AN INVESTIGATION OF THE REHABILITATION POTENTIAL OF THE BAAKENS RIVER, GQEBERHA

PART 4: RECOMMENDATIONS

Amanda Uys, James MacKenzie, Anton Bok and Patsy Scherman

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WATER RESEARCH COMMISSION

TT 910/4/23

An Investigation of the Rehabilitation Potential of the Baakens River, Gqeberha

Part 4: Recommendations

Report to the
Water Research Commission

by

J MacKenzie, A Bok & P Scherman
Laughing Waters & Associates

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This report forms part of a set of five reports emanating from WRC project no. C2022/2023-01121. The other reports are:

An investigation of the rehabilitation potential of the Baakens River, Gqeberha. Part 1: Current state of the river. (WRC Report No. TT 910/1/23)
An investigation of the rehabilitation potential of the Baakens River, Gqeberha. Part 2: River rehabilitation scenarios. (WRC Report No. TT 910/2/23)
An Investigation of the rehabilitation potential of the Baakens River. Part 3: Cost benefit analysis. (WRC Report No. TT 910/3/23)
Rehabilitation potential of the Baakens River, Gqeberha. Part 5: Summary Report. (WRC Report No. TT 910/5/23)

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Human rights are not things that are put on the table for people to enjoy. These are things you fight for and then you protect.

Wangari Maathai

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EXECUTIVE SUMMARY

PART 4: PRIORITIZATION AND RECOMMENDATIONS

Chapter 1. Background

This report represents the final part of a study funded by the Mandela Bay Development Agency and managed by the Water Research Commission. The main objective of the study was to determine the feasibility and cost-benefit of rehabilitating the Baakens River in the city of Gqeberha, Eastern Cape. The four study phases were: 1) Assessment of current state of the river at four sites; 2) Development of river rehabilitation scenarios; 3) Cost benefit analysis of scenarios; and 4) Recommendations regarding the prioritisation of rehabilitation scenarios and actions. The main method adapted for use was the 12-step Australian Stream Rehabilitation method, with additional reference to the South African, British and American guidelines. Only those procedural steps that were accommodated within the project brief were included.

Chapter 2. Recommendations on rehabilitation priorities

The prioritisation process was based both on the outcomes of the Cost Benefit Analysis of the three rehabilitation scenarios, and on the prioritisation categories documented in the Australian method and adapted for the local context. Account has also been taken of matters for in which there is some assurance in the current political milieu, and for those in which there is not. For instance, it is assured that the Mandela Bay Development Agency plans to develop the South End Precinct, which commits them to fulfilling certain environmental authorisation conditions including the production of a rehabilitation plan for the lower river and estuary. There is, however, a lack of assurance regarding the stability of the local political leadership in Nelson Mandela Bay, and this leadership has been threatened in recent months, despite the vast strides made in service delivery. This could result in delays in decision-making and implementation of plans.

The 3 rehabilitation scenarios to be prioritised were each associated with numerous interventions. These had been developed in the previous project phase, on the basis of what was known of the river reaches in terms of their current state, ecological importance and sensitivity, natural assets under threat, and the trajectory of these assets. The cost-benefit analysis was a separate exercise in which the scenarios were assessed.

Outside of the outcomes of the Cost:Benefit study (Part 3 of this series), the prioritisation process was based on a rehabilitation prioritisation process, adapted from the Australian method. This takes into account a number of prioritisation principles, and are focussed on how much natural biodiversity can be returned to the system for a given expenditure or rehabilitation effort in the shortest time. The principles include the preference to protect reaches of stream that remain in good condition before rehabilitating damaged reaches; halting stream deterioration rather than addressing this problem later; and identifying any fatal and limiting problems and treating these prior to rehabilitation.

Ten prioritisation categories were recognised, and each of the scenario/s and interventions were tested against these categories and assigned to one. The categories were slightly adapted to accommodate the specific context of this project, and as such the first two categories (0 and 1) were additions from this project team. The categories are: Category 0. Implement actions required in terms of existing plans or environmental authorisation conditions. 1. Address critical ecological and urban threats. 2. Protect reaches with regional conservation value. 3. Protect reaches with local conservation value. 4. Protect and improve deteriorating reaches. 5. Expand

good reaches. 6. Improve impeded-recovery reaches. 7. Improve moderately damaged reaches. 8. Improve basket case reaches. 9. Improve basket case reaches with hope. Each category represents the ranking of the priority, so category 1 represents the top priority.

Category 0 covers for those aspects of scenarios/interventions which are strictly not optional, as they are requirements of the environmental authorisation for the Mandela Bay Development Agency's South End Precinct Development. The development cannot go cannot go ahead in the absence of these activities. As such they are, strictly speaking, not priorities but requirements, and thus excluded from the prioritisation process and numbered '0'.

The requirements are for a river rehabilitation plan for the lower river and estuary, and its implementation; the submission of detailed designs for any implementations which could be seen as having a rehabilitation function; the design and construction of the two fishways in Settlers Park Nature Reserve; and the development of a stormwater plan for the South End Precinct Development. Certain of the proposed interventions associated with Rehabilitation Scenario 3 address these requirements. These focus on returning a more natural connectivity, channel form, habitat and biodiversity to the river and estuary. The estimated costs of implementing this scenario (all interventions) are R45.6 million, and the benefit:cost ratio over a 20-year period following implementation is in the range of 1.6 to 2.3 (second highest ratio of the three scenarios). The marginal benefits, or estimated change in value of ecoservice benefits, are estimated as R7 to R10 million per annum.

Outside of these requirements are those scenarios and interventions which have been prioritised for action in the various reaches of the river.

Priority 1: Address critical ecological and urban threats

In terms of both the prioritisation method, and the benefit:cost ratios, the top rehabilitation priority is to address water quality. This is the focus of Scenario 1.

1.1. The most urgent intervention regarding current urban and ecological threats is the commissioning of a Sewerage Situation Analysis and Master Plan for the Baakens Valley. This plan should focus on the identification of issues affecting the sewerage infrastructure through the valley, the Driftsands Collector Sewer and the Cape Recife wastewater treatment works, and all staffing and maintenance. Issues should be prioritised, solutions budgeted, and an implementation plan with schedules and targets produced. Implementation of this plan should be expedited. The responsible authority is the NMB Metro. The NMB Business Chamber has already partnered with the Metro to assist in this regard.

The estimated costs of addressing Scenario 1 adequately are estimated at R30.5 million. The benefit:cost ratio over a 20 year period following implementation is in the range of 2.6 to 3.4, the highest of the three scenarios. The marginal benefits (or estimated change in value of ecoservice benefits over a 20 year period) are estimated as R9 to R12 million per annum.

The next most critical urban and ecological threat to address is that of flooding in the valley, which falls under Scenario 2: Address water quantity. Catastrophic flooding could occur at any time in the Baakens Valley, costing lives and significant infrastructure, as has happened historically.

1.2. The most urgent intervention under Scenario 2 is the commissioning of an updated Stormwater Situation Analysis and Management Plan for the catchment, which should be drafted with reference to an updated catchment floodline analysis (scheduled for early 2023).
1.3. Linking to this intervention, and considered urgent, is the initiation of a campaign for the installation of rainwater tanks catchment-wide, and the drafting of policy requiring that new developments are equipped with the same. This will somewhat ease the domestic demand for water in the current drought, and may to a lesser extent assist with the elevated runoff and thus with stormwater management in the catchment. In addition, the Green Lung Project recommends the drafting of local policy to control and measure water usage via boreholes in the catchment. This too falls within Scenario 2. (However, note that these interventions were excluded from the costing for this scenario as water tanks are considered a householder cost, and drafting of local policy should be an internal Metro function).

Scenario 2 also includes numerous other, more ecologically-focussed interventions, as discussed in Part 2 of this report series. The total cost of implementing these is estimated at R44.4 million.

The benefit:cost ratio over a 20 year period following implementation of all actions in Scenario 2 is in the range of 1.1 to 1.6, the lowest ratio of the three scenarios. The marginal benefits are estimated as R5 to R7.5 million per annum, also the lowest return of the three. While these values suggest that Scenario 2 is a lower priority, the rehabilitation prioritisation process has different outcomes, and ranks it as the second highest priority. There is no question that water is a focus of the city at present, and that urgent interventions in this regard are required. It is also logical to get an understanding of, and management for, both high and low flows in the catchment before attending to physical interventions in the lower river and estuary (the focus of Scenario 3).

Priority 2. Protect Regional Conservation Value

The remainder of the interventions in Scenario 2 are focussed on ecological means of managing water quantity in the catchment, and as they are largely focussed on protection they fit the description of Priority 2 (despite not being associated with the second highest benefit:cost ratio).

Actions expected to have the greatest value in returning a more natural flood management capability to the system are focussed in the upper source area which remains largely undeveloped. There are large critical biodiversity areas here. Numerous seep and depressional wetlands occur, and it is home to a number of plant species of special concern, including the endemic, critically endangered honeybush plant which is associated with seep wetlands. Irreplaceable rocky outcrops occur in association with certain plant species.

The proposed interventions include the declaration of a moratorium on further development in this area, the clearing of all alien invasive vegetation from this area, the rehabilitation of the seep and depressional wetlands, and the application for formal protection of the area (e.g. nature reserve status). These actions would assist greatly in protecting regional conservation value, and reinstating wetland functionality including wetland 'sponge' behaviour, gradual release of baseflows to the river, stormwater retention, and flood attenuation.

Most of these interventions recommended in Scenario 2 are Metro functions, but it is recommended that Working for Water is partnered with in regard to alien clearing, and that Working for Wetlands and the South African National Biodiversity Institute are consulted in regard to the urgent assessment of the wetlands and assistance in the process of acquiring formal protection for the area.

Priority 3. Protect local conservation value

This category description is fulfilled by Scenario 3: Improve connectivity, channel form and habitat in the lower river and estuary. These actions would result in greatly improved estuarine functionality, the improvement of nursery areas for juvenile fish, and the return of fish passage for all species. Scenario 3 also addresses the removal of alien fish from the system.

Some of the Scenario 3 interventions may already have been implemented as part of Category 0, as they were required to be in terms of the Environmental Authorisation for the development of the South End Precinct. It is recommended that the remaining interventions are scheduled in at this level of prioritisation.

The environmental authorisation requirement was for construction of only two fishways in Settlers Park, whereas numerous additional fishways were recommended and costed as part of Scenario 3. This is in order to reinstate meaningful longitudinal connectivity between the ocean, estuary and lower river. A fishway is required for every road-crossing representing a barrier to upstream fish or eel migration (there are a minimum of 8 in Settlers Park alone). The reinstatement of fish passage through the lower system would have a substantial effect on the system's local conservation value, as migratory fish and eels previously precluded from this reach will now move up-river and into this habitat.

Once fishways have been installed, it has been recommended that investigations are made into the possibility of removing alien fish from this reach. This would likely be an intensive physical process (electro-shocking or netting) and, according to the project team specialist, would most likely need to be repeated on an annual basis to give the indigenous fish species a chance to recover to more natural abundances in this section of the river.

As the estuarine rehabilitation (Lower Valley Road circle to Port) is a far more complex intervention than is the upstream river channel (Bridge Street to Lower Valley Road circle), it is possible that the estuarine rehabilitation should be delayed until after the upstream works are complete and the various documents providing guidance on floodlines and stormwater flows have been prepared, as these will be important inputs to the estuary rehabilitation plan.

Priority 4: Protect and improve deteriorating reaches, and **Priority 5: Expand good reaches**

The best fit for these priorities are the proposals made by the Green Lung Project report on the Baakens Valley Restoration. These are highlighted as actions to be pursued once the priority concerns of invasive alien vegetation, sewage contamination of the river, and safety and security have been addressed. The proposals call for the revival of recreational facilities, natural areas and educational opportunities within the valley. Three zones are recognised as having the potential to be developed: Recreational (zone 1), Natural/protected (zone 2) and Educational (zone 3). These are considered fluid nodes and pockets situated throughout the valley. However there are focus areas: Dodd's Farm (zone 1), Settlers Valley (zone 2) and the upper catchment (zone 3). Settlers Valley is in a deteriorating reach (study Reach 5), requiring improvement and more rigorous protection as suggested by Priority 4. Dodd's Farm is within Reach 4 which is in a relatively good condition and befits Priority 5.

Chapter 3. Recommendations regarding the ongoing rehabilitation process

These recommendations are based on the findings of the study and the ongoing interactions with the Mandela Bay Development Agency and identified stakeholders.

At this stage it is important for the Development Agency to enter into open discussion with other agencies, organisations and stakeholders regarding the rehabilitation of the river. Those parties who have already initiated studies and made recommendations in this regard, and those involved in or affected by the rehabilitation measures, should participate in these deliberations. As will be clear from the previous chapters, a successful rehabilitation effort will require the commitment and input of a number of agencies and authorities. Coordination and cooperative management of this extensive effort will be fundamental to effective implementation, and to realising the rehabilitation benefits.

This rehabilitation initiative provides the opportunity to strengthen existing relevant partnerships, and to create new ones. Existing partnerships include those between the Mandela Bay Development Agency and the Metro, and between the Development Agency and the Nelson Mandela Bay Business Chamber. The Business Chamber, and the Civil Society Coalition of which they are a member, are active and effective in working with businesses to assist with important and practical local issues in their own sphere of influence. They are also one of the parties involved in the Green Lung Project, which aims to create three green lung corridors as protected areas for the city (Baakens, Van der Kemps Kloof and Swartkops Rivers). As discussed, a report on the restoration of the Baakens River has been produced under the auspices of this project, and interest has been shown by business in partnering with this initiative. This represents a major opportunity for collaboration, as there is common vision and also possible access to funds which are not administratively or politically tethered.

In addition, engagement with organisations that will play a critical role in implementation of scenarios is vital at an early stage. These include Working for Water (clearing of alien invasives), Working for Wetlands (wetland assessment, delineation and rehabilitation), South African National Biodiversity Institute (protection of the upper catchment), and Nelson Mandela University, who have already produced a number of studies focussed on the conservation value of the Baakens River and Estuary, and have shown active interest in the rehabilitation of the river.

It is recommended that a Management Committee is established once the role players are known.

This committee could either a Catchment Management Forum as advocated by Department of Water and Sanitation; or along the lines recommended in the Green Lung report on the Baakens restoration, which includes a Steering Committee overseeing numerous Task Teams and reporting to stakeholder representatives; or another management structure.

Consider including on this committee relevant representatives of the Development Agency, the Metro, the Business Chamber, the Department of Water and Sanitation, Department of Forestry, Fisheries and Environment (or local Department of Economic Affairs, Environment and Tourism), Wildlife and Environment Society of SA, the Civil Society Coalition, Nelson Mandela University, the Community Crime Awareness group, one or more sporting bodies such as Fat Traxx, a representative of Traditional Healers, an Engineering Consultancy, Environmental Consultancy, and a Rehabilitation Specialist.

The committee should comprise a number of Task Teams covering more specialised areas of intervention, such as natural resources, water quality, security, stormwater management, recreation, sport and adventure and tourism and amenities. Stakeholders could include representatives of business, environmental organisations, community groups, religious or spiritual groups, traditional healers, and sporting bodies.

The committee would ideally draft a constitution or charter. Guidelines for a charter for a Catchment Management Forum are available.

The Management Committee would assist in making final decisions regarding the priority interventions for the river, the allocation of funds, and the programme of action. These decisions should be well supported by the options presented in this series of reports, and the proposals presented in the Green Lung: Baakens Valley restoration report.

The remainder of the rehabilitation process will typically involve the completion of the remaining Steps and Tasks as presented in the rehabilitation method, including (in brief) the setting of measurable objectives, planning and designing the details of the implementation, planning the evaluation, scheduling and supervising the works, and assessing and maintaining the project.

Ongoing open discussion with role-players and other stakeholders is very important during this process.

The setting of measurable objectives is detailed process which will apply to individual interventions rather than scenarios, and will probably require specialist inputs. These objectives should be a precise, clear, measurable statement of the intended outcomes of prioritised interventions. They form the basis for the evaluation of the project at a future stage. The process involves defining the amount of change expected, spatial scope, time frame, how success will be measured, and the feasibility of the objective. In the context of Nelson Mandela Bay Metro, with its current infrastructural challenges, it is important that the objectives take into account the possibility of failure or compromised outcomes due to circumstances beyond the implementer's control.

In terms of further studies identified as urgent, the following would assist in informing detailed planning of the rehabilitation exercise: a sewerage situation analysis and management plan; a stormwater situation analysis and management plan; an updated floodline report for the catchment; and a detailed rehabilitation plan and design drawings for the lower river and estuary.

The project options that are selected in the pre-design phase will then be subjected to detailed description and design. The final report and drawings for one or more interventions will be submitted to the controlling authorities together with applications for authorisation as and where required. Final design would require the input of various specialists, the project initiator, and the Management Committee.

Depending on which interventions are selected for implementation, any or all of the following studies could be required for the detailed planning phase: a wetland delineation and current state assessment hydraulic computations for the naturalisation of channel form in the lower river and estuary; geotechnical studies of the lower river and estuary; engineering studies and design for the fishways, with specialist input from a fish biologist; engineering studies and design for biodetention or bioretention ponds, with specialist input from a wetland specialist.

The final design documents per major intervention would likely include a written report, a set of maps, a set of drawings, hydraulic computations, relevant engineering designs and stability analysis of hydraulic structures, a full costing, and specialist reports as necessary. Further information or studies may be required for the purposes of environmental or water use authorisations.

Based on this documentation, the various authorisations required would be applied for. Rehabilitation activities may trigger numerous approvals or permits, including water use licences or general authorisations, environmental authorisation, heritage permits, waste management licenses, permits in terms of biodiversity, and other approvals. The Construction and Operational Environmental Management Programmes as required must be drafted in consultation with the relevant ecological specialists, as these are likely to differ significantly from standard construction programmes.

Once the authorisations are acquired, or during the authorisation process, tender documents can be prepared. These will include timing schedules for the various activities, specific materials to be used, specific environmental conditions to be met during the construction and operational phases, and the quality the finished work is to achieve.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF TEXT BOXES

ACRONYMS, ABBREVIATIONS, NOMENCLATURE

approx.	Approximately
BGIS	Biodiversity GIS
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry (historic name)
DHSWS	Department of Human Settlements, Water and Sanitation (historic name)
DWS	Department of Water and Sanitation (current name)
EA	Environmental Authorisation
EC	Ecological Category
EIS	Ecological Importance & sensitivity
FRAI	Fish Response Assessment Index
GIS	Geographical Information System
ha	hectares (10 000 m^2 or 0.01 km^2)
IHAS	Integrated Habitat Assessment System
IHI	Index of Habitat Integrity
km^2	square kilometres
mamsl	metres above mean sea level
MBDA	Mandela Bay Development Agency
mcm	Million cubic metres
MIRAI	Macroinvertebrate Response Assessment Index
mm	Millimetres
m^3/s	cubic metres per second
m^3/a	cubic metres per annum
na	not applicable
NMBM	Nelson Mandela Bay Metro
NWA	National Water Act
PAI	Physico-chemical Assessment Index
PES	Present Ecological State
REC	Recommended Ecological Category
spp.	several species
VEGRAI	Vegetation Response Assessment Index
WRC	Water Research Commission
WR2012	Water Resources of South Africa, 2012

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1 BACKGROUND TO THIS STUDY

This report represents the final stage of a four-part process to determine the feasibility and cost-benefit of rehabilitating the Baakens River in the city of Gqeberha, Eastern Cape. The 10-month study has been funded by Nelson Mandela Bay Development Agency (NMBDA), in terms of a Memorandum of Understanding with the Water Research Commission of SA (WRC) who manage and provide the necessary oversight to the project.

The major rehabilitation planning methodology adapted for use in this study is that of Rutherfurd et al. (2000) as shown in in Figure 1.1 (necessary adaptations to the sequence shown in blue). Seven of the twelve steps could be accommodated within the scope of this project. The project outputs in four parts are: 1. The Current State of the Baakens River; 2. The Development of Rehabilitation Scenarios; 3. A Cost Benefit Analysis of the three scenarios; and 4. Recommendations regarding the prioritisation of scenarios, and further actions to be taken.

This is the fourth report, and refers to our Step 7 (Set Priorities). It provides a series of recommendations to the Nelson Mandela Bay Development Agency (NMBDA) regarding the rehabilitation of this iconic river system.

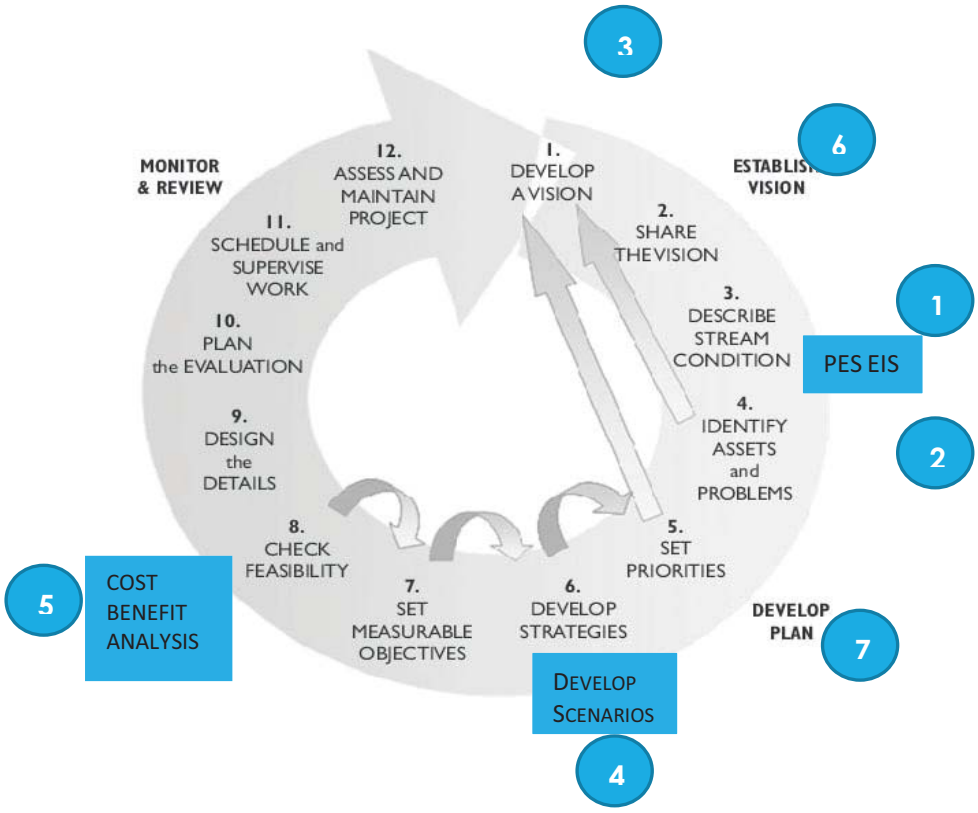

Figure 1.1 A graphic summary of the 12-step river rehabilitation process of Rutherfurd et al., 2000. Numbers in blue circles represent the altered sequence of steps in this study, and blue text boxes indicate the slightly different approach taken.

2 RECOMMENDATIONS REGARDING PRIORITISATION OF SCENARIOS

2.1 The prioritisation process

The prioritisation process is adapted from that of Rutherfurd et al. (2000), but contextualised for the present situation in South Africa, Eastern Cape, and Nelson Mandela Bay as at 2023.

At this stage of the study, we now have a clear picture of the following:

- ✓ The Present Ecological State (PES) of the Baakens River in the reaches surveyed;
- ✓ The Ecological Importance and Sensitivity (EIS) of these reaches;
- ✓ The problems threatening or degrading the reaches;
- ✓ The interventions considered most important to enable the management and rehabilitation of the river
- ✓ The three broad Scenarios into which the numerous interventions are assigned.

The current context, through which all decision-making is filtered, includes:

Relatively sound assurance regarding

- The intention of the MBDA to implement the South Precinct development plans, which include the rehabilitation of the lower Baakens River and the development of the Baakens River Parkway, as discussed in Part 2 of this study (Uys et al., 2022b).
- The requirement for detailed planning of rehabilitation for the lower river and estuary before the South Precinct Development can be initiated. This is one of the conditions of the 2019/2022 Environmental Authorisation for the South-End Precinct Final Basic Assessment Report (FBAR, EAPSE 2019).
- The positive intention of the Civil Society Coalition and the Business Community (as represented by NMB Business Chamber) to assist with urgent issues regarding the state and services of the city;
- The positive will of the catchment community at large, including sporting and recreational groups, to assist with the upgrading of the river valley and the rehabilitation of the river.

A lack of assurance regarding:

- The stability of national and local political structures and leadership;
- The competing imperatives and priorities of the day, and where the rehabilitation of the Baakens River (and other urban rivers) fit in this context;
- The service delivery mechanisms and efficiency, which rely to some extent on current leadership;
- Assurance of power supply (e.g. to sewage pump stations);
- The funding available for the process of rehabilitation;
- The willingness of agencies other than MBDA to contribute to those operational measures necessary to ensure the effectiveness and monitoring of intervention measures (e.g. ongoing water quality sampling and biomonitoring).

Priorities must be set with this context in mind, or they are likely to be difficult to action and sustain.

2.2 Key points for setting priorities

The key points on priority setting provided by Rutherfurd et al. (2000) are presented below.

1. Priorities should be set in terms of the basic measure of river rehabilitation **how much natural biodiversity** (or other measure of stream health) you can get for your money or effort, usually in the shortest time.

2. In terms of stream health **it is usually more effective to protect reaches of stream that remain in good condition**, than to spend large amounts of money trying to rehabilitate reaches that are already damaged.

3. It is important to **address the right problem in each reach** and not necessarily the most obvious or the easiest to fix.

4. It is usually more efficient to **stop a stream deteriorating** than it is to address problems later**.**

5. When protecting or improving a reach, **identify any fatal and limiting problems** and treat these first.

6. Once the major assets of the stream have been protected, you can begin to improve the stream condition.

7. Priorities should be set within a regional framework, i.e. priorities should be set hierarchically from national down to local scale, from large catchments down to sub-catchments and reaches of sub catchments.

2.3 Inputs and assumptions

The prioritisation process is focussed on the three rehabilitation scenarios developed in Part 2 of this study. These were developed on the basis of the main issues of concern in the river: **poor water quality, unnatural water quantity** (particularly during stormwater runoff, due to the urban nature of the catchment)**, loss of system connectivity** (lateral/longitudinal)**, loss of natural channel morphology, habitat and biodiversity** particularly in the lower reaches**,** and **threats to recreational safety and security for recreational access**.

In order to address the issues identified with only three scenarios (as per the Project Scope) it was necessary to make the assumption that the need for safe outdoor recreational areas and facilities for the people of Gqeberha would to a large extent be met by organisations involved in two existing initiatives:

a) **Baakens River Park.** The Mandela Bay Development Agency (MBDA) plans to develop a safe urban recreational area known as Baakens River Park, alongside the lower river, and as part of the South End Precinct Development, which has already been granted Environmental Approval (see Uys et al., 2022b, Section 2.3.2). The assumption is that this development, which is focussed on providing a safe outdoor recreational space for the residents of Gqeberha, will be forthcoming.

b) **The upgrade and re-development of Dodd's Farm as a community recreational hub and venue.** The NMB Business Chamber (NMB BC), in collaboration with a number of partners, have established 'Project Green Lung', which focusses on the upgrade and restoration of some of Gqeberha's major river systems: the Baakens, Van der Kemp's Kloof and the Zwartkops Estuary. One component of this project is the Baakens River Restoration, the proposals for which is detailed in a report by the Mantis Group (Mantis, 2021). The re-development of Dodd's Farm as a vibrant nature-oriented community hub and venue (and potentially a future botanical garden) is one of the numerous interventions proposed. It is referred to as the Pilot Phase 1 of the restoration plan. A number of potential business partners who have already shown interest in partnering with the restoration project are referred to in the report. The other interventions proposed are summarised in Report 2 of this study (Uys et al., 2022b).

With these assumptions being made, the Rehabilitation Scenarios for this study were set with a focus on the ecological issues and urban threats facing this urban catchment.

Scenario 1. Address water quality deterioration attributed largely to ongoing sewage spills and litter.
Scenario 2. Attend to water quantity threats in the form of floods, droughts, uncertain hydrology, and altered base-flows.
Scenario 3. Address the loss of lateral and longitudinal connectivity, the modification of channel form, and loss of habitat and biodiversity in the lower reaches of the river/estuary.

For each scenario objectives were set, and a suite of interventions identified (Uys et al., 2022b, Part 2 this series). The scenarios were then subjected to a Cost-Benefit Analysis (CBA; Moynihan et al., 2023, Part 3 this series).

2.3.1 The outcomes of the Cost Benefit Analysis

The outcomes of the Cost Benefit Analysis (CBA, Part 3 of this series), which are of relevance in the prioritisation process, are presented in Table 2.1.

Table 2.1 Summary of outcomes: Cost-Benefit Analysis of the rehabilitation scenarios

ECOPHYSICAL ISSUE	WATER QUALITY	WATER QUANTITY (Flood and baseflows)	CONNECTIVITY, BIODIVERSITY, CHANNEL FORM, HABITAT - LOWER RIVER & ESTUARY
REHABILITATION SCENARIO and MAJOR ACTION	1. ADDRESS CURRENT SEWAGE ISSUES IN THE CATCHMENT (PUMP STATIONS, SEWAGE LINES, MANHOLES), AUGMENT SYSTEMS FOR FUTURE PREDICTED LOADS, MAINTAIN AND MANAGE TO A STATE ACCEPTABLE FOR A HEALTHY AQUATIC ECOSYSTEM (CATEGORY B/C TO C).	2. GAIN AN UNDERSTANDING OF NATURAL AND CURRENT HYDROLOGY; REINSTATE NATURAL FLOOD MANAGEMENT (NFM) CAPABILITY WHERE POSSIBLE; MITIGATE FLOOD AND CLIMATE CHANGE THREATS.	3. IMPROVE CONNECTIVITY BETWEEN OCEAN, ESTUARY, RIVER, FLOODPLAIN AND WETLANDS. NATURALISE CHANNEL FORM AND INSTREAM, MARGINAL AND RIPARIAN HABITAT IN LOWER RIVER AND ESTUARY. ELIMINATE ALIEN FISH SPECIES IF POSSIBLE.
ESTIMATED TOTAL CAPITAL EXPENDITURE FOR LISTED INTERVENTIONS (CAPEX)	R 30.5 million	R 44.4 million	R 45.6 million
OPERATIONAL EXPENDITURE PER ANNUM (OPEX)	R 350 000	ZAR 440 000	NA
BENEFIT : COST RATIO OF IMPLEMENTATION (Over 20y)	Range: 2.6 to 3.4	Range: 1.1 to 1.6	Range: 1.6 to 2.3
MARGINAL BENEFITS (Estimated change in the value of benefits per annum, in millions of Rand per annum)	R9m to R12m p.a.	R5m - R7.5m p.a.	R7m - R10m p.a.
LIKELY IMPLEMENTING AGENCIES	NMB METRO IN COLLABORATION WITH NMB BC and CIVIL SOCIETY COALITION	NMB METRO, NMB BC, WORKING FOR WATER, WORKING FOR WETLANDS	MBDA, NMB BC, NMB METRO, NELSON MANDELA UNIVERSITY

2.4 Prioritisation categories

The next step in the Rutherfurd et al. (2000) prioritisation process is to assign different Reaches of the river to various prioritisation categories. Eight categories are recognised and described. For the purposes of this study, two further categories have been added. These are:

(i) Instances in which there are either existing plans (assumed to be backed by funds) or Environmental Authorisation conditions which require that the work is done within a Reach. We have referred to this as an 'uncontested priority' (Category 0).

(ii) Issues which represent critical and urgent ecological and urban threats, and thus should be given precedence over other priorities. These take the place of the top priority (Category 1).

The categories used in this project are shown in

Table 2.2

Table 2.2 Amendments to the original prioritisation categories

	PRIORITISATION CATEGORIES		
	RUTHERFURD ET AL., 2000		**AMENDMENTS FOR THIS STUDY**
0	REACHES THAT ARE IN GOOD CONDITION THROUGHOUT, THAT ARE ALREADY PROTECTED	0	IMPLEMENT ACTIONS REQUIRED IN TERMS OF EXISTING PLANS OR ENVIRONMENTAL AUTHORISATION CONDITIONS
		1	ADDRESS CRITICAL ECOLOGICAL AND URBAN THREATS
1	PROTECT REGIONAL CONSERVATION VALUE	2	PROTECT REGIONAL CONSERVATION VALUE
2	PROTECT LOCAL CONSERVATION VALUE	3	PROTECT LOCAL CONSERVATION VALUE
3	PROTECT AND IMPROVE DETERIORATING REACHES	4	PROTECT AND IMPROVE DETERIORATING REACHES
4	EXPAND GOOD REACHES	5	EXPAND GOOD REACHES
5	IMPROVE IMPEDED-RECOVERY REACHES	6	IMPROVE IMPEDED-RECOVERY REACHES
6	IMPROVE MODERATELY DAMAGED REACHES	7	IMPROVE MODERATELY DAMAGED REACHES
7	IMPROVE BASKET CASE REACHES	8	IMPROVE BASKET CASE REACHES
8	IMPROVE BASKET CASE REACHES WITH HOPE	9	IMPROVE BASKET CASE REACHES WITH HOPE

Assigning either different reaches of the river, or different scenarios and interventions, to these categories is the next step. The results of this process are presented in Table 2.3.

In each instance the relevant scenario is cited. Where a scenario occurs more than once in a category (as they do in Category 1), it means that certain interventions in the scenario will, if implemented, have an outcome which fits the category description (as described by Rutherfurd et al., 2000).

Table 2.3 The application of the Prioritisation categories to the various Reaches, Interventions and Scenarios. Where more than one reach/intervention in a Category it is in Row 2

CATEGORY/PRIORITY:	0	1	2	3	4	5	6	7	8	9
DESCRIPTION OF CATEGORY:	IMPLEMENT ACTIONS REQUIRED ITO EXISTING PLANS / ENVIRONMENTAL AUTHORISATION CONDITIONS *	ADDRESS CRITICAL ECOLOGICAL AND URBAN THREATS*	PROTECT REGIONAL CONSERVATION VALUE	PROTECT LOCAL CONSERVATION VALUE	PROTECT AND IMPROVE DETERIORATING REACHES	EXPAND GOOD REACHES	IMPROVE IMPEDED-RECOVERY REACHES	IMPROVE MODERATELY DAMAGED REACHES	IMPROVE BASKET CASE REACHES	IMPROVE BASKET CASE REACHES WITH HOPE
RELEVANT SCENARIO:	SC 3	SC 1	SC 2	SC 3	SC 3	NA	NA			
REACH/ES TO WHICH PRIORITY ASSIGNED:	**REACH 6: LOWER RIVER and ESTUARY**	**REACH 0-6 WHOLE RIVER**	**REACH 0: UPPER CATCHMENT WETLANDS**	**REACH 5 SETTLERS REACH 6 ESTUARY**	**REACH 5: SETTLERS VALLEY**	**REACHES 4, 5: DODD'S FARM TO SETTLERS VALLEY**	**REACHES 2,3: UPPER RIVER**			
MAJOR INTERVENTIONS:	Rehabilitation plan and design drawings for the lower river and estuary. These should include the clearing of AIV, and naturalisation of channel. Install two fishways in Settlers Valley. These actions should dovetail with the existing plans for Baakens River Park.	Commission Sewerage Situation Analysis and Management Plan Prioritise upgrades to sewage pump stations, construction of emergency sumps at all SPS. Implement other recommended actions as top priority. Employ more staff, monitor river, ensure efficient procurement.	Place a moratorium on further development in upper catchment. Clear AIV. Assess wetlands for rehabilitation and protection. Implement wetland rehabilitation plans. Apply for formal Protected Area status for whole Reach 1 or sensitive (CBA) areas thereof.	SETTLERS PARK: Design and install fishways on all barriers to flow. LOWER RIVER/ESTUARY: Implement any of the SC3 rehabilitation actions for Reach 6 which have not been completed as part of authorisation conditions (Naturalisation of channel form, habitat and floodplain)	Investigate the possibility of removal of alien fish species (at least for certain reaches). Implement Green Lung Project Plan for Zone 2 (conservation areas, bird hides, possible amphitheatre), upgrade trails, revive the Metro's ranger programme.	Implement Phase 1 Mantis (2021) plan for Dodd's Farm as active recreational venue, pop-ups, events, amphitheatre. Clear AIV, thin IV, recommence ranger programme; initiate educational programme	Clear AIV, thin indigenous vegetation, and naturalise floodplain. Improve security for recreation. Longer term, extend the Guinea Fowl Trail into this area (Part of this intervention is included in the Mantis 2021 report under clearing of AIV catchment-wide).			
LIKELY RESPONSIBLE AGENCY:	**MBDA/Specialists**	**NMB METRO/ NMB BC**	**NMB METRO / SANBI /Wfg for Water and Wf Wetlands**	**MBDA/Specialists**	**MBDA/Specialists**	**NMB METRO/ NMB BC**	**NMB METRO/ Working for Water**			
REASON	*Rehabilitation is required by Environmental Authorisation (EA) conditions*	*Mandated function, proposed MOU with Business Chamber*	*Falls within the mandates of both organisations*	*As recommended by Strydom (2014) and Buchanan (2013)*	*Required by EA Conditions*	*Metro Parks Function, Green Lung Project /Mantis, 2021 Recommendation*	*AIV management (Green Lung Project/ Mantis Recommendation 2021)*			
FROM SCENARIO:		**SC 2**	**ABBREVIATIONS**							
REACH/ES TO WHICH PRIORITY ASSIGNED:		**REACHES 1-6 WHOLE RIVER**	Abbreviations: AIV - Alien Invasive Vegetation CBA – Critical Biodiversity Area EA – Environmental Authorisation for South End Precinct Development plan ITO- in terms of MOU - Memorandum of Understanding NA – Not Applicable SC – Scenario SSC – Species of Special concern							
MAJOR INTERVENTIONS:		Commission Stormwater Master Plan. Install bioretention ponds; improve SuDS; Incentivise rainwater tanks.	* Categories added by this Team							
LIKELY RESPONSIBLE AGENCY:		**NMB METRO/ Specialists**								
Reason for this:		*Stormwater management function*								

2.5 Prioritisation recommendations

The recommended priorities are presented this section. These are by no means cast in stone and should be considered a point of further discussion and debate. The rankings of the Benefit:Cost ratios derived per scenario in the Cost Benefit Analysis (Part 3 of this series, Moynihan et al., 2023), are compared to the results of the adapted prioritisation method of Rutherfurd et al. (2000) in Table 2.4.

Table 2.4 A comparison of the ranking of the three scenarios based on Benefit:Cost ratios versus the adapted prioritisation method

BENEFIT:COST RATIO RANKINGS As per Moynihan et al. (2023)			PRIORITY DETERMINED ACCORDING TO CATEGORY As per Rutherfurd et al. (2000, adapted)			
PRIORITY RANK	BENEFIT: COST	SCENARIO	PRIORITY RANK	DESCRIPTION	SCENARIO	REACH
			0	REACHES WITH GUARANTEED PLANS, FUNDS OR EA CONDITIONS	SC3	**CONNECTIVITY AND CHANNEL FORM** REACHES 5, 6 LOWER RIVER Env. Authorisation conditions require a river rehabilitation plan and construction of two fishways
1	HIGHEST B:C RATIO (2.6-3.4)	**Scenario 1** Address Water quality	**1**	ADDRESS CRITICAL ECOLOGICAL AND URBAN THREATS*	SC1	**ADDRESS WATER QUALITY: ALL REACHES** Commission Sewerage Assessment and Management Plan. Implement.
					SC2	**ADDRESS WATER QUANTITY (Floods)** Commission a Stormwater Management Plan. Implement. Launch campaign for rainwater harvesting.
2	SECOND HIGHEST B:C (1.6 – 2.3)	**Scenario 3** Reinstate connectivity and naturalise lower river	**2**	PROTECT REGIONAL CONSERVATION VALUE	SC 2	**ADDRESS WATER QUANTITY: UPPER CATCHMENT ACTIONS** Clear AIV and rehabilitate wetlands to restore some natural flood management capability. Apply for formal protection.
3	THIRD HIGHEST B:C RATIO (1.1-1.6)	**Scenario 2** Manage water quantity	**3**	PROTECT LOCAL CONSERVATION VALUE	SC 3	**NATURALISE CONNECTIVITY, FORM, FUNCTION and HABITAT in LOWER RIVER.** Stepwise implementation of remaining SC3 interventions
			4	PROTECT AND IMPROVE DETERIORATING REACHES	Green Lung Prj	**SETTLERS VALLEY REACH 5** Create conservancy pockets, safe trails, bird hides, amphitheatre (Mantis, 2021)
			5	EXPAND GOOD REACHES	Green Lung Prj	**REVITALISE DODD'S FARM REACH 4** Revive Dodd's Farm as safe recreational and sporting venue (Mantis, 2021, Pilot Phase)
			6	IMPROVE IMPEDED-RECOVERY REACHES	Green Lung Prj	**CLEAR AIV** REACH 2,3 Clear AIV, improve security, extend trails (Mantis, 2021 Plan)

Abbreviations: B:C Ratio: Benefit cost ratio (range); CBA: Critical Biodiversity Areas Green Lung Prj: Green Lung Project (Mantis, 2021) Sc – Scenario; SC1 – Water Quality, SC2 – Water Quantity, SC3 – Connectivity, channel form, habitat

2.6 Priority 0: Address reaches in which there are existing plans/requirements

As discussed, the prioritisation process was adapted to make space for those interventions which were either already planned or required in terms of existing authorisations. These are considered 'uncontested priorities' not requiring ranking, and as such were included as Category 0 (

Table 2.2, Table 2.3). These are:

- Proposed MBDA plans for the redevelopment of the South End Precinct, which include plans for a Baakens River Park, envisaged to be designed along the lines of the Greenpoint Stadium Park in Cape Town (see Part 2, Section 2.3.1).
- Activities and submissions required in terms of the Environmental Authorisation (EA) conditions for the South End Precinct Development[1].

The activities needed to address these requirements are consistent with **Scenario 3** which is focussed on improving connectivity, channel form, habitat and biodiversity in the lower river and estuary (Reaches 5 and 6).

Environmental Authorisation Conditions

In terms of the EA for the Baakens Valley Precinct Development[2], the MBDA is required to produce an Operational Environmental Management Plan (OEMPr) which makes provision for a rehabilitation plan that addresses rehabilitation of the lower Baakens River and estuary, following a 'commitment to rehabilitation of aspects of the Baakens River' made in the Basic Assessment Report (BAR, EAPSE 2019). This presumably refers to the following statement in the BAR (highlighted):

'In response to comments during the public participation process and further discussions with the application and other role-players, the intent is to also provide or upgrade facilities within the River Park area (…) and the Open Space area along the banks of the Baakens River (the northern boundary of the project area). This will include landscaping and beautification of the 'park area', upgrading of parking and recreational facilities (such as installation of tables and benches, walkways and street lighting) to enhance the area for public use and safety. ***In addition, it is proposed to clear the congested river banks of alien vegetation and implement rehabilitation measures on the canalised Baakens River and estuary.****' (BAR page 2)*

Furthermore, the EA conditions require that rehabilitation of the river is undertaken based on this rehabilitation plan. Detailed designs of all structures envisaged to effect rehabilitation, inclusive of the two proposed fishways in Settlers Park, are to be submitted for approval before the structures are put in place. Finally, there is a requirement to produce a stormwater management plan for the South End

[1] The conditions of approval, issued in 2019 and relevant to the March 2022 renewal, include the submission of a Layout Plan and Construction and Operational Environmental Management Programmes (CEMPr and OEMPr) covering the various aspects of the plan. As the BAR included a commitment to rehabilitation of aspects of the Baakens River, this is reflected in the Conditions of Environmental Authorisation (EA), which require, inter alia:

3.3.3 *Detailed designs of all structures envisaged to effect rehabilitation/restoration of the Baakens River inclusive of the two proposed fishways are to be submitted to the Department for approval/endorsement prior to such structures being put in place. Furthermore, rehabilitation and restoration of the Baakens River to be undertaken with the Rehabilitation Plan contemplated in Condition 3.4.2.2*.

And that the OEMPr make provision for:

3.4.2.2. A ***rehabilitation plan*** *that addresses rehabilitation of the Baakens River as addressed in this Environmental Authorisation and the FBAR (Final Basic Assessment Report).*

3.4.2.7 A comprehensive ***storm water management programme*** *including special measures that may be necessary to ensure that stormwater from residential units are managed and controlled to prevent damage to or pollution of the Baakens River and Estuary.*

[2]

Precinct development, which must include measures to manage stormwater from residential units to prevent damage or pollution to the river and estuary (see Footnote 1, previous page).

This means before they can commence the South-End Precinct development, the MBDA is obliged to submit a rehabilitation plan for the lower river and estuary, including detailed designs for any structures to be included in the plan, and that this plan must be implemented. Recommendations in this regard are provided in Chapter 3.

2.6.1 Priority 1: Address critical ecological and urban threats

In terms of both the Benefit:Cost ratios (Table 2.1) and the prioritisation process, the top priority for the rehabilitation of the Baakens River is **Scenario 1: Address water quality throughout the catchment.** This is certainly the most critical issue in terms of both the river ecology and the threat it represents in an urban environment. Improvement in water quality is fundamental to the continued ecological functioning of the river, the protection of human health, and maintenance of the many ecosystem service benefits associated with a healthy riverine ecosystem.

Priority 1.1: The most urgent intervention in Scenario 1 is the commissioning of a Sewerage Situation Analysis and Management Plan. This plan should focus on the identification of issues across the Baakens Valley sewerage and sanitation network, the Driftsands Collector Sewer, the Cape Recife wastewater treatment works, and all related infrastructure, staffing and maintenance. The report should serve to identify and detail the critical issues, prioritise these, plan interventions and budget and schedule the works[1].

Addressing water quality is also a top priority for the NMB Business Chamber. In recent months (i.e. prior to January 2023), the Civil Society Coalition (CSC) and the NMB Business Chamber have assisted the Executive Mayor and Councillors with site visits to identify the key sewerage infrastructure issues in the Metro area including Baakens Valley[2].

Priority 1.2: Another top priority in terms of urban threats is that of flooding. Management of floods and droughts is a high priority for the city, particularly in the context of climate change (Green Lung Project presentation 2022). Catastrophic flooding could occur at any time in Gqeberha, as it has repeatedly over the past 150 years. The city is currently not adequately prepared and should be geared towards flood-resilience to prevent loss of life and infrastructure. Following the disastrous consequences and loss of life that resulted from lack of preparedness in the April 2022 floods in eThekwini Metro (formerly Durban), no Metro can justify poor planning in this regard, particularly as floods are predicted to increase in both size (peak) and duration. Flood management is addressed by **Scenario 2: Address water quantity (floods, high flows, baseflows)**.

The priority intervention in Sc2 is the commissioning of a Stormwater Situation Analysis and Management Plan. This should focus on assessment of, and plans for, the current flood 'weak spots', such as stormwater concentration areas, clogged stormwater drains, dense vegetation growth

[1] January 2023: Identification and prioritiisation of remedial actions required on key sewage pump stations in the catchment is already underway, under the auspices of a Team which includes the Executive Mayor, the NMB Business Chamber and the Civil Society Coalition (Koekemoer pers.comm. 2023).

upstream and downstream of bridges (which can result in bridge openings being obstructed during floods), and the lower river where flow is constrained into an artificial canal.

The plan should also make provision for changes to the current stormwater runoff system based on what is now known about the efficacy of Sustainable Drainage Systems[1] (SuDS; refer to Part 2 of this series, Section 6.4.2). Recommendations should include the construction of biodetention ponds and flood channels in appropriate areas. The plan should also ensure alignment with the (anticipated) updated Floodline report for the catchment.

Priority 1.3: The other top priority intervention in Sc2 is the initiation of a campaign or policy to ensure that new developments are equipped with rainwater tanks in the Baakens catchment (and others). This measure will assist with the current water supply crisis, and may to a lesser extent assist with flood management. The Green Lung Project also recommends the drafting of local policy to control and measure water usage via boreholes in the catchment (this is not explicitly included in Sc2 so has not been costed).

The interventions in Scenarios 1 and 2 fall under the mandate of the NMB Metro.

2.6.2 Priority 2: Protect Regional Conservation Value

In terms of the benefit:cost ratios discussed in the Cost Benefit Analysis, the second most effective 'spend' was shown to be Scenario 3 which aims to improve connectivity, channel form, habitat and biodiversity in the lower river and estuary (Table 2.1 and Part 3 of this series). However, in terms of the prioritisation categories in use here, the interventions which best align with the category description fall under **Scenario 2: Manage water quantity (floods, high flows, baseflows).** For clarity, the interventions referred to are those in Scenario 2 that have not yet been attended to under Priority 1.

Three of the main interventions in this scenario relate to the conservation of regionally-important species, while also fulfilling the role of ecosystem rehabilitation and improvement of the natural flood management capability of the system. These are:

- The clearing of all alien invasive vegetation in the uppermost catchment (Reach 1);
- The rehabilitation of the seep and depressional wetlands which occur in this source area of the Baakens;
- The consideration of a moratorium on further development of the upper catchment. Application for formal protection of this minimally-developed area, which includes Rowallan Park and Hunters Retreat. Grobler (2014) reported on the irreplaceable rocky outcrops and associated populations of species of special concern (SSCs) which occur in this area (Figure 2.1). The SSCs include the endemic and critically endangered honeybush (*Cyclopia pubescens)*, the critically endangered *Agathosma gonaquensis (*Gonaqua buchu) and *Corpuscularia lehmannii (a succulent)* and the endangered *Disa lugens var. lugens (Greenbearded Disa orchid),* as well as vast areas of Rowallan Park fynbos (see Part 2, Section 6.4.5).

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[1] The SuDS approach is to manage surface water drainage systems holistically in line with the ideals of sustainable development. The aim is to design for water quantity management, water quality treatment, enhanced amenity, and the maintenance of biodiversity. In so doing many of the negative environmental impacts of stormwater are mitigated and benefits may be realised.

These interventions will have the longer term effect of assisting water quantity management**.** The removal of alien vegetation will facilitate a return to a more natural land surface, capable of intercepting and storing storm rainfall. The restoration of wetland function will reinstate the 'sponge' type functionality of these systems and their surrounds, playing a major role in flood attenuation and baseflow regulation. The formal protection of the entire area, a large portion of which is critical biodiversity area (CBA), will serve as valuable protection against future floods, both by retaining the value of the ecosystem and its biota and preventing further damaging developments.

The protection of the upper catchment area is likely to prove to be time consuming, so the sooner this action is initiated with the help of the relevant agencies (Working for Wetlands and South African National Biodiversity Institute or SANBI), the better.

	
Agathosma gonaquensis. Gonaqua buchu	*Cyclopia pubescens.* Honeybush
. Critically endangered	Endemic, critically endangered
	
Corpuscularia lehmannii, Succulent	*Disa lugens var. lugens. Green-bearded Disa (orchid)*
Critically endangered	Endangered

Figure 2.1 Four of the SSCs in the upper catchment area which require formal protection

2.6.3 Priority 3: Protect local conservation value

The third 'best-spend' on rehabilitation based on the ranking of benefit : cost ratios is Scenario 2, however as discussed in the previous section, interventions in this scenario were assigned to first and second priority when using the Rutherfurd et al. (2000) prioritisation method. For the purposes of this project, the third priority is for the remaining interventions in **Scenario 3: Improve connectivity, channel form and habitat in the lower river and estuary.**

This takes into account the fact that many of the Scenario 3 interventions may already have been implemented, as they were required to be in terms of the Environmental Authorisation. However, the estuarine rehabilitation is a more complex intervention than is the rehabilitation of the river (Bridge St. to Lower Valley Road circle), and it is possible that the estuarine rehabilitation may be delayed until after the upstream works are complete and the various required documents (updated floodlines and stormwater plan) have been prepared, as these will be important inputs to this plan.

Regarding the reinstatement of connectivity, the EA requirement was for construction of only two fishways in Settlers Park. The recommendation made by Dr Bok, the study Fish Specialist was as follows: 'It is recommended that fishways be installed on **all** man-made barriers to fish migration in the Baakens River, to facilitate fish and eel upstream migration, and to reconnect the estuary and lower part of the river with the upper sections.' (Part 2 of this series, Section 7.4.1).

There are numerous crossings over the river which require fishways. There are at least another six required in Settlers Park, and more upstream of this. It is recommended that the Settlers Park ones are given priority, to link this section of river to the estuary and ocean. The reinstatement of fish passage through this lower system of river would have a substantial effect on its local conservation value, as migratory fish previously precluded from the higher river reaches reach would now be able to move up-river and occupy this habitat.

Either before or after this intervention is implemented, it has been recommended by Strydom (2014) that investigations be done into the possibility of removing alien fish from this reach. This would likely be an intensive physical process (electro-shocking or netting) and, according to Bok (2021, pers. comm.) would most likely need to be repeated on an annual basis to give the sensitive indigenous fish species a chance to recover to more natural abundances in this section of the river. Note that this intervention has not been costed in Scenario 3.

2.6.4 Priority 4: Protect and improve deteriorating reaches, Priority 5: Expand good reaches

The best fit for Priorities 4 and 5 are the proposals made in The Green Lung Project: Restoration of Baakens River report (Mantis, 2021) for the revival of recreational facilities, natural areas and educational opportunities within the Valley, and in particular at Settlers Valley (Reach 5, considered to be a deteriorating reach) and Dodd's Farm (Reach 4, considered a relatively good reach).

This aligns with the Mantis (2021) report which states the following:

'*Once the priority concerns (*Text Box 2.1*) are addressed and the clean-up and rehabilitation process has commenced, a doorway will be opened to what could be achieved within the grounds of the Valley. In this study, we have focused on 3 primary zones which have the potential to be developed throughout the Valley, namely; Recreational (area 1), Natural/protected (area 2) and educational (area 3;* Figure *). While referred to as 'areas', it is important to note that these will not be designated areas, but more fluid nodes and pockets situated throughout the Valley.*

Text Box 2.1 Classification of the main problems of the Baakens Valley into key issues

The main problems identified by the research can be classified into key issues and are summarized below as:

Invasive alien vegetation

• Presence of alien invasive vegetation • Biodiversity loss and degradation • Fire hazard due to alien vegetation • Improper harvesting of trees causing accelerated regrowth • Unsustainable efforts towards rehabilitating the river valley, among others. • Flood risk (due to stormwater pollution and debris choking bridges and causeways)

Sewage

• Sewage leaking constantly from the city's major sewage line which runs down the length of the Baakens River and contaminates the river and the sea

Safety & Security

• An increasing number of robberies, rapes and assaults make the area unsafe for the local communities.

Extract from Mantis report (2021)

RECREATION:

These areas will be dedicated to recreation and commercial activities:
• Concentrated activity
• Controlled footfall
• Protection of the vegetation
• Secure environment for community

NATURAL:
These areas and pockets will be dedicated to the protection and preservation of the natural vegetation and will be situated throughout the valley.
• Protection of the natural vegetation
• Controlled, minimal entry and footfall to these areas
• Minimal to no disturbance to natural vegetation (trails, etc.)

EDUCATIONAL:
We propose dedicated educational areas be created throughout the Valley. These areas can run in parallel to the protected and recreational areas, and can be utilized for education purposes (school trips), research, skills development and training, indigenous vegetation nurseries, and guided tours.

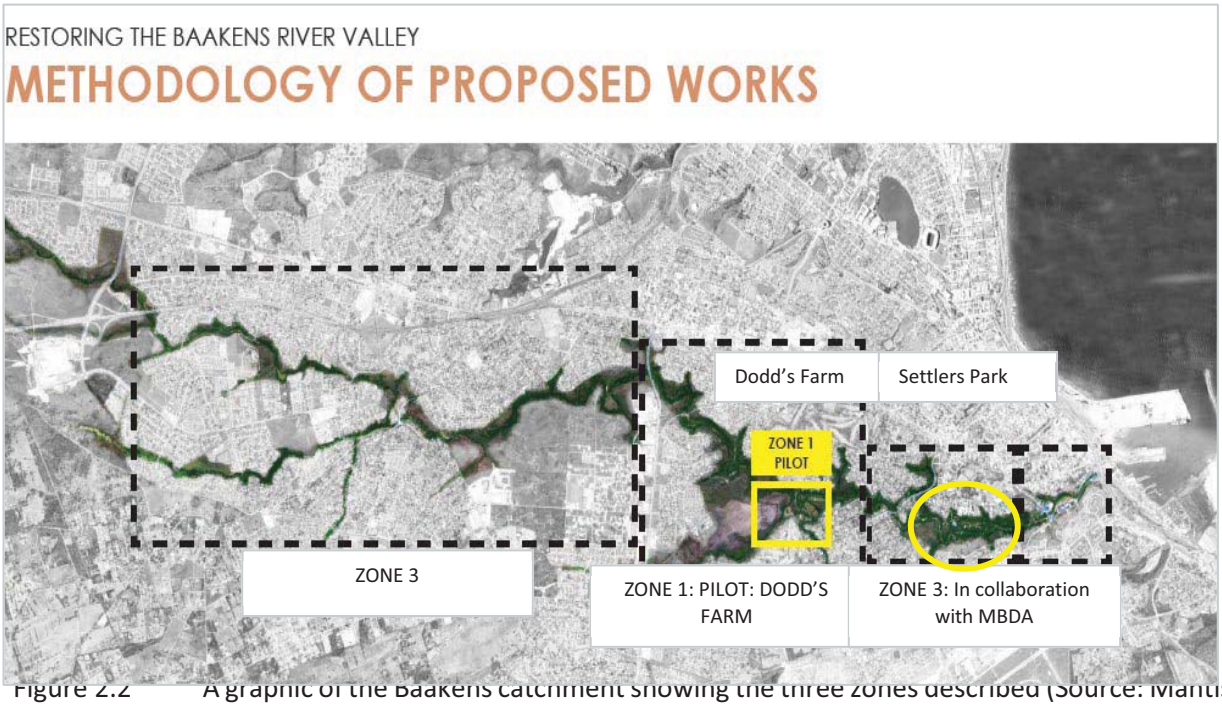

Figure 2.2 A graphic of the Baakens catchment showing the three zones described (Source: Mantis, 2021). The yellow circle (added) shows the Settler's Park area

2.6.5 Priority 6: Protect and improve deteriorating reaches

The activity assigned to this Priority category is the clearing of alien invasive vegetation through those reaches which have not been cleared up to this point, likely Reaches 2 to 4. This intervention is not included in the Scenarios. The clearing of alien invasive vegetation catchment-wide is a recommendation of the Green Lung Project: Baakens Valley Restoration report (Mantis, 2021). Additional interventions recommended by this Team for Reaches 2 and 3 would be the thinning of indigenous vegetation for 500m upstream and downstream of all bridge crossings to assist with flood management, planting of the floodplain with appropriate indigenous species in areas where it has been cleared, improvement of safety and security, and over the long term, the extension of the Guinea Fowl Trail Improve security for recreation. Longer term, extend the Guinea Fowl Trail into the upper catchment.

3 RECOMMENDATIONS REGARDING THE ONGOING REHABILITATION PROCESS

The prioritisation process and outputs serve as preliminary recommendations to the MBDA. Here, the recommendations regarding the continuation of the rehabilitation process are presented.

3.1 Initial actions to consider

3.1.1 Open the discussion

The current state of the river is now better understood, a number of rehabilitation scenarios (alternatives) have been elaborated, a Cost Benefit Analysis has been performed on these scenarios, and a prioritisation process has been followed (Parts 1-3, this series). It is now important now to enter into open discussion about the rehabilitation exercise.

All parties involved or affected by the rehabilitation measures should have the opportunity to hear about future plans, and to participate in the further deliberations. These stakeholders should be told about the South Precinct Development Plans, the Green Lung Baakens Restoration Plan, and this Study, and how the three can be dovetailed. The reasons for selecting the preferred scenarios (or interventions), and any restrictions to them, should be presented.

Once discussions have been initiated it will become clear which parties wish to participate in the rehabilitation effort, and discussion regarding details can ensue. Some consideration could be given to the creation of a management structure to represent the various role-players and sectors.

3.1.2 Work with existing partnerships and initiate new ones

There are a number of pre-existing rehabilitation proposals for the Baakens, which were summarized in Part 2 of this series (Uys et al., 2022b). The organisations responsible for these reports are likely to be committed to implementation, meaning that if well organised, a multi-party effort would be possible and would achieve a great deal more than the efforts of a single agency such as the MBDA.

While a number of partnerships are already active, additional collaborations should be considered. These relationships do not have to be formalised contractually, however if work is to be done collaboratively, a Memorandum of Agreement (MoA) is recommended.

Existing partnerships include those between :

- **NMB Development Agency and NMB Metro.** MBDA is an implementing agent for projects and events which align with the various planning and development initiatives of the Metro. As such this partnership is fundamental and it is vital that all lines of communication are kept open and the working relationship nurtured. Many of the interventions recommended in this study are the mandate of the Metro, which makes this working relationship even more important.
- **NMB Development Agency and NMB Business Chamber.** The Chamber is very active in a suite of projects across the Metro. They are collaborators in a number of projects considered vital to the future state of the city, the stability of its political structures, and the protection of its

environment. These include the Green Lung Project[1], responsible for the Mantis (2021) report on the Restoration of the Baakens River; and the Civil Society Coalition which is a grouping of civil society representatives which serves to take action in critical service delivery matters. The Business Chamber has taken the initiative to partner with the Metro in the ongoing attempts to address the issue of sewage contamination of the rivers including the Baakens. The relationship between MBDA and NMB BC is seen to be a strong one and it is hoped that the organisations will collaborate on this project.

Engagement between the NMB Metro, MBDA and the following organisations is considered critical to the implementation of the rehabilitation scenarios. Some of these organisations have been involved in previous studies, or proposals contributing to the rehabilitation of the river (e.g. Strydom, 2014; Grobler, 2013).

- **Nelson Mandela University** (Zoology and Botany Departments). As discussed in Part 2 of this series, a conceptual plan for the rehabilitation of the estuarine section of the Baakens has been written (Strydom, 2014). The author, Professor Nadine Strydom, has shown interest in being involved in the further planning and execution of this exercise (Strydom pers. comm. 2022).
- **Working for Water (WfW).** This organisation is critical to the clearing and management of Alien Invasive Vegetation catchment-wide. A clearing plan for the entire catchment was reportedly presented to the city by WfW in 2013 / 2014, however this was not implemented for various reasons (Buckle pers. Comm. 2022). The business plan for this project has not been located by this team despite many attempts to do so. Nonetheless, if alien clearing is to be done at a large scale, WfW should be consulted to assist where possible.
- **Working for Wetlands (WfWet).** It is recommended that WfWet be approached with a preliminary report on these wetlands, and requested to assist with the assessment of wetland status and the development of wetland rehabilitation plans in the upper catchment. WfWetlands, together with SANBI, may also be the best parties to assist in the application for formal protection of the upper catchment.
- **SA National Biodiversity Institute (SANBI).** SANBI can assist with advice regarding the application for formal protection of the upper catchment, particularly as there is a large Critical Biodiversity Area located in this upper reach.

3.2 Establish a Management Committee for Baakens Valley rehabilitation

Once there is clear understanding of who the role-players are, the establishment of a management structure is advised.

- Establish a **Baakens Valley Management or Steering Committee.** This could either be along the lines recommended by Mantis (2021, see Figure 3.1), or using the structure of a Catchment Management Forum (CMF), as advocated by Department of Water and Sanitation (DWS). This Forum can be officially registered with DWS but does not have to be. If it is registered as a Forum, it will have official recognition within DWS and will have DWS participation and assistance. Further information on this structure is available from DWS local office or online (Award, 2014).

[1] The Green Lung project aims to:
1. Create three "Green Lung" corridors: (Baakens, Van der Kemps Kloof, & Swartkops Rivers) as Protected Areas
2. Link to (and co-manage) current reserves: Van Stadens, the Island, Cape Recife, Settlers Park, Van der Kemps Kloof, Swartkops & Aloes
3. Link to the Blue Lung Project (Ocean related project)

- Consider including on this committee relevant representatives of MBDA, NMB Metro, NMB Business Chamber, Department of Water and Sanitation, Department of Forestry, Fisheries and Environment (or local department of Economic Affairs, Environment and Tourism), the Civil Society Coalition, Nelson Mandela University (relevant department/s), the Community Crime Awareness group, Fat Traxx Mountain Bike Club; Engineering Consultants, Environmental Consultant (authorisations), Rehabilitation Specialist, Wetland and Riparian Vegetation Specialist.

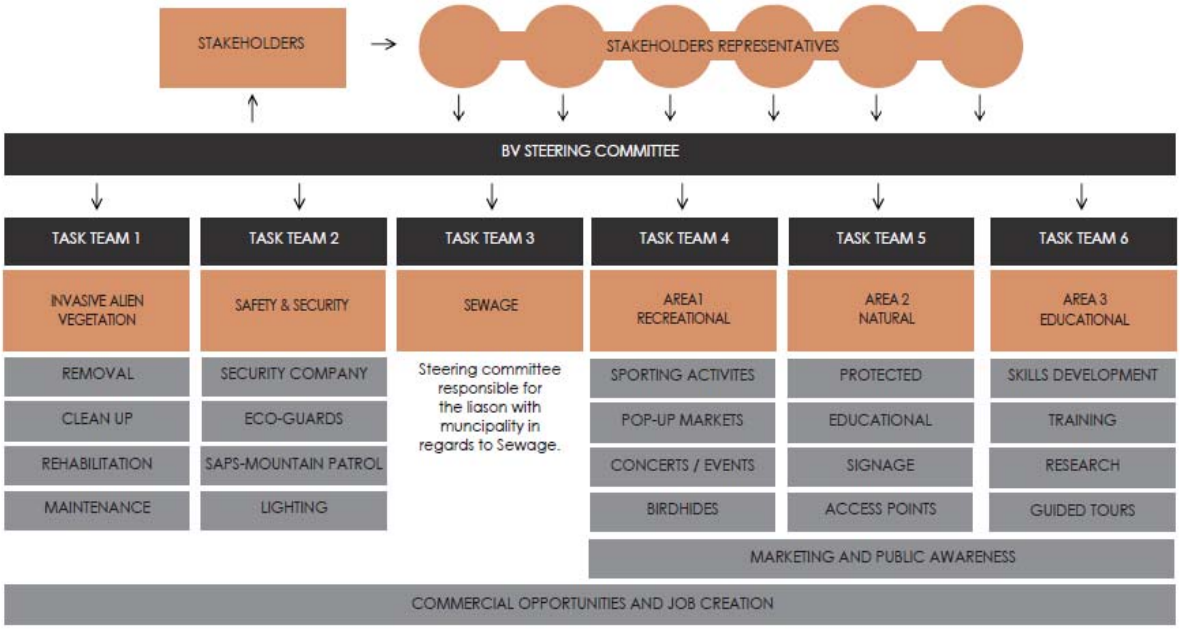

Figure 3.1 An optional management structure for the Baakens Valley restoration as envisaged in the Mantis Report (2021) commissioned by the Business Chamber

- The committee may comprise a number of Task Teams covering more specialised areas of intervention, as per Mantis (2021):
  - *Water quality*
    - *Sewage*
    - *Water quality monitoring, assessment, information distribution*
  - *Security*
    - *Community Crime Awareness group (CCA)*
    - *Security along the length of the river*
    - *Security at sewage pump stations*
  - *Stormwater Management*
  - *Sport and recreation*
  - *Natural Resources of the River*
    - *Protection of the upper catchment (Protected Area status)*
    - *Wetlands (assessment and rehabilitation)*
    - *Estuary (rehabilitation)*
    - *Vegetation: Indigenous (replanting); Alien Invasive Vegetation (clearance and management)*
    - *Fish (indigenous, alien, fishways)*

- Stakeholder representatives should meet with the Management Committee regularly to get and give feedback. These organisations may also have representatives on the Steering Committee or Task Teams. Stakeholders should include:

    - *Security representatives (e.g. Community Crime Awareness)*
    - *Formal and informal environmental organisations (e.g. Wildlife and Environment Society of SA)*
    - *Tertiary institutions (e.g. Nelson Mandela University)*
    - *Mountain bike Clubs and other sporting clubs (e.g. Fat Traxx)*
    - *Ratepayers representatives*
    - *A South End representative*
    - *Local school environmental or outdoor groups*
    - *Religious or spiritual groups*
    - *Traditional healers.*

3.2.1 Develop a charter for the management body

The guidelines for the establishment of a charter for a Catchment Management Forum (Award, 2014) provides a list of contents for a charter for the CMF. This is a useful guideline for the development of a charter or constitution for the management structure (referred to as the Forum in the list below).

- Name and identity of the Forum
- Mission and Objectives of the Forum
- Functions of the Forum
- Area of Jurisdiction / Operation
- Structure of the Forum
- Membership of the Forum
- Rights and Responsibilities of Members
- Office Bearers and their Roles and Responsibilities
- Composition and Reporting Lines of Management Structures
- Operating Procedures
- Sources of Funding
- Reporting and Accountability
- Relationships with Other Structures

3.3 Make decisions regarding priority scenarios, interventions, projects

In consultation with the Management/Steering Committee, make final decisions regarding the priority interventions for the river, the role each party should play, and what further studies will be required to commence detailed planning. These decisions should be based on:

- Availability of funds;
- The options presented in Part 2 of this study (Uys et al., 2022b) which provided three complimentary rehabilitation scenarios and associated interventions;
- The cost-benefit analysis study done on these scenarios (Part 3 of this study, Moynihan et al., 2023) and the prioritisation process presented in this report.
- The proposals presented in the Mantis Group (2021) report on the Restoration of the Baakens River.

3.4 Commission the rehabilitation plan as required by the EA

Once priority interventions have been agreed upon, particularly those for the lower river and estuary, the rehabilitation plan required in terms of the Environmental Authorisation should be commissioned.

it is recommended that both the Green Lung Project: Baakens Valley Restoration report (Mantis, 2021), and this series of reports (Uys et al., 2022a and b; Uys et al., 2023) are reviewed before these new reports are compiled, as these reports represent researched material that can be referenced or used as a baseline for the rehabilitation detail.

In particular, reference can be made to the numerous interventions proposed for this lower section of the river and estuary as part of the proposed Scenario 3 (Part 2, Section 7 this series). These include the clearing of all AIV, thinning of indigenous vegetation; removal of the gabion/concrete canal sides; sloping, stabilisation and planting of banks; the reinstatement of instream, marginal and riparian habitat; the creation of embayments for larval fish; the planting of the floodplain with indigenous floodplain trees, and the creation of flood channel wetlands on the floodplain to increase lateral connectivity and improve floodplain function.

Bear in mind that a number of studies may be required in support of the rehabilitation plan:

- Hydraulic computations and models for any interventions in the channel.
- Detailed engineering designs for any interventions in the channel. Note that when working in a river, normal construction rules do not necessarily apply and great care must be taken to protect the ecosystem. These measures must be stipulated in the rehabilitation report. A rehabilitation specialist should be consulted.
- Specialist inputs on larval and other fish (for fishway design).
- Specialist input on rehabilitation of estuarine form and function.
- Guidance on all aspects of vegetation clearing and replanting.
- A planting plan and bill of quantities.

It is recommended that the various reports be commissioned in consultation with the relevant specialists, or once a management committee has been established.

The updated Stormwater Master Plan and Floodline reports will provide relevant information on measured baseflows, predicted changes in stormwater runoff, and modelled floods. These would serve as crucial inputs to the hydraulic computations and engineering designs for the lower river channel and estuary, instream habitat, and floodplain channels – all core elements of Scenario 3.

It should also be noted, that until water quality has been substantially improved catchment-wide, rehabilitation interventions on the lower river are unlikely to yield the expected benefits.

3.5 Continue the rehabilitation process

While the rehabilitation plan for the lower river is being attended to, the remainder of the rehabilitation process should be applied to the remaining interventions. This would typically involve completing the remainder of the Steps and Tasks in the Rutherfurd et al. (2000) method (see Figure 3.1). These are outside of the scope of this project, however broad descriptions will be provided for Steps 7 and 9.

Step 7: Set measurable objectives
Step 9: Plan/design the details
Step 10: Plan the evaluation
Step 11: Schedule and supervise works
Step 12: Assess and maintain project[1].

3.6 Set measurable objectives

Broad objectives were set for each of the three rehabilitation scenarios (Part 2 of this series, Uys et al., 2022). The setting of measurable objectives is a more detailed process which will apply to individual interventions rather than scenarios, and will probably require specialist inputs. These objectives should be a precise, clear, measurable statement of the intended outcomes of prioritised interventions. They form the basis for the evaluation of the project at a future stage.

In short, this process involves five steps, briefly presented here. For further detail the manual should be consulted:

- Define the **amount of change** you want to see (it is safest to assign a range of values rather than one);
- Define the **spatial scope** of the objective;
- Set the **time frame** for the desired change;
- Determine the **type of objective** – is it defined in terms of outputs (i.e. completed interventions) or outcomes (system response);
- Check that the objective is **achievable**. Most recovery is measured in the scale of years. A range of outcomes can be specified here, from failure to great success.

From Rutherfurd et al. (2000).

In the context of Nelson Mandela Bay, with its current infrastructural challenges, it is important that the objectives take into account the possibility of failure due to circumstances beyond the implementer's control.

[1] Further details on these Steps are available in the Australian stream rehabilitation manuals which can be accessed online:

Volume 1: Method:
https://www.researchgate.net/publication/340135028_A_Rehabilitation_Manual_for_Australian_Streams_VOLUME_1

Volume 2: Common Stream Problems, Planning Tools, Intervention Tools
https://www.researchgate.net/publication/340134793_Australian_stream_rehabilitation_manual_vol_2

3.7 Plan/design the details

This stage of the process may take some time to implement and complete. It does however set the basis for successful outcomes, while also providing the NMB Metro and MBDA with information which it critically needs.

3.7.1 Commission the further studies required

The following studies were identified in Report 2 (Uys, 2022b) as being required as a matter of urgency. These would assist in informing detailed planning of the rehabilitation exercise:

- Sewerage situation analysis and management plan (Scenario 1);
- Stormwater situation analysis and management plan (Scenario 2);
- 1:500 and 1:100 year floodlines for the whole catchment (this study is already planned, Davids pers. comm. 2022);
- Rehabilitation plan for the lower river as required by DEDEAT (Environmental Authorisation for the South Precinct Development; Scenario 0, see Uys, 2022b). This could to some extent draw

Depending on which interventions are selected for implementation, any or all of the following studies would be required for the detailed planning phase:

- Wetland delineation and current state assessment (for Scenario 2, rehabilitation of upper catchment wetlands);
- Hydraulic computations to provide guidance for the naturalisation of channel form in the lower 1km of river and estuary (for Scenario 3, naturalisation of channel form and habitat);
- Geotechnical studies of the lower 500m of river/estuary, where the channel widening and possibly deepening and bank stabilisation (for Scenario 3; naturalisation of channel form and habitat);
- Engineering studies and design for the numerous Fishways (for Scenario 3, reinstatement of system connectivity);
- Engineering studies and design, together with a wetland (or other relevant) specialist, for biodetention ponds (for Scenario 2, stormwater regulation and management).

3.7.2 Final Report and Designs

With inputs from Larsen, 1996

The project options that are selected in the pre-design phase are now subjected to detailed description and design. The final report and drawings for one or more interventions will be submitted to the controlling authorities together with applications for authorisation as and where required.

Final design would require the input of various specialists, the project initiator, and the Management Committee. The final design documents would include at a minimum the following: a written report, a set of maps, a set of drawings, hydraulic computations (where necessary), design and stability analysis of hydraulic structures (where relevant), full costing, and specialist reports (where necessary, e.g. clearing and planting plans). Further information may be required for the purposes of environmental or water use authorisations.

Based on this documentation, the various authorisations required can be applied for. Rehabilitation activities may trigger numerous approvals or permits, including water use licenses or general authorisations, environmental authorisation, heritage permits, waste management licenses, permits in terms of biodiversity, and other approvals.

Once the authorisations are acquired, or during the authorisation process, tender documents can be prepared. These will include timing schedules for the various activities, specific materials to be used, specific environmental conditions to be met during the construction and operational phases, and the quality the finished work is to achieve.

The final stages of the rehabilitation process are planning the evaluation, implementation, and assessing the outcomes. These are well beyond the scope of this study, however guidance is available in the Rutherfurd et al. (2000) methodology.

It is important that the Construction Environmental Management Programme (CEMPr) required as part of the environmental management of the construction phase is developed in consultation with the rehabilitation specialists, as implementation of this type of project differs significantly from a normal construction project, and methods will need to be adapted.

The project Implementation, monitoring and post-implementation monitoring are subjects well beyond the Scope of this report and would be covered by the various reports required for the rehabilitation of the Baakens River.

REFERENCES

Bok, A.H. 1994. Report on a Fish Survey of the Baakens River: December 1994. Eastern Cape Nature Conservation, Port Elizabeth. 23pp

Bok, A.H. 1997. Necessity for and conceptual design of fishways in the Baakens River, Settlers Park. Unpubl. Report for the City of Port Elizabeth. 28pp.

Larsen, P. 1996. Restoration of river corridors: German experiences. Pp 124 – 143 in: In. G. Petts and P. Calow. River Restoration. Blackwell Science.

Moynihan, M., Crafford, J. and Macquela, B. 2023. An investigation of the rehabilitation potential of the Baakens River, Gqeberha. Part 3: Cost Benefit Analysis. Report to the Water Research Commission, Project No. 2022-23 01121.

Rutherfurd, I.D., Jerie, K., and Marsh, N. 2000. A rehabilitation manual for Australian Streams. Volumes 1 and 2. Cooperative Research Centre for Catchment Hydrology, Land and Water Resources Research and Development Corporation.

Strydom, N. 2014. Status of fishes in the Baakens River, Port Elizabeth, with notes on rehabilitation. Unpubl. Report to CEN Integrated Environmental Management, Port Elizabeth. 17pp.

Uys, A.C., Bok, A., MacKenzie, J., Scherman, P., and Kanise, N. 2022a. An investigation of the rehabilitation Potential of the Baakens River, Gqeberha. Part 1: Current State of the River. Report to the Water Research Commission, Project No. 2022-23 01121.

Uys, A.C., Bok, A. and McKenzie, J. 2022b. An investigation of the rehabilitation potential of the Baakens River, Gqeberha. Part 2: River rehabilitation scenarios. Report to the Water Research Commission, Project No. 2022-23 01121.

Uys, A.C., Bok, A., MacKenzie, J. and Scherman, P. 2023a. Rehabilitation Potential of the Baakens River, Gqeberha. Part 4: Recommendations. Report to the Water Research Commission. Project No. 2022-23 01121.

Uys, A.C., Moynihan, M., Uys, Bok, A., MacKenzie, J., Scherman, P., Crafford, J., Macquela, B. and Kanise, N. 2023b. Rehabilitation Potential of the Baakens River, Gqeberha. Part 5: Summary Report. Report to the Water Research Commission. Project No. 2022-23 01121.

PERSONAL COMMUNICATIONS

Buckle, Japie. 2022. Mr Japie Buckle. Formerly occupied several positions with the 'Working for…' programmes within DEAT. Currently a Director of HIVE Ecosystems.

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