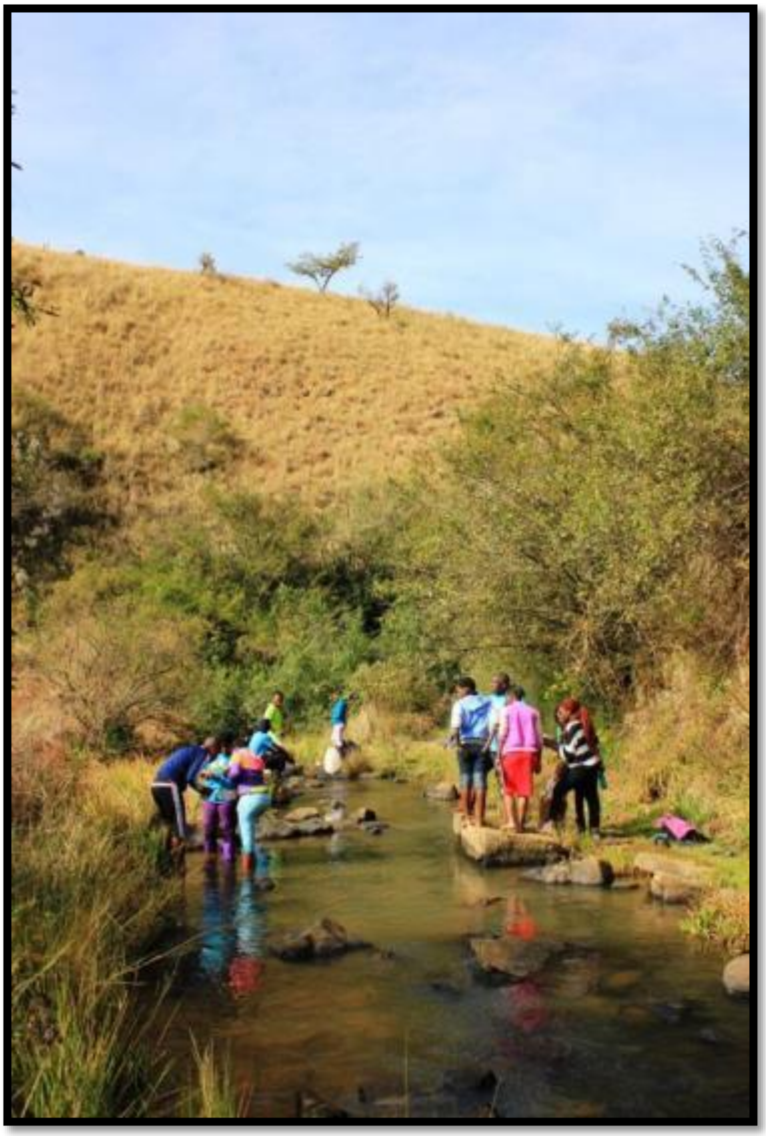
Riparian Health Audit



A simple Citizen Science tool for assessing riparian ecosystem integrity

This is a product of The Water Research Commission: Project No. K5/2350

Contents

List of Figures

List of Tables

Introduction and Background

1.1 Introduction

This document serves as a manual for the assessment of the ecological health of riparian ecosystems using the Riparian Health Audit.

The key users of the assessment tool include:

- Citizen scientists
- Communities
- NGOs
- Local environmental authorities
- Landowners

It is recommended that prior to utilising the tool; assessors should review basic literature on riparian ecosystems and attend various training courses related to the subject. Though this may not be necessary, it will aid assessors in the identification of impacts and thereby, improve confidence in the data.

The application of the tool includes:

- Determining the current ecological health of the riparian system of interest and identifying the key impacts that should be addressed to maintain or restore its health
- Monitoring potential impacts to the riparian system from any development and industrial activities
- Monitoring for auditing of rehabilitation strategies

The fields of application include:

- Benchmarking studies (studies that confirm status compared to other riparian areas)
- Scientific research of citizen science studies
- Integrated catchment management programmes

Please note: This tool is intended to be a simple but effective tool that will allow the user to identify, rate and report on the impacts to local rivers and streams on a basic level.

To assess a river on an intermediate level particularly within an urban area the following document should be read:

Braid, S. 2014. Tools to Determine Enforcement Driven Rehabilitation Objectives on Urban River Reaches-Guideline Document, Water Research Commission, South Africa. Report No: TT594/14.

This guideline was aimed at Compliance and Enforcement Officials within Governmental bodies and contains South African legislation regarding river ecosystems.

Citizen scientists are therefore encouraged to first use the Riparian Health Audit given the intermediate level of knowledge and skill required.

1.2 Background

The National Water Act defines riparian areas as "*The physical structure and associated vegetation of areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas*." In simpler terms riparian ecosystems are defined as the interface between aquatic (water) and terrestrial (land) ecosystems; Figure 0. and Figure 1.2 provides an example.

It is important to note that wetlands are defined as transitional between aquatic and terrestrial systems. Therefore, riparian areas that are saturated or flooded for prolonged periods could be described as riparian wetlands. However, not all riparian areas are wetlands especially in areas that are well-drained.

Riparian areas form corridors through the catchment and are primarily structured through hydrological and geological activities. Due to their location and the associated environmental phenomena that influence their structure, they possess substantially different properties from the surrounding landscape.

The importance of riparian zones in maintaining catchment health exceeds their area of occupancy within the catchment by virtue of the ecosystem processes that occur within them. Furthermore, riparian ecosystems provide people with a diversity of natural resources. Collectively, these are referred to as Ecosystem Goods and Services.

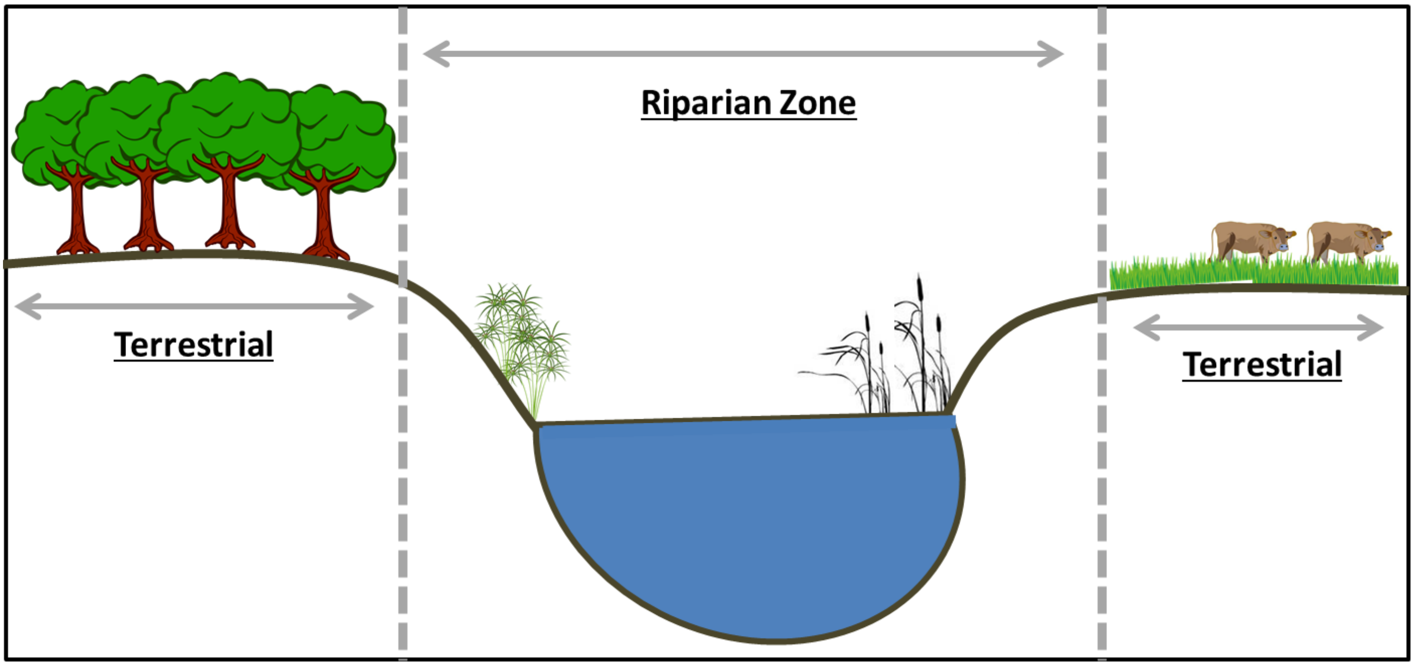


Figure 0.1 The riparian zone

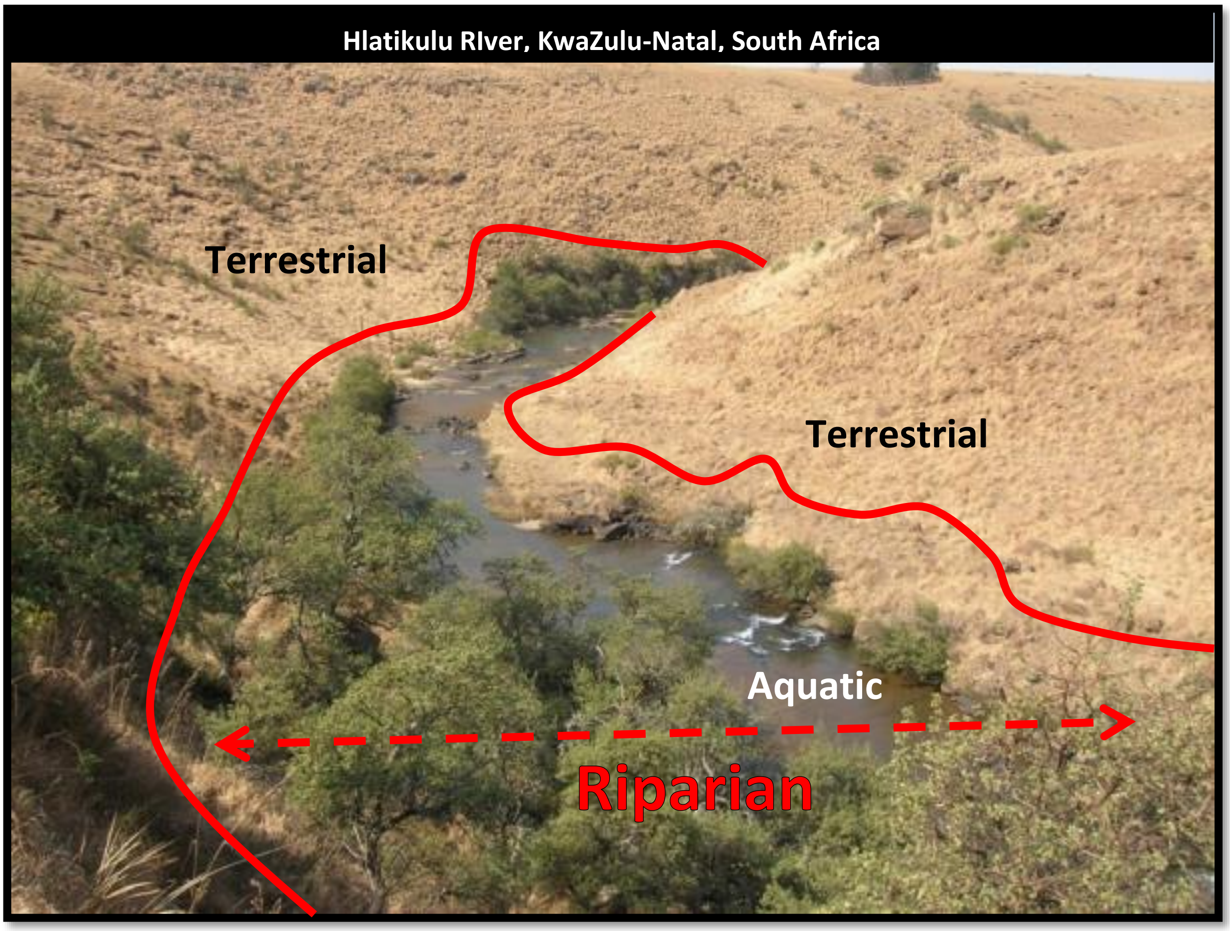


Figure 0.2 Riparian ecosystems (indicated by the red outline) are at the boundary between terrestrial and aquatic ecosystems

Rivers can be viewed as transport routes, carrying sediments and chemical compounds from one location to another. Riparian ecosystems effectively trap sediment from surface runoff decreasing sediment load. Moreover, due to the vegetation present within the riparian zone, bank erosion is generally impeded.

Riparian systems accumulate and remove nutrient and contaminant loads, such as Nitrogen, Phosphorous and pesticides by virtue of the ecological processes that occur within them. Therefore, riparian ecosystems are critical in maintaining water quality.

The alluvial soil (soil deposited by water flows) tends to form a relatively deep layer and is able to store quantities of water from run-off or rainfall. Therefore, riparian habitats support base flows when groundwater from the riparian zone seeps into the channel. (Base flow is the portion of stream flow that results from seepage of water from the ground into a channel slowly over time.)

Riparian ecosystems provide habitat and corridors for movement for many living organisms (biota), including amphibious and terrestrial organisms. These organisms themselves provide many ecosystem goods and services to people. They provide pest control, medicinal compounds and a pollination function. In addition, riparian systems are important for maintaining optimal habitat conditions for aquatic organisms by: a) providing physical structure in the form of woody debris; b) moderating water temperature through shading and evapotranspiration and c) providing energy resources. Furthermore, they aid in attenuating floods (attenuation is the process of water retention on site and slowly releasing it in a controlled discharge) thus preventing damage to downstream ecological and built infrastructure. Figure 1.3 provides an example of some of the ecosystem goods and services provided by riparian ecosystems.

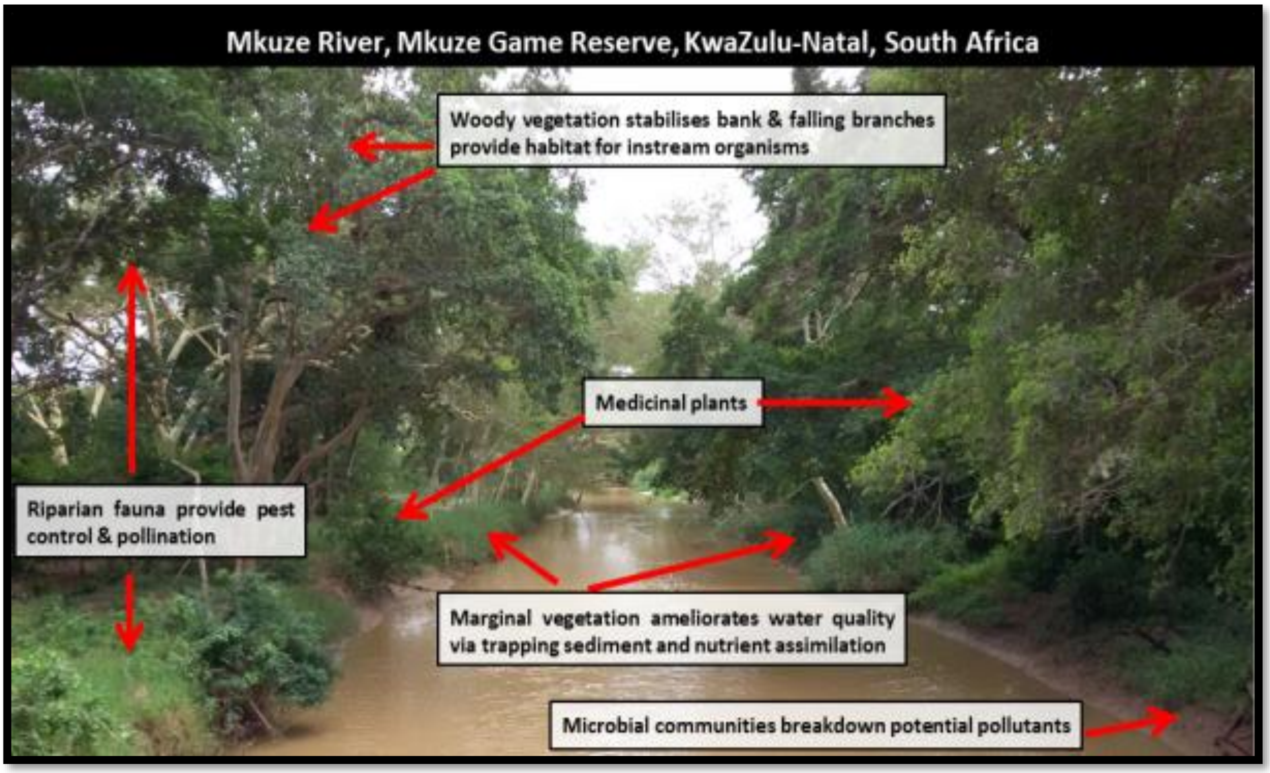


Figure 0.3 an example of the array of ecosystem goods and services that a naturally functioning riparian system can supply

Riparian systems can be referred to as 'Critical Transition Zones' as they serve as a pathway of a relatively vast amount of energy and matter from one clearly defined ecosystem to another. Due to their nature, these systems are usually subjected to intensive pressure by human activity. Therefore, riparian ecosystems are often impacted and transformed by these human activities on a local and global scale.

In order to manage these vital ecosystems it is important that their ecological condition can be assessed. Remember: *"You can't manage what you don't measure"*. The Riparian Health Audit (RHA) was developed to provide a simple and easy-to-use tool that will enable the assessment of riparian ecosystem condition by a wider range of users for various applications.

1.3 Background to the Structure of the Riparian Health Audit

The RHA method demonstrates to a user how to:

- Prepare for and undertake fieldwork
- Identify the riparian zone
- Identify key impacts within the riparian zone;
- Determine the extent to which these impacts are compromising the ability of the riparian zone to function naturally

Each impact is rated according to the intensity and extensiveness of that negative impact. The recorded scores are entered into the RHA Model on an Excel spreadsheet that produces a score, rating the ecological condition of the riparian zone. The score is based on the extent to which the riparian zone being assessed is degraded compared to that of natural conditions.

This guide is designed to aid prospective RHA users, and enables and assists in the:

- Identification of the lateral extent of riparian habitat
- Identification of human influences and negative impacts to the assessed riparian habitat
- Rating the intensity of these negative impacts

Through literature reviews and research, 8 impacts were identified as the principle negative influencers to the functioning and integrity of riparian ecosystems. The impacts identified are as follows:

- Exotic Vegetation
- Rubbish Dumping
- Bank Erosion
- Inundation
- Flow Modification
- Evidence of Decreased Water Quality
- Vegetation Removal
- Channel Modification

1.4 Glossary and Description of Impacts Observed and Recorded for the Riparian Health Audit

1.4.1 Exotic Vegetation

Exotic plants are species that are not indigenous to the specific geographic region being assessed. In this context, we include alien plants, alien invasive plants, commercial crops, gardens and hedgerows as exotic. Due to a lack of natural predators (as well as a number of other factors), exotic plants are able to outcompete indigenous plant species and therefore are able to spread. Some exotic species are so successful in their new environments that they become invasive and dominate the landscape. These invasive alien species (IAP's) out-compete the indigenous vegetation for resources. Exotic plants alter the natural functioning of riparian areas by exacerbating erosion and reducing biodiversity. They also negatively influence the instream habitat as they use more water than indigenous plants and change natural temperature cycles through excessive shading of the channel.

Ideally, the assessor should be able to identify exotic plants, particularly locally important species. There are several field guides available that will aid in identification.

Some possible references to aid the identification process:

- Bromilow C, 2010. *Problem plants and alien weeds of South Africa,* Third edition, Briza, Pretoria.
- www.ispotnature.org
- www.invasives.org.za

1.4.2 Rubbish Dumping

Rubbish dumping can be defined as the presence of solid waste within riparian ecosystems as a result of direct disposal into the riparian system or transported by the river or stream from upstream sources. Dumped rubbish changes habitat characteristics and negatively impacts ecosystem functioning. Furthermore, rubbish dumps drive health and safety issues, both locally and downstream and become breeding grounds for pest species including disease hosts and vectors.

1.4.3 Bank Erosion

The bank of a river or stream is the relatively steep part of the channel above the water level; this makes it susceptible to bank erosion. Bank erosion is a type of water erosion whereby the bank of a stream is eroded due to runoff. Although bank erosion (i.e. weathering) is a natural geological process (without bank erosion we would have no meandering streams); it may be accelerated by the impacts to the river system. Therefore, it is critical for an assessor to consider the environmental setting where the assessment is undertaken. The assessor should look to see if erosion is driven by vegetation removal, cattle access paths, an increase in water flow due to wastewater and storm water discharge, or the presence of exotic plants. If the user is not confident in distinguishing between natural or accelerated erosion, a riparian expert should be consulted.

1.4.4 Inundation

Inundation is the flooding of the riparian zone through the construction of impoundments or dams to slow down or stop water flow. Inundation typically results in an alteration of habitat characteristics. The riparian system is transformed into an aquatic system with a resultant change in ecosystem processes and biota.

1.4.5 Flow Modification

Flow modification refers to a change in the natural flow regime of a river. This could be either an increase in flow or a decrease in flow. This change in flow will affect the riparian zone, although the impact might not be that obvious initially or after a long time, as it is difficult to judge changes in riparian vegetation on a once-off visit. For this reason, it is necessary to investigate changes in flow above and below the reach that you are investigating. You will need to look for indications that the flow is being changed. Look for pipes and waterworks that are either pumping water into or out of the stream. It is also sometimes possible to assess change using the google earth timeline function. Floods that occur according to a natural cycle are required to prevent any one particular vegetation type from dominating the riparian zone. Naturally occurring high flows also aid in dispersing vegetation seeds or spores, transporting nutrients into the riparian zone and recharging groundwater. Therefore, modification of flows may reduce groundwater recharge, impede propagule dispersion and support the growth of plant species that will favour the new conditions.

Additionally, artificially sustained flows during the dry season, through the release of wastewater for example, may influence the reproductive and growth cycle of riparian vegetation. On the other hand, systems that normally have naturally sustained flows during the dry season may be impacted through diminished flows through water abstraction.

IMPORTANT NOTE: Where flow modification from wastewater and storm water exacerbates erosion and alters the water quality, these should be rated under their relevant sections to avoid duplication of impact ratings.

1.4.6 Channel Modification

Channel modification to the riparian zone is the alteration of the natural physical shape of the banks making up the riparian area. These can be caused by the construction of physical, man-made structures such as causeways, road-alignments, culverts, gabions and canals.

An important phenomenon to look out for, particularly in urban locations, is the re-shaping of the channel through increased discharges into the channel. In this scenario, increased discharges particularly through storm water erode the banks until the system eventually settles and lead to alterations of the channel dimensions. However, this may be difficult to identify in-field and may require historical knowledge of the area (again, try the timeline function on google earth).

IMPORTANT NOTE: Please take note and be clear of the difference between flow modification and channel modification before going into the field.

1.4.7 Evidence of Decreased Water Quality

This includes; Physico-chemical modifications which are changes to the riparian zone due to the alteration of water quality in the channel. Sources of pollution that change water quality may arise from a point (municipal and industrial wastewater effluent or storm water discharge points), or diffuse sources (run-off from surrounding landscape). Nutrient inputs may intensify exotic vegetation growth and may lead to root fanning towards the channel, and excessive shading. Excess sediment may be deposited within the riparian zone leading to an alteration in habitat characteristics and ultimately ecosystem functioning. Toxins present may cause acute and chronic affects to riparian biota through direct and indirect exposure.

1.4.8 Vegetation Removal

This is the removal of indigenous vegetation through livestock trampling (when livestock are gaining access to the channel for water), excessive harvesting by people, construction (including the construction of sports fields), agricultural and mining activities. It may be helpful at this stage to have a look at the site with the google earth timeline function.

Method to undertake the riparian health audit

The purpose of this section is to provide the user with the necessary guidelines to collect field data to assess the riparian system/s of interest.

Good Practices when using the Method:

a) **Thoroughly read and ensure you understand the manual**
b) **Understand basic riparian ecology and functioning by reading background information on riparian ecology**
c) **Attend basic ecological education and training courses**
d) **Walk throughout the area that you are interested in rather than observing from a single point**
e) **Regularly refer to the photographic and illustrative guide section of this manual when rating impacts**
f) **Obtain landowner permission when and where required**
g) **Engage with the local community and authority in order to promote sustainable management and/or rehabilitation options**
h) **Talk to locals about the condition of the area; try to find out some history about the site to assist you with your assessment**

1.5 Step 1 – Preliminary Steps

Before you start your assessment of a riparian system of interest, certain steps are needed to facilitate the assessment and aid in data collection. Preliminary activities include:

- Reach Delineation
- Visualisation of Natural Conditions
- Creation of Field Work Maps
- Checklist of items that will assist in undertaking the Riparian Health Audit

In order to facilitate these preliminary steps, users of the RHA should learn and use Google™ Earth or Google™ Earth Pro and be familiar with its capabilities. Download Google™ Earth Pro at http://www.google.co.za/earth/download/gep/agree.html

1.5.1 Reach Delineation

A reach is a length or section of river or stream that is relatively similar in terms of the channel pattern that can be observed on a map, for example some reaches have a much more twisted (i.e., sinuous) pattern than other reaches. The division of the riparian system of interest into reaches is dependent on the scale of the project. Large-scale projects should divide the riparian systems into reaches to provide greater detail of riparian ecological health and to highlight key areas within the catchment. The division of riparian systems into reaches for small-scale projects is not necessary, as the length of the system of interest may be limited to a relatively small area such as a single property or river crossing. The division of the riparian zone into reaches could be based on the following:

- Land-cover/use
- Obvious changes in the pattern of the channel

- Property boundaries
- River confluences (where two or more rivers meet)

Therefore, the division of reaches by geographical features is left to the discrepancy of the assessor but the aim or question of their study must be considered.

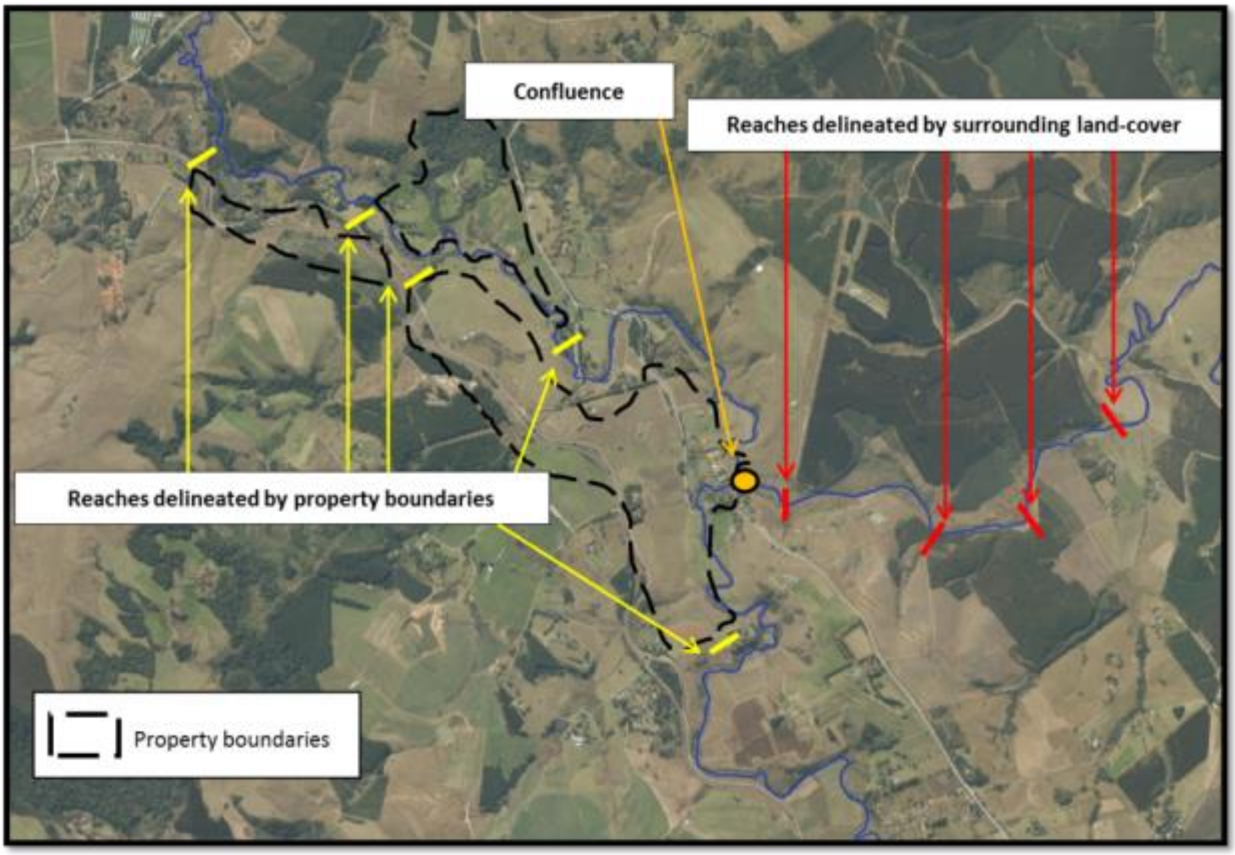


Figure 0.2 Example of reaches delineated by surrounding land-cover, property boundaries or at a confluence.

1.5.2 Visualisation of Natural Conditions

Prior to assessing the riparian system of interest, users should envision the reach as it would have been under natural conditions. While doing this it is also important to consider the landscape in which you are working. Are you in an arid or semi-arid part of the country, where rivers tend to be dry in the dry season, and prone to flash floods in the rainy season, or are you in a high rainfall area, where there rivers flow throughout the year?

Important features to note include the way it meanders (the channel sinuosity), the dominant vegetation growth form (grasses, reeds or woody vegetation) and the level of bank erosion. This can be determined through several means:

a) Review historical photographs or historical aerial imagery
b) Observe nearby systems that are in well-managed protected areas (such as nature reserves and national parks)
c) Speak to elderly members of the community. They have tremendous local knowledge and may be able to describe the past conditions of the system such as flood levels, vegetation types etc.

1.5.3 Generation of Field Work Maps

To facilitate the assessment of riparian ecological health of a selected river system utilising the RHA, fieldwork maps should be made, if possible using Google™ Earth. These maps provide useful background conception to the current land-use and land-cover and annotations or notes can be added to the map once in the field. Therefore, it is preferable that these maps are in black and white. Figure 0.3 provides an example of a fieldwork map.

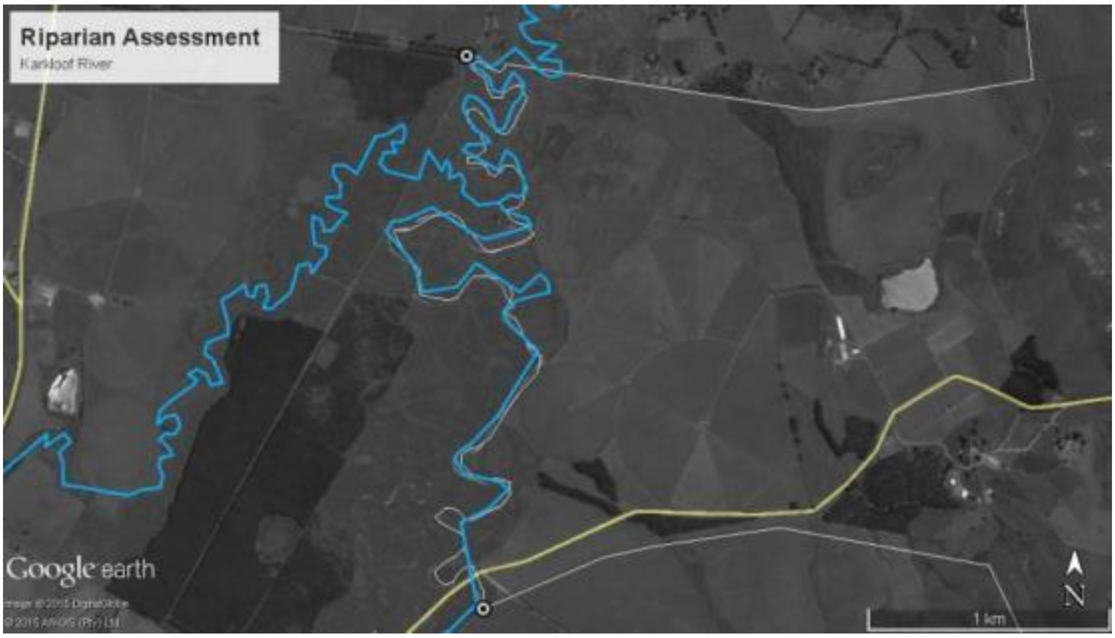


Figure 0.3 Example of a fieldwork map generated using Google™ Earth

1.5.4 Checklist of items that will assist in undertaking the Riparian Health Audit

Before undertaking fieldwork, the assessor/s should make a checklist of items that would be required or prove useful in the field (Table 0.1).

Table 0.1 Summary of essential and potentially useful fieldwork items for the Riparian Health Audit

Item	Essential	Potentially Useful
Field sheet	✓	
Suitable notebook[1], pencil and eraser	✓	
Clipboard (for field sheets)	✓	
Photographic & illustrative guide of the manual	✓	
Camera or camera phone	✓	
First aid kit	✓	
Field guides for identifying plants & animals	✓	
Global Positioning System / phone with GPS		✓
Gumboots		✓
Binoculars		✓
Spare batteries		✓
Machete		✓

[1] Handy hint: make notes about anything relevant to the site in your notebook. This information might be very useful when you get back, especially if you are assessing a number of riparian areas on one day.

1.6 Step 2 – Identification of Riparian Zone and Determination of Lateral Extent

To correctly undertake the RHA and provide an accurate assessment of the system's health, the lateral extent (or boundary) of the riparian zone needs to be identified.

Riparian habitats are influenced by the hydrological and geological dynamics of their associated river systems and consequently have vegetation which is distinguishable from the surrounding landscape. Therefore, users of the RHA are required to observe where transitions between different vegetation types occur. The lateral extent depends on the topography of the catchment. The riparian area may be narrow where the valley bottom is narrow with steep sides or wide where the valley bottom is wide with gentle slopes (Figure 0.4).

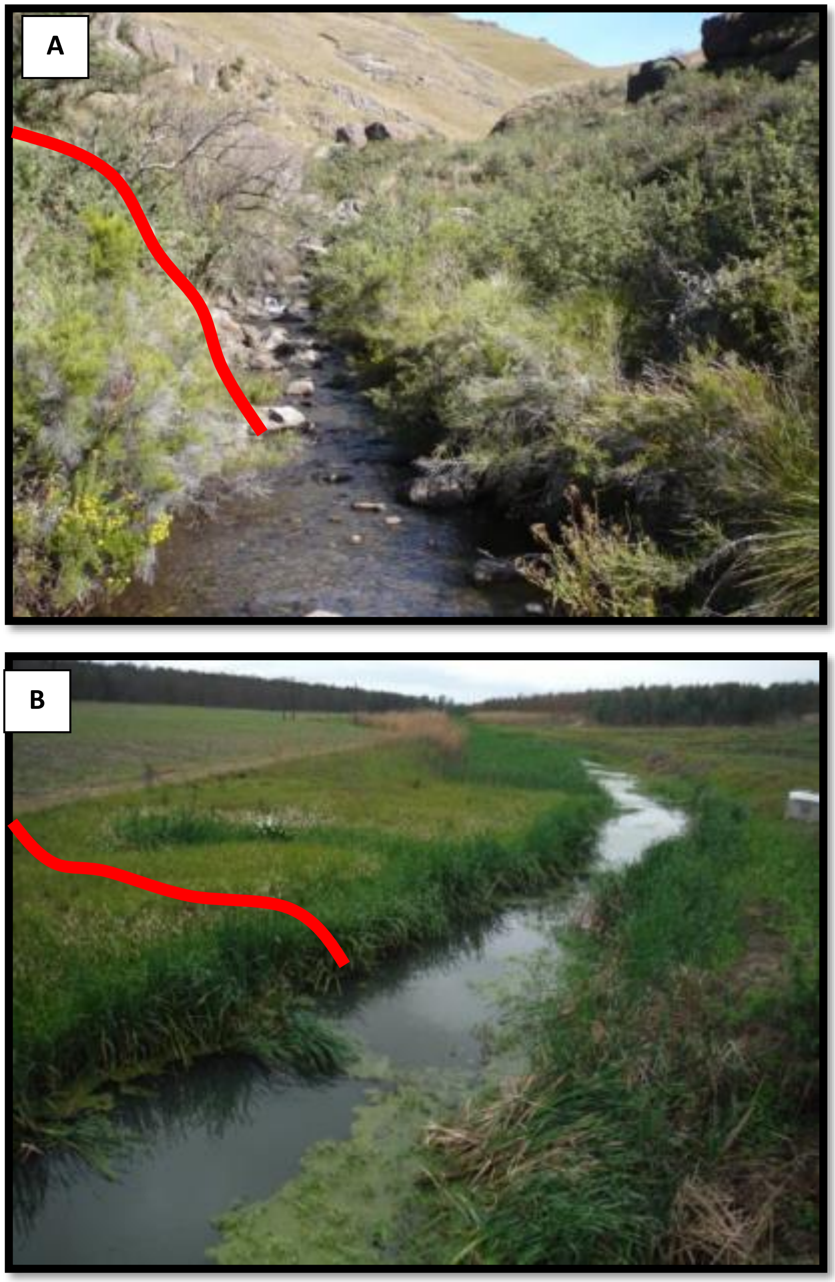


Figure 0.4 Examples of riparian zone extent indicated by the red line for a steep valley bottom (A) and a gently sloped valley bottom (B).

1.7 Step 3 – Rating Impacts

Subsequent to the identification of impacts, the rating of each impact must be undertaken. The rating system ranges from 0 – 5 and is dependent on the intensity and extensiveness of the impact. The impacts are rated as a percentage of change to the riparian system or coverage by the impacts. Table 0.2 provides a guideline to enable the rating of impacts.

IMPORTANT NOTE: Remember to consider the coverage or percentage change to both banks.

Table 0.2 A guideline to rating impacts in terms of the percentage of change caused by the impact or coverage of the impact to the riparian zone

Rating	Percentage Change or Coverage	Description
0	0	No Impact
0.5	1-10	Minor Impact
1	11-20	
1.5	21-30	Moderate impact
2	31-40	
2.5	41-50	Large impact
3	51-60	
3.5	61-70	Serious impact
4	71-80	
4.5	81-90	Critical impact
5	91-100	

To aid in data collection a field sheet where site information and impact ratings can be noted is provided (Figure **0.5**).

The accurate rating of impacts is very important. If the data recorded is inaccurate and is used in catchment management programs, the wrong decisions could be made by management, consequently, the incorrect allocations of resources will occur.

If assessors are unsure of a rating for a particular impact, it is useful to discuss the rating with colleagues. Ideally, although not essential, at least two assessors should undertake the assessment to ensure that all impacts are observed and a variety of perspectives considered.

Riparian Health Audit Field Sheet

Date:	Upstream boundary longitude (dd):	Downstream boundary longitude (dd):
River:	Upstream boundary latitude (dd):	Downstream boundary latitude (dd):
Project name/no:	General observations/comments:	

Rate each impact from 0-5
Please refer to the manual for rating guidelines

Site Name	Exotic Vegetation	Rubbish Dumping	Bank Erosion	Inundation	Flow Modification	Channel Modification	Evidence of decreased water quality	Vegetation Removal

Figure 0.5 Field sheet used for the Riparian Health Audit

Before leaving the assessment site always ensure the following:

- **All data have been entered onto the field data sheets**
- **Photograph numbers specific for each site have been recorded**
- **All equipment has been returned to the vehicle**
- **All gates were left as they were found if assessing an external party's property**

The impact ratings recorded are utilised to create a score that indicates the percentage of change that has occurred to the riparian system compared to the natural conditions. The score then translates to an Ecological Condition (EC) that describes the state of the system (Table 0.3).

Table 0.3 Summary of scores and percentage of change and their respective Ecological Condition for the Riparian Health Audit

Score	Percentage Change	Ecological Condition
0-4.5	0-10	Natural
5-11.5	11-29	Good
12-19.5	30-49	Fair
20-27.5	50-69	Poor
28-35.5	70-89	Very Poor
36-40	90-100	Critical

1.8 Step 4 – Data Entry into the Riparian Health Audit

The following section provides information on data entry into the RHA model and the calculation of the EC. It has two sub-sections for two different categories of assessors:

- Users that can use the digital model in the form of a Microsoft Excel spreadsheet (see sub-section 3.4.1)
- Manual Assessors - users that do not have access to the digital model and have to determine the EC manually (see sub-section 3.4.2)

1.8.1 Use of the automated RHA model to determine Ecological Condition

The data collected based on the in-field survey is entered into the RHA model to determine the EC. To enter data into the model go to the "IMPACT_RATING" tab in the associated RHA Excel file. Then, the site data and each impact must be rated according to the guideline in Table 0.2. The model will automatically generate a score, percentage of change and the respective EC. Table 0.4 provides an example of the data entered into the model and the generation of the EC.

Table 0.4 An example of data entry into the Riparian Health Audit model and the generation of the Ecological Condition[2]

Upstream Boundary - Latitude (decimal degrees)	Upstream Boundary - Longitude (decimal degrees)	Downstream Boundary - Latitude (decimal degrees)	Downstream Boundary - Longitude (decimal degrees)	Quaternary Catchment	River	Site Name	Exotic Vegetation (0-5)	Rubbish Dumping (0-5)	Bank Erosion (0-5)	Inundation (0-5)	Flow Modification (0-5)	Evidence of decrease water quality (0-5)	Vegetation Removal (0-5)	Channel Modification (0-5)	Score	Percentage Transformed	Ecological Condition
-29.4736	29.8846	-29.4747	29.8849	U20A	uMngeni	Test 1	5	3	3	0	2	4.5	3	0	**21**	**51**	**Poor**
-29.4986	29.9272	29.5001	29.9288	U20A	uMngeni	Test 2	4	3.5	2	3	4	4	5	4	**30**	**74**	**Very Poor**
-29.5246	30.0297	29.5254	30.0292	U20A	uMngeni	Test 3	2.5	3.5	3	0	0	3.5	3.5	4	**20**	**50**	**Poor**
-29.5225	30.0874	29.5224	30.0882	U20A	uMngeni	Test 4	1.5	2	1	2	1.5	2	0	2	**12**	**30**	**Fair**
-29.4857	30.4877	29.4874	30.4882	U20G	uMngeni	Test 5	1	0	1	0	1	1	1	0	**5**	**13**	**Good**
-29.5564	30.5526	29.5559	30.5532	U20G	uMngeni	Test 6	0.5	0	1	0	0	1	1.5	0	**4**	**10**	**Natural**
-29.9635	30.9697	29.9645	30.9712	U60D	Mlaas	Test 7	5	5	5	5	5	5	5	5	**40**	**100**	**Critical**
-28.1907	31.7349	28.1911	31.7377	W20A	Mfolozi	Test 8	1	0	0	0	0	0	3	0	**4**	**10**	**Natural**

[2] N.B. this dataset is fictional and does not represent the actual EC of the reaches assessed

In addition, the spreadsheet enables users to develop a plot / graph to illustrate their ratings of impacts. Figure 0.6 below provides a plot of the impacts from the example data. From the example it can be seen when comparing pre- and post-development that although the rating for flow modification and flow channel modification decline, the rating for the other six impacts improve. The applications of this include the visual comparison of impacts between:

- Different assessment sites
- Pre- and post- development scenarios
- Pre- and post- riparian rehabilitation actions

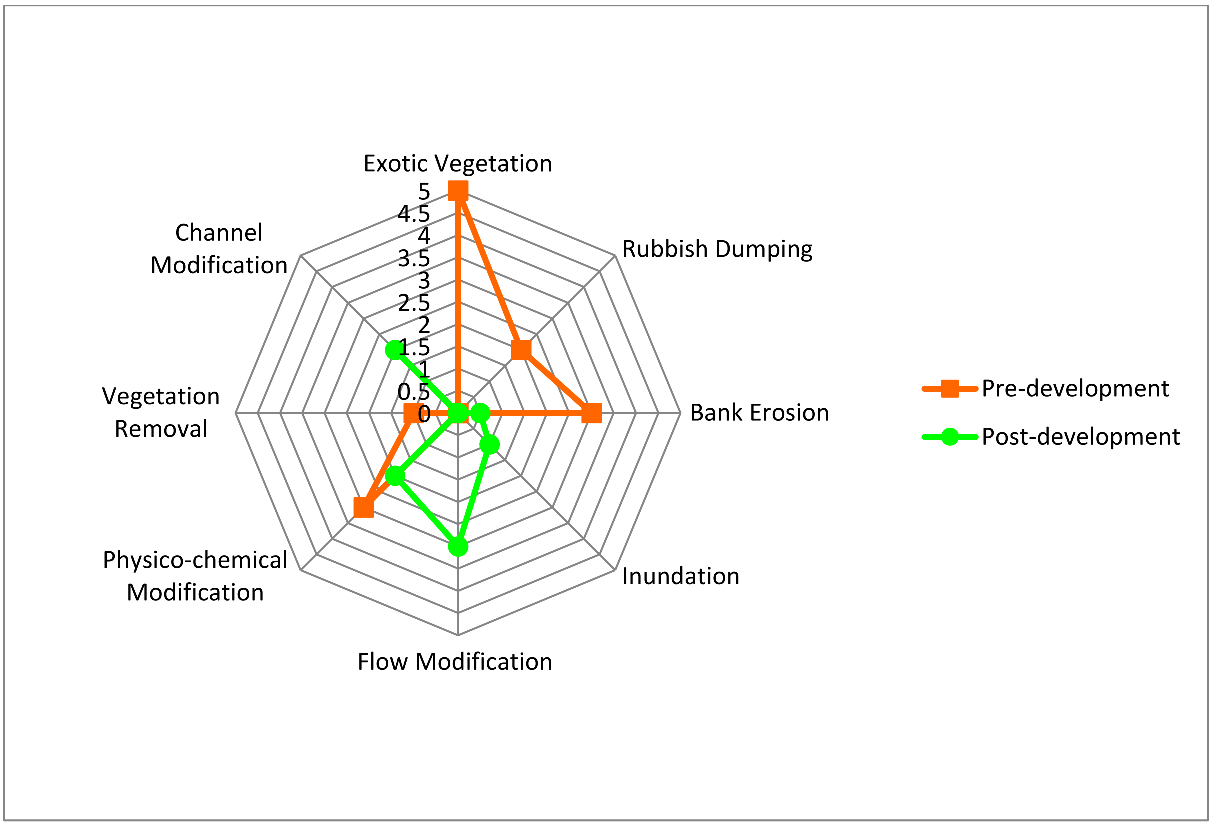


Figure 0.6 Example of a radar plot illustrating the ratings of impacts for the Riparian Health Audit from two example sites.

1.8.2 Manual calculation of Ecological Condition

Assessors that do not have the capability of utilising the digital model can calculate the EC manually. The various impact ratings are summed and then converted to a percentage of the maximum total impact rating. The maximum total impact rating is a product of the number of impacts and the maximum rating per impact: ***Number of impacts X Maximum rating = 8 X 5 = 40***

Table 0.3 of this document provides the EC for the percentage of change determined. An example of the manual calculation of riparian EC is demonstrated in Table 0.5 below.

Table 0.5 **Example of the manual calculation of the Ecological Condition of a riparian system using the Riparian Health Audit**

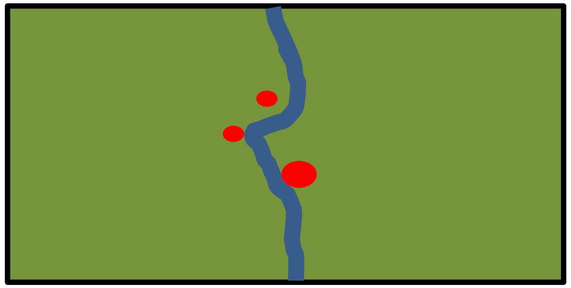
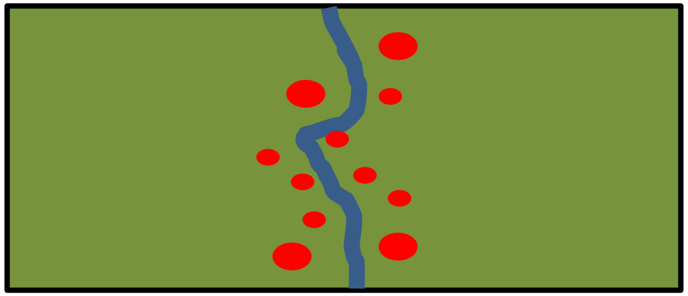
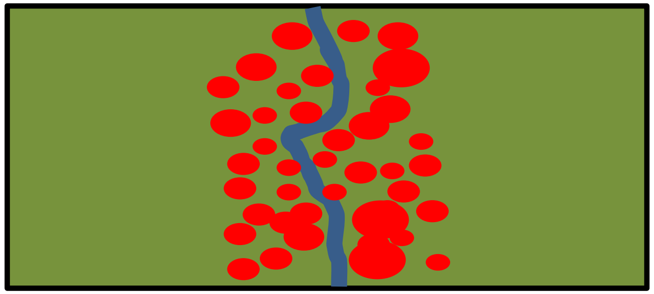
Impact	Rating
Exotic Vegetation	5
Rubbish Dumping	3
Bank Erosion	3
Inundation	0
Flow Modification	2
Evidence of decreased water quality	4,5
Vegetation Removal	3
Channel Modification	0
Score	**21**
Percentage Change (Score/40 X 100)	**51**
Ecological Condition	**Poor**

Photographic and illustrative Guide to Impacts

This section is a photographic and illustrative guide to aid prospective riparian assessors to identify and assist in rating the impacts considered in the RHA. The section is divided into subsections illustrating each impact.

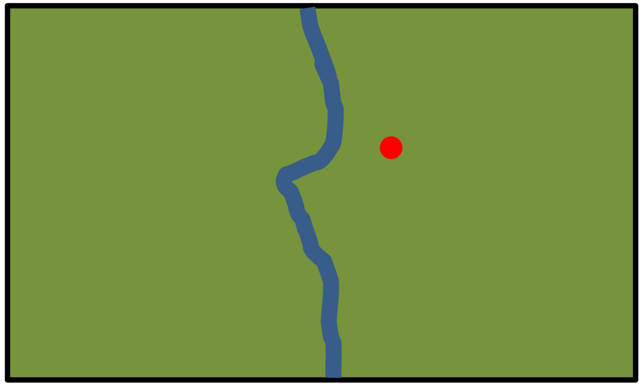
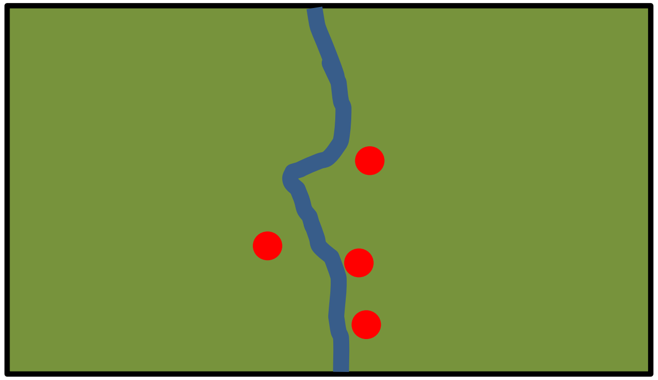
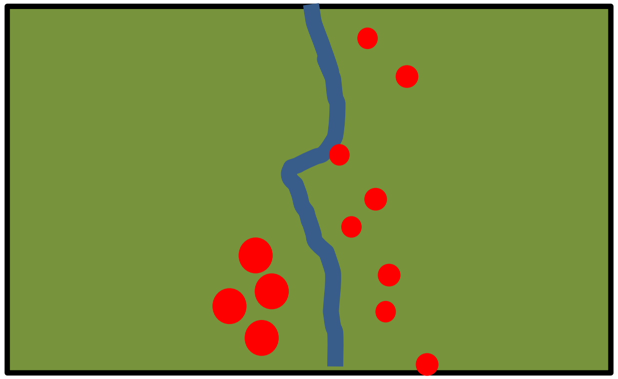
1.9 Exotic Vegetation

Exotic vegetation should be rated according to their abundance within the riparian zone. Remember, this includes IAP's, gardens, crops & hedgerows.

Rating 0.5 - 1	Rating 1.5 - 3	Rating 3.5 - 5
		
Hlatikulu River, KwaZulu-Natal		
		

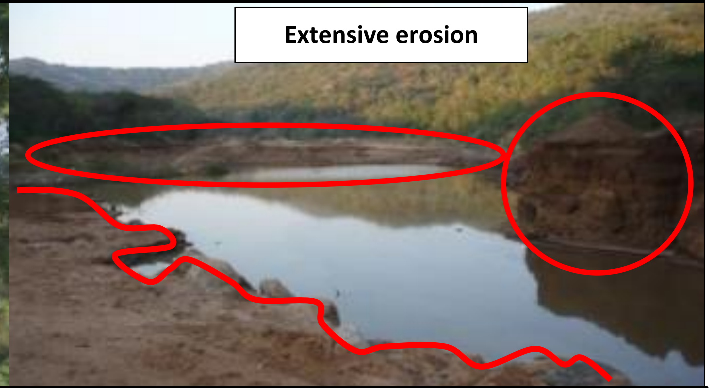
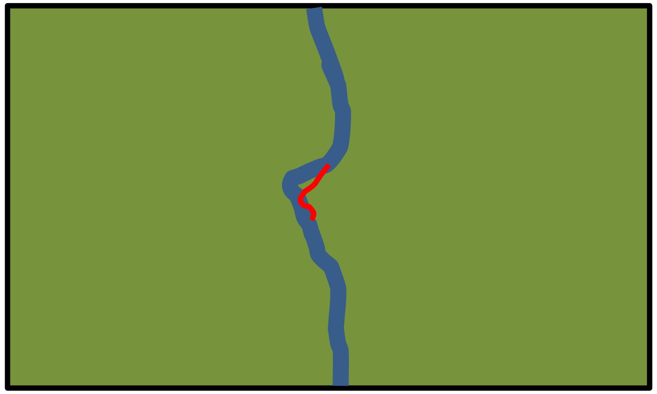
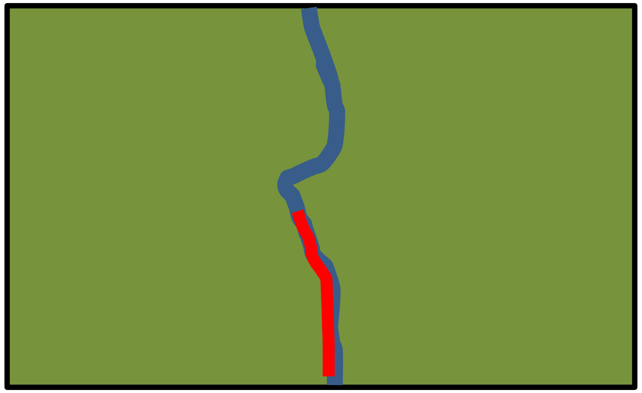
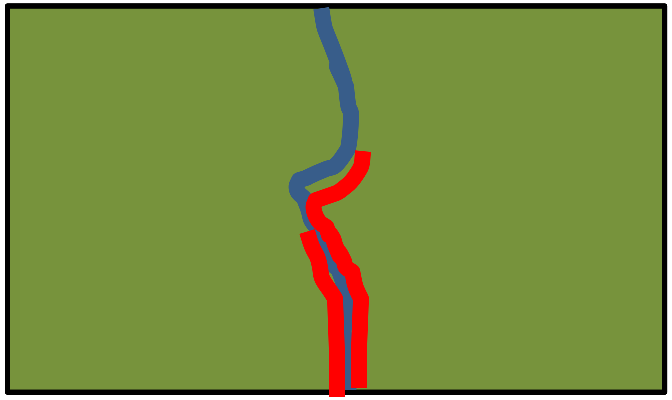
1.10 Rubbish Dumping

Rubbish dumping should be rated on the intensity and extent of coverage (percentage of cover) within the riparian zone and the local effects on ecological health.

Rating 0.5 - 1	Rating 1.5 - 3	Rating 3.5 - 5
		
Dorpspruit River, KwaZulu-Natal	Isipingo River, KwaZulu-Natal	Kwa Pata Stream, KwaZulu-Natal
		

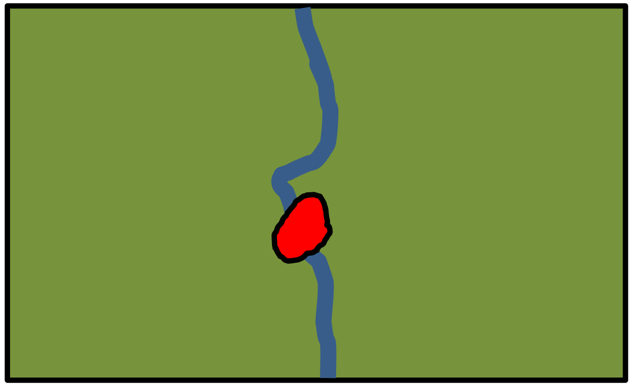
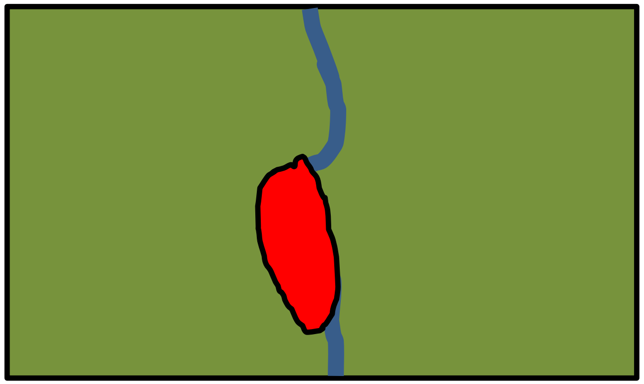
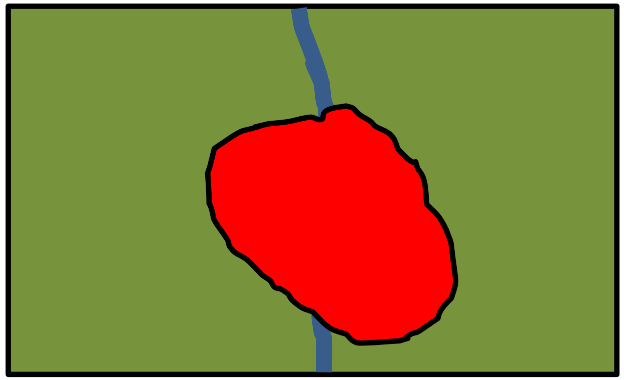
1.11 Bank Erosion

Bank erosion should be rated when it is caused by unnatural circumstances and should be based on the extent of coverage.

Rating 0.5 - 1	Rating 1.5 - 3	Rating 3.5 - 5
		
Lions River, KwaZulu-Natal	uMngeni River, KwaZulu-Natal	Lions River, KwaZulu-Natal
		

1.12 Inundation

Inundation is the flooding of the riparian zone through the construction of impoundments to impede water flow and typically results in an alteration of habitat characteristics. The riparian system is transformed into an aquatic system with a resultant change in geochemical processes and biota.

Rating 0.5 - 1	Rating 1.5 - 3	Rating 3.5 - 5
		
Thukela River, KwaZulu-Natal	Mkuze River, KwaZulu-Natal	Hlatikulu River, KwaZulu-Natal
		

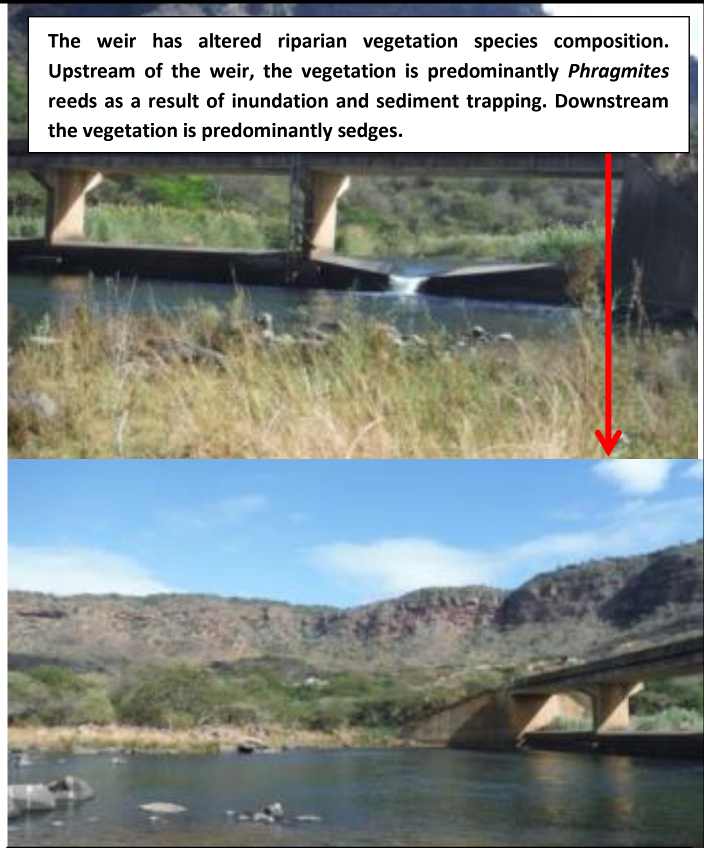
1.13 Flow Modification

Flow modifications can be either an increase or decrease in flow, or a change in the natural seasonal flow.

Rating 0.5 - 1

Bush stream, KwaZulu-Natal

Rating 1.5 - 3



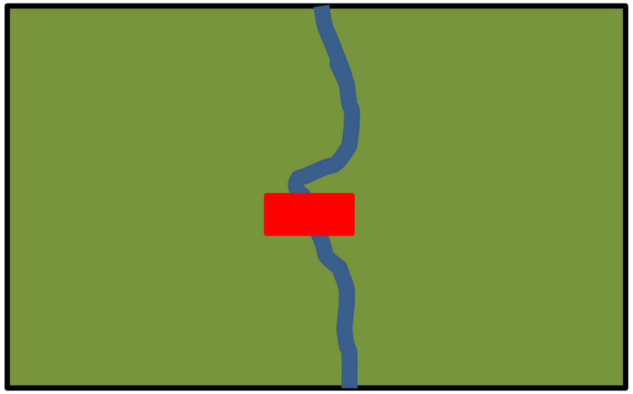
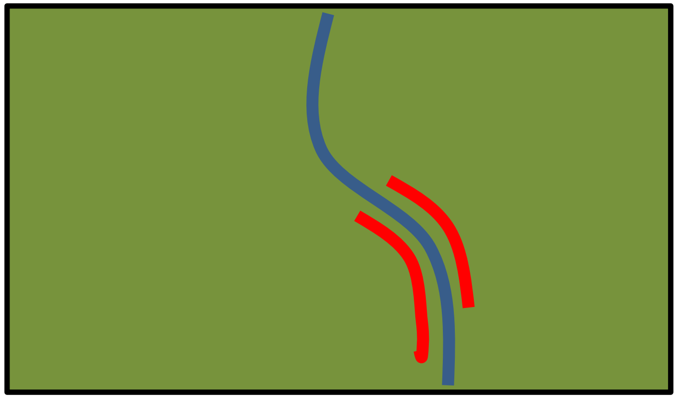
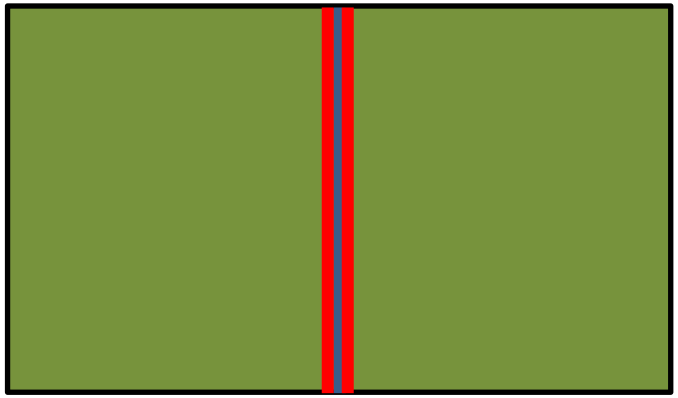
uMngeni River, KwaZulu-Natal

Rating 3.5 - 5

Mpushini River, KwaZulu-Natal

1.14 Channel Modification

The rating should be based on the longitudinal extensiveness (how far along the bank) of the modification within the reach being assessed.

Rating 0.5 - 1	Rating 1.5 - 3	Rating 3.5 - 5
		
Mooi River, KwaZulu-Natal	Mooi River, KwaZulu-Natal	Umlaas River, KwaZulu-Natal
		

1.15 Evidence of Decreased Water Quality

The impact rating is based on the extent of the impact and the overall affect to riparian systems.

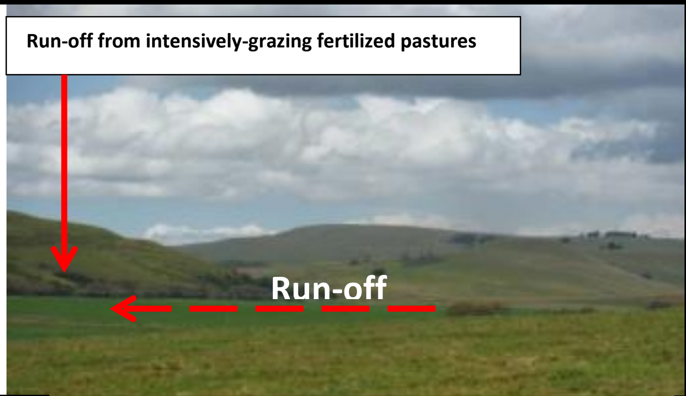
Rating 0.5 - 1

Mdloti River, KwaZulu-Natal

Matigulu River, KwaZulu-Natal

Rating 1.5 - 3

Mthinzima River, KwaZulu-Natal



Lions River, KwaZulu-Natal

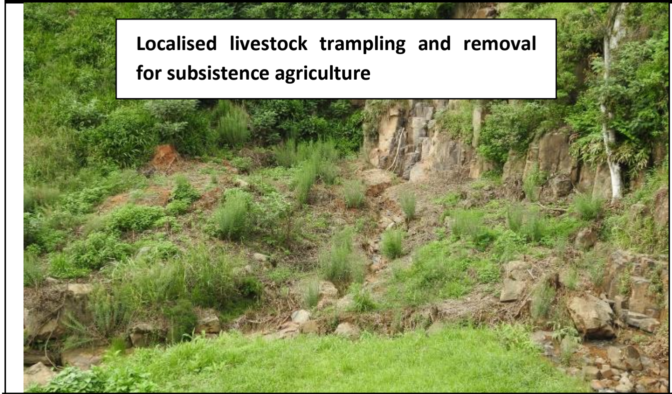
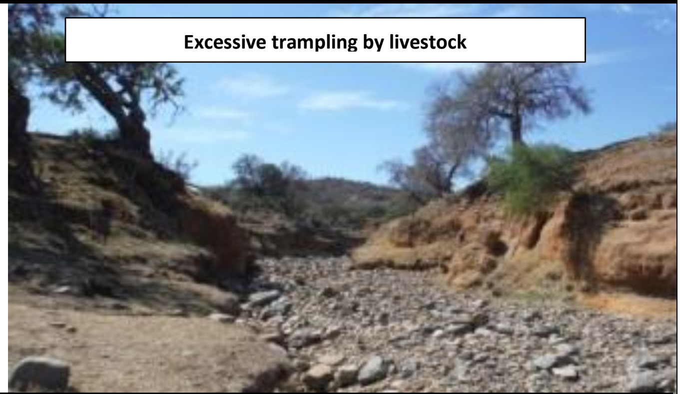
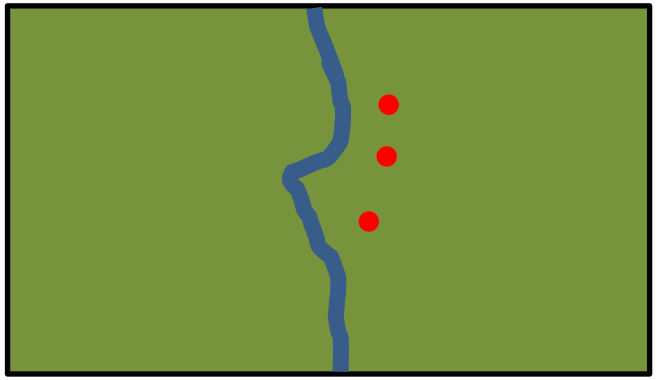
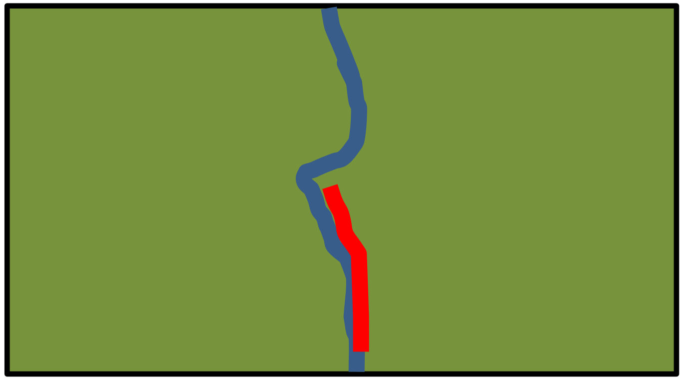
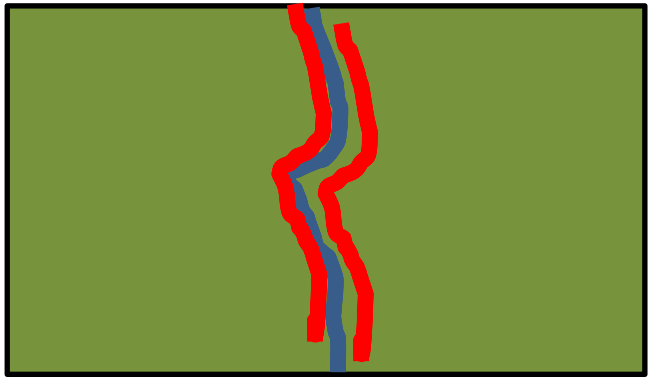
Rating 3.5 - 5

Palmiet River, KwaZulu-Natal

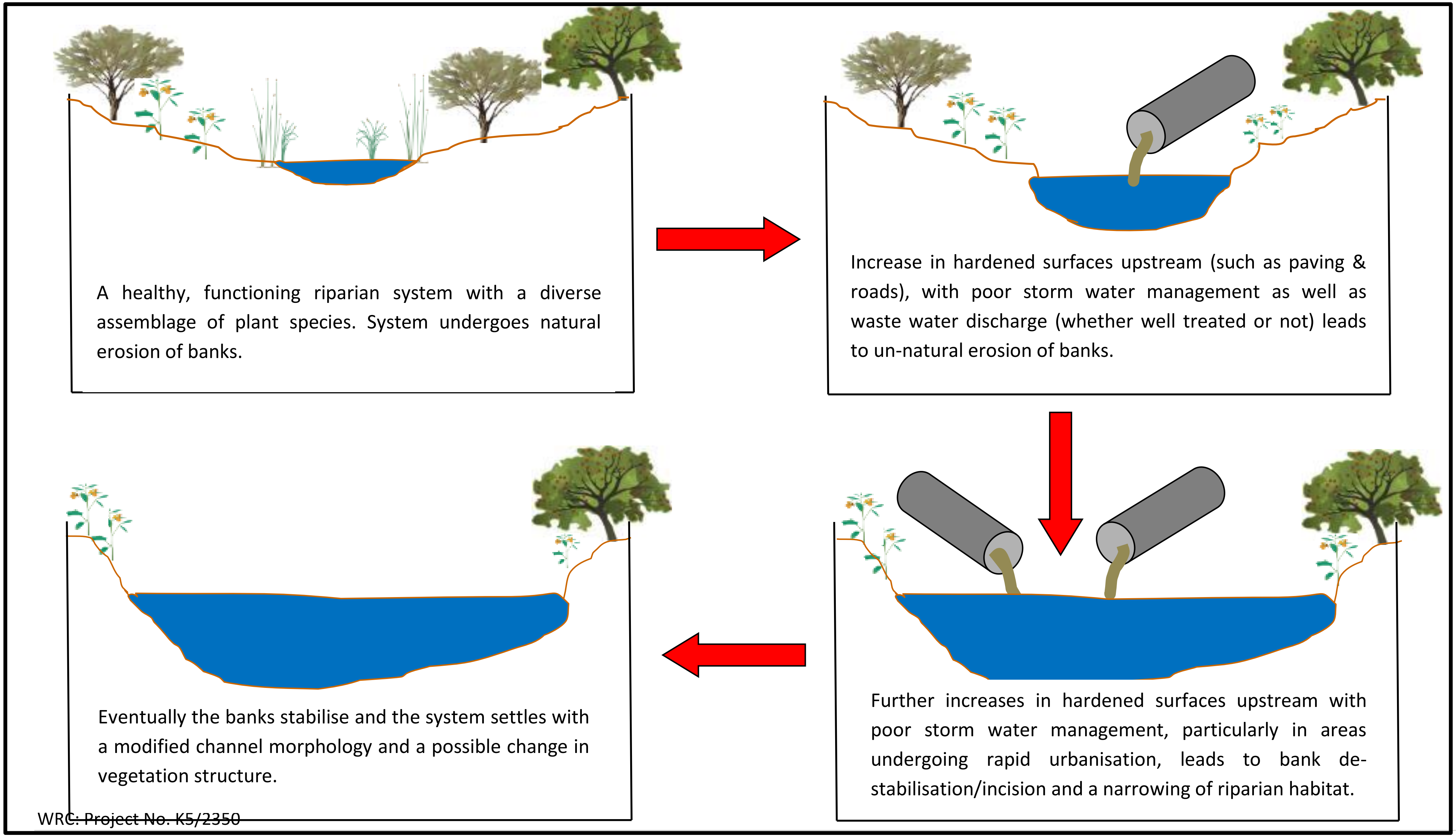
Palmiet River, KwaZulu-Natal

1.16 Vegetation Removal

The impact rating should be based on the extent of removal.

Rating 0.5 - 1	Rating 1.5 - 3	Rating 3.5 - 5
		
Bush stream, KwaZulu-Natal	Lovu River, KwaZulu-Natal	Unnamed tributary of Thukela River, KwaZulu-Natal
		

As described in Section **Error! Reference source not found.**, riparian ecosystems within urban areas are subject to major re-shaping as a result of poorly managed storm water runoff. The diagram below briefly describes the process. However, this is difficult to recognise and may require speaking to long-term residents of the area to obtain a better understanding of the channel shape and width.



Acknowledgements

Joint funding of the development of this tool by WWF-Mondi Wetlands Programme and the Water Research Commission is gratefully acknowledged. Donovan Kotze, Mark Graham, Kirsten Mahood and Bonani Madikizela are thanked for providing valuable comments on an earlier version of the tool.

Appendix A – DEVELOPMENT OF THE RIPARIAN HEALTH AUDIT

The Riparian Health Audit was derived from the Department of Water and Sanitation (previously known as the Department of Water Affairs) Index of Habitat Integrity[3] (IHI) Eco Classification tool. The IHI tool assesses the modification in riverine ecosystem habitat characteristics for both, the instream and riparian zones. The tool was aimed at specialist ecological consultants and professional scientists, to determine and understand the alteration of habitat characteristics by human drivers that have created a negative response in their biological unit (fish, macroinvertebrate, vegetation, etc.) of interest.

The IHI method is comprehensive and assesses eight (five for instream and three for riparian) primary metric groups, each based on several sub-metrics. In addition, metric ratings are integrated into each other where feasible and the calculation of the habitat integrity EcoClass complex. The tool, while valuable for experienced professionals, is complex for amateur or citizen scientists to use for assessing their systems of interest. Extensive data collection is required and the model is intimidating to use.

Therefore, the Riparian Health Audit was developed for citizen scientists by eliminating the sub-metric component, through the amalgamation of them into one metric that citizen scientists can rate. Furthermore, the calculation to determine the ecological category was simplified to allow users to calculate by hand if required. In addition, the model was developed to be user-friendly and allows for graphing outputs.

[3] Kleynhans CJ, Louw MD, Graham M, 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical manual) Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08