

Chapter 8 Wetland Monitoring

Environmental monitoring can be undertaken at various levels of detail to satisfy a number of purposes. Wetlands can be monitored for

- compliance to licence conditions
- performance assessment
- operational control and maintenance
- research.

The objectives for any monitoring program need to be clearly outlined. Purpose and objectives of the monitoring will tend to determine what variables are assessed and in what detail. Most monitoring programs need to be individually designed to focus on the specific requirements of the system, the level of detail required and how the results will be used. For example:

- monitoring for compliance may only characterise the quality of the effluent
- monitoring for performance will require the determination of the quantity and quality of both the influent and effluent
- monitoring for operational control and maintenance may focus on how treatment performance and wetland structure varies spatially within the system and over time
- monitoring for research may focus on the environmental variables controlling the rate of various treatment processes. Research monitoring is outside the scope of these guidelines.

Compliance Monitoring

Compliance monitoring is largely determined by the relevant environmental legislation and conditions imposed by the approval authorities. Compliance monitoring should characterise the quality of the effluent well enough to evaluate its likely impact on the receiving water. Situations will vary but compliance monitoring should at least determine seasonal variations in the concentration of: BOD, suspended solids, dissolved oxygen, temperature, electrical conductivity, pH, total nitrogen, total phosphorus, and some indicator measure of pathogens like *E. coli*. Flow, ammonium, filterable reactive phosphorus and nitrate monitoring may also be required.

Performance Monitoring

Performance monitoring is essentially a two-stage process. The first stage is to monitor all the necessary quantity variables to be able to construct a water balance model for the system. Preferably this requires a simultaneous continuous record of: inflow, outflow, water level, rainfall and evaporation. The second stage is to sample the range of

flow conditions for water quality. The combination of these datasets allows the estimation of loads in and out of the wetland and an accurate determination of the mass of pollutants removed by the wetland.

In terms of protection of receiving waters, it is usually the mass of pollutant input that is critical rather than the simple concentration. Variables to monitor in addition to the compliance list include: total oxidised nitrogen, ammonium, and filterable reactive phosphorus.

Operational Control and Maintenance

Operational control and maintenance monitoring is designed to provide information to help manage the performance of the system.

To adequately manage a wetland treatment system requires some information on all wetland components (see Figure 3.1: Conceptual Wetland Model): inflow, through flow, outflow, substrate and detritus, microbiota, flora, and fauna. **Table 8.1: Operational Control and Maintenance Monitoring Components** summarises the typical components of operational monitoring.

An important element of operational and maintenance monitoring is that it must be linked to appropriate management responses so that remedial action is timely. Appropriate response times can vary considerably. For example microbial communities may start to respond to a change in organic loading within hours. Depending on conditions, mosquitoes can complete their entire life cycle in as little as 7 to 10 days. Consequently mosquito control procedures have to be initiated immediately after a risk is detected. Many aquatic plant species form large vegetative stands that may survive for many years. Consequently actions undertaken to manage aquatic plants (drying cycles or water level changes) may take an entire growing season to become evident.

Operational and maintenance monitoring forms an important link in the adaptive management feedback system for successful wetland operation.

Table 8.1: Operational Control and Maintenance Monitoring Components

Component	Monitoring Focus	Suggested Frequency	Typical/possible management response
Inflow, throughflow, outflow	Monitoring these components can be based on performance monitoring. The main difference is the additional monitoring of throughflow within the wetland. These additional sites allow the spatial variation and rate of treatment processes to be described.	Quantity = continuous/daily Quality = can be highly variable depending on the system (daily to weekly).	Vary influent load, change operational water depth, instigate a drying cycle.
Substrate and detritus	Monitoring the composition of these components allows the build up of litter to be tracked, the effectiveness of drying cycles to be assessed and the accumulation of phosphorus and toxicants to be evaluated.	Quarterly to annually.	Vary organic load, change operational water depth, instigate a drying cycle, change toxicant pre-treatment.
Microbiota	Monitoring of wetland microbiota can be either direct or indirect. Direct methods include determining organic matter degradation rates by placing artificial substrates into the wetland or incubation of sediment cores to determine denitrification potential. Indirect methods include tracking changes in BOD as a measure of organic carbon degradation or tracking the conversion of organic nitrogen to ammonium and to nitrate.	Indirect measures can be incorporated into performance monitoring. Direct measures = quarterly to annually.	Vary organic load, change operational water depth, instigate a drying cycle.
Flora	Monitoring of wetland vegetation allows the composition, evenness and density of plant cover to be recorded. Variations in these parameters can influence performance. Standing litter load can also be assessed.	Routine – quarterly to annually. Inspections should also occur after major environmental events, eg. flood, strong winds, frosts.	Change operational water depth, instigate a drying cycle, harvest standing litter, instigate weed control, initiate spot replanting, modify edge zone management.
Fauna	Monitoring of wetland fauna can be useful in assessing the overall health of the wetland community. Typically, aquatic macroinvertebrates can be used for this purpose. Pest species (eg. mosquitoes) in particular need to be regularly monitored. Other species, like birds, need to be regularly monitored also. Birds that either eat aquatic vegetation or use it for habitat and nesting can cause major damage to wetland vegetation.	Health assessment = annually. Pest monitoring = weekly.	Vary organic load, change operational water depth, instigate a drying cycle, instigate pest (mosquito) control procedures, modify edge zone management, review terrestrial vegetation layout – re-plant to interrupt water bird approach paths to the wetland.