) to the old underground mining voids (typically flooded). This will alter the pan water body directly or will affect water inputs (flow drivers) to the pan. The severity of this impact depends on the location and extent of the failures. Any failure within the pan catchment will reduce the flow driver to the pan from the affected portion of the catchment while a failure within the pan basin could lead to a draining of the pan water body itself.

The groundwater level below the pan basin is usually controlled by a decant point elevation of the groundwater for the respective underground workings. This information was only available for the New Largo Pan, and it is likely that the groundwater level for other pans is below their respective basin that are situated above historical underground mining. It was therefore assumed that any increase in connectivity between the surface and the old underground workings would mean a loss of water to the pan.

The risk assessment conducted by Saxum Mining and Trading (August 2024 and September 2024) consisted of 4 main categories:

- **Depth** – Depth of the underground mining in relation to surface elevations.
- **Competence** – the competency of the overburden material referring to the strength of the rock layers between the underground workings and the surface.
- **Sinkhole** – The likelihood of sinkhole formation.
- **Pillar stability** – the likely competency of the pillar providing a temporal component to the time until pillar failure is likely.

Each of these categories were rated into three risk categories Low, Medium and High.

The following subsections represent a summary of the findings for New Largo Pan (Saxum Mining and Trading CC, August 2024 Rev02) and the other pans where historical underground mining occurred at least within its catchment (Saxum Mining and Trading CC, September 2024).

9.5.1 New Largo Pan

Underground mining within the New Largo Pan catchment and basin was extensive and both the #2 and #4 seam was mined in 1956 and 1987 respectively (Saxum Mining and Trading, August 2024 Rev. 02). Both within the pan catchment as well as the pan basin there are high risks in all four categories, i.e. depth, competence, sinkhole and pillar stability. This means that either pillar failure or overburden failure in the future is likely and that flows to the pan will be reduced to some degree. It is also likely that the vertical hydraulic conductivity within the pan basin will increase following failure within the pan basin and that there is a possibility that water from the pan basin may drain into the below lying underground workings. The clay rich sediments within the pan basin have the potential to seal cracks forming within the pan basin. Further mitigation within the pan catchment is planned and detailed in Section 0. This includes possible methods to address the risks associated with either pillar or overburden failure during implementation of the rehabilitation (WSP Memo, September 2024). It was concluded that rehabilitation is possible if the implementation is done in accordance with the methods proposed by WSP. Long-term monitoring will be required to monitor the area for any pillar or overburden failure in the future and Seriti will have to address such in the pan basin or catchment in the future should it pose a risk to the pan.

9.5.2 Pan 3 (Southern Pans)

Pan 3 was undermined in the shallower #4 coal seam. Two different historical collieries exist east and west of the pan basin while the eastern mining extent overlaps with the pan basin. The risks for the mining block directly under the pan basin was rated high for sinkhole formation as well as pillar stability. This means that it is likely that crack formation and the associated increase in connectivity between the pan basin and the historical underground workings will occur in the future. The clays within the pan basin have the potential to seal any cracks as they occur. Parts of the western catchment showed high risks for the overburden competence, and sinkhole formation. During detailed design a method statement for rehabilitation and monitoring will need to be undertaken to address the risks as indicated above.

9.5.3 Pan 5 (Southern Pans)

Pan 5 was extensively undermined both underneath the pan basin as well as the pan catchment. The categories depth, sinkhole formation and competency of overburden scored as high risks within the pan basin in all of the assessment areas. Parts of the catchment area showed high risk for sinkhole formation and overburden competence while the other categories showed moderate risks only. Again, during detailed design, a method statement for rehabilitation and monitoring will need to be undertaken to address the risks as indicated above.

9.5.4 Pan 6 (Southern Pans)

A small portion of the pan basin of Pan 6 was undermined. Most of the eastern portion of the pan catchment was also undermined. The pan basin shows high risk in sinkhole formation and moderate risk for the other categories. The catchment area showed a moderate risk for pillar stability and high risks for the other categories. Again, during detailed design, a method statement for rehabilitation and monitoring will need to be undertaken to address the risks as indicated above.

9.5.5 BMK Pan 3 (BMKP01)

Within the catchment of BMK Pan 3 (BMKP01) no mining took place underneath the pan basin. The eastern colliery showed a medium risk for pillar stability and overburden competence and low risk for the other categories. The western colliery showed a high risk of pillar stability and low risk for the other categories.

Rehabilitation will likely not require specific method statements for dealing with pillar stability and overburden competence.

9.5.6 Kriel Pan 1

Only about a quarter of the footprint of the pan basin of Kriel Pan 1 was undermined. The risk for this portion was rated low in all categories. The mining within the pan catchment is limited to the western, smaller portion of the pan catchment. This highest risk within these portions was a medium risk for pillar stability and low risk for the remaining categories. Rehabilitation will likely not require specific method statements for dealing with pillar stability and overburden competence.

9.5.7 Kriel Pan 2

Kriel Pan 2 was undermined extensively under its basin and approximately 60 % of its catchment. Both within the pan basin and within the pan catchment there was each one area with a moderate risk of pillar stability while the other categories showed low risks throughout the remainder of the areas. Again, during detailed design, a method statement for rehabilitation and monitoring will need to be undertaken to address the risks as indicated above.

9.6 Evaluation of Possible Gains

In evaluating offset gains according to the SANBI & DWS (2016) Wetland Offset Guidelines, a number of important rehabilitation interventions need to be highlighted as they play a significant role in terms of achieving the estimated offset gains:

- Withdrawal of cultivation from the catchments of the Category 3 wetlands within the Seriti SRA has been assumed as part of the rehabilitation strategy to reduce the impact of cultivation on the wetlands and to improve the habitat quality of the wetlands. This intervention has therefore been assumed in the calculation of gains.
- All alien vegetation will be removed and controlled to prevent re-establishment.
- The New Largo Pan will be rehabilitated under the conditions outlined in the rehabilitation method statement (WSP Memo, September 2024).

Other considerations that should be noted in terms of the results of the offset calculations are as follows:

- It has been assumed that, in a scenario where no rehabilitation or management interventions are implemented as per this strategy, and the *status quo* persists, many of the targeted wetlands (specifically the seep and valley bottom wetlands) would continue to degrade as they are currently on a negative trajectory of change due to ongoing land-use impacts.
- A 0.66 risk multiplier has been applied to all proposed structural interventions as per requirements of the SANBI & DWS (2016) Wetland Offset Guidelines.

Through the implementation of the proposed onsite and offsite wetland rehabilitation strategy detailed above, anticipated gains per each wetland offset category are summarised in Table 24.

Table 24. Summary of estimated Water Resources & Ecoservices and Ecosystem Conservation gains that can be realised through implementation of the proposed rehabilitation strategy.

Overall Offset Requirements		
Requirements	***Functional Targets (ha.eq)***	***Ecosystem Conservation Targets (ha.eq)***
	138.19	905.73
Offset Evaluations		
Categories	***Functional gains (ha.eq)***	***Ecosystem Conservation (ha.eq)***
Category 1	97.76	516.07
Category 2	11.18	44.94
Category 3	5.45	56.10
Category 3 - New Largo Pan	15.02	74.83
Category 4	4.37	123.42
Additional Pans		
Dispatch Rider Pans	8.66	130.10
MMS-BMK Pan	2.39	8.08
Kriel Pans with WWTW	2.07	26.41
TOTAL	***146.89***	***979.95***
(-) Deficit/(+) Surplus)	**8.70**	**74.22**

The goal of wetland offsets is to achieve a measurable "**No Net Loss**" or "**Net Gain**" in functional outcomes as a means of compensating for residual adverse impacts on wetlands. In the case of New Largo, rehabilitation, and protection of the four categories of wetlands described is expected to result in **"Net Gains"** in terms of the Functional Offset requirements. This means that with the successful implementation of the proposed strategy in full, it could be possible to achieve no net loss of wetland functions.

The proposed rehabilitation strategy will also go a long way towards protecting and conserving the ecosystem and biodiversity support functions of the wetlands, and meeting the ecosystem conservation targets. Protection of the pans in particular (Category 3 and 4), even without any rehabilitation and improvement of their condition, would secure ecosystem conservation gains from a wetland offsetting perspective. The benefits associated with this strategy are evident in terms of ecosystem conservation and protection and will likely also result in water quality and quantity improvement. If implemented correctly, they will also prevent the further deterioration of the systems and improve biotic health and diversity in the receiving watercourses surrounding the mining activities.

It is also worth mentioning that, assuming the successful implementation of the strategy, the contribution of both Categories 3, 4 and additional pan wetlands combined, in terms of the **"Like for Like"** pan offset principle, *this will meet at least 83 % of the functional offset requirements associated with the loss of Honingkrantz Pan and its associated seeps*. Table 25 indicates the contribution of both Categories 3 and 4 pan and seep wetlands in relation to the offset requirements for the Honingkrantz Pan only.

The results indicate that in terms of the pans, the offset contributes slightly less to functional offset targets but significantly more towards meeting the ecosystem conservation targets (refer to the specialist review of the offset guidelines and associated calculators). This is mainly because fewer activities are required within the pan basins themselves, with most necessary actions focused in the catchment areas that sustain the pan's functioning and key hydrological drivers. This is evident in the much higher net gains associated with ecosystem conservation targets across all the assessed pans.

Table 25. Summary of the offset contribution of Category 3 and 4 wetlands in relation to the offset requirements for the Honingkrantz Pan.

Like for Like Offset Requirements (Honingkrantz Pan)		
Requirements	***Functional Targets (ha.eq)***	***Ecosystem Conservation Targets (ha.eq)***
	45.78	132.60
Offset Evaluations		
Categories	***Functional gains (ha.eq)***	***Ecosystem Conservation (ha.eq)***
Category 3	5.45	56.10
Category 3 - New Largo Pan	15.02	74.83
Category 4	4.37	123.42
Dispatch Rider Pans	8.66	130.10
MMS-BMK Pan	2.39	8.08
Kriel Pans with WWTW	2.07	26.41
TOTAL	***37.95***	***418.93***
(-) Deficit/(+) Surplus)	**-7.83**	**286.33**

9.7 Implementation Timeline

The implementation of the proposed offset activities is divided into four phases, as described above. These phases will commence should the strategy be approved and signed off by the DWS, and they will be executed systematically to achieve the offset targets in line with the completion of the proposed mining activities. While some phases will run concurrently, they will conclude at different stages throughout the mining activities onsite. The following three conditions must be met across all phases for practical implementation, and ideally, they should all be fulfilled before any phase can commence:

1. Strategy Approval: The strategy must be approval by relevant authorities through the necessary authorisations.
2. Coal Supply Agreements (CSA): These agreements should be finalised and signed off.
3. Commencement of Mining and related Activities: Mining or mining-related activities must begin onsite to ensure concurrent rehabilitation and the refinancing of rehabilitation work as income is generated.

Project Phases:

- **Phase 1** will begin as soon as the all the three conditions are fully met, with the goal to complete it within the first five years post meeting all three requirements.

- **Phases 2 and 3** are targeted for completion within 5 to 10 years after all three conditions are fully met.
- **Phase 4** is expected to occur between 10 to 15 years after all three conditions are fully met, as its completion largely depends on various sources of environmental flow requirements once all WTPs are constructed and operational.

Summary of expected timeframes:

- Phase 1 – Within the first five years after all the three conditions are fully met– Category 1 wetlands
- Phases 2 and 3 – Five to ten years after all the three conditions are fully met– Categories 3 & 4 wetlands
- Phase 4 – Ten to fifteen years after all the three conditions are fully met– Category 2 wetlands

Defining an exact start date for the implementation strategy is challenging, as it depends on the approval and issuance of various regulatory authorisations, signing of CSA and commencement of mining onsite. However, the wetland offset strategy is expected to begin within 18 months of being approved by the DWS and will follow the general timelines outlined in Table 26. Ideally, implementation should align with available funding. The schedule in Table 26 serves as a guideline, but Seriti should finalise the timing based on yearly available funds to ensure the practical and financially viable execution of offset activities.

Table 26. Approximate implementation timeline proposed for the wetland offsets strategy. Commencement is assumed to be within 5 years of environmental and water use authorisation approval.

Tasks	Commencement	Duration (months)
Phase 1: Rehabilitation of Category 1 Wetland Offsets	**Within 5 years of meeting of all three conditions for practical implementation.**	**5 years**
Planning phase (Financial, detailed designs, costing & tendering and engagement with stakeholders)		1 year
Implementation phase (rehabilitation, management, monitoring, protection)		4 years
Phase 2: Rehabilitation of Category 3 Wetland Offsets	**Within 10 years of meeting of all three conditions for practical implementation.**	**10 years**
Negotiation with third-party landowners		Not required
Planning phase (Financial, detailed designs, costing & tendering and engagement with stakeholders)		5 years
Implementation phase (rehabilitation, management, monitoring, protection)		5 years
Phase 3: Rehabilitation of Category 4 Wetland Offsets	**Within 10 years of meeting of all three conditions for practical implementation.**	**10 years**

Tasks	Commencement	Duration (months)
Negotiation with third-party landowners		Completed – Pan 7
Planning phase (Financial, detailed design, engagement with stakeholders, environmental authorisations etc.)		5 years
Implementation phase (rehabilitation, management, monitoring, protection)		5 years
Phase 4: Rehabilitation of Category 2 Wetland Offsets	**Within 15 years of meeting of all three conditions for practical implementation.**	**15 years**
Planning phase (Financial, detailed design, engagement with stakeholders) Identification of water sources and construction of WTP and delivery systems and design of discharge mechanisms to wetlands		10 years
Implementation phase (instream activities - rehabilitation, management, monitoring, protection)		5 years

10. OPPORTUNITIES PROVIDED BY THE OFFSET STRATEGY

The proposed wetland offset strategy offers several benefits for conservation and sustainable ecosystem management. Key points include:

- **Wetland Protection and Long-term Stewardship:** The offset focuses on safeguarding some of the surrounding wetlands which are vital for maintaining biodiversity, supporting ecological processes and maintaining water quality, and providing important freshwater habitats for various species.
- **Pan Habitat Enhancement:** As many of the pans fall within Seriti's boundaries, the offset ensures their long-term preservation and improvement, which will further support the protection of bird species that utilise these pans, or may return to utilising these pans as conditions improve, and for overall freshwater habitat conservation.
- **Water Resource and Quality Improvement:** The offset will play a role in terms of enhancing water resource management in a developed landscape, thereby helping to maintain and even improve water quality. Improving the condition of the targeted wetlands will also promote water retention in general, contributing to the overall health of the associated catchment areas.
- **Focused and Secure Implementation:** By selecting wetlands within its operational reach, Seriti can more effectively oversee and manage the offset programme. This focus allows for practical, and timeous implementation and guarantees long-term stewardship through ongoing maintenance and monitoring supported by adaptive management.
- **Contribution to the Upper Olifants River Catchment:** Through the protection and rehabilitation of the selected wetlands and wetland clusters, the offset will to some extent contribute to wetland management in this hard-working section of the Upper Olifants River catchment. Likely benefits are expected for water quality improvement where the wetlands are linked to the drainage network, and improved biodiversity support related to the endorheic pan systems
- **Alignment with Seriti's Environmental Goals:** The offset initiative reflects Seriti's broader environmental stewardship commitment related to the New Largo MRA, demonstrating a proactive approach to trying to offset and manage the residual wetland impacts associated with the proposed mining operation.

11. WAY FORWARD

11.1 Authority Consultation

The updated report, incorporating feedback from the consultation process and the stakeholder engagement reports by the WSP, will be submitted and presented to the Department of Water and Sanitation (DWS) and the Department of Forestry, Fisheries, and the Environment (DFFE) for strategy review and approval.

11.2 Engagement, Agreements, Detailed Planning, and Implementation Schedules

Following review, Seriti and identified implementation partners, will need to:

1. Finalise agreements with relevant landowners and implementation partners.
2. Develop detailed designs for rehabilitation interventions and their associated costs.
3. Create implementation schedules and phasing plans. This information will be communicated to the relevant authorities for auditing, monitoring, and evaluation.

11.3 Development of a wetland offset plan

Seriti shall develop and implement a Wetland Offset Management Plan. While Appendices 7 and 8 provide a generic guide for this plan, a site-specific plan will need to be compiled during the next phase of the offset project. This site-specific plan will include detailed designs for interventions tailored to each wetland cluster and outline specific management requirements to ensure the successful execution of the offset strategy. These requirements will address all critical phases, including pre-construction, construction, and post-construction. The management plan will need to address important key aspects as indicated below.

Regular monitoring of rehabilitation interventions to ensure:

- No signs of erosion
- No signs of scouring
- No cracks in civil structures
- No head cuts developing
- No possible failure of berms
- Vegetation recovery is stable

Monitoring for upstream impacts entering the wetlands including:

- Stormwater Infrastructure Maintenance
- Management of agricultural lands
- Fire management
- Control of alien species
- Control of livestock

Monitoring recommendations related to stability assessments - Implementation of New Largo (NL) Pan rehab method statement activities:

- Sealing of the pan slopes
- Infilling pan slopes with high permeability material to facilitate interflow
- Handling of salt precipitates from pan slopes
- Stabilising underground workings
- Repair sinkholes
- Removal and Control of alien species
- Convert cultivated land to grasslands

To facilitate the implementation of the strategy, Seriti Power should consider appointing dedicated land management personnel with a background in agricultural extension and environmental monitoring. These individuals would need to manage the project and provide ongoing support, focusing on improving land management practices within the catchments of the targeted wetlands.

12. REFERENCES

Brinson, M. M. 1993. A hydrogeomorphic classification for wetlands. Wetlands Research Program Technical Report WRP-DE-4. U. S. Army Corps of Engineers, Waterway Experiment Station. Vicksburg, MS.

Business and Biodiversity Offsets Programme (BBOP). 2018. Working for Biodiversity Net Gain: An Overview of the Business and Biodiversity Offsets Programme (BBOP) 2004–2018. Washington, D.C.

Cowden, C. and Kotze, D.C. 2009. WETRehabEvaluate: Guidelines for the monitoring and evaluation of wetland rehabilitation projects. WRC Report No TT 342/08, Water Research Commission, Pretoria.

Department of Water Affairs and Forestry, 2005. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

Ferrar, A.A. & Lötter, M.C. 2007. *Mpumalanga Biodiversity Conservation Plan Handbook.* Mpumalanga Tourism & Parks Agency, Nelspruit.

JMA Consulting, 2022. Water and Salt Balance Report: New Largo Coal (Pty) Ltd – New Largo Colliery. Project Number: JMA/10538, Report Number: Prj6429.

Lötter, M.C. 2014. Technical Report for the Mpumalanga Biodiversity Sector Plan – MBSP. Mpumalanga Tourism & Parks Agency, Nelspruit.

Macfarlane DM, Kotze DC, Ellery WN, Walters D, Koopman V, Goodman P and Goge C. 2007. *WET-Health: A technique for rapidly assessing wetland health*. WRC Report No TT 340/08, Water Research Commission, Pretoria.

Macfarlane, D. M., Ollis, D. J., and Kotze, D. C. 2020. ***WET-Health (Version 2.0)*** *– A refined suite of tools for assessing the present ecological state of wetland ecosystems: Technical guide*. WRC Report No. TT 820/20. South Africa: WRC.

Middleton B.J. and Bailey A.K. 2009. Water Resources of South Africa, 2005 study. Water Research Commission Report Number TT 380/08, Water Research Commission, Pretoria, South Africa.

MTPA. 2014. Mpumalanga Biodiversity Sector Plan Handbook. Compiled by Lötter M.C., Cadman, M.J. and Lechmere-Oertel R.G. Mpumalanga Tourism & Parks Agency, Mbombela (Nelspruit).

Nel, Jeanne & Driver, Amanda & Strydom, Wilma & Maherry, Ashton & Petersen, Chantel & Hill, Liesl & Roux, Dirk & S, Nienaber & Van Deventer, Heidi & Swartz, Ernst & Smith-Adao, Lindie. 2011. ATLAS of Freshwater Ecosystem Priority Areas in South Africa: Maps to support the sustainable development of water resources.

Mucina, L. & Rutherford, M. C. (Eds) 2006. The vegetation of South Africa, Lesotho and Swaziland. *Strelitzia 19*. South African National Biodiversity Institute, Pretoria. 807pp.

Rountree M.W., Malan H.L. and Weston B.C. (editors) 2013. *Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0)*. Report to the Water Research Commission and Department of Water Affairs. Report No. 1788/1/12. Water Research Commission, Pretoria, South Africa.

Russell, W., Sieben, E., Micheal B., Ellery, W and Kotze, D. 2009. WET-RehabMethods: National guidelines and methods for wetland rehabilitation. Wetland Management Series. Water Research Commission Report TT341/08, Water Research Commission, Pretoria.

Soil Advisory Services (Pty.) Ltd., August 2024. New Largo Pan & Honingkrantz Pan Initial Soil Investigation in support of the Honingkrantz Pan Water Use License Application. Draft Report for WSP Africa, Document no. SAS20230906-1-SCRA-HGK.

South African National Biodiversity Institute & Department of Water and Sanitation. 2016. Wetland Offsets: A best-practice guideline for South Africa. Water Research Commission. WRC Report No. TT 660/16.

Gauteng Department: Agriculture and Rural Development (GDARD), 2011. Gauteng Conservation Plan Version 3.3.

Mbona N, Job N, Smith J, Nel J, Holness S, Memani S and Dini J (2015). Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands. WRC Report No. TT 614/14. Water Research Commission, Pretoria.

Mucina, L. and Rutherford, M.C. 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. SANBI, Pretoria.

Nel, J.L., Driver, A., Strydom, W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H. Swartz, E. and Smith-Adao, L.B. 2011. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. Water Research Commission, Gezina. WRC Report No. TT 500/11.

Ollis, D., Snaddon, K., Job. N. and Mbona. N. 2013. Classification system for wetland and other aquatic ecosystems in South Africa. User manual: inland systems. SANBI biodiversity series 22. SANBI Pretoria. Republic of South Africa. 1998. National Water Act (Act No 36 of 1998).

SANBI, 2014. *Grazing and Burning Guidelines: Managing Grasslands for Biodiversity and Livestock Production.* Compiled by Lechmere-Oertel, R.G. South African National Biodiversity Institute, Pretoria. 42 pages.

SANBI and DWS. 2016. *Wetland Offsets: A best practice guideline for South Africa*. South African National Biodiversity Institute and the Department of Water and Sanitation. WRC Report No. TT 660/16. Pretoria. 53 pages.

Saxum Mining & Trading CC, August 2024, Rev.02. Rock Engineering Review and Verification of the Seriti New Largo Pan as Part of the Reclassification Study. Report reference STP 2405-1069.

Saxum Mining & Trading CC, September 2024. Rock Engineering Review and Verification of Honingkrantz Offsite Pans. Presentation for initial feedback and discussion purposes.

Taylor, M., Peacock, F. and Wanless, R., eds. (2015). The 2015 Eskom Red Data Book of Birds of South Africa, Lesotho, and Swaziland. BirdLife South Africa.

Wetland Consulting Services (Pty.) Ltd. (WCS), 2014. Preliminary Determination of the Reserve and Resource Class for Selected Wetlands in Quaternary Catchments B20F and B20G: Related to the Proposed New Largo Colliery. For Anglo Inyosi Coal, Unpublished draft report.

Wetland Consulting Services (Pty.) Ltd. (WCS), 2016. Wetland Rehabilitation and Management Strategy for New Largo Opencast Coal Mine, Mpumalanga Province. Final Draft Report. Reference Number: 1037-2014.

Wetland Consulting Services (Pty.) Ltd. (WCS), 2020. Technical Memorandum: Wetland Mitigation Strategy related to mining of the Remainder of the Honingkrantz 526JR within the New Largo Coal (Pty) Ltd Mining Right Area (MRA).

Wetland Consulting Services (Pty.) Ltd. (WCS), 2022. New Largo Coal - Wetland Mitigation and Offset Strategy for WSP Golder on behalf of Seriti Power, Final Report. Reference W2022_040.

Van Deventer, H., Van Niekerk, L., Adams, J., Dinala, M., Gangat, R., Lamberth, S., Lotter, M., Mbona, N., MacKay, F., Nel, J., Ramjukadh, C-L., Skowno, A., & Weerts, S. 2019. National Wetland Map 5 – An improved spatial extent and representation of inland aquatic and estuarine ecosystems in South Africa. 10.1101/640441.

Walters, D., Kotze, D., Cowden, C., Browne, M., Grewcock, M., Jamk, M., amd Eggers, F. 2019. Wet Rehabevaluate Version 2: An integrated monitoring and evaluation framework to assess wetland rehabilitation in South Africa. WRC Report No.2344/1/19, Water Research Commission, Pretoria.

WSP Memo, September 2024. New Largo Pan Rehabilitation – Work Method Statement, Francois Marais, Riana Munnik, Brent Baxter, Olivia Allen. To Pavan Rajlal, Seriti Power (Pty.) Ltd.

APPENDIX 1 OFFSET REQUIREMENTS (DIRECT AND INDIRECT LOSSES)

Table A 1-1. Offset requirements – direct wetland losses (Water Resources and Ecosystem Services)

Wetland ID	Type	Area (ha)	PES	Hectare Equivalents (ha-eq)
S0	Seep	13.66	D	6.69
S54	Seep	3.67	D	2.06
P01	Pan	49.08	C	34.85
S57	Seep	24.00	D	11.76
S56	Seep	1.49	D	0.45
S08	Seep	2.11	D	1.10
S08	Seep	0.04	D	0.02
S07	Seep	0.21	D	0.15
P08	Pan	0.49	D	0.28
S44	Seep	0.01	E	0.00
S53	Seep	7.88	D	4.73
S07	Seep	0.31	D	0.22
S59	Seep	2.08	D	0.87
S59	Seep	15.15	D	6.36
S08	Seep	0.07	D	0.04
S58	Seep	1.48	D	0.72
S57	Seep	0.20	D	0.10
S59	Seep	0.00	D	0.00
P07	Pan	3.03	C	2.27
S07	Seep	7.89	D	5.45
CVB10	Channelled valley bottom	2.74	E	0.96
S01	Seep	19.52	D	10.93
S67	Seep	1.99	C	1.45
P08	Pan	3.62	D	2.07
S48	Seep	3.78	C	1.89
S55	Seep	2.66	E	0.85
S91	Seep	0.70	D	0.34
S90	Seep	2.00	E	0.52
S75	Seep	1.47	D	0.75
S66	Seep	0.88	D	0.38
S65	Seep	2.30	D	1.10
S76	Seep	4.67	E	2.33
S29	Seep	0.01	D	0.01
S90	Seep	0.28	E	0.07
Total		***179.48***		***101.77***

Table A 1-2. Offset requirements – direct wetland losses – (Ecosystem Conservation targets)

Wetland ID	Type	Area (ha)	Habitat Intactness (%)	Threat Status	Ecosystem Conservation Ratio	Ecosystem Conservation Target (ha. eq)
S0	Seep	13.66	50.5	CR	7.03	48.50
S54	Seep	3.67	60	CR	4.69	10.33
P01	Pan	49.08	87	LT	0.75	32.02
S57	Seep	24.00	60	CR	6.47	93.16
S56	Seep	1.49	60	CR	4.69	4.20
S08	Seep	2.11	66	CR	6.00	8.35
S08	Seep	0.04	66	CR	6.00	0.17
S07	Seep	0.21	57	CR	6.75	0.82
P08	Pan	0.49	66	LT	0.80	0.26
S44	Seep	0.01	31	CR	7.03	0.03
S53	Seep	7.88	57	CR	7.03	31.59
S07	Seep	0.31	57	CR	7.03	1.25
S59	Seep	2.08	43	CR	4.69	4.20
S59	Seep	15.15	43	CR	4.69	30.53
S08	Seep	0.07	66	CR	6.00	0.28
S58	Seep	1.48	46	CR	4.69	3.19
S57	Seep	0.20	60	CR	7.03	0.85
S59	Seep	0.00	43	CR	4.69	0.00
P07	Pan	3.03	99	LT	0.75	2.25
S07	Seep	7.89	57	CR	7.03	31.64
CVB10	Channelled valley bottom	2.74	35	CR	6.75	6.46
S01	Seep	19.52	52	CR	9.00	91.38

Wetland ID	Type	Area (ha)	Habitat Intactness (%)	Threat Status	Ecosystem Conservation Ratio	Ecosystem Conservation Target (ha. eq)
S67	Seep	1.99	83	CR	6.47	10.67
P08	Pan	3.62	66	LT	0.78	1.85
S48	Seep	3.78	66	CR	4.69	11.70
S55	Seep	2.66	30	CR	4.69	3.74
S91	Seep	0.70	36	CR	5.06	1.27
S90	Seep	2.00	12	CR	3.38	0.81
S75	Seep	1.47	60	CR	4.69	4.12
S66	Seep	0.88	24	CR	4.31	0.91
S65	Seep	2.30	34	CR	4.31	3.37
S76	Seep	4.67	60	CR	4.69	13.13
S29	Seep	0.01	56	CR	7.03	0.05
S90	Seep	0.28	12	CR	3.38	0.11
Total		***179.48***				***453.19***

Table A 1-3. Offset requirements – indirect wetland impacts – (Water Resources and Ecosystem Services)

Wetland ID	Type	Area (ha)	PES	Hectare Equivalents (ha-eq)
CVB02	Channelled valley bottom	11.52	D	0.58
CVB10	Channelled valley bottom	1.09	E	0.11
CVB10	Channelled valley bottom	1.23	E	0.12
DL02	Drainage line	0.42	E	0.06
DL04	Drainage line	0.43	C	0.02
E1	Hillslope seepage	2.19	C	0.11
E2	Hillslope seepage	4.30	C	0.22
S29	Seep	0.00	D	0.00
S29	Seep	0.10	D	0.02
S29	Seep	17.74	D	3.55
S29	Seep	14.73	D	1.47
S32	Seep	7.62	D	0.76
S33	Seep	5.15	E	0.77
S34	Seep	1.20	E	0.12
S34	Seep	1.33	E	0.13
S34	Seep	5.83	E	0.29
S35	Seep	22.23	D	3.33
S39	Seep	36.27	C	3.63
S41	Seep	2.30	D	0.34
S41	Seep	18.07	D	1.81
S41	Seep	1.53	D	0.08
S41	Seep	1.39	D	0.07
S42	Seep	10.77	D	0.54
S42	Seep	1.54	D	0.08
S42	Seep	1.13	D	0.06
S48	Seep	4.53	D	0.00
S53	Seep	3.06	D	0.46
S53	Seep	4.91	D	0.74
S59	Seep	13.57	D	3.39
S59	Seep	1.99	D	0.30
S59	Seep	3.00	D	0.15
S64	Seep	0.19	D	0.01
S66	Seep	1.56	D	0.28
S68	Seep	12.21	D	2.44
S69	Seep	5.02	E	0.50
S75	Seep	13.83	D	1.38
S76	Seep	15.45	D	1.54
S80	Seep	4.87	D	0.24
S90	Seep	1.51	E	0.15
UVB01	Unchannelled valley bottom	2.23	C	0.33
UVB03	Unchannelled valley bottom	2.59	D	0.26
UVB03	Unchannelled valley bottom	9.00	D	0.45
UVB05	Unchannelled valley bottom	23.36	D	2.34
UVB06	Unchannelled valley bottom	2.45	C	0.12
UVB06	Unchannelled valley bottom	1.84	C	0.09
UVB06	Unchannelled valley bottom	1.84	C	0.09
UVB07	Unchannelled valley bottom	0.36	D	0.02
UVB07	Channelled valley bottom	3.19	D	0.16
UVB08	Unchannelled valley bottom	14.43	D	1.80
UVB09	Unchannelled valley bottom	5.61	D	0.56
V2	Hillslope seepage	3.35	C	0.34

Wetland ID	Type	Area (ha)	PES	Hectare Equivalents (ha-eq)
Total		***326.07***		***36.42***

Table A 1-4. Offset requirements – indirect wetland impacts – (Ecosystem Conservation targets).

Wetland ID	Type	Area (ha)	Habitat Intactness (%)	Threat Status	Ecosystem Conservation Ratio	Ecosystem Conservation Target (ha. eq)
CVB02	Channelled valley bottom	11.52	42	CR	18.75	21.60
CVB10	Channelled valley bottom	1.09	35	CR	10.13	1.11
CVB10	Channelled valley bottom	1.23	35	CR	13.50	0.83
DL02	Drainage line	0.42	13	LT	0.23	0.01
DL04	Drainage line	0.43	41	LT	0.23	0.01
E1	Hillslope seepage	2.19	37	CR	7.03	1.54
E2	Hillslope seepage	4.30	43	CR	7.03	3.02
S29	Seep	0.00	56	CR	7.03	0.00
S29	Seep	0.10	56	CR	7.03	0.07
S29	Seep	17.74	56	CR	7.03	12.47
S29	Seep	14.73	56	CR	7.03	10.36
S32	Seep	7.62	31	CR	7.03	5.35
S33	Seep	5.15	36	CR	5.06	2.61
S34	Seep	1.20	46	CR	9.38	2.24
S34	Seep	1.33	46	CR	9.38	1.87
S34	Seep	5.83	46	CR	9.38	10.93
S35	Seep	22.23	52	CR	7.03	15.63
S39	Seep	36.27	70	CR	6.00	54.41
S41	Seep	2.30	43	CR	9.00	0.00
S41	Seep	18.07	43	CR	9.00	32.53
S41	Seep	1.53	43	CR	9.00	2.75
S41	Seep	1.39	43	CR	9.00	0.62
S42	Seep	10.77	51	CR	9.00	19.39
S42	Seep	1.54	51	CR	9.00	1.39
S42	Seep	1.13	51	CR	9.00	1.01
S48	Seep	4.53	66	CR	4.69	2.12
S53	Seep	3.06	57	CR	7.03	1.08
S53	Seep	4.91	57	CR	7.03	1.73
S59	Seep	13.57	43	CR	9.38	6.36
S59	Seep	1.99	43	CR	9.38	0.93
S59	Seep	3.00	43	CR	9.38	1.41
S64	Seep	0.19	10	CR	6.00	0.06
S66	Seep	1.56	24	CR	4.69	0.00
S68	Seep	12.21	37	CR	9.38	5.72
S69	Seep	5.02	18	CR	9.38	4.71
S75	Seep	13.83	60	CR	9.38	32.42
S76	Seep	15.45	60	CR	9.38	36.20
S80	Seep	4.87	35	CR	4.69	2.29
S90	Seep	1.51	12	CR	6.75	1.02
UVB01	Unchannelled valley bottom	2.23	52	CR	14.06	4.70
UVB03	Unchannelled valley bottom	2.59	42	CR	18.75	7.27
UVB03	Unchannelled valley bottom	9.00	42	CR	18.75	25.30
UVB05	Unchannelled valley bottom	23.36	37	CR	14.06	49.28
UVB06	Unchannelled valley bottom	2.45	49	CR	18.75	6.89
UVB06	Unchannelled valley bottom	1.84	49	CR	18.75	1.73
UVB06	Unchannelled valley bottom	1.84	49	CR	18.75	3.45
UVB07	Unchannelled valley bottom	0.36	37	CR	24.00	0.44
UVB07	Channelled valley bottom	3.19	37	CR	24.00	3.83
UVB08	Unchannelled valley bottom	14.43	47	CR	18.00	38.95
UVB09	Unchannelled valley bottom	5.61	52	CR	18.75	10.52
V2	Hillslope seepage	3.35	49	CR	4.69	2.36
Total		***326.07***				***452.54***

APPENDIX 2 OFFSET EVALUATIONS – CATEGORY 1 WETLAND OFFSETS

Table A 2-1. Category 1 wetlands (PES, IS and REC).

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	REC
CVB01	Channelled valley bottom	1,07	High	D	49	C/D
CVB01	Channelled valley bottom	3,21	High	D	49	C/D
CVB02	Channelled valley bottom	32,88	Moderate	D	44	D
CVB03	Channelled valley bottom	17,30	Moderate	C	69	C
CVB04	Channelled valley bottom	1,64	Moderate	D	56	D
CVB05	Channelled valley bottom	1,55	Moderate	D	58	D
CVB07	Channelled valley bottom	2,33	Moderate	D	50	D
CVB08	Channelled valley bottom	2,77	Moderate	D	50	D
CVB10	Channelled valley bottom	1,06	Low/Marginal	E	35	D
CVB11	Channelled valley bottom	6,78	Moderate	D	42	D
CVB12	Channelled valley bottom	8,66	Moderate	D	47	D
V3	Channelled valley bottom	6,80	Moderate	C	60	C
V4	Channelled valley bottom	1,10	High	D	50	C/D
V5	Channelled valley bottom	3,19	High	D	50	C/D
DL03	Drainage line	0,26	Low/Marginal	D	58	D
HS5	Hillslope seepage	7,34	Moderate	C	60	C
HS1	Hillslope seepage	29,50	Moderate	C	60	C
HS10	Hillslope seepage	4,30	Moderate	C	60	C
HS2	Hillslope seepage	1,01	Moderate	C	60	C
HS3	Hillslope seepage	1,28	Low/Marginal	D	50	D
HS4	Hillslope seepage	1,67	Low/Marginal	D	50	D
HS6	Hillslope seepage	5,45	High	B	80	B
HS7	Hillslope seepage	19,36	Moderate	C	60	C
HS8	Hillslope seepage	21,02	Low/Marginal	D	50	D
HS9	Hillslope seepage	2,23	Moderate	C	60	C
S09	Seep	2,29	Moderate	D	46	D
S15	Seep	27,15	Moderate	D	48	D
S16	Seep	5,59	Moderate	D	45	D
S19	Seep	34,71	High	C	73	B/C
S20	Seep	8,56	High	D	50	C/D
S21	Seep	10,53	High	D	52	C/D
S22	Seep	6,13	High	C	63	B/C
S23	Seep	12,91	High	C	75	B/C
S24	Seep	10,06	Moderate	D	45	D
S25	Seep	4,15	Low/Marginal	D	48	D
S26	Seep	185,30	Low/Marginal	D	42	D
S27	Seep	10,80	Moderate	D	46	D
S28	Seep	16,47	Moderate	D	49	D
S29	Seep	1,71	Moderate	D	55	D
S30	Seep	23,86	Moderate	D	47	D
S31	Seep	2,50	Moderate	D	59	D
S32	Seep	2,62	Moderate	D	42	D
S32	Seep	9,99	Moderate	D	42	D
S34	Seep	1,42	Moderate	E	31	D
S34	Seep	7,03	Moderate	E	31	D
S36	Seep	2,70	Moderate	D	51	D
S37	Seep	36,83	Moderate	D	45	D
S38	Seep	87,70	Moderate	D	50	D
S39	Seep	36,76	High	C	70	B/C
S40	Seep	25,62	High	C	68	B/C
S43	Seep	3,21	Moderate	D	41	D
S44	Seep	6,43	Moderate	E	37	D
S44	Seep	0,31	Moderate	E	37	D
S45	Seep	3,71	Moderate	E	36	D
S46	Seep	12,34	Moderate	D	42	D
S47	Seep	13,91	High	D	50	C/D
S49	Seep	9,93	High	B	81	A/B
S71	Seep	22,25	Moderate	D	50	D
S71	Seep	15,37	Moderate	D	50	D
S72	Seep	10,89	Moderate	E	35	D
S73	Seep	3,17	Moderate	C	64	C
S74	Seep	6,55	Moderate	D	47	D
S77	Seep	66,61	Moderate	D	52	D

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	REC
S78	Seep	34,35	Moderate	D	55	D
UVB02	Unchannelled valley bottom	59,58	Moderate	D	50	D
UVB04	Unchannelled valley bottom	33,82	Moderate	D	55	D
UVB06	Unchannelled valley bottom	0,33	Moderate	C	70	C
UVB08	Unchannelled valley bottom	2,07	High	D	58	C/D
UVB11	Unchannelled valley bottom	20,82	Moderate	D	48	D
UVB12	Unchannelled valley bottom	4,44	High	D	49	C/D
V1	Valley bottom	13,64	Moderate	C	60	C
V2	Valley bottom	4,04	Moderate	C	60	C
CVB06	Channelled valley bottom	3,09	Moderate	D	56	D
CVB02	Channelled valley bottom	9,45	Moderate	D	44	D
S60	Seep	22,38	Low/Marginal	E	22	D
S79	Seep	0,22	High	D	41	C/D
S79	Seep	27,95	High	D	41	C/D
S41	Seep	1,39	High	D	49	C/D
S42	Seep	1,13	High	D	58	C/D
S79	Seep	4,57	High	D	41	C/D
S71	Seep	15,32	Moderate	E	38	D
S79	Seep	5,86	High	D	41	C/D
S80	Seep	1,94	Moderate	D	40	D
S29	Seep	0,35	Moderate	D	55	D
UVB08	Unchannelled valley bottom	14,43	High	D	58	C/D
UVB06	Unchannelled valley bottom	0,13	Moderate	D	60	D
UVB10	Unchannelled valley bottom	5,05	Moderate	D	56	D
UVB06	Unchannelled valley bottom	1,51	Moderate	D	60	D
UVB10	Unchannelled valley bottom	3,63	Moderate	D	56	D
UVB08	Unchannelled valley bottom	0,95	High	D	58	C/D
Total		**1224,24**				

Table A 2-2. Category 1 wetlands - Offset evaluations – (Water Resources and Ecosystem Services)

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
CVB01	Channelled valley bottom	1.07	High	D	49	64	0.16	0.66	0.11
CVB01	Channelled valley bottom	3.21	High	D	49	64	0.48	0.66	0.32
CVB02	Channelled valley bottom	32.88	Moderate	D	44	60	5.26	0.66	3.47
CVB03	Channelled valley bottom	17.30	Moderate	C	69	75	1.04	0.66	0.68
CVB04	Channelled valley bottom	1.64	Moderate	D	56	67	0.18	0.66	0.12
CVB05	Channelled valley bottom	1.55	Moderate	D	58	71	0.20	0.66	0.13
CVB07	Channelled valley bottom	2.33	Moderate	D	50	64	0.33	0.66	0.21
CVB08	Channelled valley bottom	2.77	Moderate	D	50	61	0.31	0.66	0.20
CVB10	Channelled valley bottom	1.06	Low/Marginal	E	35	53	0.19	0.66	0.13
CVB11	Channelled valley bottom	6.78	Moderate	D	42	54	0.81	0.66	0.54
CVB12	Channelled valley bottom	8.66	Moderate	D	47	66	1.65	0.66	1.09
V3	Channelled valley bottom	6.80	Moderate	C	60	77	1.16	0.66	0.76
V4	Channelled valley bottom	1.10	Largely Natural	D	50	75	0.28	0.66	0.18
V5	Channelled valley bottom	3.19	Largely Natural	D	50	75	0.80	0.66	0.53
DL03	Drainage line	0.26	Low/Marginal	D	58	74	0.04	0.66	0.03
HS5	Hillslope seepage	7.34	Moderate	C	60	77	1.25	0.66	0.82
HS1	Hillslope seepage	29.50	Moderate	C	60	75	4.42	0.66	2.92
HS10	Hillslope seepage	4.30	Moderate	C	60	75	0.65	0.66	0.43
HS2	Hillslope seepage	1.01	Moderate	C	60	75	0.15	0.66	0.10
HS3	Hillslope seepage	1.28	Low/Marginal	D	50	75	0.32	0.66	0.21
HS4	Hillslope seepage	1.67	Low/Marginal	D	50	75	0.42	0.66	0.28
HS6	Hillslope seepage	5.45	Largely Natural	B	80	80	0.00	0.66	0.00
HS7	Hillslope seepage	19.36	Moderate	C	60	75	2.90	0.66	1.92
HS8	Hillslope seepage	21.02	Low/Marginal	D	50	75	5.25	0.66	3.47
HS9	Hillslope seepage	2.23	Moderate	C	60	75	0.33	0.66	0.22
S09	Seep	2.29	Moderate	D	46	59	0.30	0.66	0.20
S15	Seep	27.15	Moderate	D	48	59	2.99	0.66	1.97
S16	Seep	5.59	Moderate	D	45	56	0.61	0.66	0.41
S19	Seep	34.71	High	C	73	77	1.39	0.66	0.92
S20	Seep	8.56	High	D	50	73	1.97	0.66	1.30
S21	Seep	10.53	High	D	52	62	1.05	0.66	0.69
S22	Seep	6.13	High	C	63	73	0.61	0.66	0.40
S23	Seep	12.91	High	C	75	84	1.16	0.66	0.77
S24	Seep	10.06	Moderate	D	45	59	1.41	0.66	0.93

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
S25	Seep	4.15	Low/Marginal	D	48	56	0.33	0.66	0.22
S26	Seep	185.30	Low/Marginal	D	42	59	31.50	0.66	20.79
S27	Seep	10.80	Moderate	D	46	59	1.40	0.66	0.93
S28	Seep	16.47	Moderate	D	49	62	2.14	0.66	1.41
S29	Seep	1.71	Moderate	D	55	65	0.17	0.66	0.11
S30	Seep	23.86	Moderate	D	47	60	3.10	0.66	2.05
S31	Seep	2.50	Moderate	D	59	70	0.28	0.66	0.18
S32	Seep	2.62	Moderate	D	42	63	0.55	0.66	0.36
S32	Seep	9.99	Moderate	D	42	63	2.10	0.66	1.38
S34	Seep	1.42	Moderate	E	31	42	0.16	0.66	0.10
S34	Seep	7.03	Moderate	E	31	42	0.77	0.66	0.51
S36	Seep	2.70	Moderate	D	51	61	0.27	0.66	0.18
S37	Seep	36.83	Moderate	D	45	61	5.89	0.66	3.89
S38	Seep	87.70	Moderate	D	50	57	6.14	0.66	4.05
S39	Seep	36.76	High	C	70	70	0.00	0.66	0.00
S40	Seep	25.62	High	C	68	71	0.77	0.66	0.51
S43	Seep	3.21	Moderate	D	41	51	0.32	0.66	0.21
S44	Seep	6.43	Moderate	E	37	55	1.16	0.66	0.76
S44	Seep	0.31	Moderate	E	37	55	0.06	0.66	0.04
S45	Seep	3.71	Moderate	E	36	52	0.59	0.66	0.39
S46	Seep	12.34	Moderate	D	42	66	2.96	0.66	1.95
S47	Seep	13.91	High	D	50	72	3.06	0.66	2.02
S49	Seep	9.93	High	B	81	81	0.00	0.66	0.00
S71	Seep	22.25	Moderate	D	50	40	0.45	0.66	0.29
S71	Seep	15.37	Moderate	D	50	40	0.31	0.66	0.20
S72	Seep	10.89	Moderate	E	35	42	0.76	0.66	0.50
S73	Seep	3.17	Moderate	C	64	74	0.32	0.66	0.21
S74	Seep	6.55	Moderate	D	47	54	0.46	0.66	0.30
S77	Seep	66.61	Moderate	D	52	62	6.66	0.66	4.40
S78	Seep	34.35	Moderate	D	55	64	3.09	0.66	2.04
UVB02	Unchannelled valley bottom	59.58	Moderate	D	50	60	5.96	0.66	3.93
UVB04	Unchannelled valley bottom	33.82	Moderate	D	55	70	5.07	0.66	3.35
UVB06	Unchannelled valley bottom	0.33	Moderate	C	70	72	0.01	0.66	0.00
UVB08	Unchannelled valley bottom	2.07	High	D	58	70	0.25	0.66	0.16
UVB11	Unchannelled valley bottom	20.82	Moderate	D	48	70	4.58	0.66	3.02
UVB12	Unchannelled valley bottom	4.44	High	D	49	69	0.89	0.66	0.59
V1	Valley bottom	13.64	Moderate	C	60	77	2.32	0.66	1.53
V2	Valley bottom	4.04	Moderate	C	60	77	0.69	0.66	0.45
CVB06	Channelled valley bottom	3.09	Moderate	D	56	70	0.43	0.66	0.29
CVB02	Channelled valley bottom	9.45	Moderate	D	44	54	0.94	0.66	0.62
S60	Seep	22.38	Low/Marginal	E	22	39	3.81	0.66	2.51
S79	Seep	0.22	High	D	41	54	0.03	0.66	0.02
S79	Seep	27.95	High	D	41	54	3.63	0.66	2.40
S41	Seep	1.39	High	D	49	63	0.19	0.66	0.13
S42	Seep	1.13	High	D	58	63	0.06	0.66	0.04
S79	Seep	4.57	High	D	41	54	0.59	0.66	0.39
S71	Seep	15.32	Moderate	E	38	40	0.31	0.66	0.20
S79	Seep	5.86	High	D	41	54	0.76	0.66	0.50
S80	Seep	1.94	Moderate	D	40	48	0.16	0.66	0.10
S29	Seep	0.35	Moderate	D	55	57	0.01	0.66	0.00
UVB08	Unchannelled valley bottom	14.43	High	D	58	62	0.58	0.66	0.38
UVB06	Unchannelled valley bottom	0.13	Moderate	D	60	68	0.01	0.66	0.01
UVB10	Unchannelled valley bottom	5.05	Moderate	D	56	66	0.50	0.66	0.33
UVB06	Unchannelled valley bottom	1.51	Moderate	D	60	68	0.12	0.66	0.08
UVB10	Unchannelled valley bottom	3.63	Moderate	D	56	66	0.36	0.66	0.24
UVB08	Unchannelled valley bottom	0.95	High	D	58	62	0.04	0.66	0.03
Total		**1224.24**					**148.12**		**97.76**

Table A 2-3. Category 1 wetlands - Offset evaluations – (Ecosystem Conservation targets)

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Change Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
CVB01	Channelled valley bottom	1.07	48	22.00	0.23	1.50	0.35
CVB01	Channelled valley bottom	3.21	48	22.00	0.71	1.50	1.06
CVB02	Channelled valley bottom	32.88	42	21.00	6.90	1.50	10.36
CVB03	Channelled valley bottom	17.30	37	18.00	3.11	1.50	4.67
CVB04	Channelled valley bottom	1.64	54	27.00	0.44	1.50	0.66
CVB05	Channelled valley bottom	1.55	45	18.00	0.28	1.50	0.42
CVB07	Channelled valley bottom	2.33	53	0.00	0.00	1.50	0.00
CVB08	Channelled valley bottom	2.77	50	0.00	0.00	1.50	0.00
CVB10	Channelled valley bottom	1.06	35	25.00	0.27	1.50	0.40
CVB11	Channelled valley bottom	6.78	41	21.00	1.42	1.50	2.14
CVB12	Channelled valley bottom	8.66	34	29.00	2.51	1.50	3.77
V3	Channelled valley bottom	6.80	40	40.00	2.72	1.50	4.08
V4	Channelled valley bottom	1.10	40	40.00	0.44	1.50	0.66
V5	Channelled valley bottom	3.19	40	40.00	1.28	1.50	1.91
DL03	Drainage line	0.26	41	20.00	0.05	1.50	0.08
HS5	Hillslope seepage	7.34	55	15.00	1.10	1.50	1.65
HS1	Hillslope seepage	29.50	48	27.00	7.96	1.50	11.95
HS10	Hillslope seepage	4.30	48	27.00	1.16	1.50	1.74
HS2	Hillslope seepage	1.01	48	27.00	0.27	1.50	0.41
HS3	Hillslope seepage	1.28	48	27.00	0.34	1.50	0.52
HS4	Hillslope seepage	1.67	48	27.00	0.45	1.50	0.68
HS6	Hillslope seepage	5.45	48	27.00	1.47	1.50	2.21
HS7	Hillslope seepage	19.36	48	27.00	5.23	1.50	7.84
HS8	Hillslope seepage	21.02	48	27.00	5.67	1.50	8.51
HS9	Hillslope seepage	2.23	48	27.00	0.60	1.50	0.90
S09	Seep	2.29	52	23.00	0.53	1.50	0.79
S15	Seep	27.15	55	31.00	8.42	1.50	12.63
S16	Seep	5.59	60	30.00	1.68	1.50	2.52
S19	Seep	34.71	80	7.00	2.43	1.50	3.64
S20	Seep	8.56	65	16.00	1.37	1.50	2.05
S21	Seep	10.53	58	31.00	3.26	1.50	4.89
S22	Seep	6.13	59	29.00	1.78	1.50	2.67
S23	Seep	12.91	66	23.00	2.97	1.50	4.45
S24	Seep	10.06	54	33.00	3.32	1.50	4.98
S25	Seep	4.15	59	30.00	1.25	1.50	1.87
S26	Seep	185.30	37	33.00	61.15	1.50	91.72
S27	Seep	10.80	52	32.00	3.46	1.50	5.18
S28	Seep	16.47	60	27.00	4.45	1.50	6.67
S29	Seep	1.71	56	29.00	0.50	1.50	0.75
S30	Seep	23.86	50	35.00	8.35	1.50	12.52
S31	Seep	2.50	57	31.00	0.78	1.50	1.16
S32	Seep	2.62	31	38.00	0.99	1.50	1.49
S32	Seep	9.99	31	38.00	3.80	1.50	5.69
S34	Seep	1.42	46	27.00	0.38	1.50	0.58
S34	Seep	7.03	46	27.00	1.90	1.50	2.85
S36	Seep	2.70	57	31.00	0.84	1.50	1.26
S37	Seep	36.83	47	35.00	12.89	1.50	19.33
S38	Seep	87.70	41	39.00	34.20	1.50	51.31
S39	Seep	36.76	70	14.00	5.15	1.50	7.72
S40	Seep	25.62	79	11.00	2.82	1.50	4.23
S43	Seep	3.21	50	34.00	1.09	1.50	1.64
S44	Seep	6.43	31	38.00	2.44	1.50	3.67
S44	Seep	0.31	31	38.00	0.12	1.50	0.18
S45	Seep	3.71	24	42.00	1.56	1.50	2.34
S46	Seep	12.34	21	46.00	5.67	1.50	8.51
S47	Seep	13.91	68	19.00	2.64	1.50	3.96
S49	Seep	9.93	90	0.00	0.00	1.50	0.00
S71	Seep	22.25	60	9.00	2.00	1.50	3.00
S71	Seep	15.37	60	9.00	1.38	1.50	2.07
S72	Seep	10.89	60	30.00	3.27	1.50	4.90
S73	Seep	3.17	60	30.00	0.95	1.50	1.43
S74	Seep	6.55	60	30.00	1.96	1.50	2.95
S77	Seep	66.61	59	31.00	20.65	1.50	30.97
S78	Seep	34.35	60	30.00	10.30	1.50	15.46
UVB02	Unchannelled valley bottom	59.58	14	56.00	33.37	1.50	50.05
UVB04	Unchannelled valley bottom	33.82	45	20.00	6.76	1.50	10.15
UVB06	Unchannelled valley bottom	0.33	49	24.00	0.08	1.50	0.12

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Change Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
UVB08	Unchannelled valley bottom	2.07	47	16.00	0.33	1.50	0.50
UVB11	Unchannelled valley bottom	20.82	40	20.00	4.16	1.50	6.25
UVB12	Unchannelled valley bottom	4.44	40	21.00	0.93	1.50	1.40
V1	Valley bottom	13.64	40	40.00	5.46	1.50	8.18
V2	Valley bottom	4.04	40	40.00	1.62	1.50	2.43
CVB06	Channelled valley bottom	3.09	42	18.00	0.56	1.50	0.84
CVB02	Channelled valley bottom	9.45	42	18.00	1.70	1.50	2.55
S60	Seep	22.38	10	36.00	8.06	1.50	12.09
S79	Seep	0.22	35	24.00	0.05	1.50	0.08
S79	Seep	27.95	35	25.00	6.99	1.50	10.48
S41	Seep	1.39	43	24.00	0.33	1.50	0.50
S42	Seep	1.13	51	10.00	0.11	1.50	0.17
S79	Seep	4.57	35	25.00	1.14	1.50	1.72
S71	Seep	15.32	60	9.00	1.38	1.50	2.07
S79	Seep	5.86	35	25.00	1.46	1.50	2.20
S80	Seep	1.94	35	25.00	0.48	1.50	0.73
S29	Seep	0.35	56	4.00	0.01	1.50	0.02
UVB08	Unchannelled valley bottom	14.43	47	6.00	0.87	1.50	1.30
UVB06	Unchannelled valley bottom	0.13	49	12.00	0.02	1.50	0.02
UVB10	Unchannelled valley bottom	5.05	53	7.00	0.35	1.50	0.53
UVB06	Unchannelled valley bottom	1.51	49	12.00	0.18	1.50	0.27
UVB10	Unchannelled valley bottom	3.63	53	7.00	0.25	1.50	0.38
UVB08	Unchannelled valley bottom	0.95	47	6.00	0.06	1.50	0.09
Total		**1224.24**			**344.05**		**516.07**

APPENDIX 3 OFFSET EVALUATIONS – CATEGORY 2 WETLAND OFFSETS

Table A 3-1. Category 2 wetlands - Offset evaluations – (Water Resources and Ecosystem Services)

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
CVB02	Channelled valley bottom	9.45	Moderate	D	44	60	1.51	0.66	1.00
CVB02	Channelled valley bottom	11.52	Moderate	D	44	60	1.84	0.66	1.22
S41	Seep	1.53	High	D	49	66	0.26	0.66	0.17
S41	Seep	2.30	High	D	49	66	0.39	0.66	0.26
S41	Seep	18.07	High	D	49	66	3.07	0.66	2.03
S42	Seep	1.54	High	D	58	71	0.20	0.66	0.13
S42	Seep	10.77	High	D	58	71	1.40	0.66	0.92
S75	Seep	13.83	Moderate	D	51	60	1.24	0.66	0.82
S76	Seep	16.02	Moderate	E	39	66	4.33	0.66	2.86
S80	Seep	4.87	Moderate	D	40	71	1.51	0.66	1.00
UVB06	Unchannelled valley bottom	1.84	Moderate	C	60	64	0.07	0.66	0.05
UVB06	Unchannelled valley bottom	2.45	Moderate	C	60	64	0.10	0.66	0.06
UVB09	Unchannelled valley bottom	5.61	Moderate	D	54	72	1.01	0.66	0.67
Total		**99.81**					**16.94**		**11.18**

Table 3-2. Category 2 wetlands - Offset evaluations – (Ecosystem Conservation)

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Change Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
CVB02	Channelled valley bottom	9.45	42	21.00	1.98	1.50	2.98
CVB02	Channelled valley bottom	11.52	42	21.00	2.42	1.50	3.63
S41	Seep	1.53	18	47.00	0.72	1.50	1.08
S41	Seep	2.30	51	33.00	0.76	1.50	1.14
S41	Seep	18.07	43	33.00	5.96	1.50	8.95
S42	Seep	1.54	43	33.00	0.51	1.50	0.76
S42	Seep	10.77	43	33.00	3.56	1.50	5.33
S75	Seep	13.83	43	33.00	4.56	1.50	6.85
S76	Seep	16.02	43	33.00	5.29	1.50	7.93
S80	Seep	4.87	43	33.00	1.61	1.50	2.41
UVB06	Unchannelled valley bottom	1.84	43	33.00	0.61	1.50	0.91
UVB06	Unchannelled valley bottom	2.45	51	33.00	0.81	1.50	1.21
UVB09	Unchannelled valley bottom	5.61	42	21.00	1.18	1.50	1.77
Total		**99.81**			**29.96**		**44.94**

APPENDIX 4 OFFSET EVALUATIONS – CATEGORY 3 WETLAND OFFSETS

Table 4-1. Category 3 wetlands - Offset evaluations – (Water Resources and Ecosystem Services)

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
P3	Depression	10.80	Moderate	E	28	34	0.65	0.66	0.43
P5	Depression	19.10	Moderate	C	61	73	2.29	0.66	1.51
P6	Depression	3.70	Low/Marginal	E	39	63	0.89	0.66	0.59
S3	Seep	18.30	Low/Marginal	F	7	10	0.55	0.66	0.36
S5	Seep	8.80	Moderate	E	37	60	2.02	0.66	1.34
S6	Seep	6.40	Moderate	E	40	69	1.86	0.66	1.22
P2	Depression	31.20	Moderate	D	57	71	6.55	0.66	4.32
S2	Seep	34.10	Low/Marginal	D	42	76	12.28	0.66	8.10
Total		**132.40**					**27.09**		**17.88**

Table 4-2. Table 4-1. Category 3 wetlands - Offset evaluations – (Ecosystem Conservation).

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Change Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
P3	Depression	10.80	42	10.38	5.19	1.50	7.78
P5	Depression	19.10	50	17.59	9.17	1.50	13.75
P6	Depression	3.70	30	3.11	2.04	1.50	3.05
S3	Seep	18.30	6	17.94	1.83	1.50	2.75
S5	Seep	8.80	49	7.46	5.98	1.50	8.98
S6	Seep	6.40	31	5.18	3.84	1.50	5.76
P2	Depression	31.20	50	14.00	23.40	1.50	35.10
S2	Seep	34.10	25	34.00	20.46	1.50	30.69
Total		132.40			71.90		107.85

APPENDIX 5 OFFSET EVALUATIONS – CATEGORY 4 WETLAND OFFSETS (PAN 7 & DISPATCH RIDER)

Pan 7

Table 5-1. Category 4 wetlands - Offset evaluations - Water Resources and Ecosystem Services - Option 1

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
P07	Depression	50.29	High	B	86	90	2.01	0.66	1.33
S07	Seep	65.89	Moderate	C	71	78	4.61	0.66	3.04
Total		116.18					6.62		4.37

Dispatch Rider Pans

Table 5-2. Category 4 wetlands - Offset evaluations – Dispatch Rider Pans - Water Resources and Ecosystem Services

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
P1	Depression	8.60	Low	D	59	64	0.43	0.66	0.28
P2	Depression	23.30	Moderate	C	78	85	1.63	0.66	1.08
P3	Depression	26.50	High	C	61	83	5.83	0.66	3.85
P4	Depression	7.70	Low	D	42	80	2.93	0.66	1.93
HS1	Seep	9.40	Moderate	D	54	69	1.41	0.66	0.93
HS2	Seep	21.50	Moderate	C	61	75	3.01	0.66	1.99
HS3	Seep	20.00	Moderate	D	41	75	6.80	0.66	4.49
Total		117.00					22.04		14.55

Pan 7

Table 5-3. Category 4 wetlands - Offset evaluations – Ecosystem Conservation - Option 1.

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
P07	Depression	50.29	85	42.75	1.50	64.13
S07	Seep	65.89	60	39.53	1.50	59.30
Total		116.18		82.28		123.42

Dispatch Rider Pans

Table 5-4. Category 4 wetlands - Offset evaluations – Dispatch Rider Pans - Ecosystem Conservation.

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha.eq)
P1	Depression	8.60	75	6.45	1.50	9.68
P2	Depression	23.30	90	20.97	1.50	31.46
P3	Depression	26.50	90	23.85	1.50	35.78
P4	Depression	7.70	71	5.47	1.50	8.21
HS1	Seep	9.40	69	6.49	1.50	9.73
HS2	Seep	21.50	79	16.99	1.50	25.48
HS3	Seep	20.00	60	12.00	1.50	18.00
Total		117.00		92.21		138.32

Pan 7

Table 5-5. Category 4 wetlands - Offset evaluations - Water Resources and Ecosystem Services - Option 2

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
P07	Depression	50.29	High	B	86	89	1.51	0.66	1.00
S07	Seep	65.89	Moderate	C	71	77	3.95	0.66	2.61
Total		**116.18**					**5.46**		**3.60**

Dispatch Rider Pans

Table 5-6. Category 4 wetlands - Offset evaluations – Dispatch Rider Pans - Water Resources and Ecosystem Services

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
P1	Depression	8.60	Low	D	59	64	0.43	0.66	0.28
P2	Depression	23.30	Moderate	C	78	85	1.63	0.66	1.08
P3	Depression	26.50	High	C	74	82	2.12	0.66	1.40
P4	Depression	7.70	Low	D	47	62	1.16	0.66	0.76
HS1	Seep	9.40	Moderate	D	54	69	1.41	0.66	0.93
HS2	Seep	21.50	Moderate	C	61	75	3.01	0.66	1.99
HS3	Seep	20.00	Moderate	D	37	68	6.20	0.66	4.09
Total		**117.00**					**15.96**		**10.53**

Pan 7

Table 5-7. Category 4 wetlands - Offset evaluations – Ecosystem Conservation - Option 2

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
P07	Depression	50.29	85	42.75	1.50	64.13
S07	Seep	65.89	60	39.53	1.50	59.30
Total		**116.18**		**82.28**		**123.42**

Dispatch Rider Pans

Table 5-8. Category 4 wetlands - Offset evaluations – Ecosystem Conservation - Option 2

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha.eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
P1	Depression	8.60	75	6.45	1.50	9.68
P2	Depression	23.30	90	20.97	1.50	31.46
P3	Depression	26.50	95	25.18	1.50	37.76
P4	Depression	7.70	57	4.39	1.50	6.58
HS1	Seep	9.40	69	6.49	1.50	9.73
HS2	Seep	21.50	79	16.99	1.50	25.48
HS3	Seep	20.00	55	11.00	1.50	16.50
Total		**117.00**		**91.46**		**137.18**

Pan 7

Table 5-9. **Category 4 wetlands - Offset evaluations - Water Resources and Ecosystem Services - Option 3**

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
P07	Depression	50.29	85	42.75	1.50	64.13
S07	Seep	65.89	60	39.53	1.50	59.30
Total		**116.18**		**82.28**		**123.42**

Dispatch Rider Pans

Table 5-10. Category 4 wetlands - Offset evaluations – Dispatch Rider Pans - Water Resources and Ecosystem Services

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
P1	Depression	8.60	Low	D	59	64	0.43	0.66	0.28
P2	Depression	23.30	Moderate	C	78	85	1.63	0.66	1.08
P3	Depression	26.50	High	C	61	80	5.04	0.66	3.33
P4	Depression	7.70	Low	D	42	42	0.00	0.66	0.00
HS1	Seep	9.40	Moderate	D	54	69	1.41	0.66	0.93

HS2	Seep	21.50	Moderate	C	61	75	3.01	0.66	1.99
HS3	Seep	20.00	Moderate	D	41	49	1.60	0.66	1.06
Total		**117.00**					**13.12**		**8.66**

Pan 7

Table 5-11. Category 4 wetlands - Offset evaluations – Ecosystem Conservation - Option 3

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
P07	Depression	50.29	85	42.75	1.50	64.13
S07	Seep	65.89	60	39.53	1.50	59.30
Total		**116.18**		**82.28**		**123.42**

Dispatch Rider Pans

Table 5-12. Category 4 wetlands - Offset evaluations – Ecosystem Conservation - Option 3

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
P1	Depression	8.60	75	6.45	1.50	9.68
P2	Depression	23.30	90	20.97	1.50	31.46
P3	Depression	26.50	94	24.91	1.50	37.37
P4	Depression	7.70	51	3.93	1.50	5.90
HS1	Seep	9.40	69	6.49	1.50	9.73
HS2	Seep	21.50	79	16.99	1.50	25.48
HS3	Seep	20.00	35	7.00	1.50	10.50
Total		**117.00**		**86.73**		**130.10**

APPENDIX 6 OFFSET EVALUATIONS – CATEGORY 4 WETLAND OFFSETS - KRIEL AND BMK PANS

Table 6-1. Water Resources and Ecosystem Services

Wet_ID	HGM unit	Area (ha)	IS	PES Category	PES %	Post-rehab PES %	Estimated Post rehab ha-eq gain	Risk multiplier applied	Estimated gain (ha-eq)
BMKP01	Depression	5.68	Moderate	C	67	85	1.02	0.66	0.67
BMKS01	Seep	5.89	Moderate	E	36	80	2.59	0.66	1.71
KP01	Depression	7.24	High	C	74	80	0.43	0.66	0.29
KP02	Depression	6.31	High	D	47	49	0.13	0.66	0.08
KS01	Seep	12.50	Moderate	C	67	74	0.88	0.66	0.58
KS02	Seep	10.58	Moderate	D	58	74	1.69	0.66	1.12
Total		**48.20**					**6.75**		**4.45**

Table 6-2. Ecosystem Conservation

Wet_ID	HGM unit	Area (ha)	Habitat Intactness (%)	Wetland habitat contribution (ha. eq)	Security of tenure Adjustment Factor	Ecosystem Conservation Contribution (ha. eq)
BMKP01	Depression	5.68	70	4.54	1.00	4.54
BMKS01	Seep	5.89	14	3.54	1.00	3.54
KP01	Depression	7.24	70	5.79	1.00	5.79
KP02	Depression	6.31	50	3.15	1.00	3.15
KS01	Seep	12.50	66	9.63	1.00	9.63
KS02	Seep	10.58	48	7.83	1.00	7.83
Total		**11.57**		**34.49**		**34.49**

APPENDIX 7 WETLAND MANAGEMENT PLAN FOR THE TARGET WETLANDS

All of the wetlands within the target clusters have been moderately or largely modified, implying that considerable opportunity exists for improving the remaining wetlands' condition and functioning through rehabilitation activities. Conceptual solutions and projected improvements and costs have been discussed briefly in the above sections. Further management measures applicable to all of the wetlands are detailed in this section.

Construction Environmental Management Plan (CEMP)

The implementation of the proposed rehabilitation interventions must take into account all relevant provisions of Best Management Practices and wetland-related Construction Environmental Management Plans. The appointed EAP (Environmental Assessment Practitioner) of the project must, in conjunction with the design engineer, compile the general construction notes and the Construction Phase EMP (CEMP) for the project.

Wetland Management Recommendations

While construction-related impacts will be addressed through best management practices and the CEMP, there are a range of longer-term aspects that need to be addressed to ensure that anticipated improvements in wetland functionality are achieved and maintained over the long term. A range of management recommendations are therefore detailed here, which will need to be taken into account when managing the wetland systems. The proponent must appoint an independent consultant to undertake monitoring of wetlands on site. The consultant and/or specialist must be a suitable specialist registered with the South African Council for Natural Scientific Profession (SACNASP) in an appropriate field of practice and have relevant wetland rehabilitation and monitoring experience. The measures included in this report plus additional measures required for managing and protecting the wetlands should be incorporated into a Wetland Management Plan for the area.

Management of rehabilitation interventions on the remaining rehabilitated wetland areas

Regular monitoring of interventions is critical to ensure that any problems with rehabilitation interventions are picked up in a timeous manner. In this regard, the following potential concerns should be taken into consideration when inspecting interventions:

- Signs of erosion around the sides of structures (particularly constructed weirs).
- Signs of scouring below the concrete weirs and other structures which could undermine the structures.
- Signs of water not being retained behind weirs which would suggest that water may be finding its way around or under the structures.
- Cracks in concrete structures or damage caused by debris washed down during storms.
- Head-cuts that may develop downstream of structures where water re-enters the main drain.

- Wash/disturbance that has caused failure of earth berms/distribution berms.
- Poor vegetation cover of areas where earthworks have been undertaken; and
- Lack of recovery of wetland vegetation in sections of the wetland.
- Non-Compliance with the specific recommended rehabilitation and monitoring measures for the New Largo Pan, particularly those related to the stability of the prospective rehabilitation area, is essential. These measures, as outlined in the Rehabilitation Method Statement by WSP, must be followed rigorously. Adherence ensures that the rehabilitation activities effectively address stability concerns and mitigate potential risks, such as subsidence or structural failures, while promoting the long-term sustainability and integrity of the rehabilitated area.

Where such concerns are noted, input from the wetland specialist should be sought to assess the need for maintenance or additional interventions to address issues of concern.

Upstream and surrounding mining activities

A number of active and defunct mines are located in close proximity to and within the catchment of the selected target wetlands. These mines pose a risk to water quality within the target wetlands, while future mining expansions could also impact further on water inputs to the wetlands. Future mine expansions must therefore be considered in planning the management of affected wetlands. Emphasis must also be placed on monitoring for upstream impacts entering the wetlands from adjacent mines or land uses, to ensure pollution sources can be accurately identified.

Stormwater Infrastructure Maintenance

All stormwater management infrastructure on site should be inspected at least twice per year, ideally just before the start of the wet season and then again during the middle of the wet season, for any damage or obstructions. Obstructions should be cleared, and damage repaired immediately to ensure optimal operation of the infrastructure. All discharge points should also be inspected for signs of erosion and any erosion damage repaired immediately and corrective measures implemented as required.

Management of agricultural lands

It is expected that cultivated fields around the selected target wetlands will continue to be used for agricultural activities. Ideally, agricultural use of herbicides, pesticides and fertilizers in the vicinity of the wetlands should be carefully controlled to avoid toxic effects on the flora and fauna occurring within the wetlands. Cultivation techniques should also employ measures to limit erosion and sediment loss from the cultivated fields, i.e. contour ploughing etc. However, it is unlikely that such measures could be practically implemented on third-party land.

Furthermore, it would be preferable if all cultivation should be withdrawn from delineated wetland areas. In addition, a vegetated buffer of, at least, 20m is recommended between any agricultural lands and wetland areas so as to limit impacts associated with sedimentation and pollutant runoff. Once again, however, it is unlikely that such measures could be practically implemented on third-party land. As the measures detailed under this sub-section are likely to be challenging to implement on land not owned by Seriti, the best-case scenario may be for Seriti to appoint an agricultural extension officer/agricultural consultant to meet with affected landowners to assist these with improved land management practices within the catchments of the targeted wetlands.

Fire management

With the exception of special treatment areas, as a general rule, for low rainfall regions (<900 mm per annum), an area of wetland should be burnt every 4 to 5 years. Where possible, burning should be undertaken on a rotational basis. Cool and patchy burns should be promoted, where possible, by burning when relative humidity is high and air temperatures are low, preferably after rain. Preference should be given to burning of areas with abundant dead (moribund) stem and leaf material that limits new growth. Autumn/early winter breeding species such as the grass owl and marsh harrier may be negatively impacted by early winter burning. Where these species occur, burning should be done rotationally through block burning and checked before burning by having 'beaters' 10 m apart walking through the area and then closely examining all localities where these birds are flushed. Areas should be left un-burnt where chicks have still not fledged, or, if possible, delay burning for that year. Further reference to this must be according to the recently published SANBI Grazing & Burning Guidelines (SANBI, 2014). A burning management strategy should be included in the Wetland Management Plan for this purpose.

As the measures detailed under this sub-section are likely to be challenging to implement on land not owned by Seriti, the best-case scenario may be for Seriti to appoint an agricultural extension officer/agricultural consultant to meet with affected landowners to assist these with improved land management practices within the catchments of the targeted wetlands.

Control of Alien Invasive Plants

Alien invasive plants (particularly Poplars, Black wattle, and Eucalyptus) occurring within the wetlands and sub-catchments pose a threat to wetland functioning and should ideally be removed and controlled through an ongoing alien vegetation management plan compiled and implemented for the entire offset target areas. Such a plan will need to be developed by a suitably qualified professional.

Livestock management

Livestock numbers should be maintained within acceptable carrying capacities to ensure that plant species composition is not compromised, and trampling does not lead to further erosion of wetland areas. Ideally, a rangeland management plan should be compiled for areas targeted for livestock grazing or, at a minimum, the Department of Agriculture should be called upon to determine the grazing capacity for the bioclimatic region in which the wetland is located. As a general rule, grazing capacity in temporary wetland areas can be estimated as 1.5 times that of dryland areas, while grazing within seasonal and permanently wet areas should be restricted to 0.5LU/ha during the spring months. Where cattle trampling is causing significant disturbance near drinking points, alternative water sources should be provided, or the area hardened to reduce the potential for erosion. As the measures detailed under this sub-section are likely to be challenging to implement on land not owned by Seriti, the best-case scenario may be for Seriti to appoint an agricultural extension officer/agricultural consultant to meet with affected landowners to work with these on establishing improved land management practices within the catchments of the targeted wetlands.

Management and monitoring of important biota

- No threatened flora should be collected or harvested.
- No threatened fauna should be hunted.
- Where endangered animal species occur in the wetland, records should ideally be kept of sightings in order to help establish whether or not wetland management practices and rehabilitation efforts are having a positive impact on these species; and
- The local district conservation officer should be contacted to obtain further information on monitoring of important species.

Road crossings

Further roads through the wetland should be avoided as far as possible. Should these be necessary, then the design and mitigation of road crossings should be informed by suitable specialists to ensure impacts to flow connectivity and changes to flow distribution and retention in the wetland are minimised.

APPENDIX 8 MONITORING AND EVALUATION MEASURES

Based on the framework outlined in Walters, Kotze, Cowden, Browne, Grewcock, Janks and Eggers, 2019, the monitoring plan for wetland rehabilitation projects follows a structured approach encompassing several key elements:

1. Identification of Appropriate Indicators: Relevant indicators reflecting the intended outcomes of wetland rehabilitation are identified. These indicators may include factors such as vegetation composition, hydrological characteristics, water quality parameters, and biodiversity metrics.
2. Description of Indicator Relevance and Threshold Levels: The significance of each indicator is described, and threshold levels of concern or success are established where applicable. This helps in evaluating the effectiveness of rehabilitation efforts and determining whether desired outcomes are being achieved.
3. Determination of Monitoring Frequency, Interval, and Timing: The frequency and timing of monitoring activities are determined based on the specific requirements of the wetland rehabilitation project. This may involve periodic assessments conducted at regular intervals to track changes over time and ensure timely intervention if necessary.
4. Selection of Sampling Techniques: Suitable sampling techniques are selected to collect data on the identified indicators. These techniques may include field surveys, water quality sampling, vegetation sampling, and other monitoring methods tailored to the characteristics of the wetland ecosystem.
5. Assignment of Responsibilities: Clear responsibilities are assigned for carrying out monitoring activities and reporting findings. This ensures accountability and effective coordination among project stakeholders involved in data collection, analysis, and reporting.

The monitoring plan encompasses three distinct phases tailored to the different stages of wetland rehabilitation:

- **Phase 1:** Pre-rehabilitation Phase: Monitoring activities focus on assessing the baseline conditions of the wetland ecosystem before rehabilitation efforts commence. This phase provides essential information for establishing reference points and evaluating changes over time.
- **Phase 2:** Rehabilitation Phase: Monitoring during this phase involves tracking the implementation of rehabilitation activities and assessing their immediate impacts on the wetland ecosystem. This includes monitoring the effectiveness of restoration measures and identifying any unforeseen challenges or issues that may arise during implementation.
- **Phase 3:** Post-Rehabilitation Phase (System Recovery and Ongoing Monitoring): Following the completion of rehabilitation activities, monitoring shifts towards evaluating the long-term recovery and ecological resilience of the wetland ecosystem. Ongoing monitoring ensures that the rehabilitated wetland continues to function effectively and that any emerging issues are promptly addressed.

Phase 1 - Pre-rehabilitation monitoring:

Pre-rehabilitation monitoring of wetlands involves assessing and managing the impacts of construction activities on wetland ecosystems before any restoration or rehabilitation efforts begin. This monitoring helps ensure that construction activities comply with environmental regulations, minimize negative impacts on wetland habitats, and lay the groundwork for successful wetland restoration projects and integrate all the stakeholder's inputs. Here is how pre-rehabilitation construction monitoring of wetlands typically unfolds:

Baseline Assessment:

Before commencing construction, an extensive baseline assessment of the wetland site is conducted to document its current ecological characteristics. This assessment encompasses vegetation types, hydrology, and water quality. The collected baseline data functions as a benchmark for assessing any changes resulting from rehabilitation activities. The ecological integrity information and assessment conducted within the scope of this project for all targeted wetlands for rehabilitation, including grab sample water quality analysis and detailed descriptions of identified issues along with corresponding measurements, form the foundational baseline information for each wetland area. For detailed insights into the ecological integrity of the wetlands earmarked for rehabilitation, please refer to the (Section 5.2 and 5.3) that comprehensively covers ecological integrity assessments for the designated wetland sites.

A stability monitoring program should be developed, incorporating the current information from the stability assessments, including risks of subsidence and sinkhole formation, as well as identifying high-risk areas where failures have occurred or are likely to occur. This information, as indicated in the stability assessment reports, should be compiled and used as a baseline for monitoring future changes in these specific areas. The baseline data will be crucial for evaluating the effectiveness of the proposed rehabilitation work method statement and associated interventions, ensuring that any changes are accurately tracked and addressed.

Environmental Impact Assessment (EIA):

An environmental impact assessment is an integral part of the preparatory phase for wetland rehabilitation projects. This assessment is conducted to identify and analyse the potential impacts that rehabilitation activities may have on wetland ecosystems and their surrounding environments. Key factors evaluated during this assessment include habitat disturbance, degradation of water quality, soil erosion, and impacts on wildlife populations.

Prior to commencing any rehabilitation activities, obtaining necessary authorisations is crucial. These authorisations must be obtained in accordance with the environmental and water use regulations. It is anticipated that Seriti has these authorisations in place for these projects.

The commencement of rehabilitation activities will be contingent upon the granting of these authorizations and compliance with their stipulated conditions. This process should be initiated promptly upon the completion and submission of the rehabilitation plan, ensuring alignment with regulatory requirements and environmental protection measures.

Regulatory Compliance:

Rehabilitation plans undergo thorough review to ensure strict compliance with pertinent environmental regulations, permits, and mitigation requirements. This entails obtaining necessary permits from regulatory agencies and adhering to wetland protection laws, as well as implementing measures aimed at minimising impacts on protected species and critical habitats.

Alignment with Environmental Impact Assessment (EIA) requirements is paramount throughout this process. The rehabilitation plans are scrutinised to ensure that they adequately address all aspects outlined in the EIA, including potential impacts on the environment and proposed mitigation measures. This comprehensive review ensures that the rehabilitation activities are conducted in a manner that minimise adverse effects on the ecosystem and adheres to all relevant legal and regulatory frameworks.

Stakeholder Engagement:

Collaboration with stakeholders, including local communities, environmental organizations, and regulatory agencies, is essential for ensuring transparency, addressing concerns, and incorporating diverse perspectives into the construction planning and monitoring process.

Adaptive Management:

The rehabilitation monitoring process is characterised by its dynamic and adaptive nature, allowing for adjustments based on evolving monitoring data, changing site conditions, and stakeholder feedback. This iterative approach is essential for minimising environmental impacts and maximising the effectiveness of wetland restoration efforts.

Thorough pre-rehabilitation construction monitoring of wetlands plays a crucial role in this process. By conducting comprehensive monitoring before any implementation of rehabilitation activities begins, project proponents can proactively identify and address potential environmental risks. This proactive approach helps to mitigate impacts on wetland ecosystems and lays the groundwork for successful restoration and rehabilitation projects.

To fulfil this obligation, the draft rehabilitation plan will be shared with the project proponent for distribution to relevant stakeholders for their input. This final report incorporates all comments and feedback received during the stakeholder participation phase. This ensures that the rehabilitation efforts are informed by a wide range of perspectives and considerations, ultimately enhancing the plan's effectiveness and acceptance.

It's important to note that Phase 1 monitoring is conducted as part of the rehabilitation planning phase. The information gathered during this phase, including baseline monitoring data, is integrated into the rehabilitation plans, providing the necessary foundation for project implementation. This ensures that rehabilitation efforts are based on a thorough understanding of the existing conditions and potential environmental impacts, further enhancing the likelihood of success.

Phase 2 - During the implementation of rehabilitation activities monitoring:

During the implementation of rehabilitation activities on wetlands, monitoring is essential to ensure that the construction activities are conducted in accordance with environmental regulations and project specifications. Here are some aspects of monitoring that are typically carried out during wetland rehabilitation construction:

Water quality:

Water quality monitoring during construction is essential for assessing and managing potential impacts on aquatic ecosystems, including wetlands. Regular sampling and analysis of water quality parameters such as pH, temperature, TDS, EC, dissolved oxygen, turbidity, and nutrient levels are conducted to ensure that construction activities are not causing significant degradation to water bodies within or adjacent to the wetland area. Baseline assessment information and monitoring points identified and analysed during this phase should be used for ongoing monitoring during and post-implementation of rehabilitation activities. The following should also be conducted during the implementation phase:

- **Regular Sampling:** During construction, water quality is regularly monitored through systematic sampling at predetermined intervals. Samples are typically collected using standardised techniques and equipment to ensure accuracy and consistency.
- **Analysis of Water Samples:** Collected water samples are analysed in laboratories for various parameters relevant to water quality. This may include tests for pollutants, nutrients, metals, and microbial contaminants.
- **Assessment of Compliance**: Water quality data is compared against regulatory standards and guidelines to assess compliance with permit requirements and environmental regulations. Any deviations from these standards are investigated, and appropriate corrective actions are taken if necessary.
- **Mitigation Measures**: If water quality monitoring indicates potential impacts or exceedances of regulatory limits, mitigation measures are implemented to minimize pollution and protect aquatic ecosystems. These measures may include sedimentation and erosion control measures, installation of sediment traps, and implementation of best management practices (BMPs) to prevent runoff.
- **Adaptive Management:** Water quality monitoring during construction is often part of an adaptive management approach, where monitoring data is used to make real-time adjustments to construction practices. This ensures that any adverse impacts on water quality are promptly identified and addressed.

By conducting water quality monitoring during construction, Seriti can effectively manage potential impacts on aquatic ecosystems, minimise pollution, and protect sensitive habitats like wetlands. This proactive approach helps ensure compliance with regulatory requirements and promotes the sustainable management of water resources.

Sediment and erosion control:

During the implementation of rehabilitation intervention activities, measures are implemented to minimise sedimentation and erosion, thereby safeguarding water quality and preventing sediment runoff into nearby water bodies, including wetland habitats. Commonly employed measures include the installation of erosion control blankets, sediment traps, and silt fences. These measures serve to mitigate the environmental impacts associated with construction and ensure compliance with regulatory requirements. Monitoring plays a crucial role in ensuring the effectiveness of these sediment control measures. Regular inspections and assessments are conducted to verify that erosion control blankets are intact, sediment traps are functioning properly, and silt fences are adequately preventing sediment runoff. Monitoring data helps identify any issues or deficiencies promptly, allowing for corrective action to be taken to maintain water quality and minimise environmental impact footprint and protect sensitive ecosystems, including downstream wetlands, from the adverse effects of sedimentation and erosion.

Vegetation monitoring:

Vegetation monitoring during construction is indeed a critical component of environmental management, particularly in ecologically sensitive areas such as wetlands. This monitoring is essential for assessing the impact of construction activities on plant communities and ensuring the preservation of vegetation. Here's how vegetation monitoring during construction is typically carried out:

- Establishing Protective Measures: Before construction begins, protective measures are implemented to safeguard vegetation. This may include creating buffer zones around sensitive vegetation areas, fencing off construction sites, and designating limits for heavy machinery to minimise disturbance.
- Regular Monitoring: Throughout the construction phase, vegetation outside the construction servitude or buffer zone is monitored regularly to detect any changes or impacts. Visual inspections, including ***fixed point photography, and transect surveys***, as recommended by WET-Rehab Evaluate guidelines (Walters et al., 2019), are commonly used methods to assess vegetation health and coverage.
- Assessment of Changes and Damage: Any observed changes or damage to vegetation are carefully evaluated for their significance and potential long-term effects. This assessment helps determine the extent of impact and informs decision-making regarding necessary mitigation measures.
- Monitoring Planting Success: If vegetation is being planted as part of wetland rehabilitation efforts, monitoring of planting success and plant health is essential. This includes assessing plant survival rates, growth rates, and the establishment of desired plant communities.
- Adaptive Management: Vegetation monitoring during construction is often integrated into an adaptive management approach. Monitoring data is continuously analysed and used to make real-time adjustments to construction practices, ensuring that any unforeseen impacts on vegetation are promptly addressed.

By incorporating vegetation monitoring into the construction process, developers can effectively minimize their environmental footprint, protect sensitive habitats like wetlands, and promote the long-term health and integrity of plant communities. This proactive approach not only fulfils regulatory requirements but also contributes to sustainable development practices and ecosystem conservation efforts.

Stability Monitoring

Regular inspections are conducted to ensure that newly developed areas of subsidence and sinkholes are identified and recorded. Rehabilitation activities in high-risk areas are carried out in strict compliance with permits, regulations, and project specifications. Any deviations or instances of non-compliance are promptly documented and addressed. Effective monitoring of stability during wetland rehabilitation construction is essential to minimise environmental impacts and ensure that the rehabilitation efforts meet the intended objectives.

Compliance monitoring:

Regular inspections are conducted to ensure that construction activities comply with permits, regulations, and project specifications. Any deviations or non-compliance issues are documented and addressed promptly. Overall, effective monitoring during wetland rehabilitation construction helps minimise environmental impacts, ensures project success, and promotes the long-term health and sustainability of the wetland ecosystem.

Table A 8-1. Summary of the monitoring requirements and timing during the implementation of rehabilitation activities.

Monitoring Activities	Equipment	Timing	Responsible Person
Water Quality	- Grab samples – water quality handheld meter. - Detailed analysis – registered water quality laboratory	During construction period	Seriti/Wetland Ecologist
Sediment and Erosion control	- Sediment traps, - Silt fences and - Erosion control blankets	During construction period	Environmental Engineer and wetland ecologist
Vegetation Monitoring	- Rapid visual observation - Transect survey using 2mx2m quadrant	During construction period	Wetland ecologist
Aesthetic outcomes - Photographic record	- Fixed point photos – Camera or related equipment	During construction period	Seriti/Wetland ecologist
Stability monitoring	- Aerial survey (Lidar Imagery) in red areas and rehabilitation areas, - Visual observation - Fixed point photographs	During construction period	Rock Engineer and qualified mine personnel specialising in stability assessments.
Compliance Monitoring	- Audits	During the construction period including winter and summer periods	Government departments mandated for the management and controlling of activities within wetlands

Phase 3 - Post-rehabilitation monitoring (recovery and ongoing)

Post-construction monitoring of wetland rehabilitation activities is crucial to assess the effectiveness of the rehabilitation efforts and to ensure that the wetland ecosystem is recovering as intended. Here are some key aspects of post-construction monitoring:

Wetland Ecological Integrity Assessment:

Using Present Ecological State (PES) scores as baseline monitoring data prior to rehabilitation is a valuable approach for assessing the current state of the ecosystem. These scores provide a comprehensive snapshot of the ecological integrity of the site, encompassing various factors such as habitat quality, biodiversity, and ecosystem functions. The integrity scores derived from PES assessments serve as benchmarks for evaluating the effectiveness of rehabilitation efforts. The goal of monitoring is to ensure that the projected integrity scores post-rehabilitation align with or exceed the baseline scores established prior to construction activities. The objective of rehabilitation is to retain or improve the baseline ecological categories identified through PES assessments. This entails implementing rehabilitation activities that target specific areas for improvement while maintaining or enhancing existing ecological functions and biodiversity. Projected improvements in ecological health categories are already integrated into the rehabilitation project's planning and design. Monitoring plays a crucial role in ensuring that rehabilitation activities are aligned with these predefined goals and objectives. By tracking progress against projected improvements, monitoring helps identify any deviations or shortcomings in the implementation of rehabilitation measures. Monitoring data provides valuable feedback that informs adaptive management decisions during the rehabilitation process. If monitoring indicates that projected improvements are not being met, adjustments can be made to rehabilitation strategies and activities to address underlying issues and enhance effectiveness. Overall, using PES scores as baseline monitoring data and setting predefined goals for rehabilitation integrity categories provide a structured framework for assessing and guiding the success of wetland rehabilitation efforts. By incorporating monitoring into the rehabilitation process, stakeholders can ensure that their efforts are targeted, and adaptive, and ultimately contribute to the long-term health and resilience of the ecosystem.

Structural Integrity:

The focus on structural vulnerability during the wetland rehabilitation project involves several key components:

Construction Inspection and Sign-off: Before rehabilitation interventions are completed, thorough inspection and verification are conducted to ensure that construction activities are executed according to specified design and engineering standards. This involves assessing the structural integrity of interventions such as gabion structures, earthworks, or other engineered features. Once construction is completed satisfactorily, appropriate sign-off procedures are followed to confirm compliance with specifications.

Post-Rehabilitation Inspection and Reporting: Following the completion of rehabilitation interventions, ongoing inspection and reporting are essential to monitor structural vulnerabilities and ensure the long-term effectiveness of the implemented measures. The following aspects are typically monitored:

- Undermining: Assessing the integrity of foundations to prevent undermining or subsidence.
- Sliding, Tilting, or Overturning: Checking for any signs of structural instability or movement.

- Side Bank Collapse: Monitoring the stability of adjacent banks to prevent collapse or erosion.
- Scouring/Erosion Upstream and Downstream: Identifying and addressing erosion issues that may impact the stability of structures.
- Side cutting Around the Structure: Observing any excavation or erosion occurring around the structure that could compromise its stability.
- Exposed Soils: Identifying areas where soils are exposed and vulnerable to erosion or degradation.
- Premature Decay of Structural Material: Monitoring the condition of materials used in interventions, such as gabion wire or earthworks, to detect signs of deterioration or decay.

Detailed Design and Monitoring Program: The detailed design phase of the project provides specific details of the interventions, including construction notes and dimensions. An inventory of the issues to be monitored is compiled by the engineer upon completion of detailed designs. These issues are then incorporated into the monitoring program of the rehabilitation project to ensure that structural vulnerabilities are adequately addressed and managed over time.

By focusing on structural vulnerability and implementing thorough inspection and monitoring protocols, the rehabilitation project can minimize risks associated with structural failures and ensure the long-term stability and effectiveness of interventions in preserving and enhancing wetland ecosystems.

Erosion stabilisation:

During the detailed design phase of the wetland rehabilitation project, dimensions of specific issues such as headcuts and gully erosion are meticulously documented. These dimensions serve as baseline measurements for monitoring any improvements or changes post-rehabilitation on-site. Here's how this process typically unfolds:

Baseline Measurements: Dimensions of headcuts and gully erosion are collected during the detailed design phase of the project. This involves accurately measuring the length, width, depth, and other relevant dimensions of these erosion features.

Monitoring Post-Rehabilitation: After rehabilitation interventions are implemented, post-rehabilitation measurements are taken to assess any improvements or changes in the dimensions of the identified issues. These measurements are recorded for further analysis and evaluation.

Recording Changes: Any changes in dimensions, whether improvements or otherwise, are documented post-rehabilitation. This includes recording any reduction in the size or severity of headcuts and gully erosion, as well as any potential expansion or new erosion features that may have developed.

Assessment and Recommendations: The recorded post-rehabilitation dimensions are assessed by the project assessor to determine the effectiveness of the rehabilitation interventions. Recommendations for further action, if necessary, are made based on the observed changes and their implications for the overall stability and health of the wetland ecosystem.

Baseline for Backfilled Areas: For areas proposed to be backfilled as part of the rehabilitation process, dimensions are recorded by the engineer during the detailed design phase. These measurements serve as baseline data for designing appropriate rehabilitation interventions. Post-rehabilitation measurements are then compared to these baseline dimensions to evaluate the success of the backfilling efforts.

Incorporation into Monitoring Programme: An inventory of the issues to be monitored, including headcuts, gully erosion, and backfilled areas, is compiled by the engineer upon completion of the concept designs. These issues are incorporated into the monitoring program of the rehabilitation project to ensure that changes are accurately tracked over time.

By systematically recording and monitoring dimensions of problematic areas before and after rehabilitation, project stakeholders can assess the effectiveness of intervention measures and make informed decisions to further enhance the stability and resilience of the wetland ecosystem.

Vegetation Establishment and Success:

Assessing the establishment and growth of vegetation is critical to the long-term success of wetland rehabilitation. Monitoring may involve surveys to determine plant species diversity, density, cover, and overall health. Comparing post-construction vegetation data with pre-construction baseline data helps evaluate the effectiveness of revegetation efforts.

Designing Interventions: Based on the baseline water level measurements and project objectives, detailed engineering interventions are designed to raise water levels and rewet the wetland. These interventions may include the construction of water control structures, installation of water retention features, or implementation of hydrological restoration techniques.

Inventory of Interventions: During the detailed design phase of the project, an inventory of interventions aimed at raising the water table and rewetting the wetland is compiled by the engineer. This inventory includes detailed specifications and design plans for each intervention.

Water Quality Monitoring:

Monitoring water quality parameters such as pH, dissolved oxygen, nutrient levels, and sedimentation helps assess the impact of rehabilitation activities on water quality and the overall health of the wetland ecosystem. Regular sampling and analysis can detect any changes or trends that may require corrective actions.

Sediment Control and Erosion Monitoring:

Continuing to monitor sediment control measures and erosion patterns post-construction ensures that erosion control measures remain effective and that sedimentation rates are within acceptable limits. Any signs of erosion or sedimentation problems should be addressed promptly to prevent degradation of the rehabilitated wetland.

Stability monitoring

Regular inspections are conducted to monitor high-risk ("red") areas and rehabilitated zones within these areas, ensuring that construction and rehabilitation activities comply with the rehabilitation method statements, permits, regulations, and project specifications. Any deviations or non-compliance are promptly documented and addressed, including the identification of new areas requiring immediate intervention to ensure that rehabilitation efforts achieve their intended purpose. Effective monitoring of subsidence, sinkhole formation, and the successful implementation of rehabilitation activities is crucial in minimizing environmental risks and impacts. This process ensures project success while promoting the long-term health and sustainability of the rehabilitated ecosystem. By conducting comprehensive post-construction monitoring of high-risk areas and rehabilitation activities, project managers can assess the effectiveness of the rehabilitation, address any emerging issues, and apply adaptive management strategies. This approach is vital for securing the long-term ecological sustainability of the rehabilitated wetland ecosystem.

Compliance monitoring:

Regular inspections are conducted to ensure that construction activities comply with permits, regulations, and project specifications. Any deviations or non-compliance issues are documented and addressed promptly. Overall, effective monitoring during wetland rehabilitation construction helps minimise environmental impacts, ensures project success, and promotes the long-term health and sustainability of the wetland ecosystem.

By conducting comprehensive post-construction monitoring of wetland rehabilitation activities, project managers can assess the success of the rehabilitation efforts, identify any issues or challenges, and implement adaptive management strategies to ensure the long-term health and sustainability of the rehabilitated wetland ecosystem.

Table A 8-2. Summary of the monitoring requirements, timing, and frequency post-implementation of rehabilitation activities.

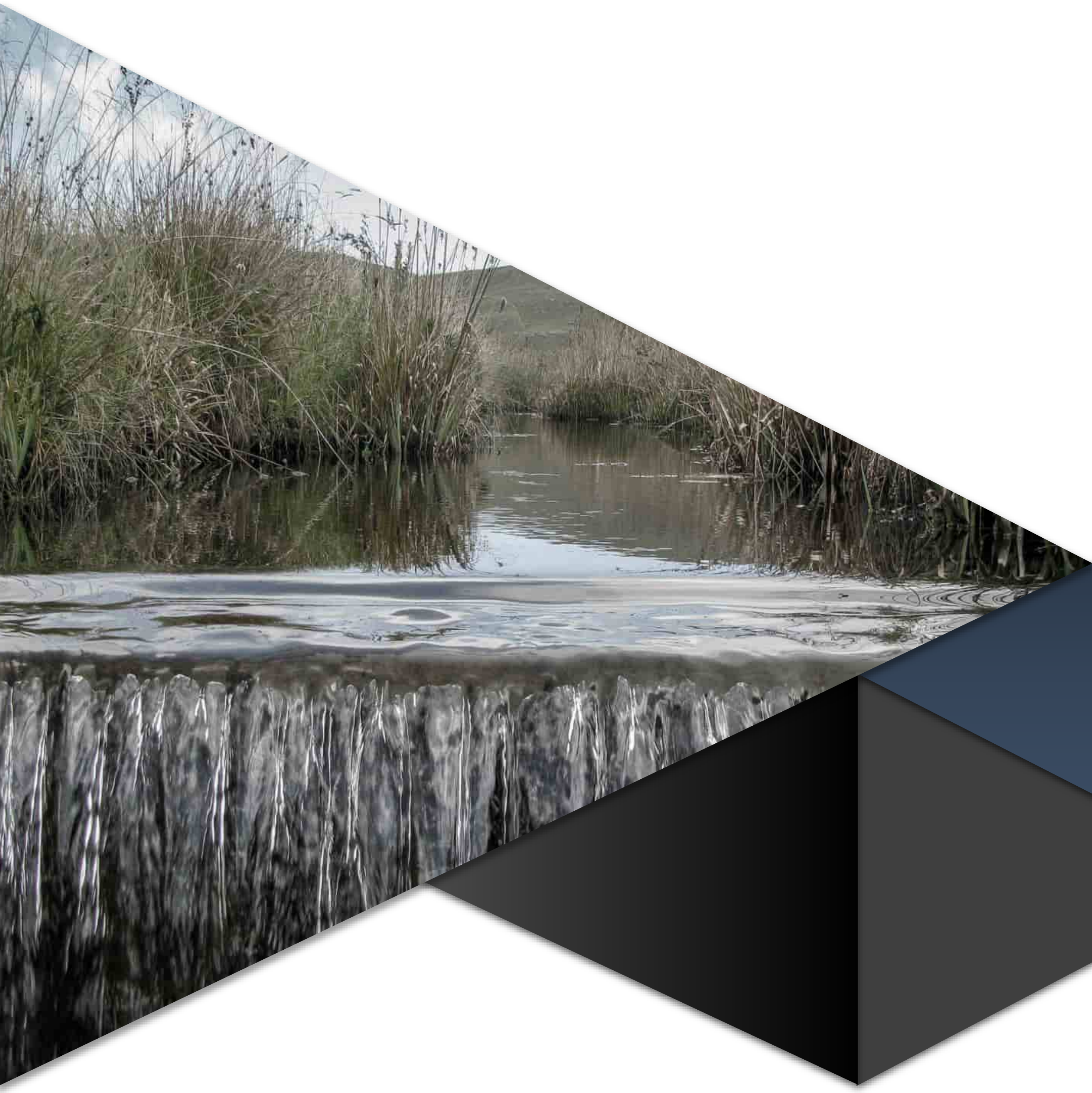
Monitoring Activities	Equipment	Timing	Frequency	Responsible Person
Ecological Integrity (PES)	- Wet-Health Assessment tools	-	Before and 3 years after completion	Wetland ecologist
Structural Integrity	- Rapid visual observation and measuring tapes	-	Immediate after construction and subsequently seasonal inspections and specifically after flood events.	Environmental Engineer and wetland ecologist
Erosion stabilisation	- Rapid visual observation and measuring tapes	Winter	Annually	Environmental Engineer and wetland ecologist

Monitoring Activities	Equipment	Timing	Frequency	Responsible Person
Water Quality	- Grab samples – water quality handheld meter. - Detailed analysis – registered water quality laboratory	Winter and Summer	Seasonally	Seriti/Wetland Ecologist
Vegetation Monitoring	- Rapid visual observation - Transect survey using 2mx2m quadrant	Late spring/Summer	Annually	Wetland ecologist
Aesthetic outcomes - Photographic record	- Fixed point photos – Camera or related equipment	During construction period	Seasonally	Seriti/Wetland ecologist
Stability Monitoring	Aerial surveys including detailed Lidar surveys. Field survey, Rapid visual observation and measuring tapes	-	Seasonally	Rock Engineer and qualified mine personnel specialising in stability assessments.
Compliance Monitoring	- Field assessment	Audits	Annually	Government departments mandated for the management and controlling of activities within wetlands

APPENDIX 9 NEW LARGO COLLIERY, SERITI POWER – EGG BANK VIABILITY ASSESSMENT (ECOLOGY INTERNATIONAL, 2024)

New Largo Colliery, Seriti Power

Egg Bank Viability Assessment



Ecology International
Sustainability through Collaboration

NEW LARGO COLLIERY, SERITI POWER

Egg Bank Viability Assessment

Project Ref No. 230077

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Declaration of Independence by Specialist

I, **BYRON GRANT**, in my capacity as a specialist consultant, hereby declare that I -

- act as an independent consultant;
- will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- declare that there are no circumstances that may compromise my objectivity in performing such work;
- do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have no, and will not engage in, conflicting interests in the undertaking of the activity;
- undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- based on information provided to me by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional ability;
- undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered; and
- as a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member.

Byron Grant Pr.Sci.Nat.
Director & Principal Specialist
Ecology International (Pty) Ltd
SACNASP Reg. No. 400275/08

11 October 2024
Date

EXECUTIVE SUMMARY

Seriti Power (Pty) Ltd is currently in the process of revising the New Largo mine plan for the main opencast mining area, the footprint of which has been reduced to consist of a number of smaller mining pits. Wetland Consulting Services (Pty) Ltd (WCS) has been appointed by WSP Group Africa (Pty) Ltd on behalf of Seriti Power (Pty) Ltd to revise and update the New Largo Wetland Mitigation and Offset Strategy to align with the new mine plan. Accordingly, WCS appointed Ecology International (Pty) Ltd to assist in the assessment of the egg banks associated with each pan so as to inform the broader study. The present study thus presents the results obtained following egg bank assessment studies for each of the identified pans.

Based on the results obtained during the present study, it was determined that Pan 7 displayed the highest diversity and abundance of nauplii of all the pans assessed, with a significantly high rate of hatching success for Branchiopoda (Anostraca) nauplii that peaked at Day 7 of the inundation period which was not observed for other pans assessed, and a progressive increase in hatching rate of Ostracoda nauplii throughout the study period that was also noted at Pan 8 Branchiopoda (Anostraca). Of additional interest was that many pans within the study area exhibited similar temporal hatching success for Branchiopoda (Anomopoda), with an initial hatching that decreased, followed by a second phase of hatching that seemingly extended past the 30-day inundation period.

Of relevance was that New Largo Pan and Pan 6 displayed little to no hatching success, thus showing little similarity with other pans assessed as part of the study. Based on available data and interpretation from relevant literature, it is likely that New Largo Pan and Pan 6 are associated with differing anthropogenic disturbances that was impacting the viability of the egg banks within each pan’s basin. Notably, potential mining-related impacts associated with New Largo Pan based on sediment salt retention appear to have had a significant impact on the viability of the potential egg bank within the sediment, whereas surrounding agricultural land use and activities that took place within the pan’s basin were likely impacting the viability of the egg bank for Pan 6.

It must however be stressed that, with the exception of Pan 6, all pans assessed during the present study were sampled in an inundated state, with the result that several sampling restrictions were experienced. Nevertheless, results obtained do provide some insight into the viability of the egg banks within the selected pans as well as anthropogenic activities and their impacts on such egg banks.

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ACRONYMS

CMA	Catchment Management Agencies
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
FEPA	Freshwater Ecosystem Priority Area
NFEPA	National Freshwater Ecosystem Priority Areas project
NWRS	National Water Resource Strategy
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
WMA	Water Management Areas
WRC	Water Research Commission
WWF	Worldwide Fund for Nature

1. INTRODUCTION

1.1 Project Description

Seriti Power (Pty) Ltd is currently in the process of revising the New Largo mine plan for the main opencast mining area, the footprint of which has been reduced to consist of a number of smaller mining pits. Wetland Consulting Services (Pty) Ltd (WCS) has been appointed by WSP Group Africa (Pty) Ltd on behalf of Seriti Power (Pty) Ltd to revise and update the New Largo Wetland Mitigation and Offset Strategy to align with the new mine plan. While the overall footprint of the new opencast mine has been reduced compared to the previous mine plans, it includes the Honingkrantz Block which proposes mining through Honingkrantz Pan. Honingkrantz Pan was previously excluded from mining and originally proposed to form part of a wetland and conservation offset to compensate for the mining of other pans included in the original mine plan.

In an attempt to achieve a like-for-like offset for the potential loss of Honingkrantz Pan, the Wetland Mitigation and Offset Strategy was previously expanded to include 5 pans (Pan 2 to Pan 6) within the New Largo Mining Rights Area (MRA) - pans previously proposed to be mined - and two pans to the west on private land (Pan 7 and Pan 8). While Honingkrantz Pan as well as Pan 2 to Pan 6 formed part of a draft Wetland Reserve study conducted over 10 years ago, no more recent detailed studies had been undertaken on these pans, and apart from a desktop assessment, no other studies had been undertaken on Pan 7 and Pan 8. In addition, no invertebrate studies had been undertaken on any of the pans previously. A key aspect of any like-for-like offset is determining like-for-like attributes. One attribute that was identified as requiring additional work was how similar or different (unique) the pans are from a conservation or biodiversity perspective. This would help clarify some of the debate as to whether or not Honingkrantz Pan is unique from a biodiversity or conservation perspective. It would also allow a comparison with the other pans being considered as possible suitable candidates for offsetting the loss of Honingkrantz Pan.

Depressions such as those assessed as part of the present study are likely to support various aquatic macroinvertebrates that have developed life strategies and unique adaptations that allow them to cope with the harsh environments and have an opportunistic life cycle that allow them to take advantage of the temporary nature of the inundation period by growing, reaching sexual maturity, and reproducing within an extremely short period of time, with the inherent aquatic macroinvertebrate diversity (most notably branchiopods) being primarily supported by the egg bank present within the upper sediment layers of each such depressional feature.

Typical approaches to the assessment of aquatic biota present within watercourses in South Africa for the purposes of environmental authorisations typically relies on the sampling of the active community present within watercourses during a single seasonal survey. Within temporary depressional systems such as those found across much of South Africa, the active biotic community at any one moment of sampling generally only represents a portion of the entire community that is likely associated with the system (Brendonck & de Meester, 2003; cited in Meyer-Milne et al., 2022). It is therefore only through the assessment of the egg banks present within the sediment of the depressions that a more complete understanding of the inherent biodiversity associated with each pan can be realised.

Recognising that the pans under consideration all have differences in land-use in the catchments, as well as water chemistry and hydroperiod, it was expected that there may be differences in the invertebrate taxa in the pans and that these differences may not only provide insight into the uniqueness of the pans, but also conservation importance. A motivation was therefore submitted to undertake an invertebrate study of Honingkrantz Pan plus the 7 targeted/candidate offset pans, focusing on Branchiopods. It was envisaged that this study would not only shed light on the uniqueness of the pans under consideration from an invertebrate community perspective, but also identify which of the target pans could potentially serve as suitable offset pans should Honingkrantz Pan be mined/lost. Accordingly, Wetland Consulting Services (Pty) Ltd (WCS) appointed Ecology International (Pty) Ltd to assist in the assessment of the egg banks associated with each pan so as to inform the broader study. The present study thus presents the results obtained following egg bank assessment studies for each of the identified pans.

1.2 Terms of Reference

The Terms of Reference for the present study were understood to include the collection and assessment of egg banks within sediment from identified pans through conducting hatching experiments under controlled laboratory conditions utilising a 30-day inundation period. Sediment collections for the present study were conducted on the 26th and 27th of March 2024, with a further collection for Honingkrantz Pan being conducted on the 22nd of April 2024.

1.3 Assumptions and Limitations

In order to sample the egg bank of depressions most effectively and ensure viability of egg banks, sediment within depressions should ideally be sampled in a newly dry state. This allows for the deepest section of the depression (which should be the last to dry up and contain newly deposited egg banks in a concentrated area) to be identified, accessed and sampled to allow for the best representation of inherent biodiversity features. Sampling depressions in a dry state further limits possible impacts associated with vegetated growth over the sediments containing the egg banks, while also reducing the period required for hatching studies. Due to project time constraints, sampling was conducted during the summer period when the pans were fully inundated, with the result that the deepest sections of each pan were not necessarily identifiable and/or accessible, while floating and submerged vegetated growth within the pans limited the suitability and access to the base sediments. As such, sediments from each pan's base were sampled where access to sediment allowed, and results may thus not be truly representative of inherent egg bank diversity. Furthermore, collected sediment samples were evaporated under laboratory conditions determined to be representative of natural temperatures, resulting in a desiccation period longer than that as used by Henri et al. (2014).

Further, the present study provides limited resolution regarding identification of nauplii that hatched during the initial phase of the inundation period, with final identification only being conducted to the Class or Order level where possible. While rearing of nauplii to larger sizes would have allowed for greater taxonomic resolution to be achieved, previous egg bank studies conducted by the author noted that during the nauplii larvae rearing period, predation was experienced which affected the determination of individual family diversity emerging from the egg bank. As such, viability of the egg banks associated with each pan was largely based on numbers of nauplii hatching rather than determining the diversity of invertebrates associated with each pan.

2. GENERAL CHARACTERISTICS

2.1 Location

The pans selected for the purpose of the present study were located within the Highveld region between Bronkhorstspruit Dam (Gauteng) and the town of Ogies (Mpumlanga) (Figure 1).

2.2 Biophysical Attributes

2.2.1 Climate

According to Kleynhans et al. (2007), the study area is located within the Highveld Ecoregion, with rainfall seasonality being early to late-summer, and mean annual temperatures ranging from 12°C to 18°C. Mean annual precipitation of the general study area is approximately 667mm/annum, with a potential evaporation of 2119mm/annum (Macfarlane et al., 2008).

2.2.2 Geology

Geology underlying pans located in the eastern portion of the study area was made up of elements from the Vryheid Formation of the Ecca group of the Karoo Supergroup, while pans located in the western portion of the study area were underlain by elements of the Dwyke Group of the Karoo Supergroup. Consequently, geology associated with the pans in the eastern portion was characterised by the presence of fine- and course-grained sandstone and shale with coal seams in places, whereas geology associated with pans in the western portion was characterised by diamictite (polymictic clasts, set in a poorly sorted, fine-grained matrix) with varved shale, mudstone with dropstones and fluvioglacial gravel (less common).

2.2.3 Bioregional Context

The New Largo study area is located within the Southern Temperate Highveld freshwater ecoregion, which is delimited by the South African interior plateau sub-region of the Highveld aquatic ecoregion, of which the main habitat type, in terms of watercourses, is regarded as Savannah-Dry Forest Rivers. Aquatic biotas within this bioregion have mixed tropical and temperate affinities, sharing species between the Limpopo and Zambezi systems. The Southern Temperate Highveld freshwater ecoregion is considered to be bio-regionally outstanding in its biological distinctiveness and its conservation status is regarded as Endangered. The ecoregion is defined by the temperate upland rivers and seasonal pans (Nel et al., 2004; Darwall et al., 2009; Scott, 2013).

2.2.4 Associated Aquatic Ecosystems

The NWRS-1 (National Water Resource Strategy, Version 1) originally established 19 Water Management Areas within South Africa and proposed the establishment of the 19 Catchment Management Agencies to correspond to these areas. In rethinking the management model and based on viability assessments with respect to water resources management, available funding, capacity, skills and expertise in regulation and oversight, as well as to improve integrated water systems management, the original 19 designated WMAs have been consolidated into nine WMAs.

As such, the New Largo study area is located within the newly revised Olifants Water Management Area (WMA), which now also includes the Letaba River catchment. Accordingly, the main rivers include the Elands River, the Wilge River, the Steelpoort River, the Olifants River, and the Letaba River. The Olifants River originates to the east of Johannesburg and flows in a northerly direction before gently turning to the east. It is joined by the Letaba River before it enters into Mozambique. More specifically, pans within the eastern portion of the study area are located on the watershed between Quaternary Catchments B20F and B20G, whereas pans within the western portion of the study area are located on the watershed between Quaternary Catchments B20C and B20F.

2.2.5 National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA; now Department of Water and Sanitation, or DWS), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and
- Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

The first aim uses systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development. The second aim comprises a national and sub-national component. The national component aims to align DWS and DEA policy mechanisms and tools for managing and conserving freshwater ecosystems. The sub-national component aims to use three case study areas to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes at a sub-national level (Driver et al., 2011). The project further aims to maximize synergies and alignment with other national level initiatives such as the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation.

Based on current outputs of the NFEPA project (Nel et al., 2011; Figure 2), the general study area does not fall within any FEPA-designated catchments. Further, SANBI recently undertook a wetland mapping exercise for the Mpumalanga Highveld region in order to expand on the detailed wetland delineations undertaken in adjacent catchments, for inclusion into the NFEPA project (Mbona et al., 2015). Mpumalanga Tourism and Parks Agency (MTPA) recognises that wetlands are specialised systems that perform various ecological functions and play an integral role in biodiversity conservation. The project sought to map the extent, distribution, condition and type of freshwater ecosystems in the Mpumalanga Highveld coal belt. The delineations were based on identifying wetlands on Spot 5 imagery within the Mpumalanga Highveld boundary and supported by Google Earth imagery, 1:50 000 contour lines, 1:50 000 river lines, data from previous studies in the area, and data from the original NFEPA wetlands layer. Hydrogeomorphic (HGM) units were identified at a desktop level and confirmed by means of ground-truthing. These refined layers will eventually be incorporated into the atlas of high-risk freshwater ecosystems and guidelines for wetland offsets, currently being developed by SANBI, in order to improve the scientific robustness of these tools (Mbona et al., 2015). According to Mbona et al. (2015), several pans under study (i.e. Horingkranz Pan, Pan 3 and Pan 6) have been identified as a FEPA wetland based on the revised wetland mapping inventory for the Mpumalanga Highveld region (Figure 2).

2.2.6 Selection of Sampling Sites

Various pans were pre-selected as part of the present study to inform the updated Wetland Mitigation and Offset Strategy and were thus the focus of the present study. Co-ordinates of the selected pans were determined using a Garmin global positioning device (GPS) and are listed in Table 1 and presented graphically in Figure 3.

Table 1: Description of pans assessed as part of the present study

Site	Co-ordinates	Elevation	Description
Honingkrantz Pan	S25°54'48.74" E28°58'27.23"	1577 m	Depressional pan located on Remainder of the farm Honingkrantz 536 JR. Size of pan 49.08 ha.
New Largo Pan	S25°58'06.02" E28°57'28.79"	1556 m	Depressional pan located on Portions 4 and 12 of the farm Klipfontein 566 JR. Size of pan 51.01 ha.
Pan 3	S25°59'54.07" E28°57'55.66"	1570 m	Depressional pan located on Portions 9 and 10 of the farm Vlakfontein 569 JR. Size of pan 10.80 ha.
Pan 4	S26°00'14.42" E28°57'56.92"	1574 m	Depressional pan located on Portion 10 of the farm Vlakfontein 569 JR. Size of pan 2.41 ha.
Pan 5	S26°00'12.59" E28°57'36.06"	1565 m	Depressional pan located at the intersection of various farms, including Portion 9 of the farm Vlakfontein 569 JR and Portions 7 and 13 of the farm Klipfontein 568 JR. Size of pan 19.13 ha.
Pan 6	S26°00'21.02" E28°57'09.75"	1566 m	Depressional pan located on Portion 13 of the farm Klipfontein 568 JR. Size of pan 3.68 ha.
Pan 7	S25°57'18.47" E28°44'54.20"	1504 m	Depressional pan located on Portion 4 of the farm Zorgvliet 557 JR. Size of pan 59.85 ha.
Pan 8	S25°55'22.18" E28°45'46.10"	1492 m	Depressional pan located at the intersection of various farms, including Portion 6 of the farm Witklip 539 JR, Portion 2 of the farm Blesbokfontein 558 JR, Portion 6 of the farm Tweefontein 541 JR, and Portions 37 and 53 of the farm Groenfontein 526 JR. Size of pan 38.68 ha.

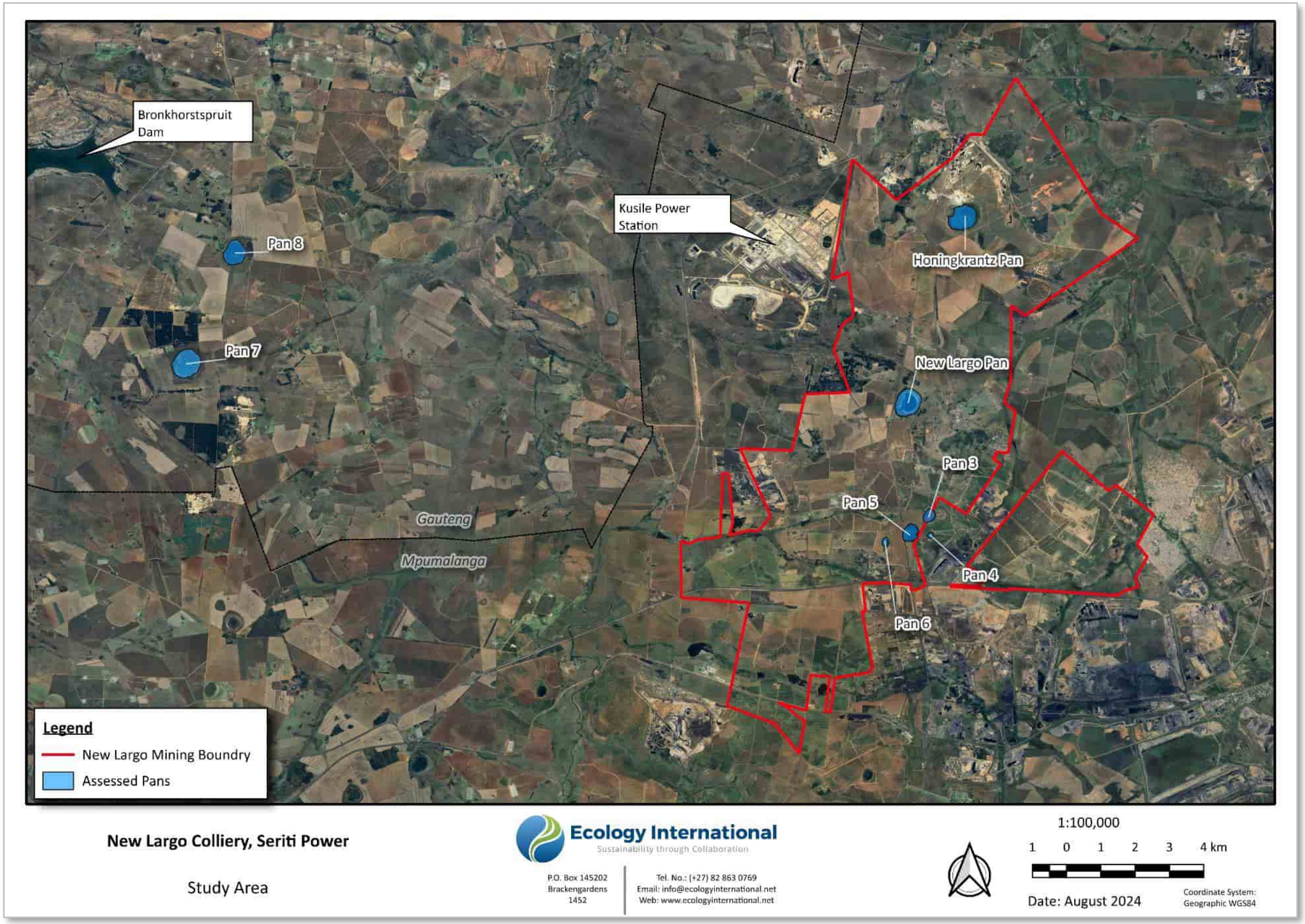


Figure 1: Study Area

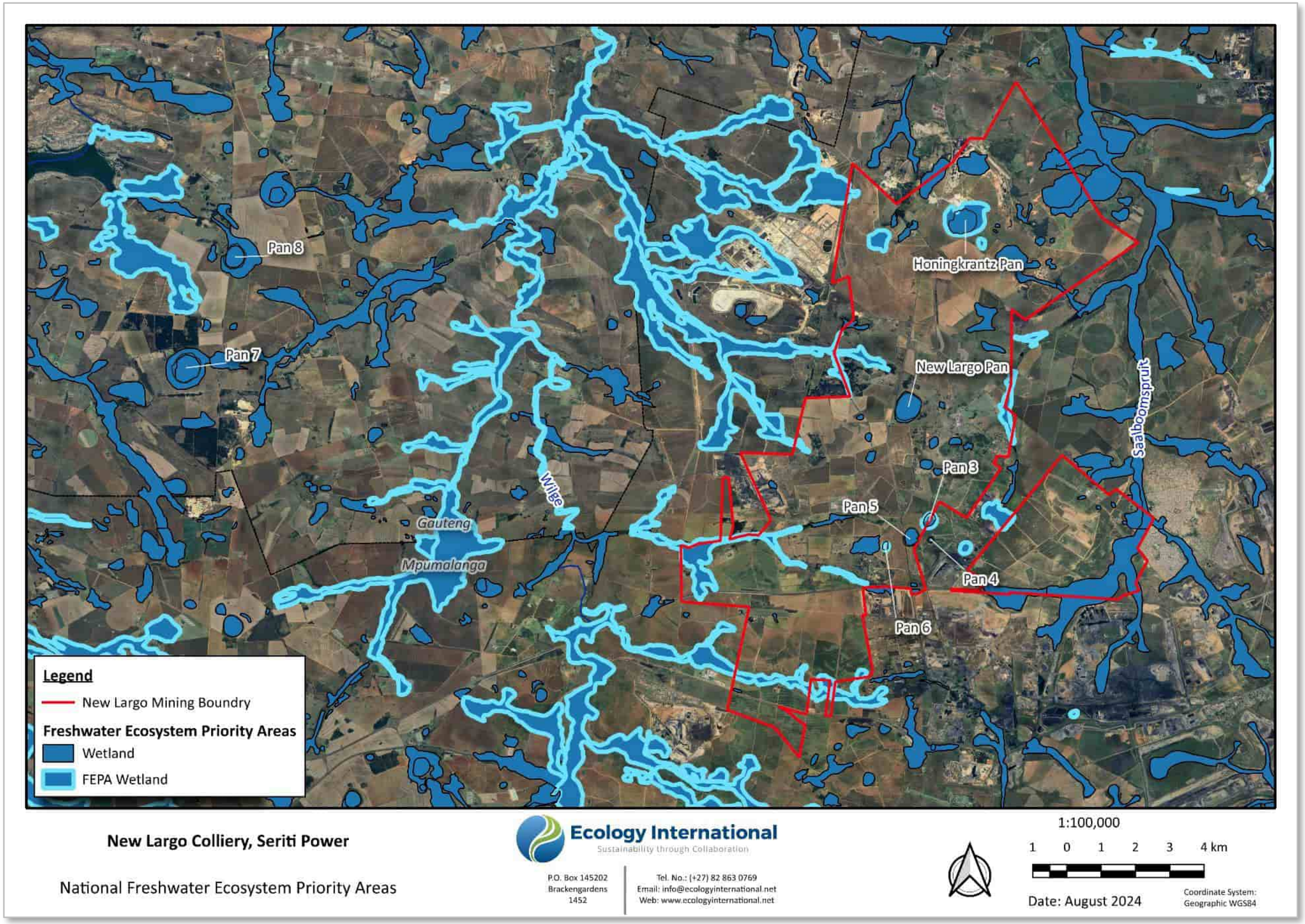


Figure 2: National Freshwater Ecosystem Priority Areas associated with the New Largo study area

3. METHODOLOGY

Given the highly variable temporal and spatial nature of such ecosystems, traditional approaches to determining the impact of such activities as proposed on the aquatic biodiversity associated with pans has relied on professional judgement with a limited degree of confidence, based largely on uncertainties with regards to timing of field studies and determination of impacts. As such, results obtained using such approaches often display a low degree of defensibility, which restricts the ability to make informed decisions regarding such activities. The present study was based on an adaptation of the approach used by Henri et al. (2014) in investigating the hatching success of egg banks of selected endorheic wetland (pan) fauna, and is briefly described below.

Given the inundated nature of many pans assessed during the present study, a stainless steel Van Veen sediment grab sampler with a sampling surface of 260cm^2 was used to extract sediment samples from the basin of each pan. Where the use of the Van Veen sampler was not feasible (such as in areas of heavy plant growth), a 5cm metal free PCV pipe was used to extract the top 10cm of soil from accessible sampling areas. Where possible, the core samples were collected at randomly selected areas of the selected pans, working from the periphery towards the centre of the pan. Core samples were taken from the deepest section of the pans, where these sections could be identified, or at the deepest wadable depth where inundation was significant.

Collected core samples from each pan were combined to form a composite sample for the pan and transported to the WSP in Africa Laboratory where desiccation and hatching of the egg banks were performed. Upon arrival at the laboratory, sediment samples were placed in large flat containers (Figure 3) to allow for more effective drying and weighed every few days to determine moisture content. To facilitate the drying process, sediment samples were carefully turned every few of days. Once all the sediment samples were evaporated/dried to a constant weight, an additional desiccation period of four weeks was initiated to ensure the activation of the egg banks contained within the sediment.

Following the completion of the desiccation period, 50g of sediment from each pan was placed in individual 5ℓ containers for the sediment inundation phase (Figure 4). In addition, the particle size distribution of a known amount of the dried sediment samples was determined using an Endecott sieve system (sieve sizes ranging from 2000 µm to 53 µm) in order to determine sediment grain size differences between pans. Control media used during the hatching experiments consisted distilled water adjusted to a salinity/Total Dissolved Salts (TDS) of 1000 mg/l using commercially available sea salt which was determined by Henri et al. (2014) to result in the best hatching success. Each hatching experiment was done in triplicate (n=3) in order to account for possible variability of egg bank distribution.

At the initiation of the hatching phase, the containers were filled with 1ℓ of the inundation medium. The level of the overlying water was marked on the exposure containers. At intervals during the experiment, the containers were topped up using reverse osmosis water when it was observed that the water had evaporated below the 1ℓ point, so as to maintain the initial concentration in the overlying waters.

Figure 3: Desiccation of collected sediment

Figure 4: Sediment egg bank hatching setup

The hatching experiments were conducted over a period of 30 days in a temperature-controlled room exposure of 23°C and a 16:8-hour photoperiod. Every fourth day the physico-chemical variables of all the containers were measured using a HACH HQ40D portable multimeter (Dissolved Oxygen, Conductivity, pH). During the measurement of the physico-chemical variables, each container was also examined for the presence of any hatchlings (nauplii emerging), and the abundance of the hatchlings, if any, were recorded. Any hatchlings which were observed were removed from the containers and placed in laboratory-prepared invertebrate culture medium/ADaM medium (Artificial Daphnia medium) for later identification, as additional time is required for nauplii to develop some of the distinguishing features that would allow the differentiation between species (Day et al., 1999).

4. RESULTS

4.1 Sediment Grain Size

Sediments associated with the substrate of aquatic ecosystems are derived from catchment geology, land use patterns and geomorphological processes that have taken place over time. From the perspective of aquatic ecosystems, sediment particle size is an important characteristic of sediment, as the smaller the grain size the higher the surface area of the specific sediment particle, thus increasing its ability to adsorb various contaminants such as metals. Sediment grain size distribution for sediment samples collected from each of the selected pans are presented in Figure 5.

During the present study, New Largo Pan and Pan 4 showed highest proportion of the finer grain sizes relative to the other pans assessed, with 77% and 72% of sediment collected falling below 212µm particle size respectively. These pans also represented the only pans with more than 20% of the collected sediment falling into the fractions finer than 53µm, with little to no particles greater than 500µm in size collected from the pans' basins. In contrast, Pan 5 and Pan 8 showed the highest proportions of sediment particles greater than 500µm within the collected samples.

In a study undertaken by Barling & Moore (1994), the majority of sediment deposition took place within the first 0.25m to 0.6m of the outer edge of a vegetate buffer where vegetation growth would have slowed the velocity of overland flow and facilitated the deposition of larger sediment particles. Finer silt and clay, which are held in suspension longer due to the smaller particle sizes, would however require larger buffer areas to facilitate deposition. However, the ability of a vegetated buffer to facilitate sediment deposition prior to entering into a wetland system is largely influenced by flow rate, which itself is largely influenced by slope of the area over which the water flows as well as the roughness of the vegetation surrounding a wetland. Where steeper slopes prevail, higher overland flow rates can be expected, and with it a higher capacity to transport more coarse sediment into the receiving water body. Similarly, where a lower basal cover of vegetation is present between the water body and the adjacent land use, the lower the surface roughness of such an area and the higher the sediment deposition within the water body. In pans however, an additional factor contributing to the possible loss of finer particles from the basin of the pan includes wind action during the dry phase, with pans that are devoid of vegetated cover within the basin likely to be impacted to a greater degree.

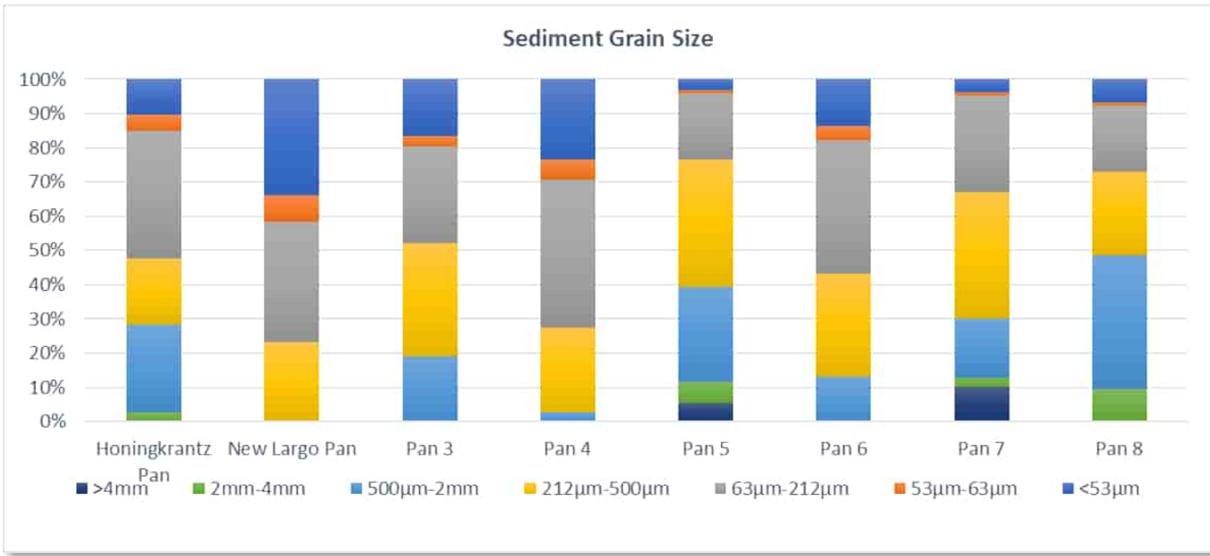


Figure 5: Sediment grain size distribution from pans assessed during the course of the present study

4.2 Physico-chemical Variables

Aquatic communities are influenced by numerous natural and human-induced factors, including physical, chemical and biological factors. The assessment of water quality variables in conjunction with assessment of biological assemblages is therefore important for the interpretation of results obtained during biological investigations. Table 2 provides the *in situ* water quality data obtained at each pan at the time of sediment collection.

Table 2: *In situ* water quality data obtained at the time of sediment sample collection

	Temp. (°C)	pH	EC [µS/cm]	Dissolved Oxygen	
				(mg/ℓ)	(%)
Horningkrantz Pan	23.63	7.02	1135	0.51	7.2
New Largo Pan	28.81	8.05	10210	5.18	82.3
Pan 3	20.03	9.66	13880	4.99	69.5
Pan 4	21.13	8.76	1286	3.70	49.9
Pan 5	19.77	7.87	677	0.91	11.9
Pan 6	Dry at time of sampling				
Pan 7	18.77	10.54	3578	3.66	47.2
Pan 8	19.30	9.34	2326	0.57	7.4

Based on the *in situ* water quality variables obtained, the greatest variability between pans was noted in the electrical conductivity values and the dissolved oxygen concentrations which reflected vastly differing values between pans sampled. The existence of pans depends entirely on the water regime, and factors such as rainfall intensity, evaporation rate and groundwater level all influence the duration of inundation. Since these features vary both seasonally and geographically, periods of inundation are also highly variable even between pans in close proximity to one another (Seaman and Kok, 1987; cited in Allan et al., 1996). For all intents and purposes, the various pans assessed as part of the present study can be classified as having endorheic drainage basins which retains water and dissolved solids that enter the system primarily from the surrounding catchment. As a result of their inwardly draining (closed) nature, water within such endorheic systems is subsequently lost via evaporation only, which results in the accumulation of salts, particularly within the central portions of the pans where elevation is marginally lower due to possible mechanical erosion by wind or other factors. As such, temporary or non-perennial pans allow for the precipitation of minerals, including phosphates, due to the concentrating effects of evaporation.

In addition, due to the highly unpredictable seasonal changes in water regime, pans may range temporally from being freshwater systems when wet weather prevails and significant inundation occurs, to hypersaline systems as the dry season progresses and evaporation intensifies or when inundation is minimal and dissolved salts are concentrated (Morant, 1983; cited in Allan et al., 1996). Further, because salts are likely to concentrate within the central portions of the pan where elevation is lower, the water quality can differ spatially within the pan at any given time within an inundation cycle

The pans within the study area are likely maintained by a combination of direct rainfall, surface runoff, interflow and shallow groundwater inputs from the weathered aquifer or from alluvial aquifers, with the water contribution from each differing between pans and which to some degree will account for differences in water qualities between the pans, as will the level of inundation. However, in addition to the natural factors affecting water quality, land use and/or anthropogenic input should be considered significant drivers in terms of the water quality observed within these systems. In particular, visual observations made at New Largo Pan and at Pan 3 during sediment collection in association with significantly elevated electrical conductivity values relative to other pans suggested anthropogenic input of possible contaminated water whether by discharge of mine-affected water directly into the pans or interaction with contaminated groundwater cannot be ruled out.

Table 3 presents the mean and standard deviations of the physico-chemical variables assessed during the course of the 28-day hatching period as part to the present study. Differences in the water chemistry between pans was however expected, and water chemistry within a pan is largely determined by the chemistry of the sediment associated with the pan with each pan expected to have a slightly different composition of ions present – a factor predetermined by the geology associated with each pan's catchment and basement. Further differences in the water quality between pans may be influenced by anthropogenic activities present within each pan's catchment, while the presence and degree of vegetation within each pan as well as the presence of organic matter within each pan can strongly influence the pH values in each pan (Meintjes et al., 1994; Day et al., 2010; cited in Henri et al., 2014). Of particular relevance during the present study however was that the electrical conductivity of rewetted sediment collected from the various pans assessed were largely similar with the exception of New Largo Pan which was significantly greater than all other pans assessed, suggesting that the degree of salt loading associated with New Largo Pan in particular may be anthropogenic in nature.

Table 3: Mean and standard deviation of physico-chemical variables recorded during egg bank hatching studies

	pH	Electrical Conductivity (µS/cm)	Dissolved Oxygen (mg/L)
Horningkrantz Pan	7.31 (±0.29)	1846.6 (±72.94)	7.04 (±0.33)
New Largo Pan	7.72 (±0.22)	4511.85 (±227.93)	6.12 (±0.73)
Pan 3	8.51 (±0.20)	2414.96 (±130.42)	5.42 (±1.00)
Pan 4	6.84 (±0.58)	2050.04 (±96.38)	6.86 (±0.20)
Pan 5	7.42 (±0.32)	1904.81 (±72.80)	7.17 (±0.15)
Pan 6	6.77 (±0.66)	1829.33 (±89.64)	6.95 (±0.27)
Pan 7	7.47 (±0.31)	1904.44 (±65.69)	7.24 (±0.18)
Pan 8	7.88 (±0.25)	1927.3 (±90.70)	6.92 (±0.25)

4.3 Egg Bank Hatching

During the course of the present study, a total of 2532 individual nauplii hatched from the sediment collected from the selected pans, with four classes of invertebrates identified, one of which (Brachiopoda) was further differentiated into two separate orders. However, hatching success varied greatly amongst the pans assessed, with New Largo Pan showing no hatching success and Pan 5 and Pan 6 showing very limited hatching success (Figure 6). In contrast, Pan 7 displaying the highest total number of nauplii hatching from the sediment (47.75% of the total hatching success across all pans) as well as the highest number of nauplii belonging to the Class Branchiopoda of all the pans assessed (Figure 7). Total hatching data collected during the present study furthermore shows higher values than those observed by Henri et al. (2014) who collected 476 individuals hatched from the sediment collected from 10 pans in the Mpumalanga Highveld area in the Lake Chrissie area. As with the pans assessed by Henri et al. (2014), sediment collection from the pans assessed during the present study was done under inundated conditions. Many studies such as Mitchell (1990) and Brendonck (1996) have looked at desiccation periods and hatching rates and generally with longer desiccation periods, a greater proportion of hatchlings are seen, and as such Henri et al. (2014) suggested that extending the descication period may assist in increasing the hatching success of the egg banks from sediment taken from inundated pans. This was taken into account during the sediment desiccation period of the present study, whereby the period for sediment desiccation was extended to timeframes beyond that utilised by Henri et al. (2014) until a constant dry weight was achieved prior to initiation of the four-week descication period utilised by Henri et al. (2014). This exended period of descication is likely to have played a factor in facilitating a higher activation of the egg bank within the pans assessed duirng the present study, and yielded higher numbers of nauplii for several of the identified pans.

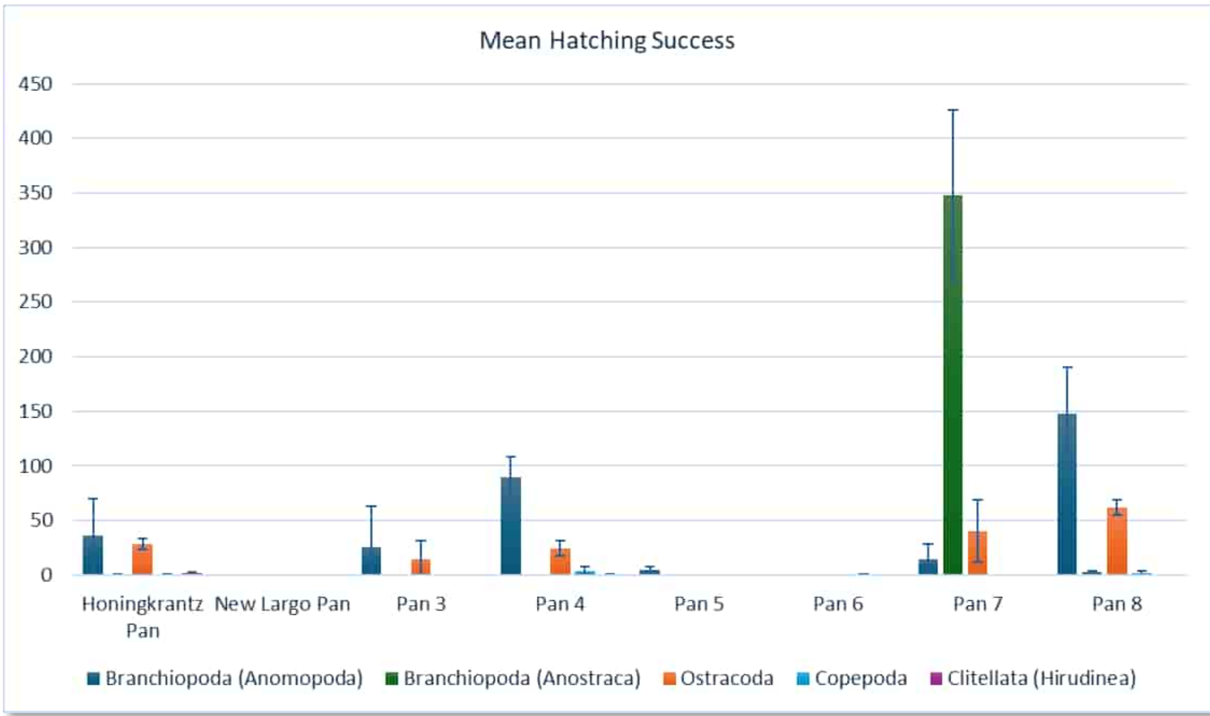


Figure 6: Mean hatching abundance for pans assessed during the present study

Evaluation of the similarity between pans utilising a Bray-Curtis similarity ranked cluster analysis based on untransformed data (Figure 7) further suggested that pans can be clustered based on the data obtained during egg bank hatching experiments. For example, Pan 3 and Horningkrantz Pan can be considered very similar in respect to egg bank hatching success despite greatly differing water quality at the time of sample collection, as can Pan 4 and Pan 8 which differed significantly in size. In contrast, Pan 6 and New Largo Pan can be considered most dissimilar to other pans assessed.

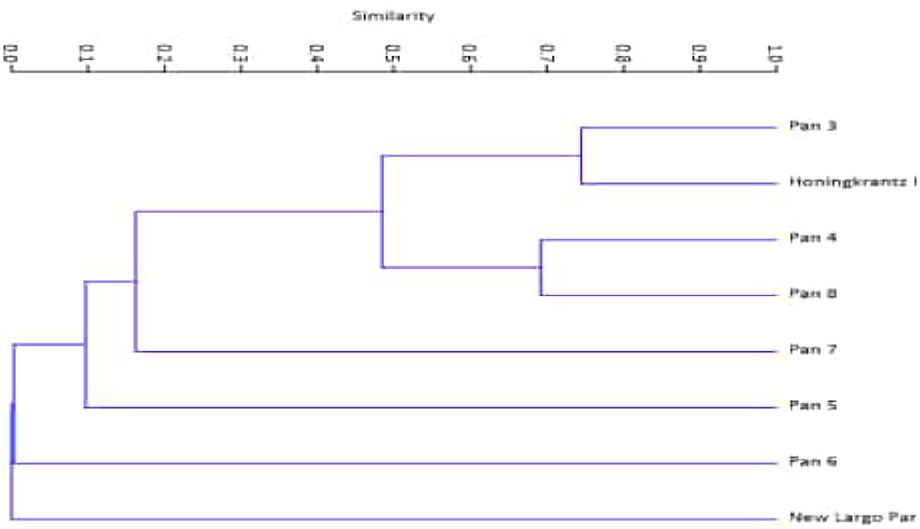
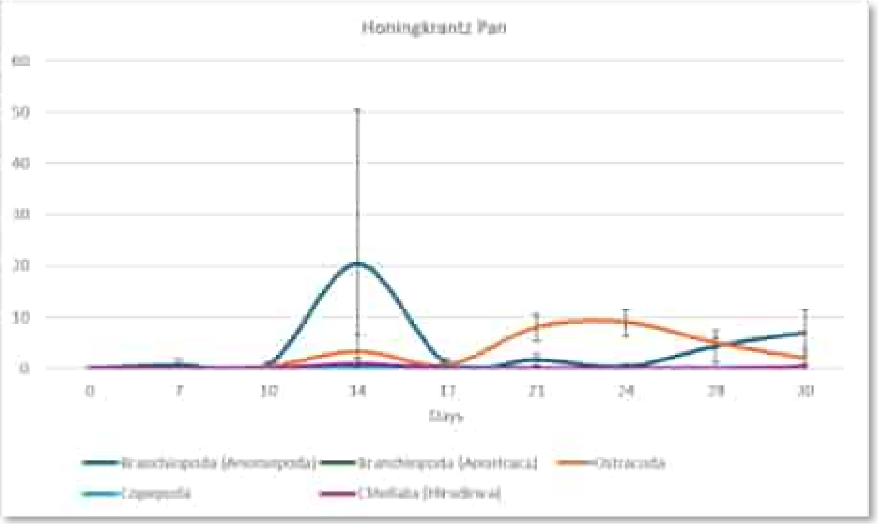
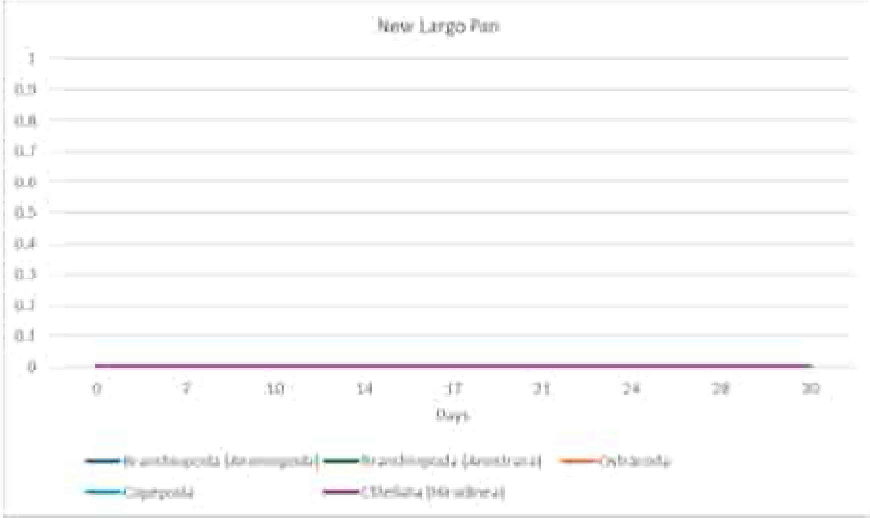
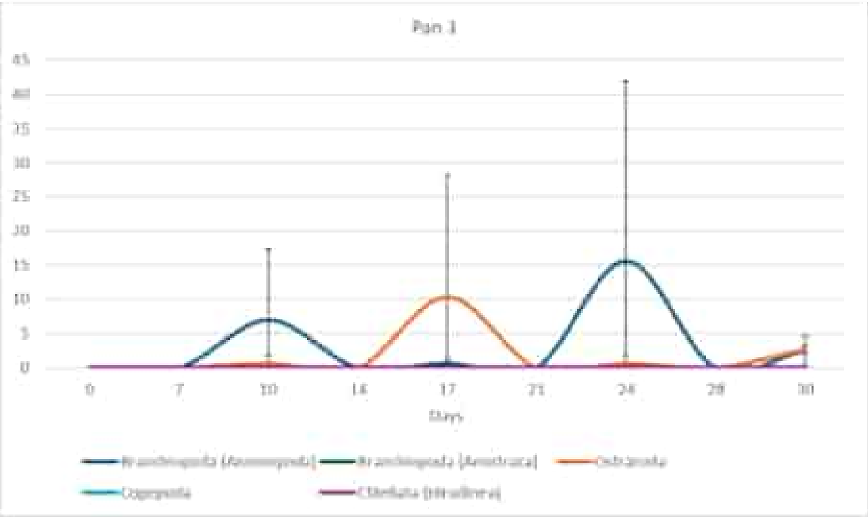
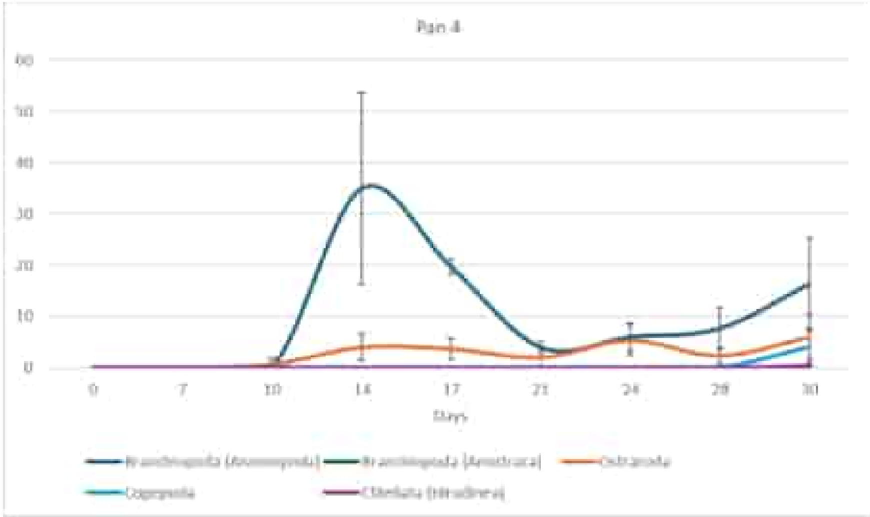


Figure 7: Bray-Curtis similarity ranked cluster analysis based on mean hatching abundance for pans assessed during the present study


Honingkrantz Pan
60
50
40
30
20
10
0
0 7 10 14 17 21 24 28 30
Days
Branchiopoda (Anomopoda)
Branchiopoda (Anostraca)
Ostracoda
Copepoda
Clitellata (Hirudinea)


New Largo Pan
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 7 10 14 17 21 24 28 30
Days
Branchiopoda (Anomopoda)
Branchiopoda (Anostraca)
Ostracoda
Copepoda
Clitellata (Hirudinea)


Pan 3
45
40
35
30
25
20
15
10
5
0
0 7 10 14 17 21 24 28 30
Days
Branchiopoda (Anomopoda)
Branchiopoda (Anostraca)
Ostracoda
Copepoda
Clitellata (Hirudinea)


Pan 4
60
50
40
30
20
10
0
0 7 10 14 17 21 24 28 30
Days
Branchiopoda (Anomopoda)
Branchiopoda (Anostraca)
Ostracoda
Copepoda
Clitellata (Hirudinea)

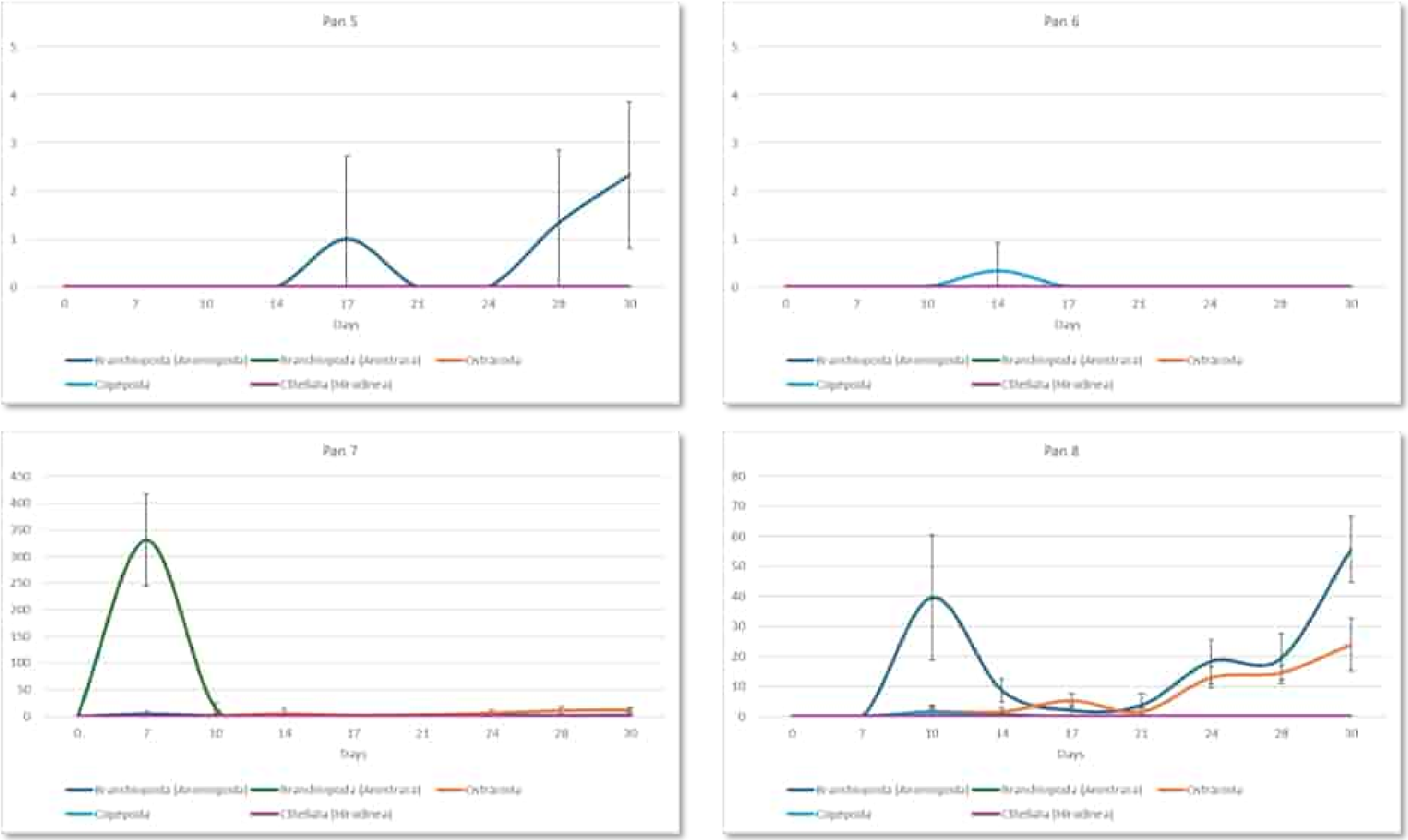


Figure 8: Temporal mean hatching abundance of egg banks within sediment collection from identified pans

Further temporal variability in the rate of nauplii hatching from the sediment of control samples during the course of the 30-day sediment inundation period was also observed (Figure 8), with mean hatching rates of nauplii differing between pans. For example, Horningkrantz Pan, Pan 3, Pan 4, Pan 5 and Pan 8 generally showed an initial peak in hatching of Branchiopoda (Anomopoda) nauplii between Day 10 and Day 17 which then declined, followed by a secondary hatching during the latter part of the 30-day inundation period, with Pan 4 and Pan 8 showing the highest hatching success rate across all pans for Branchiopoda (Anomopoda) nauplii during the initial hatching period. While Pan 7 showed a similar trend in the general two-phase hatching success of Branchiopoda (Anomopoda) nauplii, albeit at low numbers, the initial hatching peak took place at Day 7. In contrast to other pans however, Pan 7 also showed a significantly high rate of hatching success for Branchiopoda (Anostraca) nauplii that peaked at Day 7 of the inundation period, and a progressive increase in hatching rate of Ostracoda nauplii throughout the study period that was also noted at Pan 8.

Variability in terms of the total number of hatched nauplii and the temporal variability of the hatching between the results obtained from each pan was however expected, as successful hatching is a function of conditions of exposure, the species present and the fraction of quiescent and diapausing eggs (Henri et al., 2014). Branchiopod eggs have been found to exhibit different states of dormancy. Diapause is one state of dormancy where the arrest in development is initiated by internal factors - eggs do not hatch even when environmental conditions are favourable as diapause termination is also internally controlled (Lavens & Sorgeloos, 1987; Drinkwater & Clegg, 1991; Brendonck et al., 1993; cited in Henri et al. 2014). Quiescence is an alternate state of dormancy where the arrest in development is initiated by external factors and is induced by unfavourable external conditions and is terminated as soon as conditions are permissible (Lavens & Sorgeloos, 1987; Drinkwater & Clegg, 1991; Brendonck, 1996; cited in Henri et al. 2014). Both forms of dormancy have been found to occur in a single brood of eggs. Quiescent eggs respond rapidly to a change in environmental conditions giving species a quick start to colonisation before the pan dries up (Brendonck, 1996; cited in Henri et al. 2014). Diapause is most likely the phenomenon which ensures some eggs always remain dormant in the sediment to ensure the continuation of the species over long periods of time and is most likely responsible for the long-term viability of eggs in the egg bank.

Hatching of individuals is also known to vary under identical conditions and only a fraction of the total viable egg bank is likely to hatch during the inundation period (Brendonck et al., 1996; Vanderkerkhove et al., 2004; cited in Henri et al. 2014). It is possible that in the pans where abundances were low the diapausing deactivating stimuli for these cysts were not met. Another cause for low abundances could be the inundation period not being long enough, and eggs within the sediment may have already lost their viability (Henri et al., 2014). In addition, according to Henri et al. (2014), a temporal succession in the diversity of invertebrates was noted during the hatching period and the rate of nauplii hatching therefore appeared to be related to the diversity of the egg bank, with pans that had a peak in hatching within the 4-16 day interval having an abundance of Anostraca, while those pans where hatching peaked in the 16-18 day interval had high numbers of Cladocera and Ostracoda. The absence of other families from the hatching experiments undertaken (such as Conchostraca) may be related to the length of the exposure period utilised during the study. Unfortunately, no meaningful identification of hatched nauplii beyond that which was conducted was feasible during the course of the present study, as during previous egg bank studies conducted by the author on similar Highveld Pan systems (unpublished data) noted high rates of predation experienced during rearing following hatching.

Of particular relevance during the present study was that New Largo Pan, for which water quality of rewetted sediment suggested that the degree of salt loading may be anthropogenic in nature, displayed no hatching success during the course of the present study. According to the results obtained during experimentation by Henri et al. (2014), the addition of mine-affected water had a negative effect on the hatching success of branchiopod crustaceans from their egg banks, with eggs unable to hatch in the presence of mine-affected water. An explanation provided by Henri et al. (2014) for eggs not hatching in the presence of mine-affected water is that water originating from mining activities has a high concentration of mineral salts (consisting of toxic metals) and generally a low pH. Salinity has consequently been said to be the most important factor explaining the distribution of branchiopods, adversely affecting hatching and survival and resulting in lower species richness (Waterkeyn et al., 2009; cited in Henri et al., 2014).

Another possible causitive factor in the hatching success of pan egg banks exposed to mine affected water according to Henri et al. (2014) was considered to be the low pH of such waters which may impact the optimal functioning of the hatching enzyme, an enzyme which is secreted by the metanauplii allowing it to break free of the inner membrane, the final membrane that has to be broken through allowing the release of the free-swimming nauplii (Van Stappen, 1996). During the present study however, there did not apprear to be any clear correlation with regards to pH being a driver for hatching success based on *in situ* water quality data or water quality data obtianed during the sediment inundation period.

A further observation made during the present study was that Pan 6 also exhibited limited hatching success during the sediment inundation period. During the field survey, Pan 6 was noted to be the only pan that was in a dry state, with a well established basal cover within the pan's basin. In addition, the pan's catchment was noted to be extensively cultivated with maize which may lead to altered hydroperiod through interception of catchment interflow pathways, while review of satellite imagery for the area noted some level of physical disturbance wihtin the pan's basin from circa 2013 (Figure 9). Natural events such as wind erosion, predation, extended length and frequencies of droughts, abortive hatching due to early drying, disease, and burial in deep sediment layers due to sediment mixing, may cause loss from egg banks or obstruct recruitment of a new generation (Brendonck et al., 1998, 2017; Bren-donck & de Meester, 2003; Gleason et al., 2003; Pinceel et al., 2020; cited in Meyer-Milne et al., 2022). However, while branchiopod communities across dryland regions are typically well buffered against natural disturbance, including prolonged droughts, early drying events and wind (Fryer, 1996; Brendonck et al., 1998, 2017; cited in Meyer-Milne et al., 2022), the opposite is expected with regard to physical disturbances caused by anthropogenic activities. Extreme alterations such as total habitat destruction or deliberate transformation of the hydrological regime typically result in complete species losses (Martens & De Moor, 1995; Eder & Hödl, 2002; cited in Meyer-Milne et al., 2022).

Figure 9: Disturbance in the basin of Pan 6 with extensive dryland cultivation within pan's catchment (Google Earth; image dated 30/11/2013)

5. CONCLUSION

Based on the results obtained during the present study, it was determined that Pan 7 displayed the highest diversity and abundance of nauplii of all the pans assessed, with a significantly high rate of hatching success for Branchiopoda (Anostraca) nauplii that peaked at Day 7 of the inundation period which was not observed for other pans assessed, and a progressive increase in hatching rate of Ostracoda nauplii throughout the study period that was also noted at Pan 8 Branchiopoda (Anostraca). Of additional interest was that many pans within the study area exhibited similar temporal hatching success for Branchiopoda (Anomopoda), with an initial hatching that decreased, followed by a second phase of hatching that seemingly extended past the 30-day inundation period.

Of relevance was that New Largo Pan and Pan 6 displayed little to no hatching success, thus showing little similarity with other pans assessed as part of the study. Based on available data and interpretation from relevant literature, it is likely that New Largo Pan and Pan 6 are associated with differing anthropogenic disturbances that was impacting the viability of the egg banks within each pan's basin. Notably, potential mining-related impacts associated with New Largo Pan based on sediment salt retention appear to have had a significant impact on the viability of the potential egg bank within the sediment, whereas surrounding agricultural land use and activities that took place within the pan's basin were likely impacting the viability of the egg bank for Pan 6.

It must however be stressed that, with the exception of Pan 6, all pans assessed during the present study were sampled in an inundated state, with the result that several sampling restrictions were experienced. Nevertheless, results obtained do provide some insight into the viability of the egg banks within the selected pans as well as anthropogenic activities and their impacts on such egg banks.

6. BIBLIOGRAPHY

Allan, G.D., Seaman, M.T. & Kaletja, B. (1996). The Endorheic Pans of South Africa. In: *Wetlands in South Africa*

Darwall, W.R.T., Smith, K.G., Tweddle, D. & Skelton, P. (2009). *The status and distribution of freshwater biodiversity in Southern Africa*. Gland, Switzerland: IUCN and Grahamstown, South Africa: SAIAB

Henri, A., Ferreira, M., Malherbe, W., de Necker, L., Wepener, V. & van Vuren, J. (2014). *The Hatching Success of Egg Banks of Selected Endorheic Wetland (Pan) Fauna and a Suggested Water Quality Classification of Pans*. WRC Report No. 2190/1/14. Water Research Commission, Pretoria, South Africa

Kleynhans, C.J., Thirion, C.A., Moolman, J. & Gaulana, L. (2007). *A Level II River Ecoregion classification System for South Africa, Lesotho and Swaziland*. Report No. N/0000/00/REQ0104. Department of Water Affairs and Forestry - Resource Quality Services, Pretoria, South Africa

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. & Goge, C. (2008). *WET-Health: A technique for rapidly assessing wetland health*. WRC Report No. TT340/09. Water Research Commission

Mbona, N., Job, N., Smith, J., Nel, J., Holness, S., Memani, S. & Dini, J. (2015). *Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands*. WRC Report No TT 614/14. Water Research Commission, Pretoria, South Africa

Meyer-Milne, E., Brendonck, L. & Pinceel, T. (2022). Egg banks in dryland wetlands provide information on the diversity and vulnerability of branchiopod communities along a longitudinal aridity gradient. *Wetlands Ecology and Management* 2

Nel, J.L., Driver, A., Strydom, N.A., Maherry, A.M., Peterson, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H., Swartz, E.R. & Smith-Adao, L.B. (2011). *Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources.* WRC Report No. TT 500/11. Water Research Commission, Pretoria, South Africa

Nel, J.L., Maree, G., Roux, D., Moolman, J., Kleynhans, C.J., Sieberbauer, M. & Driver, A. (2004). *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 2: River Component*. CSIR Report Number ENV-S-I-2004-063. Council for Scientific and Industrial Research, Stellenbosch

Scott, L. (2013). Freshwater Ecoregions of the World: Southern Temperate Highveld. http://www.feow.org/ecoregions/details/575. Accessed 05/06/2017

Appendix A: Curriculum Vitae of Specialist

Name:	**Byron Grant Pr.Sci.Nat.**
Company:	Ecology International (Pty) Ltd
Years of Experience:	20 years
Nationality:	South African
Languages:	English (mother tongue), Afrikaans
SACNASP Status:	Professional Natural Scientist (Reg. No. 400275/08)
Email address:	byron@ecologyinternational.net
Contact Number:	(+27) 82 863 0769

EDUCATIONAL QUALIFICATIONS

- B. Sc. (Botany & Zoology), Rand Afrikaans University (1997 - 1999);
- B. Sc. (Honours) Zoology, Rand Afrikaans University (2000);
- M. Sc. (Aquatic Health) *cum laude,* Rand Afrikaans University (2001 – 2004);
- Introduction to quantitative research using sample surveys, Rand Afrikaans University (2004);
- SASS5 Field Assessment Accreditation in terms of the River Health Programme, Department of Water Affairs (2005 – present);
- Monitoring Contaminant Levels: Freshwater Fish (*awarded Best Practice*), University of Johannesburg (2005);
- EcoStatus Determination training workshop, Department of Water Affairs and Forestry (2006);
- Multi-disciplinary roles in defining EcoStatus and setting flow requirements during an ecological reserve study, Department of Water Affairs (2008);
- Water Use Licence Applications: Section 21 (c) and (i) training workshop, Department of Water Affairs (2009);
- Advanced Wetland Course, University of Pretoria (2010) (*awarded with Distinction*);
- Determination of the Present Ecological State within the EcoClassification process, University of the Free State (2011);
- River Health Programme Training Workshop, Department of Water and Sanitation – Resource Quality Information Services (2014);
- Tools for Wetland Assessments, Rhodes University (2015);
- RHAM (Rapid Habitat Assessment Model) Training Workshop, Department of Water and Sanitation – Resource Quality Information Services (2015);
- Wetland, River and Estuary Buffer Determination Training Workshop, Institute for Natural Resources (2015);
- Fish Invertebrate Flow Habitat Assessment Model (FIFHA), Department of Water and Sanitation – Resource Quality Information Services (2015);
- Wetland Plant Taxonomy, Water Research Commission (2017);
- Vegetation Response Assessment Index (VEGRAI), Mr. James MacKenzie (co-developer of index) (2018);
- Wetland Soils, Agricultural Research Council in association with the University of the Free State (2018);

- Hydropedology and Wetland Functioning (Short course), Terrasoil Science in association with the Water Business Academy (2018).
- HCV (High Conservation Value) Assessor Training Course, Astra-Academy (2019)

KEY QUALIFICATIONS

- **Project Management:**
  Project management and co-ordination of specialist-related projects, including:
  - Aquatic assessments (see below);
  - Floral and Faunal assessments:
    - Design and implementation of monitoring programmes;
    - Baseline ecological assessments
    - Ecological impact and mitigation assessments;
    - Rescue and relocation assessments;
    - Alien and invasive vegetation management plans;
  - Wetland assessments:
    - Design and implementation of wetland monitoring programmes;
    - Wetland delineation studies;
    - Wetland Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) determination assessments;
    - Wetland management plans;
    - Wetland impact and mitigation assessments;
    - Wetland offset strategies and assessments;
    - Wetland Reserve Determinations;
  - Water quality studies;
  - Dust monitoring studies;
  - Ecological Risk Assessments;
  - Biodiversity Action Plans (BAP);
  - Biodiversity Management Strategies;
  - Water Research Commission projects.

- **Specialist Assessments:**
  Extensive experience in conducting specialist aquatic assessments and providing specialist ecological input, including:
  - Baseline aquatic biodiversity assessments, including the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) according to latest methodology;
  - Aquatic impact and mitigation assessments;
  - Design, management and implementation of biological monitoring programmes for the aquatic environment;
  - Protocol development;
  - Fish kill investigations;
  - Ecological Flow Requirements;
  - Aquatic toxicity assessments;
  - Bioaccumulation studies;
  - Human health risk assessments for the consumption of freshwater fish;

- Surface water quality studies;
- Application of various monitoring indices, including the South African Scoring System version 5 (SASS5), the Macro-Invertebrate Response Assessment Index (MIRAI), the Invertebrate Habitat Assessment System (IHAS), the Index for Habitat Integrity (IHI), the Rapid Habitat Assessment Model (RHAM), the Fish Assemblage Integrity Index (FAII), the Fish Response Assessment Index (FRAI), the Physico-chemical Assessment Index (PAI), Riparian Vegetation Response Index (VEGRAI), Fish Invertebrate Flow Habitat Assessment Model (FIFHA), determination of EcoStatus, etc.;
- Eco-Conditional Requirement (Eco-0) assessments for Green Star Accreditation;
- Watercourse Protection Plans relating to Eco-Conditional Requirement (Eco-0) for Green Star Accreditation.

- **Specialist Review:**

  Specialist and independent review of impact assessment and management reports for all sectors of government, civil society and the scientific and legal fraternity:
  - Member of Technical Advisory Group for the Green Building Council of South Africa;
  - Member of Reference Groups for Water Research Commission;
  - Peer review of specialist biodiversity reports;
  - Peer reviewer for African Journal of Aquatic Science.

PROFESSIONAL REGISTRATIONS

- South African Council for Natural Scientific Professions (SACNASP):
  - Professional Natural Scientist (Reg. No. 400275/08): Aquatic Science, Ecological Science & Zoological Science
  - Professional Advisory Committee (Deputy Chair): Aquatic Science Field of Practice
  - Professional Advisory Committee (Member): Wetland Science Sub-Field of Practice

Other Society Memberships

- South African Society of Aquatic Scientists
- South African Wetland Society (Founding Member)

Other Memberships

- Aquatox Forum
- Gauteng Wetland Forum
- Klipriviersberg Sustainability Association – Development Integration Team
- Yellowfish Working Group

COUNTRIES OF EXPERIENCE

- South Africa
- Lesotho
- Swaziland
- Mozambique
- Ghana
- Namibia
- Cameroon
- Rwanda
- Zimbabwe

SPECIALIST WORKSHOP PARTICIPATION

- Wetland and Watercourse Buffers Determination workshop. Project for the Department of Water Affairs, Sub-directorate: Water Abstraction and Instream Use;
- NEMBA category 2 alien fish species mapping for Gauteng, Limpopo and Northwest Provinces and a national review workshop, South African Institute for Aquatic Biodiversity (SAIAB);
- National Freshwater Ecosystem Priority Areas project – Specialist Input Workshop, South African National Biodiversity Institute (SANBI);
- Biodiversity Offsets Strategy workshop, Gauteng Department of Agriculture, Conservation and Environment (GDACE);
- Minimum Requirements for Biodiversity Assessments (Version 2) workshop, Gauteng Department of Agriculture, Conservation and Environment (GDACE);
- Gauteng Nature Conservation Bill, Gauteng Department of Agriculture and Rural Development (GDARD);
- Mainstreaming Biodiversity in Mining Training Workshop, SANBI's Grasslands Programme (in partnership with the South African Mining and Biodiversity Forum and the Departments of Environmental Affairs and Mineral Resources);
- National Biodiversity Offset Workshop, Department of Environmental Affairs (DEA), Endangered Wildlife Trust (EWT);
- Accreditation/certification of Wetland Practitioners Workshop, South African Wetland Society.

PRESENTATIONS AND PUBLICATIONS

Brink, K., Gough, P., Royte, J.J., Schollema, P.P. & Wanningen, H. (eds). (2018). From Sea to Source 2.0. Protection and restoration of fish migration in rivers worldwide. World Fish Migration Foundation. *Contributing author.*

Grant, B., Huchzermeyer, D. & Hohls, B. (2014). *A Manual for Fish Kill Investigations in South Africa.* WRC Report No. TT 589/14. Water Research Commission, Pretoria.

Grant, B., Hohls, B. & Huchzermeyer, D. (2013). Development of a Fish Kill Protocol for South Africa. South African Society for Aquatic Scientists - 2013 Conference, Arniston. Oral presentation.

Mlambo, S.S., van Vuren, J.H.J., Basson, R. & Grant, B. (2010). Accumulation of hepatic HSP70 and plasma cortisol in *Oreochromis mossambicus* following sub-lethal metal and DDT exposure. *African Journal of Aquatic Science* 35(1): 47-53.

Grant, B., van Vuren, J.H.J. & Cronjé, M.J. (2004). HSP 70 response of *Oreochromis mossambicus* to Cu^{2+} exposure in two different types of exposure media. South African Society for Aquatic Scientists – 2004 Conference, Cape Town. Poster presentation.

EMPLOYMENT EXPERIENCE

- **Ecology International:** Date: June 2017 - Present

  Role: Director & Principal Biodiversity Specialist
  - Management and co-ordination of staff members and specialists
  - Project management on various scales for environmental and biodiversity specialist-related services;
  - Co-ordinating, implementing and conducting specialist studies for various types of projects, including:
    - Protocol development;
    - Monitoring programmes;
    - Environmental Impact Assessments;
    - Strategic-level assessments (e.g. Strategic Environmental Assessments, Environmental Management Frameworks, State of the Environment Reports, etc.);
    - Biodiversity Management Plans, Biodiversity Action Plans, etc.;
  - Acting as an information source concerning environmental legislation;
  - Development of terms of reference and project proposals;
  - Quality control of specialist reports; and
  - Interfacing with clients in the consulting, mining, and government industries.

- **Independent Specialist:** Date: February 2017 – May 2017

  Role: Principal Biodiversity Specialist
  - Project management on various scales for biodiversity specialist-related services;
  - Co-ordinating, implementing and conducting specialist studies for various types of projects, including:
    - Protocol development;
    - Monitoring programmes;
    - Environmental Impact Assessments;
    - Strategic-level assessments (e.g. Strategic Environmental Assessments, Environmental Management Frameworks, State of the Environment Reports, etc.);
    - Biodiversity Management Plans, Biodiversity Action Plans, etc.;
  - Acting as an information source concerning environmental legislation;
  - Development of terms of reference and project proposals;
  - Quality control of specialist reports; and
  - Interfacing with clients in the consulting, mining, and government industries.

- **GIBB** (June 2015 – January 2017)

  Role: Principal Specialist
  - Project management on various scales for specialist-related services;
  - Co-ordinating, implementing and conducting studies for various types of projects, including:
    - Monitoring programmes;

    - Environmental Impact Assessments;
    - Strategic-level assessments (e.g. Strategic Environmental Assessments, Environmental Management Frameworks, State of the Environment Reports, etc.);
    - Biodiversity Management Plans, Biodiversity Action Plans, etc.;
- Acting as an information source concerning environmental legislation;
- Development of terms of reference and project proposals;
- Quality control of specialist reports; and
- Interfacing with clients in the consulting, mining, and government industries.

- **Strategic Environmental Focus** (August 2009 – June 2015)
  Role: Principal: Specialist Services
  - Management and co-ordination of staff members and specialists;
  - Project management on various scales for specialist-related services;
  - Co-ordinating, implementing and conducting studies for various types of projects, including:
    - Monitoring programmes;
    - Environmental Impact Assessments;
    - Strategic-level assessments (e.g. Strategic Environmental Assessments, Environmental Management Frameworks, State of the Environment Reports, etc.);
    - Biodiversity Management Plans, Biodiversity Action Plans, etc.;
  - Acting as an information source concerning environmental legislation;
  - Development of terms of reference and project proposals;
  - Quality control of specialist reports; and
  - Interfacing with clients in the consulting, mining, and government industries.

- **Strategic Environmental Focus** (March 2009 – July 2009)
  Role: Senior Natural Scientist
  - Project management for water, aquatic and monitoring-related projects;
  - Management and co-ordination of specialists;
  - Co-ordinating, implementing and conducting studies for various water and monitoring-related projects;
  - Acting as an information source concerning environmental legislation;
  - Development of terms of reference and project proposals;
  - Quality control of specialist reports; and
  - Interfacing with clients in the consulting, mining, and government industries.

- **Strategic Environmental Focus** (July 2006 – February 2009)
  Role: Aquatic Specialist
  - Conducting specialist assessments in the field of aquatic ecology and water science.
  - Acting as an information source concerning environmental legislation.

- **ECOSUN cc.** (January 2005 – June 2006)

  Role: Aquatic Scientist
  - Conducting specialist assessments in the field of aquatic ecology and water science.
  - Acting as an information source concerning environmental legislation.

- **Rand Afrikaans University** (January 2003 – December 2004).

  Role: Student Mentor / Post-Graduate Research Assistant
  - Validation of Antibodies for HSP70 Detection in the Freshwater Snail *Melanoides tuberculata* - B.Sc. (Honours) Student (January 2003 – December 2003);
  - The use of genotoxic and stress proteins in the active biomonitoring of the Rietvlei system, South Africa – M.Sc. Student (January 2003 – December 2003);
  - A comparison between Whole Effluent Toxicity (WET) testing and Active Biomonitoring (ABM) as indicators of in stream aquatic health – M.Sc. Student (January 2003 – December 2003);
  - The use of HSP70 and cortisol as biomarkers for heavy metal exposure - M.Sc. Student (January 2004 – December 2005).

- **Rand Afrikaans University** (January 2000 – December 2004)

  Role: Practical Demonstrator
  - Field supervisor for B.Sc. Honours (Zoology);
  - Aquatic Ecology (3rd year);
  - Human Physiology (2nd year); and
  - Ecology and Conservation (for Vista University)

Appendix B: Proof of Professional Registration

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Byron Grant

Registration Number: 400275/08

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following field(s) of practice (Schedule 1 of the Act)

Ecological Science (Professional Natural Scientist)
Zoological Science (Professional Natural Scientist)
Aquatic Science (Professional Natural Scientist)

Effective **29 January 2014** Expires **31 March 2025**

Chairperson

Chief Executive Officer

To verify this certificate scan this code