ECOLOGICAL REFERENCE CONDITION PROJECT:

FIELD-MANUAL

VOLUME 1: GENERAL INFORMATION, CATCHMENT CONDITION, INVERTEBRATES AND WATER CHEMISTRY

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February 2000

For client:
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1. INTRODUCTION

The implementation design phase of the National Aquatic Ecosystem Biomonitoring Programme (NAEBP) was initiated in August 1997. The riverine programme, renamed the River Health Programme (RHP), consists of four portfolios each focusing on different aspects of river health such as communication (including stakeholder and grassroots communication); capacity building; research, development and funding; and training. In addition to these general portfolios, each province of South Africa is represented by a regional "champion" who is responsible for the initiation of biomonitoring within their province. The overall objective of the RHP is to develop the procedures and infrastructures for implementation and ongoing maintenance of biomonitoring on a national scale.

Within the research and development component, attention has focused on establishing a method for the derivation of ecological reference conditions. The need for such a reference condition or established benchmark with which monitoring information can be compared, has been expressed on several occasions by organisations involved in biomonitoring. Reference conditions enable the degree of degradation or deviation from natural conditions to be ascertained. South Africa has a varied climate (and hence hydrological type), geology (and hence water chemistry) and geomorphology (and hence channel type, substratum composition, erosion potential). Variation in these factors, both among and within rivers, together with natural biogeographic differences in the distribution of riverine biota, may potentially lead to biotic differences. Such differences need to be taken into account when implementing a national biomonitoring programme and deriving ecological reference conditions.

The information described in this field-manual and which pertains to the *Ecological Reference Condition Field-data Sheets* and *Rivers Database* (Fowler *et al*. 2000), attempts to consolidate the aspects necessary for the characterisation of a site. Although the focus of the ecological reference condition project is the invertebrates, it is important to take into consideration other factors which will, either influence which river-type the site falls into, or which may affect the invertebrate assemblage. To this purpose, substantial information for the characterisation of a site has been included.

This field-manual is the first in a series of three to be published under the auspices of the RHP, all three of which incorporate aspects developed for the Rivers Database. This volume pertains to the general characterisation of a site, catchment condition and land-use, invertebrates and water chemistry. The field-manual and associated field-data sheets are divided into three sections as follows.

- **Section A:** Site specific information which is assessed during or after the first site visit. It includes:
  - General information
  - Geo-reference
  - Location details
  - Physical characteristics and geomorphology

- Photographic record (Records of initial or any subsequent site visit can be recorded here).

- **Section B:** Site visit information which is assessed during the first site visit and is checked and reassessed on each subsequent site visit. It includes:
  - Catchment and land-use
  - Water quality impacts
  - Channel condition
  - Channel morphology
  - Present status

- **Section C:** site visit information which is assessed during each site visit. It includes:
  - General: site visit information, stream dimensions, substratum composition
  - Invertebrates: biotopes, invertebrates taxa, habitat assessment
  - Water chemistry

Volume two will include information for the assessment of riparian vegetation and volume three for the assessment of fish.

2. SECTION A: SITE INFORMATION (to be filled in before or during initial visit to site)

2.1 GENERAL

Site Code: the following standard has been adopted for naming sites: Secondary catchment code, first four letters of river name, first five letters of location. E.g. X2CROC-VELOR (Crocodile River at Veloren Vallei Nature Reserve, X3MARI-VERSA (Martisane River at Versailles). The site code needs to be a unique entry so if a duplicate site code will result with the standardised naming method, a change to the location code should be made.

River: name of river assessed.

Site Description: details of site location, e.g. farm name, road bridge, village etc.

Site Length: length of river being assessed, recommended length 30-50 m.

Tributary of: parent river , e.g. Marite is a tributary of the Sabie.

Map Reference: either 1: 250 000 or 1: 50 000.

Political Region: one of seven regions.

Bioregion: one of 18 bioregions as identified in Brown *et al.* (1996).

Ecoregion: one of 18 as identified in Kleynhans *et al.* (1998).

Water Quality Management Region: one of seven as identified in Day *et al.* (1998).

Secondary Catchment Code: DWAF secondary drainage region.

Catchment Area: area (km^2) of secondary catchment.

Quartenary Catchment Code: DWAF quartenary drainage region.

Sub-region: based on Rowntree *et al.'s* (1996) geomorphological zonation of river channels (Table 1). Using these descriptions the assessor should allocate a site to a sub-region which may be confirmed by calculating gradient (see below).

River Segment: based on aerial or other surveys wherein the river is divided into 5 km sections.

Lat/Long: GPS (degrees and minutes+seconds) or degree/minutes/seconds co-ordinates of the site (preferably GPS).

Source Distance: distance from source of river estimated from 1: 50 000 map.

Contour Range: altitude range within which site falls estimated off 1:50 000 map.

Stream Order: order estimated of 1: 50 000 map using the Strahler method. Finger tributaries are designated as first order; successively higher orders are formed by the junction of two stream segments of the same order (see Rowntree and Wadeson 1999).

Slope/gradient: calculated: vertical difference between contours (m) divided by horizontal distance between contours, estimated from 1: 50 000 map.

Geological Type: based on Vegter's (1995) simplified lithostratigraphic units.

Vegetation Type: based on Low and Rebelo's (1996) potential natural vegetation of South Africa, Lesotho and Swaziland.

Note: Classification of sites into ecoregions, bioregions, water quality management region, geology and vegetation types is easily done using the appropriate Geographical Information System (GIS) coverages.

Hydrological Type: based on the following types:

- Perennial: flows continuously all year round.
- Seasonal: flows annually at a predictable time of year, but ceases to flow for some time each year.
- Ephemeral: flows periodically every few years.

Note: Hydrological type should be recorded for "natural" conditions and for "present-day" conditions .

Rainfall Region: season in which the majority of rain falls.

DWAF Gauging Station: indicate the presence of a DWAF gauging station and estimate distance upstream or downstream of the site.

Associated System: indicate the presence of important systems that may be associated with the site or river, e.g. wetlands or estuaries.

Table 1. Geomorphological zonation of river channels (after Rowntree *et al.* 1996, Rowntree *et al.* 1998 and Rowntree and Wadeson 1999, with acknowledgement to Harrison and Elsworth 1958, Olif 1960 and Chutter 1967).

Geomorphological Zone	Characteristic Gradient	Diagnostic Channel Characteristics
A. Zonation associated with a 'normal' profile *(and which has a characteristic concave profile)*		
Source zone	not specified	Low gradient, upland plateau or upland basin able to store water. Spongy or peaty hydromorphic soils.
Mountain Headwater Stream	0.1 - 0.7	A very steep gradient stream dominated by vertical flow over bedrock with waterfalls and plunge pools. Normally first or second order. Reach types include bedrock fall and cascades.
Mountain Stream	0.01 - 0.1	Steep gradient stream dominated by bedrock and boulders, locally cobble or coarse gravels in pools. Reach types include cascades, bedrock fall, step-pool, plane bed, pool-rapid or pool riffle. Approximate equal distribution of 'vertical' and 'horizontal' flow components.
Foothills - Cobble Bed	0.005 - 0.01	Moderately steep, cobble-bed or mixed bedrock-cobble bed channel, with plane bed, pool-riffle or pool-rapid reach types. Length of pools and riffles/rapids similar. Narrow floodplain of sand, gravel or cobble often present.
Foothills - Gravel Bed	0.001 - 0.005	Lower gradient mixed bed alluvial channel with sand and gravel dominating the bed, locally may be bedrock controlled. Reach types typically include pool- riffle or pool-rapid, sand bars common in pools. Pools of significantly greater extent than rapids or riffles. Floodplain often present.
Lowland Floodplain or Lowland Sand Bed	0.0001- 0.001	Low gradient alluvial sand bed channel, typically regime reach type. Often confined, but fully developed meandering pattern within a distinct floodplain develops in unconfined reaches where there is an increased silt content in bed or banks.
B. Additional zones associated with a rejuvenated profile *(which exhibits steepening in the downstream segments)*		
Rejuvenated Bedrock Fall / Cascades	0.01 - 0.5	Moderate to steep gradient, often confined channel (gorge) resulting from uplift in the middle to lower reaches of the long profile, limited lateral development of alluvial features, reach types include bedrock fall, cascades and pool-rapid.
Rejuvenated Foothills	0.001 - 0.01	Steepened section within middle reaches of the river caused by uplift, often within or downstream of gorge; characteristics similar to foothills (gravel/cobble bed rivers with pool-riffle/ pool-rapid morphology) but of a higher order. A compound channel is often present with an active channel contained within a macro channel activated only during infrequent flood events. A floodplain may be present between the active and macro-channel.
Upland Floodplain	0.0001- 0.001	An upland low gradient channel, often associated with uplifted plateau areas as occur beneath the eastern escarpment.

Note: Definitions of terms available in Rowntree and Wadeson (1999).

2.2 LOCATION DETAILS

This is a sketch of the site location to enable a new assessor to find it. It therefore needs details such as direction of north, road access to site, road names or codes, bridges/crossings, gauges/instream barriers, buildings, scale and flow direction. The landowners name, contact number, permit and key details, and farm name and registration code should also be recorded.

2.3 GEOMORPHOLOGY AND PHYSICAL CHARACTERISTICS

Definitions:

- *Macro-channel width:* the outer channel of a compound channel. The bank top is well above "normal" flood levels but may be inundated infrequently (e.g. once in 20 years). Flood bench between active and macro-channel banks is usually vegetated. Macro-channel banks may or may not be vegetated.
- *Active channel width:* the area of the channel(s) that has been inundated at sufficiently regular intervals to maintain channel form and to keep the channel free of established terrestrial vegetation.

Valley form or floor: describes the general shape of the river valley. The valley form is classified according to the presence or absence of sedimentary deposits and their relationship to the modern channel (Rowntree and Wadeson 1999). Although some of the valley floor features can be recognised from cartographic maps, field verification is necessary. Common features and additional definitions are given below (from Rowntree and Wadeson 1999). More than one feature may be present.

- *Floodplain*: a relatively level alluvial (sand or gravel) area lying adjacent to the river channel which has been constructed by the present river in its existing regime.
- *Erosional bench*: terrace-like features resulting from active down cutting within a broader macro-channel.
- *Terraces*: relict floodplains which have been raise above the level regularly inundated by flooding due to lowering of the river channel.
- *Valleyside bench:* narrow terrace-like feature formed at the edge of the active channel abutting on to the valley side slope.
- *Pediment*: a low angled hillslope which is formed by surface wash processes.
- *Valley floor absent:* no valley floor.

Lateral mobility or entrenchment: relates to the extent to which the river channel is restricted by the valley side walls or migrates laterally over the valley floor. One of four categories have been identified (Rowntree and Wadeson 1999).

- *Confined:* channel laterally confined by valley side walls.

- *Moderately confined:* channel course determined by macro-scale features, but some lateral migration is possible.
- *Non-confined:* channel free to migrate laterally over the valley floor (associated with floodplain).
- *Entrenched:* active channel confined by steep banks and/or terraces.

Channel form: relates to the presence or absence of a macro-channel. Macro-channels appear to develop as the result of incision by the active channel into former terraces which mark the outer boundary of all but the most extreme flood flows (Rowntree and Wadeson 1999). Two types are identified:

- *Compound* (macro-channel present).
- *Simple* (no macro-channel).

Channel pattern: The simplest classification of channel pattern distinguishes two main groups: single thread and multi-thread. Single thread channels are further subdivided into straight or sinuous and meandering; multi-thread channels can de subdivided into braided, and anastomosing or anabranching (Rowntree and Wadeson 1999). The following descriptions are modified from Rowntree and Wadeson (1999) and Rowntree and Ziervogel (in prep).

- *Single thread: low sinuosity*: single channel, laterally inactive.
- *Single thread: high sinuosity - stable-sinuous*: single channel, moderately, laterally inactive.
- *Single thread: high sinuosity - laterally mobile*: meandering: laterally active, single channel with significant s-bends, sometimes cutting off from the main channel to form ox-bows.
- *Multiple thread: braided (unstable)*: multi-thread channels, laterally active, two or more channels divided by alluvial (sand or gravel) bars or islands with one dominant channel.
- *Multiple thread: anatomosing/anabranching*: multi-thread channels separated by vegetated or otherwise stable alluvial islands or bedrock.

Channel type: river channels can be classified into two broad types: bedrock channels and alluvial channels (Rowntree and Wadeson 1999). Sometimes a mixture of bedrock and alluvial channels occurs. Alluvial channels may be further subdivided depending on the size of their bed material.

- *Bedrock*: bedrock bed
- *Mixed bedrock and alluvial*: mixture of bedrock and either fine (sand) or coarse (gravel) alluvial beds
- *Alluvial with dominant type(s)*: alluvial bed, with dominant bed material(s) of:
    - Sand, gravel, cobble and/or boulder

3. SECTION B. CATCHMENT CONDITION AND LAND-USE (reassessed on each visit to site)

3.1 PHOTOGRAPHIC RECORD

Photographs of the upstream and downstream views need to be taken when the site is first assessed. Bank to bank or specific features (e.g. riffle) may also be photographed. Photographs of subsequent site visits may be included if desired. These photographs will be available for viewing in the Rivers Database.

3.2 CONDITION OF LOCAL CATCHMENT, LAND-USE AND WATER QUALITY CONDITION

Rate extent of or impact of each factor using the following guidelines. Note: the focus is on the area upstream (approximately 5 km) and adjacent to the site, not merely the site.

0 - none: none in vicinity of site, no discernible impact.

1 - limited: limited to a few localities, impact minimal.

2 - moderate: land-use generally present, impact noticeable.

3 - extensive: land-use widespread, impact significant, small areas unaffected.

4 - entire: land-use 100% in area, impact significant.

Indicate using the rating scale the land-use(s) present within and beyond 5 m of the river, the potential impact of each on receiving water quality and/or observed impact(s), whether the impact is a point or non-point source and any comments pertaining to the distance etc.

Note: 1) agriculture has been split to account for crops, livestock and irrigation return-flows

2) Afforestation refers to exotic forests.

3) Impoundment refers to dams but also includes diversion weirs, farm dams, etc.

4) Wilderness area refers to a area with no anthropogenic modification(s) but which is not officially a nature conservation area. No rating for water quality impact is required for this land-use option.

3.3 CHANNEL CONDITION

In-channel and bank modifications

Using the same rating scale as for Section B2, indicate the extent of in-channel and bank modifications affecting the site and estimate the distance upstream or downstream.

Geomorphological indicators: (modified from Rowntree and Ziervogel, in prep.). Using the rating scale below, rate the extent of each of the factors listed below.

0 - none: none in vicinity of site.

1 - limited: limited to a few localities.

2 - moderate: generally present.

3 - extensive: widespread, small areas unaffected.

4 - entire: 100% of area affected.

Erosion: Due to river action

- *Fluvial bank erosion:* erosion due the effect of streamflow, such as undercutting.
- *Sub-aerial erosion:* erosion due to surface processes such as removal of vegetation, livestock, wildlife, surface wash etc.
- *Macro-channel shifting:* channel changing course leaving an abandoned channel (rare).
- *Active-channel shifting:* occurs in alluvial (sand/gravel) meandering rivers where erosion occurs on one side and deposition on the other.

Deposition: Due to river action

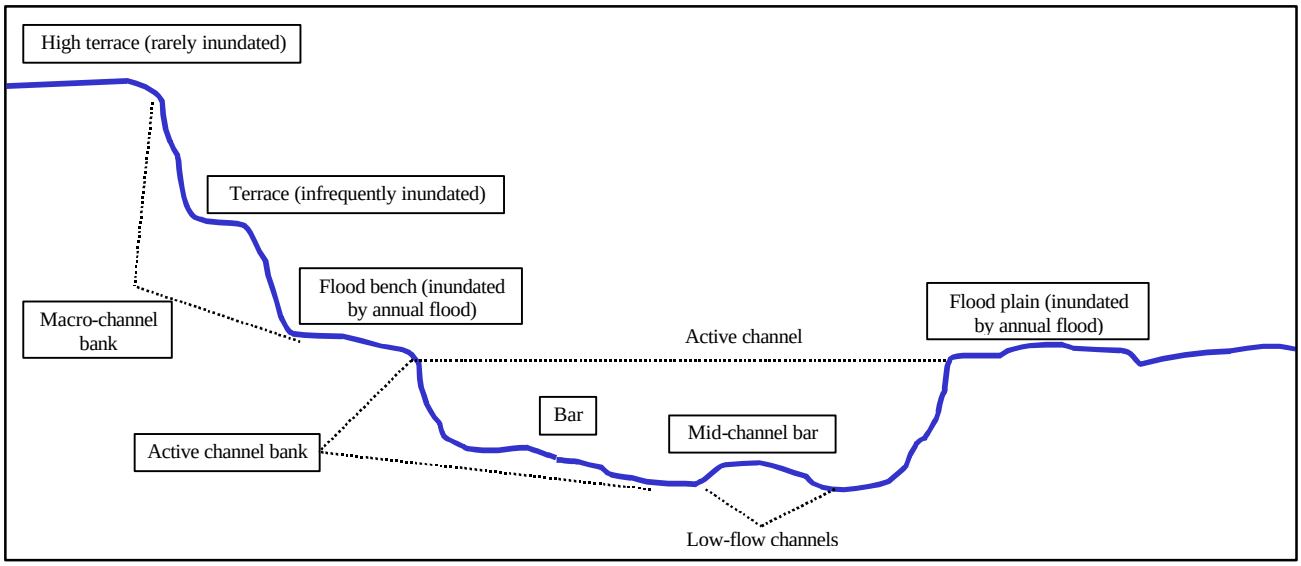
- *Sand or gravel deposits:* deposits of sand or gravel on the riverbed.
- *Silt drapes:* deposits of silt covering bedrock, boulders and cobbles.
- *Silt in pools:* deposits of silt in slower-flowing areas such as pools.
- *Encroaching vegetation:* vegetation stabilising in-channel sediment deposits, e.g. reeds on mid-channel sand bar.

3.4 CHANNEL MORPHOLOGY

The presence of each cross-sectional feature on the left and right-hand banks of the site are indicated. Features are illustrated in the diagram and listed below. Please note some of these features are also recorded in the geomorphology section in Section A, but are repeated here in diagrammatic form to provide additional information.

- *High Terrace (rarely inundated):* relict floodplains which have been raise above the level regularly inundated by flooding due to lowering of the river channel.
- *Macro Channel Bank* : the outer bank of a compound channel. Flood bench between active and macro-channel banks is usually vegetated.
- *Terrace (infrequently inundated):* area raised above the level regularly inundated by flooding.
- *Flood Bench (inundated by annual flood):* area between active and macro-channel, usually vegetated.
- *Active Channel Bank:* the bank of the channel(s) that has been inundated at sufficiently regular intervals to maintain channel form and to keep the channel free of established terrestrial vegetation.

- *Bar:* accumulations of sediment associated with the channel margins or bars forming in meandering rivers where erosion is occurring on the opposite bank to the bar.
- *Mid-Channel Bar:* single bar(s) formed within the middle of the channel; flow on both sides.
- *Flood Plain (inundated by annual flood):* a relatively level alluvial (sand or gravel) area lying adjacent to the river channel which has been constructed by the present river in its existing regime.



3.5 PRESENT STATUS

The term present status refers to the number and severity of anthropogenic perturbations on a river and the damage they potentially inflict on the system. These disturbances include abiotic factors, such as water abstraction, weirs, dams, pollution and dumping of rubble, and biotic factors, such as the presence of alien plants and animals. The method adopted for the establishment of reference conditions is a modified version of Kemper and Kleynhans' (1998) preliminary present status which was developed as one of the procedures to be used for the determination of the preliminary ecological reserve for rivers of South Africa. The emphasis in the present assessment is, however, placed on the field-based site assessment, supplemented, where possible, with information gleaned from other sources such as catchment study reports, GIS coverages, together with local knowledge. It should be noted that any site-based assessment will lack longitudinal continuity and therefore may not adequately reflect the present status of the river.

Aspects considered in the assessment comprise those instream and riparian zone perturbations regarded as primary causes of degradation of a river ecosystem (see section 7.1). The severity of each of these impacts is assessed, using scores as a measure of impact (Table 2).

Table 2. Summary of the scoring procedures used to determine Present Status.

Impact Class	Description	Score
None	No discernible impact, or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Limited	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability is limited.	1 - 5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are fairly limited.	6 - 10
Extensive	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not affected.	11 - 15
Extreme	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16 - 20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21 - 25

3.5.1 Individual criteria

It is a near impossibility to remove all subjectivity involved in making Present Status assessments such as those presented here. Descriptions of each criterion are provided to assist with the assessment.

Criterion 1: Water abstraction

Direct abstraction from within the specified river/river reach as well as upstream (including tributaries) must be considered (excludes indirect abstraction by for example exotic vegetation). The presence of any of the following can be used as an indication of abstraction: cultivated lands, water pumps, canals, pipelines, cities, towns, settlements, mines, impoundments, weirs, industries. Water abstraction has a direct impact on habitat type, abundance and size; is implicated in flow, bed, channel and water quality characteristics; and riparian vegetation may be influenced by a decrease in water quantity.

Criterion 2: Inundation

Destruction of instream habitat (e.g. riffle, rapid) and riparian zone habitat through submerging with water by, for example, construction of an on-channel impoundment such as a dam or weir. Leads to a reduction in habitat available to aquatic fauna and may obstruct movement of aquatic fauna; influences water quality and sediment transport.

Criterion 3: Water quality

The following aspects should be considered; untreated sewage, urban and industrial runoff, agricultural runoff, mining effluent, effects of impoundments. Ranking may be based on direct measurements or indirectly via observation of agricultural activities, human settlements and industrial activities in the area. Water quality is aggravated by a decrease in the volume of water during low or no flow conditions.

Criterion 4: Flow modification

This relates to the consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow such as an increase in duration of low flow season, can have an impact on habitat attributes, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season. Effects of flow regulation of floods and low flows are assessed separately.

Criterion 5: Bed modifications

This is regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.

Criterion 6: Channel modifications

This may be the result of a change in flow which alters channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.

Criterion 7: Presence of exotic aquatic fauna (e.g. fish)

The disturbance of the stream bottom during feeding may influence, for example, the water quality and lead to increased turbidity. Predation on indigenous fish is also a factor. The extent of the effect is dependant upon the species involved and their abundance.

Criterion 8: Presence of exotic macrophytes

Exotic macrophytes may alter habitat by obstruction of flow and may influence water quality. Consider the extent of infestation over instream area by exotic macrophytes, the species involved and its invasive abilities.

Criterion 9: Solid waste disposal

The amount and type of waste present in and on the banks of a river (e.g. litter, building rubble) is an obvious indicator of external influences on stream and a general indication of the misuse and mismanagement of the river.

Criterion 10: Indigenous vegetation removal

This refers to physical removal of indigenous vegetation for farming, firewood and overgrazing. Impairment of the riparian buffer zone which the vegetation forms may lead to movement of sediment and other catchment runoff products (e.g. nutrients) into the river.

Criterion 11: Exotic vegetation encroachment

This excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Encroachment of exotic vegetation leads to changes in the quality and proportion of natural allochthonous organic matter input and diversity of the riparian zone habitat is reduced.

Criterion 12: Bank erosion

A decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or encroachment of exotic vegetation.

3.5.2 Weightings and calculation of instream and riparian status

Once a score has been allocated to an impact, it is moderated by a weighting system, devised by Kleynhans *et al*. (1988) and modified by Kemper and Kleynhans (1998). Assignment of weights is based on the relative threat of the impact to the habitat integrity of the riverine ecosystem. The total score for each impact is equal to the assigned score multiplied by the weight of that impact (Table 3). Flow modifications (indicated with an * in Table 3) have been divided into floods and low flows as specified in Eekhout and Brown (1996).

Based on the relative weights of the criteria, the impacts of each criterion are estimated as follows:
Rating for the criterion /maximum value (25) x the weight (percent). Example: for a criterion which receives a rating of 10 in the assessment, with a weighting of 14, the impact score is calculated as follows:

$$10/25 \times 14 = 5.6$$

The estimated impacts of all criteria calculated in this way are summed, expressed as a percentage and subtracted from 100 to arrive at a present status score for the instream and riparian components, respectively. The present status scores (%) for the instream and riparian zone components are then used to place these two components into a specific preliminary present status class. These classes are indicated in Table 4.

Table 3. Criteria used to assess assessment of instream and riparian status and the weightings accorded them (Kemper and Kleynhans 1998).

Instream Criteria	Wgt	Riparian Zone Criteria	Wgt
Water abstraction (presence of pumps, irrigation, etc.)	14	Water abstraction (presence of pumps, irrigation, etc.)	13
Inundation	10	Inundation	11
Water quality (clarity, odour, presence of macrophytes)	14	Water quality (clarity, odour, presence of macrophytes)	13
Flow modification: Floods*	7	Flow modification: Floods*	6
Flow modification: Low flows*	6	Flow modification: Low flows*	6
Bed modification (bulldozing, etc. of river bed)	13		
Channel modification (e.g. bulldozing of macro-channel, floodplain)	13	Channel modification (e.g. bulldozing of macro-channel, floodplain)	12
Presence of exotic macrophytes	9		
Presence of exotic fauna (e.g. fish)	8		
Solid waste disposal	6		
		Removal of indigenous vegetation	13
		Exotic vegetation encroachment	12
		Bank erosion	14
Total	100	Total	100

Table 4. Preliminary present status classes (From Kleynhans 1996).

Class	Description	Score (% Of Total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place, but the assumption is that ecosystem functioning is essentially unchanged.	80 - 89
C	Moderately modified. A loss of change in natural habitat and biota has occurred, but basic ecosystem functioning appears predominately unchanged.	60 - 79
D	Largely modified. A loss of natural habitat and biota and a reduction in basic ecosystem functioning is assumed to have occurred.	40 - 59
E	Seriously modified. The loss of natural habitat, biota and ecosystem functioning is extensive.	20 - 39
F	Modifications have reached a critical level and there has been an almost complete loss of natural habitat and biota. In the worst cases, the basic ecosystem functioning has been destroyed.	0 - 19

4. SECTION C: FIELD-BASED DATA FOR EACH SAMPLING VISIT

4.1 GENERAL

4.1.1 General Site Visit Information

Specified the date and time of the assessment and record the name of the assessor(s) and organisation.

Water level at time of sampling (modified from Rowntree and Ziervogel, in prep.):

- *Dry:* no water flowing.
- *Isolated pools:* pools that have a trickle of water between them, but no evident flow.
- *Low flow:* water not touching the riparian vegetation.
- *Moderate flow:* water touching riparian vegetation in places.
- *High flow:* water completely into riparian vegetation.
- *Flood:* water above active channel.

Rainfall in last four days: indicate the presence and extent of any rainfall event preceding the sampling visit. Under comments provide some indication of the level of certainty.

Water turbidity: Indicate the "colour" and degree of visibility through water column or of the riverbed (it is more difficult to assess certain factors such as substratum composition if the river is turbid).

- *Clear:* water transparent, riverbed visible.
- *Discoloured:* water clear, but with a definite tinge to it, usually brown, green or cloudy (riverbed still visible.
- *Opaque:* water cloudy, riverbed not visible.
- *Silty:* usually after a rainfall event, when silt loads are elevated.

Vegetation sampling instructions: Describe details specific to sampling the riparian vegetation.

Canopy Cover: Estimate the extent of cover of riparian vegetation over the stream.

- *Open*
- *Partially open*
- *Closed*

Impact on channel flow: Organic debris, either from upstream imported during flood events or local, can impede the flow of water in the river. Rate impacts on a scale of 0 to 3, as follows:

0 - no impact

1 - limited impact

2 - extensive impact

3 - channel blocked

4.1.2 Stream dimensions

Estimate widths, heights and depths for the main stream dimensions including:

- *Macro-channel width:* see Section A, part 2 for definition.
- *Active channel width:* see Section A, part 2 for definition.
- *Water surface width:*width of wetted section of the river from bank to bank at 90^{o} to the direction of flow (i.e. the actual water width).
- *Bank height:* height from surface of water to top of bank. Estimate left and right banks separately.
- *Deep-water physical biotope:* minimum, maximum and average depth of deep-water areas such as pools or runs. The average is a rough estimate. NB. Record the type of biotope e.g. pool, backwater etc.
- *Shallow-water physical biotope:* minimum, maximum and average depth of shallow-water areas such as riffle and rapids. The average is a rough estimate. NB. Record the type of biotope e.g. cobble riffle, bedrock rapid, cascade, etc.

4.1.3 Substratum composition

Estimate the relative percentage cover of the bed and bank by each substratum type present at the site (assess the site length as specified in Section A). Size classes for each substratum type have been modified from the Wentworth grade scale and are given below. Units are in mm.

- Bedrock
- Boulder - $x > 256$
- Cobble - $100 < x < 256$
- Pebble - $16 < x < 100$
- Gravel - $2 < x < 16$ (fine pebble or small gravel of Wentworth)
- Sand - $0.06 < x < 2$
- Silt/mud/clay - $x < 0.06$

Degree of embeddedness: estimate the extent to which boulder/cobble/gravel particles are embedded in the surrounding fine sediments such as small gravel, sand, silt and/or mud.

4.2 INVERTEBRATES

4.2.1 Biotopes present

Biotopes have been grouped into two types, namely SASS biotopes and specific biotopes. They relate to the type of habitat available for habitation by aquatic organisms as well as the hydraulic conditions in some instances. The relative percentage of each SASS biotope at the site, and the relative percentage of each specific biotope within each SASS biotope should be estimated. Details of the biotopes are given below:

SASS biotopes include:

- stones-in-current (SIC)
- stones-out-of-current (SOOC)
- marginal vegetation (at water's edge)
- aquatic vegetation (in-channel, submerged or partially submerged)
- gravel
- sand
- silt/mud/clay

Specific biotopes provide further details of the types of biotope within each SASS biotope. Descriptions of some of these have been extracted from Rowntree and Wadeson (1999).

SIC:

- *Cobble riffle* - occur over coarse alluvial substrates from gravel to cobble; undular standing waves or breaking standing waves.
- *Run* - occur over any substrate e.g. gravel, cobble, boulder; ripple flow but surface of water not broken.
- *Bedrock rapid* - occur over a fixed substrate such as boulder or bedrock; undular standing waves or breaking standing waves.
- *Chute* - typically occur in boulder or bedrock channels where flow is being funneled between macro bed elements; smooth boundary turbulent flow exhibiting flow acceleration.
- *Cascade* - occur over a substrate of boulder or bedrock. Small cascades may occur in cobble where the bed has a stepped structure due to cobble accumulations. Free-falling flow, contact with substrate largely maintained.
- *Waterfall* - associated with bedrock steps, cliff like features or large channel spanning boulders. Face near vertical or overhanging. Free-falling flow, generally separated from substrate.

SOOC:

- *Backwater* - a morphologically defined area along-side but physically separated from the channel, connected to it at its downstream end; barely perceptible or no flow.
- *Slackwater* - an area of no perceptible flow which is hydraulically detached from the main flow but is within the main channel; barely perceptible or no flow.
- *Pool* - has direct hydraulic contact with upstream and downstream water; barely perceptible flow.

Marginal vegetation:

- grasses, reeds, shrubs, palmiet (*Prionium serratum*), sedges, etc. Also includes floating macrophytes such as water hyacinth, parrot's feather, etc. that are adjacent to the river bank.

Aquatic vegetation:

- sedges, *Isolepis*, trailing grasses, etc. Vegetation is in-channel, submerged or partially submerged.

Gravel, sand and silt/mud/clay:

- specify if present in backwater, slackwater and/or in-channel, i.e. in main flowing part of the channel.

4.2.2 SASS4 Assessment

The standard sampling protocol is to be used, except SASS biotopes are to be sampled separately as follows:

- SIC (**SI**): riffle and run, sample for 2 min if all kickable, otherwise for a maximum of 5 min
- SOOC (**SO**): backwater and pool, kick $\mp$ 1 m^2
- Marginal Vegetation (**M**): back and forward sweep - 2 m
- Instream/aquatic vegetation (**A**),
- Gravel, sand and mud (**G**): stir with feet and sweep net over disturbed area for 0.5 minute

For each, tip net contents into tray, remove leaves and twigs, check taxa present on list for the lesser of 15 minutes or 5 minutes since the last taxon was found. Estimate abundances using the following scale:

- 1: 1
- A: 2 - 10
- B: 10 - 100
- C: 100 - 1000
- D: >1000

Collect the invertebrate sample from each biotope in benthic jar and preserve with alcohol (70%). Label jar inside and outside and repeat for other biotopes. It is important to adhere to the time limits specified in the protocol. * indicate that the taxon or the adult life-stage of the taxon (A*) are air-breathers.

4.2.3 Habitat Assessment : Invertebrate habitat assessment system (IHAS)

IHAS attempts to account for the variability in the amount and quality of habitats or biotopes available for habitation by aquatic biota. It is related to SASS4 in that the IHAS scores may be used to adjust the SASS4 scores. This habitat scoring system is based on 100 points and is split into two sections: the habitat sampled and the stream characteristics. The sampling section is further broken down into three sub-sections: stones-in-current, vegetation and other habitat or general. The method is currently under further development and details are given in McMillan (1998).

4.3 WATER CHEMISTRY

4.3.1 General

Instrument positioning: Instruments should be positioned in clearly-flowing points of the river where possible, otherwise location of meter and hydraulic biotope type (e.g. riffle, run, rapid, pool, etc.) should be specified.

Samples collected? Details of the filtering, freezing, preservation and analysis method should be recorded.

Macrophytes and algae: The presence of macrophytes (e.g. water hyacinth, Kariba weed, etc.) and algae should be recorded and their percentage cover estimated. Species details should be recorded if known and an indication given if an algal sample was collected.

4.3.2 Data

Variables measured: It is important to measure the system (temperature, dissolved oxygen, pH) and non-toxic inorganic (conductivity or total dissolved solids, turbidity or total suspended solids) variables. If possible the concentrations of alkalinity, total inorganic nitrogen, total inorganic phosphorus, orthophosphate, ammonia or ammonium should also be measured.

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Appendix A. Reference condition project: Field-data sheets

BIOMONITORING: ECOLOGICAL REFERENCE CONDITION FIELD-DATA SHEETS

Assessor Name(s):	
Organisation:	
Date:	

NB: An explanation of the terminology used in the field-data sheets is given in the associated Ecological Reference Condition Project: Field-manual (Dallas 1999).

SECTION A: SITE INFORMATION (to be filled in before or during initial visit to site)

1. GENERAL SITE INFORMATION

Site Code:		River:				
Site Description:				Site Length (m):		
Tributary of:		Map Reference:				
Political Region:		Bioregion:				
Ecoregion:		Water Quality Region:				
Secondary Catchment Code:		Catchment Area (km^2):				
Quartenary Catchment Code:		River Segment:				
Sub-region:	Source Zone	Mountain Headwater Stream	Mountain Stream	Foothill-Cobble Bed	Foothill - Gravel Bed	Lowland Floodplain
	Rejuvenated Cascades (Gorge)	Rejuvenated Foothill	Upland Floodplain	Other:		
Lat: S ____ º ____ ' ____ "				Long: E ____ º ____ ' ____ "		
Source Distance (km):		Contour Range (m): From: ____ to: ____				
Stream Order:		Slope/gradient:				
Geological Type:						
Vegetation Type:						
Rainfall Region:	Summer	Winter	Aseasonal	Other:		
Hydrological Type: "natural"	Perennial	Seasonal	Ephemeral	Other:		
Hydrological Type: "present-day"	Perennial	Seasonal	Ephemeral	Other:		
Comment:						
DWAF Gauging Station:	Yes	No	Code:	Distance Upstream:		Or Downstream:
Associated Systems:	Wetland	Estuary	Other:			Distance:
Additional Comments:						

2. LOCATION DETAILS

Sketch a **map** of the site showing the following details: scale, north, access to site, roads, bridges/crossings, gauges/ instream barriers, buildings, flow direction. **Record the following:**

Location and Landowner Detail:				Contact No.:		
				Notify Owner?	yes	no
Permit Required?	yes	no	Details:			
Key Needed?	yes	no	Details:			
Farm Name:			Farm Reg. Code:			
Comments:						

3. GEOMORPHOLOGY AND PHYSICAL CHARACTERISTICS

Tick presence of the following features					
Valley form	Floodplain	Erosional bench	Terrace		
	Valley side bench	Pediment	Valley floor absent		
Lateral mobility or entrenchment	Confined	Moderately confined	Non-confined	Entrenched	
Channel form	Compound (macro-channel present)	Simple (no macro-channel)			
Channel pattern	Single thread: low sinuosity	Single thread: high sinuosity - stable-sinuous	Single thread: high sinuosity - laterally mobile		
	Multiple thread: braided (unstable)	Multiple thread: anatomosing/anabranching			
Channel type	Bedrock	Mixed bedrock and alluvial			
	Alluvial with dominant type(s)	sand	gravel	cobble	boulder

SECTION B. CATCHMENT CONDITION AND LAND-USE (to be checked on each visit to site)

Assessor Name(s):	
Organisation:	
Date:	

1. PHOTOGRAPHIC RECORD

		Spool No.	Photo No.	Comments
Photographs	Upstream			
	Downstream			
	Bank to bank			
	Specific features			

2. CONDITION OF LOCAL CATCHMENT, LAND-USE AND WATER QUALITY CONDITION

Rate extent (land-use) or impact (water quality) on a scale of 0 to 4: 0 – none; 1 – limited; 2 – moderate; 3 – extensive; 4 - entire

Land-use	Within 5 m of river	Beyond 5 m of river	Potential impact on receiving water quality	Indicate if:		Comments (e.g. distance upstream)
				Point Source	Non-point Source	
Afforestation - general						
Afforestation - felled area						
Agriculture - crops						
Agriculture - livestock						
Agriculture - irrigation return flow						
Aquaculture						
Construction						
Impoundment (incl. weirs, farm dams etc.)						
Industrial Development						
Litter/Debris						
Nature Conservation			N/A	N/A	N/A	
Recreational						
Rural Development						
Sewage Treatment Works						
Urban Development						
Wilderness Area			N/A	N/A	N/A	
Wildlife						
Other:						

3. CHANNEL CONDITION

In-channel and bank modifications

Rate impacts on a scale of 0 to 4: 0 – none; 1 – limited; 2 – moderate; 3 – extensive; 4 - entire

In-channel and bank modifications	**Upstream**		**Downstream**	
	Impact score	**Distance**	**Impact score**	**Distance**
Bridge (regular)				
Bulldozing				
Canalisation				
Causeways / low-flow bridges				
Fences				
Gabions				
Gravel, cobble and/or sand extraction				
Reinforced bank				
Roads				
Water Storage Facility-large (e.g. major dam)				
Water Storage Facility-small (e.g. farm dam)				
Weirs (e.g. diversion weir)				
Other:				
Comments:				

Geomorphological indicators

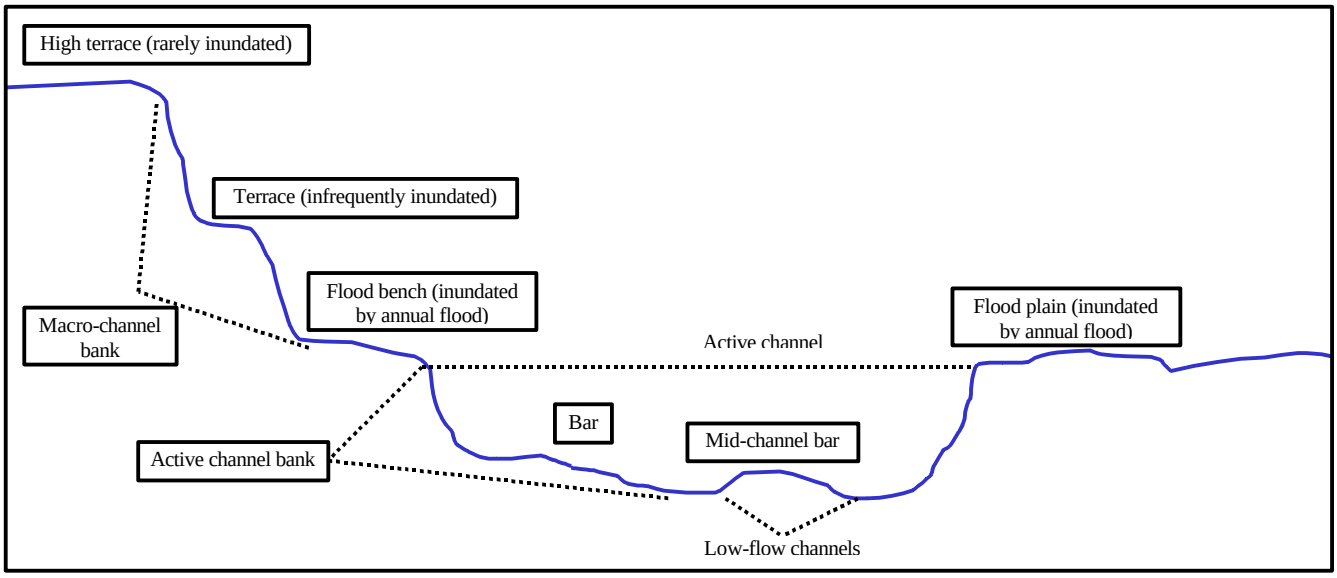
Rate impacts on a scale of 0 to 4: 0 – none; 1 – limited; 2 – moderate; 3 – extensive; 4 - entire

Geomorphological indicators (Explanation of terms in manual)			
Erosion: Due to river action		**Deposition: Due to river action**	
Fluvial bank erosion		Sand/gravel bars	
Sub-aerial erosion		Silt drapes	
Macro-channel shifting		Silt in pools	
Active-channel shifting		Encroaching vegetation	
Comments:			

4. CHANNEL MORPHOLOGY

Indicate the cross-sectional features present on the left and/or right banks (see diagram below)

Cross Sectional Feature	Left Bank	Right Bank
High terrace (rarely inundated)		
Macro Channel Bank		
Terrace (infreq inundated)		
Flood Bench (inundated by annual flood)		
Active Channel Bank		
Bar		
Mid-Channel Bar		
Flood plain (inundated by annual flood)		



5. PRESENT STATUS

Rate impacts on a scale of 0 to 25: 0 - none, 1 to 5 - limited, 6 to 10 - moderate, 11 to 15 - extensive, 16 to 20 - extreme, 21 to 25 - critical (see manual for explanation). As a general rule those criteria marked with an asterisk are to be assessed at the site. All others are to be assessed on a regional basis, i.e. 5km upstream.

CRITERION	Score	Comment
INSTREAM		
Water abstraction (presence of pumps, irrigation etc.)		
Extent of inundation*		
Water quality (clarity, odour, presence of macrophytes etc.)		
Flow modifications: A: Floods		
Flow modifications: B: Low flows		
Bed modification (bulldozing of bed)*		
Channel modification (e.g. bulldozing of macro-channel/floodplain)*		
Presence of exotic macrophytes (Species?)*		
Presence of exotic fauna (e.g. fish)		
Presence of solid waste / solid waste disposal*		
RIPARIAN ZONE		
Removal of indigenous vegetation from the riparian zone*		
Exotic vegetation encroachment (Species?)*		
Bank erosion*		

SECTION C: FIELD-BASED DATA FOR EACH SAMPLING VISIT

GENERAL

1. GENERAL SITE VISIT INFORMATION

Assessor Name(s):	
Organisation:	
Date:	
Time:	

Water level at time of sampling (tick appropriate category)

Dry	Isolated pools	Low flow	Moderate flow	High flow	Flood

Rainfall in the last 4 days ?

Yes	No	Comment:

Water turbidity (tick appropriate category)

Clear	Discoloured	Opaque	Silty	Comment:

Vegetation sampling instructions:

Canopy Cover (tick appropriate category)

Open	Partially Open	Closed	Comment:

Impact on channel flow

Rate impacts on a scale of 0 to 3: 0 – no impact; 1- limited impact; 2 – extensive impact; 3 – channel blocked

	Score	**Source: local / upstream**
Coarse woody debris		
Other:		

2. STREAM DIMENSIONS (estimate widths, heights and depths)

	(m)	**Comments**
Macro-channel width		
Active-channel width		
Water surface width		
Bank Height	**LB:**	**RB:**

		Depth (m)	**Comments (specify physical biotope type)**
Deep-water physical biotope (e.g. pool)	Average		
	Minimum		
	Maximum		
Shallow-water physical biotope (e.g. riffle)	Average		
	Minimum		
	Maximum		

3. SUBSTRATUM COMPOSITION

Material	**% Cover Bed**	**% Cover Bank**	**Riparian**
Bedrock			
Boulder			
Cobble			
Pebble			
Gravel			
Sand			
Silt / mud / clay			
Soil (Riparian only)			
TOTAL % =	**100**		**100**

Degree of embeddedness of substratum (%)	0-25	26-50	51-75	76-100

INVERTEBRATES

4. BIOTOPES PRESENT (tick appropriate combinations and estimate relative percentages for each SASS biotope).
Note the percentages for each specific biotope should equal 100%.

		Specific Biotope (% of general)								**Total = 100%**
SASS Biotope	**%**		**%**		**%**		**%**		**%**	
SIC		Cobble riffle		Run		Bedrock Rapid		Chute		
		Cascade		Waterfall		Other				
SOOC		Backwater		Slackwater		Pool		Other		
Mg. Veg		Grasses		Reeds		Shrubs		Palmiet		
		Sedges		Other						
Aq. Veg		Sedges		*Isolepis*		Other				
Gravel		Backwater		Slackwater		In channel				
Sand		Backwater		Slackwater		In channel				
Silt/mud/clay		Backwater		Slackwater		In channel				
TOTAL	**100**									

5. SASS4 ASSESSMENT

Protocol: Sample each of the following SASS biotopes separately

- SIC (SI): riffle and run, sample for 2 min if all kickable, otherwise for a maximum of 5 min
- SOOC (SO): backwater and pool, kick +/- 1 m^2
- Marginal Vegetation (M): back and forward sweep 2 m
- Instream/aquatic vegetation (A),
- Gravel, sand and mud (G): stir with feet and sweep net over disturbed area for 0.5 minute

For each, tip net contents into tray, remove leaves and twigs, check taxa present on list for the lesser of 15 minutes or 5 minutes since the last taxon was found. Estimate abundances on scale: 1:1; A: 2 to 10; B: 10 to 100; C: 100 to 1000; D: >1000. Collect sample in benthic jar and preserve with 70% alcohol. Repeat for other biotopes. NB Adhere to time limits

TAXON	SI	SO	M	A	G
Porifera-sponges					
Coelenterata					
Hydrozoa-Hydra sp.					
Turbellaria					
Planariidae-Planaria					
Annelida					
Oligochaeta					
Hirudinea					
Crustacea					
Amphipoda					
Brachyura (Decapoda - crabs)*					
Natantia-shrimps					
Arachnida					
Hydrachnellae					
Plecoptera					
Notonemouridae					
Perlidae					
Ephemeroptera					
Polymitarcyidae					
Ephemeridae					
Baetidae-1 type					
Baetidae-2 types					
Baetidae-3 or >types					
Oligoneuridae					
Heptageniidae					
Leptophlebiidae					
Ephemerellidae					
Tricorythidae					
Prosopistomatidae					
Caenidae					
Odonata					
Chlorolestidae					
Lestidae					
Protoneuridae					
Platycnemidae					
Coenagrionidae					
Calopterygidae					
Chlorocyphidae					
Libellulidae					
Gomphidae					
Aeshnidae					
Corduliidae					
Zygoptera juvs.					
Hemiptera					
Notonectidae*					
Pleidae*					
Naucoridae*					
Nepidae*					
Belastomatidae*					
Corixidae*					
Gerridae*					
Veliidae					
Megaloptera					
Corydalidae					
Trichoptera					
Cased caddis-1 type					
Cased caddis-2 types					
Cased caddis-3 types					
Cased caddis-4 types					
Cased caddis-5 types					
Cased caddis>5 types					
Philopotamidae					
Polycentropodidae					
Psychomyiidae					
Ecnomidae					
Hydroptilidae					
Hydropsychidae:					
1 type					
2 types					
3 or more types					
Lepidoptera					
Pyraustidae					
Coleoptera (A*=adult)					
Dytiscidae (A*)					
Elmidae/Dryopidae (A*)					
Gyrinidae (A*)					
Haliplidae (A*)					
Helodidae					
Hydraenidae (A*)					
Hydrophilidae (A*)					
Limnichidae					
Psephenidae					
Diptera					
Blephariceridae					
Tipulidae					
Psychodidae					
Culicidae*					
Dixidae*					
Simuliidae					
Chironomidae					
Ceratopogonidae					
Tabanidae					
Syrphidae*					
Athericidae					
Empididae					
Ephydridae					
Muscidae					
Gastropoda					
Lymnaeidae*					
Melaniidae*					
Planorbidae*					
Physidae*					
Ancylidae					
Hydrobiidae*					
Pelecypoda					
Sphaeriidae					
Unionidae					

Comments:

6. HABITAT ASSESSMENT: INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

SAMPLING HABITAT **Boxes score:**	**0**	**1**	**2**	**3**	**4**	**5**
Stones-in-current (SIC)						
Total length (m) of broken water (riffles or rapids)	none	0-1	>1-2	>2-3	>3-5	>5
Total length (m) of submerged stones in current (run)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC areas kicked	0	1	2-3	4-5	6+	
Average size (cm) of stones kicked (gravel <2, bedrock >20)	none	<2, >20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, silt etc)*	n/a	0-25	26-50	51-75	>75	
Protocol: time (mins) spent actually kicking SIC (grvl/bedr=0)	0	<1	>1-2	2	>2-3	>3
SIC Scores: (A= SIC boxes total; B=adjustment to equal 20; C= final total) **Note: up to 25% of stone is usually embedded in stream bottom.*	*actual*	**A**	*adj.*	**B**	*max. 20*	**C**
Vegetation						
Length (m) of fringing vegetation sampled (banks)	none	0-½	>½1	>1-2	2	>2
Amount (m^2) of aquatic vegetation / algae sampled	none	0-½	>½1	>1		
Fringing vegetation sampled in: (none; pool or still only; run only; mixture of both)	none		run	pool		mix
Type of veg (% leafy vegetation vs stems/shoots) (aqv only =49)	none	0	1-25	26-50	51-75	>75
Veg Scores: (D= Veg boxes total; E=adjustment to equal 15; F= final total)	*actual*	**D**	*adj.*	**E**	***max. 15***	**F**
Other Habitat						
Stones-out-of-current (SOOC) sampled: (protocol = 1 m^2)	none	0- ½	>½1	1	>1	
Sand sampled: (protocol = 1 min) (present, but only below stones)	none	below	0-½	>½1	1	>1
Mud sampled: (protocol = ½min) (present, but only below stones)	none	below	0-½	½	>½	
Gravel sampled: (protocol = ½min) (if all, SIC stone size=<2)**	none	0-½	½	>½**		
Bedrock sampled (*all* = no SIC, sand, gravel) (if all, SIC stone size >*20*)**	none	some			All**	
Algae present (1-2m^2=algal bed, rocks=on rocks, isol=isolated clumps	>2m^2	rocks	1-2m^2	<1m^2	Isol.	none
Tray identification (using time as per protocol)		under		Correct		over
Other habitat Scores: (G= O.H/G boxes total; H=adjustment to equal 15; I= final total)	*actual*	**G**	*adj.*	**H**	***max. 20***	**I**
HABITAT TOTALS						
J=Total adjustment (B+E+H); K=Total habitat (C+F+I)			*adj.*	**J**	***max. 55***	**K**
STREAM CHARACTERISTICS						
Physical						
River make-up (pool = pool/dam only; run only; rapid/riffle only; 2mix = 2 types etc.)	pool		run	Rapid/ riffle	2mix	3mix
Average stream width (m)		>10	5-10	<1	1-2	>2-5
Average stream depth (m)	>2	>1-2	1	>½1	½	<½
Approximate stream velocity (slow = <½m/s; fast = >1 m/s)	still	slow	fast	med.		mix
Water colour (disc.= discoloured with visible colour but still clearish)	silty	opaque		disc.		clear
Recent disturbances due to: (constr. = construction)***	flood	fire	Constr.	other		none
Bank/riparian vegetation is: grass=includes reeds; shrubs=includes trees)	none		grass	shrubs		mix
Surrounding impacts: (erosn=erosion/shear bare banks; farm=farmland/settlements)***	erosn.	farm	trees	other		open
Left bank cover (%) (rocks and vegetation; shear = 0%)	0-50	51-80	81-95	>95		
Right bank cover (%) (rocks and vegetation; shear = 0%)	0-50	51-80	81-95	>95		
Stream characteristics total (L=physical boxes final total) *** Note: if more than one option, choose lowest					***max. 50***	**L**
TOTAL IHAS SCORE (K+L)		**%**	**M**			

WATER CHEMISTRY

7. WATER CHEMISTRY

(Instruments should be positioned in the clearly-flowing points of the river when possible, otherwise specify locations and hydraulic biotope type)

Fast flow?	Yes	No	If no, where:	
Water filtered ?	Yes	No	Volume filtered (mℓ):	
Samples collected ?	Yes	No	Date sent for analysis?	
Samples frozen?	Yes	No	Other preservation?	
Name of institution to which samples were sent:				

Variable	**Value**	**Units**	**Comment: (e.g. type of meter)**
pH			
Conductivity			
Turbidity			
Temperature			
Dissolved Oxygen (mg ℓ^{-1})			
Percentage O_2 Saturation			
Other:			

Indicate the presence of:			**% Cover**	**Comments: (species details if known)**
Macrophytes	Yes	No		
Algae	Yes	No		
Algal sample collected?	Yes	No		