2.4 Pond site investigation

Site investigations are critical for assessing the suitability of sites and soils for dairy effluent pond construction and ongoing maintenance, and the information garnered should be utilised in pond design. The primary objective is to provide secure storage that minimises seepage losses and facilitates recycling of treated wastewater. Secondary objectives include locating ponds to improve farm management and gaining earth for other farm infrastructure such as silage pits, feedpads and laneways.

Initial siting

Careful consideration is required in the siting of a dairy effluent pond, and a range of sites may need to be evaluated before the preferred location is chosen. It is unwise to site ponds solely on the basis of regulatory requirements or where historically effluent has flowed. As earthworks are typically required to achieve the effective collection of effluent and contaminated runoff, planning for a dairy effluent pond should be undertaken in conjunction with overall farm planning. The following points should be considered in initial pond site selection.

Farm integration

- Provide for effective and efficient collection of as much effluent and contaminated runoff from the dairy and other stock management areas as possible.
- Aim to achieve sufficient distribution of nutrients over the farm; this is important where gravity irrigation systems are used (McDonald 2006).
- Where required, allow for the recycling of treated wastewater for flood washdown.
- Integrate ponds with other farm features, such as using pond embankments as causeways, allowing for laneways, facilitating effective cow flow, improving all-weather access and making effective use of land while integrating the pond within the existing landscape.
- Provide for efficient pond operation, maintenance and monitoring; this is often achieved by ensuring that ponds are visible from the dairy.
- Prefer a site with all-weather access for maintenance of pumps and ponds.
- To limit the propensity for seepage, do not locate ponds adjacent to drains or incised water courses.

Environmental considerations

- Individual states have specific policies on the siting of effluent ponds in relation to flood waters and flood return periods; refer to these (Environment Protection Authority 2003). However, it is not recommended that these be definitively applied, as each site requires assessment on its own merits, and more sensitive areas may require stricter application of these policies than less sensitive areas. Ideally, avoid areas subject to 1-in-100-year floods. However, this is often not possible, so install adequate safeguards to protect the environment (see the next point).
- The NSW Dairy Effluent Subcommittee (1999) recommends protection of ponds against overtopping from 1-in-5-year floods in existing dairies, and from 1-in-25-year floods in new dairies.

2.4 Pond site investigation

- The soils at any proposed site need to undergo adequate soil geotechnical analysis (see 'Soli assessment') to determine suitability for pond construction (Standards Australia 1993).
- The potential for and the implications of both groundwater contamination from seepage and groundwater influx into the ponds should be assessed for any intended pond site as detailed below (Hopkins and Waters 1999).
- Acid sulphate soils must not be disturbed unless a Statement of Environmental Effect (ESS) or an Environmental Impact Statement (EIS) is produced (NSW Dairy Effluent Subcommittee 1999).
- Avoid sites which rely on the diversion of general catchment runoff, such as depressions and gullies, and do not divert flood flows elsewhere.

Regulatory requirements

Consultation with regulatory bodies is recommended to determine what is required before pond construction (e.g. a planning permit). Works need to adhere to any relevant State Planning Policy frameworks and local council permit requirements. Earthworks particularly attract regulation, given the potential danger of collapse or diversion of water. In Queensland, some water resource plans prohibit the taking of overland flow without an extraction licence. Farm dam legislation in Victoria is similar in intent.

Typically it is up to the applicant to demonstrate how their proposal fits with the relevant state government and local council policies. Land owners are expected to undertake sufficient planning to ensure that the system adopted is the best solution for both the operation and the surrounding environment.

Public amenity and food safety

The location of a dairy effluent pond should take into account the location of existing housing, other sensitive uses and land zoned for residential or urban purposes. In addition, effluent storage is not permitted within 45 m of a milk room in Victoria. Conventional practice favours the adoption of buffer distances based on the nature of a receptor and the organic loading generated by an emitter. However, in the case of dairy effluent ponds, buffer distances are often specified. Alternatively, proponents may wish to undertake odour dispersion modelling to demonstrate satisfactory performance for a proposed effluent pond (see chapter 5 'Odour emissions and control'). The general principle that should be adhered to is that no discharge should give rise to material detriment to any person (i.e. interfere with the normal use and enjoyment of life and property to more than a trivial or minor extent). It is critical to avoid alienation of neighbours. Whenever possible, they should be consulted as early as possible in the planning process. Ideally, existing buildings, topography and vegetation should be used to screen ponds from major roads and nearby residences.

Soil assessment

Soil investigations

It is imperative to investigate subsurface features of an intended site by test boring or excavation trenches and soil geotechnical analysis to determine the soil's suitability for pond construction. The results of this analysis combined with the specific intended use of the material (e.g. embankment core, outer embankment batter, embankment liner) should determine final suitability.

Although there is no standard for the number of investigation sites required, the number should depend on the footprint dimensions and on site soil and surface feature variability. It is critical that the subsurface investigations adequately represent the soils across the proposed site. These investigations can be assisted by aerial photographs, farm plans containing topographical details or geophysical surveys (e.g. electromagnetic survey). Pertinent aspects to be assessed are detailed in Standards Australia (1993).

Soil physical assessment

Assess and document the exposed soil profile at each inspection site in detail and note features such as:

- depth of the each soil horizon (layer)
- texture
- colour and mottling
- structure
- mechanical resistance (hardness)
- friability
- porosity
- drainage status
- presence of natural lime ($CaCO_3$) or gypsum ($CaSO_4$)
- proportion and type of rock
- water table presence
- groundwater quality (EC)
- presence of sand or layers conductive to preferential water flow
- other distinguishing soil features; e.g. manganese layers, clay skins or structural peds.

For a full appreciation of the information that can be collected and definitions of soil-related terms, see McDonald *et al.* (1990).

Soil geotechnical analysis

Soil geotechnical laboratory testing is recommended for all pond sites and is required to determine permeability and structural stability (NSW Dairy Effluent Subcommittee 1999, Standards Australia 1993). The sampling and geotechnical analysis process should include the following considerations:

- Analysis of soil samples representative of material intended to be used in the pond floor, embankments and other pond structures.
- Analysis for dispersion, shrink–swell capacity, Atterberg limits and USCS engineering classification.
- Analysis for saturated hydraulic conductivity on remoulded samples to demonstrate that the material can achieve a permeability of $<1 \times 10^{-9}$ $m \cdot s^{-1}$ at the specified target density (Environment Protection Authority 2003, NSW Dairy Effluent Subcommittee 1999). However, as significant site variability is possible, more than one test may be required; the number should be based on recommendations from a qualified practitioner.
- AS 1289 (Standards Australia 2000) requires that the Electrical Conductivity (EC) of the test solution used to test saturated hydraulic conductivity be representative of the material. Although the NSW Dairy Effluent Subcommittee (1999) recommends using 0.01 M KCl as the test solution, either a sample of effluent or water with an EC adjusted to within the typical range (2.8–7.8 $dS \cdot m^{-1}$ according to Waters (1999) is suitable.

Soil suitability

The soil suitability information detailed in this section (from Skerman *et al.* (2004)) provides a useful indication of the suitability of site material for pond construction. See also AS 1726 (Standards Australia 1993).

The clay used to line ponds should be well-graded impervious material, classified as either CL, CI, CH, SC or GC (see Appendix A, Table A1, in AS 1726; (Standards Australia 1993). The lining material must conform with the particle size distribution and plasticity limits shown in Tables 1 and 2.

Table 1. Particle size distribution.

AS metric sieve size (mm)	Percentage passing (by dry weight)
75.0	100
19.0	70–100
2.36	40–100
0.075	25–90

Table 2. Plasticity limits on fines fraction, passing 0.425-mm sieve.

Liquid limit	30–60%
Plasticity index	>10%

If materials complying with these plasticity limits are not readily available, clays having liquid limits between 60% and 80% may be used as lining material, provided that the clay lining layer is covered with a layer of compacted gravel (or other approved material). The compacted gravel layer should have a minimum thickness of 100 mm to prevent the clay lining from drying out and cracking. To determine compliance with the above requirements, materials must be tested in accordance with AS 1289 (Standards Australia 2000). Any material which does not compact properly (e.g. topsoil, tree roots, organic matter) must not be used in clay lining or be placed in areas to be lined. Wherever non-dispersive materials are available, use them in preference to materials shown to be dispersive by the Emerson test, as described in Method 3.8.1 of AS 1289.

Groundwater

In addition to soil investigations, hydrogeological investigations are also important to determine the depth to groundwater and the location of geological formations that favour groundwater flow. Examine existing groundwater data to determine possible hydrogeological conditions and district beneficial groundwater use. These data can sometimes take the form of a risk assessment. The following important groundwater factors need to be considered:

- The potential for and the implications of both groundwater contamination from seepage and groundwater influx into ponds should be assessed.
- Individual states have specific policies on the siting of ponds in relation to the depth of groundwater below the pond base or below the natural surface. Although these policies need to be followed, each site requires assessment on its own merits, and final suitability will be dictated by pond depth, soil permeability and beneficial use of groundwater.
- Ponds should not be situated above groundwater resources that are deemed to be vulnerable to contamination unless those resources can be shown to be protected (NSW Dairy Effluent Subcommittee 1999). Karst limestone systems are at particular risk; these are omnipresent in south-eastern SA.
- Extra justification or safeguards are required where shallow or saline groundwaters occur (NSW Dairy Effluent Subcommittee 1999).

Final pond site suitability assessment

All relevant information should be assessed by a suitably qualified person to evaluate the appropriateness of a site for construction of a dairy effluent pond. Appropriate representative soil samples need to meet the suitability criteria of Skerman *et al.* (2004) as detailed above. In addition, information on flooding potential and groundwater also needs to be considered, along with public amenity and farm planning considerations, to determine site suitability.

The site assessment should result in recommendations on appropriate construction techniques and on monitoring and management. Further information is provided in chapters 2.5 'Pond design and construction' and 7 'Monitoring and sampling'. It is advisable to have a written contract prepared before construction to assist the earthmoving contractor and to ensure that all parties agree on the nature of the works required and the costs likely to be incurred. Avoid verbal agreements.

Professional supervision may be necessary on larger, more sensitive sites or where materials are highly variable. It is advisable to determine whether any cultural and heritage overlays apply to the site (check with the local council) during the investigation and avoid any sensitive sites. In particular areas it may be necessary to undertake a cultural and heritage survey.

References

Environment Protection Authority 2003, 'Code of practice for milking shed effluent', Environment Protection Authority, Adelaide.

Hopkins, D. & C. Waters 1999, 'Dairy effluent: protecting groundwater', AG0841, viewed 22 November 2006, www.dpi.vic.gov.au/dpi/nreninf.nsf/9e58661e880ba9e44a256c640023eb2e/adbdcf8c7e376492ca256f10000fbf6d/$FILE/AG0841.pdf# Dept. of Primary Industries, Melbourne.

McDonald, R.C., R.F. Isbell, J.G. Speight, J. Walker & M.S. Hopkins 1990, *Australian soil and land survey field handbook*, CSIRO Land and Water, Canberra.

McDonald, S. 2006, 'Dairy effluent: pond site selection', viewed 22 November 2006, www.dpi.vic.gov.au/dpi/nreninf.nsf/9e58661e880ba9e44a256c640023eb2e/c21e1b0563b67b2dca25716a0005ad98/$FILE/AG0424.pdf# Dept. of Primary Industries, Melbourne.

NSW Dairy Effluent Subcommittee 1999, 'Draft NSW guidelines for dairy effluent resource management', NSW Agriculture, Orange.

Skerman, A., M. Redding & D. McLean 2004, 'Clay lining and compaction of effluent ponds', IL0068, Dept. of Primary Industries & Fisheries, Brisbane.

Standards Australia 1993, *Geotechnical site investigations*, Australian Standard AS 1726:1993, Standards Australia, Homebush NSW.

Standards Australia 2000, *Method of testing soils for engineering purposes*, Australian Standard AS 1289, Standards Australia, Strathfield NSW.

Waters, C. 1999, 'Dairy effluent: application to pastures', AG0419, viewed 22 November 2006, www.dpi.vic.gov.au/dpi/nreninf.nsf/9e58661e880ba9e44a256c640023eb2e/771d977e1d21acbeca256f10000e3834/$FILE/AG0419.pdf# Dept. of Primary Industries, Melbourne.