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MONITORING RIVER HEALTH INITIATIVE TECHNICAL REPORT
REPORT NUMBER 15

Australia-Wide Assessment of River Health: Victorian AusRivAS Sampling and Processing Manual

Rapid Bioassessment of Victorian Streams (The Approach and Methods of the Environment Protection Authority)

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RAPID BIOASSESSMENT OF VICTORIAN STREAMS: THE APPROACH AND METHODS OF THE ENVIRONMENT PROTECTION AUTHORITY

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Freshwater Sciences

Environment Protection Authority
Government of Victoria

February 1998

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CONTENTS

TABLES

1. Introduction

Biological assessment is a key component of EPA's approach to environmental monitoring as water quality is only one of several factors, including in-stream habitat, riparian condition and hydrology which affect aquatic biota.

Physico-chemical monitoring alone provides only a partial assessment of ecosystem health. Furthermore, adverse water quality conditions may go undetected because measurements have not been taken at the right time or under the right conditions, or the right indicator has not been measured. The effects of such events on the aquatic ecosystem may last long after physico-chemical conditions have returned to normal.

The great value in directly monitoring the biological community is that it responds to all types of disturbances and toxicants, and this response can be assessed from infrequent sampling of the community. The aquatic biological community reflects the net effect of all environmental factors, including impacts and stresses over a period of weeks, months or years, effectively summarising the past history of conditions in the stream.

Biological assessment therefore plays a key role in effective monitoring and reporting on the environmental condition of Victorian waterways, with the macroinvertebrate community as the preferred indicator of ecosystem condition.

2. EPA's approach to biological assessment

In 1984, EPA established a quantitative biological monitoring program for the Yarra River using benthic macroinvertebrate communities as indicators. In subsequent years, this program was extended to three other river basins. The program was reviewed during 1989 by a group with representatives from the then State Water Laboratories (now Water ECOscience), Museum of Victoria and EPA. From this review, a semi-quantitative approach to sampling was adopted (now called *rapid bioassessment*), based on the procedures used by EPA in monitoring the LaTrobe River since 1982. Similar approaches have been developed in the USA (Plafkin *et al*. 1989) and the UK (Wright *et al*. 1984).

The semi-quantitative approach was implemented in 1990 and required one sample to be taken from each of three habitats - benthic (streambed), log and littoral (stream edges, backwaters and around macrophytes) - with the samples sorted live on site for 30 minutes. A recent revision to the sorting method has now placed the emphasis on the number of animals picked from the sample, with the aim being to pick around 200 animals within a maximum of 60 minutes.

A major advantage of this procedure over the previous, intensive approach was that many more sites could be sampled for the same cost. When this new phase of the biological monitoring program began, 55 sites in six catchments were sampled twice yearly for about the same cost as the previous 20 sites had been.

This sampling strategy aims to provide the maximum diversity for the minimum sampling effort. No attempt is made to measure population numbers in anything but a relative way, in contrast to the previous approach in which the repeated sampling at a site enabled a statistical estimate of population density to be made. The clear assumption in this rapid approach is that for monitoring purposes, the information gained from sampling diverse habitats and increasing the likelihood of collecting more species, overcomes the loss of precision in estimating population density when assessing the status of the stream invertebrate community.

The sampling strategy is continually being refined. For example, the log samples within all catchments were found to be far more variable than either the benthic or littoral samples. Such variability made interpretations very difficult and as a consequence, the log sampling was discontinued late in 1992.

This manual outlines EPA's approach to biological assessment, encompassing both the rapid bioassessment approach used to sample stream macroinvertebrates, and some of the methods for interpreting sampling data in order to make an assessment of ecosystem health.

The rapid bioassessment method described here formed the basis for the national stream monitoring protocol (CEPA 1994). This manual does not attempt to provide directions on study design, site selection or sampling frequency as these will vary with every study and receive far greater consideration in texts such as Green (1979). It is however, worth noting that the rapid bioassessment method described is not appropriate in all studies of stream impacts. This approach has been shown to work when large changes in community structure or changes in species composition occur. When an impact is suspected to cause only small changes in species composition or changes only to population density, then a traditional quantitative method of sampling maybe necessary.

3. The Rapid Bioassessment Method

The rapid bioassessment method involves collection of samples from two habitats at each site: benthic (streambed) and littoral (edge). Samples are live sorted in the field for thirty minutes and animals captured are preserved and retained for identification. Integral to the method are the collection of physico-chemical and habitat data to assist in accurate interpretation of the factors influencing the invertebrate communities.

3.1 Benthic Sampling:

Benthic samples should be collected from wadeable areas of flowing water. Typically these are rocky riffles where the flow is rapid and turbulent but gravel or sand bars can also be sampled as long as there is still a flow over the substrate. This type of sampling is not appropriate for pools or areas with muddy bottoms.

This sampling is often called kick sampling due to the actions made by the sampler in taking the sample. The sampler disturbs the streambed by vigorous kicking while holding a collecting net (mesh size 250 µm; for further information see Hellawell, 1978) down current. Debris dislodged by the kicking is collected in the net as the sampler moves upstream continually kicking the streambed.

About ten metres of streambed from areas of moderate to fast current are sampled in this manner, typically taking about five minutes. It is preferable to collect the sample from two or three transects rather than a single transect along the streambed. This will increase the range of depths and current velocities sampled.

3.2 Littoral Sampling:

A littoral sample is collected by sweeping the collecting net along the edge of the stream in areas of little or no current. (The net is usually shorter than that used for the benthic sampling to avoid getting caught on branches or other such objects.) The net is swept around overhanging vegetation, snags and logs, in backwaters and through beds of macrophytes for 10 metres, typically taking five to ten minutes.

Although the streambed is not deliberately disturbed as in the kick sampling, the sweeping of the net just above the streambed in the backwaters and along the edges should result in some fine sediment being collected.

3.3 Live Sorting:

The sample is washed in the net and then spread out onto a large white tray (photographic or butchers trays) where it is sorted for a standard time between 30 and 60 minutes. Animals are collected with the aid of forceps, pipettes and spoons. Many animals can be quickly collected from the edges and corners of the tray, particularly when using pipettes. It is advisable, once or twice during the sorting, to strand animals by tilting the tray to one side, thus exposing a third or half of the bottom. Rapidly moving animals can be collected in this way as well as molluscs which are adhered to the bottom of the tray.

If large amounts of leaves, wood or aquatic vegetation are collected, these should be rinsed and removed prior to sorting.

If the water is cloudy due to clays or fine sediment in suspension, put the sample back into the net and rinse it in the stream again.

If large amounts of sand or coarse organic material are collected, put only a proportion of the whole sample into the tray at one time, bearing in mind that you need to completely sort the entire sample within the allotted time.

Good practice requires working in relatively high light levels. If ambient light is low then artificial lighting will be required. Rain drops also adversely affect sorting ability and umbrellas or tarps should be employed.

The main objective of sorting is to collect as many different types of animals as possible. Care must be taken not to expend too much time picking out large numbers of very abundant species as this will result in the less common species being under-represented or not even collected. For example, lowland river samples may contain 1,000 or more corixids (water bugs). Only about 30 need be picked out; they can then be ignored and the remaining sorting effort applied to collecting other species. Similarly, it is not necessary to pick out every individual of the large and conspicuous but less abundant species. Considerable effort needs to be directed to searching for small or cryptic species. The number of animals collected in 30 minutes typically is about 200; grossly impacted sites are likely to have fewer than 50. The live sorting should aim to collect about 200 animals in the allotted time.

The live sorted sample is then preserved in the field in 80% ethanol and returned to the laboratory for identification.

For quality assurance purposes, the residues from a randomly selected 5% of the samples collected should be retained, preserved and 10% or more of each sample sorted in the laboratory to identify taxa which may have been missed by the live sorting.

3.4 Physico-chemical Measurement and Sampling:

A standardised set of measurements and observations of the sampling site and stream should be made at each site. These are required to aid interpretation of the results of the biological sampling. Standard field sheets should be used on which basic information such as date and time of day are recorded. It is important to note the state of the streamflow (i.e. low, moderate or high) as sampling should not be attempted when the stream is in spate or flood. For an example of the field sheets used by EPA, see Appendix 1.

The following variables should be measured *in situ*:

- dissolved oxygen
- electrical conductivity
- pH
- water temperature
- turbidity (or in laboratory)
- current velocity in the riffle (a range of measurements just above the streambed in the riffle)

Water samples should be collected for laboratory analysis of:

- total phosphorus
- nitrate/nitrite
- total Kjeldahl nitrogen
- alkalinity

These water samples should be collected, stored and analysed using standard protocols (EPA 1995a). Other water chemistry variables may need to be collected depending on specific circumstances or likely contaminants (e.g. metals).

3.5 Habitat Descriptions:

The following habitat desciptors should be recorded and reviewed by a second person while at the site:

- Streambed composition - percentage of streambed that is bedrock, boulder (>256 mm), cobble (64 -256 mm), pebble (16 - 64 mm), gravel (4 - 16 mm), sand (1 - 4 mm) and silt or clay (<1 mm).
- Macrophytes - list of species present and percentage cover of each species in the riffle, littoral zone and reach.
- Stream width and depth over the sampled reach.
- Riparian zone - vegetation cover, noting major species and percent of stream covered.
- Surrounding land use.
- Location - latitude and longitude and AMG using hand held Geographic Positioning System (GPS) and confirmed from maps.

Other site descriptors obtained from maps (or elsewhere) include:

- altitude
- catchment area
- discharge (mean annual)
- distance form source

3.6 Laboratory Processing of Invertebrate Samples:

All identifications should be carried out using a stereo microscope using appropriate keys and up to date texts. For a listing of invertebrate keys, see Hawking (1994). Animals should be identified to the lowest possible taxonomic level, that is, species, and counted. Species level identification is not readily undertaken on all groups of aquatic macroinvertebrates due to taxonomic difficulties.

Where there is gross disturbance, family level identification is sufficient. Where more subtle impacts are expected or the magnitude of the impact is unknown, species level identification is necessary. For a general introduction to the taxonomy of invertebrate groups and laboratory procedures, Williams (1980) is recommended.

For quality control purposes, and in particular to ensure consistency across laboratory staff, a random selection of 10% of the samples should be re-identified by a senior taxonomist or ecologist. Errors at Family level should be less than 1%, whereas errors at species level should be less than 10%.

4. Assessing the condition of aquatic ecosystems

There are many ways of analysing and interpreting invertebrate data. Use of a number of methods to assess ecosystem health is desirable, improving the robustness and reliability of the conclusions. When results are in accord, greater confidence may be placed in the outcome. Discrepancies, where they occur, can be used to indicate the type of environmental problem involved.

In general, there are two approaches used in assessing macroinvertebrate data:

- statistical analysis and modelling; and
- calculating simple biotic indices.

Recent revisions to State environment protection policies (SEPP) for the Yarra (EPA 1995b) and Westernport catchments (EPA in prep) have used a range of analytical procedures in setting ecological objectives. The following four methods have been found by EPA to be useful in assessing ecosystem health for the attainment of SEPP objectives.

4.1 RIVPACS and AUSRIVAS

An example of the first approach is RIVPACS (River InVertebrate Prediction And Classification System) developed in the UK for the evaluation of the biological quality of rivers. It generates site-specific predictions of the macroinvertebrate fauna expected to be present in the absence of environmental stress (Wright *et al*. 1984). The expected fauna are then compared to the observed and the ratio derived is used to indicate the extent of the impact. This ratio is expressed as the observed number of families / expected number of families, or O/E families.

This approach has been adopted in Australia and an Australian version of RIVPACS has recently been developed as part of the National River Health Program (NRHP) (CEPA 1994). It is called AUSRIVAS (AUStralian RIVer Assessment System) and improves on the UK approach by keeping samples from different habitats separate in the models, rather than using a single composite sample from all available habitats. This is the preferred method of assessing stream condition using macroinvertebrates but is not yet generally available for widespread use at the time of this publication. Access to the models are expected to be available over the world wide web during 1998.

Each model uses reference data collected under the NRHP from a single aquatic habitat (benthos or littoral) and from either a single season (autumn or spring) or from the two seasons combined (Simpson, *et al.* 1997). The value of the O/E index can range from a minimum of 0 (none of the expected families were found at the site) to around 1 (all of the families which were expected were found). It is also possible to derive a score of greater than 1, if more families were found at the site than were predicted by the model. A site with a score greater than 1 might be an unexpectedly diverse location, or the score may indicate mild nutrient enrichment by organic pollution, allowing additional macroinvertebrates to colonise.

The O/E scores derived from the model can then be compared to bands representing different levels of biological condition, as recommended under the NRHP (Table 1). This allows an assessment of the level of impact on the site to be made, and characterisation of the general health of that part of the river which was sampled.

Table 1: Example AUSRIVAS O/E family score categories

Band Label	**O/E score**	**Band Name**	**Comments**
X	>1.15	richer than reference	• more families found than expected • potential biodiversity "hot spot" • possible mild organic enrichment
A	0.85-1.15	reference	• index value within range of the central 80% of reference sites
B	0.55-0.84	below reference	• fewer families than expected • potential mild impact on water quality, habitat or both, resulting in loss of families
C	0.25-0.54	well below reference	• many fewer families than expected • loss of families due to moderate to severe impact on water and/or habitat quality
D	<0.25	impoverished	• very few families collected • highly degraded • very poor water and/or habitat quality

4.2 SIGNAL Index

In addition to AUSRIVAS, it is recommended that the biotic index SIGNAL (Stream Invertebrate Grade Number - Average Level) be used. This index has been developed for eastern Australia by Chessman (1995) and is a modification of the British Biological Monitoring Working Party score system (Armitage *et al*. 1983).

SIGNAL is an index of water pollution based on tolerance or intolerance of biota to pollution. The output is a single number, reflecting the degree of water pollution. Families of aquatic invertebrates have been awarded sensitivity scores, according to their tolerance or intolerance to various pollutants. These values are shown in Table 2, however, it should be noted a score of 1 is generally used by EPA for the Oligochaeta as the families of this group are not routinely identified.

Table 2: Pollution sensitivity grades for common families of eastern Australian river macroinvertebrates. (From Chessman 1995)

Family	Grade	Family	Grade	Family	Grade
Aeshnidae	6	Gelastocoridae	6	Naididae	1
Ameletopsidae	10	Gerridae	4	Nannochoristidae	10
Amphipterygidae	8	Glossiphoniidae	3	Naucoridae	5
Ancylidae	6	Glossosomatidae	8	Nepidae	5
Antipodoecidae	10	Gomphidae	7	Neurorthidae	8
Athericidae	7	Gordiidae	7	Notonectidae	4
Atriplectididae	10	Gripopterygidae	7	Notonemouridae	8
Atyidae	6	Gyrinidae	5	Odontoceridae	8
Austroperlidae	10	Haliplidae	5	Oniscigastridae	10
Baetidae	5	Haplotaxidae	5	Osmylidae	8
Belostomatidae	5	Hebridae	6	Parastacidae	7
Blepharoceridae	10	Helicophidae	10	Philopotamidae	10
Caenidae	7	Helicopsychidae	10	Philorheithridae	8
Calamoceratidae	8	Hydraenidae	7	Phreodrilidae	5
Calocidae	8	Hydridae	4	Physidae	3
Ceinidae	5	Hydrobiidae	5	Planorbidae	3
Ceratopogonidae	6	Hydrobiosidae	7	Polycentropodidae	8
Chironomidae	1	Hydrochidae	7	Protoneuridae	7
Coenagrionidae	7	Hydrometridae	5	Psephenidae	5
Coloburiscidae	10	Hydrophilidae	5	Psychodidae	2
Conoesucidae	8	Hydropsychidae	5	Ptilodactylidae	10
Corbiculidae	6	Hydroptilidae	6	Pyralidae	6
Corduliidae	7	Hygrobiidae	5	Scirtidae	8
Corixidae	5	Hyriidae	6	Sialidae	4
Corydalidae	4	Isostictidae	7	Simuliidae	5
Culicidae	2	Janiridae	5	Sphaeriidae	6
Dixidae	8	Kokiriidae	10	Staphylinidae	5
Dugesiidae	3	Leptoceridae	7	Stratiomyidae	2
Dytiscidae	5	Leptophlebiidae	10	Synlestidae	7
Ecnomidae	4	Lestidae	7	Synthemidae	7
Elmidae	7	Libellulidae	8	Tabanidae	5
Empididae	4	Limnephilidae	8	Tasimiidae	7
Ephydridae	2	Lumbriculidae	1	Thaumaleidae	7
Erpobdellidae	3	Lymnaeidae	3	Thiaridae	7
Eusiridae	8	Megapodagrionidae	7	Tipulidae	5
Eustheniidae	10	Mesoveliidae	4	Tubificidae	1
Gammaridae	6	Muscidae	3	Veliidae	4

Limitations of this approach are that species within a single family can often show considerable variation in their response to pollutants, and some families are sensitive to certain types of pollutants yet tolerant of others.

SIGNAL has been validated for assessment of stream salinisation and organic pollution from sewage treatment plants (Chessman 1995) but its usefulness for assessing toxic pollution and other types of disturbance is uncertain. Also, its applicability to ephemeral streams and large lowland rivers is uncertain as it has been developed largely on perennially flowing streams in eastern Australia. Its applicability in other ecoregions is currently being tested under the NRHP.

The index is calculated by summing the grades listed in Table 2 for all the families present at a site, and then dividing by the number of families present. This gives an average grade per family. The resulting value or SIGNAL can vary from 1 to 10, and can be used to assess a site's status in terms of water quality. A site with typically high water quality would have a high SIGNAL value (>6) and a site with probable severe pollution would have a low value (<4) (Chessman 1995), as shown in Table 3.

Table 3: Ratings of values of the SIGNAL index

SIGNAL value	Comment
>7	Excellent
6-7	Clean water
5-6	Doubtful, mild pollution
4-5	Moderate pollution
<4	Severe pollution

4.3 Number of Families

The total number of invertebrate families found in streams can also give a reasonable representation of the health of a stream, although it is too great a simplification of data to be adequate on its own. The expected number of families will vary according to type of habitat and stream size, with larger streams generally supporting more families of invertebrates. Lack of suitable habitat or the presence of various pollutants can cause a reduction in the number of families present. This assessment method complements SIGNAL which tends to underestimate toxic effects.

4.4 Key Invertebrate Families

This measure aims to provide an indication of habitat availability as well as water quality, through the use of lists of key families which are expected to be found in different ecoregions. For example, three lists, as shown in Table 4, have been developed by EPA for use in the Yarra catchment for assessing the condition of streams in:

- areas of little or no disturbance, such as water supply catchments, national parks and state forests (List 1);
- rural areas cleared for agriculture and sporadic settlement (List 2); and
- urban areas (List 3).

Table 4: Lists of Key Families used in the Yarra Catchment

	List 1 **Forests and Aquatic Reserves**	**List 2** **Rural areas**	**List 3** **Urban areas**
Stoneflies	Gripopterygidae Austroperlidae Eustheniidae Notonemouridae	Gripopterygidae Austroperlidae	Gripopterygidae
Mayflies	Leptophlebiidae Baetidae Coloburiscidae	Leptophlebiidae Baetidae Caenidae Coloburiscidae	Leptophlebiidae Baetidae Caenidae
Dragonflies	Aeshnidae	Aeshnidae Lestidae/Synlestidae/Cordulidae	Aeshnidae Lestidae/Synlestidae/Cordulidae Megapodagrionidae Any other family of Odonata
True flies	Athericidae Blephariceridae	Athericidae	
Caddis flies	Leptoceridae Philorheithridae Helicopsychidae Glossosomatidae Hydrobiosidae Philopotamidae Hydropsychidae Calocidae Helicophidae Conoesucidae	Leptoceridae Philorheithridae Glossosomatidae Calocidae Calamoceratidae Hydrobiosidae Hydropsychidae Ecnomidae Atriplectididae Conoesucidae	Leptoceridae Ecnomidae Hydrobiosidae Hydropsychidae Calamoceratidae
Beetles	Elmidae Ptilodactilidae Scirtidae	Elmidae Ptilodactylidae Hydrophilidae Hydrochidae	Elmidae Hydrophilidae Psephenidae
Amphipods	Eusiridae	Ceinidae/Eusiridae	Ceinidae/Eusiridae
Shrimps		Atyidae	Atyidae
Snails/Bivalves		Hydrobiidae/Corbiculidae	Hydrobiidae/Corbiculidae
TOTAL	24	26	19

It is unlikely that a site would support all families, as the lists incorporate families from a range of habitat types, river sizes and river types within each eco-region. This is especially so for rural areas, where the range of habitat types, stream sizes and altitude is greatest and a larger number of families have been included in order to cater for this variability.

The lists have been developed using information from both within and external to the Yarra catchment but have not been properly tested on streams outside of the Yarra. Therefore, they should be used cautiously, if at all, in other catchments, until adequate testing is carried out.

This method focuses mainly on the families which are indicative of good habitat and water quality. The families selected are those which:

- are typically found in the types of stream in that eco-region. For example, families such as Coloburiscidae and Blephariceridae occur in the high, cool streams typical of undisturbed catchment headwaters. Other families such as Calamoceratidae, Ecnomidae and Ceinidae become more common in the lower, warmer streams of rural and urban areas.
- are representative of a particular habitat type - such as wood debris, fringing vegetation or macrophytes, cobbles, pools and riffles;
- represent reasonable to good water quality, tending to disappear as conditions deteriorate; and
- are commonly collected when present, using the sampling and collection method as described.

5. Summary

♦ Rapid bioassessment sampling provides a simple, quick, reliable and relatively cheap means of assessing the health of aquatic ecosystems.
♦ To be done effectively, all the steps described in this manual need to be strictly adhered to.
♦ Sampling and interpretation should be carried out by properly trained biologists.
♦ Rapid bioassessment is not appropriate in all circumstances (for example, where the presumed impact is expected to affect faunal abundances rather than diversity) and should not be used indiscriminately.
♦ Other methods of data analysis (for example, ordinations, classifications etc.) should also be used where appropriate.

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Appendix 1. Field records and Habitat Assessment Sheets

FIELD SAMPLING AND HABITAT ASSESSMENT SHEETS (ver 7 9/2/99)

DATE .... **TIME** .... **LOCATION CODE** ....
RIVER .... **LOCATION** ....
RECORDERS NAME .... **PHOTOGRAPH NUMBER (S)**..
MAP DRAWN/MODIFIED.. **AIR TEMPERATURE** ....°C
RAIN IN LAST WEEK ? **Y [ ] N [ ]** **LOCATION NOTED IN BASIN BOOK**........................

AMG...
....
LATITUDE..**LONGITUDE**...
....

RIPARIAN VEGETATION
Width of riparian zone[1]: estimated / measured left bank[2] ....**m**
estimated / measured right bank[2] ....**m**

Vegetation type:	**% Cover of riparian zone[3]**	**Description**
trees (>10m)	....	....
trees (<10m)	....	....
shrubs / vines	....	....
grasses / ferns / sedges	....	....

Vegetation cover of river[4]: <5% [ ] 6-25% [ ] 26-50% [ ] 51-75% [ ] >76% [ ]

Cover of Exotic vegetation[5]	0%(4)	1-10%(3)	11-40%(2)	41-60%(1)	>60%(0)
Overstorey	[ ]	[ ]	[ ]	[ ]	[ ]
Shrub Layer	[ ]	[ ]	[ ]	[ ]	[ ]
Groundcover	[ ]	[ ]	[ ]	[ ]	[ ]

1 Area where waterway interacts with vegetation. 2 Facing downstream. 3 From 'Plan' view, estimation of outline cover; may total >100%. 4 Estimate as at midday. 5 Total may be >100%. 6. From edge of water to cleared land.

MEASUREMENTS:

Stream Width[6] (m) 1............ **2**............... **3**............. **channel width[7]** ....**m** **bank height[8]**............**m**
(Max.) (Min.) (Mean)

Water Temperature[9] (°C)	....	**pH[9]**	....
Conductivity[9] (uS/cm,ambient)	....	**Alkalinity..(mg/L).....**	....
Conductivity (uS/cm @ 25 °C)	....	**Turbidity[9] (FTU)**	....
Dissolved Oxygen[9] (mg/l)	....	....	....
% Sat. Dissolved Oxygen............................	....	....	

Depth[11] (cm)
1 2 3
....…..

Flow[11,12] (revs/30sec)
U / L U / L U / L
........../............ ..../........... ..../...........

% in Reach[10] **Riffle**……… **Pool** .... **Macrophyte** .... **Run** ....

Flow meter fan no. .... **Water sample(s) taken? yes [ ] number**................ **no [ ]**

6 From edges of water. 7 From tops of banks. 8 From water surface vertical to top of bank. 9 Measured/sampled from riffle area. 10 Within 'Reach' :ie. 5 times mean water width either side of riffle sampling site. 11 U = Upper, at 4/5 depth; L = Lower, at 1/5 depth; if <30cm, measure at 1/2 depth only. 12 Measurements at 1/4, 1/2, 3/4 width along mean width transect.

RIVER... **DATE**.............................. **LOCATION CODE**..

OBSERVATIONS (Indicate appropriate number in box)

WATER ODOURS: **1. normal** **2. sewage** **3. petroleum** **4. chemical** **5.stormwater** **6. musty** **[ ]**

WATER OILS: **1. slick** **2. sheen** **3. globs** **4. flecks** **5. none** **[ ]**

TURBIDITY: **1. clear** **2. slight** **3. turbid** **4.opaque/liquid silt (clay like)** **[ ]**

PLUME: **1. little** **2. some** **3. lots** **[ ]**
(amount of fine sediment generated when kick-sampling)

SEDIMENT OILS: **1. absent** **2. light** **3. moderate** **4. profuse** **[ ]**

SEDIMENT ODOURS: **1. normal** **2. sewage** **3. petroleum** **4. chemical** **5. anaerobic** **6. none** **7. other**...................................... **[ ]**

FLOW LEVEL: (relative to "water mark" ie. **normal inundation level shown by limit of terrestrial grasses, or by eroded area**, or boundary in bank sediment types).
1. No flow (dry / isolated) **2. Low** (<water mark) **3. Moderate** (=) **4. High** **5. Flood** (>water mark) **[ ]**

Bare ground above normal inundation level shown by above: **Left bank**.................% **Right bank**................%

SEDIMENT DEPOSITS: **1. none** **2. sludge** **3. sand** **4. floc/silt (very light)** **5. other** **[ ]**

LOCAL CATCHMENT EROSION (within sight of site) **1. none** **2. moderate** **3. heavy** **[ ]**

LOCAL NPS POLLUTION: **1. no evidence** **2. potential**.............................**3. obvious**........................... **[ ]**

LOCAL PS POLLUTION: **1. STP** **2. road** **3. other**.. **[ ]**

DAMS / BARRIERS (local) **1. present upstream / downstream** **2. absent** **3. river regulated** **[ ]**

BRAIDING: **1. yes** **no. of channels** .... **2. no** **[ ]**

SITE CLASSIFICATION: **1. steep valley** **2. broad valley** **3. wetland/bog** **4. heath**
(indicate >1 if required) **5. plains** **6. natural riparian meadow** **[ ]**

LANDUSE: Left Bank[2] **1. Native forest** **2. Forestry** **3. Native pasture** **4. Grazing** **5. Cropped** **6. Residential** **7. Industrial** **8. Recreational** **[ ]**

LANDUSE: Right Bank[2] **1. Native forest** **2. Forestry** **3. Native pasture** **4. Grazing** **5. Cropped** **6. Residential** **7. Industrial** **8. Recreational** **[ ]**

VEGCAT (for AUSRIVAS)
1. Urban/Residential **2. Intensive agriculture/some residential**
3. Some forestry/agriculture(eg grazing) **4. Native forest/natural vegetation** **[ ]**

BARS: (bed surface protruding from water & forming a bar) ....%

RIVER... **DATE**.............................. **LOCATION CODE**.............................

REACH[10]

Length of Reach[10].........................metres.

SUBSTRATUM DESCRIPTION (% cover):

			PHI
Bedrock		[.................]	-9.5
Boulder	(>256mm)	[.................]	-9.0
Cobble	(64-256mm)	[.................]	-6.5
Pebble	(16-64mm)	[.................]	-4.5
Gravel	(2-16mm)	[.................]	-2.0
Sand	(0.06-2mm)	[.................]	2.0
Silt	(0.004-0.06mm)	[.................]	6.5
Clay	(<0.004mm)	[.................]	9.5

ORGANIC SUBSTRATUM (% cover of inorganic substrate)

Detritus (sticks, wood, CPOM[14]) [..................]
Muck/Mud (black, very fine organics) [................…]

FPOM/CPOM categories 1= <5%
2 = 5 - 20 %
3 = >20 %

Moss	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Filamentous algae	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**
Macrophytes	**0**	**1**	**2**	**3**	**4**	**(percent of reach covered by)**

0= <10% 1=10-35% 2=35-65% 3=65-90% 4=>90%

10 'Reach' :ie. 5 times mean water width either side of riffle sampling site.
14 Coarse Particulate Organic Material.

RIFFLE

Macroinvertebrates collected by ....
Macroinvertebrates picked/ sorted by ....
Method: **Kicknet [ ]** **Other**..
Length of riffle sampled 10 metres [ ] Other....................**metres.**
Sample preserved [ ]
Time taken to pick sample:..

SUBSTRATUM DESCRIPTION (% cover):

			PHI
Bedrock		[.................]	-9.5
Boulder	(>256mm)	[.................]	-9.0
Cobble	(64-256mm)	[.................]	-6.5
Pebble	(16-64mm)	[.................]	-4.5
Gravel	(2-16mm)	[.................]	-2.0
Sand	(0.06-2mm)	[.................]	2.0
Silt	(0.004-0.06mm)	[.................]	6.5
Clay	(<0.004mm)	[.................]	9.5

ORGANIC SUBSTRATUM (% cover of inorganic substrate)

Detritus (sticks, wood, CPOM[14]) [..................]
Muck/Mud (black, very fine organics) [..................]

FPOM/CPOM categories 1= <5%
2 = 5 - 20 %
3 = >20 %

Moss	**0**	**1**	**2**	**3**	**4**	**(percent of riffle covered by)**
Filamentous algae	**0**	**1**	**2**	**3**	**4**	**(percent of riffle covered by)**
Macrophytes	**0**	**1**	**2**	**3**	**4**	**(percent of riffle covered by)**

0= <10% 1=10-35% 2=35-65% 3=65-90% 4=>90%

RIVER... **DATE**............................... **LOCATION CODE**.............................

EDGE / BACKWATER (where sample was taken)**:**

Macroinvertebrates collected by ....
Macroinvertebrates picked/ sorted by ....
Method: **Sweep [ ]** **Other**...
Length of edge sampled **10 metres [ ]** **Other**..................**metres.**
Sample preserved [ ]
Time taken to pick sample:...

ORGANIC SUBSTRATUM (% cover of inorganic substrate)

Detritus (sticks, wood, CPOM[14]) **[**..................**]**
Muck/Mud (black, very fine organics) **[**..................**]**
FPOM/CPOM categories 1= <5%
2 = 5 - 20 %
3 = >20 %

Trailing bank Vegetation:
nil [ ] **slight (<10%) [ ]** **moderate (10-30%) [ ]** **extensive (.>30%) [ ]**
Edge description.(plants sampled in sweep)..
....

Percentage of edge covered by:

backwaters	**[ ]**
leaf packs	**[ ]**
undercut banks	**[ ]**
roots	**[ ]**
other...	

Moss	**0**	**1**	**2**	**3**	**4**	**(percent of edge covered by)**
Filamentous algae	**0**	**1**	**2**	**3**	**4**	**(percent of edge covered by)**
Macrophytes	**0**	**1**	**2**	**3**	**4**	**(percent of edge covered by)**

0= <10% 1=10-35% 2=35-65% 3=65-90% 4=>90%

MACROPHYTES IN REACH

Indicate whether the following common taxa are present in the reach:

SUBMERGED/ FLOATING	EMERGENT
Ceratophyllum (Hornwort)	*Callitriche* (Starwort).................................
Chara (Stonewort)...	*Carex* (Tussock Sedge) ....
Elodea (Canadian Pondweed)	*Crassula* (Crassula) ....
Myriophyllum (Water Milfoil)	*Cyperus* (Sedge)..
Nitella (Stonewort)	*Eleocharis* (Spikerush)................................
Potamogeton (Pondweed)	*Juncus* (Rush)..
Triglochin (Water Ribbon)	*Paspalum* (Water Couch) ....
Vallisneria (Ribbonweed)	*Polygonum* (Smartweed) ....
Other	*Phragmites* (Common Reed).......................
....	*Ranunculus* (Buttercup) ....
....	*Scirpus* (Clubrush)......................................
....	*Typha* (Cumbungi)......................................
....	Other ....

Vegetation samples collected: Yes [ ] No [ ]

Epiphyte cover on macrophytes Nil [ ] Slight [ ] Moderate [ ] Extensive [ ]

RIVER.. **DATE**.............................. **LOCATION CODE**.......................

DIATOM SAMPLING FIELD NOTES

HARD SURFACE SAMPLE

substrate type ....

substrate shaken before sampling yes no
approximate depth of substrate (15cm preferred) ....
habitat type riffle run other ....

MUD/DETRITUS SAMPLE

habitat type pool backwater other ....
approximate depth of substrate (5cm preferred) ....

RIVER.. **DATE**.............................. **LOCATION CODE**.......................

1. Width of streamside zone (measured for 30 m along one bank – note which one) left/right

Small streams (baseflow width less than 15 m)
Indicate width of streamside zone

- [ ] ≥ 40 m
- [ ] 30 m – <40 m
- [ ] 10 m – <30 m
- [ ] 5 m – <10 m
- [ ] < 5 m

Large streams (baseflow width greater than 15 m)

Is the streamside zone width greater than 3 * baseflow width?	Yes	☐	Go to 2
	No	☐	Go to a
a. Is the streamside zone width less than 1/4 * baseflow width?	Yes	☐	Go to 2
	No	☐	Go to b&c
b. Width of baseflow		☐	m
c. Width of streamside vegetation		☐	m

2. Longitudinal continuity of streamside zone

Look for any gaps in the overstorey and understorey streamside vegetation for 3 transects, each with a bank length of 50 m. A gap is where the cover of overstorey and understorey combined is less than 20%, within 5 m distance laterally from the edge of the stream and greater than 10 m along the bank.

Transect 1	Transect 2	Transect 3
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

3. Regeneration of indigenous understorey and overstorey

Assessed for the measuring site as a whole.

Is the catchment surrounding the measuring site forested? Yes ☐ No ☐ *If yes, you don't need to go any further. If no, please fill in the following table*

	Typical features (all of these not necessarily occurring simultaneously)
☐ Abundant (>5% cover) and healthy (2)	Many young (< 5 years old) indigenous trees and shrubs; with few dead or stressed leaves; with few parasites; and that probably have not been subject to grazing pressure (eg. from rabbits or cattle).
☐ Present (1)	Few young indigenous trees and shrubs, with many dead or stressed leaves; with many parasites; and that probably have been subject to grazing pressure
☐ Absent (<1%)	No young indigenous trees and shrubs.

1. Refer to the examples in appendix 3 to determine over what distance to measure this indicator if there is not a clear change in land-use to define the boundary of the streamside zone.
2. Regeneration is defined as being immature woody plants under a metre high. Take care in determining the difference between indigenous and exotic vegetation.