National Aquatic Ecosystem
Biomonitoring Programme

An Implementation Manual for the River Health Programme – a hitch hiker's guide to putting the RHP into action

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ASPT	Average Score Per Taxon (Invertebrates**)**
BP1-5	Biomonitoring Protocol 1 to 5
CMA	Catchment Management Agency
DEAT	Department of Environmental Affairs and Tourism
DWAF	Department of Water Affairs and Forestry
FWI	Department of Freshwater Invertebrates, Albany Museum
FAII	Fish Assemblage Integrity Index
FCII	Fish Community Integrity Index
GI	Geomorphological Index
HI	Hydrological Index
I&AP	Interested and Affected Parties
IHAS	Invertebrate Habitat Assessment System
IHI	Index of Habitat Integrity
IWQS	Institute of Water Quality Studies
IWR	Institute of Water Research (Rhodes University)
NAEBP	National Aquatic Ecosystem Biomonitoring Programme
NEMA	National Environmental Management Act
NCC	National Coordinating Committee
NCT	National Coordinating Team
NWA	National Water Act
NWRS	National Water Resource Strategy
PIT	Provincial Implementation Team
PMT	Provincial Monitoring Team
PP	Public Participation
QC/QA	Quality Control/Quality Assurance
R&D	Research and development
RHP	River Health Programme
RVI	Riparian Vegetation Index
SASS4	South African Scoring System version 4
SoE	State of the Environment
SoR	State of Rivers
WMA	Water Management Area
WMS	Water Management System (as used by DWAF IWQS)
WQI	Water Quality Index
WUA	Water User Association
WRC	Water Research Commission

GLOSSARY OF TERMS

Aquatic ecosystems. Ecosystems which provide a medium for habitation by aquatic organisms and sustain aquatic ecological processes.

Anthropogenic. Resulting from the presence or activities of humans.

Benthic. Living on the bottom substrata (sediments, debris, logs, cobbles, etc.) of aquatic biotopes.

Biological River Segment. A portion of a river in which the fish community remains generally homogenous due to the relatively uniform nature of the physical habitat.

Biomonitoring. The gathering of biological information in both the laboratory and the field for the purpose of making an assessment or decision or in determining whether quality objectives are being met.

Biodiversity. The array of life from gene to species to communities and associated habitats. Biodiversity comprises composition, structure and function. Composition is the identity and variety of elements in a collection, and includes species lists and measures of species diversity and genetic diversity. Structure is the physical organization or pattern of a system, from habitat complexity as measured within communities to the pattern of patches and other elements at a landscape scale. Function involves ecological and evolutionary processes, including gene flow, disturbances, and nutrient cycling.

Bioregions. Geographical regions delineated by South African river scientists as the first level of an hierarchical classification of the rivers of the country. The rivers within each bioregion were considered, on the basis of expert opinion, to be similar in terms of physical and biotic characteristics.

Biota. Animal and plant life characteristic of a given region.

Biotic Integrity. The ability to support and maintain a balanced, integrated, adaptive community of organisms having a full range of elements (genes, species and assemblages) and processes (mutation, demography, biotic interactions, nutrient and energy dynamics and metapopulation processes) expected in the natural habitat of the region.

Biotope. A homogeneous environment that satisfies the habitat requirements of a biotic community (e.g. riffle, pool or sandbank).

Catchment. The area from which any rainfall will drain into a watercourse through surface flow.

Catchment Management Agency. A statutory body established by the Minister of Water Affairs to delegate water resource management to a local level and to involve local communities. They may be established for specific geographical areas, after public consultation, on the initiative of the community and stakeholders concerned.

Diffuse-source Pollution. Pollution that comes from a wide area, such as fertilisers draining off farmlands or pollutants in the runoff from urban areas (also known as non-point source pollution).

Ecological Indicator. Measurable attribute of a high-level ecosystem component (biological, chemical or physical). A high-level biological component would typically be either fish, invertebrates or riparian vegetation. (For example, one measurable attribute of fish is frequency of occurrence at a series of sites.) A high-level non-biological component might be either habitat, water quality or geomorphology. (One measurable attribute of geomorphology is bank stability.)

Ecological Index. A single quantitative value that incorporates the information contained in a number of related ecological indicators. It is based on field data that are simple to collect and it provides a meaningful and accurate representation of the river condition for a high-level ecosystem component. The purpose is to simplify the interpretation of the indicators and hence make them more understandable to non-specialists such as resource managers, conservationists and the general public.

Ecological Integrity. The ability of and ecosystem to support and maintain a balanced, integrated composition of physicochemical habitat characteristics, as well as biotic components, on a temporal and spatial scale, that are comparable to the natural (i.e. unimpaired) characteristics of such an ecosystem. (High ecological integrity implies that the structure and functioning of an ecosystem are unimpaired by anthropogenic stresses.)

Ecoregions. Geographic regions grouped together on the basis of shared similar characteristics, such as geology, rainfall, vegetation and altitude.

Ecosystem. Any unit that includes all of the organisms (i.e. the community) in a given area interacting with the

physical environment so that a flow of energy leads to clearly defined trophic structure, biodiversity and material cycles (i.e. exchange of material between living and non-living parts) within the system.

Ecosystem Health. A value judgement of the overall condition of an ecosystem.

Geomorphology. The study of the origin of secondary topographic features which are carved by erosion in the primary elements and built up of the erosional debris.

Groundwater. Water found underground, typically supplying wells, boreholes, and springs.

Habitat Integrity. The maintenance of a balanced, integrated composition of physicochemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region.

Hydraulics. The branch of science and technology concerned with the mechanics of fluids.

Hydrology. The science that treats the occurrence, circulation, distribution, and properties of the waters of the earth, and their reaction with the environment.

Infrastructure. The basic structure of an organisation, system, etc.

Integrated Catchment Management. Environmental considerations are fully integrated into the management of all activities within a catchment in order to achieve a desirable balance between conservation and development

Integrated Environmental Management. A code of practice ensuring that environmental considerations are fully integrated into the management of all activities in order to achieve a desirable balance between conservation and development.

Invertebrate. An animal lacking backbone and internal skeleton.

Macroinvertebrates. Invertebrates retained by mesh size 200 um.

Monitoring Site. Sites identified as important in assessing the condition (i.e. available habitat, water quality and biological parameters) of a river or reach, relative to a reference site. For State-of-Environment reporting, monitoring sites are randomly selected sites to assess the range of conditions prevailing in rivers.

Morphology. The form and structure.

Perennial. All year round.

Provincial Implementation Team. A group of people involved in implementing the RHP provincially.

Provincial Monitoring Team. A group of people charged with RHP monitoring provincially using the indices of ecosystem health.

Point-source Pollution. Pollution that comes from a single source, such as a pipe.

Pool. A feature with slow through-flow of water (low or zero velocity,) generally deep relative to river size.

Reference Condition. A benchmark of the best attainable ecological conditions for a specific type of river.

Reference Site. A site that has been exposed to relatively little or no anthropogenic impact that can be used to define the be physical habitat, water quality and biological parameters for a particular kind of river. These sites represent the best condition that can be achieved in a particular kind of river, against which the conditions found at the monitoring sites in the kind of river can be assessed.

Riffle. A shallow, fast-flowing reach of a river with turbulent flow and broken water.

Riparian. Living or located on the banks of streams or rivers.

River Forum. A group of interested and affected parties living within a river catchment which have come together to address common issues

Run. An area of transition between a pool/rapid and riffle. Depth is variable and velocity is generally moderate.

Runoff. Water that does not filter into soil but flows over the surface and into natural surface waters.

Site-specific. Unique or specific to a certain locality.

State-of-the-Environment Reporting. Detailed reporting on the current state of the biophysical components of the environment (i.e. air, land, water and oceans) and on the social, economic and political activities that impact on these resources.

Stressor. Any physical, chemical or biological entity or process that can induce adverse effects on individuals, populations, communities or ecosystems.

Surface Water. Water above the ground surface in lakes, dams, rivers and pans.

Suspended Solids. Inorganic or organic matter, such as clay, minerals, decay products and living organisms, that remains in suspension in water. In surface waters it is usually associated with erosion or runoff after rainfall events.

Sustainable Development. Integrating social, economic and environmental considerations into planning, implementation and decision-making to ensure that development meets the needs of the present without compromising the ability of future generations to meet their own needs.

Turbidity. A measure of the light-scattering ability of water. It indicates the concentration of suspended solids in the water.

Water Board. An organ of state established or regarded as having been established in terms of the Water Services Act (No 108 of 1997) to perform, as its primary activity, a public function. This includes a "water services provider" who provides water services institution, but does not include a water services intermediary. The National Water Act (No 36 of 1998) provides for the restructuring of water boards as water user associations.

Watercourse. A river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which, water flows.

Water Management Area. A geographical area demarcated i.t.o. National Water Act to be administered by the relevant Catchment Management Agency.

Water Management Institution. A catchment management agency, a water user association, a body responsible for international water management or any person who fulfills the functions of a water management institution in terms of the National Water Act (No 36 of 1998).

Water Resource. Includes the physical or structural aquatic habitats (both instream and riparian), the water, the aquatic biota, and the physical, chemical and ecological processes which link habitats, water and biota.

Water User Association. Co-operative associations of individual water users who wish to undertake water-related activities for their mutual benefit. They operate at a restricted local level.

FOREWORD

The intention of this manual is to serve as a recipe or cookbook to guide those involved in putting the RHP into action. It is designed to complement the *National Implementation Assessment*
NAEBP Report Series No.8 (Murray, 1999) and *Overview of the design process and guidelines for implementation* NAEBP Report Series No6 (Roux, 1997) by providing practical insights into implementing the RHP programme.

In so doing, it strives to bridge the gap between the theoretical components of the River Health Programme and the practical realities of getting a fully-fledged provincial River Health Programme up and running . Hence, it will (where possible) steer clear of the theoretical aspects of the programme and the scientific aspects of the biomonitoring indices as there is a large body of literature available for the user to consult on these topics.

As the RHP continues to grow in South Africa, so too will the wealth of insights and experiences in the practical implementation of the programme. Hence, it is believed that this first edition of the RHP implementation manual is the forerunner of future versions to complement the advancements of the RHP in South Africa. It is hoped that this manual will be of benefit to the many people out there who are planning to do or are doing River Health to develop their programme and reap the rewards of successful implementation.

1. INTRODUCTION

What is the River Health Programme? The RHP is essentially a national initiative to assess and monitor the ecological state of the South Africa's rivers using standardised indicators to garner information on the long-term environmental trends of the country's freshwater resources. The RHP rests on the foundations of the biomonitoring of aquatic ecosystems, which has been defined as "the systematic use of biological responses to evaluate changes in the environment with the intent to use this information in a quality control programme" (Matthews *et al.* 1982).

Why is it important to implement the RHP in your province? The World Resources Institute says that freshwater systems are globally by far the most degraded ecosystem and that half of the world's wetlands were lost in the 20th century. This view is supported by the United Nation's Environmental Programme (UNEP). One of South Africa's most limiting resources currently is freshwater. South Africa's National State of the Environment Report of 1999, predicts that the demand for water will increase by close to 50% by the year 2030 from present requirements. It is hence essential that we begin to monitor and assess the state of our river systems NOW so that informed management decisions can be made to ensure that the goals of sustainable development can be met. The RHP is an ideal programme to make a significant and cost effective contribution to this.

There are currently seven biomonitoring indices of "ecosystem health" which are in various stages of development and use in RHP programmes nationwide. The primary indices, which are the most well known and widely used are: SASS (South African Scoring System) for the sampling of macroinvertebrates, which is used in conjunction with IHAS (Invertebrate Habitat Assessment System). The secondary RHP indices are the FAII (Fish Assemblage Integrity Index), IHI (Index of Habitat Integrity) and RVI (Riparian Vegetation Index) which are currently being used, but to a lesser extent. The tertiary RHP indices are the GI (Geomorphological Index) and HI (Hydrological Index), for which prototypes have recently been developed, but are not currently being applied routinely in the RHP. The WQI (Water Quality Index), although previously mentioned in the literature, has not been developed at this stage of the RHP.

Not only do these biomonitoring indices provide a useful set of tools for comparatively benchmarking existing ecological conditions and prevailing water quality, they can also be used to monitor the ecological recovery of rivers and sites after major chemical spills for example. In practice, however, biomonitoring lies somewhere between a science and an art. It relies on the use of scientifically proven and tested methodologies, but the actual interpretation of significance of the results also requires a certain "feel" that only comes with experience and familiarity with rivers being monitored.

However, the RHP is much broader than just the biomonitoring of rivers. The River Health Programme is a ***people-driven process*** which requires a ***team effort*** from committed individuals. It also requires communication, liaison, promotion, quality control, information management, reporting and management actions as key components amongst others (Figure 1).

What is meant by "implementation"? In a nutshell, "implementation" can be defined as: putting a theoretical concept (or core set of objectives) into practice or something tangible. It can also be described as "producing, carrying out, or executing, achieving and accomplishing". To achieve this, the following simple (yet crucial!) questions need to be asked:

- ***What is to be done?***
- ***Where is it to be done?***
- ***How and how often?***
- ***By who?***
- ***For who?***

Therefore, the first step in implementation is to decide on a core set of objectives or principles for your particular programme (the "what" component). To recap, the broad objectives of the RHP are as follows (Roux, 1997):

1. To measure, assess and report on the ecological state of aquatic ecosystems;

2. To detect and report on spatial and temporal trends in the ecological state of aquatic ecosystems;

3. To identify and report on emerging problems regarding the ecological state of aquatic ecosystems in South Africa.

Murray (1999) proposes a fourth objective which essentially extends the reporting function of the RHP to aquatic ecosystem management.

4. To ensure that all reports provide scientifically and managerially relevant information for national aquatic ecosystem management.

The key ingredients for successful implementation of the above objectives can be found on the shelves marked: a well thought out and realistic plan, sufficient budget, dedication, commitment to putting the implementation plan into practice, patience and of course enthusiasm. Some of these ingredients (and in some cases where to get them!) for your RHP are contained in this manual and of course from wise old sages living in your area.

However, this manual is not intended to be prescriptive. The recipe and ingredients for implementing your RHP put forward in this manual are intended only as factors to consider when designing your particular programme (Figure 1). You, as the prospective implementer, have the discretion to choose which aspects you may find useful to include in your RHP design. Additional considerations not mentioned in this manual may also be pertinent to your RHP.

The underlying assumption is that each situation where implementation is required will be different, with its own unique set of practical considerations and conditions. Compounding this, is the capricious nature of reality - of ever changing circumstances and unpredictable eventualities. Prospective RHP implementers will probably encounter many obstacles (the majority of which are man made or from divine sources!) while on the implementation path. ***Perseverence, flexibility*** and ***patience*** are the qualities that you'll need to overcome these. Remember that opportunities present themselves in many different guises!

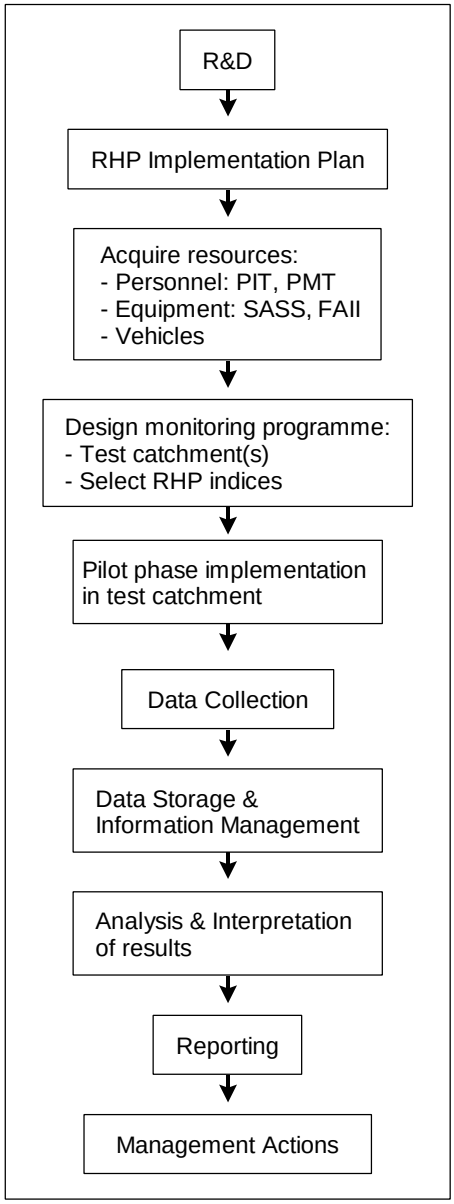

Figure 1. Fundamental steps to RHP implementation.

The RHP is a relatively new concept in environmental management in South Africa. As the programme has only recently emerged from the research and development phase, it can be expected that the RHP will take time to become fully integrated into environmental management strategies countrywide. Although there has been some implementation of the programme in some catchments in several provinces, full-scale countrywide implementation remains on the horizon. Hence it is envisaged that further practical insights into implementing the programme will emerge with time, as more RHP practitioners become involved in the programme and share their experiences with the wider RHP community.

2. LEGAL CONTEXT

Legal principles form the basis for the creation of Bills and Acts and other legal instruments which govern the activities of the nation. There are a number of Acts which are relevant to the broader environmental management field. For those who are not legally orientated, the good news is that there are only two Acts which are directly relevant to the RHP, namely the ***National Water Act (NWA) Act No. 36 of 1998*** and the ***National Environmental Management Act (NEMA) Act No. 107 of 1998.*** Both of these stem from ***Section 24 of the Constitution of South Africa (Act No. 108 of 1996)*** which states that citizens have a right to a clean and healthy environment and advocates the protection of the environment for the benefit of present and future generations through:

(i) the prevention of pollution and ecological degradation
(ii) promotion of conservation
(iii) securing of ecologically sustainable development and use of natural resources while promoting justifiable economic and social development

NOTE:
It is vital that those involved with implementing RHP become familiar with relevant Acts and take cognizance of the provisions and implications of these. These Acts are powerful legal instruments which can be used to justify stakeholder's investment in your RHP (particularly government departments) and your RHP to interested and affected parties for example.

2.1 NATIONAL WATER ACT (NWA)

The NWA is the main Act relevant to the RHP. The NWA, which came into effect in October 1999, heralded a major change in approach from controlled supply and demand management to participatory water resource management. Under the new Act, the National Government is the public trustee of the nation's water resources.

2.1.1 Sections of the NWA relevant to the RHP

Chapter 2: Water Management Strategies

Part 1: National Water Resource Strategy
The Act charges the Minister with establishing a National Water Resource Strategy (NWRS) through public consultation for the use, protection, development, management, conservation and control of the nation's water resources.

Part 2: Catchment Management Strategies
Every Catchment Management Agency (CMA) is required to develop a catchment management strategy for the water resources within its water management area. The RHP could conceivably contribute directly to the catchment management strategy of the CMA and indirectly to the national water resource strategy.

Chapter 3: Protection of Water Resources

Part 2: Determination of class of water resources and resource quality objectives:
A component of determining the class of water resources and resource quality objectives is consideration of: the characteristics and quality of the water resource and the instream and riparian habitat; the characteristics and distribution of aquatic biota. The RHP can play a direct role in both of these aspects.

Part 3: Determination of The Reserve (Ecological Reserve and Human Reserve):
The Ecological Reserve refers to the water quality and quantity required to protect the aquatic ecosystems of the water resource, which is related to the class of the water resource. The RHP can guide this process.

Chapter 7: Catchment Management Agencies

The NWA advocates the establishment of Catchment Management Agencies (CMAs) to oversee the management of the nineteen demarcated Water Management Areas (WMAs) in South Africa.
Catchment Management Agencies are composed of a number of River Forums, which in turn comprise representatives of Water User Associations (WUAs) and a number of other stakeholders from industry, government, local councils and communities. This is an exciting and novel development of taking water management to the people.

As River Fora and CMAs are catchment-based, they have the potential to play a significant role in implementing the RHP. In the future, CMAs may play the lead role in RHP implementation rather than the current provincial RHP arrangement.

Chapter 14: Monitoring, Assessment and Information

Part 1: Establishment of National Monitoring Systems
The Minister must establish national monitoring systems on water resources for the collection of appropriate information, *inter alia,* on the quantity and quality of water resources and the health of aquatic ecosystems. This is the most applicable aspect of the NWA to the RHP as the objectives of the RHP are almost identical.

Part 2: National information systems on water resources
This includes, *inter alia*, a water resource quality information system. The objectives of the National information system include the storage and provision of information for the protection, sustainable use and management of water resources. The national RHP can contribute significantly to this information system.

2.2 NATIONAL ENVIRONMENTAL MANAGEMENT ACT (NEMA)

The NEMA is essentially an enabling piece of legislation largely governing the sustainable use of the environment (including the aquatic environment) and the protection of ecosystems. It also advocates the principle of co-operative environmental governance between government departments and stakeholders, with integrated environmental management being the key underlying principle.

2.2.1 Relevant sections of NEMA for the RHP

Chapter 5: Integrated Environmental Management

The general objectives of this section include the identification, prediction and evaluation of the actual and potential impacts on the environment, risks, consequences and alternatives and options for mitigation of activities. This section also deals with the monitoring and management of environmental impacts , and the effectiveness of the implementation of mitigating measures. The RHP could contribute to this through the monitoring of sites where potential or actual environmental impacts are occurring.

Chapter 7: Compliance, Enforcement and Protection:

Part 2: Information, enforcement and compliance
Organs of State and individuals are entitled to access to information held by the State on the state of the environment and actual and future threats to the environment. The RHP therefore has an obligation to make its information available to relevant parties, particularly if this information is being held by an organ of State such as Nature Conservation and Water Boards.

NOTE:
These and other pieces of legislation (1993 onwards) are available on the internet on the South African government website: www.polity.org.za. It is strongly advocated that prospective RHP implementers become familiar with the key sections of the new legislation.

2.3 PROVINCIAL ORDINANCES

Provincial Ordinances may be relevant to your local RHP and it is worth investigating whether their are specific implications for your programme. The main provincial ordinances are the Cape Nature and Environmental Conservation Ordinance (No.19 of 1974), Transvaal Nature Conservation Ordinance (No.12 of 1983), Orange Free State Nature Conservation Ordinance (No.8 of 1969) and the Natal Nature Conservation Ordinance (No.15 of 1974). It is also worth noting that provincial ordinances promulgated in another province, can be applied within your own province. With the establishment of the new provinces of South Africa, it is anticipated that a range of new provincial ordinances will be promulgated in the near future. In some cases, ordinances from the erstwhile homelands (former TVBC States) are still valid (unless repealed). Depending on whether the geographical location of the catchment falls within the boundaries of a former TVBC State, these may be applicable to your RHP.

2.4 LEGAL POWERS OF THE RHP

As the RHP is basically a tool for monitoring of the ecological and environmental condition of rivers, it does not have any legal standing in itself i.e. it is not specifically mandated by any South African Act. What this means is that the results obtained from the various biomonitoring indices (eg SASS4 score) cannot *per se* be used in a court of law as evidence to prosecute an organisation or individual. However, the RHP can invoke certain legal principles contained in NEMA and NWA, such as the Polluter Pays Principle and Duty of Care Principle, where there is irrefutable evidence of environmental degradation or a violation of permit conditions.

3. RESEARCH AND DEVELOPMENT

The success of most projects depends on thorough background research and development and a well thought out plan. The RHP is no exception. It should include a literature review and practical assessment of local conditions and organisations which could contribute and benefit from the RHP.

Fortunately, for your review of pertinent literature, there is a large body of RHP scientific research that has been done covering the theoretical (and some practical) aspects of the RHP. The following list of documents and references are a good starting point for research and guidance:

- **$** National Aquatic Ecosystem Biomonitoring Programme (NAEBP) reports, particularly pertinent is NAEBP report series no.6: *Overview of the design process and guidelines for implementation* (Roux, 1997). Appendix A is a comprehensive list of useful reading.
- **$** RHP Newsletters - regular newsletters of the latest developments and news from the national NCC and experiences of other provinces
- **$** Water Research Commission reports
- **$** SA Waterbulletin articles
- **$** SASS4 Manual (Thirion *et. al.*, 1995)
- **$** Scientific articles on indices - especially the Fish Assemblage Integrity Index (FAII) and South African Scoring System (SASS4)
- **$** RHP website: www.csir.co.za/rhp/ and www.riverhealth.co.za (for mini SASS)
- **$** DWAF website: www-dwaf.pwv.gov.za.

Practical R&D considerations:

- **$** Your R&D should include an investigation of available resources, expertise and organisations which could play a significant role in your RHP.
- **$** A thorough examination of maps of your area (both 1:250 000 and 1:50 000 scales) is recommended. This will provide valuable information on distances, road and potential access points as well as yielding information on surrounding land-use and developments within river catchments.
- **$** An initial reconnaissance exploration of your area is also an important part of the initial R&D for your programme.
- **$** Further revelations may come to light during public participation which is bound to yield useful information about local conditions (see public participation section).

NOTE:
Research and development is an ongoing process and should continue even after your initial RHP plan has been formulated and implementation has commenced. R&D is essential to continuous improvement of your RHP.

After doing some initial research, the prospective RHP implementer may feel a bit overwhelmed and possibly a bit daunted. Do not pay homage to these feelings. There are many people out there who are doing it and who are willing to offer support, advice and guidance. They are just a phone call away!

4. REGISTERING YOUR PROVINCIAL RHP PROGRAMME

4.1 REGISTRATION WITH THE NATIONAL RHP NCT

It is important to register your provincial RHP programme with the National Coordinating Team (NCT) and report to this body on a regular basis. The NCT is there to lend support to the provincial endeavours and communicate the latest developments to the provinces.

4.2 REGISTRATION WITH DWAF IWQS

If it is envisaged that the DWAF - Institute of Water Quality Studies (IWQS) laboratory will be performing routine chemical analysis of water samples (for heavy metals and other components) for your provincial programme, it needs to be registered with IWQS. In this way, your RHP monitoring programme will be incorporated into DWAF's electronic Water Management System (WMS) and will form part of the national water monitoring programme. In addition, registered programmes receive priority with their laboratory and analysis of samples will be assured.

5. RIVER HEALTH CHAMPION

The provincial River Health champion has the overall responsibility for implementing the RHP within his or her province. At present, RHP champions are based at the provincial government environment department or parks board or water board.

5.1 ROLES AND RESPONSIBILITIES OF THE RIVER HEALTH CHAMPION

- **$** Implementation and co-ordination of the provincial RHP
- **$** Forming and leading the Provincial Implementation Team (PIT)
- **$** Formulating the RHP Implementation and Business Plans
- **$** Reporting to the National Coordinating Team (NCT)
- **$** Attending National Coordinating Committee (NCC) meetings
- **$** Training and skills development of the PIT and PMT
- **$** Co-ordinating the RHP with neighbouring provinces and/or WMAs
- **$** Liaising and promoting of the programme to other relevant stakeholders.

NOTE:
With the coming into effect of the nineteen Water Management Areas (WMAs) - along major drainage lines or water sheds - and the associated Catchment Management Agencies (CMAs), the RHP Champion may become CMA- based rather than provincially based. However, the RHP Champion's roles and responsibilities will probably remain the same.

6. FORMING THE PROVINCIAL IMPLEMENTATION TEAM (PIT)

The RHP requires a team effort to get it up and running provincially. The PIT is *THAT* team of dedicated individuals which drives the RHP programme in your province. It is the "board of directors" of your RHP.

There are no fixed rules concerning the appointment of PIT members or the PIT's size and composition. However, the PIT should comprise of the major role players and stakeholders in water management in your province. Individual PIT members also have an additional role of garnering support for the programme from their organisations and conveying information to and from the PIT. Hence a good strong and representative PIT is imperative for your RHP to be successful. The PIT should meet regularly to review progress and discuss pertinent issues.

6.1 IDEAL COMPOSITION OF THE PIT

- The RHP champion (leader)
- Other staff from within the Champion's organisation (environmental officers or aquatic scientists)
- Provincial Environmental Affairs officers
- Regional DWAF representatives
- Representatives from the relevant River Forum or Water Users Association within your Catchment Management Agency
- Water Board representatives
- Environmental officers from industries within the catchment with an interest or impact on rivers within the province
- Staff and students from local universities
- Environmental consultants (if the budget allows!)
- Representatives from environmental NGOs
- Representatives from local communities.

6.2 ROLES AND RESPONSIBILITIES OF THE PIT

- Implementing the RHP according to available capacity and expertise and provincial requirements
- Researching biomonitoring needs and requirements
- Identifying important rivers for the RHP
- Selecting monitoring and reference sites
- Coordinating the programme and liaising with relevant authorities
- Obtaining support for the RHP from major stakeholders in the province such as government, river fora, industry, NGOs, farmers and local communities
- Securing and attracting funding
- Managing the programme (resources and infrastructure)
- Training of monitoring personnel
- Promoting the RHP in your province/WMA
- Setting of standards of rivers being monitored
- Quality control
- Storage and management of information
- Analysing results and detection of environmental trends
- Disseminating information and reporting to stakeholders, government and CMAs
- Management actions within the catchment
- Communication between RHP initiatives in other provinces.

Based on the above list, it is suggested that clear roles and responsibilities be assigned to each PIT member. In addition, a signed memorandum of understanding between key government departments and other collaborating organisations within the PIT which clearly spells out the roles, functions and responsibilities of each organisation is a useful document for successful RHP implementation. This also assists these government departments in justifying their RHP expenditure to top management and even their auditors.

An alternative to the PIT is the **"community-of-practice" (COP)** for co-ordinating collaborative RHP efforts. The COP is a less formal arrangement than the PIT consisting of a guiding team, strategic partners and tactical partners which share resources, expertise and take on set roles and responsibilities (Roux, 2000). The Mpumalanga Parks Board took the COP route to successfully implementing their RHP programme.

NOTE
As with the case of the River Health Champion, the PIT may in the near future become the Water Management Area (WMA) Implementation Team rather than be provincially based. It will probably form part of the Catchment Management Agency Committee.

7. FORMING THE PROVINCIAL MONITORING TEAM (PMT)

The PMT is a pivotal component of your RHP, as this is the group of people who actually go out and do the biomonitoring of the selected rivers. This team consists of the technicians and trained monitoring staff which may be part of the PIT if this is more expedient. However, if it is not, then it is imperative that the PMT liaise with the PIT on a regular basis to report on findings, site conditions etc.

7.1 SELECTION OF SUITABLE MONITORING PERSONNEL - APTITUDES, INTERESTS AND BACKGROUND

Literacy and a valid drivers licence are about the only “qualifications” needed for monitoring staff as well as enthusiasm and commitment. A broad knowledge and interest in the environment is a strong recommendation. Willingness to work in the field is another important consideration. For this reason, nature conservation or Parks Board staff are ideal candidates.

7.2 IMPORTANT CONSIDERATIONS FOR FIELD PERSONNEL

$ Fieldwork is potentially hazardous. The occupational health and safety of field workers must be borne in mind at all times. Make sure that adequate measures to protect field workers have been taken and that your RHP field activities comply with the requirements of the Occupational Health and Safety Act (Act No 85 of 1993). Apart from the possibility of jeopardising the safety of your PMT staff, failure to do so may result in costly legal action if an accident occurs while in the field.

$ First Aid - it is essential for monitoring staff to attend a course on basic first aid. First Aid kits must be supplied to each biomonitoring team.

$ Ability to swim - often assumed or overlooked, but a very real concern for RHP monitoring personnel.

$ Physical fitness - ideally monitoring staff should be reasonably fit and willing to spend long hours in the field. Sampling often requires long trips over rough terrain and can be strenuous.

$ Security of vehicles and equipment - an important consideration, especially out in remote areas.

$ Knowledge of the area being monitored is a definite advantage for monitoring personnel.

$ ***Warning!! Monitoring personnel must never go out into the field alone!!*** Ideally monitoring staff should work in pairs. This reduces the workload and time spent at each site, and if an emergency situation arises, two people will be in a better position to deal with it than one.

8. TRAINING AND SKILLS DEVELOPMENT

Depending on their assigned roles and responsibilities, the different people involved with your RHP will require different forms of training, It is assumed that members of the PIT would generally have some environmental management experience and knowledge, but may benefit from attending a course on the theoretical aspects of biomonitoring and the objectives of the RHP. It is recommended that PIT members become familiar with the RHP indices (particularly SASS and IHAS) as well.

Members of the PMT obviously require more “hands-on” practical training to perform their biomonitoring tasks effectively. It is advised that training begin with SASS and IHAS. Biomonitoring (particulary SASS) requires a fair amount of training for staff to become familiar with the wide array of aquatic invertebrates and to identify them accurately and consistently. On-site training is preferred, so that staff gain experience with sampling techniques and protocols.

In addition, PMT staff require training in the use of water quality instruments, such as pH meters, dissolved oxygen and conductivity meters and taking water samples. Because the RHP demands spatial and navigational skills of monitoring staff, competency in the use of a Global Positioning System (GPS) and the ability to read and interpret maps is essential. If digital cameras are to be used for the recording of the site, then a basic course in how to use the camera and fundamentals of photography is also required. Skills in using these instruments will become honed with time and experience in the field.

The PMT staff should attend a course in basic First Aid before going out into the field. These courses are offered by a variety of organisations such as the St Johns Ambulance Association.

It is also beneficial for PMT to become familiar with the theoretical aspects of the RHP, especially criteria for site selection, advantages and limitations of the different indices etc. Information sharing and capacity building is the name of the game!

NOTE:
For a list of expertise and organisations offering training in the Indices of Ecosystem Health, see the section on “Organisations offering support for the RHP”.

9. COMMUNICATION

Communication is especially crucial where a “multi-disciplinary” team is setting out to achieve a common objective in a coordinated fashion, such as the RHP. Successful implementation of your RHP *will depend on an efficient and reliable flow of information* between the various participants. Ironically, despite technological advancements such as email and cellular phones, communication is often taken for granted or neglected, leading to misunderstandings and a range of avoidable problems.

Attention should be given to the intended flow of communication, tools available to inform those involved, language and what needs to be communicated to or by whom. It is also important to use the medium of communication which is best suited to the situation at hand, given budget and technological constraints.

The two major forms of communication are internal (e.g. between members within your provincial RHP, such as the PIT and PMT) and external (e.g. to/from your provincial RHP to/from external stakeholders and interested and affected parties). In addition, communication between your RHP and adjacent RHP initiatives should also be included in your RHP communication strategy to coordinate monitoring activities of shared catchments.

9.1 INTERNAL CHANNELS OF COMMUNICATION

This includes the important issues of day-to-day communication essential for coordinating the PMTs monitoring activities and circulating minutes of PIT meetings to all your RHP participants. Important channels of internal communication include:

- **$** National RHP NCT/NCC to/from Provincial Champion
- **$** Provincial Champion to neighbouring Provincial Champion
- **$** Provincial Champion to/from PIT
- **$** PIT to/from PMT.

9.2 EXTERNAL CHANNELS OF COMMUNICATION

This aspect should address the flow of information to and from your RHP and external “clients” of the programme. These include:

- **$** RHP Champion or PIT to/from funding organisations
- **$** PIT members to/from their respective organisations
- **$** PIT to/from relevant River Fora or Catchment Management Agencies
- **$** PIT to/from interested and affected parties.

NOTE:
See sections on liaison, promotion and marketing and reporting for more details.

10. PROMOTION AND MARKETING

This is very important component of your RHP which can be easily overlooked, while attending to day-to-day practicalities. For your RHP to gain acceptance in your area, promoting it to the wider community who have an interest in water quality is essential. Achieving “stakeholder buy-in” will make successful implementation of your RHP that much easier. Promotion and marketing aimed at attracting funding for your programme is another important aspect to consider. The “what”, “how”, “why”, “when” and to “who” questions are useful starting points to formulate your RHP liaison, promotion and marketing strategy.

Your RHPs promotion and marketing strategy should aim to:

- **$** promote acceptance of your RHP amongst key clients and stakeholders
- **$** convince these groups of the value and benefits of the RHP
- **$** promote the use of information generated by the RHP in water resource management decisions
- **$** attract participation and/or funding for your programme
- **$** nurture a sense of responsibility and ownership of the RHP amongst these groups
- **$** promote the role that the RHP and biomonitoring can play in maintaining and monitoring the state of river systems
- **$** promote awareness and need for conserving aquatic ecosystems.

10.1 IDENTIFICATION OF CLIENTS AND STAKEHOLDERS

It is essential to know who the clients and stakeholders are so that your promotion reaches your intended target audience. This target audience will probably consist of a wide variety of people and organisations from equally diverse backgrounds. They will probably have one thing in common: an interest or stake in the rivers of your RHP. Manyaka Greyling Meiring (1998) have divided the potential target audience into different levels: political, implementation, stakeholder and information levels.

10.1.2 Your potential target audience should include

- **$** Government department officials (provincial and national departments.)
- **$** Municipal and district councils
- **$** Representatives from Industry (particularly mining, forestry and agriculture)
- **$** Potential funders or contributors to your RHP (including the above sectors)
- **$** Universities - several departments (eg biology or geography depts.) may be interested in participating in research relevant to the RHP
- **$** Non-governmental Organisations (NGOs) - existing structures in the community, which may serve as useful conduits to get the RHP message to people.
- **$** Conservation and conservancy groups (eg Wildlife and Environment Society of SA)
- **$** Local Communities with an interest in the river
- **$** Schools and youth groups such as Eco- and Conservation Clubs
- **$** River Fora and Water Users Associations are the building blocks for the Water Management Areas - which are scheduled to be run by Catchment Management Agencies. Depending on how developed these are in the area concerned, these are useful springboards for launching the RHP in your area.

10.2 CONTENT AND STYLE OF PROMOTIONAL AND MARKETING INITIATIVES

The content and style of your promotion and marketing initiatives will depend on what you intend promoting and to whom these are aimed at. It is important to include pertinent information in a way that is readily understood by your target audience in an interesting and appealing format.

The content should include the basic facts of the RHP such as:

- **$** background and origins of the RHP
- **$** objectives of the programme
- **$** description of the various biomonitoring indices and how they work
- **$** advantages of the RHP both provincially and nationally and why the programme is important
- **$** potential role players and how to get involved
- **$** key points from your implementation plan.

The style of presentation is also important and should be tailored to suite the intended audience. School groups will require a different level of information and presentation style to a corporate or government audience. Remember to use the corporate image of the RHP where possible (particularly the logo). This will help entrench the identity of the RHP with your audience.

To attract financial investment, the contribution of resources or skills and to encourage direct participation in the programme, requires advertising to "sell" your programme.

NOTE:
The level of detail, style of presentation and medium for which particular audience will ultimately be left to you to decide.

10.3 CHOOSING THE MEDIUM FOR PROMOTION AND MARKETING

The next challenging step is to choose the most effective method to get the RHP message across. Generally, one of the most effective ways to "penetrate the market" is by means of talks and practical demonstrations, preferably in the field. Demonstrating either SASS and FAII sampling techniques may be useful to garner support for your porgamme. Environmental Festivals and EcoForum meetings are useful events at which to introduce your programme. Including an environmental education component in your promotion strategy would be effective in reaching school and youth groups.

Other media options include:

- **$** RHP fact sheets (available from the RHP Communication Office of Manyaka Greyling (Pty) Ltd)
- **$** RHP newsletters and posters
- **$** local newspaper press-releases and magazine articles
- **$** word of mouth
- **$** radio and television coverage
- **$** press conferences have the potential to reach a wide audience
- **$** corporate RHP video would also be a valuable promotional and educational tool
- **$** RHP website (www.csir.co.za/RHP) - provincial initiatives and progress can be posted regularly on the website which has the potential to reach the global audience.

NOTE:
Manyaka Greyling Meiring (1998) have produced a draft of a Strategic External Communication Programme manual for the RHP. This document addresses the communication, promotion and liaison for the RHP. It also covers identifying key target audiences an how to arrange workshops, field demonstrations and open days and a range of other relevant topics. See section on organisations offering support to the RHP for more information.

11. PUBLIC PARTICIPATION

Public participation has been defined as A producing a process leading to a joint effort by stakeholders representing all relevant interests and sectors of society, technical specialists and the various relevant organs of state who work together to produce better decisions than if they had acted independently, and better implementation of decisions through stakeholders "owning the process" (Greyling and Manyaka, 1999).

Public participation (PP) is required under the National Water Act as an essential process for decision making regarding shared resources such as water. As the RHP is, by its very nature, a ***participative programme,*** some form of public participation is required to ensure "stakeholder buy-in" in your RHP. The ***"who", "what", "why", "when"*** and ***"how"*** questions should be addressed to inform and elicit feedback from stakeholders on how best to implement your local RHP.

Who should be involved in the PP process

Ideally, all stakeholders and interested and affected parties in the river catchment should be involved, i.e. people or organisations which have a vested interest in the river and are dependent on prevailing water quantity and quality. These include industries, farmers and local communities living near or within the catchment (see proposed "target audience" in the Promotion and Marketing section). Remember that representation of the different sectors is more important than obtaining the views of every individual living in the catchment (Figure 2).

Please download diagram seperately

Figure 2. Identifying stakeholders from each of the three dimensions of sustainability (economic growth, social equity, ecological integrity) (Greyling and Manyaka, 1999).

How should PP be conducted

The PP process should begin with a public announcement such as an advertisement in a newspaper calling for meeting to discuss your RHP. Depending on the circumstances, public meetings and open fora with local communities or one-on-one meetings with farmers and representatives from industry are PP options (Figure 3).

Your PP should include a presentation of the RHP to provide stakeholders and interested and affected parties with the necessary context of your RHP. The presentation could include a summary of your provisional Implementation Plan and RHP goals and options of how to get there. The various RHP indices should be explained or demonstrated.

Once the stakeholders are on board, the next step is the ***identification of problems and needs through consultation***. Through interactive dialogue, the PP should lead to "consensus building" and a convergence of thinking amongst stakeholders, and ultimately ***shared solutions.*** In other words, your RHP PP programme can play a pivotal role in bringing people from diverse backgrounds together through the common goal of water resource management.

Outcomes of meetings should be made available to all stakeholders so that the are kept informed of progress and developments. Ensure that meetings are properly minuted and that these are circulated to all present and absent stakeholders. Regular progress reports are another option.

When should PP be conducted

Regular PP should be an integral component of implementing your RHP. Consultation with stakeholders and interested and affected parties should be a part of your planning process and should continue on a regular basis, particularly when new developments are planned or expansion of the programme to additional river catchments is envisaged.

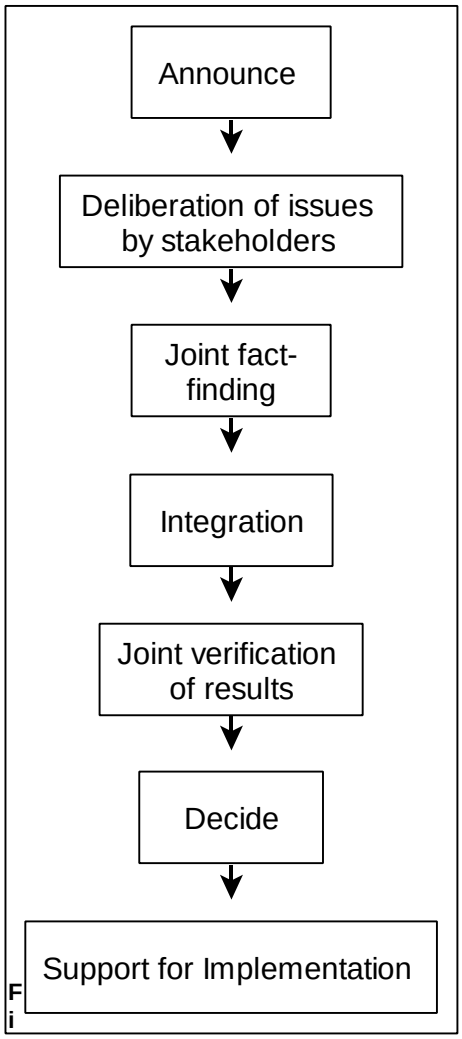

Figure 3. A model for public participation (adapted from Greyling and Manyaka,1999).

11.1 GUIDING PRINCIPLES FOR PUBLIC PARTICIPATION

- **$** Flexibility - accommodation of local needs and circumstances
- **$** Announcement of opportunity for involvement - ensuring that people have ample chance to become involved
- **$** Representivity - broadest range of participants should be involved
- **$** Sufficient and accessible information - language and level of information is important to meet the needs of the stakeholders
- **$** Opportunity for comment - a variety of media should be considered - e.g. verbal or written
- **$** Opportunity for exchanging views and information
- **$** Continuous feedback and acknowledgment - stakeholders should see that their contributions are being considered in the PP process
- **$** Respect for cultural and language preference - this should be considered at all times
- **$** Ability and interest levels of stakeholders - important to take into account when presenting information

$ Assigning roles and responsibilities of stakeholders - this should be done at the beginning of the process

- **$** Transparency, openness and honesty - this is essential to inculcate a sense of trust in the process amongst participants
- **$** Efficiency and effectiveness - both essential for the nurturing of stakeholder respect in the process
- **$** Independent facilitation - this may encourage stakeholder participation through the “neutral” facilitator.

Things to remember for public participation and the RHP

There is no prescribed recipe for fruitful public participation, however ***wide consultation, openness and transparency*** are some of the essential ingredients. How much public participation is necessary for successfully involving stakeholders in implementing your RHP will depend largely on your local circumstances and approach.

Stakeholders and potential participants will probably have widely diverse backgrounds and experiences. This diversity is great in many respects, but of course means that the enthusiasm and the degree of acceptance of the RHP will vary from person to person. Do not despair if at first there is resistance (particularly from older members and skeptics). Be patient and persevere! Practical demonstrations which actively involve your audience is a good way to overcome this.

Involving local communities in your RHP may not be that easy. Local communities will probably have expectations of a direct spinoff of the programme, such as jobs or free water. Be aware of this from the beginning and do not make empty promises.

As a RHP practitioner, you also need to be aware of the socio-cultural and knowledge gap that exists between you and local communities. Your RHP objectives probably do not coincide with the livelihood security priorities of the community.

For community involvement and support for your RHP from this sector, building relationships is imperative. Your approach and attitude is important for this. Respect for local customs and language should be maintained at all times.

Public participation is a ***a two way process***. River Health implementers stand to learn a lot from the public participation process, as farmers and members of local communities often possess a long-term and intimate knowledge of their river and will point to where they feel monitoring should be taking place. Other useful information may include possible sites to sample, historical and geographical aspects of the catchment - such as the effects of droughts and floods, whether there have been any recent major pollution events, local hazards and pitfalls associated with the terrain and of course who the friendly farmers are!

In return, the RHP will offer education and environmental awareness and information pertaining to the river to the various interested and affected parties and give local communities an opportunity to be involved in the management of their own water resources. Some of the interested and affected parties may wish to become more actively involved and eventually join your PIT or PMT. In such a way, public participation encourages ownership of the RHP.

For more on public participation, see Procedures for Provincial Implementation of the National River Health Programme. Chapter 4 - Development of Social Tools for the River Health Programme.

NOTE:
Contact Manyaka Greyling (Pty) Ltd for more information and assistance on public participation.

12. EQUIPMENT

One of the major advantages of the RHP is that it does not require a huge financial investment in equipment. *The equipment your RHP will require, will largely depend on your RHP objectives, which indices you intend using and of course the budget.* Your initial investment in equipment will probably include the basic RHP equipment, SASS and IHAS equipment (primary RHP indices) which is relatively inexpensive. The equipment required for each index is detailed below.

12.1 BASIC RHP EQUIPMENT

- **$** Waders for the PMT staff - these should preferably be made of strong nylon of the type used by fly-fishermen. Chest waders are preferable, although some people prefer hip waders. Obtainable from most angling shops. ***Caution!! Waders can cause drowning if they fill up with water. Take Care!***
- **$** Gloves - preferably elbow length. These are particularly useful to avoid contact with the river water if the site is polluted or in a bilharzia area.
- **$** Life jacket - should be worn by monitoring staff when sampling large or strongly flowing rivers as an added precautionary measure.
- **$** Water quality monitoring instruments: Basic essentials include a pH meter, Dissolved Oxygen meter and Conductivity meter (instruments are available which perform the latter two functions as well as temperature reading). Ideally, one set of each for each monitoring team. These instruments are available from suppliers of scientific and laboratory equipment.
- **$** Water sample bottles and preservatives - for chemical analysis of trace metals and other constituents. Contact the IWQS for more details.
- **$** A set of maps of your area - minimum 1:250 000 scale, but preferably 1:50 000 scale as well. These are available from the Government Printers or Surveyor-General.
- **$** Global Positioning Systems (GPSs). These are useful for recording exact locality details (altitude, longitude and latitude as well as date and time) of biomonitoring sites. A variety of models are available, some of which come with computer software which enables direct download of information from the GPS to the computer. Some models have navigational capabilities as well. They are relatively cheap (ranging from R1500 upwards) and available from suppliers of scientific and laboratory equipment.
- **$** Towel and hat (and don't forget the sunscreen!)
- **$** A supply of drinking water - long trips out in the field can be very thirsty work. Beware of dehydration!

12.2 EQUIPMENT FOR SAMPLING INVERTEBRATE FAUNA USING SASS4*

- **$** Standard SASS net (300X300mm with mesh size of 1mm) - these are being made commercially by "Catchem Biomonitoring" (see Organisations offering support to the RHP section for contact details) or can be made up privately. IWQS can supply a pattern for the net and a list of suppliers for the components. The net material should be durable and reinforced with double stitching. Make sure that the frame is rigid and preferably made of stainless steel. SASS work can be demanding! Two nets per monitoring team is sufficient.
- **$** Sorting trays (preferably white). The trays should white or a pale colour and of a suitable size (approximately 300 X 500mm and 120mm deep) so that the small animals can be seen amongst debris and stones. Ideally three sampling trays are needed for each SASS net as it is preferred that Stones-in-Current, Marginal Vegetation and Sediment samples can be analysed separately.
- **$** Forceps (medium size +/- 120 mm in length) - for catching small invertebrates, removing debris and sorting. Two pairs per team is sufficient, although it is useful to keep a couple of spare pairs as they are inclined to get lost.
- **$** Buckets - for carrying water to the sorting trays, preferably between 10-20 L capacity.
- **$** Magnifying glass or hand lens - for closer examination of the more minute invertebrate species. Two pairs per team is sufficient..

- **$** Stopwatch or timer - to ensure that the correct time is spent sampling and identifying the invertebrates. One per team.
- **$** Sample tubes and jars - for the preservation of animals to take back to the laboratory or to send away for further identification. Tubes can be made of glass or plastic. Keep at least one hundred tubes in stock and a sufficient quantity of jars.
- **$** Preservatives- ethanol (70-80% concentration) or formalin (***caution: handle with care!***). Take a litre of either into the field.
- **$** Waterproof labels to be placed inside the sample tube or jar.
- **$** SASS Score Sheets.
- **$** SASS4 manual.
- **$** Invertebrate photographic identification guide - contact IWQS.
- **$** Pencils.
- **$** Folding table and chair - makes analysing the sample a more comfortable experience.

See SASS4 Manual (Thirion *et al.*, 1995) for further information on invertebrate sampling equipment and preservation techniques.

* SASS5 is about to be launched. There may be some changes in the equipment required.

NOTE:
A small portable reference collection of preidentified invertebrates from your region is very useful for SASS4 field identifications. Each monitoring team should have one to assist monitoring personnel in obtaining consistent SASS identifications and become more proficient in the field.

Take an additional supply of fresh water (10L) to the field to pour into your SASS trays for sorting. This is useful if the river water is very murky (which happens after heavy rains) which can make spotting inconspicuous invertebrates in the SASS sorting tray difficult. Also, fieldwork can also be thirsty work!

12.3 EQUIPMENT FOR SAMPLING FOR FISH USING THE FISH ASSEMBLAGE INTEGRITY INDEX (FAII)

12.3.1 Electroshockers

The primary piece of equipment for the biomonitoring of fish communities using the FAII is an electroshocker. Electroshockers, as the name implies, function by emitting a strong localised electrical current into the water which temporarily stuns the fish, which can then be easily collected with a handheld net. There are a number of options available, depending on your budget.

A backpack electroshocker such as the DEKA 3000 is the ideal option . It consists of a backpack battery and transformer unit connected to pole which has a scoop net attached. The advantage of the backpack electroshocker is that it is relatively lightweight and only requires one person to operate. The disadvantage is that it can be a fairly expensive piece of equipment if imported. A number of different models are available from various overseas companies. Alternatively, battery powered electroshockers can also be made locally and more cheaply. Contact IWQS for further details.

> ***Useful tip!***
> Keep a fully charged spare battery for your electroshocker with you at all times in the field. Also, a battery charger which fits into your vehicle's cigarette lighter is another useful accessory.

An alternative electroshocking device can be constructed which consists of two electrodes powered by a conventional generator. The advantage of this is that it is a much cheaper option and is fairly easy to build. However, it is much more cumbersome in the field, as the heavy generator needs to be physically carried to the sampling site It also requires two people to operate (one to shock the fish and the other to catch them with the scoop net). Contact the Aquatic Research Section of the Mpumalanga Parks Board for further information.

> **NOTE:**
> There may be other options for building a suitable electroshocking device. It may be worthwhile to explore these, before committing yourself to any of the suggestions mentioned here.

Warning!! Electroshockers are dangerous pieces of equipment. Wear your waders at all times when using these devices as this insulates you from the electric current conducted by the water. Make sure that the emergency switch on the electroshocker is functioning properly.

12.3.2 Additional fish sampling equipment required

- **$** Buckets - for the holding of fish during sampling, preferably between 10-20 L capacity
- **$** Aquarium handnets - useful for catching fish while scoring
- **$** Sampling bottles- for preserving fish for later confirmation of identifications or to museum collections. Plastic bottles of various sizes with screwtop lids which seal well are usually used.
- **$** Preservatives Formalin is usually used. One part formalin added to nine parts fresh water **Caution!!** Formalin is highly toxic and possibly carcinogenic. Inhalation and skin contact should be avoided.
- **$** Fish Assemblage Integrity Index Scoring sheets
- **$** A guide to the freshwater fishes of southern Africa. Skelton's *Complete Guide to the Freshwater Fishes of Southern Africa* (Southern Publishers) is recommended.

12.4 RIPARIAN VEGETATION INDEX (RVI)

The Riparian Vegetation Index (RVI) requires very little in the way of equipment. The following is a useful list of accessories:

- **$** Plant Identification Guide
- **$** Botanical plant presses - useful for the collection of plant specimens for sending to herbaria for further identification.
- **$** RVI Score Sheets

12.5 EQUIPMENT REQUIRED FOR THE OTHER RHP INDICES

Apart from the Index of Habitat Integrity (IHI) - which requires a helicopter and video camera! - the remaining RHP indices (Invertebrate Habitat Assessment System (IHAS), Hydrological Index (HI) and Geomorphological Index (GI) only require the relevant score sheets and of course a pencil!

12.6 ADDITIONAL RHP EQUIPMENT TO CONSIDER

- **$** Digital cameras - for photographically recording the general condition of sampling sites. Images can be transferred directly into your RHP Rivers database. A number of models are available, varying considerably in price. It is preferable to obtain digital cameras that are fairly easy to use and do not require an in depth knowledge of photography to obtain images of a reasonable quality. Alternatively, ordinary cameras may also be used and the pictures can then be scanned electronically.

- **$** Dissecting microscope. This is useful if your RHP intends establishing a laboratory or has access to an existing laboratory. A dissecting microscope is indispensable for the identifying of invertebrates which could not be identified in the field. Several models are available such as Zeiss or Nickon. The bad news is that these imported pieces of high-precision equipment are expensive (in excess of R30 000).

- **$** Invertebrate keys and identification manuals are essential accessories if a dissecting microscope is to be purchased or your RHP has access to one. The WRC is currently producing a series of invertebrate guides in collaboration with the Dept of Freshwater Invertebrates at the Albany Museum. Also contact the IWQS for further information on these.

12.7 STORAGE AND MAINTENANCE OF EQUIPMENT

12.7.1 Storage

Your RHP equipment should be stored in a safe place, preferably under lock and key. Most of the equipment is highly specialised and will probably take a fair amount of valuable time to replace if lost or stolen. *Take care with your equipment!*

You may consider insuring your RHP equipment for theft, loss or damage, although given the nature of its use, this may be fairly expensive.

12.7.2 Maintenance

RHP equipment is often used under rugged and demanding conditions and hence requires regular maintenance to ensure that it is performs optimally and produces reliable results. All equipment should be checked regularly for wear and tear. Waders should be checked for holes and repairedif needs be. SASS nets should be checked regularly for tears and be repaired if needs be. Repair kits are available. Water quality instruments (particularly pH meters) should be calibrated and serviced regularly. Fish electroshockers also require care and maintenance. Check the condition of the scoop net and batteries regularly and that switches and cables are functioning properly.

13. VEHICLES

It is likely that many of your RHP sites will be off the beaten track with bad roads and bundu bashing being part and parcel of the average biomonitoring fieldtrip. Rainy conditions, mud and rough terrain are all pretty persuasive in making a bakkie (LDV) your first choice of vehicle. A 4X4 or 2X4 with good ground clearance is recommended. Diesel vehicles tend to be more economical fuel-wise in the long-run. The choice depends largely on your budget or which vehicles are readily available.

14. COMPUTER HARDWARE AND SOFTWARE

14.1 COMPUTER HARDWARE REQUIREMENTS

A dedicated server is a preferable means of storing and managing information electronically. Many organisations are currently using Windows NT operating system, although some organisations prefer Novell or the older Unix systems. To run these systems, the computer designated as the file server should have a pentium processor and substantial amount of hard disk space (additional SCSI drives can be fitted) and random access memory (RAM). Servers have the added advantage in that most have a back-up system (such as a tape drive) on which the invaluable information can readily be stored at set intervals. Consult your local IT experts for more information on this and of course the budget too!

Alternatively, if the server option is not feasible, a standard PC can be used to house the Rivers Database (see Rivers Database section).

14.2 SOFTWARE REQUIREMENTS

Basic software requirements include spreadsheet programmes such as Microsoft's Excel or Quatro Pro which can readily be interfaced with database programmes such as Microsoft Access or DBase. A number of other database programmes are available, which range considerably in price. However, costly database systems such as Oracle are not necessities for managing your RHP information.

14.2.1 Rivers Database

The Rivers Database has been specifically tailored for the RHP. It is very useful for the standardisation and harmonisation of RHP information storage and management, enabling results obtained from different RHP initiatives to be readily comparable. The Rivers Database consists of a data storage component (for the editing and viewing of data) and a query centre for data extraction underpinned by Microsoft Access database files.

It is also envisaged that the Rivers Database will be the means for transferring regional RHP information to the national RHP database housed by Southern Waters Ecological Research and Consulting in Cape Town. The Rivers Database could also potentially interface RHP initiatives with DWAF's Water Management System (WMS) which has been designed to house all water resource related information in South Africa. The Rivers Database is available from the IWQS and further information can be obtained from Southern Waters Ecological Research and Consulting. See NAEBP Report No11 "Rivers Database: A user manual" (Fowler *et al.,* 2000).

Minimum hardware and software requirements for the Rivers Database:

- **$** Operating system: Windows NT and Windows 98
- **$** Memory: minimum 64 MB RAM
- **$** Minimum Screen Resolution: 800x600
- **$** Software: MS Office Professional 97.

NOTE:
A runtime version has been developed for those users who do not have MS Access 97.

14.2.2 Geographical Information Systems (GIS)

Another application of RHP information is that of spatial representation and analysis. Because the RHP information has a spatial component, it is ideally suited to this type of application. Using a suitable database where longitude and latitude co-ordinates for sites are stored, the GIS programme plots these on an electronic map of the area. The advantages of GIS are manifold, including routine queries and statistical analysis and the production of thematic maps depicting sampling points and results (see reporting section) in relation to environmental information such as geology, topography, rainfall and land use.

ArcView and GeoMedia are two of the more popular GIS software packages being used in the environmental field. These can be obtained from Geographical Information Management Information Systems (GIMS) and Intergraph respectively, both based in Mid-Rand, Johannesburg. As these are imported from the US, prices are subject to exchange rates.

NOTE:
Although a wide range of GIS programmes are available, it is strongly advised that you choose a package that is compatible with those being used by other organisations in the environmental field. The reason for this is that most environmental databases (such as ENPAT) are designed for a particular GIS application and GIS programmes are notorious for their inability to convert from one format to another, which has the potential to make data sharing and exchange a very tedious process.

15. FUNDING YOUR RHP

Although a considerable amount of WRC and government money has been invested in the initial research and development of the RHP and its associated biomonitoring indices, the provincial implementation of RHP remains an unfunded mandate (not funded by the national RHP). Given the paucity of available funds at the provincial level, this may be a stumbling block. However, this need not be the case. Successfully attracting an initial injection of external funding for the purchase of equipment, training and marketing and promotion of your programme could hinge on the effectiveness of your business plan, marketing and promotion of your programme.

The greatest amount of funding is required initially for purchase of equipment, vehicles, training and skills development, promotion and local research and development. Remember that it is not necessary to obtain all the required funding for all the aforementioned aspects before embarking on your RHP.

15.1 POTENTIAL RHP FUNDING SOURCES

The following organisations may be approached to provide the initial investment to get your RHP rolling. These include:

- **$** Water Research Commission - particularly for research and development aspects.
- **$** Dept. Water Affairs and Forestry - may contribute seed money to purchase equipment.
- **$** Dept. Environmental Affairs and Tourism - may be in a position to do the same through the provincial environment affairs government department..
- **$** Your local Water Board - has a vested interest in monitoring the state of rivers from which it draws its water.
- **$** Local and District Councils - these organisations may contribute to the monitoring of sites which are important to them.
- **$** Overseas funders such as DANCED, European Union and a number of other organisations.
- **$** Local industries within the river catchment - may contribute funding for the monitoring of sites which are potentially being impacted by their activities.

NOTE:
For additional potential avenues of funding, contact the RHP National Co-ordinating Team (NCT). The NCT can assist in strengthening your RHP funding motivation. Also both DEAT and DWAF are focal points for overseas funding organisations and can be contacted in this regard.

In the long-term, the RHP will probably become a recognized programme of the relevant provincial environment affairs department by virtue of its objectives of monitoring environmental and ecological trends. The RHP's potential for contributing to the knowledge of the State of the Environment (SoE) is another strong motivation for these organisations to adopt and fund the programme. Similarly, the RHP should become integrated into the monitoring programmes of the regional DWAF department and a budget allocated to the programme. Once established, it is envisaged that the relevant CMA will assume the funding and management of the RHP.

16. PLANNING YOUR RHP

Planning your RHP goes hand-in-hand with R&D. It is essential that your plan be ***realistic*** and ***feasible*** which takes into account prevailing circumstances and practical limitations (such as budget constraints). The bad news is that there is no fixed or universal plan that is readily available. Hopefully this manual will assist you in formulating your RHP implementation plan by providing a list of potential ingredients for your RHP recipe to be successful.

Your RHP plan should cater for the ***initial pilot phase*** of the programme as well as ***full-scale monitoring***. A gradual phased approach is recommended as the safer and preferred route to successful implementation. The projected phases should be consistent with the short, medium and long term goals of your RHP. It should be borne in mind that the long-term goal of full implementation will probably take several years to achieve.

Two types of plans can be developed for your RHP, namely an ***implementation plan*** and a ***business plan*****.**

16.1 RHP IMPLEMENTATION PLAN

This is your ***guiding RHP tablet***, tailor-made by you and your PIT team for your area. It is an essential document which formalizes the programme and demonstrates to management and other organisations what your local RHP is about and why it is essential. It should basically address the ***five basic questions*** mentioned earlier - the "what, where, who, when and how" these will be applied to your local scenario. The plan should be dynamic, flexible and adaptable.

16.1.1 RHP Implementation Plan - key components

- **$** Goals - what your RHP aims to achieve
- **$** Methods - detailing the "how" component. Include important rivers to be monitored and which biomonitoring indices are to be used
- **$** Funding - attracting the necessary funding and how it is to be utilized
- **$** Participating organisations and responsibilities
- **$** The River Health Champion and Provincial Implementation Team (PIT) and roles and responsibilities
- **$** The Provincial Monitoring Team (PMT)
- **$** Training and skills development schedule - what kind of training and for who
- **$** Equipment and vehicles required - a detailed list of what is required and the associated costs
- **$** Public participation - through your CMA, River Fora, NGOs and local communities and schools
- **$** Other interested and affected parties - who and how could they become involved
- **$** Promotion and marketing - media and target audiences
- **$** Models and options for implementation
- **$** Phasing of the programme (pilot phase etc)
- **$** Key rivers to be sampled - the "where" component
- **$** Reference and monitoring sites - a detailed inventory of these
- **$** Sampling programme - where and how often and with which indices
- **$** Auditing and Quality Control - how is the quality of monitoring to be assured and maintained
- **$** Recording and management of information - where and how and computer hardware and software requirements
- **$** Monitoring and reporting - environmental trend analysis and information dissemination
- **$** Management actions for the PIT
- **$** Gant chart for RHP implementation - this is a graphical schedule of the essential components with an associated timeframe of each detailing when each of the components are scheduled to happen (Appendix 1).

NOTE:
In reality, unforeseen circumstances may conspire against the clearly thought out implementation plan. Do not be defeated and remember, DON'T PANIC! Your implementation plan is intended to be a basic guiding document and, like all maps, will not mirror the territory perfectly. It can be altered periodically to suit your changing needs periodically.

16.2 RHP BUSINESS PLAN

A business plan may be necessary if stakeholders are investing in your programme financially or where donor or additional funding from sponsors is being sought. To bolster their confidence in your RHP, such organisations require assurance that their money is being invested in a sound, well-planned project In a nutshell, the business plan ***demonstrates exactly how and where the money is to be spent***. Hence a good business plan may make the difference as to whether your RHP actually comes into fruition or not.

The business plan should ideally incorporate the key concepts of the Implementation Plan, but with greater emphasis on the financial aspects of your RHP. A brief motivation is also useful (see Appendix 2 for an example of the KwaZulu-Natal RHP business plan).

16.2.1 Business Plan - key components

- **$** Aims and Motivation - these are important to inform potential funding agencies about the RHP and its objectives and why it is necessary.
- **$** Methods - detailing the "how" component. Include which important rivers are to monitored and which biomonitoring indices are to be used.
- **$** Products - this tells the funding organisation or financial department what exactly the investment in the programme will produce.
- **$** Quality Control - how is the quality of programme's components to be assured and maintained.
- **$** Participating organisations and responsibilities - this includes the PIT and other interested and affected parties.
- **$** Training and skills development programme - what kind of training and for whom.
- **$** Equipment required - a detailed list of what is required and the associated costs.
- **$** Gant chart for RHP implementation- this is a graphical schedule of the essential components with an associated time-frame of each detailing when each of the components are scheduled to happen (see Appendix 1).
- **$** Funding and budget - the most important aspect of the business plan. A realistic costing forecast of your RHP is essential. This should divided into the following:
  - Capital costs - including equipment, vehicles
  - Staff - salaries and wages
  - Training and skills development costs
  - Marketing and promotion costs
  - Running costs - actual costs of taking samples, analysis and data capture and storage.

17. HOW TO START: "IMPLEMENTING" YOUR RHP IMPLEMENTATION PLAN

Right, now that you've gone through all the preparations, lets get down to the real business of doing the RHP. Where to start? A good place to begin is to revisit the goals and objectives set out in your implementation plan.

17.1 SELECTING A TEST RIVER CATCHMENT FOR THE PILOT PHASE

After careful study of the maps of your area and consultation during the R&D stage, you should have an idea of potential test catchments for the pilot phase. An initial "groundtruthing" survey of the selected rivers is part of the selection process . This will give you a "feel" for the area while choosing a test river catchment (or catchments) for the pilot phase.

Criteria to bear in mind while choosing a test river catchment:

- **$** suitability of the catchment from a RHP perspective - preferably with perennial flow and a range of sites from relatively pristine to impacted (for selection of reference and monitoring sites)
- **$** relative importance within your province or WMA - is the river important for water supply or conservation or possibly under threat from development or industry
- **$** proximity and accessibility - does it have a number of good access points.

17.2 SITE SELECTION IN YOUR TEST CATCHMENT

Once you've decided on your test catchment, the next step is to select your biomonitoring sites. Site selection is process of exploring and evaluating whether a potential site measures up to the criteria required for the biomonitoring you intend doing. Although this is theoretically an objective process, a subjective decision is often the result due to various practicalities. Two main categories of sites are required for your RHP, namely: ***reference*** and ***monitoring sites***.

Site selection can begin with looking at the relevant maps or if the aerial survey of the river was undertaken as part of the Index of Habitat Integrity, potential sites may have been identified from the air. Replaying the video may provide further confirmation of possible sites to be investigated. Consulting local residents, researchers, regional DWAF and District Council officials for sites to consider may also be useful (Figure 4). Other potential sites for consideration may emerge from the public participation process.

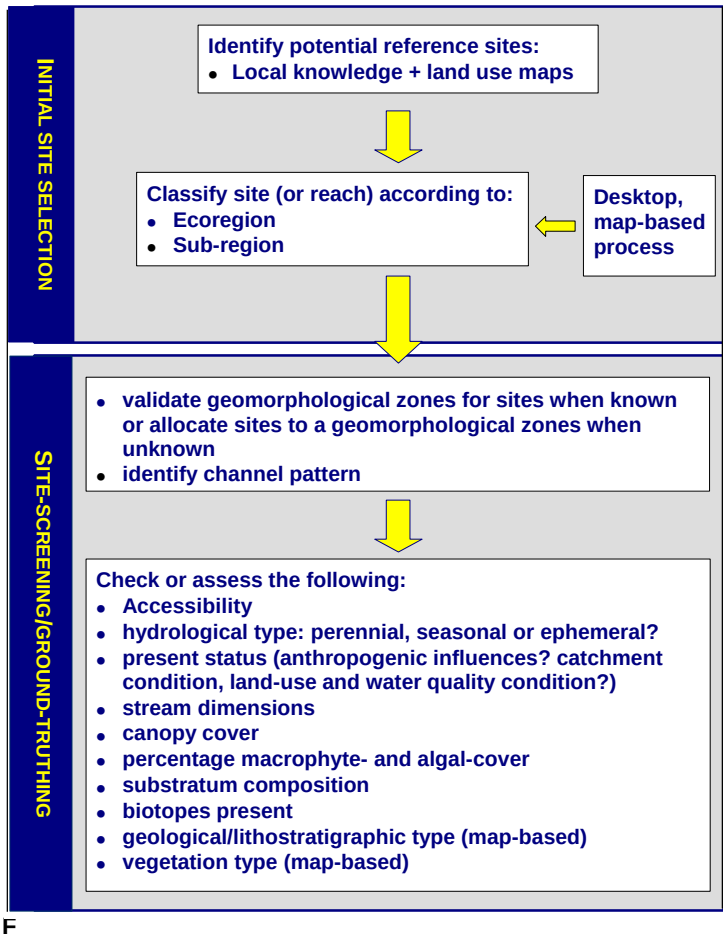

Figure 4. The site selection process (adapted from Dallas, 2000).

It should be borne in mind when selecting sites that the different RHP Indices have different site criteria. For example, SASS requires a diversity of biotopes (habitats) within a 20 m section of the river, while the FAII requires a “homogenous fish segment” of river which may by 100's of meters in length.

All sites should have ***good perennial flow***, with a ***wide range of available biotopes or habitats*** (particularly for SASS monitoring). Make sure that your potential sites are relatively ***accessible.*** In practical terms, this means that one can get fairly close to your site by road and to the water’s edge by foot within a reasonable period of time.

If one needs to enter private land, then make prior arrangements with the landowner and explain what you intend doing and why you need to enter the land. Failure to do so constitutes trespassing which not only shows lack of consideration, but may jeopardise future monitoring on the owner’s property.

Useful tip!
Another option to pursue is to consult with organisations which may have an existing monitoring programme in the test catchment, such as municipalities or district councils. Visit their monitoring sites to assess the suitability of these for biomonitoring. This has an added advantage in that the RHP can contribute another “layer” of information to an existing monitoring programme and vice versa.

Additional factors to consider for potential site evaluation:

- **$** The site’s position for the detection of possible water quality impacts in the test catchment from the surrounding land-use practices
- **$** Importance of the site for assessing water quality for human and other needs
- **$** Suitability for monitoring the recovery of the aquatic ecosystem after a major impact
- **$** Conservation importance of the site. Is it upstream or in a nature reserve?

All sites should be photographed and sampled to obtain initial results. This is an important component of the selection process, as site selection goes beyond just visual assessment.

Remember to inform the PMT about the selection process and which sites have been provisionally selected. It is recommended that members of your PIT then accompany the PMT members concerned and show them the sites and which biotopes to sample.

NOTE:
Selecting suitable sites may take time. It can be expected that conditions at prospective sites may change over time. Seasonal and natural fluctuations in water flow, catastrophic events such as floods and droughts and anthropogenic (human-induced) developments within the catchment will all affect the condition of the sites.

Ideally, sites should be assessed over the entire year to obtain an idea of site conditions during both the wet and dry season. For this reason, your first year of active biomonitoring will be partly devoted to assessing the suitability of your initial selection of sites.

17.2.1 Reference sites

Reference sites, as the name implies, are used to determine the “reference condition” against which results obtained from the monitoring sites can be compared. Hence it is imperative that these sites are relatively unimpacted (preferably pristine!) where water quality is deemed to be natural (or as close to natural as possible) with optimal aquatic ecological conditions. For SASS and IHAS reference sites, a wide variety of available biotopes (habitats such as stones, marginal vegetation, sediment) should be present (Figure 5).

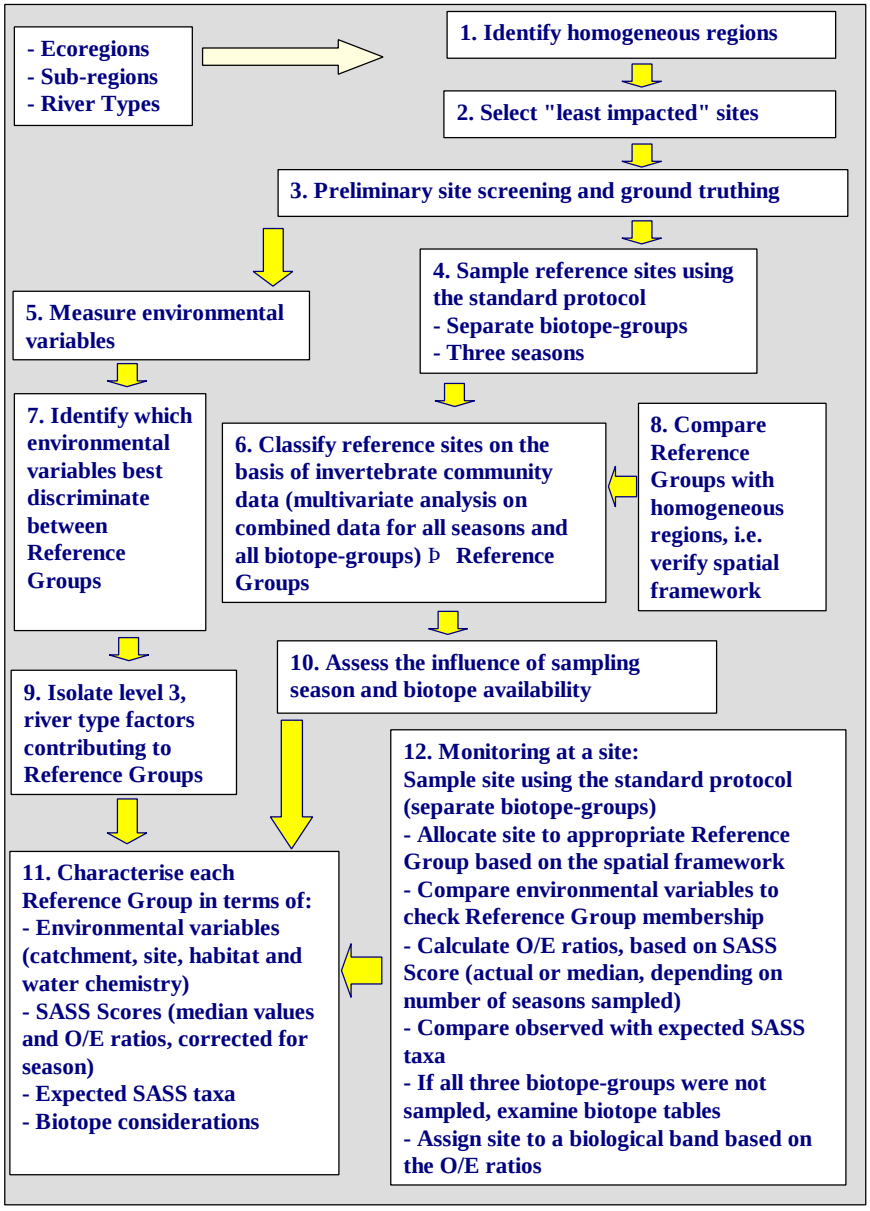

Figure 5. Proposed protocol for deriving ecological reference conditions for riverine macroinvertebrates (adapted from Dallas, 2000).

Preferably more than one reference site is needed per river and optimally one for each reach of the river i.e. near the source or unimpacted tributary of the river, in the middle reaches and lower reaches. However, as most unimpacted or pristine sites tend to be situated in the upper reaches of rivers, you may only be able to find one for each river in there.

NOTE:
In reality, it isn’t easy to find such “ideal” sites in the field. So a good place to look for these is in nature reserves or protected areas if these are within your catchment. Sites on tributaries may also possess good reference characteristics.

17.2.2 Monitoring sites

Monitoring sites should ideally be randomly chosen to reflect the general range of ecological conditions within the catchment. Monitoring sites should be located so that the full range of the effects of the different landuses within the catchment can be evaluated. This is important to obtain objective information for state of the environment (SoE) reporting on environmental trends within the catchment.

Some monitoring sites may be intentionally chosen to assess the effects of specific environmental problems such as point-source pollution entering the river. In this case, they should be located as close as possible (both upstream and downstream) to potential points of impact such as industrial or mine effluents and confluences of rivers.

For more details on site selection, consult Eekhout *et al.* (1996) NAEBP Report No.3 and Dallas, H. F. (2000) NAEBP Report No.10.

NOTE:
There is no minimum or standard number of either reference or monitoring sites required for each river catchment. The number and quality of sites will be governed by the availability of suitable sites within the catchment (tributaries and main river included). Ideally, at least 10 monitoring sites should be considered for each catchment.

Once the PIT and PMT are satisfied with the preliminary selection of monitoring and reference sites, RHP experts may be consulted to verify the suitability of the initial site selection and assessment. A unique identifying number (or site code) should be allocated to each site once it has been “OKed” for inclusion into your RHP.

Baseline surveys of aquatic fauna and flora by experts are very useful for the initial stage of the programme. These provide a detailed benchmark inventory of biodiversity in your test catchment to which future monitoring results can be compared. This is particularly useful for the invertebrates, as there are often a wide variety of species in one river system.

NOTE:
A detailed initial “once-off” ecological assessment of conditions at each of the sites is needed for the Rivers Database. A standard form is available for this (see data storage and information management section).

18. MONITORING PROGRAMME AND SAMPLING FREQUENCIES

18.1 SELECTION OF BIOMONITORING INDICES FOR YOUR MONITORING PROGRAMME

There are currently seven RHP indices. Each of these indices is designed to measure a particular aspect of the health of the aquatic ecosystem, such as the invertebrates, fish, habitat, riparian vegetation and the geomorphological condition of the river channel (Table 18.1). Therefore, each RHP index has its own requirements regarding training, equipment application and frequency.

The selection of which RHP indices for the pilot phase of your programme will depend on your basic RHP objectives, budget, level of training and capacity and available resources. It is recommended that you start off with something manageable during the pilot phase (such as SASS4 and IHAS) and introduce some of the other indices as your programme develops from the pilot to the full implementation phase.

Table 18.1. RHP Biomonitoring indices.

Index	Brief description
Primary	
South African Scoring System (SASS4)	Monitoring of freshwater invertebrate communities, both diversity and abundance
Invertebrate Habitat Assessment System (IHAS)	Assessing the condition and availability of invertebrate habitats of the site being sampled
Secondary	
Fish Assemblage Integrity Index (FAII)	Monitoring of the composition of fish communities
Riparian Vegetation Index (RVI)	Monitoring of ecological condition of plant communities in and alongside the river
Tertiary	
Index of Habitat Integrity (IHI)	Aerial assessment of the overall condition of the river and catchment with respect to habitat availability and diversity, as well as surrounding land-use
Geomorphological Index (GI)	Assessing the physical condition of the river channel's morphology (prototype only)
Hydrological Index (HI)	Assessing the hydrological (FLOW) conditions of the river (prototype only)

18.1.1 Developmental status of the RHP Indices

Each of the above indices has undergone varying degrees of research and development for South African conditions. The most widely used biomonitoring index is the SASS, which has been in development since 1990 and version four (SASS4) has been in use since 1995. Version five (SASS5) is due for release.

IHAS has been in development for some time and is the descendant of forerunners such as the Habitat Assessment Matrix (HAM) and Habitat Quality Index (HQI). It can be applied with confidence along with SASS in all regions of South Africa.

The FAII has also been in development for several years and the current index's precursor was known as the Fish Community Integrity Index (FCII). The FAII has been applied successfully for rivers in the north-eastern parts of South Africa. Further testing and verification is required for other regions.

The IHI has also been tested in various regions in South Africa over a number of years. It can be applied with confidence at this stage.

The RVI is relatively new to the family of RHP indices. The initial RVI prototype has been tested successfully for some of the rivers of the Lowveld of Mpumalanga, but further testing and verification is still required for other regions of South Africa.

Only initial prototypes have been developed for the GI and HI at this stage. Testing and verification of these is still required.

For more information on the RHP indices, please consult the relevant literature.

18.1.2 Biomonitoring Protocols

NAEBP Reports Nos 6 and 8 explain a number of Biomonitoring Protocols (BP), which are proposed as different levels of biomonitoring using different RHP indices (Table 18.2). These range from BP 1 to 5 with a corresponding increase in the number and combination of indices.

Table 18.2. The range of Biomonitoring Protocols and associated indices.

Biomonitoring Protocol	Combination of Indices
BP1	SASS4 + IHAS
BP2	SASS4 + IHAS + FAII
BP3	SASS4 + IHAS + FAII + RVI
BP4	SASS4 + IHAS + FAII + RVI + IHI/HI
BP5	SASS4 + IHAS + FAII + RVI + IHI +HI + GI

The full implementation phase requires both a diversification in the number of catchments being monitored as well as the number of RHP indices being used. The progression from pilot to full implementation will probably be gradual and BP1-5 provides a useful means of assessing your programme's development for a particular catchment.

NOTE:
The combinations of indices in the aforementioned BP's are by no means compulsory as there is no prescribed recipe for which BP is best suited to which situation. The selection of the appropriate BP for your RHP largely depends on budget, time constraints, level of expertise and training and other logistical considerations.

18.2 MONITORING FREQUENCY

The RHP has been designed for the monitoring of long-term environmental trends in a practical and achievable way, even when resources are limited. As aquatic fauna and flora provide a long-term reflection of prevailing water quality and ecological conditions, biomonitoring demands less frequent sampling than chemical monitoring. This is one of the main advantages of biomonitoring and the RHP, particularly from a cost and logistical perspective.

NAEBP report no 8 proposes a biomonitoring frequency table for the RHP (Table 18.3). It is suggested that your RHP follows this, where possible. Both SASS and IHAS, should be conducted more frequently than the other indices. The reason for this is that invertebrates have a much shorter life span than fish or plants and hence are more responsive to changes in ecological conditions. Fortunately, these two indices are also the easiest and most rapid of the indices to perform!

Table 18.3. The application of biomonitoring indices and suggested monitoring frequencies.

Index	Monitoring frequency
South African Scoring System (SASS)	2-3 times per year - to be done with IHAS
Invertebrate Habitat Assessment System (IHAS)	2-3 times per year - to be done in conjunction with SASS
Fish Assemblage Integrity Index (FAII)	Every 2-3 years - to be done with RVI
Riparian Vegetation Index (RVI)	Every 2-3 years - to be done with FAII
Index of Habitat Integrity (IHI)	Every three to five years
Geomorphological Index (GI)	Initially once - to be repeated after major flood events which significantly alter the river channel
Hydrological Index (HI)	N/A

It is proposed that SASS and IHAS be conducted during the dry season, at the end of the dry season and at the end of the wet season. Ultimately though, the best monitoring times to perform these indices will largely be governed by local conditions.

Other factors which may affect your monitoring frequencies:

- **$** The biogeographical region in which you are launching the programme may play a role in determining your monitoring times during the year. For example, many of the larger rivers in Mpumalanga are flowing too strongly to sample effectively during the wet summer months. However, the opposite seasonal effect may occur for rivers in the Western Cape where peak river flows generally occur in July to September.
- **$** Apart from hindering monitoring activities, major floods can wash away habitat as well as much of the resident invertebrate communities. These will need some time to recover.
- **$** Certain activities and developments in the river catchment may also influence your monitoring routine, as with major pollution spills.

NOTE:
The recommended monitoring frequencies of SASS and the FAII may not co-incide with the length of the lifecycles of some of the organisms which these indices are striving to monitor. For example, the recolonisation of a site by aquatic invertebrates after a major catastrophic pollution spill can take as little as six and eight weeks.

It is suggested that if a major pollution spill has occurred in one of your RHP catchments, SASS, IHAS and FAII be conducted as soon as possible at the affected sites. If possible, both SASS and IHAS should be repeated two months later at these sites and the FAII six months later. Such ecological recovery biomonitoring may also be a component of a special monitoring programme separate from your RHP.

19. DATA STORAGE AND INFORMATION MANAGEMENT

19.1 DATA STORAGE

The RHP is an ***information orientated programme***. A large volume of information is generated, to be analysed and interpreted for dissemination to a wide variety of people. Therefore the efficient and effective storage of your RHP information is critical to your programme's success.

19.2 INFORMATION MANAGEMENT

Information management is a very important component of your RHP and begins with the systematic filing of the original SASS and IHAS and other biomonitoring forms. It is important to keep these as these are the original data source which may need to be referred to at a later stage. The results of these need to be captured electronically on a regular basis on to your Rivers Database. Your database periodically needs to be transferred to the National Rivers Database maintained by Southern Waters in Cape Town (Figure 6).

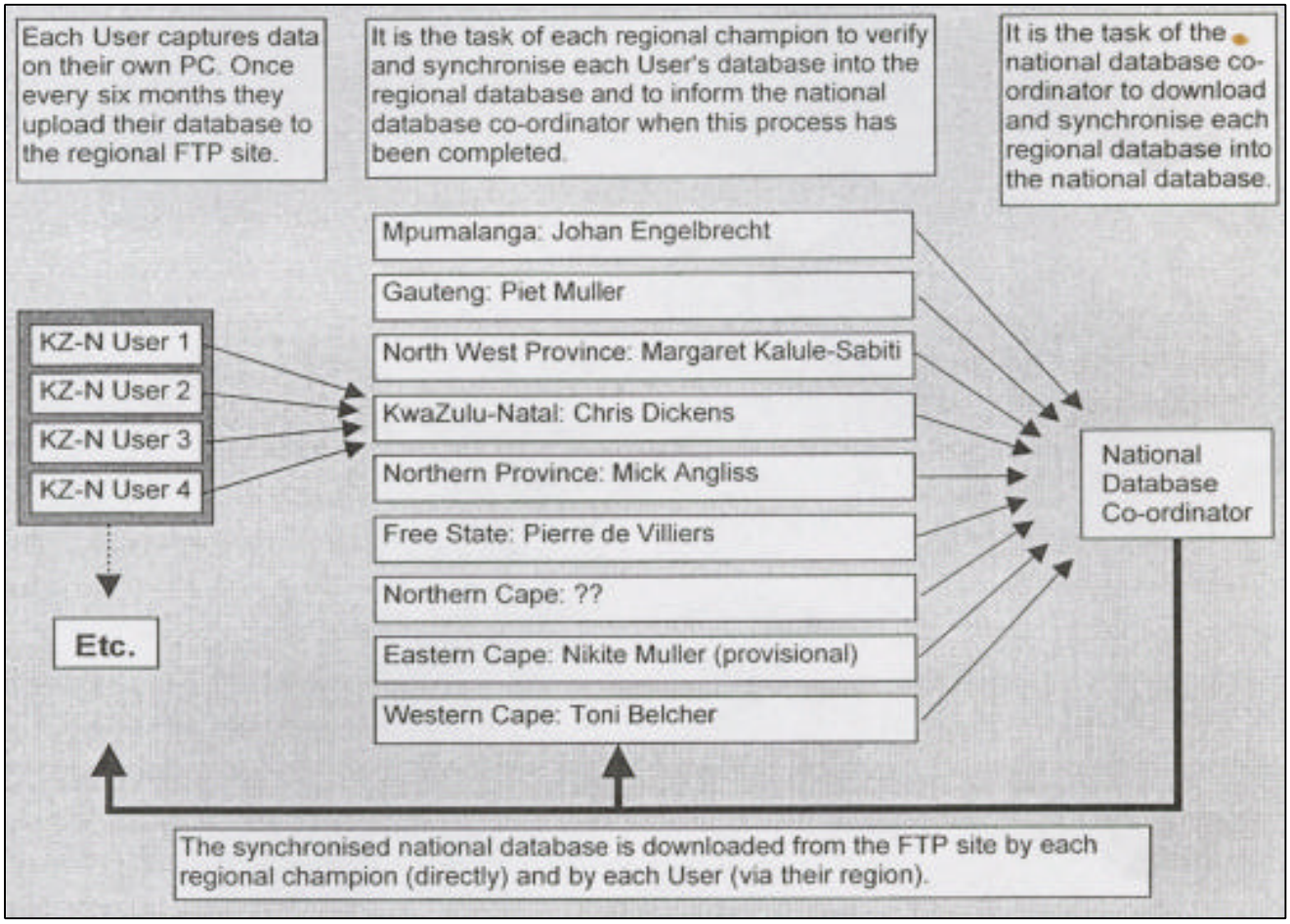

Figure 6. Information transfer using the Rivers Database system (local, regional, national) (adapted from Fowler *et al*.2000).

For information on the use of the Rivers Database see NAEBP Report No.11.

Useful tip!

As most of us have experienced, computers have this innate tendency to crash periodically, often with the disastrous results. To safeguard against losing a lot of hard work, it is important to make regular back up copies of your information. Copying the relevant files to a centralised server, which has a built in tape back-up drive or CD-writer will minimise the chances of a total information loss occurring. The back-up tapes or CDs should be stored off-site, so that in the event of fire, theft or any other "act of God", the information can readily be restored once new equipment has been purchased.

19.3 INFORMATION SECURITY AND USER ACCESS

This is an important consideration, particularly where a number of users are envisaged to be contributing to your RHP database on your server. User rights can be assigned to individual users, such as "read only" or "read and write" or "full control" (for the administrator), as Windows NT has the capacity for sharing of directories and files located on the server. The PIT should decide on the user rights for individuals involved. This is important to prevent accidental (or intentional!) alteration of files as well as ensuring that the information is centrally managed by the systems or database administrator. Your Network Controller will be able to assist with this.

20. ANALYSIS AND INTERPRETATION OF RESULTS

Analysing your RHP results requires a thorough evaluation of incoming information. This includes checking all scores and comparing these to known standards and previous results. To assist with drawing meaningful conclusions from SASS and IHAS results, a set of guidelines have been produced (see SASS4 manual and NAEBP Report No8). Water quality conditions have been proposed for different categories of total score and average score per taxon.

The software packages (such as Rivers Database Query Centre and GIS programmes) mentioned in the previous section (section 19.2) offer a number of analytical tools to assist the user in analysing results. It may take some time to become familiar with all of these features and what they are capable of doing. Depending on your circumstances, you may wish to outsource the GIS spatial analysis component to a specialised GIS unit attached to a university or water board.

Interpretation implies deriving meaning from the analysis of the results. This is probably the most complex and demanding aspect of the RHP. A thorough knowledge of land-use and developments within the catchment is necessary to provide the context for understanding and interpreting your RHP results. Particularly for locating and identifying potential sources of environmental impacts and quantifying the effects of these on the aquatic ecosystem and prevailing water quality.

Additional factors to take into account when interpreting results:

- **$** Seasonality - the season when monitoring took place is an important factor to consider when analysing results. For SASS scores, expect the diversity of invertebrates to be considerably lower during the cold winter months, with no attendant deterioration in water quality. Some fish species migrate with the changing of seasons, which may also influence your FAII results.
- **$** Flow conditions - South African rivers are renown to possess highly variable flows, often independent of seasonality. Changes in flow conditions of a river during wet and dry climatic conditions will influence your results and may not necessarily point to major anthropogenic (man-induced) alterations in water quality.
- **$** Natural variation in invertebrate, fish and plant diversity - this may be independent of water quality and habitat conditions. Fauna and flora are known to vary from region to region or even from site to site and over time. This should be borne in mind when applying predetermined guidelines to your results.
- **$** The resolution of SASS scores is at invertebrate family level, so changes in species level composition of some invertebrate communities in response to alterations in water quality may not be detected. However, major changes in abundance of invertebrate taxa (especially of the environmentally tolerant groups) may be significant in this respect.
- **$** Level of training of the PMT staff. This may affect the consistency of your results, particularly in the first year of your programme.

As the RHP is a long-term commitment to the garnering of pertinent environmental information, it will take some time before a meaningful set of results is accumulated for analysis and interpretation. For example, a data set of one year may show seasonal trends and major impacts, whereas a time-series of several years of information for a particular catchment will be much more valuable in terms of understanding environmental trends.

NOTE:
Your ability to analyse and interpret results will improve with experience and as you become more familiar with local environmental conditions and how these affect your RHP results. Other RHP practitioners can be consulted to assist in drawing meaningful conclusions from your results.

21. REPORTING

Now that the information has been captured, analysed and meaningful deductions have been made, the next step is to make these available to your target audience. This group of people includes environmental managers and the variety of organisations mentioned in the previous sections.

Reporting should take into account the five key questions:

- **$** What to report - what type of information is relevant to your target audience
- **$** To whom - who is your target audience
- **$** When - how often should reporting be conducted
- **$** How to report - which format to use to ensure that your information is understandable
- **$** Why - ensure that your target audience actually needs the information.

The level of reporting will determine the amount of detail required. RHP reporting may be required at local, regional or national scale, with different prerogatives attached to each (see NAEBP report No 8 for more details). However, at the provincial or catchment level where implementation actually happens, you will mostly concerned with local and regional reporting. Potential target audiences at the local and regional level include your relevant River Forum, CMAs, government departments and interested and affected parties.

The ***presentation, format*** and ***content*** of the information should preferably be tailored to suite the nature and background of the target audience to ensure that your audience derives the maximum benefit from your RHP. For example, aquatic scientists and managers who are familiar with the RHP indices, would probably be more interested in the actual results of the indices, while school groups would derive more meaning from synthesised graphical representations of the RHP results. However, there is no fixed recipe for which format to use for which audience. Various options will have to be tried and tested to determine which is the most effective for which audience. Other RHP practitioners should be contacted for guidance on reporting formats and content.

Another important aspect to consider is whether your reporting is to other role-players within the RHP, or whether it is intended for external parties. This will influence the style, composition and presentation of the results. For example, the RHP NCT may require a very different report to say government officials or representatives from industry.

A useful starting point would be to categorise your potential audiences (based on information needs, type of information required and presentation format) into the following three broad groups:

21.1 POTENTIAL AUDIENCES

- **$** Political and administrative - includes national and provincial government department heads
- **$** Operational and managerial - includes directors and senior managers of government departments with an environmental responsibility, national and provincial Parks and Tourism Boards, Water Boards, Local and District Councils, River Forums, CMAs and Industry
- **$** Interested and Affected Parties - local communities, farmers, industry, scientists, conservationists, schools and the media.

See NAEBP report No6 chapter 5 for more details on reporting and target audiences.

21.2 TYPES OF ENVIRONMENTAL REPORTING TO WHICH THE RHP CAN CONTRIBUTE

- **$** State of the Environment reporting - this is becoming increasingly important nationally, provincially and locally. The RHP is ideally suited to making significant contributions to the knowledge of the state of ecological conditions of rivers, as the RHP indices are useful predetermined indicators of ecosystem health.
- **$** State of Rivers reporting - is based on principles of State of the Environment reporting. A report has been produced for the Mpumalanga rivers.
- **$** Environmental reports of the relevant government departments and industries within the catchment.

22. MANAGEMENT ACTIONS

The RHP is specifically designed to ***assist environmental decision makers with the management of South Africa's freshwater resources.*** Hence the results obtained through data collection, analysis of results and interpretation and reporting on environmental trends should lead to ***management actions*** where these are required. Such management actions can only realistically arise from what the RHP is designed to monitor and assess.

The RHP is primarily ***a tool for keeping "a finger on the pulse" of long-term environmental trends*** such as the gradual deterioration in water quality and ecological integrity and the possible causes or sources of these. Hence, where this has been shown to occur, the RHP can contribute to **a *management plan which addresses these issues***. The formulation and implementation of this management plan should involve all the stakeholders and interested and affected parties in an integrated manner, with clear roles and responsibilities assigned to each (Figure 7).

After discussion with your PIT, the next step in initiating such management actions is to identify the possible causes and sources of the ecological and water quality deterioration. Once these have been established, ***contact the parties concerned and present your RHP findings.*** These should be in the form of a report clearly showing the RHP results and an interpretation of these. Through a ***participatory process***, managerial solutions may be reached and mitigatory measures can then be implemented, without resorting to legal litigation. However, if this fails, then the situation requires the attention of government authorities.

The RHP is also a ***monitoring tool designed to "red-flag" environmental problems*** detected at monitoring sites. Where your RHP has detected a severe ecological impairment due to a major catastrophic event (e.g. a pollution spill), the results can be used as ***preliminary evidence*** to initiate a more detailed investigation. The RHP can also be used to monitor the long-term ecological recovery of such impacted sites and assess the effectiveness of the rehabilitation measures.

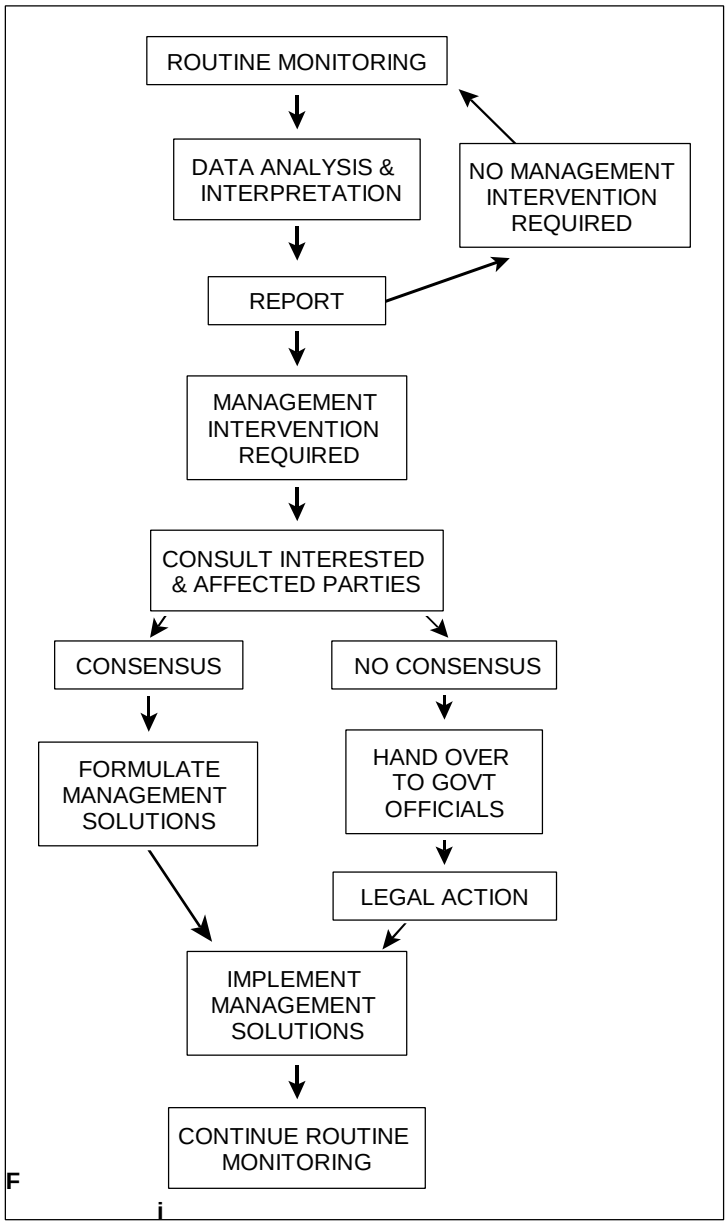

Figure 7. A diagram for the instituting management actions for the RHP.

Non-compliance by industry to Environmental Impact Assessment permit conditions or DWAF permit conditions may also be detected through the RHP monitoring and bring about management interventions to protect the river system from further degradation. The relevant DWAF and provincial environmental affairs officials should be alerted to this immediately. Municipal and local council officers should also be informed.

If a consultative management solution is not reached, then ***legal litigation*** is required. This is the domain of the DWAF, environmental affairs and local council officials. Where such legal litigation is called for, it must be remembered that your RHP results obtained from the various indices do not have legal standing in a court of law. For this, ***legally recognised methods of gathering environmental evidence*** must be used. These normally involve the collecting of water samples by an externally approved agency for chemical analysis at an accredited laboratory.

See legal context section (section 2) for more information on the RHP and the law.

23. QUALITY CONTROL AND ASSURANCE

To ensure that your RHP results are reliably comparable over time and between sites, it is vital that ***biomonitoring and data collection be performed in a consistent and standardised way***. It is no use having a brilliantly designed RHP programme, if the information being gathered is unreliable. Quality control and quality assurance (QC/QA) are the procedures which ensure that ***set standards are maintained*** throughout your programme.

The QC/QA is very important as persistent undetected errors that occur at the biomonitoring stage, could ultimately distort the interpretation of the perceived ecological trends and condition of a catchment. Preferably all aspects of the RHP process (programme design and implementation, sampling, recording of results, data capture, analysis and reporting) should be subjected to periodic audits (inspections) and quality control measures.

Quality control an assurance ***should begin with your RHP programme design*** and ***implementation plan***. To make sure that your programme is realistically designed and incorporates all important aspects, it should be reviewed by the NCT. Once this has been successfully achieved, standards and procedures need to be set for the different aspects of your programme.

Some RHP aspects for QC/QA include:

- **$** Equipment checks
- **$** Biomonitoring sampling techniques
- **$** Identification proficiency (invertebrates, fish, riparian vegetation)
- **$** Recording of results on standard forms
- **$** Adherence to RHP index methodology
- **$** Coverage of Monitoring and Reference sites
- **$** Adherence to biomonitoring frequencies
- **$** Data capturing on computer
- **$** Maintenance of data
- **$** Analysis of information
- **$** Presentation of information
- **$** Reporting methods
- **$** Remedial actions by management.

The auditing of biomonitoring sampling techniques and use of instruments can be done by random spot checks in the field. Auditing of invertebrate identifications can be done by preserving whole samples and bringing these back to the laboratory for analysis. The results obtained can then be compared to the field based results. This should be done preferably by either a central auditor or one of the members of the PIT with biomonitoring experience. Occasional checks on the accuracy of the recording of results on the database are also recommended. We are all human, so occasional mistakes can be expected!

NOTE:
A Proficiency Testing Scheme (PTS) has been developed by Umgeni Water to test the SASS identifying ability of SASS practitioners countrywide. Once practitioners have qualified, then their data collected will be flagged as "validated" on the national Rivers Database. A similar system could be devised for fish identification.

Auditing may also be done during the process of analysing your RHP results for the detection of environmental

trends. Due to the discriminatory nature of data analysis, major anomalies during data capture can be detected and checked. Follow up investigations can then be made to ascertain where the error crept in.

NOTE:
It is very important that QC/QA should not be seen as a policing exercise. It should rather be a process of enhancing the performance and proficiency of all personnel, from the PMT to the provincial champion.

For more information on QC/QA, see report by Chris Dickens on the RHP website and Procedures for Provincial Implementation. Chapter 3. Quality Control and Assurance by Rob Palmer.

24. ADDITIONAL CONSIDERATIONS

24.1 THE RHP AND TRANSBOUNDARY RIVERS AND SHARED CATCHMENTS

Rivers form the borders of a number of the provinces in South Africa. Hence the issue of shared catchments (between two or more provinces) and transboundary rivers (headwaters in one province and lower reaches in another) is likely to arise. For example, the Vaal River catchment straddles five provinces!

Transboundary rivers and shared catchments may occur both at a provincial and WMA scale and this basically translates into shared responsibilities for RHP monitoring of these rivers. It is essential to coordinate and plan your RHP initiatives with your neighbouring provincial RHPs for these rivers and to exchange pertinent information on a regular basis. In this way, a holistic picture of the entire river system can be developed and that the river catchment is managed in an integrated way.

24.2 INTERNATIONAL RIVER SYSTEMS

The RHP implications for the management of international river systems such as the Limpopo are not being considered in the short and medium term. However, this is presumed to be an important aspect in the long-term as it is envisaged that the national RHP will eventually become a southern African freshwater resources management programme.

24.3 COLLABORATING WITH THE STATE-OF-RIVERS (SOR) INITIATIVE

This is a relatively new initiative in South Africa which has its roots in the State of the Environment (SOE) reporting. The state of the rivers is a catchment-based assessment of how climate, topography and human activities such as land-use and population interact and the effect of these to the general condition of the river. SoR reports have already been produced for the Crocodile, Sabie-Sand, and Olifants Rivers in Mpumalanga Province.

The SoR approach is based on the Drivers, Pressures, States, Impacts and Responses (D,P,S,I,R) model used in the State of the Environment (SoE) reporting. A set of standardised environmental indicators is used to evaluate environmental trends. The RHP's objectives of "measuring, assessing and reporting on the ecological state of aquatic ecosystems" and the programme's use of standardised indices to "measure" aquatic ecosystem health, makes the RHP an ideal partner of SoR reporting.

For more on the State-of-Rivers reporting consult the RHP website:
www.csir.co.za/rhp/state_of_rivers.html.

24.4 LINKING YOUR RHP WITH EXISTING CONSERVATION AND BIODIVERSITY PROGRAMMES

The RHP has the potential to make a significant contribution to freshwater conservation and biodiversity research programmes. For a little extra effort, your RHP fieldwork could also include the collection of representative samples of aquatic fauna and flora which can be sent to museums and universities for further research.

The Albany Museum in Grahamstown houses the National Collection of Freshwater Invertebrates, the largest freshwater fish collection in South Africa as well as a large herbarium. The JLB Smith Institute of Ichthyology in Grahamstown also houses a large freshwater fish collection. The Port Elizabeth Museum houses a major reptile and amphibian collection. The National Botanical Institute (NBI) could be contacted for the RHP contributions to further research into plant biodiversity. Apart from making a contribution to the knowledge of local biodiversity and ecology by donating specimens to these organisations, researchers there are generally willing to share ecological and taxonomic information which will benefit your RHP.

It is suggested that provincial RHP implementers contact the aforementioned organisations to investigate the potential for collaborative biodiversity and ecological research. They may be able to supply you with bottles, labels, preservatives and advice on collecting techniques. Most essential is to record the date, locality, latitude and longitude and possibly habitat on a label attached to each sample or specimen. Any other field notes will be useful.

24.5 WORKING-FOR-WATER PROGRAMME

The Working for Water (WFW) programme is a national programme initiated by the DWAF to remove thirsty alien tree species growing in river catchments. These include black wattle, pinetrees, bluegums and poplars and many others. Apart from increasing the flow, the sudden removal of these trees can alter the river catchment characteristics significantly, particulary in the upper reaches of the river.

The RHP is an ideal monitoring tool for assessing the before, during and after effects of removal of alien tree species from river catchments. The RHP could also be a useful source of information of long-term environmental trends associated with the monitoring of the ecological status of alien tree cleared catchments. The geomorphological index can be used to assess whether the river channel condition becomes significantly altered through possible erosion or siltation after the alien tree infestations have been chopped out. Habitat quality for fish and invertebrates may also be affected.

25. ORGANISATIONS OFFERING SUPPORT FOR THE RHP

- DWAF - National. Dr Henk van Vliet is chairperson of RHP National Coordinating Committee and can be contacted regarding major policy issues.

- DWAF - IWQS. For expert advice and training. On site training in SASS and IHAS and preliminary site selection can be arranged with the IWQS staff. They can also offer advice on equipment issues, sampling and other practicalities. The IWQS water quality laboratory has capacity for chemical analysis of water samples, including heavy metals. Ms Annelize Gerber and Ms Mary-Jean Gabriel have produced a SASS colour pictorial guide to identifying invertebrates in the field. Dr Neels Kleynhans has spearheaded the research and development of the Fish Assemblage Integrity Index (FAII) as well as the Index of Habitat Integrity (IHI).

- DWAF - Cape Town. Ms Toni Belcher is the Western Cape RHP Champion. Various initiatives are currently taking place such as training, customising of RHP indices and applying the Rivers Database.

- DEAT. Dr Geoff Cowan is currently the DEAT representative on the RHP NCC and is involved with the national wetlands initiative.

- WRC. Dr Steve Mitchell is the WRC representative on the RHP NCC who is responsible for the coordination of RHP training requirements. He can also be contacted for RHP research and funding issues.

- CSIR. Dr Dirk Roux for general assistance regarding the design and implementation of the RHP and coordination of the programme as well as NCT matters. Ms Anna Ballance is compiling the State-of Rivers reports for several Mpumalanga rivers.

- NFHR Consulting. Ms Nomsa Ntshingila for training and capacity building requirements of provincial RHP initiatives.

- Umgeni Water. Dr Chris Dickens and his team have considerable experience in biomonitoring programmes (especially SASS) and implementation of the KwaZulu-Natal RHP.

- Provincial Environmental Affairs Depts - particularly Mpumalanga Parks and Tourism Board. The Mpumalanga RHP was the first provincial RHP and is now well established in many rivers. Dr Johan Engelbrecht and his biomonitoring team have considerable experience in applying the Fish Assemblage Integrity Index (FAII), SASS and Riparian Vegetation Index (RVI). Mr Mick Angliss of the Northern Province Dept of Agriculture, Environment and Land Affairs has been involved with applying and developing the FAII and the RHP is well established in the province. Mr Pierre de Villiers of the Free State Dept of Agriculture, Environment and Conservation has been using the FAII and launching the provincial RHP. Mr Piet Muller of the Gauteng Dept of Agriculture, Environment and Conservation has taken command of the Gauteng provincial RHP. Dr Margaret Kalule-Sabiti and Mr Stuart Mangold of North West Dept of Agriculture, Conservation and Environment have conducted initial site surveys and training in selected rivers in the province.

- The RHP National Coordinating Team should be your starting point to support your local RHP. Dr Dirk Roux, Ms Liesl Hill and Ms Vassie Maharaj can be contacted for more information on the various aspects of the RHP.

- Southern Waters Ecological Research and Consulting. This organisation can be contacted for information about the Rivers Database and aquatic ecological surveys and general RHP issues. Also Dr Helen Dallas for assistance with the establishement of ecological reference conditions for riverine macroinvertebrates. This organisation has been involved with the RHP from its inception.

- Institute for Water Research (IWR), Rhodes University. Prof. Jay O'Keeffe, Dr Patsy Sherman and Dr Nikite Muller. IWR offers a comprehensive biomonitoring training course twice per year. IWR has also been involved with various aspects of the RHP from its inception.

- Dept of Freshwater Invertebrates (FWI), Albany Museum, Grahamstown . FWI can be consulted for specialist identification of freshwater invertebrates and initial baseline surveys of freshwater invertebrates in selected rivers and housing of aquatic invertebrate collections and biodiversity research. In collaboration with the WRC, FWI is developing a series of invertebrate guides with keys to most groups. Contact Dr Ferdy de Moor and Ms Helen James.

- Dept of Freshwater Fishes, Albany Museum, Grahamstown . Dr Jim Cambray can be contacted for initial baseline surveys of freshwater fishes in selected rivers and housing of fish collections and biodiversity research.

- AfriDev Consultants. This company does ecological assessments, catchment management studies, community consultation and participation and runs SASS training courses. Dr Mark Chutter developed SASS for South African conditions. Dr Rob Palmer has developed criteria for RHP quality control.

- Manyaka Greyling (Pty) Ltd - for communication and promotion of the RHP as well as public participation and liaison issues. They are the editors of the RHP Newsletter. Contact Ms Vassie Maharaj.

- Catchem Biomonitoring. This company specialises in making biomonitoring equipment, particularly SASS nets and SASS sampling kits. Contact George Johnstone.

26. LIST OF CONTACTS

For a comprehensive and up to date list of contacts, contact the RHP Communication Office:

Mayaka Greyling (Pty) Ltd
P O Box 95823
Waterkloof
Pretoria 0145
Tel: (012) 362 0848
Fax: (012) 362 0869
Email: vassie@liaison.co.za

Alternatively, visit the **RHP website: http://www.csir.co.za/rhp/**

27. USEFUL READING

For a comprehensive list of reading material relevant to the RHP:

$ NAEBP Report No6. *Overview of the design process and guidelines for implementation* Appendix A (Roux, 1997).

$ NAEBP Report No8 *National Implementation Assessment* reference list (Murray, 1999).

$ The national RHP website: **http://www.csir.co.za/rhp/**.

$ Water Research Commission Report No. *Procedures for Provincial Implementation of the National River Health Programme* (available on the RHP website).

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APPENDIX 1
AN EXAMPLE OF A GANT CHART FOR RHP PILOT IMPLEMENTATIO

COMPONENTS	YEARS	Year One												Year Two									
	MONTHS	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
Research and Development																							
Registration of your provincial RHP																							
Personnel PIT/PMT recruitment																							
Training and Skills Development																							
Draft RHP Implementation Plan																							
Fund-raising																							
Purchase General RHP and SASS Equipment																							
Purchase FAII Equipment																							
Purchase additional Equipment																							
Purchase Vehicle																							
Promotion and Marketing																							
Public Participation																							
Test Catchment Selection																							
Monitoring and Reference Site Selection																							
Routine Monitoring SASS and IHAS																							
Routine Monitoring FAII																							
Routine Monitoring RVI																							
Data Storage and Information Management																							
Analysis and Interpretation of Results																							
Reporting																							
Management Actions																							
Quality Control and Quality Assurance																							

APPENDIX 2
AN EXAMPLE OF A RHP BUSINESS PLAN (DICKENS, 1998. UMGENI WATER, KWAZULU-NATAL)

River Health Programme - Business Plan
*to be used by organisations wishing to participate with the KZN River Health Programme and who would like to "Adopt a River".

Aim:
To promote river health by providing information for management.

Target of the KZN Implementation Plan: (adapted from the National Target)
By December 1998, provincial and / or local catchment authorities make water resource management decisions based also on information provided by an operational River Health Programme.

Products:
- a structured framework for monitoring river health
- State of the Environment Reporting
- to identify and quantify where **impacts** are taking place
- to assist in setting specific **objectives** for rivers (eg. based on a river classification scheme)
- to measure and evaluate the impact of **developments** on ecosystems
- to be able to **predict** changes in the ecosystem due to planned developments
- access to data will enable the **management** of rivers
- improve the **awareness** of river health.

Motivation:
The limited nature of freshwater in South Africa makes these resources critically important in terms of sustainable economic and social development. It is essential therefore, that all responsible agencies including Government authorities, local catchment managers, landowners and industrialists, should take a hand in maintaining the integrity of this resource.

The River Health programme puts into place a system that monitors *directly* the health of river ecosystems. In the River Health programme, use is made of ecological indicators, i.e. biological (eg. invertebrates, fish etc) and non biological indices (eg. habitat characteristics) to measure and quantify changes in the river ecosystem. Information produced in this way can be fed into any programme whether at the National or Provincial scale or small areas of private land. This information then assists with making management decisions that will influence the quality of the freshwater resource.

The benefits to the Nation as a whole are obvious i.e. by providing information to assist with maintaining the integrity of the freshwater resource. The benefits to catchment managers are also obvious. Rivers flow down the length of catchments and link together all of the inhabitants. With the increasing scarcity of this resource and the increasing demands that are being made on it, it is important that all members of a catchment should have fair access to the resource and that it is not detrimentally affected by any one party.

In simple economic terms, the River Health programme has significant implications for landowners and industries. In the long-term, maintenance of the freshwater resource is essential for ongoing business. In the short-term, business practises that have few impacts on the environment are becoming increasingly important. In order to encourage these, it is now demanded of companies around the world to demonstrate their care for the environment. Accreditation via systems such as ISO 14000 is becoming necessary to conduct business abroad and

is even becoming important for local business. Numerous South African companies will already only do business with companies that are able to demonstrate a minimal impact on natural resources. The River Health Programme will provide many of the answers needed to satisfy such a system of accreditation.

Another short-term benefit for companies and catchment managers is that the River Health programme will identify problems in rivers early and help to prevent them from becoming severe. In an age when forced rehabilitation of ecosystems by polluting organisations, and the polluter pays principle, are becoming the norm, this could have a major impact on safeguarding the bottom line of businesses.

The unique advantage of this River Health programme is that all of the above is provided without a massive investment of funds. Biological monitoring is relatively inexpensive and yet is the most direct measure of ecosystem health. Results are rapidly obtained and easy to interpret thus affording managers with useful information.

Methodologies:
A number of methodologies have been recommended by the National Aquatic Ecosystem Biomonitoring Programme (NEABP report 6) but it was suggested that local implementers decide for themselves the intensity of monitoring that will be undertaken. The backbone of biomonitoring in South Africa is the invertebrate assessment technique called SASS (South African Scoring System) that was developed by Dr. Mark Chutter (1994). This technique is thus recommended, but should be coupled with the HAM (Habitat Assessment Matrix- Plafkin et al. 1989) that is used to assist with the interpretation of SASS results. Where a more complete assessment of the river, including the river bank, is required, then the RVI (Riparian Vegetation Index- under development or alternately Ripari-Man development by Kotze et al. 1997) needs to be added. These are all cost effective and rapid techniques that produce reliable results.

Other methods recommended by the National programme include indices of fish health, water quality, hydrology, geomorphology and a general Index of Habitat Integrity which assesses the entire river from source to sea. All of these have considerable merit but it is recommended that they be put aside until the basic programme is up and running. Thereafter it may be decided to add some of these methods.

Quality Control:
It is essential that some control is kept on the quality of surveys. Although there is likely to be a National guideline, in the meantime the Implementation Team will ensure that a check on quality takes place. This will involve the submission of infrequent random samples for checking by a central auditor.

Action Plan:
- The National Programme has set a target of December 1998 by when information produced by the programme will be in use as part of decision making. They have suggested monitoring at least one important catchment in each province, but with the “Adopt a River” policy being followed in KZN, it is likely that implementation will be wider than this.
- Those organisations that have already indicated a willingness to participate with the programme, meet to decide which rivers they will be responsible for, reference and monitoring points, submission of data and output of the programme. They should also indicate how they will use the information produced. Probable date 3 April.
- On acceptance of this Business Plan, a public meeting will be held (date to be decided) to launch the implementation of the programme. Thereafter a roadshow will be held with all / any bodies who are or who ought to be interested in the programme. Participants are encouraged to organise meetings in their area which will be supported by the implementation team. Presentations on the programme can be given.
- Training workshops will be held in June / July 1998 in Pietermaritzburg and in Richards Bay for those who wish to learn the skills required to conduct the monitoring. If necessary a further training workshop will be held later in the year.

- As soon as participating organisations commence biomonitoring, their results can be included in the

provincial database.

C Selecting the reference sites, which are used as "pristine" sites against which impacted sites are compared, is a complicated that the location and number of reference sites will change during the implementation phase. It may take several years to complete this task. Guidance and co-ordination will come from the Implementation Team although data from participants will be incorporated in the process.

Participating bodies:
The Departments of Water Affairs and Forestry, Environmental Affairs and Tourism and the Water Research Commission are the custodians of the National Programme. In this province, a number of organisations have indicated their willingness to participate. This includes government, quasi-government, local authorities, industries, universities, environmental organisations and even private individuals and small companies. Several individuals have also contributed information for the selection of reference sites.

Responsible persons / organisations:
In a letter from the National River Health office to all provincial environmental and water authorities, an invitation was extended to nominate a person to attend a National Consultative (Sept. 1996) meeting to launch the programme. At this meeting, the KZN delegates met together and elected a single representative (the "Provincial Champion") who in this case was Dr. C. Dickens from Umgeni Water. At a later open meeting to launch the programme in KZN a Provincial Implementation Team was selected. This includes the following who are (Umgeni Water) Jake Alletson - deputy chair (Alletson Ecologicals) Hugh Dixon-Paver - secretary (DWAF) Rob Hattingh (Richards Bay Minerals) Mike Coke (Parks Board) Brian Fowles (CSIR) Scotty Kyle (KZN Nature Conservation) Raymond Auerbach (Farmer Support Group) Victor Wepener (University of Zululand) Kerry Seppings (Durban Metro) Max Taylor and Tandi Moffet (Town and Regional Planning Commission) Mark Graham (Umgeni Water).

It is hoped that as the programme expands, more and more organisations will assume responsibility for the rivers in their area. Groups of participants could combine resources or alternately a small entrepreneur could take on the monitoring for a group of customers. Overall responsibility for the programme will reside with DWAF and DEAT but not in an executive manner.

Skills required:
Monitoring using SASS requires an alert person with a moderate training. Training is not to be found in any of the Universities or Technikons (except University of Zululand), but can be offered by various organisations that have the cabability (eg. CSIR and Umgeni Water).

Minimum qualification would be a reasonable matric, but ideally would include a diploma or degree in an environmental science. Training of an inexperienced individual would take approximately six weeks including 40 hours of instruction and the balance self study. HAM would take approximately 3 hours of instruction.

Equipment required:
Little equipment is needed for biomonitoring. The following lists approximate costs:

SASS kick net	DIY for R100 or R500 to import
Waders	R200
Other SASS needs	R100
Fish electro-shocker	R5000 (only if or when fish monitoring is pursued).

Data Storage and Access:
Raw data will be stored on the Umgeni Water LIMS database and outputs generated on GIS. These will be freely available on the Umgeni Water Internet site or on request.

Budget:

The WRC and DWAF have funded the National development of the project and are currently funding the full scale implementation of the project in Mpumalanga together with further research. The budget for this is several million. Other provinces have been unsuccessful in raising government funds but in the longer term this is a possibility as is the prospect of foreign funds.

So far there have been minimal budget requirements in KZN. In the longer term it is envisaged that responsible organisations will fund their own monitoring as partof the provincial effort. In areas where there is an obvious gap it may be possible to raise the funds from government or from elsewhere. Obviously some organisations may wish to sponsor monitoring in areas outside of their own- this will be most welcomeand would be useful publicity for those organisations.

In the medium term the following costs will need to be met:

	Activity	Approximate Cost	Responsibility
1.	Minor costs for workshops and road show	R3000	Participants
2.	Ground-truthing of all of the suggested reference sites. Ideally a total of up to 500 reference sites should be visited to select 200 final sites.	Variable	Carried out by all participants.
3.	Collection of initial SASS and HAM data from the 500 possible reference sites.	R120 000 total or R240 per site or part of operational costs	Many of these samples may be collected by participating organisations as part of their own programme implementation.
4.	Statistical analysis of the reference site data and elimination of those sites not suitable.	R30 000	A single agent should take on this responsibility for the whole province.

After the initial reference site selection, participating organisations would monitor sufficient monitoring sites on potentially impacted rivers to fulfill their needs (the costs are reflected in Table 1). A number of extra sites may need to be monitored to satisfy the State of the Environment investigation and report.

Use of Data:
The programme will encourage participants and catchment managers to make use of the data to make management decisions. Obviously this cannot be prescribed but it is hoped that the value of the data will naturally lead to its inclusion in management decision making.

References:
Chutter, FM (1994) The rapid biological assessment of streams and river water quality by means of the macroinvertebrate community in South Africa. In Uys MC (ed) Classification of rivers and environmental health indicators. Proceedings of a joint SA/Australian workshop. Cape Town. Water Research Commission Report No. TT 63/94.

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Plafkin, JL; Barbour, MT; Porter, KD; Gross, SK and Hughes, RM (1989) Rapid bioassessment protocols for use in streams and rivers: benthic invertebrates and fish. Us EPA Report No. EPA/440/4-89-001. Washington, DC 20460.

Approximate costs per site per annum for 1998.
Costs are based on likely costs if in-house staff are used for monitoring

	Costs in Rands per site per annum			
	Recommended survey#		Minimum survey˜	
Survey cost*	Reference site	Monitoring site	Reference site	Monitoring site
SASS*	300	75	200	50
HAM*	38	38	25	25
RVI*	100	100	5.	-
Average transport cost @R1,20/km				
5 km local	18	18	12	12
10 km	36	36	24	24
50 km rural	180	180	120	120
100 km rural	360	360	240	240
Travel time*				
local trip 5 km	38	38	25	25
long trip 100 km	150	150	100	100
Cost/annum for a local site	**494**	**268**	**262**	**112**
Cost/annum for a distant site (100 km)	**948**	**723**	**565**	**415**

*Labour cost based on rate of R50/hour (technician level)

#The **Recommended** survey is base on 3 samples per annum (late summer (March, April);winter (July, August) and late spring (October, Novembe˜). The difference in the SASS costs are that ALL of the biotopes (habitats) are monitored for Reference sites, but only ONE for Monitoring sites.

˜The **Minimum** survey is based on 2 samples per annum (autumn and spring)