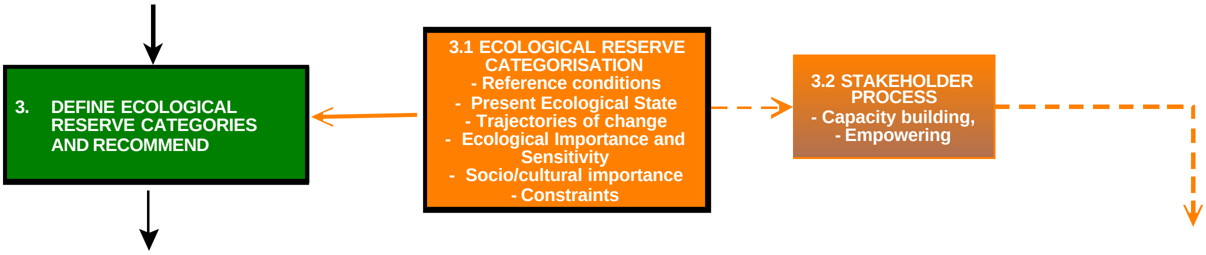
# 5. DEFINE ECOLOGICAL RESERVE CATEGORIES *(3)*




**Resources required to define Ecological Reserve Categories**

IFR coordinator (All levels)
Instream specialists (All levels)
Fluvial Geomorphologist (IERM & CERM)
Habitat integrity specialist (IERM & CERM)
Riparian vegetation specialist (IERM & CERM)
Hydrologist (CERM)

**Approximate time required**

| | |
|---|---|
| Collation and reporting | CERM : 4 days |
| Specialist meeting : | RERM : Included in field visit.<br>IERM : Included in IFR specialist meeting.<br>CERM : Specialist meeting of 2.5 days |

**Definitions of terms used in this document** (EPA, 2000)

*EFFECT :* A biological change traceable to a cause.
*Cause (no change) :* A stressor that occurs at an intensity, duration and frequency of exposure that results in a change in the ecological conditions.
*SOURCE :* A source is the origin of a stressor. It is an entity or action that releases or imposes a stressor into the waterbody.

## 5.1 THE NATIONAL WATER ACT AND CLASSIFICATION

The National Water Act (No. 36 of 1998) (NWA) is based on the central guiding principles of sustainability and equity (NWA: Chapter 1, Introduction). Sustainability of resource use is ensured by the implementation of resource protection (NWA: Chapter 3), through the application of the ecological Reserve (the quality, quantity and reliability of water required to maintain the ecological functioning of aquatic ecosystems (Principle 7, National Water Policy, DWAF, 1997)). However, since different levels of resource use, resource protection, and ecosystem health are possible, it is clear that it would be necessary to classify each water resource for which the Reserve is to be determined. The classification system describes levels of ecosystem health, and from these, tolerable degrees of risk to ecosystem health, and levels of acceptable use of the resource, can be derived. The volume and quality of water allocated to the ecological Reserve therefore depend on the level of classification.

Classification is explained in the following extract from the White Paper on a National Water Policy for South Africa (Department of Water Affairs and Forestry, April 1997):

*"6.3.3 Resource Protection*

*A national resource protection classification system will be introduced. Through a process of consensus-seeking among water users and other stakeholders, the level of protection for a resource will be decided by setting objectives for each aspect of the Reserve (water quality, quantity and assurance, habitat structure, and living organisms). The objectives for each aspect of the Reserve will show what degree of change or impact is considered acceptable and unlikely to damage a water resource beyond repair. Resources will be grouped into a number of protection classes, with each class representing a certain level of protection. Where a high level of protection is required, the objectives will be strict, demanding a low risk of damage and the use of great caution. In other cases, the need for short to medium term use may be more pressing and the need for protection lower. Some resources may already need action to restore them to a healthy state, and, in future, no resources should be allowed to become irreversibly degraded."*

Chapter 3 of the National Water Act - Protection of Water Resources - describes how resource protection must be achieved by:

- The establishment of a system for classifying water resources (resource classification).
- The determination of
  - the class of significant water resources;
  - resource quality objectives (water quantity, water quality, habitat and biotic integrity);
  - the Reserve.

A system to classify the resources into Management Classes is being developed. The Management Class will consist of various components, each within a category of its own. These components are amongst others ecology, domestic use, recreation, agriculture.

## 5.2 ECOLOGICAL COMPONENT

The aim in the quantification of the Reserve is to provide Reserve scenarios ***(4)***, i.e. flow regimes that would result in a variety of river state categories or Ecological Reserve Categories (ERCs). Prior to the quantification of the Reserve scenarios, these categories must therefore be defined.

A technical recommendation about the ERC, which should represent the aim for the river, must also be made. This represents the *ecological component* of the Management Class.

## 5.3 PROCESS TO RECOMMEND ERCs

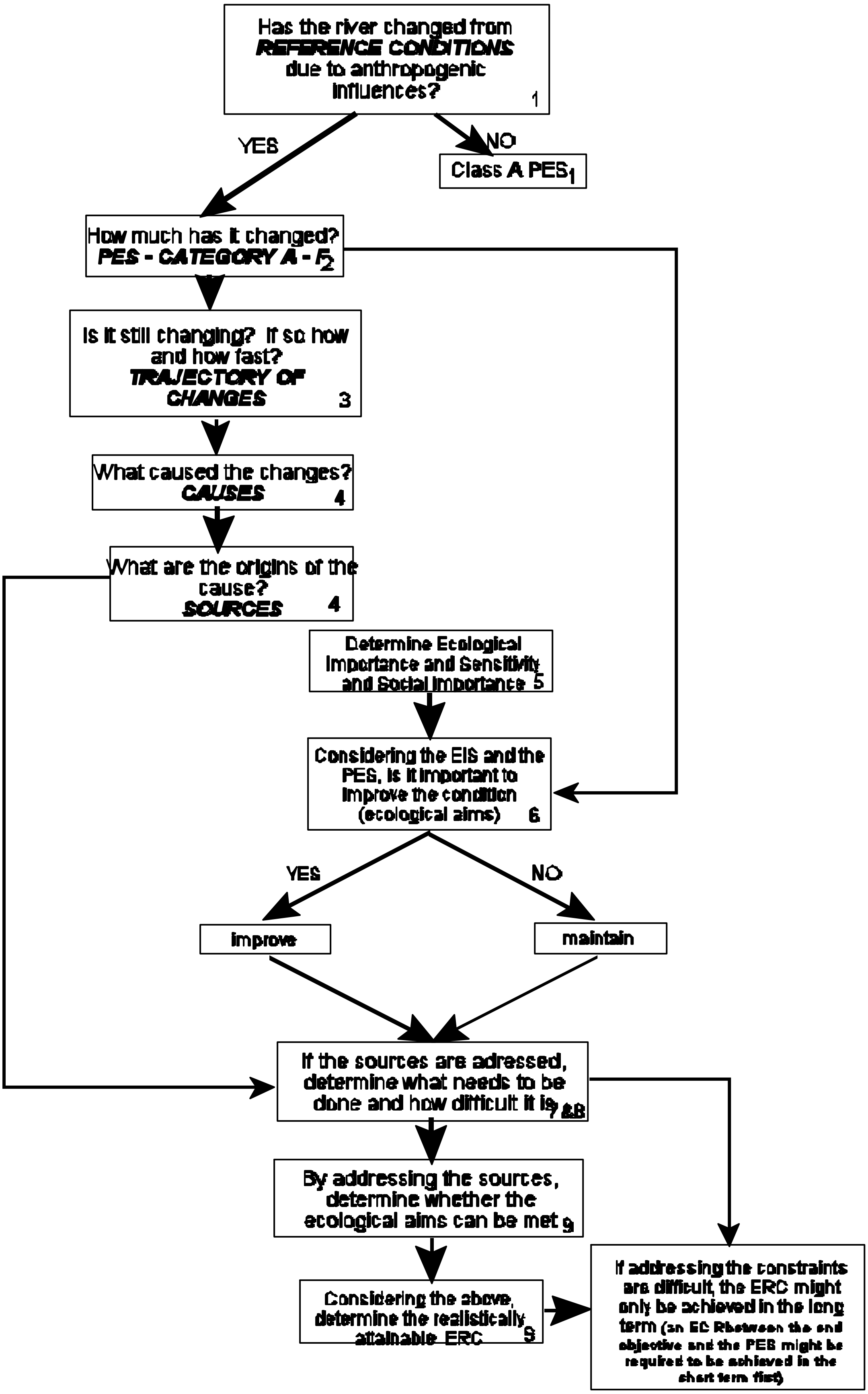
Table 5.1 shows a sequence of questions addressed during the ERC process, where the left column illustrates simple questions, and the equivalent more technical version is given in the right column.

**Table 5.1 The sequence of actions required for providing technical information on the ERC.**

| | |
|---|---|
| What did the river look like before? | 1. DETERMINE REFERENCE CONDITIONS |
| Compared to how the river used to look, what does it look like now? | 2. DETERMINE PES<br>(Category A-F) |
| Is the river still changing, and if so how?<br><br>How severely?<br>How fast? | 3. DETERMINE TRAJECTORY OF CHANGE (FOR EACH COMPONENT WITH REASONS) IF THE STATUS QUO IS MAINTAINED<br>Trajectory (None, negative, positive)<br>Short term and/or long term (Category A - F) |
| What is the main cause for the change? | 4. DETERMINE CRITICAL CAUSE FOR THE PES and/or the TRAJECTORY OF CHANGE |
| What are the sources of the causes? | AND GIVE THE SOURCE OF THE CAUSE |
| How ecologically and socially important is the river? | 5. DETERMINE IMPORTANCE & SENSITIVITY CATEGORIES (Low, Moderate, High, Very High) AND STATE CONFIDENCE IN EVALUATIONS. |
| What would the ecological aims be for the river? | 6. CONSIDERING THE IMPORTANCE AND THE PRESENT ECOLOGICAL STATE; SHOULD THE PES BE IMPROVED (if so, by how much) OR MAINTAINED (NOTE : MAINTAINING THE PES COULD STILL REQUIRE RESTORATION MANAGEMENT, DEPENDING ON THE TRAJECTORY OF CHANGE.)<br>(Category A - D) |
| Can the main cause realistically be addressed to achieve the ecological aims? | 7. DETERMINE WHAT WOULD BE REQUIRED TO ADDRESS THE CAUSES.<br><br>8. DETERMINE HOW DIFFICULT IT WOULD BE TO ADDRESS THE SOURCE.<br>(RESTORATION/REVERSIBILITY POTENTIAL).<br>(Easy, reasonable, difficult, very difficult)<br>PROVIDE REASONS. |
| What should be ecological category be for the river? | 9. CONSIDERING THE ECOLOGICAL AIMS, AND THE DIFFICULTY OF ACHIEVING THE AIMS, DETERMINE THE ATTAINABLE ECOLOGICAL CATEGORY FOR EACH COMPONENT |

The way in which the above questions are addressed is described in the flow-diagram below. The steps in the flow-diagram are discussed according to the numbers within the flow-diagram.

**Figure 5.1: Flow diagram illustrating the information generated to determine the ERC**



‘ **1. Has the river changed from reference conditions due to anthropogenic changes?**

Detailed guidelines are provided by DWAF (1999, Volume 8) for the determination of reference conditions for both quantity and quality aspects of a Reserve determination. The reference condition describes the natural condition prior to anthropogenic change and is described for each specialist component using the information below.

- Search for the least-impacted sites, either in the same or in comparable river zones.
- Use the results of historical surveys before major human impacts.
- Use aerial photographs.
- Use expert judgement.

Historical information and data, and/or data from reference sites (minimally impacted sites) are used to describe the reference conditions for the channel, hydrology, biota, and the water quality. Due to data limitations and/or the absence of any existing category A resource units, the reference condition may not represent a natural river state, but rather the best estimate of a minimally impaired baseline state. If the river has not changed, then the present ecological state can be described as in an A category condition, and the resource is in a natural, near to pristine, or minimally impacted state. For such a resource, the present state equals the reference condition. If the river has changed, it leads to the next step.

‘ **2. How much has it changed (Categories B - F)?**

The PES is derived from, or described as a change for the worse from a described reference condition, which ideally relates to an A category condition - the historically natural condition (DWAF 1999 - Volume 8). The degree of change is described by one of a range of categories (Table 3.2). The PES of the river is expressed in the components: habitat (habitat integrity), biophysical (fish, riparian vegetation, aquatic invertebrates and geomorphology) and water quality (chemistry) integrity. Each component is assigned a category level (A-F), where categories A-D are judged to be ecologically sustainable, and categories E and F indicate a current state that is ecologically unsustainable. The PES is compared with the reference conditions using:

- Surveys during the project
- Results of historical surveys/databases
- Aerial photographs
- Expert judgement

No integration of the different PES components into a single category is required, as this would detract from the specific details provided. However an overall ‘ecostatus’ is provided which consists of a subjective evaluation of all the information provided into an overall category for the river. The ecostatus evaluation is also important for the determination of an ERC for the river, as an ERC is determined for each of the different components, as well as for an overall (i.e. ecostatus) ERC for the river. The factors which contribute to an overall classification of the ecological status of a resource unit are complex and interactive. The best information that the specialists have, are the motivations for the individual components, as these are data-based and individually argued and motivated. *It is therefore not possible to define a rigorous process, since conditions* *and the interactions between different processes and components differ markedly in different rivers. However, the following guidelines may be useful:*

- First examine the driving processes (flow, water quality, geomorphology)
- If one of these is in a lower category than the biota:
  - Examine the causes, sources and trajectories of change
    - If the biota are likely to follow the critical driving process;
    - Then the ecostatus class will usually be set in the same class as the driver.
  - If not, then the ecostatus may be set in the same class as the critical biotic component.
- If the biotic category are in the same as or lower classes than the drivers:
  - Examine the causes, origins and trajectories, and the confidence in the assessment of each component
    - The ecostatus class will usually be set in the same class as the critical biotic component.

It should be noted that each reach is assessed individually by best expert judgement, taking account of the above steps, but also of the specialists' holistic assessments of the state of the riverine ecosystem, and of their experience and knowledge of the system.

**Table 5.2 Definitions of generic PES categories**

| Category | DESCRIPTION |
|---|---|
| A | Natural;<br>! The resource base has not been decreased;<br>! The resource capability has not been exploited |
| B | Largely natural with few modification;<br>! The resource base has been decreased to a small extent;<br>! A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged. |
| C | Moderately modified;<br>! The resource base has been decreased to a moderate extent;<br>! A change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged. |
| D | Largely modified;<br>! The resource base has been decreased to a large extent;<br>! Large changes in natural habitat, biota and basic ecosystem functions have occurred. |
| E | Seriously modified;<br>! The resource base has been seriously decreased and regularly exceeds the resource base;<br>! The loss of natural habitat, biota and basic ecosystem functions is extensive. |
| F | Critically modified;<br>! The resource base has been critically decreased and permanently exceeds the resource base;<br>! Modifications have reached a critical level and the resource has been modified completely with an almost total loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. |

‘ **3. Is it still changing, if so, how, and how fast? (Trajectory of Change)**

The Trajectory of Change describes how fast the changes (as a result of the causes & sources described in 3) are taking place. The trajectory can be stable, negative or positive. The trajectory is described for each of the components for which a PES is determined, and from this information it is therefore possible to derive whether the PES evaluation reflects a stable state, or whether it is still changing under present conditions. The Trajectory of Change evaluation is provided as ‘0' for stable, ‘+’ for improving, and ‘-‘ for degrading.

The Trajectory of Change describes the current trend of changes in the river in present conditions. The changes can happen at different rates, which are reflected by short term and long term changes. The results of the ‘do nothing’ scenario are presented by illustrating the Category in which the river would be in the short term (less than 5 years) and the long term (more than 20 years). This information is derived from the Trajectory of Change. The short and long term changes are provided for each resource unit of the river for which an ERC will be generated and for each component for which a PES was determined.

‘ **4. What caused the changes and what are the sources of the causes?**

The impacts on the river are listed and separated into flow-related and non-flow related activities and are referred to as causes. Proximal causes observed in the system due to changes in water quality, flow and external factors are for example higher salinity, sedimentation, loss of indigenous riparian plants, flow reduction, low abundance of indigenous fish, etc.

Certain causes may be related to changes in flow, for example a decrease in fish population. Loss of indigenous riparian vegetation could, however, be caused by catchment related activities such as deforestation for purposes of collecting fire wood. The determination of whether the causes are flow or non-flow related is important as this influences the decision of whether mitigation solely by flow manipulation is possible and appropriate, or whether source-directed measures are necessary. For example: Flow reduction due to abstraction for irrigation could be mitigated by flow measures; loss of indigenous riparian vegetation due to overgrazing could not be mitigated by flow manipulation; water quality problems due to sewage treatment works could be mitigated by increasing flows for dilution, but it would not be appropriate to recommend Reserve flows for this purpose.

Best judgement of the activities which have been responsible for the changes from the reference state to the PES, such as: overgrazing, irrigation, mining effluent, sewage treatment works, etc is used.

‘ **5. Determine the Ecological Importance and Sensitivity (EIS) and Socio-cultural Importance (SI)**

EIS : The ecological importance of a river is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system’s ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (DWAF, 1999 - Volume 3).

SI : Specific methods to determine social importance have not yet been determined. During the IERM, a simple set of questions is asked to determine the dependancy of people on a healthy functioning river and also to assess the cultural and tourism potential. This provides some measure of the importance with low confidence.

Considering Social Importance, within the context of Ecological Importance and Sensitivity:

The underlying assumptions in the process are the following:
- If the EIS is High or Very High, the ERC should be an improvement of the PES.
- If the EIS is Low or Moderate, the SI is also considered, and if also Moderate or Low, the ERC should be a Category that equals the PES.
- If the EIS is Low or Moderate, but the SI is High or Very High, the ERC should be an improvement of the PES.

‘ **6. Considering the EIS, SI and PES, determine the ecological aims for the river.**

If the ecological importance or social importance are high or very high, the ecological aims should be to improve the river. However, the PES should also be considered to determine whether improvement is realistic. If the EIS and SI evaluation is moderate or low, the ecological aims should be to maintain the river in its PES.

‘ **7. If the sources are addressed, what needs to be done to achieve the aim.**

The recommended ERC must be attainable and it must therefore be considered whether the problems in the catchment can be addressed to ensure that the ecological aims are achieved. The specialists decide to the best of their ability what would have to be done to address the causes of degradation, how effective such remedial actions might be, and how difficult they might be to achieve (for example, if a major supply dam had to be demolished to improve the river, this would be classed as ‘very difficult’) (O’Keeffe & Louw, 1999). It is acknowledged that this process is subjective and that evaluations are undertaken on technical possibilities by ecological specialists.

‘ **8. Considering the difficulty of addressing the source of critical causes.**

In general it can be accepted that if the PES is in a C or D category or lower and the importance is High or Very High, more effort would be required to attain an ERC which is an improvement on the PES. However, the kind of change(s) that resulted in a particular PES may vary in terms of the possibility of reducing their impact in order to achieve restoration of the system. It follows that each of the attributes will have to be assessed in terms of the perceived possibility of restoring them to a condition where such an improvement will lead to an improvement of the PES (DWAF, 1999 - Volume 8). Some changes may be practically irreversible within the limits of time and effort (including financial resources) required to achieve this. While five years is a commonly used time frame for many institutions and is considered a realistic period for attempting to estimate future conditions (Gonzalez, 1996), it is difficult to put limits to what can be regarded as realistic efforts.

' **9. Recommend attainable ERC.**

The role of the technical recommendations made by the specialists must be emphasized. These are technical recommendations concerning what is possible and what is considered to be the most realistic option, taking account of all the factors at this stage.

The long term ERC recommended, ***indicates the ERC which is the end target for the river***. This ERC, even though considered attainable, might only be achieved in the long term, due to the present constraints in the system. Several causes of change are landscape-based, and even immediate improvements in management practice would not show immediate improvements in river condition. This means that in the short term, an intermediate, short term ERC might need to be achieved first, and that ongoing efforts to achieve improvement of the system would be required to achieve the long term ERC. This will require a long term catchment strategy. However, since one of the aims of the NWA is to protect the water resource for future generations, the long term ERC is the ERC recommended by the ecological specialists.

The PES and the difficulty of addressing the sources are assessed. As the ERC must be realistic and attainable, even if only in the long term, an assessment must now be made whether the aims (i.e. improvement or maintenance) can be met (see 6 above). For each component, an ERC is set on this basis and then the component ERCs are integrated into one value, i.e. the Ecostatus ERC and if necessary, a long term ERC. The integration process is the same as followed when determining the PES for the ecostatus.

## 5.4 DEFINING THE ERCs

This process is intended to provide detailed criteria for each ERC for which an Ecological Reserve will be determined. Each specialist should define the following:

- The ERC (as described above)
- General flow criteria. For example, maintenance of perennial flow; early wet season high flows; the ratio of wet to dry season base flows; an annual bankfull flow; etc, according to the importance of different flows for the particular component.
- General criteria for the particular component. For example, invertebrate SASS scores greater than 120 for wet seasons except during droughts; removal of silt and sand from riffle areas during the wet season; maintenance of a target number of fish species, and increased abundance of flow dependent fish species; etc.
- Identification of target species/variables: Each specialist will select one or a few key flow-dependent indicators on which to concentrate the assessment of flow requirements. There is no limit to the number of species/groups/components which can be accommodated, if the specialist understands their flow requirements and considers that each will contribute to the overall assessment of flow requirements. Written reasons and justification for the choice of the target indicators selected

above must be provided

- Objectives for target organisms: For example, reduced salinity to below 100 mS/m for more than 90% of the time; habitat maintenance for *Chiloglanis anoterus* (rock catlet) in terms of velocities, depths and substrate type; seeding of critical flow dependent riparian trees.

NOTE : The above must be related to the individual indices which describe the different categories.

This "objectives hierarchy" is intended to convert the general criteria of the ERC to specific measurable objectives, for which particular flow regimes can be designed, and which will form the basis of monitoring activities. For these reasons, it is important that the detailed criteria (at the component and target species level), should be quantified as far as possible. This information will then form the basis of the Resource Quality Objectives