Wetlands in Working Landscapes

HIGH RISK WETLANDS ATLAS: Reference Guide to the Mpumalanga Mining Decision Support Tool

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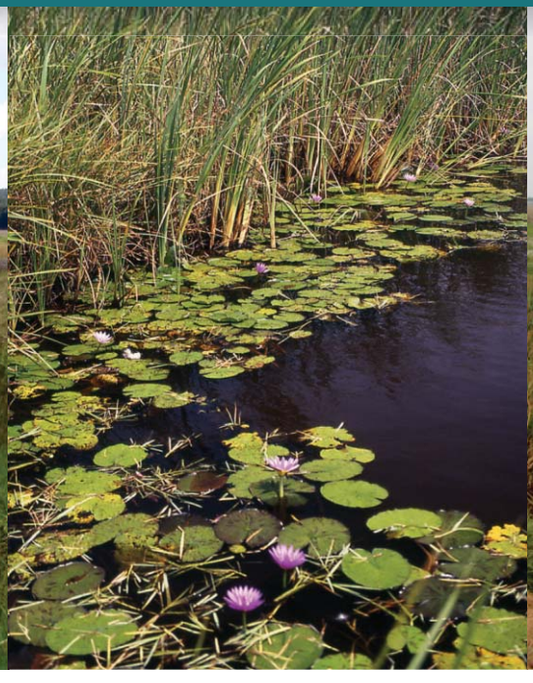
Series Editors: Arno R de Klerk, John Dini, Stephen Holness and Paul Oberholster



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HIGH RISK WETLANDS ATLAS: Reference Guide to the Mpumalanga Mining Decision Support Tool

Report to the
Water Research Commission

by

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The publication of this report emanates from a project entitled *Limiting and mitigating the impact of coal mines in wetlands* (WRC Project No. K5/2230/3).

This report is supplemented with a DVD at the back that contains the high risk wetlands atlas, software to use the tool and underlying spatial data.

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EXECUTIVE SUMMARY

By virtue of their positions in the landscape and relationship to drainage networks, wetlands are frequently impacted by coal mining activities, especially through opencast mining methods. These impacts will be ongoing, since coal is a strategic resource and will continue to be mined extensively to support the country's development. At the same time, however, regulatory authorities and the public now have an improved understanding of the range of economic, social, ecological and hydrological costs of wetland loss and degradation. There is now far more pressure to ensure that mines avoid, minimise, rehabilitate, and where necessary offset their impacts on wetlands. Thus, in 2011 the CSIR and SANBI embarked on a three year cooperative applied research project, funded by the Coaltech Research Association, with supplementary funding by the SANBI Grasslands Programme and Working for Wetlands for particular components of the work. The project's focus was on developing mechanisms for limiting and mitigating the impact of coal mining on wetlands, and providing guidelines to the coal mining industry and regulators in this regard. The WRC expressed interest in supporting this project to expand on its original scope and thereby improve its impact, by allowing further work to be undertaken that was not part of the original scope of the Coaltech funding.

One of the key project aims was to improve the knowledge and use of appropriate spatial information to guide both mining companies and regulators in their planning and decision-making. The project aimed to compile a High Risk Wetlands Atlas ("atlas") to guide both mining companies and regulators with regard to high risk wetlands and associated landscapes. The atlas aimed to identify key wetlands landscapes in the grassland biome of Mpumalanga that are particularly important or irreplaceable in terms of biodiversity, water resource management and other ecosystem services. This report serves as a reference guide to the content and use of the High Risk Wetlands Atlas. The data DVD associated this report contains this High Risk Wetlands Atlas, the required software to use the tool, as well as the underlying spatial data for those use their own GIS systems.

The report aims to provide the required information for users to install the atlas and access the underlying spatial data, as well as to provide supporting information on the preparation and content of the spatial data. It particular it provides details on the methodology used to develop four new spatial data layers relevant for helping the mining sector limit and mitigate its impact on wetlands in Mpumalanga. These layers are:

- A revised spatial layer for the Mining and Biodiversity Guideline (DEA et al., 2013) which has been updated to include the new Mpumalanga Biodiversity Sector Plan (MTPA, 2014), updated Protected Area data, revised Strategic Water Source data (Nel et al., 2013a), and revised Freshwater Ecosystem Protection Area (FEPA) and wetland data for Mpumalanga (Mbona et al., 2014).
- A disaggregated set of the underlying spatial data for the Mining and Biodiversity Guideline (DEA et al., 2013), which allow one to identify the specific features that triggered the categories in the summary data.
- An interpreted version of the Mining and Biodiversity Guideline spatial summary layer (DEA et al., 2013), which divides the broad national categories based on local landcover and the features found at a site. The layer quickly summarizes probable low, medium and high value areas within each category on the Mining and Biodiversity Guideline Spatial layer. The assessment is relative to all sites in Mpumalanga.
- An Ecological Infrastructure for Water analysis of Mpumalanga, which incorporates a combined Ecological Infrastructure for Water Supply summary layer as well as individual layers for:
    - Ecological Infrastructure for Water Production and Flow Augmentation Analysis.
    - Ecological Infrastructure for Flood Attenuation.
    - Ecological Infrastructure for Water Quality.
    - Ecological Infrastructure for Erosion Control.

In addition, the atlas provides access to other key data that were not developed by the project but that are very useful for mining planners such as the new Mpumalanga Biodiversity Sector Plan (MTPA, 2014), updated Protected Area data, revised Strategic Water Source Data (Nel et al., 2013a), revised Freshwater Ecosystem Protection Area (FEPA) data and the new wetland data for Mpumalanga (Mbona et al., 2014).

ACKNOWLEDGEMENTS

The High Risk Wetlands Atlas was primarily funded by the Coaltech Research Association, with additional support to the integrated programme of work being provided by the Global Environment Fund and the Water Research Commission. The development process for the High Risk Wetlands Atlas was supported by a programme of work focusing on mining implemented by the SANBI Grasslands and Ecological Infrastructure Programmes. The Coaltech and WRC projects were jointly implemented by SANBI and the CSIR. The contributions of each of the funding organizations are gratefully acknowledged. However, this does not imply any specific endorsement by any of these organizations. Furthermore, none of these organizations was involved in the compilation of this tool.

The development of this tool was informed through discussions with a wide range of stakeholders whom we would like to acknowledge for their contributions. It is not possible to list everyone. However, we would like specifically to acknowledge:

- Anthea Stephens; SANBI Grasslands Programme
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- Jeanne Nel; CSIR
- Jeffrey Manuel; SANBI
- Jo Burgess; WRC
- Johann Beukes; Coaltech
- Mandy Driver; SANBI
- Mervyn Lötter; Mpumalanga Tourism and Parks Agency

The Reference Group consisted of Jo Burgess and Bonani Madikizela (Water Research Commission), Andre Beetge (SANBI), Johann Beukes (Coaltech), Vik Cogho (Glencore), Clinton Lee (South 32), Reginald Mabalane (Chamber of Mines), Wendy Mey (South32), Ritva Mühlbauer (Anglo Coal), Meera Ormea (Eskom), Martin Platt (Anglo Coal), Wietsche Roets (Department of Water and Sanitation), Rod Schwab (Department of Water and Sanitation), Koos Smit (Exxaro), Graham Trusler (Digby Wells Environmental), Annalise van Zyl (Glencore), Pieter Viljoen (Department of Water and Sanitation), and Elmien Webb (Glencore).

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DWA	Department of Water Affairs (formerly DWAF; now DWS)
DWS	Department of Water and Sanitation (formerly DWA)
EI	Ecological Infrastructure
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information Systems
NBA	National Biodiversity Assessment
NEMA	National Environmental Management Act
NEMPAA	National Environmental Management: Protected Areas Act
NFEPA	National Freshwater Ecosystem Priority Areas
SAMBF	South African Mining and Biodiversity Forum
SANBI	South African National Biodiversity Institute
WRC	Water Research Commission

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CHAPTER 1: BACKGROUND

1.1 INTRODUCTION

By virtue of their positions in the landscape and relationship to drainage networks, wetlands are frequently impacted by coal mining activities, especially opencast methods. These impacts will be ongoing, since coal is a strategic resource and will continue to be mined extensively to support the country's development. At the same time, however, regulatory authorities and the public now have an improved understanding of the range of economic, social, ecological and hydrological costs of wetland loss and degradation. The rules of the game have changed, with regulators increasingly insisting that mines avoid, minimise and mitigate their impacts on wetlands, and internalise the true costs of wetland loss into their balance sheets. Many mining proposals entailing large-scale wetland loss have encountered delays in licence approvals, unrealistic rehabilitation commitments and unwelcome public and media attention. As a result, the coal mining sector has realised that it needs to proactively and systematically address the business risk posed by its impact on wetlands.

Thus, in 2011 the CSIR and SANBI embarked on a three year cooperative applied research project, funded by the Coaltech Research Association. Supplementary funding was provided by the SANBI Grasslands Programme and Working for Wetlands, for particular components of the work. The project's focus was on developing mechanisms for limiting and mitigating the impact of coal mining on wetlands, and providing guidelines to the coal mining industry and regulators in this regard. The WRC expressed in supporting this project to expand on its original scope and thereby improve its impact, by allowing further work to be undertaken that was not part of the original scope of the Coaltech funding.

One of the key project aims was to improve the knowledge and use of appropriate spatial information to guide both mining companies and regulators in their planning and decision-making. The project aimed to compile a spatial decision support tool to guide both mining companies and regulators with regard to high risk wetlands and associated landscapes. The atlas aimed to identify key wetlands or catchments in the grassland biome of Mpumalanga that are particularly important or irreplaceable in terms of biodiversity, water resource management and other ecosystem services.

This report serves as a reference guide to the content and use of the High Risk Wetlands Atlas. The report aims to provide the required information for users to install the atlas and access the underlying spatial data, as well as to provide supporting information on the preparation and content of the spatial data.

1.2 PROJECT AIMS

The following were the aims of the project:

1. To improve planning and decision-making around coal mining by developing products, for both regulators and mining companies, that highlight high risk wetlands and ecosystem services.
2. To improve the science and practice of wetland rehabilitation in a coal mining context, by improving current wetland rehabilitation guidelines with particular focus on post-mining landscapes and mitigating mining pollutants including Acid Mine Drainage.
3. To enhance the quality of planning and regulatory processes by providing improved data on resource economics and risk assessment with respect to wetlands and coal mining.
4. To compensate for unavoidable residual loss of wetlands due to coal mining by developing, testing and submitting to DWS for approval a systematic framework for wetland offsite mitigation, as well as identifying wetland offset receiving areas.

The High Risk Wetlands Atlas is largely focussed on Aim 1, but is also relevant for Aims 3 and 4.

1.3 SCOPE AND LIMITATIONS

1.3.1 Scope

The High Risk Wetlands Atlas (or "atlas") aims to improve planning and decision-making around coal mining by providing a single and easily accessible access point to the most appropriate spatial information which should be taken into account when making decisions on mining related projects. In particular it aims to highlight high risk wetlands and key areas for the delivery of ecosystem services.

The atlas is closely linked to, and builds onto, work undertaken for the:

- Mining and Biodiversity Guidelines (DEA *et al.*, 2013) which set the framework for identifying high risk sites. The spatial data for the guidelines was updated using revised datasets. The layer was disaggregated to allow the key features at a site to be identified, and a refined version was developed to quickly summarize probable low, medium and high value areas within each category on the Mining and Biodiversity Guideline Spatial layer.
- The WRC project "Supporting better decision-making around coal mining in the Mpumalanga Highveld through the development of mapping tools and refinement of spatial data on wetlands" (Mbona et al., 2014) which refined the mapping of wetlands in the Mpumalanga Highveld. This data was used to revise the identified Freshwater Ecosystem Protection Areas (FEPA) for Mpumalanga (Nel *et al*., 2011a,b).

The atlas incorporates key spatial data from the:

- The revised terrestrial and aquatic layers from the Mpumalanga Biodiversity Sector Plan 2014 (MTPA, 2014). This plan updates the previous conservation plan from the province.
- The revised Protected Area layers for the province reflecting recent declarations.
- The revised layer of Protected Area Expansion Priorities based on the new Mpumalanga Biodiversity Sector Plan 2014 (MTPA, 2014).
- The new Strategic Water Source Areas data for Mpumalanga (Nel et al., 2013a). This data replaces the previous High Water Yield dataset.
- A new integrated landcover map for the province incorporating the new landcover from the Mpumalanga Biodiversity Sector Plan 2014 (MTPA, 2014), supplemented with additional dam and erosion gully data.

The project produced a map of water related Ecological Infrastructure for Mpumalanga. Key areas identified include:

- Combined Ecological Infrastructure for Water.
- Ecological Infrastructure for Water Production and Flow Augmentation Analysis.
- Ecological Infrastructure for Flood Attenuation.
- Ecological Infrastructure for Water Quality.
- Ecological Infrastructure for Erosion Control.

1.3.2 Limitations

All spatial data are only representations of reality. In some areas, specific spatial datasets will very closely represent the situation on the ground, while in other areas the data are less accurate. The differences between the spatial datasets and the real world can have a number of different sources or causes:

- Scale issues: Specific datasets may be reasonable representations of the actual landscape at a broader scale (e.g. at 1:50 000) but may be a poor representation at a fine scale (e.g. 1:10 000). This does not mean that the broader data (and its associated "inaccurate" boundaries) are not useful at a fine scale, but rather that they need to be carefully interpreted. For example, a national level dataset may have identified a specific wetland as important, but when one examines the boundaries of the wetland at a site level, the boundaries do not align. In this case the national level dataset may not be very useful for site level delineation of the wetland (i.e. to delineate a wetland accurately a wetland specialist may need to take soil samples to identify areas with seasonally saturated soils and map the exact distributions of wetland associated plants) but this would not reduce the usefulness of the national data in indicating whether or not the wetland was important. The national

values (e.g. that the wetland was a selected priority FEPA wetland or that it was a Critically Endangered wetland type) would then need to be applied to the more accurately delineated wetland boundaries on the ground. Depending on how the datasets are being used, it may be necessary to undertake more detailed desktop (e.g. from Google Earth or other satellite imagery) or field based mapping.

- Classification issues: Spatial dataset of contain classification errors, especially when the dataset is based on remote sensing. For example, in a landcover dataset, an area of natural/intact habitat could be misidentified as a degraded area. Conversely, a highly impacted area may be wrongly classified as natural. A consequence of this is that an analysis based on this dataset could indicate that the site had lower or higher value than was actually the case. Depending on how the datasets are being used, it may be critical that field assessments are undertaken to rectify these errors.
- Omissions and incomplete datasets: The atlas was developed using appropriate methods and the best available data at the time of its development. However, current scientific knowledge of key aspects such as the distribution of certain threatened species remains incomplete. Again, site level verification of actual wetland features and their associated biodiversity (e.g. the presence of key threatened species) is critical.
- Errors: Although every attempt has been made to ensure the datasets are accurate, errors can creep into GIS datasets especially if these are very large.

It is therefore critical to understand that:

- The atlas does not replace the underlying datasets. These datasets and analyses are updated over time, and hence it is important to check that you have the most up to date dataset. This is particularly important if you are using the data or GIS viewer on the DVD supplied with this report. This data is designed to supplement the main distribution point for the atlas, which is online interactive website maps that will be served from http://bgis.sanbi.org. Unlike the DVD, which is published on a particular date, the data on the website will be kept current. Spatial data will be served at both http://bgis.sanbi.org and www.wrc.org.za.
- The atlas does not in itself give or limit any rights (e.g. development rights) or give any guarantee that an environmental application will be approved or disapproved. The atlas is only a compilation of existing datasets and some secondary analyses (e.g. of ecological infrastructure). It contains information that is useful to support sensible decision-making, but does not make any decisions.
- The atlas does not replace the need for site assessments, particularly for Environmental Impact Assessments. Although it is based on the appropriate a fine-scale systematic biodiversity planning, this does not remove the need for on-site verification of the identified priority features.
- The atlas is designed to be used at a scale of approximately 1:50 000. Although it can be used at a finer scale, this requires specialist interpretation of the specific features.
- The atlas was developed using appropriate methods; and uses the best available data at the time of its development. However, current scientific knowledge of key aspects such as the distribution of certain threatened species remains incomplete.
- Land use change in the province is rapid and on-going, and results in biodiversity losses. This may result in additional areas being designated as important (e.g. as Critical Biodiversity Areas in future iterations of the provincial conservation plan).

CHAPTER 2: INSTRUCTIONS FOR INSTALLING THE GIS VIEWER AND ACCESSING THE DATA

2.1 INTRODUCTION

The High Risk Wetlands Atlas can be accessed in three ways:

- The main distribution point for the atlas is via the online interactive website maps that will be served from http://bgis.sanbi.org.
- Using the GIS viewer provided on a DVD at the back of this report. This GIS Viewer provides an easy to use interface for viewing and printing the maps.
- Direct use of the data in the users own GIS system. The DVD includes the key GIS data layers in ESRI Grid and shapefile format for GIS users to display in their own systems. However, it is suggested that users access the shapefiles from **http://bgis.sanbi.org** to ensure they are obtaining the most up to date version of the data. Spatial data will also be served at www.wrc.org.za.

2.2 ACCESSING THE HIGH RISK WETLANDS ATLAS VIA BGIS

The main distribution point for the atlas is via the online interactive website maps that will be served from http://bgis.sanbi.org. It is strongly recommended that the atlas and the data is accessed via this website, as this will both ensure that you have access to the full functionality of the atlas and, more importantly, that you are utilizing the most up to data version of the data. Spatial data will also be served at www.wrc.org.za.

2.3 INSTALLING AND USING THE GIS VIEWER

The High Risk Wetlands Atlas is provided on a DVD at the back of this report. This GIS Viewer provides an easy to use interface for viewing and printing the maps (Figure 1). The GIS viewer is designed to supplement the main distribution point for the atlas, which is online interactive website maps that will be served from **http://bgis.sanbi.org**. The GIS viewer is only intended for users without rapid online access. Even when using the GIS viewer, certain background data layers are only available when you are connected to the internet.

2.3.1 Basic Instructions:

In order to install the GIS viewer and open the atlas, you need to do the following:

- Copy the entire DVD onto your hard drive, or download the Atlas software from www.wrc.org.za.
- Unzip the Arcreader file in the folder Arcreader software and install it on your computer.
- Detailed Arcreader instructions and tutorials can be downloaded from the www.esri.com website.
- Users should start ArcReader and then open the file ..\ mpumalanga pmf\Mpumalanga Atlas 2014.pmf. If you directly open the pmf file (without opening Arcreader first), depending on your computer, you may have to use the file drop-down menu to navigate to, and then open the pmf file again. This is a glitch in the program, but does not impact on its functionality.

Once you are in the GIS viewer and have the atlas open, you can make use of the help functions under the help dropdown menu, or you can just freely explore the GIS viewer's functionality as the underlying files are not impacted by your exploration (Just re-open the pmf if you want to start again). The key functions available in the GIS viewer are summarized in Table 1.

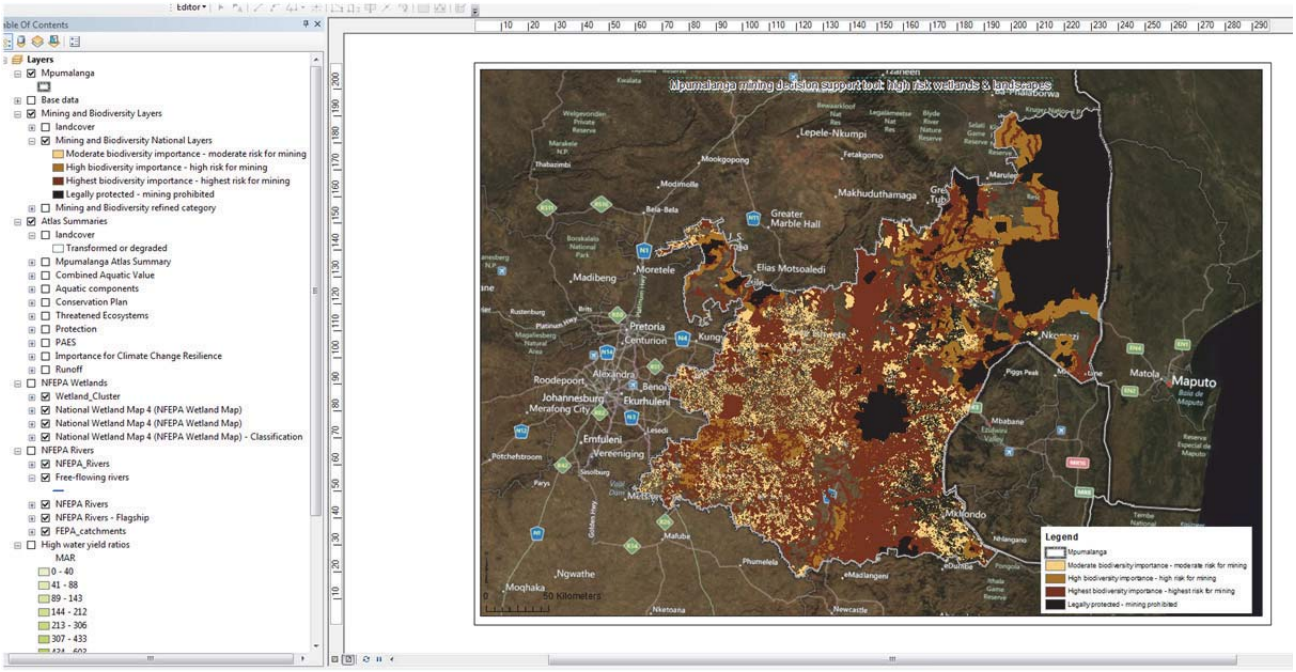
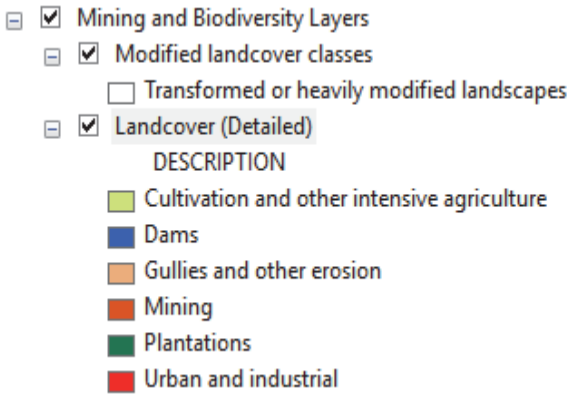


Figure 1: Screenshot of the GIS Viewer.

2.4 DIRECTLY ACCESSING THE GIS DATA

The DVD also includes the key GIS data layers in ESRI Grid and shapefile format for GIS users to display in their own systems. These layers, along with layer files to allow convenient display are in the folder Mpumalanga Atlas 2015/ GIS_Viewer/Data Mpumalanga. It is beyond the scope of this report to provide instructions on the direct use of the GIS data. If you are unfamiliar with GIS it is suggested that you use the interactive website maps that will be served from http://bgis.sanbi.org or the GIS Viewer which does not require any specific technical skills to use. Although the key GIS layers have been provided on the DVD, these obviously cannot be kept updated, therefore it is recommended that users access the shapefiles from http://bgis.sanbi.org to ensure they are using the current version of the data. Spatial data will also be available at www.wrc.org.za.

Table 1: Key functions available in the GIS viewer.

Buttons	Use
	These small icons at the bottom of the screen used to toggle between a "data view" and "layout view" where you can produce printable map products of your area. You can also toggle between these views using the dropdown menu under "View". The arrows redraw the map.
	If you are in the "data view" use these data view zoom in, zoom out, or pan icons to navigate around the map. These buttons will change the size and extent of the area mapped.
	If you are in the "layout view" then you need to use the layout zoom in, zoom out, or pan buttons to navigate. These buttons change how you view the map, but don't impact on any map layout you have created, i.e. they are just temporary effects.
	The data layers can be queried with the "i" button, while the ruler is used to measure distances and areas. The x,y button can be used to go to a specific GPS point.
	Layers can be clicked on or off using the left hand panel. Tick the boxes that you want shown. Note that the layers have been grouped together, so can turn whole groups of layers on or off with the group tickbox, without removing all the individual ticks. This does mean that you may have to tick a group tick box and an individual layer tick box to show an individual layer. The + and – in the panel allows you to minimise or expand the information. Note that if a layer is greyed out, that is only designed to show at specific scales. You may need to zoom in or out to use these layers.
	The print button can be used to print your map layout.
File	Use the export map button under the file menu to export a map image.

CHAPTER 3: MINING AND BIODIVERSITY GUIDELINES (UPDATED AND REFINED SPATIAL DATA)

3.1 INTRODUCTION

The mining industry plays a vital role in South Africa's growth and development. However, if mining is not strategically planned and carefully implemented, it has significant negative impacts on biodiversity and ecosystems, in particular the catchments, rivers and wetlands that produce and deliver water-related services. The *Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector* (DEA et al., 2013) interprets the best available biodiversity knowledge and science in terms of the implications and risks for mining in a practical and user-friendly guideline for integrating relevant biodiversity information into decision-making (Figure 2).

The guideline is a product of the unique collaboration between the mining and biodiversity sectors. The Chamber of Mines and the South African Mining and Biodiversity Forum (SAMBF) initiated the development of this guideline, in partnership with the Department of Environmental Affairs (DEA) and the Department of Mineral Resources (DMR), and with technical input and co-ordination by the South African National Biodiversity Institute (SANBI) Grasslands Programme. Numerous other stakeholders including government, non-governmental organisations (NGOs), the scientific community and the private sector co-operated in its development. The guideline has the highest possible political support, being formally endorsed by the Ministers of both Environmental Affairs and Mineral Resources, as well as the Chief Executive Officer of the Chamber of Mines. The Chamber of Mines has committed its full membership to implementing the guideline.

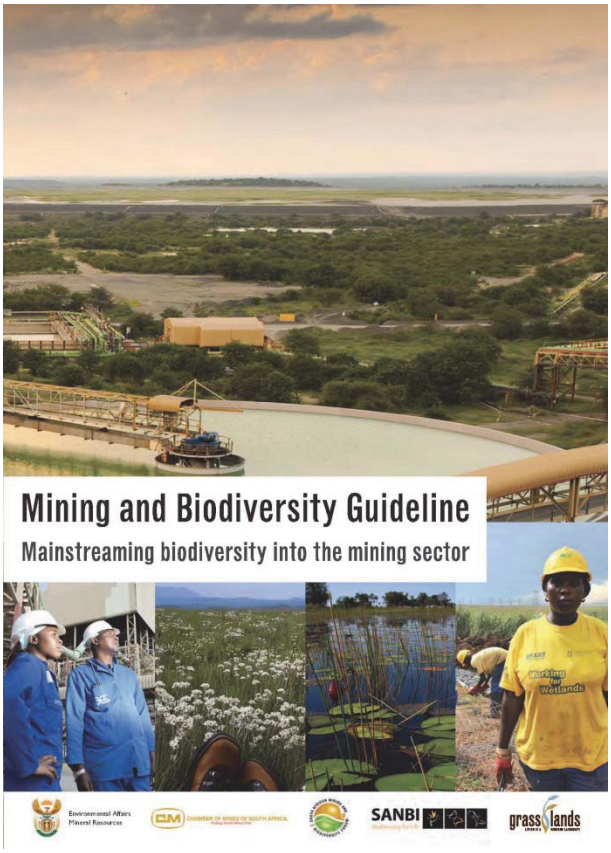


Figure 2: The Mining and Biodiversity Guideline interprets the best available biodiversity knowledge and science in terms of the implications and risks for mining.

The guideline provides a tool to facilitate the sustainable development of South Africa's mineral resources in a way that enables regulators, industry and practitioners to minimise the impact of mining on the country's biodiversity and ecosystem services. It provides the mining sector with a practical, user-friendly manual for integrating biodiversity considerations into planning processes and managing biodiversity during the

operational phases of a mine, from exploration through to closure. From a business perspective, the guideline explains the value for mining companies of adopting a risk-based approach to managing biodiversity. The early identification and assessment of mining impacts on biodiversity provides an opportunity to put in place environmental management plans and actions that reduce risks to biodiversity, people and business. It gives direction on how to avoid, minimise or remedy mining impacts, as part of a thorough environmental impact assessment and robust environmental management programme.

The mitigation of negative impacts on biodiversity and ecosystem services is a legal requirement and should take on different forms depending on the significance of the impact and the area being affected. Mitigation requires proactive planning that is enabled by following the mitigation hierarchy. Its application is intended to avoid disturbance of ecosystems and loss of biodiversity, and where they cannot be avoided altogether, to minimise, rehabilitate or offset negative impacts on biodiversity. This approach lays the groundwork for integrating relevant biodiversity information into decision-making at every stage of the mining life cycle.

The Mining and Biodiversity Guideline provides explicit direction in terms of where mining-related impacts are legally prohibited, where biodiversity priority areas may present high risks for mining projects, and where biodiversity may limit the potential for mining. A primary product of the Mining and Biodiversity Guideline was a map of Biodiversity Priority Areas sensitive to the impacts of mining. The guideline distinguishes between priority areas in relation to their importance from a biodiversity and ecosystem service point of view as well as the implications for mining. This map identified four different categories of Biodiversity Priority Areas sensitive to the impacts of mining (Figure 3, Table 2). For each category, the implications for mining are clearly set out, and a framework for appropriate decision-making in that area is described based on its biodiversity importance and sensitivity to mining (Table 2). The biodiversity priority areas are divided into four categories based on the underlying biodiversity features (e.g. priority wetlands) and the sensitivity of these features to mining impacts. A number of these biodiversity features are wetland related and it is critical that they are appropriately identified. Readers are referred to the guideline (DEA et al., 2013) for detailed descriptions of what the categories mean and how they should be interpreted. It is beyond the scope of the current project to repeat this.

Although the Mining and Biodiversity Guideline Spatial layer is often shown at a national level (as in Figure 3), it is supported by far more detailed GIS information, which is distributed electronically. The usefulness of the spatial data in the Mining and Biodiversity Guideline is only maintained if users can be confident that the layer represents the current best available information. As significant updates and improvements have been made to key spatial datasets in Mpumalanga (e.g. significantly improved wetland data, revised Strategic Water Source Areas, expanded Protected Areas, and a new provincial conservation plan), it was necessary to update the Mining and Biodiversity Guideline spatial data for the province.

The current project undertook three key revisions of the original spatial data for Mpumalanga included in the Mining and Biodiversity Guideline:

- The spatial data for the guidelines was updated using revised datasets.
- The layer was disaggregated to allow the key features at a site to be identified,
- A refined version was developed to quickly summarize probable low, medium and high value areas within each category on the Mining and Biodiversity Guideline Spatial layer.

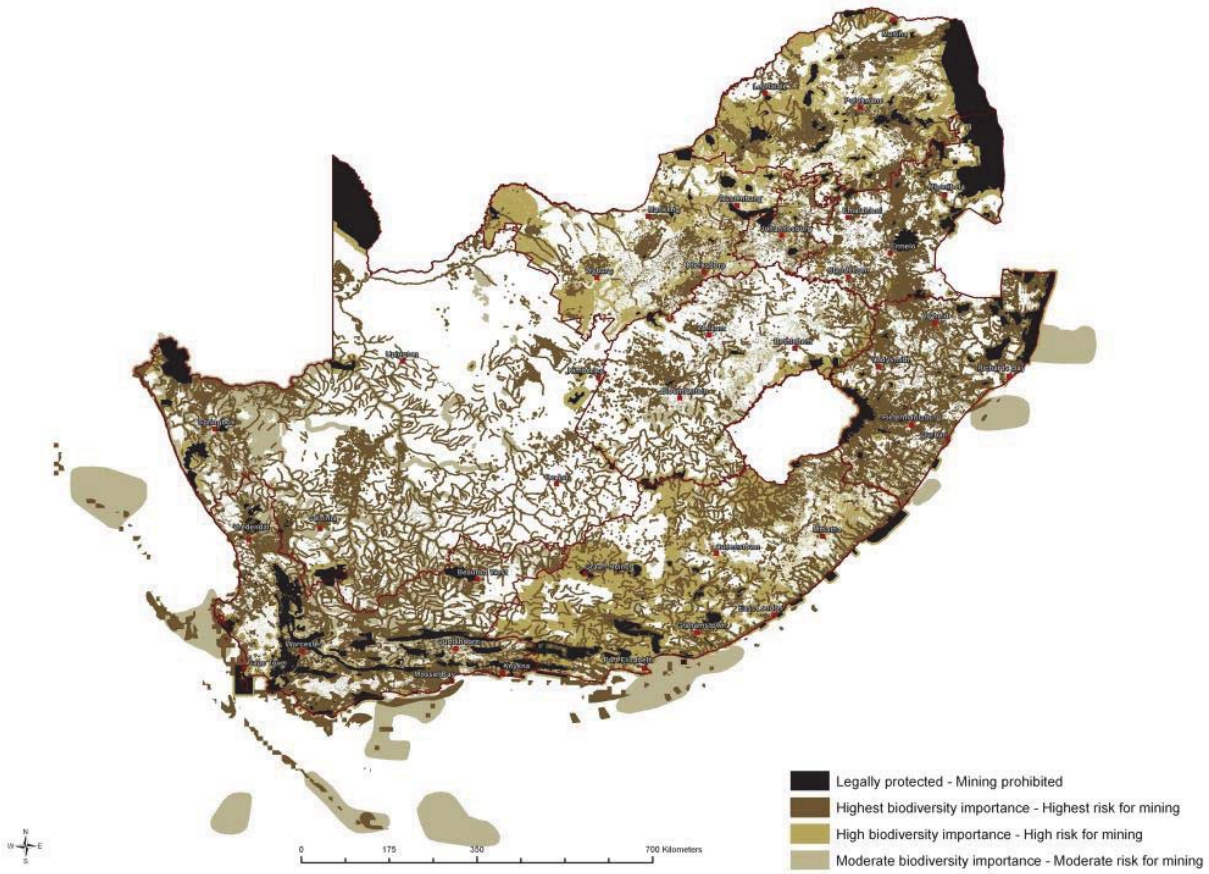


Figure 3: Biodiversity priority areas sensitive to the impacts of mining placed into four categories.

Table 2: Categories of Biodiversity Priority Areas included in the Mining and Biodiversity Guideline.

Category	Biodiversity priority areas	Risk for mining	Implications for mining
A. Legally protected	• Protected areas (including National Parks, Nature Reserves, World Heritage Sites, Protected Environments, Nature Reserves) • Areas declared under Section 49 of the Mineral and Petroleum Resources Development Act	Mining prohibited	Mining projects cannot commence as mining is legally prohibited. Although mining is prohibited in Protected Areas, it may be allowed in Protected Environments if both the Minister of Mineral Resources and Minister of Environmental Affairs approve it. In cases where mining activities were conducted lawfully in protected areas before Section 48 of the Protected Areas Act came into effect, the Minister of Environmental Affairs may, after consulting with the Minister of Mineral Resources, allow such mining activities to continue, subject to prescribed conditions that reduce environmental impacts.
B. Highest biodiversity importance	• Critically endangered and endangered ecosystems • Critical Biodiversity Areas (or equivalent areas) from provincial spatial biodiversity plans • River and wetland Freshwater Ecosystem Priority Areas (FEPAs), and a 1km buffer around these FEPAs • Ramsar Sites	Highest risk for mining	Environmental screening, EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, and to provide site-specific basis on which to apply the mitigation hierarchy to inform regulatory decision-making for mining, water use licences, and environmental authorisations. If they are confirmed, the likelihood of a fatal flaw for new mining projects is very high because of the significance of the biodiversity features in these areas and the associated ecosystem services. These areas are viewed as necessary to ensure protection of biodiversity, environmental sustainability, and human well-being. An environmental impact assessment should include the strategic assessment of optimum, sustainable land use for a particular area will determine the significance of the impact on biodiversity. This assessment should fully take into account the environmental sensitivity of the area, the overall environmental and socio-economic costs and benefits of mining, as well as the potential strategic importance of the minerals to the country. Authorisations may well not be granted. If granted, the authorisation may set limits on allowed activities and impacts, and may specify biodiversity offsets that would be written into licence agreements and/or authorisations.
C. High biodiversity importance	• Protected area buffers (including buffers around National Parks, World Heritage Sites* and Nature Reserves) • Transfrontier Conservation	High risk to mining	These areas are important for conserving biodiversity, for supporting or buffering other biodiversity priority areas, for maintaining important ecosystem services for particular communities or the country as a whole. An environmental impact assessment should include an assessment of optimum, sustainable land use for a particular area and will determine the significance of the impact on biodiversity. Mining options may be limited in these areas, and

Category	Biodiversity priority areas	Risk for mining	Implications for mining
	Areas (remaining areas outside of formally proclaimed protected areas) • Other identified priorities from provincial spatial biodiversity plans • High water yield areas • Coastal Protection Zone • Estuarine functional zone		red flags for mining projects are possible. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations. * Note that the status of buffer areas of WHS is subject to a current intra-governmental process. If this recognises buffers areas as having the same status as the core areas in terms of mining, then the guidelines will need to be revised. The implications for existing mines would need to be clarified.
D. Moderate biodiversity importance	• Ecological support areas • Vulnerable ecosystems • Focus areas for protected area expansion (land-based and offshore protection)	Moderate risk for mining	These areas of moderate biodiversity value. EIAs and their associated specialist studies should focus on confirming the presence and significance of these biodiversity features, identifying features (e.g. threatened species) not included in the existing datasets, and on providing site-specific information to guide the application of the mitigation hierarchy. Authorisations may set limits and specify biodiversity offsets that would be written into licence agreements and/or authorisations.

3.2 UPDATED BIODIVERSITY PRIORITY AREA LAYER FOR THE MINING AND BIODIVERSITY GUIDELINES

3.2.1 Approach to developing the layer

The usefulness of the spatial data in the Mining and Biodiversity Guideline is only maintained if users can be confident that the layer represents the current best available information. As significant updates and improvements have been made to key spatial datasets in Mpumalanga (e.g. significantly improved wetland data, revised Strategic Water Source Areas, expanded Protected Areas, and a new provincial conservation plan), it was necessary to update the Mining and Biodiversity Guideline spatial data for the province:

- The current project updated the original Mining and Biodiversity Guideline spatial data for Mpumalanga using the identical method, but based on these new or revised datasets. The input datasets are described in Section 3.3.
- Scores and categories were determined by overlaying the individual input datasets and assigning a site to the category of the highest (i.e. most sensitive) feature found at a site. Sites often have a number of different features associated with them (e.g. they could be a FEPA, a threatened terrestrial habitat and be in a Protected Area), and hence could trigger a number of different Biodiversity Priority Area categories, and/or trigger the same category a number of times.
- This map is shown in Figure 4. Importantly, land use guidelines associated with many types of Biodiversity Priority Area identified in the Mining and Biodiversity Guidelines (DEA et al., 2013) are only relevant for intact portions of the landscape (See the following bullet point for more details). Figure 5 shows the remaining intact extent of the Biodiversity Priority Areas. This map can be created by displaying the Modified landcover classes layer provided in the atlas over the Biodiversity Priority Areas layer.
- Although the Biodiversity Priority Area map is useful in providing a quick summary of a landscape, it has two major limitations:

- Firstly, the basic Biodiversity Priority Area map does not indicate which feature/s triggered the category. This means that when a detailed evaluation of a site is taking place, it can be difficult to know what the key features are that need to be investigated. This issue is dealt with in the Section 3.3, which provides a disaggregated set of inputs so that all the features at a site can be quickly identified.
- Secondly, the basic Biodiversity Priority Area map does not indicate when many overlapping features are found at a site, and also does not take the current condition (i.e. landcover class) of the site into account. Both these factors limit the ability to quickly assess the likely sensitivity of a site. This issue is dealt with in Section 3.4 which provides a single composite layer to distinguish the likely highest sensitivity sites (i.e. ones with multiply overlapping high sensitivity features that are intact), from the sites with just one high sensitivity feature, and from the sites which may once have been highly sensitive but no longer have the sensitive feature present in an intact state. Note that we are not implying that a site that has multiple features is always going to be more important than the single feature (as the single feature may be critical), nor that sites where the landscape is no longer intact as necessarily being of limited further sensitivity (e.g. in a Protected Area, mining is still illegal even if the site is impacted; and a site within a Strategic Water Source Area may still be highly sensitive to additional mining impacts even if it has been transformed by agriculture). Nevertheless, it is very useful to have a landscape-wide quick view of the probable relative sensitivity of different sites, especially in the early scoping stages of a project where detailed site level evaluations are not feasible across broad areas.

3.2.2 Technical details of the data layer

- The detailed raster grid is available on the data DVD at :\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guidelines Mpumalanga Nov 2014\Mine2014.rrd. The data is provided with a layer file (Mining and Biodiversity Guidelines (updated Mpumalanga Nov 2014).lyr) to facilitate display. The data will be served from **http://bgis.sanbi.org**.
- Its short description is: Mining and Biodiversity Guidelines (updated Mpumalanga Nov 2014). Updated version of the Mining and Biodiversity Guidelines spatial analysis for Mpumalanga. The key changes are the inclusion of the revised Mpumalanga wetland data (Mbona et al., 2014) which updates the FEPA wetlands, and the revised Mpumalanga Biodiversity Sector Plan (MTPA, 2014).
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.
- The coding is:
    - Moderate biodiversity importance - moderate risk for mining = 3
    - High biodiversity importance - high risk for mining = 6
    - Highest biodiversity importance - highest risk for mining = 10
    - Legally protected mining prohibited = 11

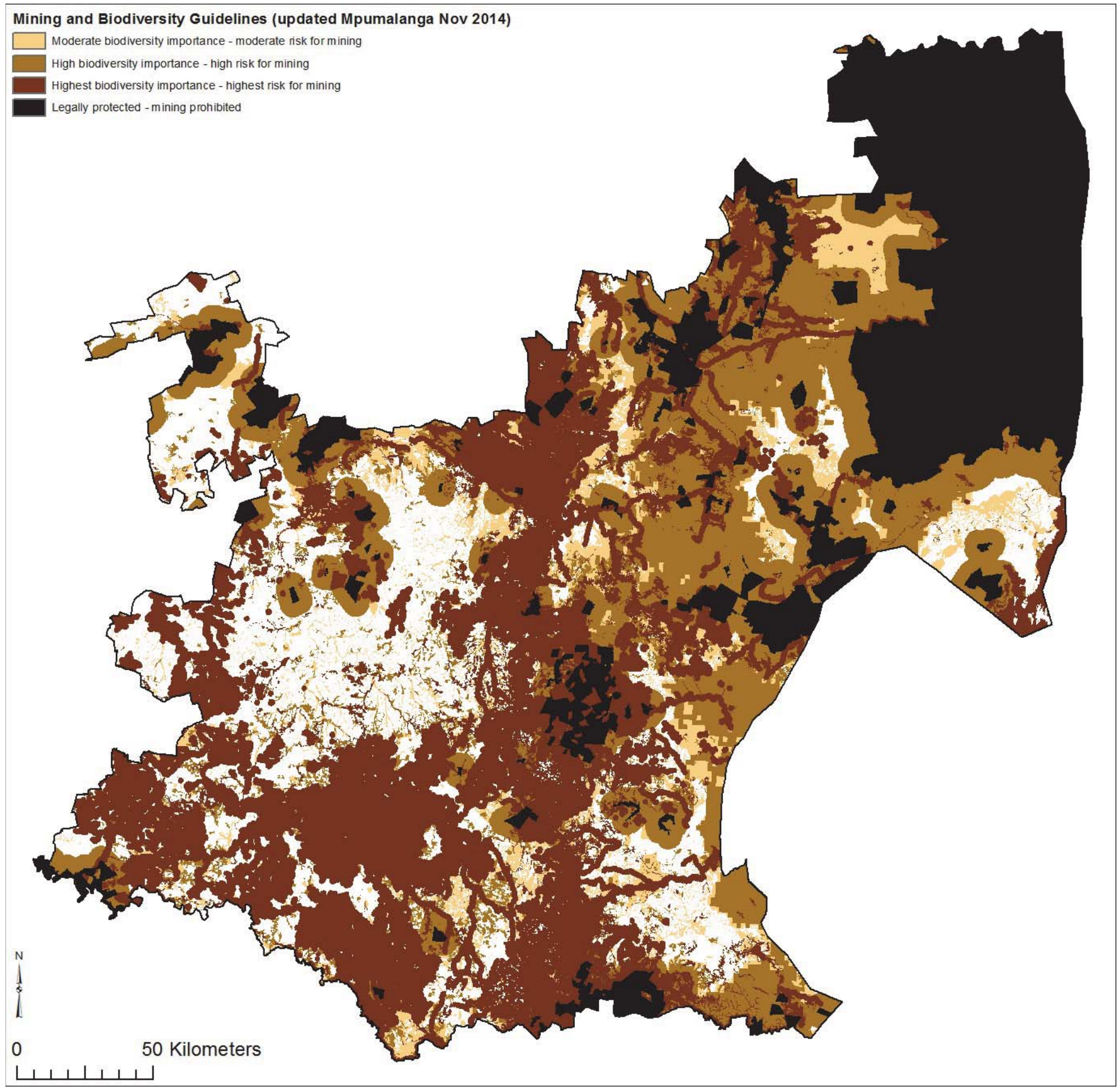


Figure 4: The integrated spatial layer prepared for the Mining and Biodiversity Guidelines (DEA et al., 2013) was updated to include revised datasets such as the new provincial conservation plan (MPTA, 2014), revised Strategic Water Source Areas (Nel et al., 2013a), and new wetland data for the province (Mbona et al., 2014). Note that in most cases the guidelines are only applicable to intact portions of the landscape (See Figure 5 for a version which excludes heavily impacted portions of the landscape).

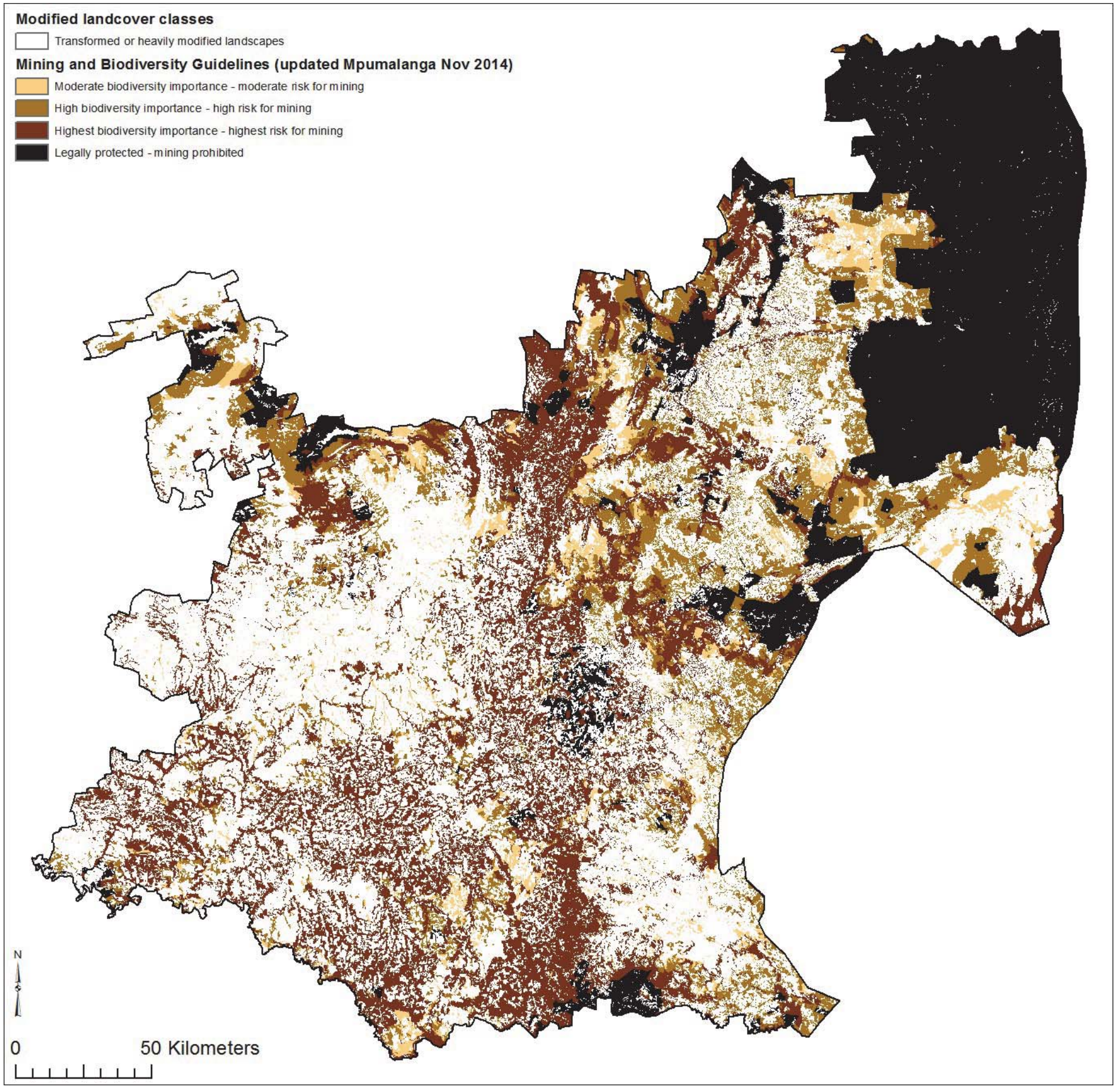


Figure 5: Land use guidelines associated with many types of Biodiversity Priority Area identified in the Mining and Biodiversity Guidelines (DEA et al., 2013) are only relevant for intact portions of the landscape. This map shows the remaining intact extent of Biodiversity Priority Areas.

3.3 INPUT FEATURES: SPLITTING THE MINING AND BIODIVERSITY INPUT LAYERS TO ALLOW KEY FEATURES TO BE IDENTIFIED

3.3.1 The individual input layers

Details of the individual inputs for the revised Biodiversity Priority Area map are given in Table 3.

Table 3: Details of the individual input layers for the revised Biodiversity Priority Area map

Category: Legally protected - mining prohibited Layer: Mpumalanga Protected Areas	
Description	Legally protected - mining prohibited. This layer shows all known Protected Areas from various provincial and national datasets.
Source	The primary source is the revised Mpumalanga Biodiversity Sector Plan 2014 (MTPA, 2014). This plan updates the previous conservation plan from the province. This layer reflects recent Protected Area declarations in the province.
Coding of data fields	Description: Legally protected - mining prohibited. This layer shows all known Protected Areas from various provincial and national datasets. PA: 11 (See Section 3.4 for an explanation of how this value is used).
Location	\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Protected Areas\Mpumalanga Protected Areas Simplified Dataset.shp The data is provided with a layer file (Mpumalanga Protected Areas Simplified Dataset.lyr) to facilitate display.
Category: Highest biodiversity importance - highest risk for mining Layer: 1km buffer on river FEPAs	
Description	Highest biodiversity importance - highest risk for mining. 1km buffer on river FEPAs.
Source	The primary source data sources are Nel et al. (2011a, b). The identified priority rivers (FEPA category 1) were buffered by 1km.
Coding of data fields	Description: Highest biodiversity importance - highest risk for mining. 1km buffer on river FEPAs. CBA: 10 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Highest Biodiversity Importance Sites\Buffers on river FEPAS.shp The data is provided with a layer file (Buffers on river FEPAS.lyr) to facilitate display.
Category: Highest biodiversity importance - highest risk for mining Layer: 1km buffer on wetland FEPAs.	
Description	Highest biodiversity importance - highest risk for mining. 1km buffer on wetland FEPAs.
Source	The WRC project "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 K5/2281" by Mbona et al. (2014) refined the mapping of wetlands in the Mpumalanga Highveld. This data was incorporated into a revised National Wetland Map 4a and was also used to revise the identified Freshwater Ecosystem Protection Areas (FEPAs) for Mpumalanga (Nel et al., 2011a, b). The revised priority wetlands (i.e. the selected FEPA priority wetlands) were buffered by 1km.
Coding of data fields	Description: 10 Highest biodiversity importance - highest risk for mining. 1km buffer on wetland FEPAs. Based on revised national wetland layer (November 2014) - National Wetland Map 4a. CBA: 10 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Highest Biodiversity Importance Sites\ Buffers on wetland FEPAs.shp The data is provided with a layer file (Buffers on wetland FEPAS.lyr) to facilitate display.

Category: Highest biodiversity importance - highest risk for mining	
Layer: Critical Biodiversity Areas 1 from the Mpumalanga Biodiversity Sector Plan	
Description	Highest biodiversity importance - highest risk for mining. Critical Biodiversity Areas 1 (Terrestrial) from the Mpumalanga Biodiversity Sector Plan (2014 update).
Source	The Mpumalanga Biodiversity Sector Plan represents the primary integrated biodiversity data source for the province. See MTPA (2014) and Lötter (2014) for full details on the derivation and content of this layer. The highest value terrestrial features in the province were designated as Critical Biodiversity Areas 1, and it is these features which are summarized in the current layer. This layer includes all terrestrial priority areas for meeting habitat and species targets in the province. Data can be obtained from http://bgis.sanbi.org/mbsp/project.asp.
Coding of data fields	Description: 10 Highest biodiversity importance - highest risk for mining. Critical Biodiversity Areas 1 from MBSP (2014 update). CBA: 10 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Highest Biodiversity Importance Sites\ Critical Biodiversity Areas 1 from MBSP.shp The data is provided with a layer file (Critical Biodiversity Areas 1 from MBSP.lyr) to facilitate display. Note the full set of data for the Mpumalanga Biodiversity Sector Plan is included in the viewer and on the data DVD in :\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Provincial Conservation Plan.
Category: Highest biodiversity importance - highest risk for mining	
Layer: Critical Biodiversity Areas 1 Aquatic from the Mpumalanga Biodiversity Sector Plan	
Description	Highest biodiversity importance - highest risk for mining. Critical Biodiversity Areas 1 Aquatic from the Mpumalanga Biodiversity Sector Plan (2014 update).
Source	The Mpumalanga Biodiversity Sector Plan represents the primary integrated biodiversity data source for the province. See MTPA (2014) and Lötter (2014) for full details on the derivation and content of this layer. The highest value aquatic features in the province were designated as Critical Biodiversity Areas 1 Aquatic, and it is these features which are summarized in the current layer. Data can be obtained from http://bgis.sanbi.org/mbsp/project.asp.
Coding of data fields	Description: 10 Highest biodiversity importance - highest risk for mining. Critical Biodiversity Areas 1 Aquatic from MBSP (2014 update). CBA: 10 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Highest Biodiversity Importance Sites\ Critical Biodiversity Areas 1 Aquatic from MBSP.shp The data is provided with a layer file (Critical Biodiversity Areas 1 Aquatic from MBSP.lyr) to facilitate display. Note the full set of data for the Mpumalanga Biodiversity Sector Plan is included in the viewer and on the data DVD in: :\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Provincial Conservation Plan

Category: Highest biodiversity importance - highest risk for mining	
Layer: Critically Endangered and Endangered Terrestrial Ecosystems	
Description	Highest biodiversity importance - highest risk for mining. National listed Critically Endangered and Endangered Ecosystems.
Source	The Biodiversity Act provides for listing of threatened or protected ecosystems, in one of four categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or protected. The purpose of listing threatened ecosystems is primarily to reduce the rate of ecosystem and species extinction. The layer provided is based on the remaining areas of Critically Endangered (CR) and Endangered (EN) habitat types identified in the spatial data associated with the National list of threatened terrestrial ecosystems for South Africa (2011) served by SANBI on their BGIS website. The original data is available at http://bgis.sanbi.org/ecosystems/project.asp.
Coding of data fields	Description: Highest biodiversity importance - highest risk for mining. National listed Critically Endangered and Endangered Ecosystems. CBA: 10 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Highest Biodiversity Importance Sites\ Critically Endangered and Endangered Terrestrial Ecosystems.shp The data is provided with a layer file (Critically Endangered and Endangered Terrestrial Ecosystems.lyr) to facilitate display.
Category: Highest biodiversity importance - highest risk for mining	
Layer: Ramsar Sites	
Description	Highest biodiversity importance - highest risk for mining. Ramsar Sites.
Source	The layer provided is based on the Ramsar Sites included as conservation areas in the National Protected Areas Database available from http://egis.environment.gov.za/sapad_detail.aspx?m=73&amid=124. Ramsar Sites are internationally recognized wetlands of the highest possible significance. Although South African legislation does not offer them formal protection, many of them are included in declared Protected Areas. Further, all Ramsar Sites are identified wetland Freshwater Ecosystem Protection Areas (FEPAs) (Nel et al., 2011a, b).
Coding of data fields	Description: Highest biodiversity importance - highest risk for mining. Ramsar site. CBA: 10 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Highest Biodiversity Importance Sites\ Ramsar_Site_MP.shp The data is provided with a layer file (Ramsar Site.lyr) to facilitate display.
Category: High biodiversity importance - high risk for mining.	
Layer: Buffer around all Protected Areas 5km	
Description	High biodiversity importance - high risk for mining. Minimum 5km buffer around all protected area types.
Source	Buffers around all Protected areas are required to be taken into account in EIAs. A minimum 5km buffer is designated around all types of declared Protected Area. Protected Areas identified in the Mpumalanga Biodiversity Sector Plan 2014 (MTPA, 2014) were buffered by 5km. Data can be obtained from http://bgis.sanbi.org/mbsp/project.asp.
Coding of data fields	Description: High biodiversity importance - high risk for mining. Minimum 5km buffer around all protected area types. CBA: 6 (See Section 3.4 for an explanation of how this value is used).

Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\High Biodiversity Importance Sites\Buffer around all Protected Areas 5km.shp The data is provided with a layer file (Buffer around all Protected Areas 5km.lyr) to facilitate display.
Category: High biodiversity importance - high risk for mining.	
Layer: Buffer around National parks 10km	
Description	High biodiversity importance - high risk for mining. Minimum 10km buffer around all National Parks.
Source	Buffers around National Parks are required to be taken into account in EIAs. A minimum 10km buffer is designated around National Parks. National Parks identified in the Mpumalanga Biodiversity Sector Plan 2014 (MTPA, 2014) were buffered by the specified distance. Data can be obtained from http://bgis.sanbi.org/mbsp/project.asp.
Coding of data fields	Description: High biodiversity importance - high risk for mining. Minimum 10km buffer around National Parks. CBA: 6 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\High Biodiversity Importance Sites\Buffer around National Parks 10km.shp The data is provided with a layer file (Buffer around National Parks 10km.lyr) to facilitate display.
Category: High biodiversity importance - high risk for mining.	
Layer: Critical Biodiversity Areas 2 from the Mpumalanga Biodiversity Sector Plan	
Description	High biodiversity importance - high risk for mining. Critical Biodiversity Area 2 (CBA Optimal) from the MBSP 2014.
Source	The Mpumalanga Biodiversity Sector Plan represents the primary integrated biodiversity data source for the province. See MTPA (2014) and Lötter (2014) for full details on the derivation and content of this layer. The second highest value terrestrial features in the province were designated as Critical Biodiversity Area 2 (CBA Optimal), and it is these features which are summarized in the current layer. This layer includes a set of identified areas which efficiently meet the remaining habitat and species targets for terrestrial features that have not already been met in Protected areas and CBA 1 Areas. Data can be obtained from http://bgis.sanbi.org/mbsp/project.asp.
Coding of data fields	Description: High biodiversity importance - high risk for mining. Critical Biodiversity Area 2 (CBA Optimal) from the MBSP 2014. CBA: 6 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\High Biodiversity Importance Sites\ Critical Biodiversity Area 2 from MBSP.shp The data is provided with a layer file (Critical Biodiversity Area 2 from MBSP.lyr) to facilitate display. Note the full set of data for the Mpumalanga Biodiversity Sector Plan is included in the viewer and on the data DVD in :\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Provincial Conservation Plan.

Category: High biodiversity importance - high risk for mining.	
Layer: Strategic Water Source Areas Mpumalanga	
Description	High biodiversity importance - high risk for mining. Strategic Water Source Areas for Mpumalanga.
Source	The Strategic Water Source Areas identified by the CSIR (Nel et al., 2013a) represent the areas most important for water supply delivery in Mpumalanga. The CSIR project produced a map of the areas of 8% of the surface area of the country which 50% of the mean annual runoff. The layer represents a significant update the high water yield layer previously included in the Mining and Biodiversity Guideline. Data and reports can be obtained from http://bgis.sanbi.org/nfepa/project.asp
Coding of data fields	Description: High biodiversity importance - high risk for mining. Strategic Water Source Areas for Mpumalanga. CBA: 6 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\High Biodiversity Importance Sites\ Strategic Water Source Areas Mpumalanga.shp. The data is provided with a layer file (Strategic Water Source Areas Mpumalanga.lyr) to facilitate display.
Category: High biodiversity importance - high risk for mining.	
Layer: Transfrontier Conservation Areas	
Description	High biodiversity importance - high risk for mining. Transfrontier Conservation Areas.
Source	Transfrontier Conservation Areas represent important implementation sites for international conservation projects. The underlying data were provided by SANBI, but are not part of an officially served dataset.
Coding of data fields	Description: High biodiversity importance - high risk for mining. Transfrontier Conservation Areas. CBA: 6 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\High Biodiversity Importance Sites\ Transfrontier Conservation Areas.shp. The data is provided with a layer file (Transfrontier Conservation Areas.lyr) to facilitate display.
Category: Moderate biodiversity value - moderate risk for mining.	
Layer: Ecological Support Areas (Terrestrial) from the Mpumalanga Biodiversity Sector Plan	
Description	Moderate biodiversity importance - moderate risk for mining. Ecological Support Areas (Terrestrial) from MBSP 2014.
Source	The Mpumalanga Biodiversity Sector Plan represents the primary integrated biodiversity data source for the province. See MTPA (2014) and Lötter (2014) for full details on the derivation and content of this layer. The supporting terrestrial features which help maintain biodiversity in Protected Areas and Critical Biodiversity Areas in the province were designated as Ecological Support Areas (Terrestrial), and it is these features which are summarized in the current layer. Data can be obtained from http://bgis.sanbi.org/mbsp/project.asp.
Coding of data fields	Description: Moderate biodiversity importance - moderate risk for mining. Ecological Support Areas (terrestrial) from MBSP 2014. CBA: 3 (See Section 3.4 for an explanation of how this value is used).

Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Moderate Biodiversity Importance \ Ecological_Support_Areas_Terrestrial_MBSP_2014.shp The data is provided with a layer file (Ecological_Support_Areas_Terrestrial_MBSP_2014.lyr) to facilitate display. Note the full set of data for the Mpumalanga Biodiversity Sector Plan is included in the viewer and on the data DVD in :\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Provincial Conservation Plan.
Category: Moderate biodiversity value - moderate risk for mining.	
Layer: Ecological Support Areas (Aquatic) from the Mpumalanga Biodiversity Sector Plan	
Description	Moderate biodiversity importance - moderate risk for mining. Ecological Support Areas (Aquatic) from MBSP 2014.
Source	The Mpumalanga Biodiversity Sector Plan represents the primary integrated biodiversity data source for the province. See MTPA (2014) and Lötter (2014) for full details on the derivation and content of this layer. The supporting aquatic features which help maintain biodiversity in Protected Areas and Critical Biodiversity Areas in the province were designated as Ecological Support Areas (Aquatic), and it is these features which are summarized in the current layer. Data can be obtained from http://bgis.sanbi.org/mbsp/ project.asp.
Coding of data fields	Description: Moderate biodiversity importance - moderate risk for mining. Ecological Support Areas (Aquatic) from MBSP 2014. CBA: 3 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Moderate Biodiversity Importance \ Ecological_Support_Areas_Aquatic_MBSP_2014.shp The data is provided with a layer file (Ecological_Support_Areas_Aquatic_MBSP_2014.lyr) to facilitate display. Note the full set of data for the Mpumalanga Biodiversity Sector Plan is included in the viewer and on the data DVD in :\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Provincial Conservation Plan
Category: Moderate biodiversity value - moderate risk for mining.	
Layer: Mpumalanga Protected Area Expansion Priorities from the Mpumalanga Biodiversity Sector Plan	
Description	Moderate biodiversity importance - moderate risk for mining. Mpumalanga Protected Area Expansion Priorities from the Mpumalanga Biodiversity Sector Plan.
Source	The Mpumalanga Biodiversity Sector Plan represents the primary integrated biodiversity data source for the province. See MTPA (2014) and Lötter (2014) for full details on the derivation and content of this layer. One of the important products of this planning process is an identified set of Protected Area expansion priorities. Data can be obtained from http://bgis.sanbi.org/mbsp/ project.asp.
Coding of data fields	Description: Moderate biodiversity importance - moderate risk for mining. Protected Area Expansion Priorities from MBSP 2014. CBA: 3 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Moderate Biodiversity Importance \ Mpumalanga_ Protected_ Area_Expansion_Priorities.shp The data is provided with a layer file (Mpumalanga_Protected_Area_Expansion_ Priorities.lyr) to facilitate display. Note the full set of data for the Mpumalanga Biodiversity Sector Plan is included in the viewer and on the data DVD in :\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Provincial Conservation Plan.

Category: Moderate biodiversity value - moderate risk for mining.	
Layer: UNESCO Biospheres	
Description	Moderate biodiversity importance - moderate risk for mining. UNESCO Biosphere.
Source	The layer provided is based on the UNESCO Biosphere sites included as conservation areas in the National Protected Areas Database available from http://egis.environment.gov.za/sapad_detail.aspx?m=73&amid=124. Biospheres are internationally recognized areas where conservation initiatives are integrated across a mosaic of different land uses. Although South African legislation does not offer them formal protection, many of them have core areas which are included in declared Protected Areas and other high areas protected through various zoning schemes.
Coding of data fields	Description: Moderate biodiversity importance - moderate risk for mining. UNESCO Biospheres. CBA: 3 (See Section 3.4 for an explanation of how this value is used).
Location	:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Mining and Biodiversity Guideline Detailed Data\Moderate Biodiversity Importance \ UNESCO Biospheres.shp The data is provided with a layer file (UNESCO Biospheres.lyr) to facilitate display.

3.3.2 Technical details relevant for all the data layers

- The details of the location of each of the individual raster or polygon data layers are given in Table 3.
- Importantly, once users have identified the important features at a site, they should check the SANBI BGIS site (http://bgis.sanbi.org) for the underlying specific dataset and for updates. The GIS data included in the Mining and Biodiversity Guidelines, and which has been revised and updated here, does not replace the original datasets.
- All the data layers are provided in the following projection:
    - The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.

3.4 SUMMARY LAYER TO ALLOW QUICKER INTERPRETATION

3.4.1 Approach

In order to ensure that the basic spatial data layer for the Mining and Biodiversity Guideline was as simple and as clear as possible, to ensure that non-specialized users would receive a message that was easy to understand, and to have a limited number of categories for which guidelines could be written; it was necessary to limit the map to only four categories. Although necessary and useful, this does represent a major simplification of the spatial data, and in some cases this simplification could severely limit the utilization of the data, or force unnecessary expense or effort to interpret it. The main limits are that the basic Biodiversity Priority Area map does not indicate when many overlapping features are found at a site, and also does not take the current condition (i.e. landcover class) of the site into account. Both these factors limit the ability to quickly assess the likely sensitivity of a site. A site with many overlapping features of a particular level of significance is likely (but not guaranteed) to be far more problematic for mining than a similar site with only a single feature of the same level of interest. Similarly, it is very useful to distinguish between sites that are in an intact state (as many of the identified features which trigger the various Biodiversity Priority Area categories only are of significance if they are in an intact state) versus sites that are no longer intact.

In this section we describe a layer developed for Mpumalanga by the current project which provides a single composite value to quickly distinguish the categories of Biodiversity Priority Area, the highest sensitivity sites (i.e. ones with multiply overlapping high sensitivity features that are intact) from the sites with fewer high sensitivity features within each of these categories, and from the sites which may once have been highly

sensitive but no longer have the sensitive feature present in an intact state and are likely to be of lower value/sensitivity. Note that we are not implying that a site that has multiple features is always going to be more important than the single feature (as the single feature may be critical), nor that sites where the landscape is no longer intact as necessarily being of limited further sensitivity (e.g. in a Protected Area, mining is still illegal even if the site is impacted; and a site within a Strategic Water Source Area may still be highly sensitive to additional mining impacts even if it has been transformed by agriculture). Nevertheless, it is very useful to have a landscape-wide quick view of the probable relative sensitivity of different sites, especially in the early scoping stages of a project where detailed site level evaluations are not feasible across broad areas.

3.4.2 Analysis

We took a low-tech approach to developing the integrated layer:

- First we developed the individual input layers described in Section 3.3. These are simple maps of the presence or absence of the biodiversity feature in question.
- Each individual layer was converted to a separate raster layer, and was coded with a value that corresponded to the category it triggered in the overall Mining and Biodiversity Guideline summary layer. The values used are given in Section 3.3. In other words, the features which trigger a “Moderate biodiversity importance - moderate risk for mining” were all coded with a value of 3, the features which trigger a “High biodiversity importance - high risk for mining” were all coded with a value of 6, the features which trigger a “Highest biodiversity importance - highest risk for mining” were all coded with a value of 10, while all “Legally protected areas - mining prohibited” areas were coded with a value of 111.
- All sites were also separately coded based on the landcover map, with different values being given based on the landcover category. For simplicity, we only distinguished between completely transformed sites (e.g. with an urban landcover) from the natural and semi-natural sites. Degraded landcover classes were included in the natural and semi-natural category.
- We then combined the individual layers, and added up the values of all features identified at that point (i.e. the 30 m x 30 m site represented by an individual pixel on the map).
- The sites within each broad Biodiversity Priority Area category were then analysed and split into sub-categories:
    - The areas within each category that were indicated as transformed were grouped.
    - Then the summed values of all the remaining intact sites in each category were analysed. A range of summed values would be found within each category based on the number and type of underlying features present.
    - The remaining intact sites in each category were then split, with the lower 50 percentile of the intact areas by value in that category being designated as middle value areas, and the top 50 percentile of the intact areas being designated as the highest value areas. As the split was based on a median value (i.e. there are as many sites above this value as below it), and all the pixels have the same area, this effectively splits the intact sites of each category into two groups of with an equal total area.
- This approach results in ten specific categories (i.e. transformed areas, middle value areas and highest value areas for each of the three categories outside of Protected Areas, plus an additional category for Protected Areas). A further implicit category of areas exists, which are all the areas which do not fall within any Biodiversity Priority Area.
- This assessment allows one to get a rapid “at a glance" interpretation of the Mining and Biodiversity Guidelines at a site level for Mpumalanga without investing in any specific additional site level GIS or interpretation.

[1] The specific numbers used are not particularly important, but were carefully selected based on experience in other projects of a similar nature. Key issues are the relative size of the values chosen, and in particular the gap between the numbers. This impacts on issues such as whether two lower value features are worth the same as a middle value feature.

- The map is shown in Figure 6. Although for logistical reasons the map is very small, the underlying data is as fine as possible, and it is possible to zoom in to the map as far as is sensible given the underlying spatial data. Although care needs to be taken when zooming in very far (e.g. at scales beyond 1:10 000), it is nevertheless possible to use the data at this sort of scale.

3.4.3 Technical details of the data layer

- The detailed raster grid is available on the data DVD at:\Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\ Mining and Biodiversity Guideline 2014 Interpreted\ minecatmpum.rrd. The data is provided with a layer file (Mining and Biodiversity refined category (Nov 2014 update).lyr) to facilitate display. The data will be served from **http://bgis.sanbi.org**.
- Its short description is: Refined analysis of subdivisions of the Mining and Biodiversity Guidelines categories for Mpumalanga. The broad divisions as per the M&B Guidelines are divided into transformed areas, middle value areas (which are the lower 50 percentile of the intact areas by value in that category) and highest value areas (which are the top 50 percentile of the intact areas by value in that category). This assessment allows one to get an "at a glance" interpretation of the Mining and Biodiversity Guidelines at a site level for Mpumalanga. Note that this is based on the revised November 2014 version of the Mining and Biodiversity Guidelines spatial data. Detailed planning should always be undertaken to identify the specific reasons why the category was triggered in the Mining and Biodiversity Guidelines summary.
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.
- The coding is:
    - 0 = Moderate biodiversity importance - moderate risk for mining - transformed
    - 1 = Moderate biodiversity importance - moderate risk for mining - middle
    - 2 = Moderate biodiversity importance - moderate risk for mining - top
    - 3 = High biodiversity importance - high risk for mining - transformed
    - 4 = High biodiversity importance- high risk for mining - middle
    - 5 = High biodiversity importance - high risk for mining - top
    - 6 = Highest biodiversity importance - highest risk for mining - transformed
    - 7 = Highest biodiversity importance - highest risk for mining - middle
    - 8 = Highest biodiversity importance - highest risk for mining - top
    - 9 = Legally protected mining prohibited
    - No data = Not specifically identified as important
- Note that in each category (e.g. High biodiversity importance – high risk for mining), the transformed category includes all the sites that fall into that category but are indicated as not intact on the landcover map; the middle category includes the non-transformed sites in that category that scored below the median value for that category; and the top category includes all the non-transformed sites that scored above the median value site for that category. The top value sites in each category will have at least two distinct features in that category which triggered Biodiversity Priority Area status, or may have a feature triggering that level of Biodiversity Priority Area and one or more features that triggered a lower level category. The middle value sites in each category will have at least a single feature which triggered the applicable Biodiversity Priority Area category. It is possible that an area might have more than one triggering feature but still be below the median value for that category, and hence still be classified as a middle value site.

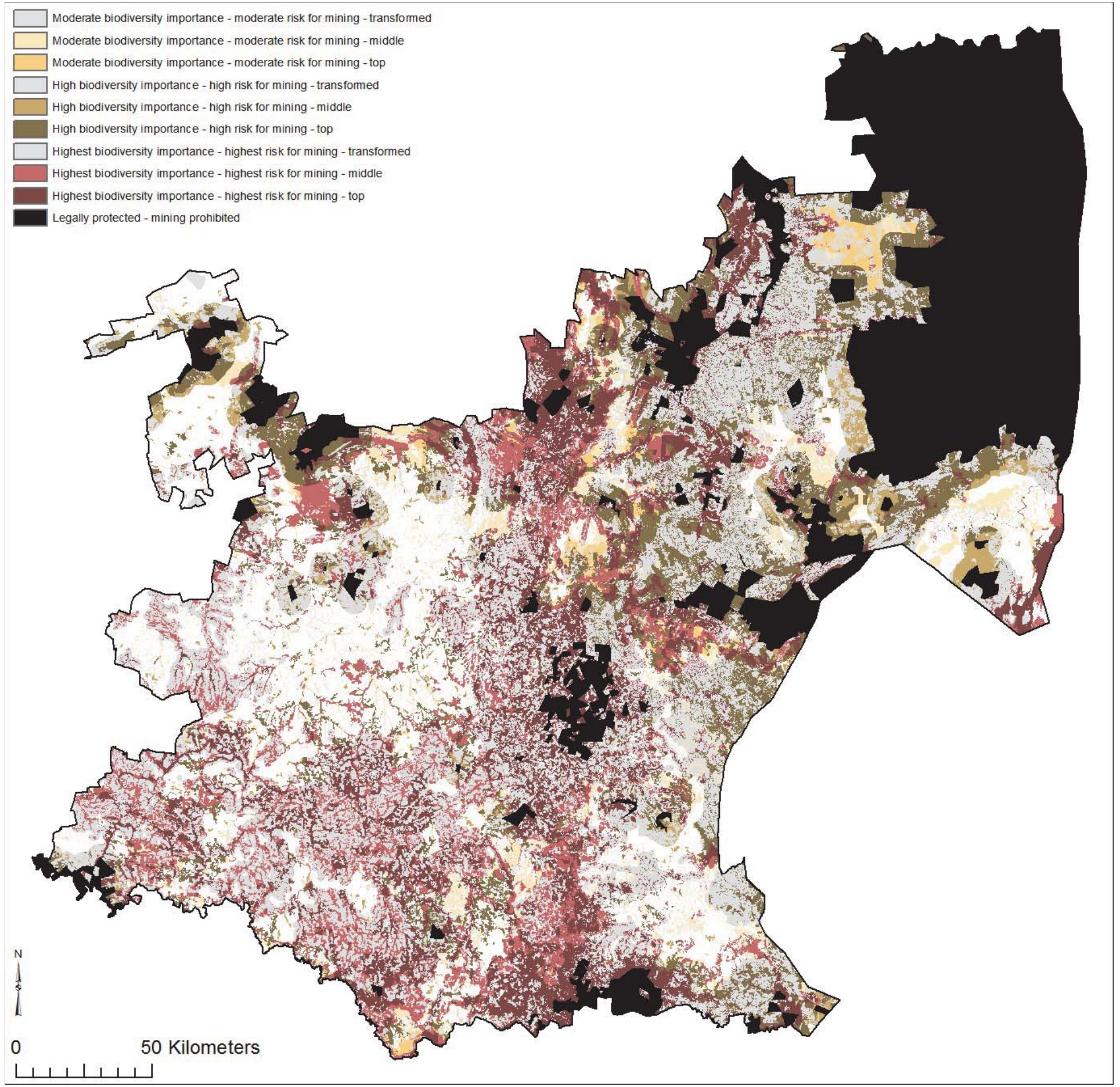


Figure 6: The map shows the single summary layer produced to allow quicker interpretation of the spatial data for the Mining and Biodiversity Guideline. This assessment allows one to get a rapid "at a glance" interpretation of the Mining and Biodiversity Guidelines at a site level for Mpumalanga without investing in any specific additional site level GIS or interpretation.

CHAPTER 4: ECOLOGICAL INFRASTRUCTURE

4.1 INTRODUCTION

Ecological Infrastructure is an important emerging concept used to describe functioning ecosystems that deliver valuable services to people e.g. fresh water, climate regulation, soil formation and disaster risk reduction. These areas include healthy mountain catchments, rivers, wetlands, coastal dunes, nodes and corridors of natural habitat, which form a network of interconnected structural elements in the landscape. The analysis used in this assessment was based on the South African conceptual framework for Ecological Infrastructure (SANBI, 2014). The current study focussed on practically identifying the functioning ecosystems that deliver valuable services to people based on the conceptual framework outlined in this documents. The analysis applied in Mpumalanga built on an earlier analysis undertaken on behalf of WWF for the greater uMngeni catchment (Holness and Skowno, 2013).

The analysis applies a rapidly desktop mapping approach to identify key areas of Ecological Infrastructure (EI) in Mpumalanga. The mapping focussed on areas important for water production and stream flow augmentation, erosion control, enhancement of water quality, and flood attenuation. Maps, based on an analysis of existing data were produced for each of these aspects of water supply related EI. A composite map of EI was then produced by bringing these four layers together. This chapter serves as a brief technical overview of the data and approach used for this mapping.

4.2 GENERAL APPROACH AND KEY DATA SOURCES

For the purposes of the current study, we have focussed on the specific areas of EI which are important for supporting water supply in Mpumalanga, and have not attempted to identify all areas of potential EI (e.g. areas supporting climate change adaptation, corridors etc.). The focus was on:

- Water production and stream flow augmentation e.g. natural areas with high water yield and portions of the landscape required to support flow during the dry season. Protecting or improving these areas of EI would reduce requirements for additional storage or inter-basin transfer.
- Erosion control e.g. erosion prone areas which need to be kept intact or rehabilitated. Protecting or improving these areas of EI would reduce capacity reduction of storage schemes and reduce water treatment costs.
- Enhancement of water quality, including areas important for sediment trapping, and reducing levels of phosphates, nitrates and toxicants. Protecting or improving these areas of EI would reduce water treatment costs.
- Flood attenuation e.g. the particular types of wetland which are important for delaying flood peaks and reducing flood intensity. Protecting or improving these areas of EI would reduce risk to water supply infrastructure during extreme flood events.

The approach taken was to build a bottom-up set of EI, rather than making the assumption that all of intact nature was delivering valuable services to people. Therefore we needed to make the case linking an area to a specific valuable service. There was no scope for new data collection, so we were largely applying a new concept and analysis to existing data. The most important specific sources were:

- Maps Strategic Water Source Areas created by the CSIR (Nel et al., 2013b).
- Wet-EcoServices (Kotze et al., 2008) which describes a method for rapidly assessing ecosystem services supplied by South African wetlands. It forms the conceptual basis used in this project for identifying which services are provided by a specific wetland type. See Table 4. Additional data sources are detailed in Table 5.

Table 4: Rating of the hydrological benefits likely to be provided by a wetland based on its particular hydro-geomorphic type (from Kotze et al., 2008).

WETLAND HYDRO-GEOMORPHIC TYPE	HYDROLOGICAL FUNCTIONS POTENTIALLY PERFORMED BY THE WETLAND								
	Flood attenuation		Stream flow augmentation		Erosion control	Enhancement of water quality			
	Early wet season	Late wet season	Early wet season	Late wet season		Sediment trapping	Phos-phates	Nitrates	Toxicants[1]
1. Floodplain	++	+	0	0	++	++	++	+	+
2. Valley bottom – channelled	+	0	0	0	++	+	+	+	+
3. Valley bottom – unchanneled	+	+	+?	+?	++	++	+	+	++
4. Hillslope seepage feeding a stream channel	+	0	+	+	++	0	0	++	++
5. Hillslope seepage not feeding a stream	+	0	0	0	++	0	0	++	+
7. Pan/ Depression	+	+	0	0	0	0	0	+	+

Note: [1]Toxicants are taken to include heavy metals and biocides

Rating:
- 0 Function unlikely to be performed to any significant extent
- \+ Function likely to be present at least to some degree
- ++ Function very likely to be present (and often performed to a high level)

Table 5: Key data sources used in the mapping of Ecological Infrastructure for Mpumalanga.

Category	Original Source	Use
Wetland & river base data	Nel et al. (2011a): Atlas of Freshwater Ecosystem Priority Areas in South Africa. Atlas and accompanying data available from CSIR or WRC. Base wetland and river data used. Mbona et al. (2014): Revised and updated wetland mapping for the Mpumalanga Highveld.	Each wetland and river type was buffered by specific distances - see methods table.
Addition minor rivers	Surveys and mapping 1:50 000 river data	The FEPA river dataset (above) only includes major rivers and tributaries. This additional dataset was used to identify minor perennial and non-perennial streams.
Wetland ecosystem service analysis	Kotze et al. (2008): Wet-EcoServices. A technique for rapidly assessing ecosystem services supplied by wetlands.	Evaluation of delivery of services by different wetland types used to help define wetland value.
Gullies & soil erosion	Mararakanye and Le Roux (2012): Gully location mapping at a national scale for South Africa. Additional areas of soil erosion identified based on the provincial landcover (see below).	Areas with or near sites with current and potential high levels of soil erosion were identified.
Strategic Water Source Areas	Nel et al. (2013b): Maps of South Africa's Strategic Water Source Areas.	Broad areas with high water yields identified in these studies were used as a starting point for identifying important areas at a fine scale.
Landcover	MTPA (2014). Landcover map from the Mpumalanga Biodiversity Sector Plan. Lötter (2014). Technical Report for the Mpumalanga Biodiversity Sector Plan – MBSP. Mpumalanga Tourism & Parks Agency, Nelspruit.	The landcover map developed for the MBSP was a key used to identify the condition of Ecological Infrastructure. It was supplemented by gully data from Mararakanye and Le Roux (2012) and dams from the revised wetland datasets for Mpumalanga (Mbona et al., 2014).

Ecological Infrastructure was classified based on two criteria (Figure 7):

- What is the value of the feature in terms of delivering water related ecological services feature. This evaluation assumed that all features were in a natural state. We differentiated between:
    - **Key ecological infrastructure** – i.e. the most important features for delivering water related services. These are areas which are very likely to be critical to the delivery of services.
    - **Additional ecological infrastructure** – i.e. other important features for delivering water related services. These are areas which are likely to be delivering fewer services, or fulfil a supporting role in service delivery.
- The current condition of the feature providing the services. We differentiated between three categories. (Note that only the first two are defined as Ecological Infrastructure, while the third is included because of its relevance for managing ecosystem services).
    - **Ecological Infrastructure (Natural)**: Areas that are in a natural or semi-natural condition, and which should be protected to ensure long term ecological service delivery.
    - **Ecological Infrastructure (Degraded)**: Areas that are currently in a poor or degraded condition, but which could be rehabilitated to improve ecological service delivery.

- **Transformed Ecological Infrastructure**: Areas where Ecological Infrastructure has been lost, but where there may be opportunities to mitigate/reduce negative impacts through improved management practices.

- Theoretically six categories can result from the combination of these two concepts. However, only five are utilized as all types of transformed EI were kept in one category, as to a large extent the original feature value is no longer relevant in a transformed landscape.

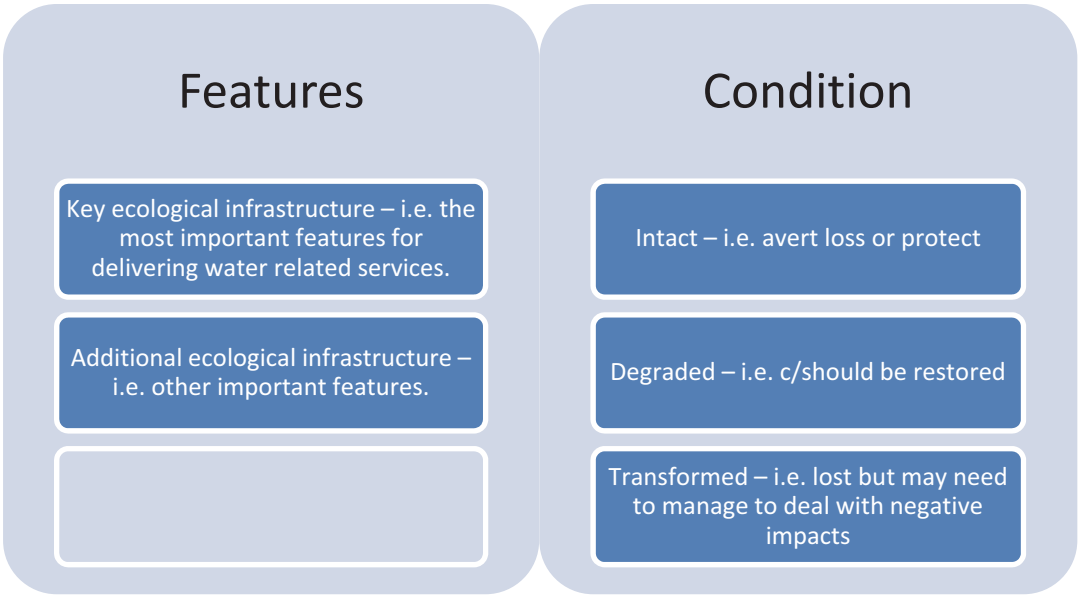


Figure 7: Two separate concepts were used to classify Ecological infrastructure. Theoretically six categories can result from the combination of these two concepts – however, we have kept all transformed EI as a single category.

4.3 LANDCOVER

4.3.1 Approach to developing the layer

An integrated landcover map was built up from the landcover map developed for the Mpumalanga Biodiversity Sector Plan (MTPA, 2014; Lotter, 2014), supplemented by additional data on gully erosion (Mararakanye and Le Roux, 2012) and dams from the revised wetland datasets for Mpumalanga (Mbona et al., 2014). The following method was used to develop the layer:

- A 30 m standardised raster grid was used as the basis for the analysis. The initial starting raster had a 0 background value.
- The vector based input layers from the landcover developed for the Mpumalanga Biodiversity Sector Plan (MTPA, 2014; Lotter, 2014) were converted to a raster layer and re-coded as follows:
  - Erosion =1
  - Cultivation = 2 (This category included both current and old lands).
  - Urban and Industrial areas =3 (This included the urban and homesteads category from the MTPA landcover).
  - Plantations = 4
  - Dams = 5
  - Mining = 6 (This category included both current and old mining categories from the MTPA landcover).

- Dams were extracted from the revised wetland datasets for Mpumalanga (Mbona et al., 2014). These were converted to a raster layer and re-coded with a value of 5.
- Additional data on gully erosion was obtained from Mararakanye and Le Roux (2012). These were converted to a raster layer and re-coded with a value of 1.
    - The three individual raster input layers were then combined using a maximum function, which identified the highest scoring values from each input layer. This resulted in a final landcover layer that showed: Natural areas = 0, Erosion =1, Cultivation = 2, Urban and Industrial areas =3, Plantations = 4, Dams = 5, Mining = 6.
- In addition, a simplified layer was prepared which had three categories:
    - Natural (natural areas)
    - Degraded (eroded areas)
    - Transformed (cultivation, urban and industrial areas, plantations, dams and mining)
- The map is shown in Figure 8.

4.3.2 Technical details of the data layer

- The detailed raster grid is available on the data DVD at \Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Landcover\landcover.rrd and will be served from **http://bgis.sanbi.org**. Spatial data will also be available at www.wrc.org.za.
- Its short description is:
    - Landcover (Detailed) - Modified landcover classes developed from underlying provincial landcover datasets, supplemented by ARC gully dataset and dams from the FEPA dataset.
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.
- The coding is:
    - Natural areas = 0
    - Erosion =1
    - Cultivation = 2
    - Urban and Industrial areas =3
    - Plantations = 4
    - Dams = 5
    - Mining = 6

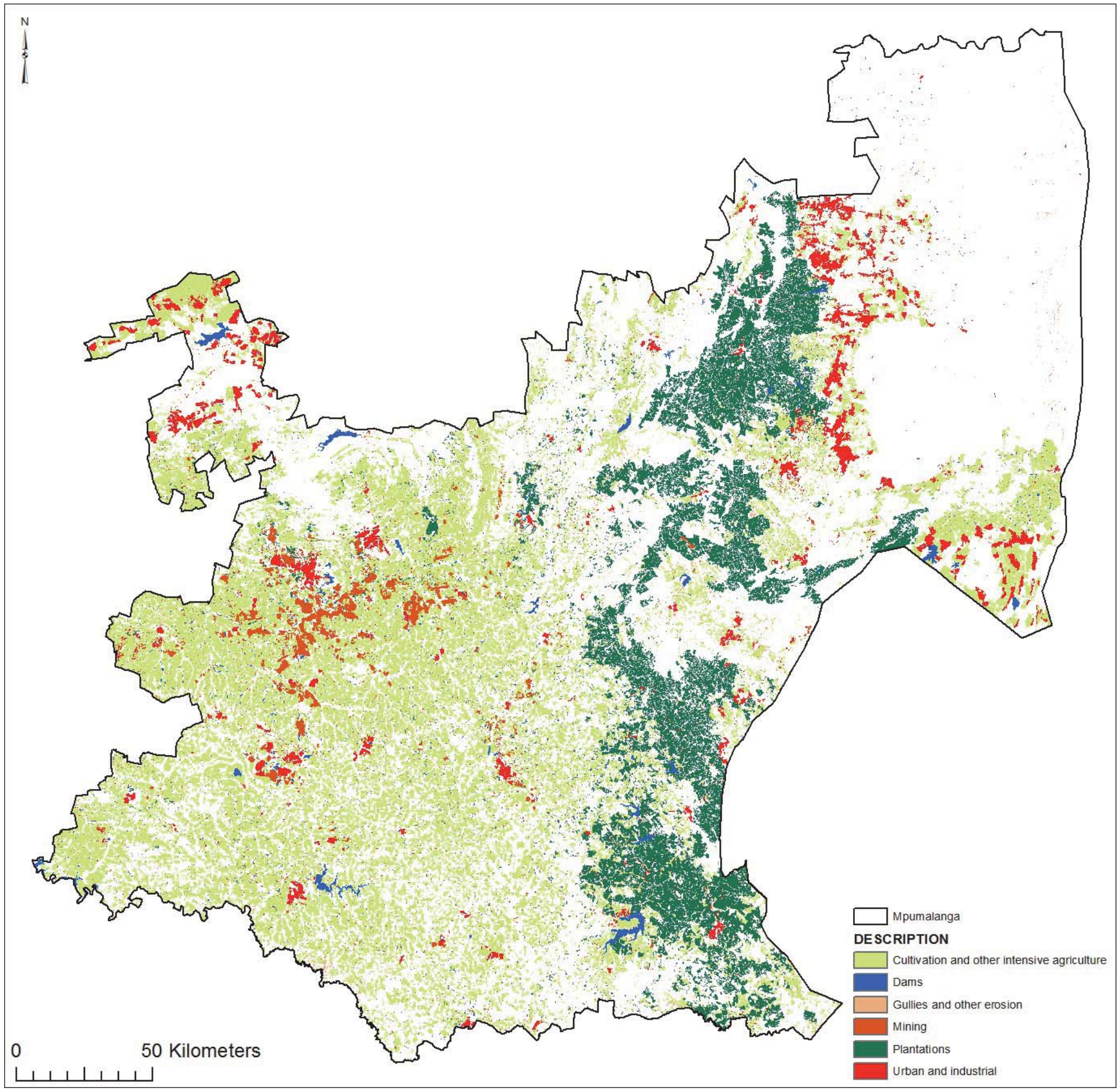


Figure 8: Integrated landcover map: The composite map was built up from the landcover map developed for the Mpumalanga Biodiversity Sector Plan (MTPA, 2014; Lotter, 2014), supplemented by additional data on gully erosion (Mararakanye and Le Roux, 2012) and dams from the revised wetland datasets for Mpumalanga (Mbona et al., 2014).

4.4 ECOLOGICAL INFRASTRUCTURE FOR WATER PRODUCTION AND STREAM FLOW AUGMENTATION

4.4.1 Approach to developing the layer

The project identified areas important for water production and stream flow regulation. The method (detailed in Table 6) is described below:

- Strategic Water Source Areas identified by the CSIR (Nel et al., 2013a) were used for as the high water yield areas. The CSIR project used Mean Annual Runoff at a quaternary catchment scale, which was then disaggregated to a 1 x 1 minute grid resolution using published rainfall-runoff relationships for South Africa. The final map of Strategic Water Source Areas was produced by grouping areas generating 50% of the mean annual runoff for the country. This cut-off equates to areas with runoff values of over 135 mm/year. Although in other areas (both more arid areas and more mesic areas), we have had to utilize different runoff cut-offs, the initial testing and exploration of the area indicated that the 135 mm/year cut-off was indeed appropriate for Mpumalanga and hence was retained. These areas were designated as high water yield.
- Various features important for delivering ecosystem services were then identified using the Wet-EcoServices categorization of wetlands (Table 4) and the services provided, the National Wetland Inventory, the river data from the FEPA project, additional rivers from the 1:50 000 topocadastral data and the landcover layer. Where possible buffer widths were linked to literature or legislation, but elsewhere these widths were determined using an iterative expert approach. The features, their classification and their treatment are detailed in Table 6:
    - In high water yield areas all areas considered important to some degree, however all natural wetlands and riparian buffers (which were wider around large rivers and narrow around smaller rivers) were most strongly highlighted. The remaining terrestrial high water yield areas were categorized according to their current condition.
    - In lower water yield areas, only wetlands and areas within narrower riparian buffers were included (again with narrower buffers for smaller systems and wider buffers for large systems).
    - In all areas wetlands and buffers were include for the specific wetland types which are specifically important for water production and stream flow augmentation.
- Scores and categories were determined by overlaying the scores assigned to the individual features from the individual input layers (i.e. the ones and twos from Table 6) and calculating the highest value at a site.
- The resultant layer of Key and Additional Ecological Infrastructure was then combined with the three class landcover map (showing natural, degraded and transformed areas). This gave an integrated layer with five categories (as we combined all transformed EI areas into a single category).
- This map is shown in Figure 9.

4.4.2 Technical details of the data layer

- The detailed raster grid is available on the data DVD at \Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Ecological Infrastructure Mpumalanga\Prod_EI_M.rrd. The data is provided with a layer file (Ecological Infrastructure for Water Production.lyr) to facilitate display. The data will be served from **http://bgis.sanbi.org**.
- Its short description is: Ecological Infrastructure for Water Production.
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.

- The coding is:
  - Key Ecological Infrastructure (Natural) = 1
  - Additional Ecological Infrastructure (Natural) = 2
  - Key Ecological Infrastructure (Degraded) = 3
  - Additional Ecological Infrastructure (Degraded) = 4
  - Transformed Ecological Infrastructure = 5

Table 6: Methods used to identify key areas of Ecological Infrastructure important for water production and stream flow augmentation.

			Ecological Infrastructure: Intact areas for protection (i.e. Areas that are in good condition)	Potential Ecological Infrastructure: Areas for rehabilitation (i.e. Areas that are in poor condition)	Transformed Ecological Infrastructure (i.e. Areas where value has been lost, but there may be opportunities to reduce negative impacts)
Water production & stream flow augmentation					
In high yield/strategic water source areas (over 135mm runoff)	Rivers	Riparian buffers (100m minimum; 500m larger rivers)	2	2	1
	Terrestrial areas	All natural habitat types (as per Degraded areas (as per landcover) Transformed areas (as per landcover)	1	1	1
	Wetlands	All natural wetlands	2	2	1
In lower yield areas (under 135mm runoff)	Rivers	Riparian buffers (32m minimum; 100m	2	2	1
	Wetlands	All natural wetlands	1	1	1
All areas	Wetlands specifically important for water production & stream flow augmentation	Unchannelled valley-bottom wetland with 50m buffer	1	1	1
		Valleyhead seep with 50m buffer	1	1	1

Values: 2 = Key ecological infrastructure; 1 = Other Ecological Infrastructure

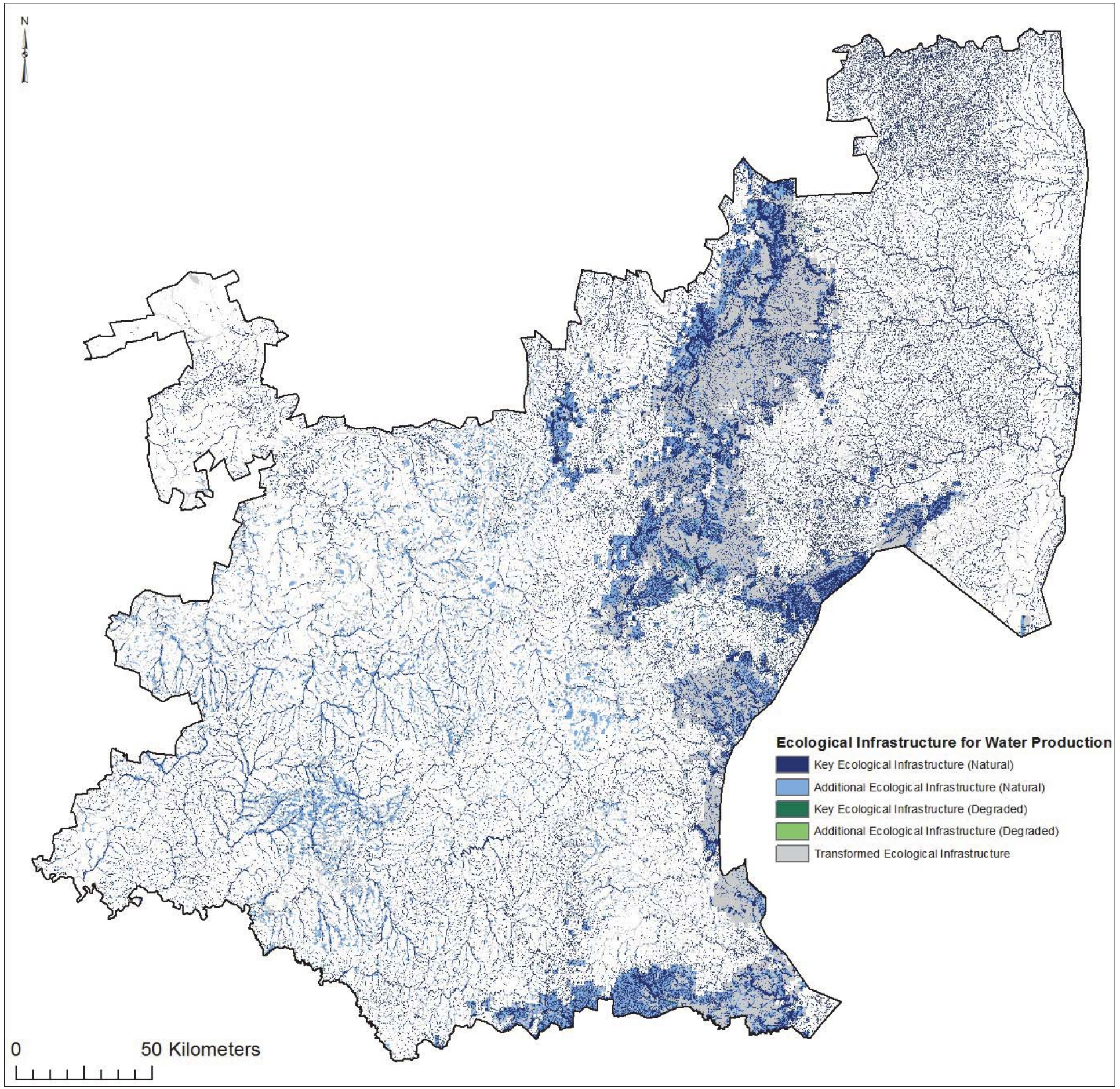


Figure 9: Areas of Ecological Infrastructure important for water production and stream flow augmentation.

4.5 ECOLOGICAL INFRASTRUCTURE FOR EROSION CONTROL

4.5.1 Approach to developing the layer

The study identified areas important for erosion control. These are types of features which are important for retaining sediment or are erosion prone areas which need to be kept intact or rehabilitated. Protecting or improving these areas of EI would reduce capacity reduction of storage schemes and reduce water treatment costs. The method (detailed in Table 7) is described below:

- Areas with gully erosion were used from the national gully erosion mapping study by DAFF (Mararakanye and Le Roux, 2012). This study mapped gully erosion locations at a national scale for South Africa. All gullied areas were included. Areas identified were cross checked against satellite imagery, which confirmed that the identified areas were both sufficiently accurate and comprehensive. This data was supplemented by all erosion gullies and other eroded areas identified in the various landcover layers. Areas with existing erosion were buffered by 1000 m to identify erosion prone areas.
- Wetland types specifically important for erosion control were prioritized. These include channelled valley-bottom wetlands, floodplain wetlands, seeps, unchannelled valley-bottom wetlands and valleyhead seeps, all with a 100 m buffer.
- Riparian buffers were also included, with wider buffers around large rivers and narrow buffers on smaller rivers.
- Scores and categories were determined by overlaying the scores assigned to the individual features from the individual input layers (i.e. the ones and twos from Table 7) and calculating the highest value at a site.
- The resultant layer of Key and Additional Ecological Infrastructure was then combined with the three class landcover map (showing natural, degraded and transformed areas). This gave an integrated layer with five categories (as we combined all transformed EI areas into a single category).
- A composite map was developed, which is shown in Figure 10.

4.5.2 Technical details of the data layer

- The detailed raster grid is available on the data DVD at \Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Ecological Infrastructure Mpumalanga\Sed_EI_M.rrd. The data is provided with a layer file (Ecological Infrastructure for Erosion Control.lyr) to facilitate display. The data will be served from **http://bgis.sanbi.org**. Spatial data will also be available at www.wrc.org.za.
- Its short description is: Ecological Infrastructure for Erosion Control.
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.
- The coding is:
    - Key Ecological Infrastructure (Natural) = 1
    - Additional Ecological Infrastructure (Natural) = 2
    - Key Ecological Infrastructure (Degraded) = 3
    - Additional Ecological Infrastructure (Degraded) = 4
    - Transformed Ecological Infrastructure = 5

Table 7: Methods used to identify key areas of Ecological Infrastructure important for erosion control.

			Ecological Infrastructure: Intact areas for protection (i.e. Areas that are in good condition)	Potential Ecological Infrastructure: Areas for rehabilitation (i.e. Areas that are in poor condition)	Transformed Ecological Infrastructure (i.e. Areas where value has been lost, but there may be opportunities to reduce negative impacts)
Erosion control					
Wetlands	Wetlands specifically important for erosion control	Channelled valley-bottom wetland with 100m buffer	2	2	1
		Floodplain wetland with 100m buffer	2	2	1
		Seep with 100m buffer	2	2	1
		Unchannelled valley-bottom wetland with 100m buffer	2	2	1
		Valleyhead seep with 100m buffer	2	2	1
Erosion prone areas which need to be kept intact or rehabilitated	Terrestrial areas	Areas with gully or other erosion buffered by 1000m	2	2	1
Rivers	Rivers	Riparian buffers (32m minimum; 100m larger rivers)	2	2	1

Values: 2 = Key ecological infrastructure; 1 = Other Ecological Infrastructure

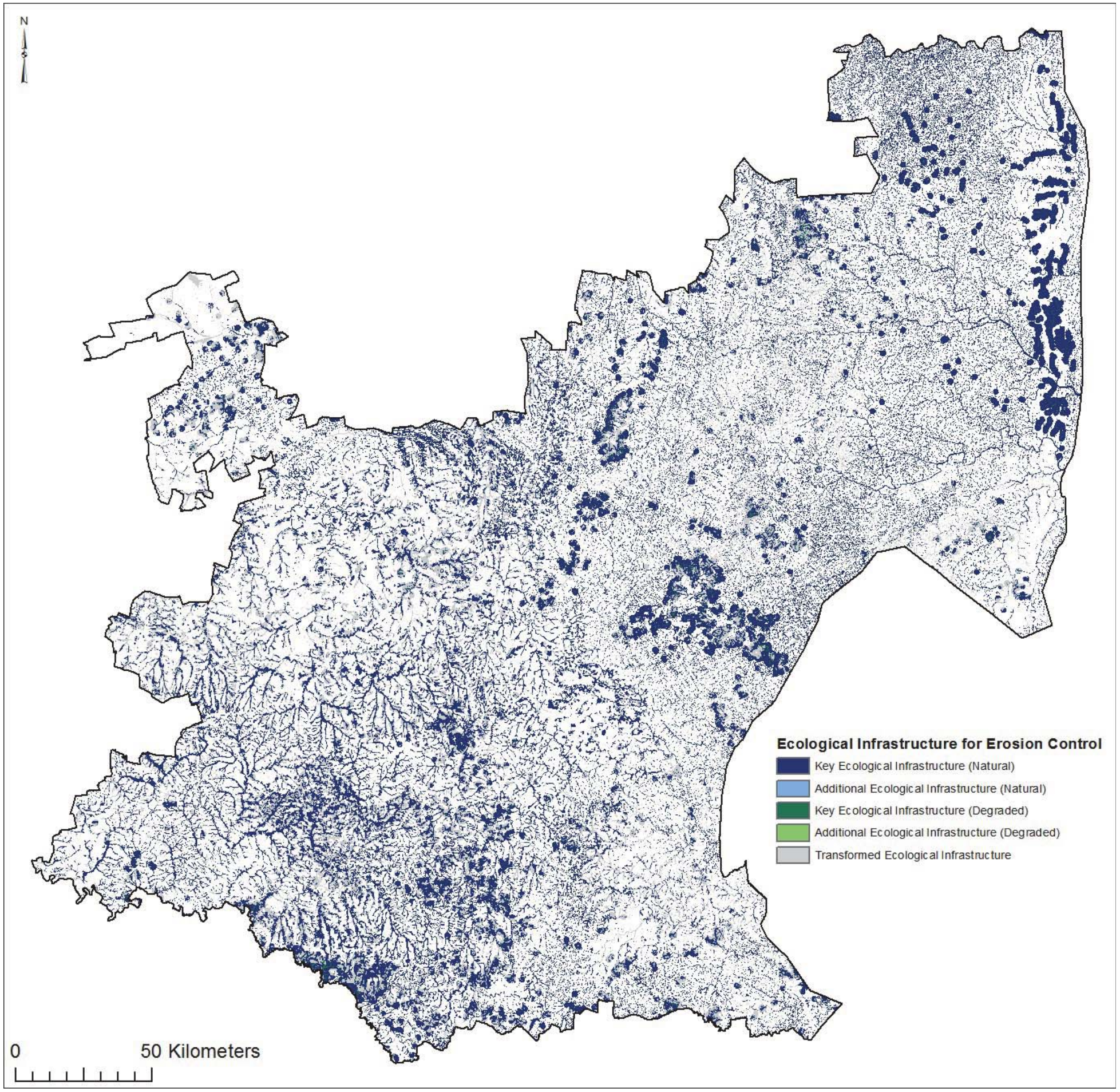


Figure 10: Areas of Ecological Infrastructure important for erosion control.

4.6 ECOLOGICAL INFRASTRUCTURE FOR WATER QUALITY

4.6.1 Approach to developing the layer

The project identified areas important for enhancement or maintenance of water quality, including areas important for sediment trapping, and reducing levels of phosphates, nitrates and toxicants. Protecting or improving these areas of EI would reduce water treatment costs. The method (detailed in Table 8) is described below:

- Wetlands specifically important for water quality enhancement were prioritized.
- The wetland plus a wide (100 m) buffer were used for the wetland types which are most important from a water quality perspective (floodplain wetland, seep, unchannelled valley-bottom wetland, valleyhead seep).
- The wetland plus a narrower 50 m buffer being included as additional ecological infrastructure for types which play a role in water quality but are not as critical (channelled valley-bottom wetlands and depression and flat pans).
- A two stage buffering of rivers was undertaken:
    - Riparian buffer areas immediately adjacent to key rivers were scored highest (100 m on larger rivers).
    - A broader but lower value buffer was then added. A buffer of 250 m was used on larger rivers and 32 m on all other rivers.
- Scores and categories were determined by overlaying the scores assigned to the individual features from the individual input layers (i.e. the ones and twos from Table 8) and calculating the highest value at a site.
- The resultant layer of Key and Additional Ecological Infrastructure was then combined with the three class landcover map (showing natural, degraded and transformed areas). This gave an integrated layer with five categories (as we combined all transformed EI areas into a single category).
- A composite map was developed, which is shown in Figure 11.

4.6.2 Technical details of the data layer

- The detailed raster grid is available on the data DVD at \Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Ecological Infrastructure Mpumalanga\qual_ei_m.rrd. The data is provided with a layer file (Ecological Infrastructure for Water Quality.lyr) to facilitate display. The data will be served from **http://bgis.sanbi.org**.
- Its short description is: Ecological Infrastructure for Water Quality.
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.
- The coding is:
    - Key Ecological Infrastructure (Natural) = 1
    - Additional Ecological Infrastructure (Natural) = 2
    - Key Ecological Infrastructure (Degraded) = 3
    - Additional Ecological Infrastructure (Degraded) = 4
    - Transformed Ecological Infrastructure = 5

Table 8: Methods used to identify key areas of Ecological Infrastructure important for water quality.

			Ecological Infrastructure: Intact areas for protection (i.e. Areas that are in good condition)	Potential Ecological Infrastructure: Areas for rehabilitation (i.e. Areas that are in poor condition)	Transformed Ecological Infrastructure (i.e. Areas where value has been lost, but there may be opportunities to reduce negative impacts)
Enhancement of water quality (including sediment trapping, phosphates, nitrates and toxicants)					
Wetlands	Wetlands specifically important for water quality enhancement	Channelled valley-bottom wetland with 50m buffer	1	1	1
		Floodplain wetland with 100m buffer	2	2	1
		Pans (Depression & flat) with 50m buffer	1	1	1
		Seep with 100m buffer	2	2	1
		Unchannelled valley-bottom wetland with 100m buffer	2	2	1
		Valleyhead seep with 100m buffer	2	2	1
Rivers	Rivers	Riparian buffers (32m minimum; 100m larger rivers)	2	2	1
		Riparian buffers (250m on larger rivers, 100m on smaller but perennial rivers)	1	1	1

Values: 2 = Key ecological infrastructure; 1 = Other Ecological Infrastructure

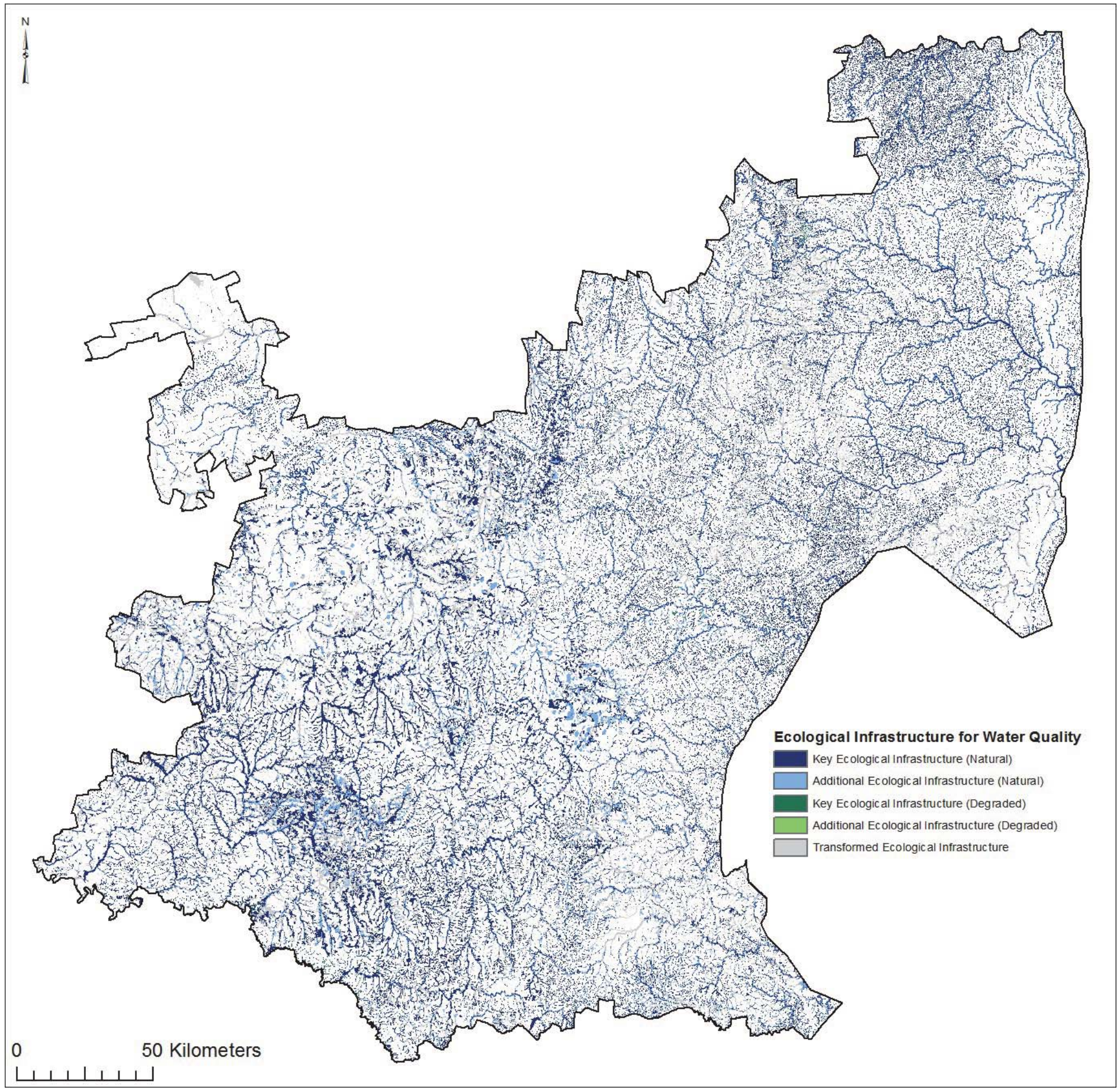


Figure 11: Areas of Ecological Infrastructure important for water quality.

4.7 ECOLOGICAL INFRASTRUCTURE FOR FLOOD ATTENUATION

4.7.1 Approach to developing the layer

The project identified areas important for flood attenuation e.g. the particular types of wetland which are important for delaying flood peaks and reducing flood intensity. Protecting or improving these areas of EI would reduce risk to water supply infrastructure during extreme flood events. The method (detailed in Table 9) is described below:

- Wetlands specifically important for flood attenuation were prioritized:
    - The wetland plus a wide (100 m) buffer were used for the wetland types which are most important from a flood attenuation perspective (floodplain wetland).
    - The wetland plus a narrower 50 m buffer were included as additional ecological infrastructure for types which play a secondary role in flood attenuation but are not as critical (channelled valley-bottom wetlands, depression and flat pans, seeps, unchannelled valley-bottom wetlands and valleyhead seeps).
- A single stage buffering of rivers was undertaken and these areas were also included as additional ecological infrastructure:
    - A buffer of 250 m was used on larger rivers and 100 m on smaller perennial rivers.
- Scores and categories were determined by overlaying the scores assigned to the individual features from the individual input layers (i.e. the ones and twos fromTable 9) and calculating the highest value at a site.
- The resultant layer of Key and Additional Ecological Infrastructure was then combined with the three class landcover map (showing natural, degraded and transformed areas). This gave an integrated layer with five categories (as we combined all transformed EI areas into a single category).
- A composite map was developed, which is shown in Figure 12.

4.7.2 Technical details of the data layer

- The detailed raster grid is available on the data DVD at \Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Ecological Infrastructure Mpumalanga\flood_ei_m.rrd. The data is provided with a layer file (Ecological Infrastructure for Flood Attenuation.lyr) to facilitate display. The data will be served from **http://bgis.sanbi.org**.
- Its short description is: Ecological Infrastructure for Erosion Control.
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.
- The coding is:
    - Key Ecological Infrastructure (Natural) = 1
    - Additional Ecological Infrastructure (Natural) = 2
    - Key Ecological Infrastructure (Degraded) = 3
    - Additional Ecological Infrastructure (Degraded) = 4
    - Transformed Ecological Infrastructure = 5

Table 9: Methods used to identify key areas of Ecological Infrastructure important for flood attenuation.

			Ecological Infrastructure: Intact areas for protection (i.e. Areas that are in good condition)	Potential Ecological Infrastructure: Areas for rehabilitation (i.e. Areas that are in poor condition)	Transformed Ecological Infrastructure (i.e. Areas where value has been lost, but there may be opportunities to reduce negative impacts)
Flood attenuation					
Rivers	Rivers	Riparian buffers (250m on larger rivers, 100m on smaller but perennial rivers)	1	1	1
Wetlands	Wetlands specifically important for flood attenuation	Channelled valley-bottom wetland with 50m buffer	1	1	1
		Floodplain wetland with 100m buffer	2	2	1
		Pans (Depression & flat) with 50m buffer	1	1	1
		Seep with 50m buffer	1	1	1
		Unchannelled valley-bottom wetland with 50m buffer	1	1	1
		Valleyhead seep with 50m buffer	1	1	1

Values: 2 = Key ecological infrastructure; 1 = Other Ecological Infrastructure

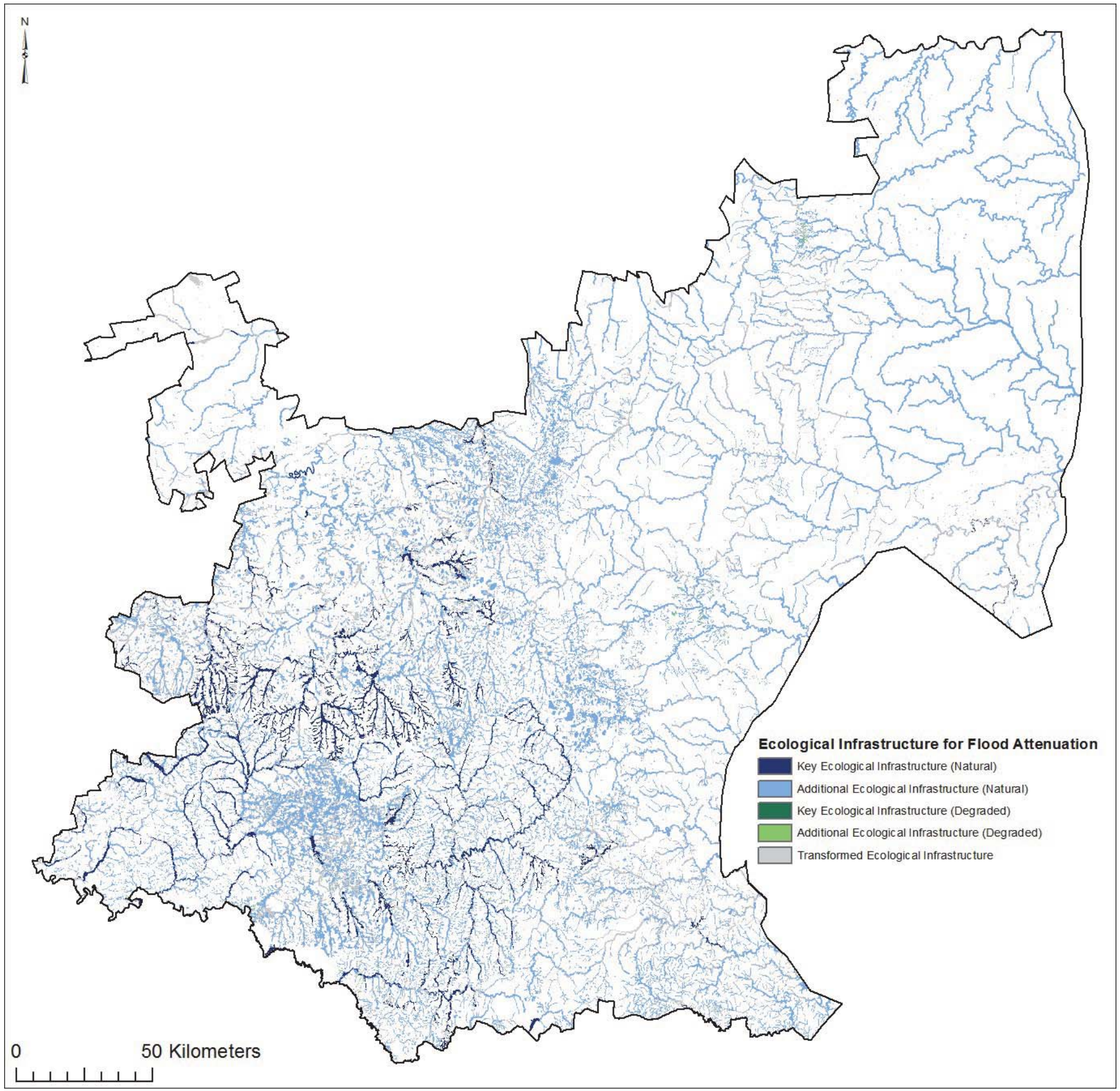


Figure 12: Areas of Ecological Infrastructure important for flood attenuation.

4.8 INTERGRATED ECOLOGICAL INFRASTRUCTURE MAP

4.8.1 Approach to developing the layer

The previous sections described how four summary layers of areas of important Ecological Infrastructure were developed. These layers described areas of Ecological infrastructure important for:

- Water production and stream flow augmentation e.g. natural areas with high water yield and portions of the landscape required to support flow during the dry season. Protecting or improving these areas of EI would reduce requirements for additional.
- Erosion control i.e. erosion prone areas which need to be kept intact or rehabilitated. Protecting or improving these areas of EI would reduce capacity reduction of storage schemes and reduce water treatment costs.
- Enhancement of water quality, including areas important for sediment trapping, and reducing levels of phosphates, nitrates and toxicants. Protecting or improving these areas of EI would reduce water treatment costs.
- Flood attenuation e.g. the particular types of wetland which are important for delaying flood peaks and reducing flood intensity. Protecting or improving these areas of EI would reduce risk to water supply infrastructure during extreme flood events.

The project utilized a simple but robust approach to integrating the four individual layers of areas of important Ecological Infrastructure:

- The individual summary layers were overlaid.
- Scores and categories were determined by overlaying the features and the transformation data.
- The highest score from any individual layer was identified and this score was used as the value for that point.
- A composite map was developed which is shown in Figure 13.

4.8.2 Interpreting the layer

The combination of the feature summary layers with the transformation data resulted in five categories:

- Key Ecological Infrastructure (Natural) – i.e. the most important features for delivering water related services and which are still in a natural or semi-natural condition. These are areas which are very likely to be critical to the delivery of services, and priority should be given to maintaining these areas in a natural state. These areas should be the focus for proactive conservation efforts such a stewardship, appropriate land management should be incentivised, and emerging threats such as alien vegetation should be carefully managed through NRM projects.
- Additional Ecological Infrastructure (Natural) – i.e. other important features for delivering water related services and which are still in a natural or semi-natural condition. These are areas which are likely to be delivering fewer services, or only fulfil a supporting role in service delivery. Nevertheless, in the context of a water stressed catchment, these areas should also be maintained in a natural state, and should be appropriately managed.
- Key Ecological Infrastructure (Degraded) – i.e. the types of features which are most important features for delivering water related services, but which have been degraded through inappropriate land management practices. These areas are currently in a poor or degraded condition, but could be rehabilitated to improve ecological service delivery. These areas are a logical focus area for NRM projects aimed at rehabilitation, and could result in significant improvements in water delivery from more resilient system of Ecological Infrastructure. Investment in these areas, or appropriate incentives to improve land management practices, should be investigated.
- Additional Ecological Infrastructure (Degraded) – i.e. the types of features which play an important secondary role in delivering water related services, but which have been degraded through inappropriate land management practices. As with the previous category, these areas should also be

considered for NRM projects and improved management. However, they are likely to be of lower value than the previous categories.

- Transformed Ecological Infrastructure: These are areas where Ecological Infrastructure has been lost, but where there may be opportunities to mitigate/reduce negative impacts through improved management practices and interventions with the production sectors (e.g. arable agriculture) active in these areas. At a finer scale, it may be possible to identify areas important for delivering ecosystem services (e.g. wetland buffers in wattle plantation areas), and through sector based interventions secure appropriate management of these areas. In the long term it may be worthwhile to consider the full cost-benefit of activities and sectors which heavily impact of ecosystem service delivery, and make appropriate decisions on the continuation or withdrawal of activities from key areas where restoration could improve ecosystem service delivery.

4.8.3 Technical details of the data layer

- The detailed raster grid is available on the data DVD at \Mpumalanga Atlas 2014\GIS_Viewer\Data Mpumalanga\Ecological Infrastructure Mpumalanga\ Water_EI_m.rrd. The data is provided with a layer file (Combined Water Related Ecological Infrastructure.lyr) to facilitate display. The data will be served from **http://bgis.sanbi.org**.
- Its short description is: Combined Water Related Ecological Infrastructure. This layer integrates the individual ecological infrastructure layers for water production, flood attenuation, water quality and erosion control.
- The GIS projection details are WGS_1984_Albers, Projection: Albers, False_Easting: 0.000000, False_Northing: 0.000000, Central_Meridian: 25.000000, Standard_Parallel_1: 20.000000, Standard_Parallel_2: -23.000000, Latitude_Of_Origin: 0.000000, Linear Unit: Meter, GCS_WGS_1984, Datum: D_WGS_1984.
- The coding is:
    - Key Ecological Infrastructure (Natural) = 1
    - Additional Ecological Infrastructure (Natural) = 2
    - Key Ecological Infrastructure (Degraded) = 3
    - Additional Ecological Infrastructure (Degraded) = 4
    - Transformed Ecological Infrastructure = 5

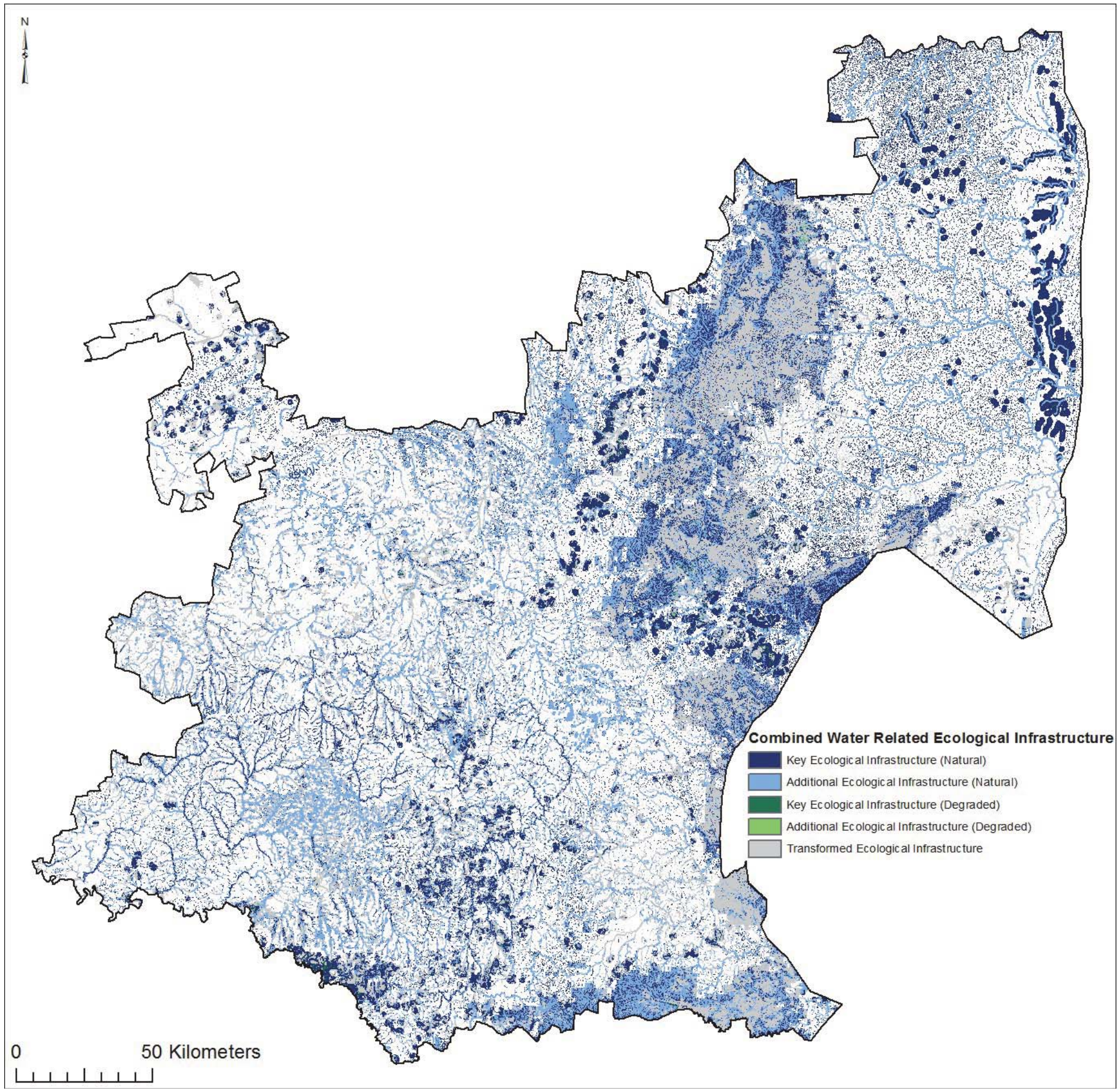


Figure 13: Integrated map of Water Related Ecological Infrastructure for Mpumalanga.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

One of the key aims of this project was to improve the knowledge and use of appropriate spatial information to guide both mining companies and regulators in their planning and decision-making. The spatial data developed by the project, and that can be accessed via the atlas, via the internet (at http://bgis.sanbi.org and www.wrc.org.za), or by directly using the data in a GIS, will hopefully contribute to a significant improvement in the spatial understanding of high risk wetlands and associated landscapes in the mining areas of Mpumalanga. The atlas aimed to identify key wetland landscapes in the grassland biome of Mpumalanga that are particularly important or irreplaceable in terms of biodiversity, water resource management and other ecosystem services.

The project developed four new spatial data layers relevant for helping the mining sector limit and mitigate its impact on wetlands in Mpumalanga. These layers are:

- A revised and updated spatial analysis for the Mining and Biodiversity Guideline (DEA et al., 2013) which has been updated to include the new Mpumalanga Biodiversity Sector Plan (MTPA, 2014), updated Protected Area data, revised Strategic Water Source Data (Nel et al., 2013a), and revised Freshwater Ecosystem Protection Area (FEPA) and wetland data for Mpumalanga (Mbona et al., 2014).
- A disaggregated set of the underlying spatial data for the Mining and Biodiversity Guideline, which allows one to identify the specific features that triggered the categories in the summary data.
- An interpreted version of the Mining and Biodiversity Guideline Spatial layer, which divides the broad national categories based on local landcover and the features found at a site. The layer quickly summarizes probable low, medium and high value areas within each category on the Mining and Biodiversity Guideline Spatial layer. The assessment is relative to all sites in Mpumalanga.
- An Ecological Infrastructure for Water analysis of Mpumalanga, which incorporates a combined Ecological Infrastructure for Water Supply summary layer as well as individual layers for:
    - Ecological Infrastructure for Water Production and Flow Augmentation Analysis.
    - Ecological Infrastructure for Flood Attenuation.
    - Ecological Infrastructure for Water Quality.
    - Ecological Infrastructure for Erosion Control.

In addition, the atlas provides access to other key data that were not developed by the project but that are very useful for mining planners such as the new Mpumalanga Biodiversity Sector Plan (MTPA, 2014), updated Protected Area data, revised Strategic Water Source data (Nel el al, 2013a), revised Freshwater Ecosystem Protection Area (FEPA) data for Mpumalanga, and the new wetland data for Mpumalanga (Mbona et al., 2014).

Consideration of these spatial informants into mining planning processes as well as regulatory processes, should result in a significant improvement in the spatial understanding of high risk wetlands and associated landscapes in the mining areas of Mpumalanga

5.2 RECOMMENDATIONS

All spatial data are only representations of reality. In some areas, specific spatial datasets will very closely represent the situation on the ground, while in other areas the data are less accurate. Therefore it is very important to recognize the limitations of any spatial dataset, and identify where these datasets can most usefully be improved over time. Critical issues include:

- Scale: Specific datasets may be reasonable representations of the actual landscape at a broader scale (e.g. at 1:50 000) but may be a poor representation at a fine scale (e.g. 1:10 000). This does not mean that the broader data (and its associated “inaccurate” boundaries) are not useful at a fine scale, but

rather that they need to be carefully interpreted. Over time, it is recommended that the key spatial data layers are refined and their useable scale improved.

- Classification issues: Spatial dataset of contain classification errors, especially when the dataset is based on remote sensing. For example, in a landcover dataset, an area of natural/intact habitat could be misidentified as a degraded area. Conversely, a highly impacted area may be wrongly classified as natural. It is recommended that additional effort be expended on refining and improving the basic datasets that underlie these summary analyses. It is however likely that one will always have to verify the spatial data with site level data for detailed decision making at a site level.
- Aging of datasets: Key features of the landscape such as the landcover and protected areas can change rapidly, and hence it is critical that sufficient effort and resources are expended to ensure that datasets are kept sufficiently up to date. Further, there can be rapid improvements in the underlying data and analyses, and hence it is important that the secondary analyses are updated to reflect the changes in underlying datasets.

It is therefore critical to understand that:

- The atlas does not replace the underlying datasets. These datasets and analyses are updated over time, and hence it is important to check that you have the most up to date dataset. This is particularly important if you are using the data or GIS viewer on the DVD supplied with this report. This data is designed to supplement the main distribution point for the atlas, which is online interactive website maps that will be served from http://bgis.sanbi.org. Unlike the DVD, which is published on a particular date, the data on the website will be kept current.
- The atlas does not in itself give or limit any rights (e.g. development rights) or give any guarantee that an environmental application will be approved or disapproved. The atlas is only a compilation of existing datasets and some secondary analyses (e.g. of ecological infrastructure). It contains information that is useful to support sensible decision-making, but does not make any decisions.
- The atlas does not replace the need for site assessments, particularly for Environmental Impact Assessments and Basic Assessment. Although it is based on the appropriate a fine-scale systematic biodiversity planning, this does not remove the need for on-site verification of the identified priority features.
- The atlas is designed to be used at a scale of approximately 1:50 000. Although it can be used at a finer scale, this requires specialist interpretation of the specific features.
- The atlas was developed using appropriate methods; and uses the best available data at the time of its development. However, current scientific knowledge of key aspects such as the distribution of certain threatened species remain incomplete. As our knowledge improves, the atlas should be revised and kept up to date.
- Land use change in the province is rapid and on-going, and results in biodiversity losses. This may result in additional areas being designated as important (e.g. as Critical Biodiversity Areas in future iterations of the provincial conservation plan).

Finally, should this approach to improving the spatial understanding and use of data on high risk wetlands and associated landscapes successfully contribute to limiting and mitigating the impact of coal mines on wetlands in the mining areas of Mpumalanga, then it is suggested that the approach should be extended to other mining areas such as the Waterberg.

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