Water Resource Quality Monitoring

VOLUME 2

sampling protocol for

Eutrophication Monitoring

the dwaf

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the dwaf
DEPARTMENT OF WATER AFFAIRS AND FORESTRY
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The Task Team

Annelise Gerber - layout, photographs, text
Carin van Ginkel - sampling protocol, text
Alfred Seloana - sampling techniques
Brendan Hohls - editing, text

Printing and binding
Government Printers, Pretoria

Background

Many South African impoundments exhibit high levels of nutrient enrichment and eutrophication related problems.

Eutrophication is of concern because it can have numerous negative impacts. These include ecological impacts such as deterioration of water quality and loss of biodiversity, aesthetic, recreational and human health impacts. All these impacts have a significant economic impact.

A National Eutrophication Monitoring Programme (NEMP) of DWAF is in the implementation phase. The primary purpose of the NEMP is to collect, assess and report on the nature and extent of eutrophication and its associated problems on a National basis in South Africa.

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Contents

1.1 WHAT IS EUTROPHICATION ?

Eutrophication refers to the enrichment of water bodies with plant nutrients, particularly phosphorus and nitrogen compounds.

It is a natural phenomenon that normally occurs during the life of an impoundment and can take thousands of years to occur without the influence of man.

Cultural eutrophication, on the other hand, is an unnatural process caused by increased nutrient loading from the surrounding catchment areas as a direct result of man's activities.

1.2 WHAT CAUSES EUTROPHICATION ?

unnatural

Atmospheric emissions of NH_3 and NO_2 resulting in increased loads of NH_3 and NO_2 in precipitation.

unnatural

Increased nutrient loads in discharges from sewage treatment plants.

unnatural

Increased nutrient loads in agricultural and urban runoff.

unnatural

Excessive nutrient loads in industrial wastewater.

natural

Nutrient leaching from local geology and soils.

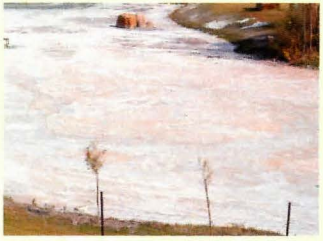
1.3 Potential negative impacts of eutrophication

Ecological impacts

Excessive growth of nuisance waterplants

Algal & non-toxic cyanobacterial blooms

Toxic cyanobacterial blooms



More situations resulting from Ecological impacts

- **increased water loss** - areas covered with waterplants lose water through evapotransporation
- **domestic and wild animal deaths** - after ingesting toxic cyanobacterial blooms
- **loss of biodiversity** - because of toxic blooms
- **fish and invertebrate mortality** - because of cyanotoxins
- **cyanotoxins in raw water** - from decaying toxic cyanobacteria
- **low dissolved oxygen levels in bottom waters** - result of decaying cyanobacteria
- **phosphate release from sediments** - because of stratification which is enhanced by bottom waters becoming oxygen depleted and this allows phosphate to re-enter the water column.

Economic impacts

- **increased water treatment costs** - to get rid of odour and taste problems
- **stock losses** - animals that died after ingesting toxic cyanobacteria
- **corrective action costs** - attempts to reverse the eutrophication process
- **loss of property value** - due to toxic cyanobacterial blooms and their associated bad appearance and unpleasant smell

Recreational impacts

- **decreased recreational use** - no more swimming, fishing etc. due to bad odour when algal blooms die off
- **decreased access to waterways** - boating is limited when masses of plants cover the water surface

Aesthetic impacts

- **unsightly scums** - decaying toxic cyanobacteria looks and smells like raw sewage. It also attracts flies to the area
- **odour and taste problems** - purified water still smell and taste bad resulting from geosnim MIB and toxins passing through the filters

Human health impacts

- **morbidity and mortality** - when water treatment is inadequate and allows cyanotoxins into the raw water
- **chronic ill-health effects** - long term exposure to low concentrations of toxins in drinking water will affect the liver
- **malaria trap** - an infestation of water hyacinth provide a breeding habitat for mosquito larvae and bilharzia carrying snails

2. MONITORING PROCEDURE

2.1 ON-SITE MEASUREMENTS

- visual area estimation
- secchi disc depth
- observations

2.2 SAMPLES TO BE COLLECTED

- integrated sample (with 5m hosepipe)
- subsurface grab sample
- chlorophyll sample
- sample for identification of algae
- sample for total suspended solids
- depth samples (optional)

The visual area estimation:

- to report on the total surface area covered by algal blooms or invasive waterplants

- stand on the highest point in order to have a clear view of the impoundment or area that is affected

- mark the areas on an A4 size map of the impoundment

  or

- express coverage as a percentage of the total area of the impoundment

  or

- estimate the area in units of soccer fields (1 soccer field is 100m x 50m = 0.5 hectares)

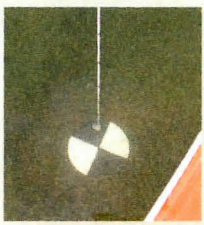
- affected area should ultimately be reported in hectares

The Secchi disc depth:

- to determine the clarity of the water (how deep can light penetrate into the water)
- the secchi disc is a metal disc, 20 cm in diameter, with black and white quadrants painted on it.

Always try to keep the sun behind you, this will reduce the glare on the water

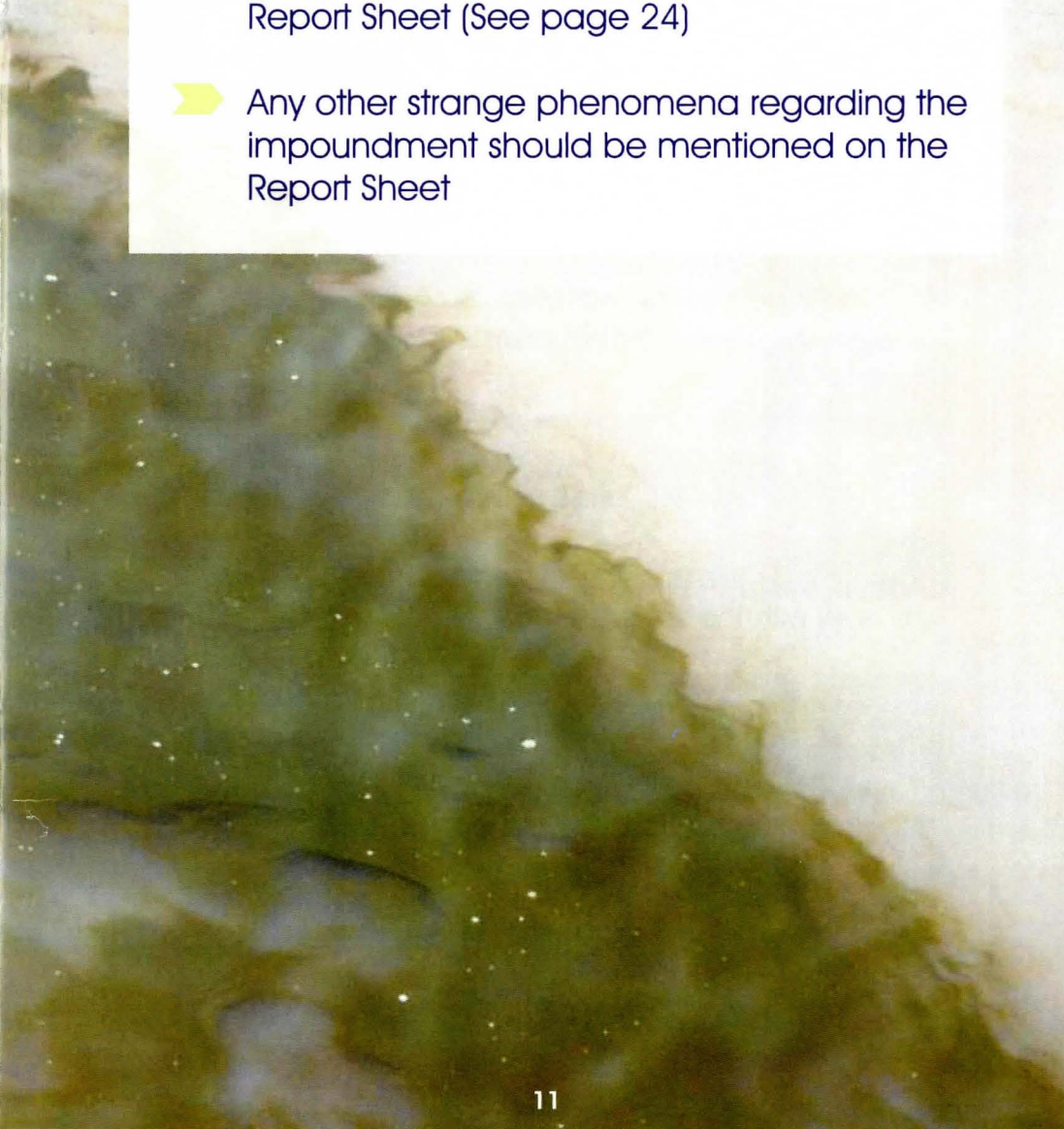
The secchi is lowered into the water until the black and white quadrants are just visible



Record the depth by counting the markings on the wet part of the rope (markings at 10cm intervals)

Additional Observations:

- to enable the Project Manager to better understand and interpret the data
- complete the Eutrophication Visual Monitoring Report Sheet (See page 24)
- Any other strange phenomena regarding the impoundment should be mentioned on the Report Sheet



The integrated sample (5m hosepipe sample):

- to get an indication of the overall population of algae present

- use 5m standard hosepipe or recomflex, tie a single piece of rope to both ends and fasten a weight to one end. On a boat the rope needs to be 7m long, from a dam wall you need 2 x the height of the wall + 7m

Slowly lower the weighted end of the pipe into the water so that it descends straight down (vertically)

Lower the pipe until the top end is level with the water surface

Hold the top end steady while pulling the weighted end up till both ends are at the water surface

Put both ends into a bucket. Remember to first rinse the bucket!

Lift the pipe to let all the water out into the bucket.

Decant water into the sample bottles. Remember to rinse the bottles first with the same water.

Add preservative and tag.

The subsurface grab sample:

- to sample the subsurface layer of the water. Not to be used when algal scum is present
- use a blue-top bottle, supplied by RQS, that has been washed with phosphate free soap

To collect the sample: Use the sample bottle or beaker when working from a boat. Use a bucket when working from the dam wall or from the bank.

Read more about sampling from a dam wall on page 18

Always rinse the container before taking a sample

Decant the water into the bottle

Do not fill to the top. Leave space for preservative and mixing

Preserve with one ampoule of mercury chloride. Drop the entire ampoule into the bottle after broken (see page 21)

Fill out the correct tag and fasten around the neck of the

Store sample in a Cooler box or dark container

The chlorophyll sample:

- this sample is used to measure the chlorophyll a concentration. This gives an indication of the algal production in an impoundment.
- you will need a plastic filtration unit with hand vacuum pump, glass fibre filter paper and a glass tube with ethanol. All the above are supplied by RQS.

Use the hosepipe to collect an integrated sample. In special cases a subsurface grab may be collected (get permission from project manager).

- **Always rinse the container before taking a sample**

Unscrew the top of the filter unit and place the filter paper inside the unit. Carefully screw the top part back on.

Pour 250ml of the sample in the filter unit.

Use the vacuum pump to draw water through the filter. Filter 500 ml if possible. **The total amount filtered must be recorded on the tag.**

Open the filter unit. Gently lift one side of the filter paper

Push the rolled filter into the glass tube and shake gently until the filter paper is immersed in the ethanol.

Complete the correct tag and fasten around the neck of the

Sample for total suspended solids:

- this sample is used to measures all suspended matter. This includes dead and alive zooplankton, phytoplankton, solids and detritus.

- you will need a plastic filtration unit with hand vacuum pump and a petri dish containing one weighed glass fibre filter paper. All the above are supplied by RQS.

Use the hosepipe to collect an integrated sample. In special cases a subsurface grab may be collected (get permission from project manager)

Unscrew the top of the filter unit and place the filter paper inside the unit. **The weighed filter paper is always marked with a black dot.** Carefully screw the top part back on

Pour 250ml of the sample in the filter unit.

Use the vacuum pump to draw water through the filter. Filter 500 ml if possible. **The total amount filtered must be recorded on the tag.**

Open filter unit. Gently lift one side of the filter paper and remove the filter paper from

Place the filter paper back into the petri dish. Close the lid.

Fill out the correct tag and attach to petri dish by inserting the end of the string between the lid and the base.

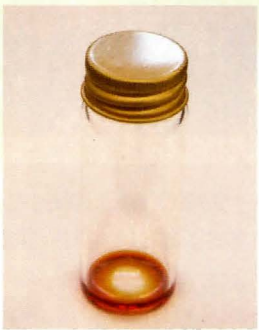
Sample for algal identification:

- this sample is used to identify all the various types of algae present in the water.

- you will need a small glass bottle with lugol preservative. All the above are supplied by RQS.

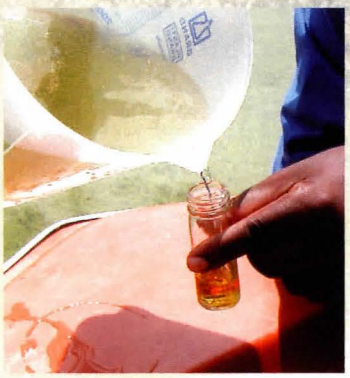
Use the hosepipe to collect an integrated sample. In special cases a subsurface grab may be collected (get permission from project manager)

The sample bottles are dispatched containing the correct amount (4drops) of lugol solution



It is possible for the lugol solution to leak out or dry out. In such instances the monitor can add lugol using a dropper

Fill the sample bottle. Make sure not to overfill the bottle because then the consentration of lugol solution in the sample will be too low to be effective



Complete the correct tag and fasten around the neck of the bottle with a piece of string.

VERY IMPORTANT

Make sure to store the sample in the original cardboard box in a dark cupboard. When the preserved sample stand outside in bright light we find that the preservative becomes unstable and loose color, making it impossible to see whether sample is

Depth Sample:

- this sampling method is mainly used by RQS personel to collect water from the deeper layers of an impoundment.

- you will need a Van Dorn sampler, bucket and sampling bottles.

The depth sampler is a device that can be used to collect water from any depth in an impoundment. The collected amount of water is transferred to a bucket before filling the sample bottle. Samples are preserved and tagged in the usual fashion.

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NEMP

On site visual monitoring report sheet

Impoundment/river/canal name: .....
Impoundment number: ..... Date: ..... Time: .....

Observations potentially related to eutrophication

		Reported by (name and contact no.)*:
Algal growth causing water discolouration?	Yes ☐ No ☐ If yes: Floating ☐ Submerged ☐ Scums ☐	
Problematic macrophyte growth? 	Yes ☐ No ☐ If yes, estimated area covered: hectares (100m x 100m) = or, % of dam surface covered = or, number of soccer fields (100m x 50m) =	
Recent fish kills? 	Yes ☐ No ☐ If yes, where?	
Recent animal deaths possibly related to the water? 	**Yes ☐ No ☐ If yes, where?**	
Recent water taste or odour problems?	Yes ☐ No ☐ If yes, where? At impoundment ☐ Treatment works ☐ End user ☐ Other:	

Local conditions and measurements

Wind speed	**Very strong ☐ Strong ☐ Mild ☐ Calm ☐**
Direction from which wind blowing (N, S, E, W, NE, ...)	
Wind direction with respect to impoundment wall	
Gauge plate reading (m)	
Secchi Depth (m)	
Additional comments: **Equipment required?**	

Sampler name _____ Sampler signature _____

UNDERSTANDING the QUESTIONS

Impoundment = the name of the dam.

Impoundment number = Hydro number e.g. A2R009

Algal growth = does the water have a green color ?
The severity of the problem can be established as follows:

- does the algae float on top,
- or are the particles mixed with the water
- Or are there foul smelling mats on top of the water?

Macrophyte growth = floating plants, including reeds.
(see area estimation on page 9)

Fish kills = yes/no and where did it occur. Try and give an indication of numbers e.g individuals or masses of joung fish.

Animal deaths = only animals who died after drinking the water!

Taste & odour problems = did people complain?
about a dam/sewerage works or
water from a tap ?

Wind speed calm = no wind or light breeze
mild = a light wind that is no nuisance
strong = a troublesome wind, blowing hats off etc.
very strong = a destructive wind that can cause damage to roofs, trees, etc.

Wind direction = if you know where south or east is you can use this option. If you do not know please use the next option.

Wind direction with respect to impoundment wall =

- wind blowing towards the dam wall

- wind blowing away from the dam wall

- wind blowing parallel to the wall

Gauge plate reading = e.g 1.4m or 140cm

Secchi depth = the same as above

Additional comments = A place to mention anything strange that the program manager should know about.

Equipment required = An opportunity to request bottles, vacuum pumps, lugol, or anything else that you might require.