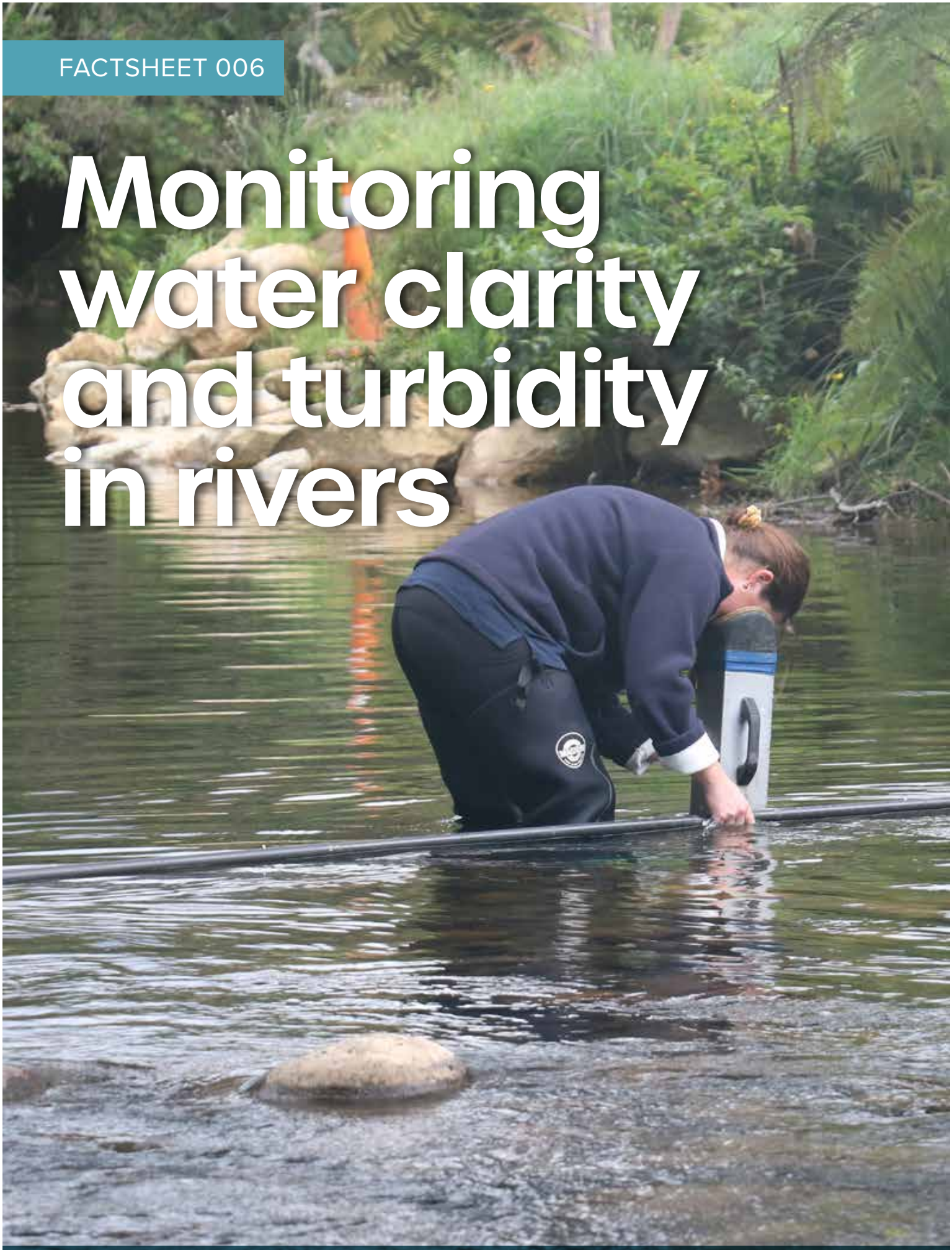
FACTSHEET 006

Monitoring water clarity and turbidity in rivers



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National SCIENCE Challenges

Monitoring Freshwater Improvement

Water clarity and turbidity are commonly used measures of optical water quality. Water clarity (also referred to as visual clarity) is the ability of light to travel through water. Turbidity is a measure of the amount of light scattered by suspended particles (such as clay, silt, algae and other particulate material) and is often referred to as water 'cloudiness' or 'haziness'.

Water clarity may be reduced, and turbidity increased, when there is an increased amount of suspended sediment in the water. Poor water clarity can adversely affect the habitat and food supply of aquatic life, such as fish and aquatic birds, and the growth of aquatic plants; it can also impact aesthetic values and recreational use of rivers and streams.

Measures of optical water quality – water clarity and turbidity – are useful in monitoring programmes for detecting the effect of environmental mitigation actions designed to reduce sediment in waterways.

How do we monitor water clarity?

There are two common methods for measuring water clarity in rivers: the clarity tube and the black disc method. Both methods measure clarity in metres.

The black disc method involves viewing a black target (disc) horizontally under the water and determining the distance at which the disc is no longer visible. It can only be done where and when it is safe to wade. The clarity tube method works on the same principle – moving a black disc backwards to determine the point at which it disappears – but this is done inside a plastic tube, filled with river water and held horizontally. However, the maximum clarity measurable with the clarity tube is 1 m, and it is recommended for use in rivers where water clarity is usually about 0.8 m or less.

Measuring water clarity using the black disc method. Photo credit: J. Milne

Detailed information on the method and equipment specifications for black disc and clarity tube measurements can be found in the relevant National Environmental Monitoring Standard (NEMS)[1].

The cost of carrying out a water clarity monitoring programme using a black disc or clarity tube will depend on the location of the monitoring site and how often measurements are taken. Some approximate costs, based on average results from a survey of regional councils in 2022, are shown in the table (excluding the cost of a vehicle). Using these estimates, monthly monitoring of water clarity will cost about $2000 per year, plus equipment cost. Some other equipment, such as waders, may also need to be purchased. For more details see the Monitoring Costs information sheet on the Monitoring Freshwater Improvements website.

Equipment purchase cost	~$800 (black disc) $600 (clarity tube)
Staff time – sampling and subsequent data processing	$140 per monitoring occasion
Mileage	$20 per monitoring occasion

**Based on regional council estimates of average distance to a monitoring site*

[1] *National Environmental Monitoring Standards - Water Quality Part 2 of 4: Sampling, Measuring, Processing and Archiving of Discrete River Water Quality Data. Available at https://nems.org.nz/documents/*

How do we measure turbidity?

Discrete measurement of turbidity (that is, turbidity at a point in time) involves taking a water sample and testing it in a laboratory, or direct measurement in the river using a portable hand-held meter. For guidance on how to collect, store and transport river water samples for laboratory analysis and equipment specifications for hand-held turbidity meters, refer to the relevant NEMS[1].

The cost of carrying out a turbidity monitoring programme will depend on how often samples are collected, the location of the monitoring site and laboratory charges for analysing the samples. Some approximate costs for a single sampling occasion, based on average results from a survey of regional councils in 2022, are shown in the table (excluding the cost of a vehicle). Using these estimates, monthly monitoring of turbidity (by sampling) will cost about $2,300 per year. Some sampling equipment may also need to be purchased.

Alternatively, measurements can be made using a portable turbidity meter. The purchase cost of a meter is approximately $4000. The staff time and operational costs per site visit will be about the same as those listed in the table. For more details see the Monitoring Costs information sheet on the Monitoring Freshwater Improvements website.

	Cost per sampling occasion
Laboratory testing	$10
Staff time – sampling and subsequent data processing	$140
Operational costs – mileage* and consumables (courier charges, ice)	$40
Total per sampling occasion	**$190**

**Based on regional council estimates of average distance to a monitoring site*

Turbidity can also be measured on a high-frequency basis by installing a sensor in the river or stream. The data are then electronically transmitted back to the office or manually downloaded during a site visit. There are two main types of sensors: turbidimeters (which measure the attenuation of a light beam along a path between the light source and receiver) and nephelometers (which measure the intensity of diffuse light scattered back towards the source). The relevant NEMS[2] gives guidance on sensor types, calibration, validation and maintenance, as well as selecting an appropriate monitoring site for sensor installation.

The pros and cons of high-frequency turbidity monitoring

High-frequency monitoring can detect subtle long-term changes in optical water quality that may be missed by a conventional monitoring programme and can tell us what is happening at times when conventional sampling is difficult, such as during floods.

Turbidity can be used as a surrogate for water clarity and/or suspended sediment concentration (SCC), by developing a statistical relationship ('rating') between turbidity and water clarity measurements taken under a range of conditions. Using these relationships, continuous records of water clarity and SSC can be derived from continuous turbidity records. When combined with flow records, continuous SSC records can be used to calculate suspended sediment loads.

Information on long-term sediment loads is extremely useful for assessing the success of sediment reduction actions in a catchment. If high-frequency turbidity records are to be used for this purpose, it is recommended that the turbidity sensor is installed at or near an existing river flow monitoring site.

However, high-frequency turbidity monitoring is more expensive than taking samples, particularly in the first year, due to the cost of purchasing the sensor and setting up the site. Running a high-frequency site requires more staff time both on site (e.g. for sensor maintenance) and in the office (e.g. checking and processing data records) compared to a conventional sampling site. If the turbidity records are to be converted to suspended sediment or water clarity records, this requires additional sampling, laboratory analysis and data processing.

[2] *National Environmental Monitoring Standards - Turbidity Recording: Continuous in situ Measurement of Turbidity Data. Available from https://nems.org.nz/documents/*

High-frequency turbidity monitoring costs

The cost of operating a high-frequency turbidity monitoring site will depend on many factors, such as:

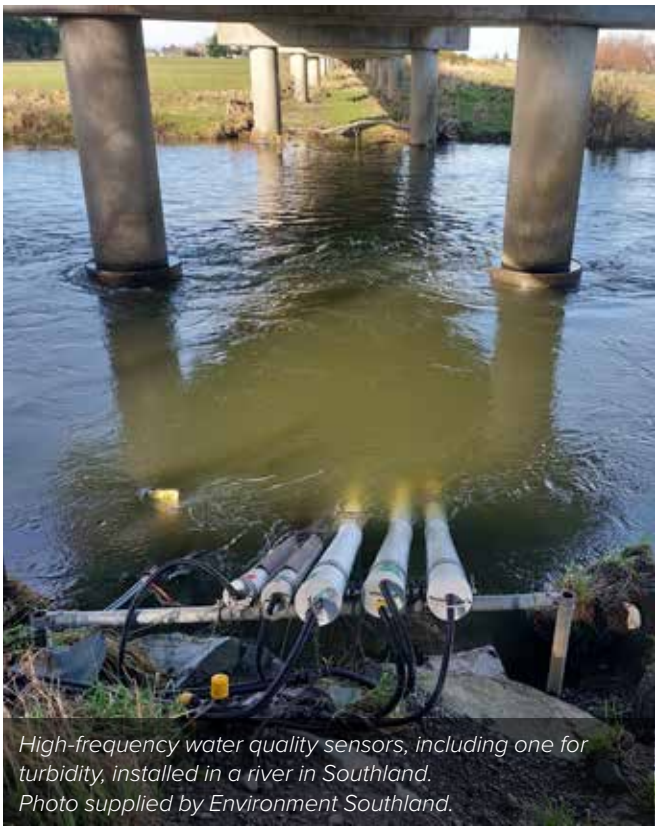
- The type of sensor chosen
- Characteristics of the monitoring site, e.g., is it prone to excessive aquatic weed growth? Is there an existing structure for mounting a turbidity sensor?
- Whether the data are electronically transmitted (telemetered) or manually downloaded.

The approximate costs associated with setting up and running a turbidity sensor, based on average results from a survey of regional councils in 2022, are shown in the table (excluding the cost of a vehicle). The cost of the sensor will vary depending on the type selected – the cost of a mid-range sensor is shown in the table. The costs will obviously be highest in the first year, due to the purchase and initial installation cost. For more details, see the Monitoring Costs information sheet.

	Year 1	Year 2+
Turbidity sensor	$10,000	
Telemetry unit	$1000	
Installation cost	$5000	
Maintenance, mileage and validation sampling	$2600	$3,000/year
Ongoing telemetry charges	$400	$400/year
Staff time for data processing, QA/QC	$2,000	$1,600/year
Total	**~$21,000**	**~$5,000/year**

Converting turbidity records to suspended sediment concentration and loads

There are several steps required to convert high-frequency turbidity records to sediment loads. Importantly, water samples need to be collected during a range of flow conditions, including during floods, and tested in a laboratory for SSC. A rating between turbidity and SSC can then be developed. For details, see the relevant NEMS[3].



High-frequency water quality sensors, including one for turbidity, installed in a river in Southland. Photo supplied by Environment Southland.

[3] *National Environmental Monitoring Standards - Measurement of Fluvial Suspended Sediment Load and its Composition. Available from https://nems.org.nz/documents/*

Monitoring Freshwater Improvement

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