Gold Coast Catchment Association

Community Waterway Monitoring Manual

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GOLD COAST Catchment ASSOCIATION INC

The information in this manual is derived from a variety of sources including:

Queensland community waterway monitoring manual, Department of Natural Resources and Water QLD, 2007.

Community/Land Manager Waterwatch Guide. Department of Environment, Climate Change and Water NSW, 2010.

Interpreting River Health Data, Waterwatch Victoria.

City of Gold Coast

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1. Introduction

1.1 City of Gold Coast

The Gold Coast is Australia's sixth largest city, located within one of Australia's fastest growing regions and possessing an extensive network of waterways, wetlands and floodplains. The City's water environments encompass pristine creeks in the hinterland to extensive floodplains, ecologically diverse wetlands, rivers, estuaries, canals and the Broadwater and beaches. As well as sustaining our environment and lifestyle, water supports a thriving economy and contributes to our cultural identity. Much of what makes the Gold Coast attractive to residents and visitors is connected to the natural environment and our abundant waterways.

The desire to live, work and play near the Gold Coast's waterways and beaches places significant pressure on these natural assets. Healthy and connected waterways provide intrinsic ecological, cultural, community and health benefits which underpin our economy. Sustaining and protecting the health of our water environments and their habitats is thus critical for supporting our way of life as well as protecting the intrinsic value of these environments.

Looking after our diverse water environments and water resources on the Gold Coast is complex and requires the coordinated effort of the City, State government agencies, community and private organisations. The City of Gold Coast promotes active and engaged joint stewardship of our water environments and resources with the community in partnership with The Gold Coast Catchment Association.

1.2 Gold Coast Catchment Association

The Gold Coast Catchment Association is the umbrella organisation for community groups who are involved in the hands on restoration, maintenance and protection of the Gold Coast's natural areas. We support the "doers" who plant trees, remove weeds, care for native animals and clean up our waterways and beaches.

The Association supports our network of members by:

- Connecting Gold Coast community groups and individuals who are involved in on-ground ecological restoration and catchment management through our website, newsletter, social media and events;
- Acting as a sponsoring organisation for unincorporated members to manage their grant funds and to provide insurance;
- Hosting and co-hosting environmental events that engage the general community;
- Co-ordinating and managing Citizen Science Programs that engage and educate the community;
- Providing our members services including marketing, web presence, insurance, assistance in obtaining grants and general administration;
- Providing independent and non-political input to Government on catchment management issues and initiatives.

There are an increasing number of groups who are taking action to protect and care for Gold Coast's catchments and environment. We seek to support and help network these groups so that collectively the community can become stronger and more effective on the ground – where it counts.

Our ultimate aim is to make a real difference to restore our catchments to places of beauty, clean water and native habitat that will support our community and wildlife for centuries to come.

1.3 Purpose of this document

This manual is intended to support the development and implementation of community based monitoring of the City's waterways. It provides technical information and guidance for planning, implementing and interpreting waterway monitoring activities.

The objectives community waterway monitoring are to:

1. Collect data to increase understanding of the health and condition of the City's waterways and to assist in their management;

2. Increase community capacity for involvement in the management of the City's waterways and general awareness of waterway health issues; and

3. Increase community engagement and connections with the City's waterways.

This manual has been developed for use by the broad range of participants involved in community-based waterway monitoring programs. It is targeted at those involved in the roles of leading, designing and coordinating community based waterway projects, although people in other roles may also find it useful. This manual promotes a strategic approach to community waterway monitoring that supports local and regional natural resource management, and improved understanding and awareness of waterway and catchment issues. This manual emphasises data confidence to ensure that community-based groups can design and implement waterway monitoring projects and collect data that meets both their needs and those of their stakeholders.

Health and safety is of primary importance and should be the first consideration before conducting any community monitoring.

2. Monitoring Waterway Health

2.1 What is a healthy waterway

An ecologically healthy waterway is one that retains its major ecological features and functioning similar to that prior to European settlement and which would be able to sustain these characteristics into the future. By this definition, an ecologically healthy waterway need not be pristine. For example, exotic species may be present or fish passage may be provided by fishways. However, overall, the major natural features, biodiversity and functions of a waterway are still present and will continue into the future

Water quality is traditionally measured to assess river health, although in more recent years biological indicators, such as macroinvertebrates, have also been used. Both water quality and biological assemblages vary from year to year, between seasons and from turbulent high mountain streams to large, meandering lowland rivers. Understanding these temporal and spatial differences is important in assessing waterway health.

2.2 Indicators of waterway health

Various indicators may be used to assess waterway health. Indicators are the best practical representation of issues impacting waterway health. For example, phosphorus is used as an indirect measure (indicator) of potential excessive plant growth (the issue). Phosphorus is a major plant nutrient and when there is excess phosphorus there is likely to be greater plant growth. However, a more direct measure would be to assess plant biomass or productivity, but this is time consuming and difficult so is not generally undertaken. Indicators are a tool and must not be the focus of an assessment. The issue must be central to the assessment. The most regularly used direct measure of river health is the macroinvertebrate community. The macroinvertebrate community is the outcome of environmental conditions, primarily water quality regime, habitat quality and flow regime. Changes in these conditions will change the community.

2.3 Developing a monitoring plan

Monitoring plans are project-specific documents that address the what, where, why and how of monitoring. They are very important documents that outline your monitoring strategy and the reasons behind it. Monitoring plans encourage a strategic approach and should be developed prior to commencing monitoring activities. They combine all relevant information about the project into one easily managed document that can be used to improve confidence in the data you collect or to promote your activities to external groups and organisations.

A monitoring plan provides a record of all decisions made in developing a monitoring program, as well as a guide ensuring that all decisions are sound and that the study will successfully meet its objectives.

A well thought out monitoring plan will ensure that the appropriate questions are asked, and that data is collected in the right way to answer these questions. The plan will assist in deciding what to measure, where to measure, when to measure, and who will be involved, as well as determining the required quality assurance and quality control procedures to support this data. The table below lists the questions that will be addressed in a monitoring plan.

Table 2.1. Steps in developing a monitoring plan

Key steps	Monitoring plan questions
Set monitoring objectives	Q1 Why are you monitoring? Q2 Who will use the data? Q3 How will the data be used? Q4 What data quality do you require?
Develop a study design	Q5 What is your study type? Q6 What will you monitor? Q7 Where will you monitor? Q8 When and how often will you monitor?
Choose monitoring methods and procedures	Q9 What methods will you use?
Plan data management, interpretation, reporting and communication	Q10 Who will be involved and how? Q11 How will the data be managed and reported? Q12 How will you ensure confidence in your data?

A Monitoring Plan Worksheet is provided in Appendix B to assist you in developing a monitoring plan for your project. Example answers that are typical for each question are provided. The City of Gold Coast can assist with developing monitoring plans. Please contact the Catchment Management Unit for information.

3. Water Quality Monitoring

3.1 Measuring physical and chemical properties of water

Water quality is never static, and always differs between any two locations and between any two times. This inherent variability makes measuring and interpreting water quality a rewarding, challenging and, at times, frustrating exercise. The concept of water quality is an abstract one, as it cannot be defined by any one measurement or indicator. Water quality is the net effect of all influences on and interactions within a body of water, including cumulative effects and their interactions. These effects are sometimes so varied and complex that it is not possible to define them all. To solve this problem, water quality is described in terms of its measurable physical and chemical characteristics, or indicators. When developing your project, you should consider study design principles. Before selecting appropriate methods, you need to thoroughly consider:

- What indicators you will monitor;
- Where you will monitor – the spatial scope of your project and where sites should be placed within your area to meet your objectives;
- When and at what frequency you are going to monitor, including sampling dates and times of day;
- Representativeness- the extent to which a proposed monitoring site is indicative of the type of conditions you are attempting to monitor;
- Comparability- the extent to which the measurements taken at one site are comparable to similar measurements taken at another site;
- Data quality- the level of confidence required in the data;
- Health and safety- the risks involved with the sites and methods selected. If the risks cannot be managed, the site must be classified as unsuitable.

For further information on designing your study, refer to Chapter 2 of this manual.

3.2 Capturing a representative water sample

The representativeness of your water sample will depend on how and where you take the water sample, and how you use water quality instruments.

3.2.1 How to take a water sample

The way you collect a sample of water can have a large influence on the accuracy of your results. Accordingly, it is important that you document the methods used to collect your samples, and that the procedures themselves do not affect the parameter you are measuring. For example, if you are collecting a sample to test for turbidity, you need to be especially careful not to stir up bed sediments in the vicinity of your sample.

The physico-chemical conditions within most waterways are naturally highly variable, so monitoring methods must be designed to minimise further variability associated with the monitoring procedures used. Variations associated with the monitoring process are referred to as artefacts and can become quite misleading if not adequately dealt with. Some simple procedures to help minimise artefacts associated with your sampling procedure include:

- Monitoring from the same place on each occasion;

- Monitoring at approximately the same time of day;
- Consistently using the same methods to sample;
- Replicating at an appropriate spatial and temporal scale—for example, collecting all samples from catchment headquarters during summer.

3.2.2 Where to take a sample

Whenever you take a sample, you should try to ensure that the sample you collect is representative of the waterway at the time of monitoring. Some ways to help improve the representativeness of your sample include:

- Monitoring in flowing waters rather than in areas of still water
- Capturing your water sample away from the stream bank, the stream bed and other physical structures such as walls or pylons
- Where possible, trying to take a water sample from the middle of the stream. The safest way of doing this is by using a sampling bottle attached to a pole.
- Taking your water sample approximately 30 cm below the surface of the water whenever possible. This avoids surface effects such as altered temperature or dissolved oxygen concentration associated with climatic conditions.

Every time you take a measurement or collect a water sample, you should record your method and, if applicable, the result on a field data sheet. These sheets help you record all the essential information associated with where, when and how the data was collected and by whom. Field data sheets should also allow you to record additional information about relevant conditions at the time of sampling—for example, climatic conditions, flow or particular disturbances relevant to the indicator.

3.2.3 Using a water quality instrument

Water quality probes come in a variety of configurations and types. In situ probes, such as multi-probes and handheld probes with sufficiently long cabling to access representative water, are those that can be deployed directly into the water body. The deployment procedure for in situ probes is as follows:

1. Remove any protective storage or transport casings.

2. Ensure that the equipment is calibrated and functioning correctly. Record the calibration on the Calibration Record Sheet in Appendix D.

3. Deploy the probe into representative section of water (see ‘Where to take a sample’).

4. Allow the reading to stabilise.

5. Record the reading and complete the remainder of the field sheet.

Table 3.1. Recommended Equipment for community waterway water quality monitoring

	Indicator				
	Temperature	**pH**	**EC**	**DO**	**Turbidity**
Recommended Equipment	Horiba Water Quality meter	Horiba Water Quality meter	Horiba Water Quality meter	Horiba Water Quality meter	Turbidity Tube

4. Macroinvertebrate Monitoring

Aquatic macroinvertebrates, or water bugs, are animals without a backbone (invertebrates) that spend all or part of their life in water, and can be seen by the naked eye (macro). Many kinds of macroinvertebrates inhabit Australian waterways, including worms, snails, mites, bugs, beetles, yabbies and various insect nymphs and larvae. Macroinvertebrates are generally between less than a millimetre and seven centimetres long, although some species of crayfish can reach lengths up to twenty centimetres or so. A group of macroinvertebrates living together is called a biological community.

4.1 Types and classification

When conducting macroinvertebrate monitoring, it is essential to have a good understanding of the biological classification (Linnean) system used to categorise all species of organisms. The Linnean classification system is hierarchical, with seven main divisions - kingdom, phylum, class, order, family, genus and species - each of which provides progressively more specific information about a particular organism. Therefore, within the animal kingdom there are several phyla, each phylum contains several classes, and so on down to the genus and species, the formal name for every living thing. Genus and species names are written in italics, with the species name always in lower case. Table 4.1 shows the Linnean classification of the common freshwater shrimp.

Table 4.1. Linnean classification of the common freshwater shrimp

Kingdom	Animalia
Phylum	Arthropoda
Class	Crustacea
Order	Decapoda
Family	Atyidae
Genus	*Paratya*
Species	*Australiensis*

Examples of common aquatic macroinvertebrate classes include Gastropoda (snails), Arachnida (spiders and mites), Crustacea (crustaceans), Insecta (insects), Turbellaria (flatworms) and Oligochaeta (segmented worms). Identifying macroinvertebrates to species level can be difficult, due to the minute size of some organisms and their lack of distinguishing features. Some groups, like the true flies, or Diptera, contain many undescribed (unclassified) species, making species-level identification impossible. Furthermore, up-to-date taxonomic identification keys are not available for some macroinvertebrate species. Therefore, the majority of macroinvertebrate identification for the purposes of community waterway monitoring occurs at the class, order or family level.

4.2 Where they live

Macroinvertebrates inhabit all types of water, from rushing, rocky rivers to sandy-bottomed streams, densely vegetated ponds and murky farm dams. This biological abundance is because many insect species require water during their early life stages; many insect larvae are aquatic. Aquatic habitats can be broadly categorised into moving water (rivers, creeks and streams) or still water (waterholes, wetlands, backwaters, lakes and pools). Most macroinvertebrate families are found in one type of habitat or the other, as macroinvertebrates possess special adaptations for the specific aquatic habitat that they live in. Flowing water habitats have both fast- and slow-moving sections. In fast moving water, macroinvertebrates must be able to grip to a surface while feeding. Adaptations to allow for this include streamlined bodies, suction parts, hooks and fine filters for sieving food from the passing water. In slow-moving or still water, macroinvertebrates do not need to hang on to a surface and their food is not provided by the water current. Consequently, macroinvertebrates in still or slow-flowing water have a wider range of shapes and sizes and are more mobile.

Within flowing water, four different macroinvertebrate habitat types are recognised: riffles, runs, pools and stream edges. These different macroinvertebrate habitats occur due to the varying flows, depths and substrates of the stream (See Figure 4.1 for a plan view of a waterway showing pool, riffle and run habitats).

Riffles are shallow, rocky sections of a waterway with fast-flowing, turbulent water. The water surface in riffle habitats is broken (the surface is not continuous and the water forms spray, foam and droplets), leading to increased levels and mixing of oxygen in the water. Rocks provide a large surface area onto which macro-invertebrates can attach and the fast-flowing water provides a continual supply of food. Some species of macroinvertebrates stay on the underside of rocks for protection from the flow. A high diversity of macroinvertebrates can be supported in riffles due to the living spaces and food provided.

Runs are areas of deeper, flowing water with a smooth water surface and smaller particles settled on the bottom (substrate). Food is suspended in the water, deposited on the bottom or growing in the waterway bed. Occasional floods can wash macroinvertebrates downstream. Due to the lack of stability and living places, fewer macroinvertebrates inhabit runs than riffles.

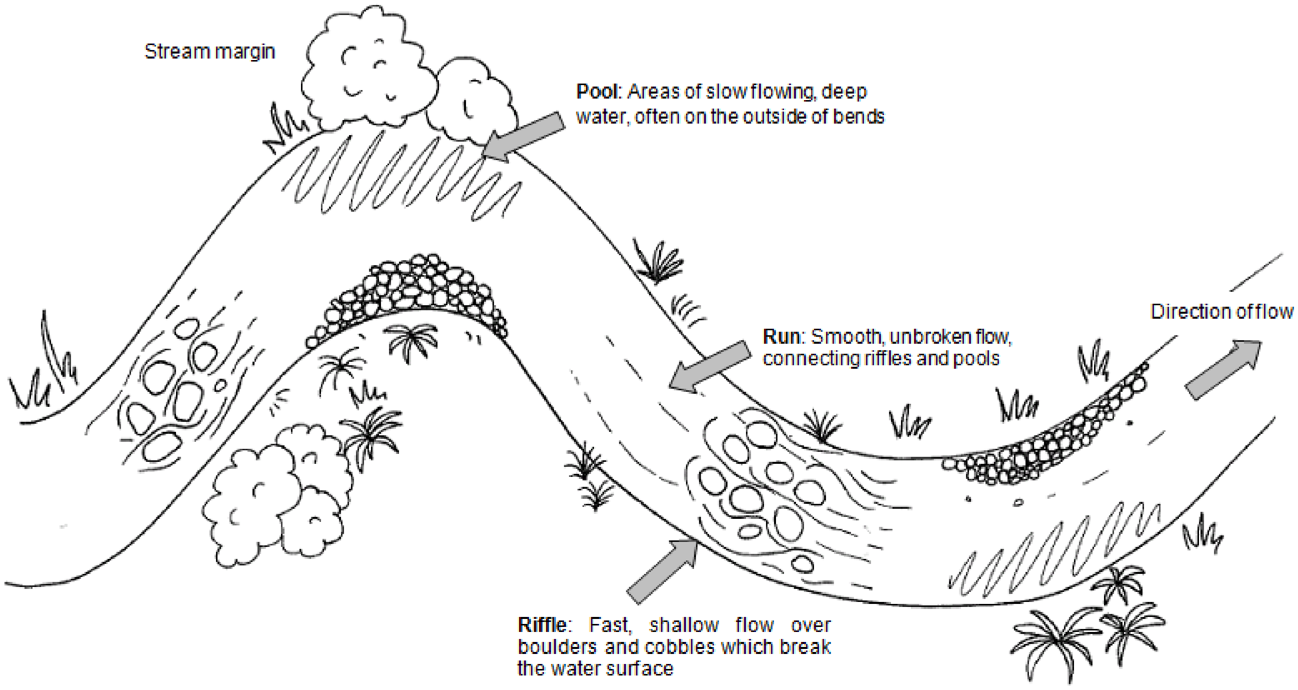

Figure 4.1. Plan view of a waterway showing pool, riffle and run habitats (image from Greater Wellington Regional Council)

Pools are deeper areas where water is still or flows slowly. Pools have sandy or muddy bottoms, so macro-invertebrates are able to attach themselves to plant stems, roots, logs and other submerged objects. Fewer types of macroinvertebrates inhabit pools than riffles.

Edge habitats occur along stream edges near the water surface. Edge habitats incorporate overhanging vegetation from the stream banks, emergent aquatic plant (macrophyte) beds, sheltered overhangs, root mats and leaf packs. The macroinvertebrate communities found in edge habitats differ from those in riffles and pools, and survive best in places that provide protection, camouflage and food sources.

Macroinvertebrates form a vital link in the food web of a river ecosystem. Many are grazers, eating leaf litter, weeds and algae and thus funnelling sunlight energy to fish and other larger predators.

Other macroinvertebrates are predators themselves, preying on smaller macroinvertebrate species. The presence or absence of macroinvertebrates will generally determine the presence or absence of animals higher up the food chain. For an example of the role that macroinvertebrates play in an aquatic food web, refer to Figure 4.2.

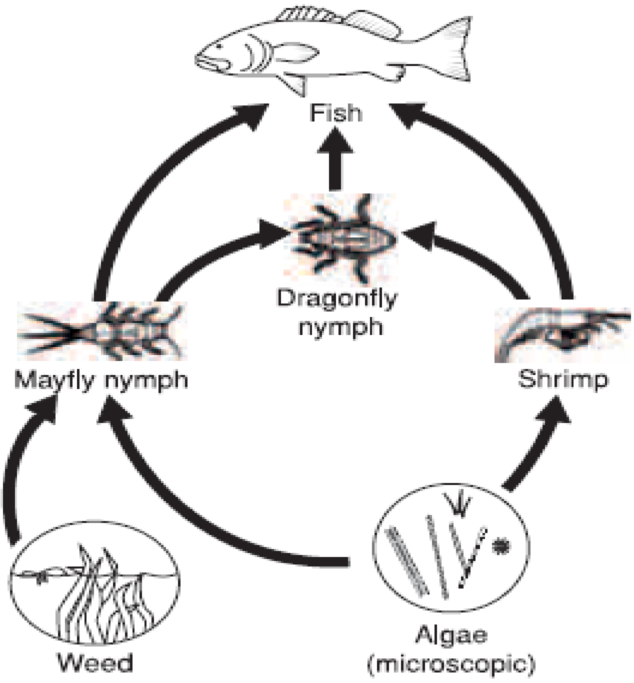

Figure 4.2. A simplified example of the role of macroinvertebrates in a stream food web

4.3 Life cycles

Many species of macroinvertebrates go through several changes in appearance throughout their life cycles. The majority of macroinvertebrates undergo either complete or incomplete metamorphosis during the process of developing from an egg to an adult. Complete metamorphosis comprises four distinct stages: the egg stage, larval stage, pupal stage and adult stage. A number of the macroinvertebrates that undergo complete metamorphosis are aquatic during their egg and larval stages, but terrestrial as adults. Examples of macroinvertebrates that go through complete metamorphosis include caddisflies (Trichoptera), beetles (Coleoptera) and true flies (Diptera). Incomplete metamorphosis comprises only three stages: the egg stage, nymph stage and adult stage.

Macroinvertebrates that go through incomplete metamorphosis include mayflies (Ephemeroptera), stoneflies (Plecoptera) and true bugs (Hemiptera). While a number of macroinvertebrates that undergo incomplete metamorphosis live in terrestrial environments during their adult stage, others such as water striders and water scorpions spend their entire lives in aquatic ecosystems.

4.4 Factors affecting macroinvertebrates

Many macroinvertebrates are highly sensitive to environmental changes. Some species have, over time, adapted to such a narrow range of habitat conditions that even the smallest change in environmental conditions can have devastating effects. The conditions influencing the composition of macro-invertebrate communities include physical, chemical, and biological waterway conditions, and human influences.

4.4.1 Physical habitat

Riffle, edges, pools, and runs – Variability in physical conditions (including flows and depths), and availability of each, influences the macroinvertebrate community composition.

Current velocity – How fast the water moves will impact on macroinvertebrate communities. A current velocity of 0.5 metres per second in riffles will support the most diverse communities, while floods may flush macro-invertebrates and plants downstream. Higher flow velocities also increase dissolved oxygen levels, so high-velocity habitats can support a greater richness of macroinvertebrates.

Bottom composition - the bottom of the waterway is made up of different materials (substrates) such as various rocks (with sizes ranging from that of marbles to basketballs), mud, sand, silt and gravel. Highly diverse substrates containing a variety of rock sizes provide the best habitat for macroinvertebrates.

Aquatic plants - known as macrophytes, aquatic plants provide habitats for many different types of macroinvertebrates. Aquatic plants also assist to camouflage some macroinvertebrates from predators and protect them from the water flow.

Flow (discharge) - The amount of water in the channel determines how much of the river bed is exposed to air. When the waterway is drying up, macroinvertebrates will converge in remaining water holes and populations will become more concentrated. Some macro-invertebrates are better at coping with these conditions than others.

Depth and water clarity – These factors affect whether light can penetrate through the water column to the bottom, allowing plants to grow and therefore provide food and shelter for macroinvertebrates.

Shading – Streamside vegetation provides shading to regulate extreme water temperatures during summer and provides food (leaves, branches and bark) for macro-invertebrates.

Temperature – Some macroinvertebrates cannot tolerate wide variations in temperature or warm water. Dissolved oxygen levels decrease as water temperature increases, which places macroinvertebrates under stress.

4.4.2 Water chemistry

The chemistry of waterways is affected by rainwater, the geology of the catchment, animals in the water and human activities. Chapter 3 details how to use physico-chemical parameters to measure water quality. The following chemical characteristics have an impact on macroinvertebrates.

pH – This is the acidity or alkalinity of the water measured on a scale of 0 to 14 units. A pH of less than 5 or more than 9 units can be toxic to macroinvertebrates.

Dissolved oxygen (DO) - DO is added to water by plant photosynthesis and by water mixing with air as it flows over rocks. Macroinvertebrates take up this oxygen, which is dissolved in water. In still or slow-flowing water with a high density of lowered to dangerous levels (less than 5 milligrams per litre) due to biological activity, disrupts the metabolism of macroinvertebrate species, leading to death.

Nutrients (phosphorus and nitrogen) – These nutrients are essential for life. Still or slow-moving water traps nutrients and silt. If nutrient levels are low, water is clear and macroinvertebrates are sparse, whereas high concentrations of nutrients promote plant growth and abundance of grazing macroinvertebrates.

Salinity (concentration of dissolved salts) - The natural salinity level varies between waterways, though human activities can lead to dramatic increases in salinity. Macroinvertebrates vary in their tolerance to salinity, thus the salinity level at a site will influence the types of macroinvertebrates that are present.

4.4.3 Biological factors

Available food – Food sources for macroinvertebrates come from small aquatic organisms, algae, streamside vegetation, and decaying food particles in the water from upstream. Algal growth is affected by sunlight and nutrients. Overhanging vegetation cover changes along the length of a waterway, varying the availability of this food source, hence the macroinvertebrate composition also changes.

Seasons – Most macroinvertebrates hatch in summer and mature from egg to adult by the next summer, so are easier to identify in spring sampling. Most macroinvertebrates have several life-cycle stages in developing from an egg to a mature adult, at which many live in water. Macroinvertebrates are generally easier to sample when they are further developed, as they are larger and thus easier to catch and identify.

4.4.4 Human factors

Human activities in a catchment or waterway can significantly modify macroinvertebrate communities and, consequently, affect animals higher in the food chain. Effects of such activities include changing the sediment load, clearing stream vegetation and increasing nutrient and effluent input.

Suspended solids – The reduction in light penetration due to suspended solids limits primary productivity and photosynthesis, resulting in reduced DO levels. Sediment deposited on the waterway bed can smother bottom-dwelling communities and fill in holes and depressions, reducing habitat diversity and availability.

Riparian vegetation - Removing riparian vegetation reduces the input of organic matter such as leaves and bark, which are food sources for macroinvertebrates. Additionally, it will increase the amount of light reaching the waterway (that was previously shaded), possibly resulting in increased algal production and increased surface water temperatures – both of which can affect the number and diversity of macroinvertebrates.

Removal of woody debris – Woody debris provides habitat and food sources for some macroinvertebrates. Reducing the variety of habitats available for colonisation decreases macroinvertebrate communities and can destabilise the bed and banks of the waterway.

Barriers – Barriers such as dams alter natural flow water temperature and water chemistry. They also restrict the movement of aquatic animals, often obstructing downstream transport, and disrupt the various life stages of many macroinvertebrates.

Run-off – increases in nutrients from catchment run-off (such as through erosion, salinity or sedimentation) promote algal production, and this change in food supply supports an abundance of grazing macroinvertebrates; however, increased nutrient levels can also increase the suspended solids in the waterway.

Sewage and industrial effluent - Toxic substances such as heavy metals and pesticides can kill macroinvertebrates. Sewage effluent also leads to reduced levels of DO in the waterway, which can affect the macroinvertebrate community. Toxic contaminants and reduced DO levels can result in decreased macroinvertebrate diversity, but may not affect the relative abundance of organisms. This is because some species of macroinvertebrates are tolerant of certain toxicants and/or low levels of dissolved oxygen. Some may even flourish in such conditions, as competition from less tolerant species is reduced. Thus, moderate organic pollution will decrease diversity but the abundance of tolerant species may actually resulting increase.

4.5 Monitoring macroinvertebrates

Macroinvertebrate monitoring can provide an insight into human impacts on waterways. This information can provide a basis for making informed decisions about the health of aquatic ecosystems and whether action is required to address certain human impacts.

4.5.1 What they indicate

Biological monitoring using macroinvertebrate sampling can tell a story about the health of your waterway, which is indicated by the abundance, diversity and composition (whether pollution tolerant taxa are present) of the macroinvertebrate community. Collecting physico-chemical (water quality) samples from the site can only provide information on the conditions at the time of sampling. However, macroinvertebrate sampling can indicate the long-term water quality and physical conditions at the site. This is because most macroinvertebrates spend all or part of their life in-stream and have a limited spatial distribution. If the water quality or physical habitat at a site deteriorates, certain types of macroinvertebrates may become extinct from the site. Therefore, macroinvertebrates can provide evidence of pollution that is not present at the time of monitoring.

Macroinvertebrate monitoring can also provide meaning to your water quality results. For example, you may record an electrical conductivity (EC) reading of 2000 microsiemens per centimetre (mS/cm) at a site; however, it can be difficult to tell whether this EC level is suitable for the health of the aquatic ecosystem, as this differs greatly between different types of waterways. Directly assessing components of the ecosystem, such as the macroinvertebrate community, will give you a more direct measure of the health of the aquatic ecosystem and whether the water quality is acceptable.

Abundance – This is the total number of macroinvertebrates. A high abundance indicates water enriched with nutrients, while a low abundance indicates erosion, toxic pollution or a recent flood event. Most methods do not measure macroinvertebrate abundance because of the time involved.

Diversity (richness) – This relates to the number of different types (taxa) of macroinvertebrates present. Healthy waterways generally have higher diversity than degraded waterways. Communities with high diversity are generally more stable over time.

Composition – This is the proportion of different types of macroinvertebrates (taxa) living together. Healthy waterways generally contain a high proportion of mayflies, stoneflies and caddisflies (Ephemeropterans, Plecopterans and Trichopterans) while degraded waterways tend to contain a high proportion of worms (Nematodes), water boatmen (Hemipterans) and midge fly larvae (Chironomids).

Pollution tolerance – This refers to the ability of macroinvertebrate taxa to withstand organic pollution from sewage, industrial effluent, heated water and other pollution types. For example, worms are quite tolerant of pollution, while most stonefly families are very sensitive and do not survive in polluted waters. Consequently, pollution-intolerant macroinvertebrates are unlikely to be present in degraded water.

4.5.2 Strengths and limitations

Macroinvertebrates are good indicators of waterway health because they:

- Are affected by physical, chemical and biological condition, and can therefore represent the overall ecological health and stream
- Are a critical part of the aquatic food web, as they feed on plants and are eaten by predators
- Cannot easily escape pollution and can consequently indicate the effects of pollution or long term changes
- Are abundant, and easily sampled and identified
- Are relatively cheap and time-effective to monitor
- Live long enough to provide a record of environmental quality
- Respond quickly and are capable of a graded response to a broad range of stress factors
- Are found in most aquatic habitats
- Tend to inhabit small-order streams that do not support other biological indicators such as fish
- Only need to be sampled twice a year, with results staying valid for 2 or more years.

Macroinvertebrates are good indicators of trends in waterway health, as they can reflect various changes in water quality and physical condition, including bank and bed stability, riparian vegetation and in-stream habitat. However, it is also important to be aware of the limitations of using macro-invertebrates as waterway health parameters. These limitations include the following:

- They are unable to indicate the cause of an impact.
- They do not respond to all impacts.
- They do not indicate the presence of micro-organisms that can cause disease in humans.

- They are not as sensitive to altered river flows as other aquatic biological indicators, such as fish because many macroinvertebrates have wings at some stage of their life cycle.
- Natural seasonal variations prevent comparisons being made between samples taken at different times of the year.

4.5.3 How information can be used

Macroinvertebrate sampling can be used for many different purposes, including the following.

Education and awareness – Macroinvertebrate monitoring is an excellent activity for learning about waterways and promoting stewardship of the environment.

Identification of ecological health – Macroinvertebrates can be used for baseline monitoring to develop a picture of stream health over the whole catchment, and to show changes from the headwaters to the mouth. Comparing results with those from reference sites (those not affected by humans, or minimally so) enables you determine whether sites are in reference (good) condition.

This assists with the effective planning of restoration actions. The Queensland water quality guidelines (Environmental Protection Agency, 2009) include biological (macroinvertebrate) guidelines for South East Queensland that have been developed using data from reference sites in the region, to allow the comparison and interpretation of biological monitoring results from that region. There is potential for this to occur in other regions of Queensland.

Identification of waterway health trends – The results of macroinvertebrate monitoring at a site can be used to identify worsening or improving conditions over time.

Identification of pollution impacts – Changes in the abundance and diversity of macroinvertebrates can show the impact of point-source or diffuse source pollution on the waterway.

Restoration activities – When stream restoration or rehabilitation projects are undertaken, or when pollution control efforts are made, macroinvertebrate sampling can be used to assess the effectiveness of such efforts.

Early warning detection of human impacts - By the time decreases in the health of the waterway (such as decreased water quality or physical condition) are noticeable to the human eye, the impacts may be severe or permanent. Macroinvertebrate monitoring can detect these impacts early and therefore trigger the necessary management actions.

4.6 Designing your study

The following questions should be addressed prior to selecting your monitoring methods:

- Where should I place my monitoring site in the catchment?
- Where should I sample in the stream?
- When should I sample?

4.6.1 Where to place monitoring sites in the catchment

The placement of your monitoring sites within the catchment will depend largely on your monitoring objectives. It is also important to consider health and safety issues as well as practical issues, such as whether access to the site is suitable. For general guidance on selecting waterway monitoring sites, refer to Chapter 2.

4.6.2 Where to sample in the stream

Deciding where to sample in the stream is important, as the sample you collect must be representative of the macroinvertebrate community present at the site. As macroinvertebrates are known to prefer specific habitats in the stream, you need to sample the full range of these. In flowing waters, three habitats that have been identified as providing good areas for macroinvertebrate sampling are riffles and runs, pools, and stream edges.

Riffles provide habitat for a diverse range of macroinvertebrates, making them highly desirable sampling sites. Sampling should take place in areas of the stream where the velocity of the current is moderate to high. Conventionally, these are rocky riffles where the flow is rapid and turbulent, but gravel and sand bars can also be sampled as riffle if the water surface is broken.

Stream edge habitats should also be sampled. Your aim when sampling edge habitats should be to include a variety of slow-flowing habitat types. Such habitats include overhanging vegetation, undercut banks, snags and logs, backwaters, leaf packs and bare edges.

Pools provide habitat for a number of macroinvertebrates that do not occur in riffle or stream edge habitats. Although pool habitats do not support species diversity as high as riffle or edge habitat, they should still be sampled whenever present at a site because the macro-invertebrate taxa found in pools will usually be different to those found in the other habitat types.

No matter which habitats are present at your site, you should sample in roughly the same place each monitoring session to enable genuine comparisons to be made between data collected during different monitoring sessions.

4.6.3 When to sample

Sampling should occur twice a year, preferably in spring and autumn. To minimise physical damage to the site, sampling should occur no more than four times a year. Spring samples will contain specimens of insects hatched the previous summer, making them easier to identify (as adult insects generally have more distinguishing features). Autumn samples will be representative of lower flows and higher temperatures, when pollution inputs may have a higher impact. Regardless of what time of year you decide to sample, it is important that sampling occur at roughly the same time in future years to enable data comparison.

For general guidance on deciding when to monitor, refer to Chapter 2.

4.7 Choosing your monitoring methods

Once you have decided where and when to monitor, you need to choose the monitoring methods that you will use. Your choice of method will be affected by the level of data quality (macroinvertebrate identification) you require to achieve your project objectives, the level of skill your group possesses in identifying macro-invertebrates, and your available resources.

The Queensland Community Waterway monitoring manual provides three methods to choose from (Table 4.3). Method 1 generates a demonstrative level of data quality, as only selected macro-invertebrates are identified to order level. These assessment methods are most suited for groups who are focused on increasing education and awareness.

Methods 2 and 3 are suitable for generating indicative and analytical data, respectively; however, the success of these methods will depend on the expertise and experience of the persons collecting the data, and the quality control measures undertaken. To choose the most appropriate method for your project, refer to Table 6–3. Consider your required data quality and your available resources (time, budget and skills).

This manual focuses on method 2, which is the method recommended for community groups who are supported by trained staff from the City of Gold Coast or elsewhere.

If you are aiming to measure a change over time (baseline condition and trend monitoring, impact assessment or restoration assessment) or to compare sites to one another, it is especially important to think about the level of data resolution and sensitivity that you require. Are you hoping to detect differences of small or large magnitudes? The method that you use, particularly the level of macro-invertebrate identification that you undertake, will influence the ability of your data to indicate differences between sites or over time. This is because macro-invertebrate taxa have varied tolerances to poor water quality.

For example, mayflies belong to the order Ephemeroptera (of which there are six families in Queensland). Most mayflies are sensitive to poor water quality; however, a small number of families are fairly tolerant. Therefore, it would be necessary to identify which families are present in your sample to determine whether any sensitive taxa are present. If you only identified your sample to order level, rather than family level, you may conclude that the water quality was good at the site even though only the tolerant mayfly families may be present.

In such cases, Method 1 will not generally be able to detect changes to the biological health of the waterway over time or across the catchment. Method 2 may be able to detect major changes only, and Method 3 should be able to detect more minor changes.

However, rapid bioassessment methods in general (on which all the methods in this manual are based) are only designed to detect broad-scale changes to the health of the waterway.

If you aim to detect minor changes to the macroinvertebrate community at a site, quantitative monitoring methods that measure the abundance and diversity of macro-invertebrates at a site and identify them to species level are probably the best option. However, keep in mind that this type of monitoring can be very costly, and requires a very high degree of experience and training in macroinvertebrate identification.

Table 4.3. Methods guide for biological monitoring

	Method 1	Method 2	Method 3
Data quality produced	Demonstrative—only selected macro-invertebrates are identified to order level, using their common names (e.g. freshwater shrimp, water boatman, dragonfly nymph).	Indicative—all macro-invertebrates are identified to order level.	Analytical—macro-invertebrates are identified to family level.
Who is to use data	Internal sharing of data	External sharing of data with: • catchment, Landcare or Waterwatch groups • landholders • schools • industry groups	External sharing of data with: • regional bodies • state agencies • universities • private consultants • local government • regional bodies • industry groups
Suitability for type of monitoring	Baseline monitoring (only snapshot assessment)	Baseline monitoring Ambient monitoring	Baseline monitoring Impact assessment (indicative use only) Restoration assessment (indicative use only) Compliance monitoring
Reasons for monitoring	• Increase community understanding and awareness • Increase community skills	• Increase community understanding and awareness • Increase community skills • Establish a baseline (identify current condition) • Monitor trends through time to identify decline or improvement in condition	• Increase community understanding and awareness • Increase community skills • Establish a baseline (identify current condition) • Monitor trends through time to identify decline or improvement in condition • Assess impact of a land use or pollution source (indicative use only) • Assess effectiveness of a management action (indicative use only)
Knowledge and skills	Beginner—groups with no or little experience (e.g. new community groups, primary and secondary students).	Some experience—groups with some experience and training who can identify macro-invertebrates to order level (e.g. community groups and upper secondary students trained by a group coordinator or equivalent). Only major body features need to be identified.	Significant experience—groups with extensive experience, skills and training who can identify macro-invertebrates to family level (e.g. experienced community groups trained by an aquatic ecologist or group facilitator with equivalent knowledge). Requires patience, knowledge and identification on the basis of subtle differences.
Time	Sampling procedure takes less than 1 hour but the activity may take longer due to education and training content. There is no requirement for how often sites should be visited.	Sampling procedure takes approximately 1–2 hours. Processing sample (identification of macros) in field takes a further 1–2 hours. Sites should be visited twice in a year (autumn and spring) for a single assessment.	Sampling procedure takes approximately 2 hours. Processing samples in laboratory takes approximately 2 hours per site sample for an experienced picker. Sites should be visited twice in a year (autumn and spring) for a single assessment.

The above methods are based on the rapid bioassessment methods currently used for most biological assessment across Australia. Rapid bioassessment is designed to enable swift evaluations of stream health to be made using biological indicators (normally macro-invertebrates), through cost effective, scientifically valid procedures. Rapid bioassessment is not suitable when the objective of the study is to collect high-level data for the following reasons:

- To assess the impact of a land use or pollution source (impact assessment)
- To assess the effectiveness of a management action (restoration assessment)
- To investigate causes of a particular water quality or river health program (investigative studies)

To meet the above objectives using biological (macro-invertebrate) monitoring methods, identification of specimens to species level would be required.

4.8 Safety considerations

Personal safety while conducting macroinvertebrate sampling is based on the management of potential risks. Always remember that personal safety comes first and that no task is so important that safety should be compromised. Some considerations for your safety when undertaking sampling include the following:

- Always let someone know where you are and how long you will be.
- Do not undertake monitoring alone or at night.

- Choose a site to sample that is safe and easy to access.
- Do not sample in areas that are heavily polluted or have toxic algae outbreaks.
- Wear appropriate clothing and footwear
- Wear gloves when sampling – even though the water may look clean, it may not be safe.
- Take fresh drinking water with you – never drink the water that you are sampling.

For a more comprehensive review of health and safety risk management, refer to the ***Health and safety guidelines for community-based waterway monitoring*** (Department of Natural Resources and Water 2006).

4.9 Method 2 for monitoring macroinvertebrates

4.9.1 Method overview

The objective of this method is to increase community understanding and awareness of stream health and, at the same time, monitor major trends to identify a decline or improvement in stream condition. To successfully achieve this, training by an individual experienced in the study of macroinvertebrates is required before commencing sampling. Identification of specimens is primarily carried out to the order level of taxonomy, drawing on numerous macro-invertebrate identification resources. Order-level data is used to calculate a SIGNAL 2 score that provides an indication of stream health at the sampling site, based on modelled sensitivities of the macro-invertebrates collected. This method can produce indicative, intermediate-quality data when identification is carried out accurately. Ideally, this level of monitoring would be appropriate for high school students or catchment, Landcare, and Waterwatch groups aiming to monitor broad trends in stream condition over time and roughly assess the general health of the waterway.

4.9.2 Equipment

For this method, you will need:

- A triangular dip net (250mm x 250mm x 250mm);
- A white plastic sorting tray;
- Tweezers and pipettes;
- Rubber gloves (for polluted sites);
- Waders;
- A bucket (for collecting stream water for sorting tray);
- An ice cube tray;
- A pencil (for writing on field sheets);
- A copy of sampling procedures;
- The method 2 record sheet (see Appendix C);
- Spoons and brushes.

4.9.3 Where to sample

Separate sampling of each habitat type is recommended because each habitat has a potentially distinct array of fauna. Riffle habitat generally has high levels of both abundance and diversity, making it ideal for macro-invertebrate sampling. Therefore, whenever riffle habitat is present at a site, it should be sampled. Edge and pool habitats are the other major types of habitat where macroinvertebrates tend to occur in large numbers. As edge habitat is always present, it can provide valuable data for comparing macroinvertebrates at different sites. Regardless of which types of habitat you sample at a site, it is important to conduct all sorting and analysis of each habitat separately. Generally, if a habitat makes up more than 10% of the stream reach, it should be considered for sampling.

4.9.4 Data confidence procedures

To ensure that your data is of the desired intermediate standard, the following measures are recommended:

- Check sampling nets for holes, and repair if necessary;
- Collect as close to 200 fauna specimens as possible so that the macro-invertebrates collected provide a fair representation of those present at the site.
- Sample in the same habitat areas for each monitoring session at given site;
- Compare your findings with previous results or with those of other groups within the region;
- Have at least one experienced and trained person present for each monitoring session.
- Disinfect equipment between sampling

4.9.5 Collecting your sample

All macroinvertebrate samples should be collected with a triangular mesh dip net. The two types of sampling methods used are kick and sweep sampling. Kick sampling is primarily used for sampling bed and riffle habitats, while sweep sampling is used for sampling edge habitats. A total distance of 10 metres should be sampled across each habitat (bed and edge) covering a variety of velocities and stream features.

Sweep sampling

This method is best suited to stream edge, pool and backwater habitats with vegetation overhanging from the stream bank, aquatic plant (macrophyte) beds, undercut banks, root mats, leaf packs, woody debris, and other stream features that provide suitable living places for macroinvertebrates. The following steps are recommended in order to gain the truest representation of a site's macroinvertebrate community when conducting sweep sampling:

1. Insert the net among the key features of the habitat (such as overhanging vegetation) and use a short, upward-sweeping movement at right angles to the bank. Stir up the bottom while doing so, ensuring that bottom-dwelling animals are suspended and then caught when sweeping through the cloud of suspended material. Continue this procedure along 10 m of the habitat to sample the full range of stream features.
2. Stop regularly to rinse mud and fine silt out of your net. The sample should be free of sediment prior to sorting. An easy way to rinse your net without losing your sample is to wash water into the side of your net while you are holding it with the mouth of the net pointing upwards above the water.
3. Once finished, scoop the net out of the water in a forward motion to prevent fauna from escaping. Flush the net with water to remove any remaining sediment prior to sorting.
4. Empty the contents of the net gently into about 2 cm of clear stream water in a white sorting tray. Rinse down the sides of your net into the tray to ensure that you transfer the full sample into the tray. Pick off any stray macro-invertebrates still clinging to the net using a pair of tweezers.

Kick sampling

This method is designed for sampling stream bed habitats and can be used to sample a range of depths and flows. It is performed most effectively in riffles – fast flowing, rocky sections of the stream bed – where the highest diversity of macro-invertebrates is generally found. However, kick sampling is also an effective method for sampling silty or sandy beds and rocky or gravel beds in slightly slower-flowing sections of the stream. All types of bed habitat present at a site should be sampled using the kick method.

The following steps are recommended in order to gain the truest representation of a site's macroinvertebrate community when conducting kick sampling:

1. Approach the sampling area from downstream to prevent disturbing fauna prior to collecting.
2. Holding the net downstream with its mouth facing the sampling area upstream, disturb the stream bed by digging your foot underneath the stones and turning them over. Macroinvertebrates will become suspended in water and will be pushed into the net by the flow of the stream. If there is little or no flow, you will have to use a short sweeping action with the net while stirring up the bed.
3. If you encounter large rocks, place them in the net by hand and rub off fauna any into the net before placing the rock back on the stream bed.
4. Stop regularly to rinse mud and fine silt out of the net.
5. Repeat these procedures over a distance of 10 m, aiming to sample the full range of flow velocities and key features of the bed habitat.
6. Once finished, scoop the net out of the water in a forward motion to prevent fauna from escaping. Flush the net with water to remove any remaining sediment prior to sorting.
7. Empty contents of the net into 2 cm of clean water in the white sorting tray.
8. Before taking another sample, rinse the net so that all fauna and debris are removed.

4.9.6 Sorting your sample

Keep your kick and sweep samples separate. Mixing samples from different habitats is not recommended, as each habitat supports a distinct community of macroinvertebrates. This enables comparisons to be made between the same types of habitat at different sites. Sample sorting should be conducted at the site or nearby possibility (safety reasons), thus enabling the return of all organisms to the waterway once they have been noted on your record sheet.
To make certain that adequate quantities of fauna are collected from the sample, 100 to 200 specimens should be moved from the sorting tray to the ice-cube trays. Sorting generally takes an individual between 30 minutes and 1 hour, depending on their experience and the fauna abundance of the site. Effective sorting of your sample can be accomplished by adhering to the following guidelines:

1. Distribute your sample out over the bottom of a white tray. Spend a moment to observe the movement, body shape and colour of the fauna within the sample.
2. Pour 1 cm of water into each of the wells of your ice-cube tray. Pick through the sample in your sorting tray and use a pipette, tweezers, spoon or brush to transfer your fauna to the wells in the ice-cube tray.
3. Transfer any fauna that you see from the sorting tray into the ice-cube trays during the initial 20 minutes. Place each macroinvertebrate type into a separate well of your ice-cube tray. Only one specimen of each taxon is needed.
4. For the following 10 to 20 minutes, focus particularly on fauna that are uncommon.

If, after 30 minutes, you discover a macroinvertebrate you had not previously seen, sort for a further 10 minutes. If, in that 10 minutes, another new specimen has been found, sort for another further 10 minutes. Continue until no new specimens are found.

5. Return the fauna to the water once you have finished, as close to the collection site as possible.

4.9.7 Processing your sample

Identify the macroinvertebrates in your sample to order level using the macro-invertebrate identification sheet, or other identification resources listed in Appendix D. If you come across a macro-invertebrate that you cannot identify, record this on your record sheet, describing what it is you have found. Take a picture and check your findings with a local macro-invertebrate expert – such as your monitoring coordinator – and various macro-invertebrate guides. Once you have identified each specimen using the identification booklet, record which fauna were found at your site by filling out the macroinvertebrate record sheet. Remember, it is best to keep the data for each habitat type separate.

4.9.8 Calculating results

SIGNAL 2 score—order

The impact of pollution on Australian macroinvertebrates can be assessed using the SIGNAL 2 Index. Each taxon has been given a sensitivity score from 1 to 10 based on its modelled sensitivity to pollution. The higher the sensitivity score of a taxonomic group of macroinvertebrates, the greater its pollution sensitivity.

The SIGNAL 2 score is calculated by averaging the pollution sensitivity scores of the macroinvertebrate groups (generally, orders) present at the site. The SIGNAL 2 score should be calculated separately for each sample from a different habitat type. To determine the overall score for the site, the resulting scores for each habitat type should be averaged. The macroinvertebrate record sheet provides the sensitivity grades for common macroinvertebrate orders. The survey sheet is designed to assist you to calculate the SIGNAL 2 scores for your site.

4.9.9 Interpreting results

The table below is a summation of stream health based on the value of a SIGNAL 2 score at a site. It is important to remember that only samples collected from the same type of habitat using the same sampling methods should be compared.

Table 4.4 Interpretation of SIGNAL 2 scores (adapted from Gooderham & Tsyrlin 2002)

Signal 2 score	Habitat Quality
Greater than 6	Healthy habitat
Between 5 and 6	Mild pollution
Between 4 and 5	Moderate pollution
Less than 4	Severe pollution

Developing a SIGNAL 2 score using specimens identified to order level is a far more accurate means of assessing waterway health than the basic method used in this chapter. However, it is worth noting that macro-invertebrate orders may consist of many different families, therefore an assessment will be far more accurate with identification to family level. It is also important to take into account that many waterways naturally have macro-invertebrate communities with low SIGNAL 2 scores – this is often the case in ephemeral streams – so caution needs to be taken when assessing stream health based entirely SIGNAL 2 score results.

5. Occupational Health and Safety

Occupational health and safety is the primary consideration before, during, and after monitoring

In Safe Hands, A Safety Management Toolkit for Community Groups in Practical Conservation, Conservation Volunteers Australia

5.1 Responsibilities and management of OHS issues

The following table outlines the responsibilities and risk management procedures related to Community Monitoring within the City of Gold Coast.

Table 5.1. Responsibilities for management of OH and S issues

Responsibilities	Risk management
1. OH&S responsibilities of NSW Waterwatch and host agencies	• Providing training to groups in OH&S relevant to the Waterwatch group**.**
2. Identify hazards	• Waterwatch protocols regarding water testing risks – site and chemical usage. • Monitoring risk assessment pro forma included (Appendix A). • Discussions with groups to identify specific actions to minimise risk – access to site for disabled participants – recorded on log.
3. Assessing risks	• Identify hazard (risk assessment) • Using the risk score assessment matrix, determine the priority action.
4. Develop and Implement actions	• From the risk score assessment matrix, calculate a risk score. • Identify the actions necessary to eliminate or control the risk. • Complete the risk assessments and store in a safe office space.
5. OH&S requirements	• The Waterwatch field manual contains the personal protective equipment (PPE) and other OH&S recommendations for the program. • Within the manual, participant OH&S requirements are identified. • Training is provided on how to incorporate OH&S into water testing activities to ensure safety when using chemicals.
6. Monitor OH&S arrangements	• Incident reporting sheets completed. • From incidents reported, the hazard assessments are reviewed and updated. • A record of the latest version is dated and included on the assessment sheets.

5.2 Risk Assessment

A risk assessment is required each time monitoring takes place. The purpose of a risk assessment is to:

- identify potential hazards that participants may be exposed to;
- assess the level of risk associated with the hazard;
- implement and enforce corrective measures to eliminate/control or reduce the level of risk of hazards according to the hierarchy of controls (write a work method statement where necessary)
- review risk assessment and evaluation of the effectiveness of the corrective measures.

Participants should be aware of the following risks:

What can harm you – potential hazards	What can happen – outcomes/consequences
UV radiation (sunlight)	• Sunburn
Walking on uneven ground	• Slip, trip fall
Unstable riverbanks/steep banks	• Slip, trip fall
Water hazards	• Drowning, water contamination and impact on hygiene
Vegetation – long grass, weeds	• Rashes/cuts
Fencing – barbed wire, star pickets, electric fences	• Injury related to hazard: cuts and scratches
Hazardous objects/syringes	• Needle stick injury
Hot/cold weather	• Exposure to the elements
Outdoor environment – snakes, insects, spiders, water	• Bites and stings; falling in/drowning
Carrying equipment – long poles	• Electrocution from power lines/electric fences
Travel, transport, public places	• Accidents travelling to site; strangers in public places such as toilets

5.3 Risk Management

It is the responsibility of the group coordinator to ensure the following action is taken:

- A risk assessment is completed each time the site is visited using the pro forma provided, as conditions may change over time.
- A volunteer list is compiled for each field event.
- The group coordinator will mark off and confirm a list of participants who are actually present before and after the event.
- Volunteers are to be warned of the risks at the site and safety procedures explained to the trainees as a group.

This warning will cover the following issues.

Water hazards
• Use the buddy system when collecting water samples.
• Develop procedures for emergency events such as flash flooding and/or sudden stormwater discharges.
• Beware of water quality contamination and ensure personal hygiene and protection.
• Handle water samples as little as possible.
• When sampling in high risk areas (e.g. stormwater drains), wear latex gloves.

Mosquitoes

• Mosquito repellent should be made available when Community monitoring occurs. However, this should not be used when entering the water for sampling to avoid contamination.

Sun sense

• Sunscreen is to be made available when Community monitoring occurs.
• Hats are to be worn at field locations.

Syringes

• Dispose of syringes safely in a sharps container or move to another location and notify council staff if in a public place.

Wildlife hazards (snakes, spiders, etc.)

• Be aware of potential hazards which may arise depending on the site.

Clothing and footwear

• Volunteers will **only** be trained if wearing enclosed footwear and the appropriate clothing.

First aid

• First aid kits will be fully stocked and taken on all field trips.
• Clean water will be available for dealing with spills or chemical contact.
• A mobile phone will be available on all field trips.

Appendix A: Risk Assessment checklist

Please note: Site hazards change over time at the same site. Complete a risk assessment and priority **each time** a Waterwatch monitoring activity occurs at a site.

Group name: ....
Location: ....
Date of monitoring: ....
Group coordinator: ....
Contact numbers: ....
Special needs: ....

Hazard/risk identification
Preliminary site inspection and assessment completed
Date: ....
Assessed risk level (see matrix, next page)
Risk management plan – Management/control measures
Who?

General: all emergencies Mobile phone and first aid kit carried in support vehicle.
Staff responsibilities agreed and emergency numbers known to all; vehicle access to site, base staff know of whereabouts and expected time of return.

Environmental hazards: weather
☐cold weather
☐heat, UV rays
☐extreme weather events, e.g. wind, storms, flash flooding
☐Checking, warning, avoidance. Protection and shelter.
☐Cold weather – take warm clothing.
☐Sun – appropriate clothing, hat, sunscreen and water bottle.
☐Extreme weather – alternative sheltered location, checking, warning.

Environmental hazards: insect/plant/animal
☐snakes
☐mosquitoes and insect pests
☐trees and branches in windy conditions
☐Warnings issued. Check sites. Avoid high risk sites.
☐Insect repellent, sunscreen and water at each site.
☐Checking trees, warnings and alternative venue.

Site surface and dangerous objects
☐needles, broken glass
☐rough or uneven terrain – slipping, tripping, grazes and sprains
☐barbed wire and electric fences/wires
☐Site check, explicit instructions prior to activities, sharps container.
☐Wear enclosed, sturdy footwear.
☐Liaison with landholder prior to training.
☐Carry poles horizontally.

TEMPL ATES AND CHECKLISTS **3–9**

Hazard/risk identification
Preliminary site inspection and assessment completed
Date: ....
Assessed risk level (see matrix, next page)
Risk management plan – Management/control measures

Who?

People

existing medical conditions
allergic reactions
Pass on information regarding existing and potential
conditions.

Water testing activities (cross out if it does not apply)
use of chemicals
use of equipment
carrying equipment, e.g. poles
Explicit instructions regarding use of chemicals.
Supervision of participants.
Safety equipment – rubber gloves and safety glasses.
Carry poles horizontally.
Proximity to water
drowning
health issues – dirty water, mud and sediment
Supervision, no swimming, work with a buddy.
Wash hands thoroughly after contact with water. Gloves on request.

Risk assessment matrix
How likely is it to be serious?
Consultation prior to monitoring:
Date: Consulted with (signature)
How serious could the injury be?
Very
likely
Likely Unlikely Very
unlikely
Death or permanent disability 1 1 2 3 Persons exposed to risk: Attach list of participants and special needs (e.g. wheelchair access)
Long-term illness or serious injury 1 2 3 4
Medical attention and several
days off
2 3 4 5
Comments:
First aid needed 3 4 5 6

Appendix B: Monitoring Plan Worksheet

Name of group ____ Date (dd/mm/yy) ___/___ /___

Group leader ____

Email ____ Phone: ________________________

(Sub)catchment ____

Name of Project ____

Part A: Set Monitoring Objectives	
Q1 Why are you monitoring?	*You may have one or several reasons, such as to:* • *Increase community awareness* • *Increase community skills* • *Assess the current condition using a snapshot (once-off) survey* • *Assess current condition by identifying and establishing baseline values* • *Monitor trends through time to determine decline or improvement in condition* • *Establish baseline values*
Q2 Who will use the data? ☐ Members of your group ☐ Landholders ☐ Catchment groups ☐ Landcare groups ☐ Regional NRM bodies ☐ State Government agencies ☐ Universities ☐ Local Government agencies	*Develop a list of potential stakeholders. Tick all the data users that may use your data*
Q3 How will the data be used?	*Data can be used differently by different organisations (e.g. the community may collect data to increase awareness but government may report on the data. Other examples include to:* • *Determine the general health of the local creek* • *identify major water quality issues or 'hot spots'*

	• *develop a catchment management plan* • *evaluate the effectiveness of river restoration work* • *Develop eater quality objectives* • *Assist with academic research*
Q4 What data quality do you require?	*Please circle*

Details of categories	Data quality categories		
	Demonstrative	Indicative	Analytical
Accuracy and precision of data Tolerable error range (TER)*	Lower level High (e.g. > 50% for physico-chemical monitoring)	Intermediate level Medium (e.g. 10–50% for physico-chemical monitoring)	Higher level Low (e.g. < 10% for physico-chemical monitoring
Data uses	Demonstrate general waterway condition Raise community or school students' awareness about waterway health concepts and issues Train in general waterway monitoring techniques	Indicate general waterway condition Identify major trends over time	Assess specific waterway conditions Identify minor trends over time Contribute to State of the Environment reporting Assist government agencies to refine or develop water quality guidelines

Developing an Objectives Statement	*Examples of objective statements:*
Now you have identified why you are monitoring, who will use your data and how it will be used. You will also have defined what data quality you require. You will to finalise your project objectives by summing up your objectives into a statement or question.	• *This project will measure turbidity in Smiths creek after rain evens to assess hotspots for sediment delivery.* • *This project will assess current stream health through Nerang catchment to establish baseline conditions.* • *This project will investigate the effectiveness of riparian plantings and stabilisation works on Jones' Farm.* *Another way to define your objectives is to state them as a question:*

	• *Is water quality in the Crane Creek catchment within recommended guidelines?* • *Is the condition of Wyangan Creek declining over* time?

Appendix D: Macro-invertebrate identification guides

Gooderham, J & Tsyrlin, E 2002, The waterbug book: a guide to the freshwater macroinvertebrates of temperate Australia CSIRO Publishing, Collingwood, Victoria.

Hawking, JH 1994, A preliminary guide to keys and zoological information to identify invertebrates from Australian freshwaters, Cooperative Research Centre for Freshwater Ecology, Albury, New South Wales.

Hawking, JH & Smith, FJ 1997, Colour guide to invertebrates of Australian inland waters, identification guide no. 8, Cooperative Research Centre for Freshwater Ecology, Albury, New South Wales.

Ingram, BA, Hawking, JA & Shiel RJ 1997, Aquatic life in freshwater ponds, Cooperative Research Centre for Freshwater Ecology, Albury, New South Wales.

Interactive guide to Australian aquatic invertebrates, 2nd edn, 1999, CD-ROM, CSIRO, Canberra.

Miller, R 1983, Freshwater invertebrates, Gould League of Victoria, Moorabbin.

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