**GSLN Streamwatch Manual Contents**

1. Introduction 3

Welcome to Streamwatch 3

Now you have joined Streamwatch, what’s next? 3

2. Streamwatch Volunteer Work Health and Safety 5

WHS Overview 5

Contextual Framework: GSLN Policies and Procedures 5

Roles and responsibilities 6

Streamwatch Coordinator, 6

Streamwatch Volunteers 7

Expectations of GSLN 7

Expectations of Volunteers 8

Risk Assessment 8

Site Hazard Assessments 8

Site Closures 8

Safety Advice: Suspension of Streamwatch Activities 9

Safety Equipment and Personal Protective Equipment (PPE) 9

Safety Equipment 9

Personal Protective Equipment 9

Training in Use of Chemicals and Equipment 10

Usage of Chemicals 10

Safe Storage of Chemicals 11

Safe Disposal of Chemicals 11

Documentation 11

Environmental Protection 11

Sensitive Environments 11

Heritage Items 12

Frog Health: Chytridiomycosis 12

3. Methods 13

Safety 13

Collecting Water Samples 14

Testing methods 16

Temperature test 16

pH test 17

Electrical conductivity test 18

Turbidity test (NTU) 19

Supplemental Turbidity (FTU, FAU) optional 20

Dissolved oxygen test 21

Available Phosphate Test 23

Petrifilm method E. coli 24

Caring for your equipment 25

4. Scientific Rationale 27

Background to the tests 27

Temperature 27

pH 28

Electrical Conductivity (EC) 28

Turbidity 29

Dissolved oxygen (DO) 30

Phosphates 32

Faecal Coliforms – E. Coli 34

Interpreting your results 35

Streamwatch Water Quality Guidelines 37



# 1. Introduction

## Welcome to Streamwatch

Streamwatch is a citizen science water monitoring program that enables community groups to monitor the quality and health of local waterways. This water monitoring program is run by Greater Sydney Landcare Network (GSLN). Previously run by Sydney Water and the Australian Museum, Streamwatch has played an important role in investigating and caring for the local environment over the past 30 years.

Streamwatch groups, made up of community volunteers, engage in the scientific observation of local waterways. Streamwatch data can be used as an early warning system for pollution events and to provide a historical record of how waterway health has tracked over time. The data may also be helpful in evaluating the effectiveness of remediation projects, changed management practices and improved infrastructure. Valid water quality data, collected by Streamwatch groups, can help inform the wider public, landowners, land managers, local councils, universities, research organisations, catchment and water management authorities on the health status of local waterways.

This manual is to be used by Streamwatch groups that use a sampling kit. Sampling kits enable groups to perform water quality tests covering parameters of temperature, pH, electrical conductivity, turbidity, phosphates, dissolved oxygen concentration and *E.Coli*.

The program has strong quality assurance elements built in to ensure that results are sound, reliable and useful. All Streamwatch groups are required to follow the methods included in this manual and use Streamwatch approved equipment if they are to enter their results into the Streamwatch website.

## Now you have joined Streamwatch, what’s next?

As a registered Streamwatch group you will have met your Streamwatch Coordinator, contributed to site hazard assessments, ensured members have submitted volunteer forms to GSLN and received training in the Streamwatch tests and safety procedures. Registered groups are able to carry out sampling at approved sites and enter collected data into the Streamwatch website.



GSLN supports Streamwatch groups in a number of ways:

* training and technical advice on use of Streamwatch equipment and methods
* assistance with analysing water quality results
* verifying Streamwatch data collected by their groups
* keeping groups up to date and informed.

You can find useful information about catchments, water quality, biodiversity, events, water quality data, contact information and more on the GSLN Streamwatch webpage.

<https://greatersydneylandcare.org/category/streamwatch/>



# 2. Streamwatch Volunteer Work Health and Safety

## WHS Overview

GSLN is committed to providing a safe and healthy working environment for our volunteers. All members of the GSLN community have a collective and individual responsibility to work safely and be engaged in activities to help prevent injuries and illness.

The GSLN overarching Work Health and Safety Policy aims to have no accidents, injuries, or workplace illnesses caused by our activities, and to improve the health and wellbeing of people working for or on behalf of GSLN. The GSLN Work Health and Safety Policy defines the principles of this commitment and the GSLN approach to the continuous improvement of health and safety in the workplace.

The Streamwatch Work Health & Safety requirements fall under the GSLN Work Health and Safety Policy and outlines the safety procedures for the GSLN Streamwatch program during field activities and when working in or near water. It identifies hazards and sets out work health and safety resources and responsibilities.

**Streamwatch volunteers are those who have submitted a completed GSLN volunteer form and are a member of a registered Streamwatch group.** In accordance with the policy, participants are responsible for their own safety when participating in the program. The Streamwatch Coordinator will advise on and monitor compliance with the Streamwatch process and procedures.

## Contextual Framework: GSLN Policies and Procedures

All GSLN policies and procedures apply throughout the duration of field activity, and in particular, staff and volunteers must be aware of Policies and procedures, which are accessible on the GSLN website:

* Safety and Environmental instructions in this Manual
* GSLN Streamwatch Standard Testing Guide
* Streamwatch Fieldsheet
* Material Safety Data Sheets: both Summary and full information sheets
* Work Health and Safety Policy (2013)
* WHS Policy Appendix A (2016)
* GSLN Site Hazard Assessment
* WHS Induction for Landcare Groups (2016)
* Streamwatch Group Agreement (2020)
* WHS Assessment for Landcare Events
* Code of Conduct
* Social Media Policy

<https://greatersydneylandcare.org/category/streamwatch/>

Other regulations that field work participants need to be aware of include:

* Statutory requirements such as those relating to flora and fauna collecting
* National Parks regulations, entry into designated areas, cultural sensitivities etc.
* Legally binding safety requirements such as Work Health and Safety Regulations, Codes of Practice, Australian Standards and Industry Codes.

## Roles and responsibilities

### Streamwatch Coordinator,

The Streamwatch Coordinator, is in charge of field work and has particular responsibilities for safeguarding the health and safety of all participants and must:

* determine the possible hazards that may be encountered during the activity
* assess the risks associated with the possible hazards
* incorporate strategies to eliminate or avoid the risks to safety and health and if this is not possible, to minimise these risks
* ensure that participants in field work are aware of relevant GSLN and Streamwatch policies procedures and other regulations
* ensure that safe working practices are developed, communicated and maintained
* ensure that all field work participants are adequately trained and instructed in safe and healthy working procedures pertinent to the site
* ensure that participants are trained in correct use of safety equipment
* ensure that first-aid and safety equipment is maintained and serviced and adequate for workshops and associated field work undertaken
* be responsible for all practical matters relating to the use of vehicles, including the sighting of licenses
* keep a list of participants’ emergency contact details.

The Streamwatch Coordinator is responsible for supervising registered volunteers, maintaining safety equipment and reporting incidents within required time frames. The Streamwatch Coordinator must assess all sites using the Site Hazard Identification and Assessment Checklist during a site visit prior to any group commencing work. The records of site inspections must be stored securely.

When working with participants, the Streamwatch Coordinator, will require that volunteers:

* are not engaged in activities which they have not received appropriate training/information
* conduct Streamwatch activities with a minimum of two people
* are aware of the relevant safety information prior to commencing work.

The Streamwatch Coordinator must have approval from a GSLN Committee member before implementing a variation to any risk control at a field work site. The GSLN Committee member will assess the proposed variation based on the Site Hazard Identification and Assessment.

### Streamwatch Volunteers

Streamwatch volunteers are those participating in unpaid volunteering with the Streamwatch program. All volunteers must be at least 18 years of age. Following the GSLN Work Health and Safety Policy and procedures, Streamwatch participants in field work are responsible for ensuring good safety and health by:

* undertaking relevant work health and safety training
* reading any notices relating to the field activity, attending any briefing sessions and returning any necessary forms to the Streamwatch Coordinator
* taking action to eliminate, minimise, avoid or report hazards of which they are aware
* complying with all work health and safety instructions
* making proper use of safety devices and PPE
* maintaining dress requirements appropriate for the work undertaken
* not placing at risk the safety and health of themselves or any other person
* being aware of the relevant GSLN policies, procedures and protocols and other regulations as per the GSLN Work Health and Safety Policy and procedures.

The Streamwatch volunteer group representative must ensure that all volunteers in the group adhere to the above responsibilities.

The Streamwatch Coordinator must ensure that Streamwatch volunteers are:

* engaged only in activities for which they have received appropriate training/information
* Know and utilise appropriate PPE when conducting field work.

Prior to commencing volunteer work, Streamwatch Coordinator, must induct the volunteers in:

* general safety requirements of activities outlined in the GSLN Work Health & Safety Policy
* hazards and controls of the specific site where monitoring is to be undertaken.

Streamwatch participants will indicate their acceptance of GSLN policies inclusive of current WH&S policies, guidelines and protocols, by submitting a fully completed GSLN Volunteers Form and Streamwatch Group Agreement form. In addition, prior to commencing work, the volunteers must accept the conditions by signing the Field Attendance Table on the Streamwatch Fieldsheet. GSLN cannot cover volunteers under the age of 18 years. Those under the age of 18 years can participate in Streamwatch activities under the guidance of a parent, teacher or guardian that has completed the GSLN Volunteer Form. However, it is not recommended that those under 18 years handle any chemicals involved in some testing procedures.

### Expectations of GSLN

For Streamwatch volunteers, GSLN will:

* Provide coordination of volunteer programs
* Abide by and ensure staff abide by all relevant policies, guidelines and procedures
* Provide Public Liability insurance coverage
* Provide Personal Accident insurance coverage
* Provide access to grievance procedures.

As stated previously, GSLN does not accept volunteers under the age of 18 years and therefore the above provisions and coverage will not be provided to minors. If groups have participants under the age of 18 years of age, the group themselves must organise their own insurance to these members.

### Expectations of Volunteers

The volunteer will:

* Support GSLN mission and purpose
* Undertake initial and ongoing training and appraisal if appropriate
* Perform all tasks in a responsible, conscientious, courteous and safe manner
* Abide by all relevant policies, guidelines and procedures
* Not engage in supported activities, while under the influence of drugs including alcohol
* Notify the Streamwatch Coordinator, if he or she intends to stop volunteering or is unable to continue as a volunteer.

## Risk Assessment

### Site Hazard Assessments

The Streamwatch Coordinator will carry out a Site Hazard Assessment (SHA) using the Site Hazard Identification and Assessment Checklist on your sites. SHAs establish whether or not a site is safe for Streamwatch activities. Each SHA captures vital hazards and identifies safety controls. This information is recorded on the Streamwatch website where it is readily available to Streamwatch groups. Streamwatch activities can only be conducted at sites with an approved SHA, registered on the Streamwatch website and assigned to a group.

When a site is assigned by the Streamwatch Coordinator, the nominated group representative must accept the conditions described in the SHA and adopt any safety controls identified. Only then, can the group undertake Streamwatch activities at the site and upload site visit data.

SHAs are performed on existing sites when a Streamwatch Coordinator attends the site, or as required by changes in hazards and safety controls. Nominated group representatives are responsible for reporting any changes in these conditions. To do this they must check the site conditions are consistent with the SHA every time they carry out a site visit.

### Site Closures

Individual sites may be closed temporarily or permanently, due to localised changes in safety conditions. These sites remain closed until a follow up SHA is performed and the site is deemed safe.

### Safety Advice: Suspension of Streamwatch Activities

Streamwatch activities should be suspended when environmental conditions make it unsafe to proceed, including extreme weather, flooding or bushfires. In the event of dangerous conditions all Streamwatch activities are to be suspended immediately.

In wet weather conditions, the decision of whether or not to proceed should be based on a combination of local conditions and information contained in the site hazard assessment. SHAs nominate whether the site is safe in wet or dry conditions.

These conditions are intended to be indicative only. Group representatives must consider the intensity and duration of rain and potential site conditions when assessing whether or not to perform Streamwatch activities. It is recommended that a site safety assessment is performed each time a site is visited prior to commencing activities.

## Safety Equipment and Personal Protective Equipment (PPE)

### Safety Equipment

Streamwatch groups are provided with all safety equipment required to conduct the Streamwatch activities they are trained to perform. Safety equipment includes:

* Sampling pole
* Sampling claw attachment
* Sampling bottle
* Liquid waste container.

The group representative is responsible for maintaining the safety equipment and ensuring that it is taken with the group each time it conducts a site visit. Any lost or damaged equipment must be reported to your Streamwatch Education Project Officer.

### Personal Protective Equipment

The following Personal Protective Equipment (PPE) is provided to all groups when they first join the Streamwatch program and thenceforth provided by volunteers:

* Disposable gloves – must be worn at all times when conducting Streamwatch activities
* Reusable protective glasses – must be worn at all times when conducting Streamwatch activities that involve the use of chemical reagents.

Participants must provide their own:

* Protective clothing (long sleeve pants and long sleeve shirts)
* Hats
* Enclosed footwear
* Eye protection (sunglasses)
* Sunscreen
* First aid kits.

**Group representatives are responsible for ensuring that appropriate PPE is taken to and used by participants during each site visit.** Group representatives are also responsible for maintaining protective glasses and must report any loss or damage to their Streamwatch Coordinator.

## Training in Use of Chemicals and Equipment

As a part of joining the Streamwatch program, participants are trained in relevant work health and safety procedures. This training provides the skills and knowledge required to safely conduct Streamwatch activities in the field.

Participants are observed conducting Streamwatch activities and are retrained in relevant safety procedures and documentation. Retraining is offered on a needs basis. Centralised training, due to geographic location of groups, may be offered in some areas.

Training is provided to the entire group; however where this is not possible or where new members join, responsibility falls to the nominated group representative to ensure that safety protocols are followed.

### Usage of Chemicals

Streamwatch monitoring involves the use of chemical reagents that are potentially harmful if not used correctly.

Hazardous substances contained in Streamwatch kits include:

* Manganous Sulfate Solution
* Alkaline Potassium Iodide Azide
* Sulphuric Acid
* Phosphate Acid Reagent
* Phosphate Reducing Reagent.

Material Safety Data Sheets (MSDSs) are provided to each group as a part of the supplemental documentation provided with this manual.

MSDSs contain specific information about the chemical reagents supplied, including first aid and clean-up procedures in the event of an accident.

Participants must familiarise themselves with relevant MSDS. Group representatives must ensure that the MSDS sheets are kept with the Streamwatch kit at all times.

**Participants must be over the age of 18 years and be trained in the safe use of these chemical reagents before using them.**

Chemical reagents should only be used for the tests that the participant is trained to perform and used according to the approved methodology. Expired chemicals should be returned to the Streamwatch Education Project Officer.

### Safe Storage of Chemicals

All chemicals must be clearly labelled and stored with a copy of the relevant MSDS in the protective cases provided. These cases should be stored in a secure area and kept out of reach of children.

### Safe Disposal of Chemicals

Liquid wastes produced during Streamwatch activities are stored in a liquid waste container and taken back to base. To dispose of liquid waste, dilute the contents of the liquid waste container with at least twice the volume of tap water and then flush down the toilet.

Contact the Streamwatch Coordinator, for chemical reagents that need to be disposed. These reagents should be stored in the protective cases in a secure area until disposed.

## Documentation

Streamwatch groups are provided with the following safety documentation on joining the program:

* Streamwatch Manual
* Streamwatch Fieldsheets (access via website after training)
* Material Safety Data Sheets for relevant chemicals
* Site Hazard Assessments for assigned sites (access via website).

This documentation is updated periodically. Streamwatch Fieldsheets must be completed and stored safely each time the group conducts a site visit.

## Environmental Protection

Streamwatch participants should minimise their impact on sites by:

* Using defined paths where possible
* Avoiding walking on sensitive vegetation
* Limiting activities to the site and its immediate area
* Removing all Streamwatch related waste and debris.

### Sensitive Environments

Sensitive environments are recorded on the Site Assessment form. Follow any environmental management controls listed on the Site Assessment if your site is defined as a sensitive environment.

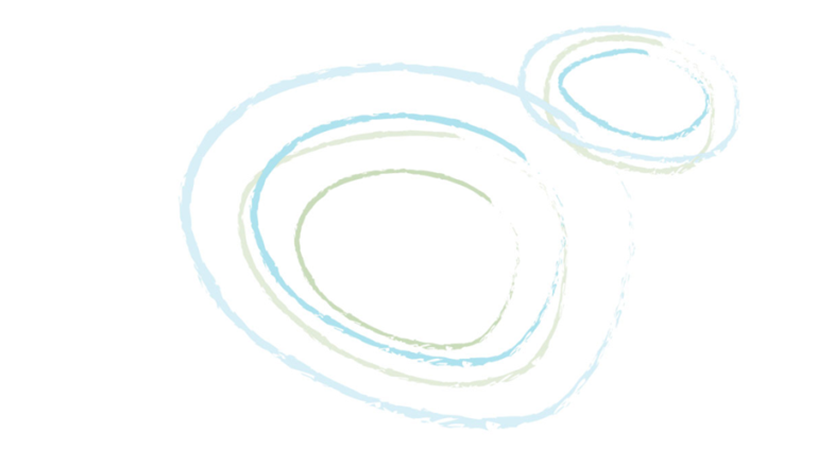
### Heritage Items

Heritage items are recorded on the Site Assessment. Follow any environmental management controls listed on the SHA if your site is associated with any heritage items.

### Frog Health: Chytridiomycosis

Chytrid fungus invades the skin of amphibians, causing up to 100% mortality in some frog populations. Chytridiomycosis occurs in over 40 species of native amphibian. There is a risk that Streamwatch activities could transfer Chytrid from site to site. It is therefore important to take measures to reduce this likelihood. It is recommended that footwear and sampling equipment are thoroughly cleaned and disinfected before entering a site and/or moving between sites. For further information please visit:

[www.environment.nsw.gov.au/resources/nature/hyprfrog.pdf](http://www.environment.nsw.gov.au/resources/nature/hyprfrog.pdf)



# 3. Methods

## Safety

**Conduct a visual site assessment**

Before beginning any activities, ensure that conditions on your site are safe and match the Site Hazard Assessment. Monitoring/sampling should not proceed if conditions are significantly different to those associated with the SHA. Contact your Streamwatch Coordinator if conditions have changed.

**Fast moving water**

If there has been heavy rain, postpone the testing until the flow has diminished.

**Contact with contaminated water**

If a preliminary inspection of a site reveals obvious water contamination such as raw sewage, blue-green algae, or a chemical spill, activities must not proceed. Relevant authorities (e.g. local council, Sydney Water, EPA) must be contacted immediately. Refer to the Reporting a Pollution Incident sheet in the supplemental documentation on the website.

**Complete volunteer field attendance table**

Complete volunteer field attendance table on the Streamwatch Fieldsheet, prior to commencing site activities. This reminds the group to have all the safety equipment and Personal Protective Equipment (PPE) required to safely conduct their Streamwatch activities in the field. It also ensures that volunteers are appropriately covered by GSLN during Streamwatch activities. You can find a copy in the supplemental documentation provided with this manual.

**Never test alone**

Participants should never undertake water testing activities alone.

**Wear gloves**

Always wear gloves when carrying out water activities. Gloves provide protection from polluted water and the chemical reagents used. Gloves also help avoid contamination of water samples.

**Wear appropriate PPE**

Participants must wear sun screen, hats and closed shoes. Always wear eye protection when handling Streamwatch chemicals.

**Read all relevant Material Safety Data Sheets (MSDS)**

Participants must be familiar with all MSDS sheets carried in the supplemental documentation provided with this manual. Some reagents used in Streamwatch are hazardous. **Participants handling chemicals must be 18 years or older and trained accordingly.**

**Minimise time at water’s edge**

Minimise time spent near the water’s edge by moving away from the water’s edge once you have collected your sample or taken measurements that need to be performed in situ. Take care to avoid slippery surfaces.

**Follow methodology set out in the instructions**

Always follow the testing methodology.

**Use liquid waste containers**

Always use liquid waste containers to capture and store any liquid wastes produced while conducting water testing activities. Dispose of liquid wastes upon return to base.

**Dispose of liquid wastes appropriately**

Dilute liquid wastes by at least two times and do not dispose of down kitchen sink. Dispose in toilet with thorough flushing.

**Solid wastes**

Always keep solid wastes separate from liquid wastes. Dispose of solid wastes as per normal rubbish. Follow manufacturer guidelines for *E.Coli* testing materials disposal.

**Hygiene**

Do not eat during Streamwatch activities and wash hands thoroughly at the conclusion of Streamwatch fieldwork and testing procedures. Have clean water on hand to deal with spills and to wash hands.

## Collecting Water Samples

There are three sample types to be collected:

* *E. coli* using a sterile Schott bottle
* Dissolved oxygen using a 25 mL DO vial
* General water sample using the Streamwatch sample bottle

The above samples need to be taken in different ways. If you are taking all three samples, it is good practice to do them in the order written above. Instructions on how to take each water sample are given below.

**Important**

Collect your water samples from the same location and at a similar time of day if possible for each site visit. Also, where safe to do so, sample from a flowing section of the water body that has enough depth to fill the bottle without disturbing the sediment below. Avoid eddies and bank influence where feasible. Always have another adult present.

**Equipment**

* Gloves
* Thermometer
* Sample bottles
* Sampling pole or similar

***E. coli* water sample**

*E.Coli* water samples are collected in a sterilised Schott bottle. The bottle can be sterilised by boiling.. To sterilise equipment by boiling, fill a large clean pot with water, place Schott bottle and lid separately into pot and bring to boil. Boil for 15 minutes. A microwave can be used if preferred. One third fill bottle and one third fill lid, place separately in microwave and boil between two and five minutes. Wait for items to cool and replace lid. Sterilisation will need to be done several hours before sample collection so that the bottle has time to cool to air temperature before sampling.

**Do not remove the lid or rinse the sterile Schott bottle**.

1. Turn the capped sample bottle on its side and lower it into the water until fully immersed.
2. Ensure lid is below the surface. Slowly unscrew the lid allowing water to enter. Fill the bottle to three-quarters full, maintaining an air gap.
3. Recap the bottle while it is still underwater and remove from the water.
4. Place the bottle into a cooler bag or small eski for preservation during transport to incubator. Sample should be processed and transferred to incubator as soon as is practical. (See Petrifilm method).

**Dissolved oxygen water sample**

Collect your sample from the stream bank as far as you can safely reach into the stream. This should be in the same location as where the E.Coli sample was collected, if feasible.

**It is important to take your temperature reading at this time and in the same location as your DO sample because temperature is directly related to DO % sat.**

**Be ready to add reagents immediately to your sample after collecting. You will also need to take a temperature reading when collecting your sample.**

1. Rinse the 25 mL DO sample vial and lid with sample water **2 times** and recap. Always pour the rinse water downstream of where the water sample is taken.
2. Turn the DO vial on its side and lower it into the water until it is fully immersed and well below the surface to avoid scum.
3. Unscrew the lid of the vial allowing the water to enter.
4. Turn the DO vial upright while still under the water to allow it to fill completely and release all the trapped air. You may need to tap the vial to dislodge small bubbles.
5. Recap the vial while it is immersed under the water.
6. Remove the vial from the water and turn it upside down to check that no bubbles have been trapped inside. Repeat steps 2 to 5 if bubbles are observed.
7. Move away from the edge of the water and move to a safe area to continue.
8. Remove lid and add 2 drops of reagent 1 (Manganous Sulphate Solution) and 2 drops of reagent 2 (Alkaline Potassium Iodide). Do this over your liquid waste container. Hold reagent bottles vertically when delivering drops.
9. Recap the DO vial and invert several times to mix well. A precipitate will form.
10. Keep the DO vial cool until you are ready to continue to the next stage of the test.

**General water sample**

Most other water quality tests will be performed using the water collected in your Streamwatch sample bottle including pH, electrical conductivity, turbidity and phosphorus. To collect your general water sample you will need:

* Sampling extension pole with sample bottle holder
* Streamwatch sample bottle.

1. Open the sample bottle lid and lower the sample bottle into the water upside down. This ensures that surface scum does not enter the bottle as it is immersed.
2. When fully immersed, turn the sample bottle onto its side to allow water to enter the bottle.
3. To rinse, fill the sample bottle almost completely.
4. To avoid spilling, turn the bottle upright before lifting the bottle out of the water.
5. Pour out the contents of the bottle downstream of where you are sampling.
6. To collect the water sample, repeat the same steps above except for step 5. Replace the lid of the sample bottle, move away from the edge of waterway and begin water testing activities.

## Testing methods

### Temperature test

**Equipment**

* Gloves
* Thermometer
* Clean water
* Paper towel.

**Method**

1. Hold the thermometer in the water for at least 1 minute. Do this at the same time and depth that the water sample for dissolved oxygen test was collected.
2. Read the temperature while the thermometer’s bulb is still immersed in the water.
3. Record the result.

**Important**

If the fluid in the thermometer separates, heat the thermometer bulb in an upright position in warm water.

Allow the liquid column to rise until the separated portion of the column enters the expansion chamber at the top of the thermometer.

**Remember to**

* Rinse the thermometer thoroughly with clean water and carefully dry with paper towel
* Return all equipment to the kit after use.

### pH test

**Equipment**

* Streamwatch sample bottle (general water sample)
* pH strips including container
* Gloves
* Small beaker
* Liquid waste container
* Stopwatch
* Clean water

**Method**

Each chemical test requires a separate beaker. Alternatively, after each test the beaker must be rinsed with sample water and refilled with fresh sample water.

To rinse the beaker, fill the beaker half way with sample water, swirl, then pour contents in liquid waste container.

1. Fill the beaker with sample water
2. Take one strip out of the container
3. Do not touch the coloured squares on the end of the strip
4. Immerse the coloured squares on the strip into the sample water as specified on the pack
5. Match the colours on the strip to the colours on the chart provided on the container by holding the strip against the chart as shown
6. Record the result.

**Important**

If the colours on the squares do not exactly match the colours on the chart, the result can be recorded as halfway between these two values (e.g. between 7 and 8 would be 7.5).

**Remember to**

* Dispose of strips into a solid waste container. Never leave the strips on the bank of the stream
* Empty the contents of the beaker into the liquid waste container and rinse with clean water
* Return all equipment to the kit after use.

### Electrical conductivity test

**Equipment**

* Gloves
* Safety glasses
* Conductivity calibration standard solution
* Small beaker
* Liquid waste container
* ECscan or Eco Testr conductivity meter
* Clean water
* Deionised water
* Streamwatch sample bottle (general water sample).

**Calibration**

You must first calibrate the conductivity meter before you test your sample. Calibrating the meter means that you check and adjust the meter reading to ensure that it measures the same as a known salt solution. You will need to do this before each use to ensure the accuracy of the data collected. Each Streamwatch group is provided with a bottle of conductivity standard solution. **Conductivity calibration standard solution should be kept cool and out of sunlight.**

For the ECScan Low and EcoTestr ECLow meters, your reading should be 500μS/cm +/- 10μS/cm.

For the ECScan High meter, your reading should be 12.90 +/- 0.2mS/cm.

1. Shake the conductivity standard solution.
2. Rinse the beaker with a small quantity of conductivity standard solution over the liquid waste container **2 times.** Fill the beaker halfway with conductivity standard solution.
3. Remove the cap from the conductivity meter and turn it on (by pressing the ‘On/Off’ button).
4. Insert the electrodes into the beaker of conductivity standard solution making sure the electrodes do not touch the bottom of the beaker.
5. Swirl the meter once and when the reading in the display window stabilises, read the result.
6. If the meter does not read the same as the conductivity standard solution, follow calibration guide in kit or on the Streamwatch Fieldsheet. If your meter reads the same as the conductivity standard solution, go straight to Method section.
7. Discard the calibration standard solution into the liquid waste container after use.

**Method**

1. Rinse electrodes with clean water **2 times** over the liquid waste container.
2. Shake the Streamwatch sample bottle. Rinse the beaker with a small quantity of this sample water over the liquid waste container.
3. Fill the beaker halfway with sample water.
4. Insert the meter into the sample water making sure the electrodes are not touching the bottom of the beaker.
5. Swirl the meter once and when the reading in the display window stabilises, press the ‘Hold’ button and read the result.
6. Record the result and the units. The result will appear in mS/cm for the ECScan Low and Eco Testr ECLow meters and mS/cm for the ECScan High meter. If you need to convert to mS/cm, multiply your mS/cm reading by 1000 (add three 0’s).

**Important**

* Conductivity calibration standard solution should be kept cool and out of sunlight.
* If ‘Or’ appears in the display window, the reading is over range. The sample will need to be diluted with a known volume of deionised water. Mix the sample thoroughly (salt water is more dense than distilled water and will sink to the bottom) before taking another reading. An appropriate calculation will need to be done, based on the dilution volume. For example, 10mL sample: 30mL distilled water - multiply the reading by 4.

### Turbidity test (NTU)

**Equipment**

* Gloves
* Nephelometric turbidity tube
* Streamwatch sample bottle (general water sample)
* Clean water
* Liquid waste container.

**Method**

**Conduct this test in the shade to ensure consistency and quality assurance.**

1. Assemble the turbidity tube.
2. Place the bottom of the turbidity tube on the ground and hold the tube steady.
3. Shake the sample bottle to mix.
4. Uncap the sample bottle and pour the water sample into the tube gradually. As you add the water, wait for the water surface to become still and then look down the tube through the water.
5. Stop pouring water into the tube when you can just barely make out the symbol at the bottom.
6. Take the reading immediately below the water level, as your result.

**Important**

Always conduct the test in the shade for consistency and quality assurance.

The turbidity tube has a logarithmic scale running down the outside of the tube therefore; readings cannot be estimated between two numbers. Read the number below the water level (e.g. read as 15 when the water level is between 10 and 15). Likewise if the turbidity tube is filled with water, take the reading as 10.

**Remember to**

* Rinse the turbidity tube with clean water before returning to the kit
* Apply a small amount of petroleum grease or similar to tube join occasionally
* Add sample water slowly and repeatedly check visibility of symbol.

### Supplemental Turbidity (FTU, FAU) optional

**Equipment**

* Gloves
* Streamwatch sample bottle (general water sample)
* Clean water
* Liquid waste container
* Blank colorimeter tube (black lid)
* Smart colorimeter
* Paper towel and microfiber lens cloth.

**Method**

1. You need to create a Blank sample to calibrate your Colorimeter. Using the 60mL syringe, draw up approximately 40mL of the General Sample Water. Attach and hold a new 0.45 micron filter to the syringe.
2. Rinse the 10mL Blank Colorimeter tube (black lid) with this filtered sample water over the liquid waste container 2 times. Gently expel a small portion of this sample water through the filter into the liquid waste container before expelling a 10mL portion into the colorimeter tube (black lid). This is the Blank sample.
3. Rinse the turbidity colorimeter tube (brown dot) with general water sample and fill to the 10ml line.
4. **Clean and dry the blank colorimeter tube and the turbidity colorimeter tube by patting dry with paper towel and using microfiber lens cloth to remove all smudge marks and fingerprints.** Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.
5. Follow the Smart Colorimeter instructions below:

**Smart 2 & 3 Colorimeter Instructions**

1. Press and hold ON button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS from testing menu.
5. Scroll to and select 98 Turbidity from menu.
6. Insert blank tube into colorimeter, close lid and select SCAN BLANK.
7. Press ENTER
8. Remove blank tube from colorimeter.
9. Clean the Turbidity colorimeter tube with microfiber lens cloth to remove all smudge marks and fingerprints.
10. Insert Turbidity sample colorimeter tube into colorimeter chamber, close lid.
11. SCAN SAMPLE.
12. Press ENTER
13. Record the Turbidity result on the website in the Site Observation section. The result will appear in FTU or FAU not NTU, they are NOT interchangeable.

### Dissolved oxygen test

**Equipment**

* Gloves
* Safety glasses
* DO sample bottle
* Liquid waste container
* DO reagent No. 1 (Manganous Sulphate Solution)
* DO reagent No. 2 (Alkaline Potassium Iodide Azide)
* Paper towel and microfibre lens cloth
* DO reagent No. 3 (Sulphuric Acid)
* Clean water
* DO colorimeter tube (yellow lid)
* Blank colorimeter tube (black lid)
* Smart colorimeter.

**Method**

**Steps 1-3 should be performed immediately after taking the dissolved oxygen sample.** **If so, go to Step 4.**

1. Hold the DO sample tube above the liquid waste container and carefully remove the lid.
2. Add 2 drops of DO reagent No. 1 (Manganous Sulphate Solution) and 2 drops of DO reagent No. 2 (Alkaline Potassium Iodide Azide) to the sample water while holding over the liquid waste container.
3. Recap and invert the DO sample vial several times to mix the solution – a brown precipitate will appear.
4. Stand the DO sample vial and wait until the precipitate has settled to at least halfway down the bottle. This will take 5 or more minutes if the water is saline.
5. Add 8 drops of DO reagent No. 3 (Sulphuric Acid) to the sample water while holding over the liquid waste container. The oxygen is now “fixed”.
6. Gently shake the DO sample tube for one minute and then wait 5 minutes until the precipitate has completely dissolved. If the precipitate has not dissolved after 5 minutes, add an extra 2 drops of DO reagent No. 3 (Sulphuric Acid) and invert until the precipitate is dissolved. Repeat if needed.
7. Rinse the 10mL DO colorimeter tube (yellow dot) with treated sample over the liquid waste container 2 times and then fill to the 10mL mark with treated sample. Recap both tubes and stand on a stable surface.
8. You will now create a Blank sample to calibrate your Colorimeter. Using the 60mL syringe, draw up approximately 40mL of the General Sample Water. Attach and hold a new 0.45 micron filter to the syringe.
9. Rinse the 10mL Blank Colorimeter tube (black lid) with this filtered sample water over the liquid waste container 2 times. Gently expel a small portion of this sample water through the filter into the liquid waste container before expelling a 10mL portion into the dissolved oxygen colorimeter tube. This is the Blank sample.
10. **Clean and dry the sample and blank colorimeter tubes with microfibre lens cloth to remove all smudge marks and fingerprints.** Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.
11. Place the Blank colorimeter tube into the colorimeter and cover with the black cap.
12. Follow the Smart Colorimeter instructions below:

**Smart 2 & 3 Colorimeter Instructions**

1. Press and hold ON button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS from testing menu.
5. Scroll to and select 39 DO from menu.
6. Insert blank tube into colorimeter, close lid and select SCAN BLANK.
7. Press ENTER.
8. Remove blank tube from colorimeter.
9. Clean the DO colorimeter tube with microfibre lens cloth to remove all smudge marks and fingerprints.
10. Insert DO colorimeter tube into colorimeter chamber, close lid.
11. SCAN SAMPLE.
12. Press ENTER.
13. Record the DO result in mg/L. The result will appear in milligrams per litre (mg/L) or parts per million (ppm). ppm is a close equivalent to mg/L. The percentage of dissolved oxygen is dependent on the water temperature. After you have entered both the DO result in mg/L and temperature on the website, the percentage saturation will be automatically calculated.

**Important**

The colorimetric tubes are made of special crystalline glass which allows light to pass directly through without being refracted. Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.

**Remember to**

Turn the colorimeter off by pressing the Off button (3 times for Smart3 and once for Smart 2). Rinse colorimeter tubes twice with distilled water over the liquid waste container. Return all equipment to the kit after use.



### Available Phosphate Test

**Equipment**

* Gloves
* Safety glasses
* Streamwatch sample bottle (general water sample)
* Phosphate colorimeter tube (blue lid)
* 60mL syringe and 0.45 micron filter
* Liquid waste container
* Phosphate Acid reagent and 1mL syringe
* Phosphate Reducing reagent and 0.1g spoon
* Stopwatch
* Blank colorimeter tube (black lid)
* Clean water
* Paper towel and microfiber lens cloth
* SMART colorimeter
* Small beaker.

**Method**

1. Shake the sample bottle well to mix.
2. Remove the phosphate colorimeter tube (blue dot) and the 60mL syringe from the kit.
3. Using the 60mL syringe, draw up approximately 40mL of sample water. Attach and hold a new 0.45 micron filter to the syringe. Gently expel a small portion of this sample water through the filter into the liquid waste container and then dispense a small amount into the phosphate colorimeter tube (blue dot). Rinse and discard. Dispense a 10mL portion into the colorimeter tube.
4. Rinse the blank colorimeter tube (black lid) with filtered sample water over the liquid waste container. Then fill this colorimeter tube to the 10mL mark with filtered sample water. **This is your Blank sample to calibrate the colorimeter for analysing your phosphate results. You could also use the same Blank sample from the DO test.**
5. Remove the Phosphate Acid reagent and the 1mL syringe from the kit. Be very careful avoid direct contact (refer to MSDS for more information)
6. Draw the plunger back halfway and insert the tip of the syringe into the small hole in the top of the bottle. Push the plunger in to expel the air into the bottle.
7. This avoids a vacuum being created in the bottle as the liquid is withdrawn.
8. Carefully turn the bottle and syringe vertically upside-down and while supporting both, slowly pull back on the plunger until the top of the black stopper is aligned with the 1mL line. If bubbles form on the black stopper, push the plunger in and redraw the phosphate acid reagent. This may have to be done several times to eliminate the bubbles.
9. Turn the bottle upright and carefully remove the syringe by pulling from its base. Add this 1mL of Phosphate Acid reagent to the phosphate colorimeter tube (blue lid).
10. Recap the tube and invert several times to mix.
11. Get the stopwatch ready to time the reaction as once the phosphate reducing reagent has dissolved, the reaction will take exactly 5 minutes.
12. Remove the Phosphate Reducing reagent and the 0.1g spoon from the kit. Add one level spoonfulof Phosphate Reducing reagent to the phosphate colorimeter tube (blue lid).
13. Recap and invert several times until the crystals are dissolved.
14. Time this 5 minute reaction with the stopwatch.
15. **Clean and dry the blank colorimeter tube by patting dry with paper towel and then using microfiber lens cloth to remove all smudge marks and fingerprints.** Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.
16. While waiting for the reaction, follow the relevant Smart Colorimeter instructions below:
17. Record the result. The result will appear in milligrams per litre (mg/L) or parts per million (ppm). ppm can be considered as equivalent to mg/L.

**Smart 2 & 3 Colorimeter Instructions**

1. Press and hold ON button until colorimeter turns on.
2. Press ENTER to start.
3. Press ENTER to select TESTING MENU.
4. Select ALL TESTS from testing menu.
5. Scroll to and select 78 PHOSPHATE-L from menu.
6. Insert Blank tube into colorimeter, close lid and select SCAN BLANK.
7. Press ENTER.
8. Remove Blank tube from colorimeter.
9. Clean the phosphate colorimeter tube with microfibre cloth to remove all smudge marks.
10. Insert phosphate colorimeter tube into colorimeter chamber, close lid.
11. SCAN SAMPLE.
12. Press ENTER.

**Important**

The colorimetric tubes are made of special crystalline glass which allows light to pass directly through without being refracted. Any lint, scratches or smudges on the glass from chemicals or fingerprints will reduce the accuracy of your results.

**Remember to**

Turn the colorimeter off by pressing the OFF button (3 times for Smart 3 and once for Smart 2). Rinse the colorimeter tubes twice with distilled water over the liquid waste container. Wipe the spoon with paper towel. Return all equipment to the kit after use.

### Petrifilm method *E. coli*

**Equipment**

* Gloves
* Sterile Schott bottle or pre-sterilized disposable container
* Petrifilm E. coli/Coliform count plate
* Disposable plastic pipette or presterilised syringe
* Permanent marker
* Liquid waste container
* Paper towel.

**Test Preparation**

* Store unused Petrifilm plates in a **sealed** plastic container in the freezer (allow ~2 mins for the Petrifilm to be left out of the freezer before applying sample water)
* Collect sample in a sterile Schott bottle or sterile disposable container
* Turn on the incubator and ensure it has reached 44°C ± 1°C
* Place a small beaker of water in the incubator for humidification.

**Method**

1. Label the Petrifilm plate using a pen or permanent marker. Include the site name and date and time of sampling. Lay the Petrifilm plate on a flat horizontal surface.
2. Shake sample bottle vigorously.
3. Using 1mL disposable plastic pipette or pre-sterilised syringe, draw up 1mL of sample water.
4. Lift up the top clear film of the Petrifilm plate.
5. Hold pipette upright and dispense the 1mL sample onto the centre (pink circle) of the bottom film.
6. Roll the top film back onto the sample evenly to minimise bubble formation.
7. Allow the water sample to spread over growth area by capillary action and then let the gel set at room temperature for 5 minutes.
8. Incubate Petrifilm plates for 24hrs±2hr at 44°C ±1°C.
9. Remove the Petrifilm plate/s from incubator.

**Interpreting results**

Indicators in the Petrifilm medium will stain E.coli colonies blue. Most E.coli colonies will produce gas or bubbles. Coliform colonies produce acid and will appear as red colonies. Do not include colonies that grow on the foam barrier.

Blue Colonies + Gas = E.coli. Red Colonies + Gas = Coliform bacteria.

Blue colonies without gas? There are a very small number of bacteria that are not E.coli but are pathogens producing blue colour and no gas. Count these and make a note that they were blue with no gas.

**Recording Results**

E.coli counts are normally reported as colony forming units per 100mL of water (CFU/100mL).

Petrifilm EC plates can only accommodate a sample volume of 1mL. This means that the resulting number of colonies requires a multiplication of 100. For example, E.coli (blue) colonies on a Petri film plate = 11 CFU/mL. This equates to 1100CFU/100mL. The Streamwatch database will multiply your count by 100 when you enter “1” as the dilution value.

## Caring for your equipment

**Thermometers**

Store the thermometer in a cool place. If the blue alcohol liquid in the tube develops bubbles or separates, run gradually warmer water along the tube until the bubbles disappear or the liquid rejoins.

**Turbidity tubes**

Turbidity tubes should be kept clean. Rinse after use, and wash periodically in warm soapy water.

Apply petroleum jelly lightly to the join occasionally for ease of assembly.

**pH strips**

Dispose of pH strips into a solid waste container. Never touch the coloured section of the strip. Keep strips and colour chart out of direct sunlight to avoid colours fading.

**Electrical conductivity (EC) meters**

Keep the meter in a cool place and replace batteries regularly as flat batteries will produce inaccurate results. Immerse only the probes of the meter in the water and rinse them with deionised water occasionally. Calibrate the meter before each test for accurate results.

**Bottles and tubes**

Wash all equipment with clean water after use. Turn the bottles and tubes while rinsing to ensure all surfaces are washed. Dry the outside of containers with paper towel – **do not dry the inside of the bottles and tubes.**

After each bottle or jar has been used, replace its lid and return it to its specific place in the kit. This avoids lids going on the wrong bottles and contaminating the contents.

**Always hold colorimeter bottles by the lid or neck to avoid putting finger marks on the glass, as this will affect the results.**



# 4. Scientific Rationale

## Background to the tests

### Temperature

**Definition**

Thermal energy or heat determines temperature. The dynamic relationship between the heat input, heat output and heat storage is exhibited as changes in temperature. The heat inputs are predominantly derived from solar radiation, whereas heat outputs can be in the form of evaporation, reflection, radiation, conduction and convection of heat out of the water. In Australia, temperature is measured on a metric scale in degrees Celsius (˚C).

**Why test temperature?**

Temperature has a major influence on biological activity and growth of aquatic organisms. Temperature is important because:

* Higher temperatures diminish the solubility of dissolved oxygen and thus decrease its availability
* Elevating temperature increases the metabolic rate, respiration and oxygen demand of aquatic life. Rates generally double for a 10° C. rise in temperature
* Unusual temperatures can affect rates of development, timing and success of reproduction
* Unusual temperatures can affect rates mobility and migration of aquatic organisms
* The solubility of toxic substances can increase with temperature elevation
* Sensitivity of organisms to toxins, parasites and diseases can change with temperature.

Most aquatic organisms are cold blooded, that means they are unable to internally regulate their core body temperature. All species of aquatic organisms have preferred temperature ranges. As the temperature gets too far above or below the preferred range, available habitat can be reduced, resulting in local species reduction or loss.

Water temperature is affected by:

* Depth
* Flow rate
* Amount of sunlight or shade
* Turbidity (cloudiness of the water)
* Altitude
* Season
* Time of day
* Incoming waters
* Source water (stormwater run-off flowing over hot urban surfaces will warm receiving waters).

### pH

**Definition**

pH is the hydrogen ion (H+) concentration and is expressed on a log scale of 0 (acid) to 14 (base), with the neutral point at 7. Alkalinity is not the same as pH as water does not need to be strongly basic (high pH) to have high alkalinity. Alkalinity can be considered as the capacity of water to neutralize an acid. In other words it is a measure of how much acid can be added to a water sample without causing a significant change in pH.

**Why test pH?**

The pH range for most organisms in Australian freshwaters is 6.5 – 8.0. Changes in pH outside this usual range will likely cause a reduction in species diversity. Acidic water can cause fish and other aquatic organisms to suffer from skin irritations and damage, tumours, ulcers and impaired gill function. Extremely high or low pH levels will lead to the death of aquatic life.

Small changes in pH can greatly influence the solubility and biological availability (amount that can be utilised by aquatic life) of nutrients (e.g. phosphorus, nitrogen and carbon) and heavy metals (e.g. lead, copper and cadmium). Levels of pH below 5.5 can cause heavy metals trapped in sediments to be released in forms that can be toxic to aquatic organisms. Aluminium will clog fish gills below pH 5.5.

Changes in pH (particularly reduced pH) can result in the toxicity of several other pollutants (e.g. ammonia, cyanide, aluminium) to significantly increase.

pH can be influenced by:

* Agriculture (Agricultural practices that lead to soil acidification can impact on stream pH. Soil acidification results when anions are leached into the subsoil, beyond the root zone)
* Geology (Limestone catchments typically contain alkaline waters whereas basaltic and sandstone catchments typically contain slightly acidic waters)
* Characteristics of the catchment (In forested catchments, waterways may be slightly acidic as water drains through leaf litter)
* Urban run-off (Run-off containing pollutants such as detergents can increase pH while fertilisers can lower the pH of waterways)
* Acid sulphate soils (When exposed to the air, these soils can leach sulphuric acid into the waterway, resulting in decreased pH levels)
* Photosynthesis (During peak periods of photosynthesis, levels of carbon dioxide in the water will decrease, resulting in an increase in pH).

### Electrical Conductivity (EC)

**Definition**

Similar to metal, water under certain conditions can conduct electricity. Salts are ionic compounds made up of both positive and negative ions. When a salt is dissolved in water the ions are free to disassociate and move within the solution. The free movement of these charged particles allows for the conduction of an electric current. Pure water with absolutely no salts, will not conduct electricity. When we measure conductivity, we are measuring how easily electricity is flowing through the solution of dissolved salts. From this, we can get an indirect estimate of how many salts are in the water. The salts naturally come from rocks that have been broken down by water flowing over them.

Sodium Chloride (NaCl) is the main contributor to water salinity but other mineral salts will also be present.

**Why test electrical conductivity?**

Salt concentrations will affect osmotic pressure within animal and plant cells. This consequently determines which species can survive at differing concentrations. Aquatic organisms adapted to low concentrations (freshwater) will have difficulty keeping water inside them under higher salinities, causing stress and possible death. Many aquatic species can only survive in a very narrow range of salt concentration.

Salinity can develop naturally, but where human activity has disturbed natural ecosystems, the movement of salts into rivers and onto the land surface, has been accelerated.

Some causes of salinity include:

* Removal of deep-rooted vegetation resulting in the rise of salty groundwater
* Flood irrigation of agricultural land
* Industrial effluent discharge into waterways
* Sewage effluent discharge into waterways
* Overuse of fertilisers leading to an increase in concentrations of phosphate, nitrate and ammonium ions
* Seawater penetrating beyond the historical limit.

### Turbidity

**Definition**

Turbidity is a measure of the cloudiness or muddiness of water. Turbidity can be caused by silt, mud, clay, algae or fine particles of organic matter. The greater the load of suspended and colloidal particulates in the water, the higher the turbidity. Colour is not turbidity. Tannin stained waters can be very dark but low in turbidity. Turbidity tends to increase after rain mainly due to soil washing from the surrounding landscape. Industrial activity, urban development, agricultural and mining activity can elevate turbidity levels.

**Why test turbidity?**

High turbidity can reduce light penetration, clog gills of aquatic organisms, suffocate eggs and smother benthic habitats. If light penetration is reduced significantly, plant and algal growth will decrease, impacting on the organisms that are dependent on the plants for food or shelter. Reduced light will result in a reduced rate of photosynthesis by plants, reduced growth and subsequently lower quantities of available dissolved oxygen in the water.

Very high levels of turbidity for short periods associated with rain events are normal; however extended periods of high turbidity can reduce biodiversity. Ongoing high turbidity combined with extreme turbidity after rain events is indicative of catchments suffering high soil mobility.

### Dissolved oxygen (DO)

**Definition**

Oxygen (O2) from the atmosphere naturally dissolves into streams and rivers. Dissolved oxygen is also a waste product of the process known as photosynthesis. Just like their terrestrial counterparts, aquatic plants and algae also produce oxygen as they are photosynthesising. Similarly, just like animals and humans living on land, animals that live in water need oxygen to survive. It is the dissolved oxygen in water that fish and other aquatic animals use to breathe. The oxygen atom within the water molecule H2O is not dissolved oxygen. It remains locked in a molecular bond and is not available for respiration processes.

**Why test dissolved oxygen?**

Dissolved oxygen is vital for the survival of aquatic organisms. Some aquatic species are more sensitive to oxygen depletion than others, but some general guidelines to consider when analysing test results are:

* 5 – 6 ppm Sufficient for most species
* <3 ppm Stressful to most aquatic species
* <2 ppm Fatal to most species

Dissolved oxygen can also be expressed as a percentage saturation (%Sat). The following indicator guidelines may apply when DO is expressed as a percentage:

* 80 – 120 %Sat Normal
* 120 – 135 or 55 – 80 %Sat Some pollution
* > 135 or < 55 %Sat High pollution

**How can oxygen be more than 100% saturated?**

Dissolved oxygen is measured as “percentage of air saturation”. 100% saturation (in a simple world) would occur when the oxygen concentration of a water body was in equilibrium with the overlying air, at a given temperature. Air is approximately 21% oxygen, so water would equilibrate with this concentration. Photosynthetically-active species (plants, algae etc.) produce pure oxygen rather than air. Hence dissolved oxygen readings of greater than 100% air saturation can occur in environmental water because of the production of pure oxygen by photosynthesis. Well oxygenated water, whether biologically or mechanically, can be out of equilibrium with the overlying air if the rate of oxygenation or temperature increase is greater than the rate that the water can release oxygen to the atmosphere. Hence dissolved oxygen readings >100% can arise from this dis-equilibration.

**How do the dissolved oxygen concentrations vary?**

The transfer, production and consumption of oxygen in water bodies influence the amount of dissolved oxygen present. Dissolved oxygen levels in waterways depend on the physical, chemical and biochemical activities that are occurring in the water body. Various processes are involved.

These include:

* Absorption – There is continuous exchange of oxygen between water and surrounding air. The greater the contact between the water and the air, the more oxygen that can dissolve. Thus, a turbulent stream will tend to have a higher oxygen concentration than a still body of water
* Photosynthesis – This process carried out by aquatic (and land) plants results in oxygen directly entering the water. Those things that reduce the amount of sunlight able to penetrate the water (e.g. turbidity) will lower the rate of photsynthesis and hence lower oxygen concentration. As photosynthesis takes place only during the day, the concentration of DO will vary over the 24 hour cycle. Levels peak early afternoon and are lowest just before sunrise.

Oxygen is consumed by:

* Respiration – all organisms (aquatic and terrestrial) consume oxygen during respiration
* Decomposition – the decomposition of plant and animal waste (whether from living or dead organisms) is carried out by bacteria and other micro-organisms that use oxygen to oxidise the organic matter.

The solubility of gases, including oxygen, in water is affected by a number of factors and this, in turn, affects dissolved oxygen measurements. Factors affecting the solubility of oxygen in water include:

* Temperature – increasing solubility with decreasing temperature
* Atmospheric pressure (altitude) – the greater the pressure the higher the solubility (i.e. there will be more oxygen at lower altitudes)
* Salt concentration – the lower the salt concentration the higher the oxygen concentration.

**The science behind the test**

The first step in a DO titration is the addition of Manganous Sulfate solution (reagent No.1) and Alkaline Potassium Iodide Azide solution (reagent No. 2) to the sample. These reagents react to form a white precipitate of manganous hydroxide Mn(OH)2. This reaction can be written as:

MnSO4 + 2KOH > Mn(OH)2 + K2SO4

Manganous Potassium Manganous Potassium

Sulfate Hydroxide Hydroxide Sulfate

At the same time the precipitate is formed, the oxygen in the water reacts with the manganous hydroxide to form brown-coloured manganic hydroxide. Chemically, this reaction can be written as:

4Mn(OH)2 + O2 + 2H20 > 4Mn(OH)3

Manganous Oxygen Water Manganic

Hydroxide Hydroxide

After the brown precipitate is formed, sulfuric acid (reagent No. 3) is added to the sample. The acid converts the manganic hydroxide to manganic sulfate. This is called “fixing” the oxygen in the sample. Chemically, this reaction can be written as:

2Mn(OH)3 + 3H2SO4 > Mn2(SO4)3 + 6H2O

Manganic Sulfuric Manganic Water

Hydroxide Acid Sulfate

At the same time, iodine from the potassium iodide in the Alkaline Potassium Iodide Azide solution (reagent No.2) is oxidized by manganic sulfate, releasing free iodine into the water. The amount of iodine released is directly proportional to the amount of oxygen present in the original sample. The release of free iodine is indicated by the sample turning a yellow-brown colour. Chemically, this reaction can be written as:

Mn2(SO4)3 + 2KI > 2MnSO4 + K2SO4 + I2

Manganic Potassium Manganous Potassium Iodine

Sulfate Iodide Sulfate Sulfate

The wavelength of the yellow-brown colour is measured using a colorimeter. A darker or more orange sample means that there is more Iodine and hence more dissolved oxygen in the sample.

### Phosphates

**Definition**

Phosphates are nutrients that are essential to the growth of plants and animals. Total phosphates is a measurement of all forms of phosphate compounds in a sample - orthophosphate, condensed phosphates and organically bound phosphates. Available phosphates is a measurement of the phosphate compounds that are soluble in water and therefore available to be absorbed by plants. Streamwatch tests for available phosphates only.

**Why test for Phosphates?**

Phosphates occur naturally in low concentrations in Australian soils and water. Native vegetation (both aquatic and terrestrial) has adapted to these low levels. In contrast, many introduced plants and weeds are adapted to the higher phosphate levels in the Northern Hemisphere.

Phosphates are derived from the weathering of rocks and the decomposition of organic material. These compounds limit and control the rate and the abundance of plant growth.

The most common problem associated with high phosphate levels is the stimulation of growth of cyanobacteria and nuisance plants such as macrophytes and algae. When they grow to nuisance proportions (or “bloom”) they can:

* Overgrow and displace native species
* Obstruct waterways and affect fish movement
* Reduce light availability for other species
* Reduce habitat quality for fish and invertebrates
* Create odours and unsightly appearances
* Some cyanobacteria and algae release toxins into the water rendering it unfit for consumption
* Cause fluctuations in pH and dissolved oxygen
* Deplete the oxygen concentration when large amounts of biomass are degraded by bacteria.

 **What affects the phosphate levels?**

Phosphate concentrations can increase because of:

* Sediment from erosion
* Manure from feedlots, dairies and pet droppings
* Sewage
* Phosphate-based detergents
* Decaying plant material
* pH changes
* Disturbance of bed sediments
* Fertilisers i.e. superphosphate
* Industrial waste

**The science behind the test**

The phosphate acid reagent is composed of sulphuric acid and ammonium molybdate written chemically as H2SO4 and (NH4)2MoO4. The sulphuric acid in the phosphate acid reagent is added to acidify the water sample.

The concentration of phosphate in a filtered water sample can be determined via a colorimetric technique. The technique involves the reaction of the hydrogenphosphate ion, in the presence of acid, with ammonium molybdate to form molydophosphate.

This is a complex reaction and may be represented as follows: (NB this is not a balanced equation)

MoO42-(aq) + HPO42- (aq) > [P(Mo3O10)4]3- (aq)

The molybdophosphate ion, [P(Mo3O10)4]3-, is then reduced with the absorbic acid in the phosphate reducing agent. This reduction reaction, as follows, produces the intensely blue-coloured phosphorus molybdenum blue, (MoO2.4MoO3)2.H3.PO4:

[P(Mo3O10)4]3- + 11H+ + 4 Sn2+ > (MoO2.4MoO3)2.H3PO4 + 2MoO2 + 4Sn4+ + 4H2O

The intensity of the blue colour is proportional to the concentration of phosphate in the filtered water sample and hence the colorimeter can give the concentration of phosphate in the sample.

### Faecal Coliforms – *E. Coli*

**Definition**

**Total Coliforms, Faecal Coliforms, and E. Coli**

Total coliforms include bacteria that are found in the soil, in water that has been influenced by surface water, and in human or animal waste.

Faecal coliforms are the group within the total coliforms that are considered to be present specifically in the gut and faeces of warm-blooded animals. Faecal coliforms are considered a more accurate indication of animal or human waste than the total coliforms.

Escherichia coli (E. coli) is the dominant group within in the faecal coliforms. It was believed E. coli is generally not found growing or persisting in the natural aquatic environment. E. coli was thus considered to be the species of coliform bacteria that is the best indicator of faecal pollution. This belief in the lack of persistence of E. coli has been challenged by some researchers, who suggest that other indicators may be better suited in some circumstances.

**Why test for *E. Coli*?**

The presence of *E. Coli* is an indicator of contamination by sewage waste. *E. Coli* are used as an indicator for assessing risk to human health. Although most *E. Coli* themselves are not commonly pathogenic (disease causing), their presence is an indication that pathogenic bacteria and viruses may also be present.

The *E. Coli* test cannot distinguish the source of the faecal coliforms (i.e. animal, bird or human). This requires a more expensive, time consuming laboratory based testing technique known as the faecal sterol test.

  
*E. Coli* can enter streams via:

* Sewer and septic systems
* Feedlot and dairy run-off (i.e. from intensive farming)
* Run-off from broad acre farming
* Stormwater carrying dog and cat droppings
* Waterfowl and livestock defecating directly into the water.

*E. Coli* numbers can rise dramatically in wet weather as stormwater flushes manure and pet droppings into streams, and sewer and septic systems overflow. It is also possible that higher water velocities can disturb stream bed sediments where some *E.Coli* populations may persist.

## Interpreting your results

Water quality data collected by Streamwatch groups can be used by various stakeholders, including agencies and local councils, to assess the quality of the water tested, and in some cases detect pollution incidents. To assist in identifying possible concerns, Streamwatch relies on “trigger values” outlined by The Australia and New Zealand Environment and Conservation Council (ANZECC), 2000 for Aquatic Ecosystems in Southeast Australia.

ANZECC uses the term “trigger value” to describe a concentration that if exceeded would indicate a potential environmental problem, and “trigger” a management response. It is important to remember that these trigger values are to be used as a guideline only and not intended to be applied as a regulatory criteria. In addition, these values have been developed in the context of ecosystem health, and are not intended to indicate acceptable levels for human health, including drinking water and recreational activities. You can view the document online here:

<https://www.waterquality.gov.au/anz-guidelines/resources/previous-guidelines/anzecc-armcanz-2000>

The ANZECC Guidelines for Aquatic Ecosystems provide indicators on the level of protection for several ecosystem types: upland and lowland rivers, lakes and reservoirs, estuarine, and marine. Aquatic ecosystems are complex and variable and it is very difficult to apply a rigorous whole number guideline on which to compare physical and chemical stressors from every waterway in Australia. ANZECC guidelines recognise this variability by providing guideline values for the level of protection for several ecosystem types, under differing degrees of disturbance.

Streamwatch references ANZECC values for “slightly to moderately disturbed” ecosystems. Many of the Streamwatch monitored sites do fit into this category. They can be described as ecosystems impacted by human activity and occur in catchments with slight to moderate clearing. Some sites do not fit this category and can be considered as “highly disturbed”. There are no ANZECC guideline values for these sites.

Because it is not reasonable to equally apply the same trigger value used for streams running through national parks and urban streams receiving poor quality stormwater runoff, ANZECC recommends identifying site specific guidelines based on the water management goals. Unfortunately this process relies on a significant amount of time and resources to perform rigorous testing, analysis of control sites and to achieve a holist understanding of the area through historical and spatial data. Therefore, the Streamwatch program has adopted ANZECC trigger values indicated for “Southeast Australia, slightly disturbed ecosystems” as a default reference to compare water quality measurements over time. Refer to the table below for the Streamwatch Guidelines.

If you would like more information on ANZECC guidelines and how they apply to your waterway, visit

<http://www.environment.nsw.gov.au/water/waterqual.htm>



## Streamwatch Water Quality Guidelines

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| **Parameter** | **Turbidity** | **Electrical Conductivity** | | **pH** | **Filterable Reactive Phosphate (FRP)\*** | **Dissolved Oxygen** |
| **units** | NTU | µs/cm | ms/cm | pH units | (mg/L) | % sat. |
| **Upland**  **>150 m** | 2-25 | 30-350 | 0.03-0.35 | 6.5-7.5 | 0.0459 | 90-110 |
| **Lowland <150m** | 6-50 | 125-2200 | 0.125-2.2 | 6.5-8.0 | 0.0612 | 85-110 |
| **Lakes and dams** | 1-20 | 20-30 | 0.02-.03 | 6.5-8.0 | 0.0153 | 90-110 |
| **Estuaries** | 0.5-10 | NA | NA | 7.0-8.5 | 0.0153 | 80-110 |

\* ANZECC trigger values indicate the amount of phosphorous molecules in the sample. Streamwatch equipment measures the amount of phosphate, which includes the phosphorous molecule surrounded by 4 oxygen molecules. Therefore, we obtained the trigger values listed above by multiplying 3.06 to the ANZECC trigger values.