

Chapter 6 Construction Principles

6.1 Construction Issues

Most sites will require the installation of an access road and the clearing of vegetation and above ground obstacles. The clearing of vegetation should be limited to the area affected by the works. Grubbing of stumps and roots may be required.

Should the wetland be sited within a water course or overland flow path, some temporary or permanent flow diversion works may be required.

Once the site is cleared the existing topsoil must be removed and stockpiled for reuse as wetland substrate, if it is suitable, and/or topsoil for planting on embankments. Providing a suitable substrate is important for the sustainability of the wetland plants. The substrate should be capable of supporting plant growth in terms of nutrients and have the ability to anchor plant root systems. The substrate should be inherently stable chemically and have some permeability to enable soakage of effluent into the substrate.

The wetland substrate should be placed to the design depth but loosely compacted, if possible, to aid the planting out process. Adding fertilisers to the substrate must be avoided since the nutrient content of the applied wastewater will assist in this respect.

Sites with shallow bedrock can impact on construction costs since this must be fractured, collected and removed off-site and replaced with suitable fill material.

Set out is important so that inlet and outlet weirs, deep zone and macrophyte zone inverts, embankment top levels and gradients are in accordance with the design. Basic landforming can then commence.

Construction plant should be carefully selected. Heavy earthmoving machinery (eg scrapers) should be confined to larger wetland systems where bulk earthworks and longer hauls are required. Larger hydraulic excavators are suitable for forming wetland zones and deep zones, embankments and diversion works. Graders are suitable for trimming wetland components and spreading substrate and topsoil. Backhoes are required for pipework and smaller excavations.

Clay or other subsoil can be excavated and used for forming the embankments. Soft and

other unsuitable material must be removed. Clay liners under the wetland substrate should be placed and well compacted to minimise effluent infiltration into the groundwater.

All materials used for embankment construction should be placed in layers not exceeding 200 mm in an uncompacted state. A minimum compaction of 90% standard in accordance with AS 1289.5.1.1 should be achieved. Each layer of fill material should have a reasonably uniform moisture content.

Weirs, overflow structures and other protective rockwork should be placed on an approved geotextile to avoid undercutting and other sources of erosion.

Final site grading follows the construction of inlets, deep zones, macrophyte zones, ephemeral zones, islands, embankments and outlets.

As soon as the embankments are dressed with topsoil they should be protected from erosion by straw, synthetic netting, hydro seeding or rapid growing grasses. Irrigation may be required to ensure good germination and growth of the grasses.

The Brisbane City Council has developed a method of retaining soil on embankments at the Willawong Landfill Remediation project. The embankments are graded and trimmed, rolled with a sheepsfoot or grid type roller to provide an effective bond, topsoil applied, padded with the back of a bucket and hydromulched.

The construction phase should give due consideration to stormwater and erosion control measures, waste management, acceptable construction hours, noise control, dust suppression, and traffic control and other local government requirements.

Gravity distribution systems should be placed on firm foundations with appropriate erosion protection. The installation of water control structures is often the only significant component of structural work in wetlands. These should be placed on adequate footings on noncompressible soils so that wave action and/or seepage cannot take place between the concrete and soil interface. Stone pitching must be placed to ensure wave action or spillage cannot undermine the structures or cause failure through the lack of compaction.

Structural concrete work and the laying of pipes and valves should be as per the Australian Standards and the accepted civil engineering construction practice of the area. Where pipes are laid through embankments, care must be taken in the replacement and recompaction of the excavated material to avoid settlement and scouring.

It is sound practice to construct wetlands and associated facilities to within acceptable limits of the design levels. Suitable tolerances for wetland construction are listed as follows:

- centreline or waters edge $\pm 200\text{mm}$
- finished invert levels $\pm 25\text{mm}$
- embankment top levels $\pm 25\text{mm}$
- cut & fill batters (as shown on the drawings)
- top width of batters $\pm 150\text{mm}$
- topsoil and substrate depth $\pm 25\text{mm}$
- thickness of clay seal $\pm 50\text{mm}$
- rockwork thickness + 100mm, - 0mm
- sill level $\pm 25\text{mm}$
- inlet/outlet levels $\pm 25\text{mm}$

6.2 Plant Establishment

It is important that certain site factors such as soil type, soil water pH, extent of the growing season, weed potential, and climatic characteristics are noted prior to the plant selection and establishment. (Simpson & Woolley, 1995). These factors are described in Section 5.4 Plant Selection.

Wetland Substrate

The wetland substrate should be thoroughly soaked prior to planting to enhance the planting process. At no time should the water level be over the height of the emergent plants being established. A maximum water depth of 150 mm at planting is suggested. This is to be maintained during the initial establishment phase to enable the transfer of oxygen to the roots.

The wetland substrate should be capable of supporting plant growth by being nutritious and firm enough to anchor the plants. A minimum of 100 mm and preferably 150 mm of organic soil is recommended for wetland plant growth (Dowling & Stephens, 1995, Simpson, 1995). Topsoil chemical testing and analyses can be undertaken to confirm the suitability.

There should be no need to add fertilisers to the substrate and this practice is not recommended. It is likely to impact on the water quality. The substrate should be

reasonably nutritious containing sufficient organic matter and basic nutrients to establish growth. A secondary standard influent will contribute additional nutrients and trace minerals, to enhance plant growth.

Substrate with a high aluminium or iron content enhances the removal of phosphorus and the organic content can aid the reduction of iron, manganese and sulphate. Most existing soils will normally be suitable as a substrate providing they have an organic content, some nutritional value and are reasonably permeable. On no account should wetland vegetation be planted directly into the clay base of the wetland. This is most likely to lead to at least partial failure in establishing the plants.

Sourcing Wetland Plants

The plants should be sourced where possible from a suitable nursery and transplanted as soon as possible. It may be more desirable in areas more remote from plant nurseries to source wetland plants from the wild. It is very important that such species are proven to be well established naturally within the area. Such plants tend to be more hardy and suited to transplanting and establishment.

The period from collection to planting depends on the temperature, humidity and wind intensity. Transporting root stock any distance, particularly during hot or windy conditions, can result in burning and potential failure. Plant stock can be covered to minimise this damage.

Currently wetland plants are supplied from nurseries in the following forms:

- mature wild plants, known to exist locally
- traditional root stock form
- viro-cell are proven low cost specially grown plants in 62 mm deep tapered cells which are treated with transplanting enhancer and a hardening off agent
- viro-tubes are wetland plant stock specially grown in a tapered tube to minimise the problem of becoming root bound and are deeper than viro-cells
- Flawra-Ej strips are a recent development consisting of a reinforced strip of wetland plants with more resistance to high velocities.

Wetland Planting

Wetland plants should be planted by experienced staff who are familiar with the requirements and techniques for successful establishment.

Planting layout patterns for emergent species include:

- band planting, for example, a band of *Eleocharis spp* then a band of *Baumea spp* across the direction of flow
- planting parallel to the wetland edge, in depth zones typically 0 to 150 mm, 150 to 300 mm, 300 to 500 mm.

Water level control is very important during the planting and establishment phases. The stems of emergent plants must be well above the water level to absorb oxygen. During the planting and initial establishment phases, emergent plants will thrive in very low water levels and also moist soil conditions. In the event of heavy rain there must be provision to adjust the water level.

Planting densities vary depending on the following factors:

- project budget
- treatment objectives
- water depths
- types of species desired
- water surface coverage
- root structure of the plant species
- ability of the plant to self propagate and spread over the bottom of the wetland.

Planting densities vary from 1 to 10 plants per m². Typical plant densities are as follows:

- Baumea articulata* - 1 to 6 per m²
- Cyperus exaltatus* - 1 to 5 per m²
- Eleocharis acuta* - 2 to 6 per m²
- Juncus planifolius* - 2 to 8 per m²

Emergent species are normally more suited to planting by digging a hole, placing the entire root or rhizome and backfilling with substrate. Ensure that much of the stem is above the water level. Further guidance on planting can also be sought from the supplier. Experience with wetland planting in Queensland has shown that the shallower edge margins are more responsive zones for planting. (Simpson & Woolley, 1995)

It is considered that in the case of a trench configuration, when the edge zones become well established the central zones will eventually do likewise. It has been found in Queensland that different species should be selected for the shallow zones when compared with those selected for the central and deeper zones.

Plant Establishment

The ideal time for planting aquatic species is within the accepted growing season for the area (refer to Section 5.4 Plant Selection). Experience in the non tropical regions in

Queensland has shown that planting should be avoided between May and August, inclusive. Planting during the winter period is certainly not recommended, with the exception of tropical areas, as frosts can seriously affect plant establishment.

All planting must be protected from stock access. Stock can damage the banks of the wetland, eat the macrophytes and disturb the substrate within the shallower zones.

Bird damage to wetland plants, particularly during the establishment stage, has been reported by the Brisbane City Council (wetlands at Willawong and Wavell Heights) and in northern New South Wales. For example, the swamp hen has been known to pick off young stems for nesting purposes.

The commissioning and establishment phase includes the time from planting to the date the wetland is considered fully operational. During this period the following aspects should be attended to:

- careful control of water levels to prevent the drying out or the flooding of plants
- checking for and the removal of weed or nuisance species
- replacing failed planting
- regular inspections to check that the wetland system is developing in accordance with the design and documentation
- attending to minor problems affecting the wetland establishment.

The initial two to four months are very important for the establishment of the aquatic vegetation. The ability of plants to survive in a wetland is governed mainly by water depth and quality. Controlling the water levels will encourage the growth of the emergent species. Most emergent plants cannot survive in depths greater than 600 mm and inundation of some species for more than about 5 days will cause death. Plant die-off is often due to the lack of oxygen under anaerobic conditions.

The control of weed or nuisance species by manual means is preferred. Should chemical control be a preferred option due to certain circumstances, specialist assistance should be sought to ensure the other plant species or aquatic organisms are not affected by spraying.