

## ADVISORY NOTE

### OPERATION OF WETLAND FILTERS

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***This advisory provides guidance on the appropriate construction and use of Wetland filters.***

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#### INTRODUCTION

Managing water is a significant operating issue at mine sites in the Northern Territory. High seasonal water flows due to the “wet” and the “dry” coupled with the need to dispose of groundwater recovered, dewatering from pits or from underground excavations may add to this issue. Significant runoff or seepage can occur from waste dumps, stockpiles and from around treatment plants.

The pH of these sources may vary significantly, in particular the presence of acidity, or they can contain high levels of dissolved metals and salts.

In the majority of cases, the only options available for managing water at a mine are containment and evaporation or off-site disposal. In releasing water from a site the mine operator must pay particular attention to water quality objectives that may be set by government, the community or through voluntary commitments.

Where there is a large volume of water to be treated wetland filters have been identified as a low cost, low maintenance alternative for improving mine site discharge water quality. The benefits of wetland filters include passive aerobic and anaerobic water treatment, sediment control and water clarification, control of stormwater run-off and run-on, aesthetic appeal, and valuable wildlife habitat

#### WETLAND FILTERS

In the Northern Territory wetland filters have been incorporated into a number of mining operations, including both base metal and gold mines. They either occur opportunistically, as a result of continuous water release, or as constructed wetlands. These wetlands receive and treat:

- acidic runoff from waste rock dumps
- groundwater and tailings dam seepage
- mine discharge water and
- routine surface flows, in particular during high rainfall periods, which may contain mobilised contaminants.

By creating a suitable environment for microbial activity the wetlands utilise nutrients present in the water to produce conditions where metals dissolved in the stream precipitate out and the physical parameters (eg. pH, conductivity) of the water stream are improved.

## WETLAND CONSTRUCTION

The following information is a guideline to operators on the construction and operation of a wetland filter. Each individual site will have its own particular requirements due to the flow volumes, chemical properties and geographical issues to be considered.

The successful operation of a wetland filter begins with construction. A passive system requires careful positioning of the inlet flows and outlet flows from the filter. Gravity is used to direct the water through the constructed cells.

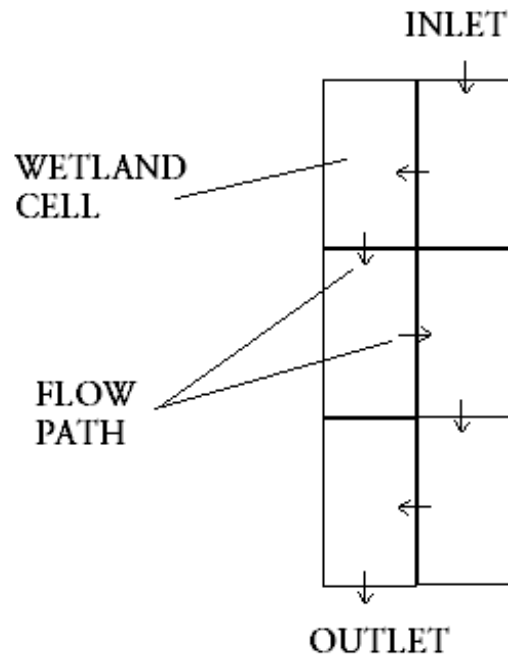
By default, low-lying areas such as creek beds or flood plains are usually chosen as wetland sites. These are areas that are normally inundated during rainfall events. In some situations, wetlands can be constructed above grade with compacted earthen embankments used for containment.

Upstream of the wetland a sediment or "silt" trap should be installed. This trap is used for removing sediment particles and debris from the water stream. Regular cleaning of the trap will enhance the capacity of the wetland to remove dissolved elements. A flow measuring system, such as a gauging station, may also be installed. This can assist in determining the most suitable flow rates and assist wetland efficiency.

To allow flexibility across the system, flow-regulating devices such as weirs and gates can be installed to create discrete cells. During periods of low flow, such as the first flush associated with the beginning of the wet season, the capacity and the contact time in the wetland can be increased. During full flow events the capacity of the wetland can be reduced with dilution processes utilised instead.

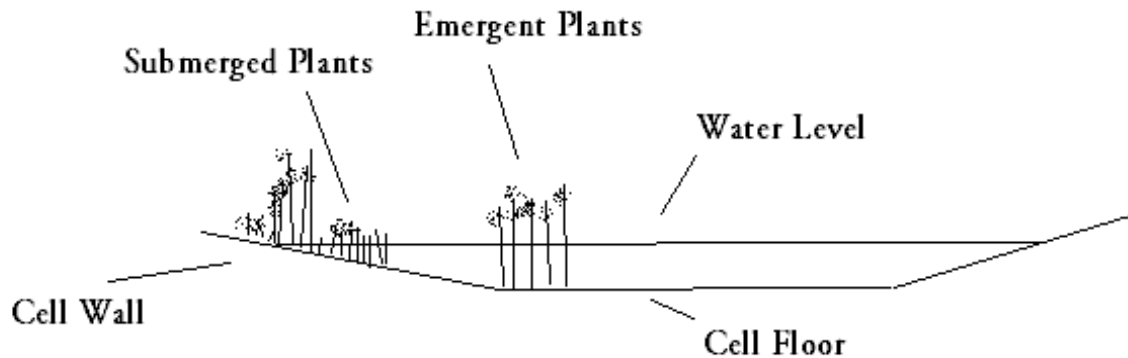
The prime requirement of a successful wetland is the establishment of self-sustaining vegetation across a permanently ponded area. On entering the wetland the water stream should be spread out evenly across the area to increase contact time with the vegetation. The optimum retention time in the wetland is between 5 and 14 days.

This process can be achieved by creating a tortuous flow path for the water using embankments and channelling. The diagram below shows an idealised flow path around a constructed wetland utilising discrete cells.



Before inundating the proposed wetland site it is important to assess the baseline characteristics of the area including soil and groundwater conditions. The soil or subsoil must have a permeability low enough to retain standing water. Metals removed from the water will be either deposited as potentially acid forming enriched muds, or they will be absorbed onto the soils and clays underlying the vegetation. A baseline study will allow the extent of contamination to be assessed more completely during the management and eventual closure processes.

As a guide, the sides of the wetland cells should be sloped to allow safe access for personnel and a suitable growing area for edge plants. The water depth should be a minimum of 0.3-0.4 m and up to 1-1.5m deep. The maximum depth is to ensure that the water to be treated remains in constant close contact with the decaying vegetation and bacteria on the floor of the wetland. By increasing the capacity of the wetland the retention time is also increased.



The specified minimum water depth is a compromise between the inhibition of the breeding of mosquitoes and the provision of a habitat for fish and other aquatic organisms. The presence of aquatic fauna is a good indicator of water quality. During periods of low or no flow, the water column will act as a barrier to the desiccation and oxidation of sediments and the release of precipitated metals.

## **VEGETATION ESTABLISHMENT**

It is important to choose vegetation that is compatible with the region, particularly wetland grasses that are temperature tolerant for the area. Propagation into the wetland may be done by direct seeding or by transplanting rhizomes from other wetland areas. Some wetland species (particularly *Typha* sp.) are aggressive colonisers.

In the early stages of the development it is important to keep the wetland inundated. Preferably the water should be of high quality to promote plant growth. It is important to build up a store of organic material and nutrients for the bacteria to act upon. This may be achieved through addition of decaying vegetation (green waste), fertilizer and the like. Once established the waste water stream should be progressively introduced to allow the system to react.

## **ADDITIONAL TREATMENT CELLS**

In addition to silt traps installed upstream of the wetland filter some operators include "neutralisation" cells as part of the process, particularly when dealing with acid drainage.

These cells consist of lime or rock with a high acid neutralising capacity placed just before the wetland area that act sacrificially. The water stream enters the cell and reacts with the rock, raising the pH of the water stream and protecting the vegetation in the filter. These neutralising materials should have a large available surface area to limit the effect of precipitation of insoluble salts that may limit the process in the longer term.

## **OPERATION**

The main operational parameters that maintain the effectiveness of the wetland are:

- keeping the wetland wet and
- maximising the contact time with the wetland vegetation.

These factors can be managed by controlling the rate of inflow and outflow of water through the cells using physical structures such as weirs and bunds.

The rate of flow through the wetland should be optimised by undertaking monitoring at regular intervals of total and dissolved metals and ion concentrations. Measuring these parameters will also allow early identification of changed wetland bed conditions. If the wetland is allowed to dry out then there is a likelihood of the metals removed from the waste water stream being remobilised.

## **CLOSURE AND REHABILITATION**

At the time that the wetland filter is constructed, consideration should be given to the closure and rehabilitation processes at the site and the long term fate of surface water runoff.

Responses to the issues identified include:

- Long term stability of ponded areas
- The fate of vegetation under seasonal events (wetting/drying)
- The remobilisation of precipitated or absorbed sediments and
- Collection of contaminated sediments during mine decommissioning

Recommended reading:

Waterplants In Australia (1994) 3rd Edition, Sainty, G.R., Jacobs, S.W.L.

Wetlands (1993) 2nd Edition, Mitsch, W.J., Gosselink, J.G.

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