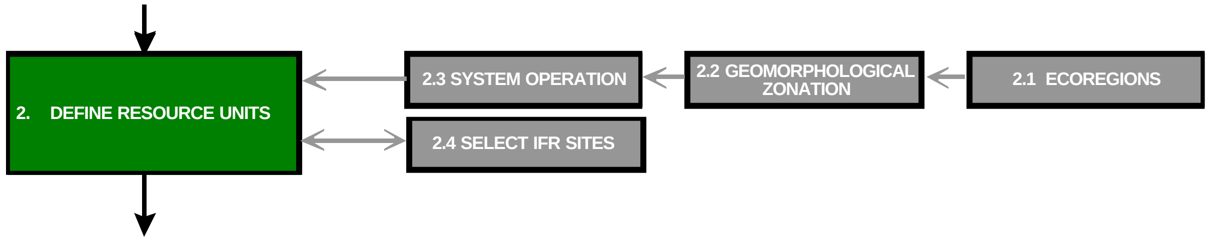
# 4. DETERMINING RESOURCE UNITS *(2)*




**Resources required to define resource units**[1]

DWAF RDM personnel
DWAF region
IFR coordinator
Fluvial Geomorphologist (IERM & CERM)
Habitat integrity specialist (IERM & CERM)
IFR site selection : IERM : IFR coordinator, and hydraulician
CERM : Full suite of specialists

**Approximate time required**[2]

| | |
|---|---|
| Collation and reporting | RERM III : 0.5 day; IERM : 1 day; CERM : 2 days |
| Geomorphological reach analysis (zone level) | IERM : 2 days; CERM : 3 days |
| IFR site selection | IERM : 4 days[3]; CERM : 6 days |

## 4.1 APPROACH

If an Ecological Reserve determination is required, say for a whole catchment, it is necessary to break down the whole catchment into Resource Units which are each significantly different to warrant their own specification of the Reserve, and to clearly delineate the geographic boundaries of each. (DWAF 99, vol 3)

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1 The resources required and time required are ESTIMATES only. It can differ significantly depending the size of the study area, the complexity of the study area, accessibility etc.

2 Time is associated with the size of the study area. For the purpose of this document the RERM III addresses a 50 km stretch of river with 1 IFR site; the IERM addresses a 100 km stretch of river with 2 IFR sites; the CERM addresses a 200 km stretch of river with 4 IFR sites.

3 Days refer to total time, not man days. For example, 4 days to under take IFR site selection would be 4 days in total for each of the 3 specialists involved.

The reason for this is because, for example, it would not be appropriate to set the same numerical Reserve for the headwaters of a river as for the lowland reaches; these sections of a river frequently have different natural flow patterns, react differently to stress according to their sensitivity, and require individual specifications of the Reserve appropriate for that reach.

The breakdown of a catchment into Resource Units for the purpose of determining the Reserve for rivers is done primarily on a biophysical basis, according to the occurrence of different ecological regions (ecoregions (Appendix 1)) within the catchment. Since the endpoint of a Reserve determination is an ecological one, the idea is to break down the catchment into units which are relatively homogenous on an ecological basis, to ensure the Reserve is set in appropriate terms. (DWAF 99, vol 3)

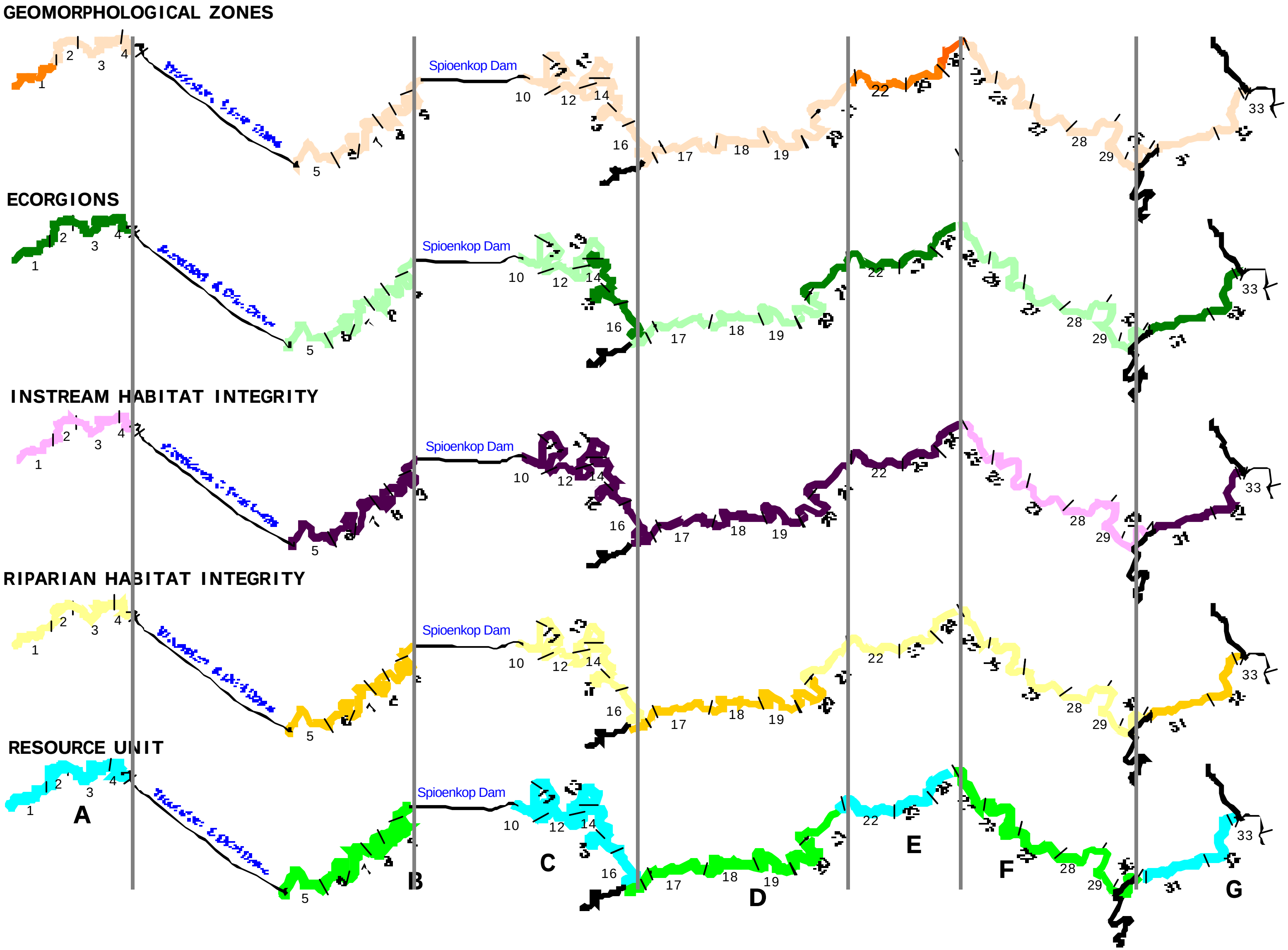
The breakdown into Resource Units via ecoregions and/or geohydrological response units could then be further resolved into smaller Resource Units which are more suited to management requirements. (DWAF 99, vol 3) An example could be where large dams and/or transfer schemes occur. The difference in operation of different river reaches also result in biophysically different river reaches and should be considered.

The process considers all of the above issues, as well as the results of the Habitat Integrity (an evaluation of river sectors according to instream and riparian Habitat Integrity (Appendix R4 and R5). Overlaying all the data does not necessarily result in a logical and clear delineation and expert judgement, a consultative process and local knowledge are required to finally determine the Resource Units. The practicalities of dealing with numerous reaches within one study must also be considered to determine a logical and practical suite of Resource Units. An example of such an overlay is illustrated in Figure 4.2.

The Reserve is determined for each Resource Unit by means of either the following:

- An IFR site is selected within the Resource Unit representing a critical site with the relevant river section. Results generated for the Resource Unit at the IFR site will then be relevant for the Resource Unit as a whole.
- No IFR site is selected within the Resource Unit and results from adjacent Resource Units with IFR sites are extrapolated to this Resource Unit. The reasons for an IFR site not being selected within the Resource Unit can be the following:
  - The characteristics of the river within the Resource Unit do not meet the criteria of IFR sites.
  - Due to the amount of Resource Units within the study area, it would not be practical and/or cost-effective to address IFR sites within each Resource Unit.

**Fig 4.1 Illustration of the overlay issues to be considered in the Upper Thukela prior to selecting the Resource Unit**



## 4.2 ECOREGIONS *(2.1)* (AppendixA)

The ecoregion typing approach developed in the USA (Omernik, 1987) was applied and tested at a preliminary level in South Africa. Ecoregional classification or typing will allow the grouping of rivers according to similarities based on a top-down approach. The purpose of this approach is to simplify and contextualise assessments and statements on ecological water requirements. One of the advantages of such a system is the extrapolation of information from data rich rivers to data poor rivers within the same hierarchical typing context.

The principles and fundamentals of the approach entail the following:

- Ecoregions can be identified or typed according to various levels of detail. The principle of river typing is that rivers or river reaches grouped together at a particular level of the typing hierarchy will be more similar to one another than to rivers in other groups.
- An ecosystems approach recognizes that ecosystem components do not function as independent systems but that they exist only in association with one another.
- Ecosystems and their components display regional patterns that are reflected in spatially variable combinations of causal factors such as climate, mineral availability (soils and geology), vegetation and physiography. These factors interact, but the importance of each factor in determining the character of ecosystems varies from place to place.
- Omernik's (1987) approach is based on patterns of terrestrial characteristics and on the premise that relatively homogenous areas exist and that these areas can be defined by simultaneously analysing a combination of causal and integrative factors. In this approach, ecoregions are regions of relative homogeneity in ecological characteristics or in relationships between organisms and their environments.
- Ecoregional classification uses multiple characteristics at each level of a typing hierarchy. Ecological regions are then regions within which there is relative similarity in the mosaic of ecosystems and ecosystem components (biotic and abiotic, aquatic and terrestrial).
- The delineation of ecological regions requires evaluating maps of all geographic phenomena believed to cause or reflect spatial differences in ecosystems. Where combinations of these phenomena coincide spatially, the ecosystems are likely to be similar. The process requires qualitative examination to account for the differences in generality, accuracy, and particular classifications of each map. The regions are essentially sketched (Omernik, 1995; Omernik pers. comm., 1998), using expert judgement to delineate boundaries.
- Ecoregional classification is a hierarchical procedure that involves the delineation of ecoregions with a progressive increase in detail at each higher level of the hierarchy, i.e. essentially the same characteristics are used at the various levels but with more detail as one moves to a higher level in the hierarchy. In addition, the characteristics that are more or less important can vary from one place to another.

The current effort used available information to delineate ecoregion boundaries at a very broad scale (i.e. Level I) for South Africa. Attributes such as physiography, climate, rainfall, geology and potential natural vegetation were evaluated in this process and 18

Level I ecoregions were identified. The next Level (II) used the same attributes but in more detail. Physiography can for example, be looked at in more detail by considering terrain morphological classes, slopes, relief, altitude, etc.

At this stage it seems evident that typing up to Level II will be required in order to link the ecoregion typing to the stream channel through stream classification. Stream classification is a separate hierarchy and includes geomorphological classification according to zones, segments and reaches. It is likely that the geomorphological segment level will provide information that can be linked to biological segments (i.e. fish, invertebrate and riparian vegetation segments) that can form a basis for the assessment and estimation of ecological reserve requirements.

## 4.3 STREAM CLASSIFICATION *(2.2)* (Appendix R2)

The physical structure of a river ecosystem is determined by the geomorphological processes which shape the channel. They determine the material from which the channel is formed, the shape of the channel and the stability of the bed and banks. The channel geomorphology in turn determines the substrate conditions for the stream fauna and flora and the hydraulic conditions for any given flow discharge. Geomorphology therefore provides an appropriate basis of classification for the purpose of describing the physical habitat of riparian and aquatic ecosystems. In addition, while rivers are resilient to temporary flow reductions (such as droughts) and to water quality problems, often recovering in a matter of months, structural changes to the river channel due, for example, to damage to the riparian zone, to sediment inputs from catchment erosion or to reservoir induced changes in the flow regime, often cause long term irreversible effects (O`Keeffe, 2000; Kochel, 1988).

Geomorphological features are the result of the interaction of processes which operate over a range of time and space scales. In common with many natural phenomena, they do not fall into discreet classes, but rather form a continuum in both time and space. Rowntree and Wadeson (1999) have developed a hierarchical classification system which is based on a combination of desk top and field approaches and aims to provide a scale-based framework linking the various components of the river system, ranging from the catchment to the instream habitat. The system consists of six levels: the catchment, the segment, the zone, the reach, the morphological unit, the hydraulic biotope. These levels are defined in Table 4.1. Catchment, segment and zone classifications are derived from desk-top studies using available secondary data sources. Classification to zone are normally undertaken during the RERM III (if time allows) and the IERM, whereas further levels are used during the CERM. Reach, morphological unit and hydraulic biotope classifications are applied to specific sites, based largely on field assessment backed up by reference to large scale maps (normally 1: 50 000) and aerial photographs.

**Table 4.1 Definition of geomorphological classification levels (after Rowntree and Wadeson, 1999)**

| Hierarchical unit | Description | Scale |
|---|---|---|
| Catchment | The catchment is the land surface which contributes water and sediment to any given stream network. | Can be applied to the whole river system, from source to mouth, or to a lower order catchment above a specified point of interest. |
| Segment | A segment is a length of channel along which there is no significant change in the flow discharge or sediment load. | Segment boundaries will tend to be co-incident with major tributary junctions. |
| Longitudinal zone | A zone is a sector of the river long profile which has a distinct valley form and valley slope. | Sectors of the river long profile. |
| Reach | The reach is a length of channel characterised by a particular channel pattern and channel morphology, resulting from a uniform set of local constraints on channel form. | >00s of meters. |
| Morphological Unit | The morphological units are the basic structures recognised by fluvial geomorphologists as comprising the channel morphology and may be either erosional or depositional features. | Morphological units occur at a scale of an order similar to that of the channel width. |
| Hydraulic biotope | Hydraulic biotopes are spatially distinct instream flow environments with characteristic hydraulic attributes. | Hydraulic biotopes occur at a spatial scale of the order of 1 $m^2$ to 100 $m^2$ and are discharge dependent. |

In the Intermediate and Comprehensive determination of the ecological Reserve, geomorphological zones are used to guide the spatial framework for the delineation of water Resource Units, the assessment of habitat integrity, and site selection.

## 4.4 SYSTEM OPERATION *(2.3)*

The following are examples of what should be considered to determine whether the present operation of the system must be considered when delineating Resource Units.

- Virgin and present MAR at various spots in the study area .
- Presence of large dams and the way they are operated.
- Presence of transfer schemes and the way they are operated.
- Presence of large scale irrigation and pump schemes.
- Presence of point sources of pollution.
- River reaches being used as a conduit with resulting unseasonal flow.
- Locality and type of planned developments.

## 4.5 IFR SITE SELECTION *(2.4)*

Details of the IFR site selection are provided in the BBM manual (King et al., 2000) and the RDM manuals (DWAF 99, vol 3). A summary is provided below.

IFRs are determined during an IFR specialist meeting where descriptions of flow in parameters such as depth and water surface level linked to habitat requirements of the various disciplines are stipulated. These parameters, e.g. a 10 cm depth, need to be converted to flow by means of a stage discharge curve for a specific cross-section. **The description of flows in depths therefore takes place at a specific cross-section in the river called an IFR site which should represent a variety of habitats.**

In order to determine the IFRs of a river system, it is necessary to determine the flow requirements at a number of points within the system, i.e. within the Resource Units.

More than one IFR site is usually selected within the system for a number of reasons:

- Tributaries entering the system may introduce different channel, bank and or habitat conditions which may need to be considered separately.
- The PES and Ecological Reserve Category of particular reaches of the river may differ from the rest and may therefore require a specific IFR.
- A river system displays biological diversity along its length, and consequently, a single IFR point is unlikely to adequately reflect this range of diversity.
- Various hydrological stage points are required within the system to cater for the inflows of tributaries and losses down the length of the system.

The more IFR sites selected for which IFRs are determined, the better the chance that all the habitat diversity in the system will be covered and therefore, the higher the confidence in the IFR result for the system as a whole. The decision as to how many sites are chosen is therefore a function of the length and diversity of the river to be assessed, and a trade-off between the need to characterise the river adequately, and the constraints of available time and resources.

The IFRs are set for each of the IFR sites, and it is therefore vital that

- the sites are selected to provide as much information as possible about the variety of conditions in a river reach and so that the specialists that use these sites to set IFRs for their discipline, can relate to the habitat they represent.
- the persons involved in selecting the sites understand and are experienced with the use of sites in IFR studies.

The selection of IFR sites is guided by a number of considerations such as:

- The locality of gauging weirs with good quality hydrological data.
- The locality of the proposed developments.
- The locality and characteristics of tributaries.
- The habitat integrity/conservation status of the different river reaches.
- The reaches where social communities depend on a healthy river ecosystem.
- The suitability of the sites for follow-up monitoring.
- **The habitat diversity for aquatic organisms, marginal and riparian vegetation.**

- **The suitability of the sites for accurate hydraulic modelling throughout the range of possible flows, especially low flows.**
- **Accessibility of the sites.**
- **An area or site that could be critical for ecosystem functioning. This is often a riffle which will stop flowing during periods of low or no flow. Cessation of flow constitutes a break in the functioning of the river. Those biota dependant on this habitat and/or on continuity of flow will be adversely affected. Pools are not considered as critical since they are still able to function as refuge habitats during periods of no flow.**
- The locality of geomorphological reaches and representative reaches within the geomorphological reaches.

Those highlighted in bold are the most important and therefore the overriding criteria.