Department of
Primary Industries and
Regional Development

GOVERNMENT OF
WESTERN AUSTRALIA

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Agribusiness Development Guidelines

Sizing a Waste Irrigation Area

Purpose

This document is written for owners and operators of agribusiness needing to dispose of liquid waste via irrigation. It demonstrates how to determine the required area for trade waste irrigation, wastewater storage requirements and the appropriate irrigation rate.

Principles

Disposal of agribusiness wastes needs to be done in a manner that does not contaminate soil, surface water or groundwater. The two accepted approaches are:

1. Apply the waste at a conservative rate that allows a cropping program to assimilate the water and nutrient, then harvest the biomass and remove from the irrigation area. This document can be used in this instance.

   OR

2. Provide detailed site-specific evidence that the proposed application of waste will not contaminate soil, surface water or groundwater. This includes establishing background levels and implementing environmental management program. Engage a professional if using this advanced method.

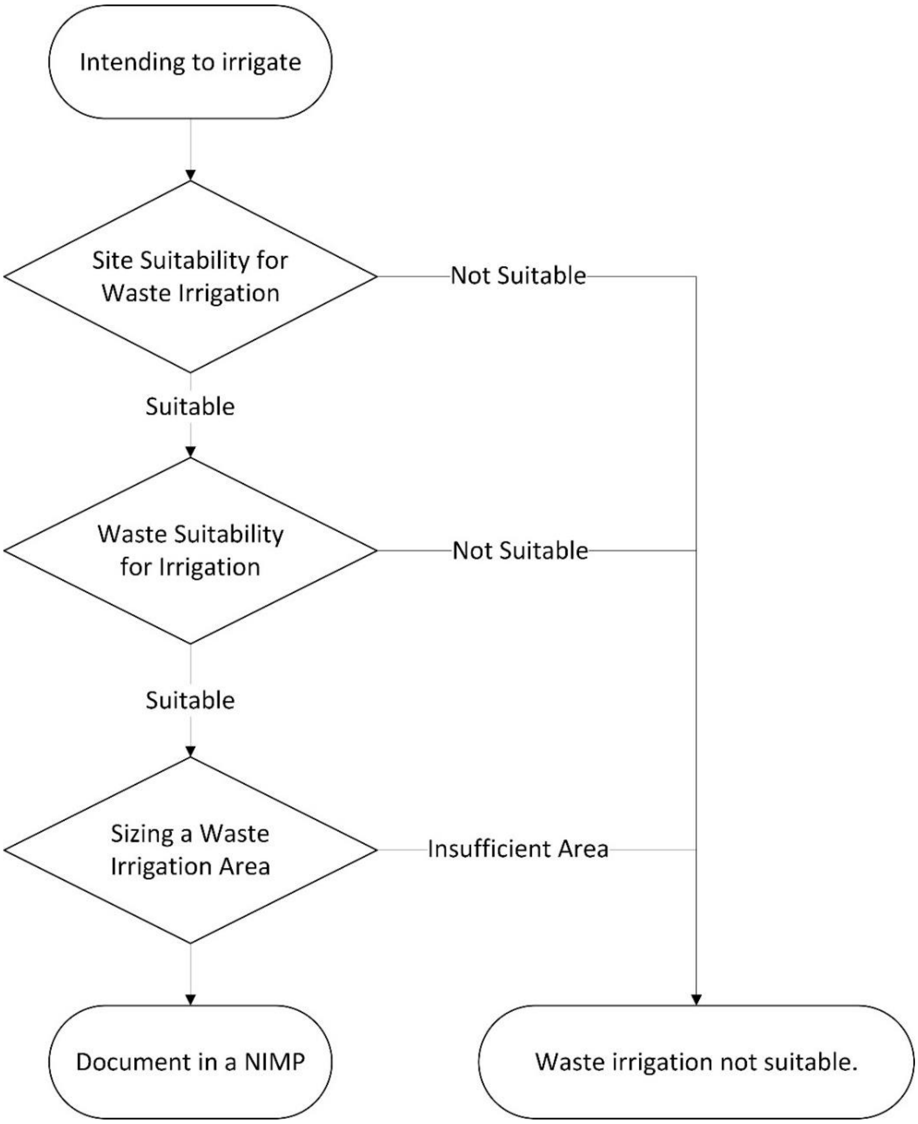
This document does not consider the second approach, and only deals with sizing an irrigation area at a conservative rate for approach #1. The principles that apply to this first approach are:

- The size of an irrigation area and irrigation scheduling should be based on the identified limiting factor.
- Nutrients irrigated should be assimilated by the chosen crop, which is then removed from the irrigation area.
- The endpoint for any biomass removed in the offtake plan is either off site or converted to a high value product.

How to use this document

This guidance is part of a three-document series that addresses environmental factors of irrigation waste disposal.

Whilst each document stands alone to support particular decisions, they should be read together to develop a comprehensive Nutrient and Irrigation Management Plan (NIMP) following the rationale outlined below.



Once the environment and liquid waste are deemed suitable for irrigation, the following steps can be taken to size a waste irrigation scheme:

1. Select a crop to be used for waste disposal.
2. Determine the expected yield
3. Determine the limiting factor
4. Determine infrastructure
5. Plan offtake strategy

Where waste irrigation is not suitable, seek professional advice or contact agribusiness@dpird.wa.gov.au

Selecting a crop

There are a number of crop options, however, grass pasture[1] is recommended to be the first consideration. Many pasture varieties are easy maintenance, water and nutrient hungry crops that will serve as a solid starting point. Higher productivity crops such cereal hays (oats, wheat, barley) or fruit trees can be considered if sufficiently large area for irrigation and winter storage capacity is demonstrated. Where there is a need to minimise the irrigation area, winter storage volumes and ongoing maintenance, pasture is the ideal choice.

If considering grazing as a method of harvesting, it is important to note than nutrient offtake will be approximately 10% of mechanical harvesting. This means that the required irrigation areas can be up to 10-fold larger compared to mowing/slashing and collecting clippings. Specialist advice is recommended when grazing is used as an offtake method.

Determine yield

Once a pasture or crop has been selected, the next step is to predict the likely annual yield. The annual yield will determine the amount of biomass removed from the irrigation area, and in turn determine the amount of nutrient that will be removed. If using pasture, data from the 'Pastures from Space'[2] project can be used for the selected site, noting that yields will be higher in the summer months if under irrigation.

Other ways to predict yields are:

- Consult with broadacre croppers in the area
- Research tree growth curves and expected fruit production yields
- Use Water Use Efficiency (WUE) for the given crop, rainfall and irrigation rate:

Crop	Water use efficiency (kg/ha/mm)
Pasture	20 - 25
Oaten Hay	30 - 35
Maize	8

If choosing pastures/crops that are not already grown in the area and on similar soil types, it is recommended to verify whether the soil type can support those yields, with particular attention paid to chemical and physical rooting depths.

[1] The term 'pasture' in the remainder of this document refers to grass-based pastures as opposed to legume pastures.
[2] https://pasturesfromspace.dpird.wa.gov.au

Once the yield is known, it can be multiplied by the crop nutrient content to estimate the resulting offtake.

Crop Type	Nitrogen (kg/t)	Phosphorus (kg/t)
Pasture / Oaten Hay	20	3
Maize	22	3
Amenity Turf (Lawn)	35	4.2

For example, a 10 t/ha pasture yield will remove 200kg-N/ha and 30kg-P/ha.

Nitrogen fixing plants such as beans or legumes should not be considered unless there is a firm understanding on the amount of nitrogen consumed by the crop from the irrigated wastewater.

Where possible, it is recommended that crop nutrient content is measured through plant tissue analysis. The plant sampling guide[3] can be used to ensure representative plant tissue samples are collected and analysed.

Determine Limiting Factor

To determine the size of the irrigation area, it is recommended to use the limiting factor approach. A limiting factor can be phosphorus, nitrogen, hydraulic loading or BOD. By calculating the minimum area requirement for each of these, the limiting factor can be identified. The largest calculated area from the four equations below will be the limiting factor. This will be the minimum required irrigation area.

For the majority of agribusiness wastes, phosphorus is the limiting factor.

Phosphorus

TP = Total Phosphorus in wastewater (mg/L)

Q = Volume of wastewater irrigated (ML/year)

C = Type of crop grown, and its corresponding phosphorus content (kg/ton)

Y = Expected crop yield (t/ha)

$$Area\ (ha) = \frac{TP\ \times Q}{C\ \times\ Y}$$

[3] https://fertilizer.org.au/Portals/0/Documents/Fertcare/Fertcare%20Plant%20Sampling%20Guide.pdf

Nitrogen

TN = Total Nitrogen in wastewater (mg/L)

Q = Volume of wastewater irrigated (ML/year)

v = Expected Nitrogen Volatilisation (%)

C = Type of crop grown, and its corresponding nitrogen content (kg/ton)

Y = Expected crop yield (t/ha)

Nitrogen volatilisation is approximately 20% for spray irrigation, and 10% for surface methods.

$$Area\ (ha) = \frac{TN\ \times\ Q\ \times\ (1 - \frac{v}{100})}{C\ \times\ Y}$$

Hydraulic loading

Hydraulic loading is the total amount of water applied to a given area; it can be expressed in mm, or ML/ha (1 ML/ha = 100 mm).

The DPIRD irrigation calculator[4] can be used to determine hydraulic loading. This tool gives irrigation requirements for commercial crops, based on plant type, soil type and location.

Alternatively, water requirements can be estimated by using monthly climate data for a crop that is actively growing year-round:

$$Hydraulic\ loading\ \left(\frac{ML}{ha.month}\right) = \frac{(pan\ evaporation\ (mm) \times\ 0.7) -\ rainfall\ (mm)}{100}$$

Other, more advanced methods of determining hydraulic loading include:

- Using pan evaporation data and crop factors (CF) specific to the growth stage of the plant.
- Using evapotranspiration[5] and crop coefficients[6].

If using advanced methods of irrigation such as FAO56 Evapotranspiration, it is recommended that irrigation scheduling is combined with weather forecasting, allowing at least 24 hours of wastewater contact time in the root zone prior to rain.

[4] https://www.agric.wa.gov.au/irrigation-calculator

[5] FAO56 Penman-Monteith Evapotranspiration data for short crops is available for download from the SILO database - https://www.longpaddock.qld.gov.au/silo/point-data/

[6] Detailed guidelines on computing crop water requirements is available from the FAO Irrigation and drainage paper 56.

Once the hydraulic loading rate has been calculated, it can be divided into the total volume of waste produced to determine the required area.

$$Area\ (ha) = \frac{Wastewater\ Volume\ (\frac{ML}{year})}{Hydraulic\ loading\ (\frac{ML}{ha.year})}$$

BOD loading

The upper limit to BOD loading is 1,500 kg/ha/month. Since irrigation demand varies month to month, it is important to use maximum monthly irrigation rates for calculating the area required.

BOD = BOD concentration in wastewater (mg/L)

Q = Volume of wastewater irrigated (ML/month)

$$Area\ (ha) = \frac{BOD\ \times\ Q}{1{,}500}$$

Determine Infrastructure

Size holding tanks or ponds

Monthly water balance for at least 2 years will be needed; showing wastewater production, irrigation outflow and tank capacity. A good starting point is to determine the number of months for which irrigation cannot take place and multiplying by the monthly wastewater production during that time.

If using open ponds as storage, include evaporation losses and rainfall in the water balance, ensuring that the pond will not overflow more frequently than once every 10 years. For assistance sizing storage ponds, contact agribusiness@dpird.wa.gov.au for an excel calculator.

Map the irrigation area

A map of the irrigation area should show:

- The location and measurements of the irrigation area
- The location of the storage tanks or ponds
- Separation distances to sensitive environments[7]

[7] As per part 1 of this guidance series – Site Assessment for Waste Irrigation

Plan Offtake Strategy

The purpose of an offtake strategy is to ensure that the estimated yields match the actual amount of biomass removed from the irrigation area. Yields will change year-to-year depending on the amount of irrigation and rainfall, therefore a 10-year running average is recommended.

Things that need to be included in an offtake strategy are agronomic practices and supplementation:

- Agronomic practices include things like seeding, weed spraying and mechanical harvest.
- Supplementation refers to any additional water or nutrients required by the plant that are not in wastewater. Most wastewaters are not balanced fertilisers, with nitrogen and additional freshwater likely to be required for optimal growth.

The end point for the harvested biomass should also be defined. If minimal ongoing effort is preferred, the recommendation is that the harvested biomass is taken off site.

If biomass from the irrigation area is to be re-used within the enterprise (at the property, or other associated properties of the business), the nutrients need to be tracked showing how they are removed from the enterprise. Alternatively, biomass needs to be transformed into a higher value product such as:

- Compost as per the Australian Standard
- Animal biomass (through grazing)
- Products fit for human consumption.

Nutrient removal through grazing is complicated and specialist advice is recommended.

Summary

The information from this section should be documented in a Nutrient and Irrigation Management Plan (NIMP). This will generally include:

- A map of irrigation area and water storage infrastructure.
- A nutrient balance, clearly demonstrating how nutrients applied in waste are removed.
- Water balance showing irrigation rates and water storage sizing.
- Offtake strategy including any supplementation and agronomic practices.
- Any future monitoring (wastewater/soil/groundwater) or record keeping.

Contact

If you require additional information, contact the Agribusiness Development team at DPIRD at agribusiness@dpird.wa.gov.au