WQPN 22, JULY 2008

Irrigation with nutrient-rich wastewater

Purpose

Irrigation with treated agricultural or food processing industry wastewater can allow more intensive use of the land, improve plant vigour and may extend growing seasons. Nutrients in wastewater (as organic carbon, nitrogen, phosphorus and potassium) can be balanced to plant growth needs, or natural waters can have had nutrients added. This form of irrigation is called *fertigation*. Irrigation with chemical addition to vegetation needs an effective environmental management plan (EMP) to prevent harm to the environment. Our aim to ensure that resources are used efficiently, that land is not degraded or waterlogged and that natural waters are protected from salinity, turbidity, nutrient-enrichment, leached trace metals, pesticides and other harmful wastewater contaminants.

We recommend the use of best available management practice for all irrigation activities. Employing such practices should lower production costs through the efficient use of resources. This will also benefit the local environment and improve the image of the industry. We recognise that reuse of industrial and agricultural wastewater is a desirable and efficient aspect of water resource management, provided it takes place in appropriate areas, and safeguards are used to protect local water resources from leaching or runoff of chemical residuals, especially nutrients.

The Department of Water is responsible for managing and protecting the state's water resources. It is also a lead agency for water conservation and reuse. This note offers:

- our current views on the irrigation of vegetation with wastewater
- guidance on acceptable practices used to protect the quality of Western Australian water resources
- a basis for the development of multi-agency codes or guidelines designed to balance the views of industry, government and the community, while sustaining a healthy environment.

This note provides a general guide on issues of environmental concern and offers potential solutions based on professional judgement and precedent. The recommendations made do not override any statutory obligation or government policy statement. Alternative practical environmental solutions suited to local conditions may be considered. Regulatory agencies should not use the note's recommendations without a site-specific assessment of any project's environmental risks.

Any conditions set should take a precautionary approach by considering the values of the surrounding environment and the environmental safeguards in place. This note shall not be used as this department's policy position on a specific matter, unless confirmed in writing.

Scope

This note covers the controlled sprinkler, dripper or sub-surface irrigation of vegetated land with stabilised, nutrient-rich wastewater from:

- industry, such as abattoirs, animal holding yards, aquaculture, breweries and food processors
- recycled run-off from agricultural and tree plantation land.

The primary aims of fertigation are to use water resources efficiently, stimulate growth of healthy vegetation (e.g. trees, crops, gardens and turf), limit the need for chemical supplements and minimise the risk of harm to water resources.

Fertigation of poorly vegetated or bare land and native vegetation acclimatised to natural rainfall patterns and low nutrient uptake is not recommended, as it fosters erosion and may harm plants accustomed to a low nutrient environment. This note may also help guide the application to land of fertiliser, manure and nutrient-rich material.

This note does not apply to treated municipal wastewater (sewage) which requires specific approval under the *Health Act 1911*.

Advice and recommendations

Location

1 Fertigation should be confined to sites with the following attributes:
   a zoned for compatible activities in the local government planning scheme
   b remote from areas where odours or spray drift may cause local nuisance
   c the minimum water table depth is two metres
   d sufficient area of arable soil is available
   e slope of land is less than one in twenty
   f appropriate buffers are retained to sensitive water resources (Appendix C)
   g the irrigated area is not subject to seasonal flooding.

Restrictions near sensitive water resources

2 Wastewater should not be applied to land that is permanently or seasonally flooded or waterlogged, needs to be artificially drained, requires natural watercourses to be diverted or where it is likely to harm fringing vegetation to waterways and wetlands. These areas provide significant natural (but fragile) water quality benefits that sustain aquatic ecosystems and filter pollutants in stormwater runoff.

3 Irrigated sites should be placed sufficiently high in the landscape to minimise contamination risks to natural waterways, wetlands and their associated vegetation, and to allow for the effective operation of filter zones and sediment control systems.

4 Irrigation activities that have been legally established for many years, though currently incompatible with our policy and guidelines, can normally remain near sensitive water resources. Operators should employ best practice to limit the risk of environmental harm.

5 Proposals to significantly alter or expand fertigation sites should undergo both a planning and environmental impact assessment and gain written approval from the appropriate regulatory agencies (Appendix B).

Within public drinking water source areas (PDWSA)

PDWSA collectively describe proclaimed underground water pollution control areas, water reserves and catchment areas. These areas provide for the protection and collection of waters used as sources for public drinking supplies. PDWSA are highly vulnerable to water contamination and are protected using the by-laws of the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947.* Each PDWSA will have a published drinking water source protection plan.

Our policy on land use compatibility in PDWSA opposes or restricts fertigation in specific areas due to the risk of contamination from leached sediments, nutrients, pathogens, pesticides and trace elements. More information on the management of PDWSA is provided in our water quality protection note *Land use compatibility in public drinking water source areas.* For any new or upgraded fertigation proposals within any proclaimed PDWSA, written approval should be sought from this department

Within P1 and P2 areas, reservoir protection zones (RPZ) and wellhead protection zones (WHPZ) shown in a published source protection plan

6 These areas are managed to avoid water contamination and to minimise environmental risks. This department will normally oppose intensive agricultural pursuits in these areas (including irrigated floriculture, turf and pasture, market gardens and introduced vegetation), as they are incompatible with our risk management policy. Fertigation may occasionally be approved with conditions when the proponent effectively demonstrates that the proposal will lower the risks presently posed by an approved land use activity.

Within P3 areas shown in a published source protection plan (excluding RPZ and WHPZ)

7 Irrigation and nutrient application will normally be compatible with conditions, provided the proponent effectively demonstrates that best practice is to be employed and that fertigation will not create a significant risk of harm to the water resources.

Near wetlands with defined conservation values

8 Wastewater irrigation should not occur within the recharge zones of natural wetlands having recognised conservation values (Appendix C) or within their fringing vegetation buffer, unless either approved by the Minister for the Environment on the advice of the Environmental Protection Authority or the Department of Environment and Conservation. Development proposals within 500 metres of any natural wetlands should be referred to the Department of Environment and Conservation for advice.

9 Wetlands require an adequate surrounding buffer to protect them from potential adverse impacts, e.g. those associated with nutrients and other pollutants, and to maintain ecological processes and functions within the wetland. The width of the buffer should be determined based on the value of the wetland and the threats posed by the adjacent land uses.

10 Recommended buffer distances are provided in *Position statement: wetlands* (Water and Rivers Commission 2001), (Appendix A, reference 4). Additional information on identifying wetland buffers is contained in the Environmental Protection Authority's *Draft guidance statement 33: Environmental guidance for planning and development,* (Appendix A, reference 6). Buffer distances may be negotiated based on wetland values, local bio-physical factors and protective management techniques used to maintain or restore the value of the wetland.

11 Any development proposals involving fertigation that may affect conservation-valued wetlands should undergo an environmental impact assessment in accordance with Part IV of the *Environmental Protection Act 1986*. Where impact on a wetland is unavoidable, a target of no change in its function should be achieved through offsets e.g. enhanced protection of a nearby equivalent water-body or a constructed extension to the affected wetland to provide the same values and wetted area. For additional information on wetland management categories and buffer determination, see Appendix A, references 4 and 6.

Near environmental protection policy lakes

12 The *Environmental protection (Swan coastal plain lakes) policy 1992* and *Environmental protection (South west agriculture zone wetlands) policy 1998* prohibit the unauthorised filling, mining, drainage change, and effluent discharge into identified wetlands, under Part III of the *Environmental Protection Act 1986*. Irrigation with wastewater should not occur in a location or manner which could harm these wetlands, unless approved by the Minister for the Environment on the advice of the Environmental Protection Authority.

Within waterways management areas

Waterways management areas in the south-west of the state are proclaimed under the *Waterways and Conservation Act 1976* to provide protection to estuaries and their associated waterways considered especially vulnerable to water contamination. Currently managed waterways include the Albany waterways, Avon River, Leschenault Inlet, Peel-Harvey Estuary and Wilson Inlet.

13 For fertigation planned or upgraded within any proclaimed waterway management area, written approval should be obtained from this department's local regional office.

14 To protect any waterway and it's associated riparian area, a foreshore area or waterway buffer should be provided based on an assessment of the biological and physical features associated with the waterway, its values and environmental pressures. Buffer selection is described in the *Foreshore policy 1 - Identifying the foreshore area* (Water and Rivers Commission 2002) (Appendix A , reference 5d). The features used in the environmental assessment are known as biophysical criteria.

15 For waterways, we aim for flexibility and support site-specific negotiated outcomes considering a range of scientific criteria, rather than solely relying on standard buffer distances that may not fully suit the local conditions. This is considered a sustainable approach to waterway management that does not restrict the social and economic opportunities for waterways, while protecting both ecological and aesthetic values.

Within the Swan River Trust management area

16 The Swan-Canning estuary and abutting reserves are managed by the Swan River Trust using the *Swan and Canning Rivers Management Act 2006*. Written approval from the Trust should be sought for any land or water-based development that could harm the estuary or drainage entering the estuary.

Water table separation

17 A minimum two metre vertical separation should be maintained between the irrigated surface and the end of the wet-season water table to maintain aerobic soils. This limits water-logging and fosters contaminant control via soil filtration and microbial action.

Within flood-ways

18 Fertigation should not occur on land that may be seasonally flooded. Land that is on recorded floodplains or may be underwater for more than 24 hours following storm events, is considered unsuited to fertigation.

Remnant native vegetation

Many areas of the state have had much of their natural vegetation cleared for agricultural or commercial land use, essential services or urbanisation. The remaining native vegetation in substantially cleared areas is regarded as a precious resource needed to sustain native plant and animal populations, maintain soil fertility and provide landscape values for future generations.

19 Clearing of native vegetation for intensive agriculture is regulated by the Department of Environment and Conservation via the *Environmental Protection (Clearing of native vegetation) Regulations*. Applications to clear any land (unless for an exempt purpose) should be sent to the Department of Environment and Conservation.

Separation buffers to sensitive water resources

20 Perennial native vegetation buffers should be retained or re-planted between irrigated sites and any sensitive water resources (Appendix C). These buffers are crucial to the protection of surface water ecology, and act as contaminant filters to allow time for effective remedial action following any chemical spill. These buffers may need to be supported by other protective measures e.g. engineered drains to control soil erosion and systems to capture and recover silt and spilt chemicals.

21 Vegetated buffers to protect water quality should be defined, created and managed using our water quality protection note *Vegetated buffers to sensitive water resources* (Appendix A, reference 5C).

Fertigation scheme design

22 Those intending to apply stabilised wastewater onto land should ensure that systems are well-matched to seasonal soil moisture levels, vegetation growth needs, soil and groundwater nutrient concentrations, and the soil infiltration and nutrient retention capacity of the soil.

23 Wastewater storage in holding ponds should be considered for the crop/pasture dormant season or if practical as a water reserve during drought periods. For pond information, see our water quality protection notes *Ponds for stabilising organic matter* and *Liners for containing pollutants using engineered soils* (Appendix A, reference 5C). More information is provided later in *On-site storage of nutrient-rich water*.

24 The fertigation scheme should be designed to minimise water-logging risk and leaching of contaminants (e.g. nutrients) into surface or ground waters. A detailed *Nutrient and irrigation management plan* (Appendix A, reference 5c) should form part of the environmental management plan prepared to support the scheme.

25 For irrigated site areas exceeding ten hectares, a proven scientifically-based contaminant fate and transport model should be used to predict the impact of applied chemical constituents on downstream water resource quality. Provided reliable technical data is available on the local environmental attributes, such models can predict the likely change in concentration of potential pollutants such as nutrients, metals and pesticides as they move from the point of release to where they may affect water resource values.

Model predictions should be compared against both local water resource quality data (if available) and the national guideline recommendations for protecting water resource values (Appendix A, references 1a and 1b).

26 Where contaminant fate and transport models are used, the selected model should include data on:

a the seasonal water and chemical inputs needed to sustain the selected irrigated vegetation type

b minimising application of chemicals (e.g. fertilisers, trace elements and pesticides) to meet plant needs, while minimising environmental risks posed by water-borne contaminants

c historical application of chemicals at the site and measured soil residues

d application frequency of chemicals used, their water solubility and degradation potential when applied according to the site's management plan

e effective disinfection of any disease-causing microbes likely to be present in applied wastewater

f the projected path of leached contaminant movement and probable duration between the release point and impact on sensitive water resources

g seasonal meteorological effects (e.g. evaporation, rainfall and temperature)

h potential for contaminant attenuation by plants and soil (i.e. likely physical, chemical and biological reactions)

i expected effects in the environment e.g. dilution, dispersion, and/ or interaction with natural or introduced elements

j receiving water quality regime and its ability to sustain present downstream environmental values

k use of a conservative factor of safety when predicting contaminant impacts on water resources.

27 Where discernible harm to water resource quality is predicted, the crop management regime should be altered to provide a safe outcome, measures employed that will correct the contaminant transfer to an acceptable level or the site used for another purpose.

28 The use of scientific modelling does not override any statutory controls or our policy position related to protection of water resource values.

29 For fertigated sites under ten hectares in area, the default nutrient application rates given in Table 2 may be used as a guide.

30 More information is provided in the horticultural guidelines *Best environmental practices for environmentally sustainable vegetable and potato production in WA* - section 4 (Appendix A, reference 9).

Consultation during the project planning stage

31 For the location of sensitive water resources, contact our local regional office or go to <www.water.wa.gov.au>, then select *maps, data and atlases* > *geographic data atlas,* or near Perth, the *Perth groundwater atlas*.

32 The Department of Health's environmental health branch should advise on appropriate community safeguards if the wastewater may contain harmful micro-organisms. Where wastewater containing human or animal waste is planned to be used for irrigation, Department of Health advice should be sought on water quality and access restrictions to avoid human exposure to disease-causing organisms. For online information go to <www.health.wa.gov.au/envirohealth/water/index.cfm>.

33 Any irrigation sites proposed within 500 metres of a sensitive water resource should be referred to our local regional office for assessment and a written response, with supporting information addressing the management of environmental risks. This ensures that environmental controls are negotiated well in advance of development, so they are made affordable, suitably located, constructed, operated and maintained with an appropriate balance of environmental, social and economic consideration.

Gaining development and environmental approvals

34 Statutes covering fertigation are summarised in Appendix B. Where a regulatory agency advises that conditional approval may be given, a detailed environmental management plan (EMP) should be prepared assessing risks and proposing safeguards. This plan should be submitted to regulatory agencies for assessment and a written response.

35 For facilities near sensitive water resources, the EMP should include:

a the site owner or operator's contact name and address

b a site plan showing the location of the irrigated areas

c a description and sketches of the local environment where fertigation is proposed e.g. soils description, land slope, drainage paths and water resources

d a description of the plants that will be irrigated and details of any planned cropping regime

e the nature of any materials stored or handled on site that may affect the environment

f the expected monthly water use budget. In proclaimed areas, a licence to take water from bores and streams for non-domestic use is required from this department

g a description of the types and quantities of nutrient-rich material that will be applied to land

h a description of water treatment systems used

i a description of the water control and application method

j proposals for any chemical containment, waste management and disposal (with design sketches)

k a nutrient and irrigation management plan and environmental monitoring plan

l details of any contingency measures to minimise the impacts of any chemical spill, and the disposal of contaminated waters from any fire, flood or other emergency.

36 The EMP should clearly demonstrate that fertigation can be established and operate without posing a discernible risk to the values of downstream water resources.

37 Fertigation with wastewater quantities exceeding 100 kilolitres per year may require a licence under Part V of the *Environmental Protection Act 1986.* For basic assessment needs contact the Department of Environment and Conservation, use EMP data above and use our water quality protection note *Nutrient and irrigation management plans*.

Management and operating conditions

38 To assist decision-making where detailed site-specific scientific studies and environmental modelling of sites for fertigation are impractical, soils and receiving environments have been divided into four risk categories shown in Table 1.

Table 1 Eutrophication risk based on soil type and location

Characteristics of the irrigated soils	Eutrophication risk of surface waters within 500 metres of irrigation site	Risk category [e]
Coarse grained soils [a] (e.g. sands and gravels)	significant [b]	A
	low [c]	B
Fine grained soils, PBI [d] > 100) (e.g. loam, clays or peat)	significant [b]	C
	low [c]	D

Table 1 notes

a Specific restrictions may apply where near-surface soil conditions (e.g. in limestone, gravels or fractured rock) are likely to lead to rapid water movement without achieving significant removal of contaminants.

b Significant eutrophication risk applies to translucent surface waters where nutrient leaching from fertilised land results in occasional algal blooms; or where warm season plant-available nitrogen (N) exceeds one milligram/ litre and filterable reactive phosphorus (P as PO_4) exceeds 0.1 milligrams/ litre in the water body.

c Low eutrophication risk applies to turbid or dark coloured waters, those with rarely observed algal blooms (i.e. less than 5000 cells per milli-litre), there is low nutrient leaching from land use and waters with warm season inorganic nitrogen concentrations of less than 0.5 milligrams per litre and filterable reactive phosphorus (P) less than 0.05 milligrams per litre.

d Phosphorus buffering index (PBI) is a scientifically determined measure of the P holding capacity of soils between the ground surface and base of the vegetation root zone, PBI details are available online at <www.agric.wa.gov.au/content/LWE/LAND/FERT/BULLETIN4591.PDF> .

e Eutrophication risk categories apply to the recommended nutrient application rates given in Table 2 in the *Nutrient application criteria* section.

On-site storage of nutrient-rich water

39 Sufficient on-site storage for wastewater should be provided to allow for interruptions in the site water supply, rainfall events and the maintenance of irrigation equipment. This storage may be in purpose-built tanks or ponds that are lined to prevent seepage (Appendix A, Reference 5c). Where practical the storage should be designed to capture any run-off from the fertigated land for recycling. Facilities should also be available for storage of wastewater during the wet season and when rainfall meets the water needs of the vegetation. A monthly water balance should be calculated to ensure adequate storage capacity, with freeboard against overflow.

40 Where recycling of run-off or long-term water retention is proposed, designers should consider the impact of increasing salt concentrations in the storage pond due to evaporation, and the risk of foul odours resulting from seasonal decay of algal blooms.

Water and chemical application rates

41 Irrigation rates should be matched to seasonal evapo-transpiration (ET) rates and the water uptake needs of the irrigated vegetation (considering the plant size). The water needs of shallow-rooted plants can normally be calculated at 60 – 80 per cent of pan

evaporation, depending on the water application method. Local climate data from the Bureau of Meteorology is available t <www.bom.gov.au/weather/wa>.

42 Irrigation rates should also consider site factors including soil infiltration capability, root-zone soil moisture content, irrigation method, land slopes and depth to water table. To minimise contaminant leaching, fertigation should not occur if the topsoil remains moist from past irrigation cycles or recent rainfall. Soil moisture meters linked to irrigation controllers provide for optimum watering management.

43 For loam soils, irrigation rates three to five millimetres/hour are suitable. Sandy sites may accept up to fifteen millimetres/hour without run-off. Irrigated water should be applied evenly. Irrigated areas should dry for 24 hours between applications during warm weather; and up to seven days during cool periods to prevent soil water-logging.

44 Irrigated areas should have a land slope of between one in 20 and one in 200 to avoid either soil erosion or formation of boggy ground.

45 Fertigation schemes should be managed to avoid excessive build-up of salts in the soil as water is lost via evapo-transpiration. Normal wet season rainfall should be checked as sufficient to flush any accumulated salt from past seasons away from top soils prior to the start of the next irrigation season. Soil electrical conductivity testing may be used to assess salt build-up in soils.

Soil nutrient status

46 Wastewater should not be applied to sites where there has been long-term application of nutrients (e.g. annual applications of super-phosphate, urea or animal manure), unless the soil nutrient status has been analysed and factored into the nutrient and irrigation management plan.

Application criteria for organic matter and trace elements

47 To avoid foul odours, wastewater containing volatile (degradable) organic matter should be applied at a biochemical oxygen demand loading of less than 30 kilograms per hectare per day.

48 For wastewater with biochemical oxygen demand concentrations exceeding 150 milligrams per litre, effective chemical or biological stabilisation methods should be used prior to irrigation.

49 Heavy metals in wastewater should not exceed the quality criteria for irrigation use given in the *Australian and New Zealand guidelines for fresh and marine water quality* (Appendix A, reference 1).

Nutrient application criteria

50 The Department of Agriculture and Food provides farm notes on commercial crops and their associated annual nutrient uptake rates (Appendix A, reference 5).
Data on tree plantation needs may be available from the Forest Products Commission (<www.fpc.wa.gov.au>).

51 For grassed area nutrient needs, see the *Environmental guidelines for establishment and maintenance of turf and grassed areas* (Appendix A, reference 5b).

52 Where scientific studies and environmental modelling is impractical for irrigated waters, indicative maximum nutrient (N and P) application criteria (unless effective management measures are demonstrated to minimise the risk of contaminant leaching) are given in Table 2.

Table 2 Nutrient application criteria to control eutrophication risk

Risk Category from Table 1	**Maximum inorganic nitrogen addition (as N)**		**Maximum reactive phosphorus addition (as P)**	
	Application rate (kg/ hectare/ year)	As water concentration (mg/litre) [a]	Application rate (kg/ hectare/ year)	As water concentration (mg/litre) [a]
A	140	9	10	0.6
B	180	11	20	1.2
C	300	19	50	3.1
D	480	30	120	7.5

Table 2 notes:

a The N and P concentrations are based on an average of 50 millimetres of water (500 kilolitres/ hectare) applied per week over 32 weeks /year, with no additional nutrient addition to the land (including animal manure). For other irrigation regimes, equivalent water concentration rates should be calculated on a pro-rata basis.

b Application rates are based on quantities of plant-available nitrogen and phosphorus (N as ammonia and nitrate, and P as ortho-phosphate) to promote healthy vegetation growth matching the growth cycle of the irrigated plant species.

c For materials that require microbiological decomposition to release plant-available nutrients (e.g. decay of green-waste), the local conditions will need to be factored into the calculations (i.e. time, moisture, warmth, available oxygen and presence of decay inhibitors).

53 Nutrients should be applied to match the seasonal needs of the selected vegetation species. Fertigation should not occur at times when plants cannot effectively use available nutrients e.g. during dormancy periods, as nitrogen and phosphorus leaching is likely to result.

Managing other potential water contaminants

Micro-organisms

54 Information should be obtained from the *National water quality management strategy* (NWQMS) guidelines and the Department of Health about irrigation controls (disinfection and withholding periods) to reduce the risk of transmission of harmful microbes i.e. bacteria, intestinal worms, protozoa and viruses.

55 Where wastewater may contain harmful organisms, general constraints include:

a unsuitable for human food crops eaten raw (for crops below ground and less than one metre high).

b fruit and nut crops and human food crops served cooked should not be harvested for at least 60 days after wastewater application

c windfall and dropped produce should not be collected for raw human consumption, if topsoil is moist

d dairy cattle, pigs and poultry should not be allowed to graze until at least three summer months (or equivalent hot weather) after wastewater application, and pasture is fully established

e beef cattle, sheep, goats, horses and other grazing animals (excluding dairy cattle, pigs and poultry) should not graze for at least 30 days after wastewater application

f fodder crops should not be harvested for at least 30 days after wastewater application.

Salts, metals, foaming substances, petroleum derivatives, pesticides and radioactive substances

This department uses the national water quality management strategy publications to help assess whether water resource quality is suitable to maintain water ecology and consumptive uses. Protective criteria are provided to sustain water values that receive run-off or leachate from irrigated land. The guidelines contain tables and supporting information on water contaminant concentrations to help in decision-making in protecting the values (uses) of water resources.

56 Contaminants above specified concentrations may harm vegetation or the values of the receiving waters. Irrigation planners and operators should arrange analyses of the contaminant concentrations in representative samples of irrigation waters, and compare the results against criteria provided in the national water quality guidelines (Appendix A, reference 1).

57 Excessive sodium can cause problems in the soil structure if soils contain clays and silts.

58 Assistance should be sought from qualified and experienced science professionals who are able to assess the fate of contaminants following the fertigation of land, as they move on the surface or in the ground towards downstream water resources.

59 When evaluating development proposals, we may employ environmental modelling techniques and risk assessment procedures to assess whether leached contaminants will be in sufficient concentrations to cause environmental harm.

Contingency planning and staff training

60 Farm employees should be well-trained and reminded via fence or depot signs of the risks to water resource ecology or water supplies posed by microbes and chemicals released into the local environment if fertigation is poorly managed.

61 A contingency plan should be developed and implemented to limit the effects of any chemical spill or equipment malfunction that may put water resources at risk of contamination. Appropriate staff should be appropriately trained and designated to implement this plan.

62 In the long term, poor fertigation practices may result in a contaminated site. Contaminated sites are regulated by the Department of Environment and Conservation via the *Environmental Protection Act 1986* and *Contaminated Sites Regulations 2004.* The cost of investigation and remedial action at such sites is likely to be far higher than for those employing the best environment management practices.

Monitoring and reporting

63 Regulatory agencies may request physical, chemical and microbiological monitoring of the impacts of irrigated land.

64 Sampling nature, frequency and analytical parameters are based on the need to assess potential contaminant impacts on the quality and values of local water resources and nearby land uses, and the level of risks posed to members of the surrounding community. For monitoring guidelines see Appendix A, references 1 and 9.

65 Well-planned monitoring programs should assess water quality and contamination risk at three stages:

a the point of supply (that is the point of water entry into the irrigation system)

b lysimeter (sub-soil) sampling for selected leachate contaminants in irrigated soils

c the condition of local water resources upstream and downstream of the irrigated land.

66 For a typical monitoring regime for irrigated land near sensitive waters see Table 3.

Table 3 Recommended water monitoring parameters and frequencies

Characteristic monitored	**Monitoring frequency**
Quantity of irrigated water applied	weekly
Record of land areas or plots irrigated	monthly
Fertigation water quality (during the irrigation season)	
pH, and salinity (measured as electrical conductivity)	monthly
Total BOD, inorganic N, reactive P and any relevant micro-biological indicators	quarterly
Representative trace contaminants e.g. metals, pesticides	annually
Impact on receiving waters (e.g. any streams, wetlands, groundwater bores within 500 metres of fertigated land)	
pH, organic carbon, nutrients, salinity and trace elements	half yearly
Irrigated plant, topsoil, and leachate characteristics	
Plant vigour and leaf tissue analysis	during growing season
pH, organic carbon, nutrients, salinity and trace elements	annually

67 Monitoring sites should be chosen to detect changes in the ground and surface water quality caused by the fertigation practices. Monitoring should be conducted by qualified and experienced personnel, using accepted sampling protocols and have analyses

performed by laboratories accredited with the National Association of Testing Authorities.

68 Records of data should be retained on site for review by regulatory authorities for the term of any licence or approval, otherwise for at least two years.

69 For small, rural or remote communities, where it is not feasible to apply routine microbiological monitoring, frequencies may be reduced. These should be negotiated on an individual basis during the time of approval of the scheme.

More information

We welcome your views on this note. Feedback provided on this topic is held on our file no. **13191.**

This note will be updated periodically as new information is received or industry/activity standards change. Updates are placed on the department's internet site <www.water.wa.gov.au > and select water quality > publications > water quality protection notes.

To comment on this note or for more information, please contact the Water Source Protection Branch at our Perth office, phone 08 6364 7600 (business hours), fax 08 6364 6516 or use contact us at our internet site, citing the note topic and version.

Where a conflict arises between our recommendations and any proposed activity that may affect a sensitive water resource, this note may be used to assist negotiations with stakeholders. The negotiated outcome should not result in a greater risk to water quality than if our recommended protection measures were used.

Appendices

Appendix A References and further reading

1 Australian government -National water quality management strategy

a *Australian drinking water guidelines 6, 2004*
available at < www.nhmrc.gov.au/publications/synopses/eh19syn.htm >.

b *Australian and New Zealand guidelines for fresh and marine water quality 2000*

c *Australian guidelines for water quality monitoring and reporting 2000*

d *Australian guidelines for water recycling; managing health and environmental risks (phase1) 2006*
available at <www.environment.gov.au/water/quality/nwqms/index.html>.

2 CSIRO
Sustainable effluent irrigated plantations - an Australian guideline
available at <www.wioa.org.au/conference_papers/99/paper9.htm> .

3 Department of Agriculture and Food (WA) - Farm notes

a 35/2000 Selection of fertigation equipment

b 103/2000 Environmental management systems for agriculture

c 68/2002 Environmental impact of nitrogen and phosphorus fertilisers in high rainfall areas

d 71/1999 Tolerance of plants to salty water

e 39/1998 Managing nutrients on irrigated pastures

f 30/1992 Design guidelines for fixed sprinklers and micro-irrigation

available online at <www.agric.wa.gov.au/aboutus/pubns/farmnote_index.htm>.

4 Department of Environment and Conservation (WA)

a Wetlands policy and guidelines

Position statement - Wetlands, (Water and Rivers Commission, June 2001)
available at <www.dec.wa.gov.au>, select *Management and protection > Wetlands > publications > Wetlands position statement.*

b Native vegetation protection

A guide for the exemptions and regulations for clearing native vegetation 2005

available at <www.dec.wa.gov.au>, select *Management and protection > plants > native vegetation > legislation*

5 Department of Water (WA)

a Policies

- State water quality management strategy - *Framework* 2001
- State water quality management strategy - *Implementation plan* 2003
- *Land use compatibility in public drinking water source areas* 2004
- *Protecting public drinking water source areas* 2005

available online at <www.water.wa.gov.au>, select *Water quality* > *Publications* > *Policies* > *State-wide policies.*

b Environmental guidelines

Environmental guidelines for establishment and maintenance of turf and grassed areas 2001.

c Water quality protection notes

- # *06 - Vegetated buffers to sensitive water resources*
- # 25 - *Land use compatibility in public drinking water source areas*
- # 27 - *Liners for containing pollutants, using engineered soils*
- # 30 - *Groundwater monitoring bores*
- # 33 - *Nutrient and irrigation management plans*
- # 39 - *Ponds for stabilising organic matter*
- # 52 - *Stormwater management at industrial sites*
- # 56 - *Tanks for above ground chemical storage*

available online at <www.water.wa.gov.au>, select *Water quality* > *Publications* > *Guidelines* or *Water quality protection notes.*

c Waterways policy and guidelines

- *Foreshore Policy 1 - Identifying the foreshore area* 2002
- *Water note 10 - Identifying the riparian zone*
- *Water note 23 - Determining foreshore reserves*

available online at <www.water.wa.gov.au>, select *Water quality* > *Waterways* > *Publications* > *Policies* or *Manuals* > *Water Notes.*

6 Environmental Protection Authority (WA):

a *Environmental protection (Swan coastal plain lakes) policy 1992*

b *Environmental protection (South west agriculture zone wetlands) policy 1998*

c Guidance statement # 3: *Industrial – residential buffer guidelines*

d Draft guidance statement # 33 *Environmental guidance for planning and development*

e Bulletin 1078 - *Implementation framework for Western Australia for the Australian and New Zealand guidelines for fresh and marine water quality,* and *Water quality monitoring and reporting;* November 2002

available online at < www.epa.wa.gov.au>, select *EIA* > *Policies (EPP), Guidance statements* or *Bulletins.*

7 Government of Western Australia

State water strategy for Western Australia 2003
available online at < www.water.wa.gov.au>, select *Planning the water future* > *State water strategy*

8 Standards Australia

AS 5667 *Water quality - sampling*

available online at < www.saiglobal.com/shop/script/search.asp >

9 WA Vegetable Growers Association/ Potato Growers Association of WA

a *Code of practice for environmentally sustainable vegetable and potato production in WA* July 2002

b *Best environmental management practices for environmentally sustainable vegetable and potato production in WA - A reference manual* July 2002

For an electronic copy of these documents, contact our water source protection branch in Perth (08 6364 6700). The documents are held as PDF files in *external guidelines* folder.

Appendix B Relevant statutory requirements and approvals

What is regulated	Statute	Regulatory agency
Land use zoning; Development approval	*Planning and Development Act 2005*	WA Planning Commission; Department for Planning and Infrastructure; Local government
Impact on the values and ecology of the environment including waters	*Environmental Protection Act 1986 -Part III Environmental Protection Policies;* *Part IV Environmental Impact Assessment.*	Minister for the Environment on advice of the Environmental Protection Authority Department of Environment and Conservation
Clearing of native vegetation	*Environmental Protection Act 1986 - Part V Environmental regulation*	Department of Environment and Conservation - regional office
Works approvals, licences or registration- prescribed premises		
Licence to take surface water or groundwater	*Rights in Water and Irrigation Act 1914*	Department of Water - regional office
Development in Waterways Management Areas	*Waterways Conservation Act 1976*	
Development and operations in Public Drinking Water Source Areas	*Metropolitan Water Supply, Sewerage and Drainage Act 1909*	
	Country Areas Water Supply Act 1947	
Drainage into the Swan or Canning River systems	*Swan and Canning Rivers Management Act 2006*	Swan River Trust
Management of human wastes, wastewater application to land, community health issues	*Health Act 1911;* *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974*	Local Government; Department of Health

For statute copies, contact the State Law Publisher (<www.slp.wa.gov.au>).

Appendix C Sensitive water resources

Clean water resources used for drinking, sustaining aquatic and terrestrial ecology, industry, and aesthetic values, along with breathable air, rank as the most fundamental and important needs for viable communities. Water resources should remain within specific quality limits to retain their values, and therefore require stringent and conservative protection measures. Guidance on water quality parameters necessary to maintain water values are published in the Australian government's *National water quality management strategy guidelines*, available at <www.environment.gov.au/water/quality/nwqms/index.html>.

This department strives to improve community awareness of catchment protection measures for both surface water and groundwater as part of a multi-barrier protection approach to water resource quality.

Human activity and land uses pose a risk to water quality if contaminants can be washed or leached into sensitive water resources in discernible quantities. These waters include shallow groundwater accessed by supply wells, waterways, wetlands and estuaries. To be considered 'sensitive', water resources must support one or more of the environmental values described below. Community support for these values, setting of practical management objectives, sustainable protection strategies and effective implementation are key elements in protecting or restoring water values.

Sensitive water resource values include:

1 Public drinking water sources (i.e. *water reserves, catchment areas* or *underground water pollution control areas*) proclaimed or assigned under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909*, the *Country Areas Water Supply Act 1947* or the *Health Act 1911.*

2 Private sources, used for the following water supplies:
   a human or stock drinking water
   b commercial or industrial water supplies (with specific qualities that support the activities e.g. aquaculture, cooling, food or mineral processing or crop irrigation)
   c urban irrigation (that can affect people's health or wellbeing).

3 Recognised ecological functions in groundwater aquifers e.g. cave ecology.

4 Ecological functions and social values in natural waterways e.g. aesthetic appeal, boating, fishing, tourism and swimming, including:
   a high conservation significance waterways described in the Environmental Protection Authority's draft guidance statement 33 *Environmental Guidance for Planning and Development* (section B5.2.2), available online at <www.epa.wa.gov.au> select *EIA > guidance statements.*
   b waterways management areas declared via the *Waterways Conservation Act 1976*, i.e. Avon, Peel-Harvey, Leschenault, Wilson Inlet and Albany waterways.
   c waterways managed via the *Swan and Canning Rivers Management Act 2006*.

   Engineered drains or constructed water features are excluded as functional and operational factors may outweigh their water quality values.

5 Conservation values in wetlands (recognised or probable, generally excluding those highly disturbed unless actively managed to restore specified environmental values), including:
   - Ramsar wetlands, advice available online at <www.ramsar.org>.
   - High conservation significance wetlands as described in the Environmental Protection Authority's draft guidance statement 33 *Environmental guidance for planning and development* (section B4.2.2), available online at <www.epa.wa.gov.au>, select *EIA > guidance statements.*

- Wetlands described by the Australian Department of the Environment, Water, Heritage and the Arts in *A Directory of important wetlands in Australia,* available online at <www.environment.gov.au/water/publications/index.html>, select *wetlands > books, reports directories*; or view the Department of Environment and Conservation web page < www.dec.wa.gov.au > select *Management and protection > wetlands > publications.*
- Conservation valued and resource enhancement category wetlands identified in the *Geomorphic wetlands of the Swan coastal plain* dataset, all wetlands identified in the *South coast significant wetlands* dataset and high value wetlands identified in the *Geomorphic wetlands Augusta to Walpole* dataset. The Augusta to Walpole wetland dataset awaits a detailed evaluation process.

Many waterways and wetlands in the state still need a detailed scientific evaluation and their value classified. Any natural waters that are largely undisturbed by human activity, should be assigned a high conservation value, unless proven otherwise.

The Department of Environment and Conservation is the custodian of wetland datasets and is responsible for maintaining and updating the information within them. The datasets can be viewed or downloaded online from <www.dec.wa.gov.au> select *Management and protection > Wetlands >Wetlands data > Geographic data atlas > inland waters > wetlands.* Guidance on viewing the wetlands is provided on the same website at *water > wetlands > data > wetland mapping > how to view wetland mapping* or phone the department's nature conservation division for assistance on 08 9334 0333.

Contact

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