



FEEDLOT DESIGN AND CONSTRUCTION

3. Water supply sources and on-site storage

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Introduction

Water for feedlots can be obtained from a number of different sources. These may be surface water such as creeks, rivers, dams, channels and land surface diversions, or groundwater which can be shallow or deep artesian bores. Whatever the source, the suitability of water that the site has available and the predicted water required for the future will depend on its quantity, quality and reliability.

As intensively-fed beef cattle must have an uninterrupted supply of clean water, every feedlot should have contingency plans for pump or pipeline failure. Water supply may be interrupted for many hours or even days due to natural disasters (damage to infrastructure), electricity blackouts, pump or pipeline failure. A temporary emergency (back-up) water supply and suitably sized water storage close to the feedlot are essential.

Design objectives

The design objectives for water supply sources and onsite water storage for a feedlot are to

- have a legal right to the required volume for the intended use
- have a reliable supply of the required volume to sustain the operations of the feedlot
- provide a second source of water in the case of failure of the primary source
- be able to store an adequate quantity of water matched to duration and the number of cattle it will be expected to serve
- ensure adequate quantities of drinking water are available in the event of system failure, malfunction or some other interruption to supply
- provide a supply of water to cattle at all times
- store fresh, cool, clean, palatable and high quality water
- cater for daily variations in water supply and demand
- minimise water losses
- provide a safe working environment for people
- have a level of quality appropriate for the intended use.

Mandatory requirements

Compliance with

- Australian Animal Standards and Guidelines for Cattle (DAFF, 2013)
- National Guidelines for Beef Cattle Feedlots in Australia (MLA, 2012a)
- National Beef Cattle Feedlot Environmental Code of Practice (MLA, 2012b)
- quality standards for beef cattle drinking as outlined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) (ANZECC and ARMCANZ 2000).
- relevant state and local authority codes and regulations as applicable to feedlot development water licensing and supply.

Technical requirements

Sources of water

Water for feedlots can be obtained from surface water, groundwater or municipal supplies or a combination of all three.

Wherever possible, feedlots should have more than one water supply source (e.g. river plus bore or bore plus dam). If one source fails, the feedlot can change to the other.

Surface water

Surface water supplies from streams, rivers and runoff into farm dams can be highly variable seasonally and annually in many parts of Australia. Surface water supplies may also include diversions from both floodplains and upland areas.

Floodplain harvesting is the collection, extraction or impoundment of water flowing across floodplains.

Rainfall runoff harvesting and overland flow harvesting take rainfall runoff from local watersheds. These diversions are often stored in an excavated structure or gully dam or hillside dam.

Surface water is mostly good quality and is suitable without extensive treatment for most feedlot uses – except as boiler feedwater. See *Section 5 – Water quality* for more information on water quality required for boilers.

Groundwater

Groundwater supplies are generally less variable than surface water supplies and evaporation losses are negligible. Once the volume of water required for the feedlot and the recharge rate of an aquifer are known, the volume of water that will be available can be predicted with a degree of certainty.

However, uncertainty over the volume of groundwater may become an issue if groundwater sources are depleted because of overuse or extended drought. In these instances, licensing restrictions may be imposed.

Groundwater is usually good quality and suitable for most feedlot uses without extensive treatment. Again, the exception is boiler feedwater which will most likely require some form of treatment to remove impurities.

Groundwater is mostly sub-artesian pumped from an aquifer. Locating and drilling a bore that will provide adequate, high quality water is an expensive task that requires the assistance of a qualified hydrogeologist. There is no guarantee that groundwater is present in quantities necessary for the intended needs.

Artesian groundwater is found in the Great Artesian Basin and can flow naturally to the surface when tapped by a bore. Generally, artesian water has a temperature ranging from 30°C to 100°C.



Water supplies from creeks and rivers are variable across Australia. Water taken from creeks and rivers for use in intensive agriculture and/or irrigation is regulated in most areas.



Water taken from land surface diversions (LSD) is regulated in most areas. LSD are characterised by infrequent takes of high volumes of water.



Land surface diversions need off-stream storages. Losses from evaporation and seepage can be large.

Municipal supply

Relatively few rural enterprises in Australia source their water from a municipal water system. However, for feedlots, the advantages of a municipal water system include

- generally high reliability with few supply interruptions
- water is treated to a higher standard than generally needed for livestock and boiler water
- water is delivered under pressure.

The main limitations of a municipal water system may include

- not available in all locations
- costly to extend the water supply line to the feedlot
- a long delivery line from the meter may result in a drop in pressure
- public water is expensive incurring connection fees, minimum monthly costs and costs for excess water use.



The reliability of the water supply will need to be assessed.

Legal right to use the water

In Australia, water rights allow water resources to be managed and used in a way that maximises their value to society.

Water rights limit the volume of water that any individual can take and places obligations upon the individual that protect the rights of others, and may also specify a range of other requirements such as when water may be used.

In some states, water rights are the personal property of water users; in others, they are vested in the state. Areas that may have unregulated water resources are unlikely to be suitable for feedlot development.

A secure water supply means the legal right to the required volume for the intended use. In areas where water usage is regulated, this usually requires an industrial or similar high security water licence, allocation or entitlement.

Bores that are licensed only for 'stock and domestic' use cannot be used for feedlots without a change to the licence and the granting of an annual allocation or limit. In some areas, there are restrictions on the capture of rainfall runoff.



Australia has many ephemeral creeks and rivers.

Water quality

Feedlots depend on an adequate supply of suitable quality water.

Water quality refers to the characteristics of a water supply that will influence its suitability for a specific use. Quality is defined by certain physical, chemical and biological characteristics.

While an ideal situation is to be able to select from several supplies, normally only one is available. In this case, the quality of the available supply must be evaluated to see how it fits the intended use. *Section 5 – Water quality* provides more information on water quality requirements at feedlots.

Reliability of supply

When planning a feedlot, the reliability of the water supply must be assessed to ensure that the intended water source(s) are sufficient to meet both the average feedlot water requirements throughout the year, as well as the peak demand days and times of the day.

In most areas of Australia, the management of water resources is complicated by the seasonal variability in supply because of the year-to-year variability in rainfall.

Surface water

Rainfall and the hydrology of catchments determine the overall volume of surface water available. To improve the reliability of supply, rivers and streams are regulated using dams and weirs.

In most areas of Australia, river and/or stream extractions are regulated to satisfy both downstream consumptive demands and environmental flow requirements. The time of extraction may be dependent on maximum and minimum flows at specific times and locations, and this needs to be considered when assessing reliability.

For land surface diversions, the catchment yield and/or the flooding frequency will need to be assessed, preferably by a suitably qualified and experienced person such as a hydrologist or agricultural engineer.

The catchment yield and the proposed types of water use will usually determine the size of the storage. A shallow storage (i.e. less than four metres deep) will suffer larger evaporation losses than a deeper one with a similar volume. Typically, to cater for extended periods of dry weather and droughts, the size of a surface storage might need to be three to four times the annual feedlot water usage plus a provision for dam evaporation.

Groundwater

Bores are generally a much more reliable source of water than surface water, and so are preferred by lot feeders. However, in recent years, some areas have been affected by regulatory restrictions on nominal allocated licence volumes.

For groundwater, establishing a bore often involves a large financial outlay and its capacity to meet long-term demand must be properly tested.

Testing the yield of a bore should be carried out by people experienced in the hydrological behaviour of pumped bores. A proper analysis will also take into account details such as location of water beds and bore construction. The yield test for the bore should determine

- the stability of the aquifer
- its maximum capacity
- the design pumping rate for a particular scheme
- the optimum pump inlet level
- its long term reliability.

Bores that produce a sufficient volume of water but do not have the capability of meeting peak water demands will require a buffer storage. The water can then be gravity fed (or re-pumped) from the storage at a much faster rate to meet or supplement the peak demand periods.

The ability to supply cool drinking water is important during summer, particularly for artesian bore supplies where the ground water is delivered at temperatures in excess of 35°C.



A groundwater bore located several kilometres from the feedlot site. Water taken from underground is regulated in most rural regions.



Groundwater bores are usually drilled on feedlot properties where surface water dries up during extended dry weather. They can be a primary or secondary supply source.



Artesian water may need spray cooling.



Uncovered turkey nest storage next to a feedlot



Uncovered turkey nest storage near a feedmill



Growth of vegetation around open earthen storages can result in significant water losses due to extraction, and will enhance algae growth.

Onsite storage

Feedlots need an onsite water storage to overcome differences in supply and demand and to also provide an emergency storage for temporary supply failures.

Emergency water storages can be constructed from almost any material as long as they safely store water at a reasonable cost. Most emergency water storages are either steel or concrete above-ground tanks or earthen embankment storages. Ideally, the emergency water storage should be part of the normal feedlot water supply system, so that it can cater for diurnal variations in supply and demand and at the same time remain relatively full in the event of an unexpected supply failure.

Earthen embankment storages

Earthen embankment storages are often referred to as ring tanks or turkey nest storages depending on their size and/or location across Australia, and are filled by pumping water from some other source.

The ring tank is in the shape of a ring (or square or rectangle) bounded by a compacted earthen embankment and usually located on relatively flat ground. The material required for the embankment is excavated from inside the embankment, hence water can be stored above and below the natural ground level.

A turkey nest storage is similar to the ring tank but the embankment material is brought from the outside. As all water is stored above natural surface level it can be gravity fed to the point(s) of usage.

Each earthen embankment storage is unique in size, shape, capacity, location, soil and environmental characteristics and hence has to be designed individually. They are constructed using the same techniques as feedlot holding ponds. See *Section 12 – Holding pond design* and *Section 8 – Bulk earthworks* for information on design and bulk earthworks of embankments.

A ring tank or turkey nest may be covered using various forms of material to prevent contamination, wildlife, pests and other animals from accessing the water storage. Covers also reduce evaporation and algal buildup in the water distribution system and provide an even water temperature in the supply.

Above-ground tanks

Above-ground tanks are an alternative to earthen embankment storages. They can be constructed from various materials (e.g. concrete, polyethylene, corrugated iron), are available in various sizes and generally have an enclosed roof. Most steel or concrete tanks can be supplied with a cover.

When located on a stand or high point above the feedlot pens, gravity assists flow of water to the off-take points.

The cost per volume of storage of these tanks is much higher than from earthen storages.

Temporary supply

Trucking emergency water is expensive and requires intensive management. It should be considered only as a temporary solution or in extreme emergencies.

Size

Emergency or back-up water sources sufficient to meet the basic water requirements of cattle during peak demand days and the anticipated emergency period must be incorporated in the design and planning process. This supply or storage should be of sufficient capacity to supply water to cattle under summer conditions until breakdowns can be repaired.

The National Feedlot Guidelines state that the emergency supply should be capable of supplying basic water requirements (e.g. domestic and livestock water) for at least 48 hours in mid-summer.

Where some infrastructure (e.g. deep artesian bores) may take much longer than 48 hours to repair, a secondary water supply source or large temporary supply is essential.

For sizing the water storage, the drinking water consumption rates for cattle are outlined in *Section 4 – Water requirements*. The number of days of storage required depends on the anticipated time needed for pumping systems to come back online. The following formula can be used to determine the emergency storage volume.

Storage Volume (L) = Peak drinking water (L/head/day) × Pen capacity × No. of supply days.

For example a feedlot with 1000 head on feed needs a two-day emergency supply volume of

$$= 40 \text{ L/head/day} \times 1000 \text{ head-on-feed} \times 2 \\ = 80,000 \text{ L}$$

Industry data on the number of available days of temporary storage at feedlots ranges from 1 day to 500 days with an average of 34 days (MLA, 2014).

Location of storage

The emergency water supply should be located close to the production pens and at the highest practical point on the site. This allows gravity flow of water to the production pens during interruption or loss in electricity supply.

Covering of open storage

Covering open storages can reduce evaporation losses, reduce algae growth and maintain water at a constant temperature. Covers also exclude water birds that can defecate in the open water supply and potentially transmit disease. See *Section 4 – Water requirements* for calculation of evaporative losses. Most steel or concrete tanks can be supplied with a cover.

A major limitation to covering large open storages is the cost of the cover – both upfront and for potential ongoing maintenance.

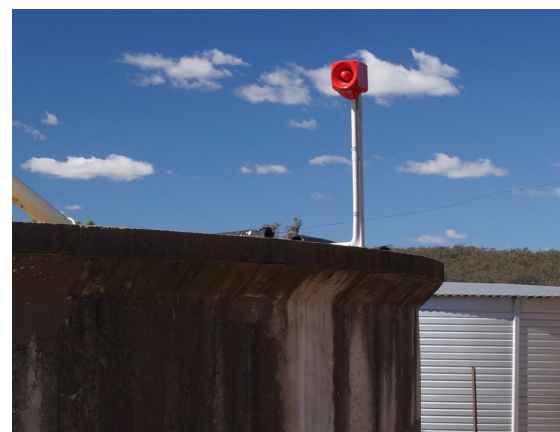
Physical covers, such as floating or shade structures, are the most appropriate and effective and many products are available. Key



Concrete water storage tanks of various capacities may be cast in-situ. Most have concrete or galvanised iron roofs.



Steel or corrugated iron water storage tanks are available in a range of sizes and capacities.



This siren alerts management when water in the tank drops to a critical level.



Covering emergency water storages helps reduce water evaporation and prevent access by wildlife and pests.



Synthetic liner to minimise water seepage



Rope nets are an important safety feature in synthetic-lined storages to allow escape if people or animals fall in the storage.

factors in selection are the cost of water (e.g. town water supply versus underground), percentage water saving, capital, operating and replacement costs, impact on water quality and deployment and storage safety issues.

In some cases, covering temporary open storages is undesirable e.g. hot water from a deep artesian bore should be allowed to cool before being supplied to cattle, especially during seasons of high daily air temperatures. A spray inlet also assists with cooling.

Floating covers

Floating covers are well suited to storages with a small surface area but are difficult to install with surface areas greater than five hectares. In some cases, these covers can be deployed as a series of large rafts covering up to 1 ha each.

Fully covering a turkey nest with an impermeable continuous floating plastic cover can reduce evaporation by more than 90%.

Most of these products have a high capital cost and replacement life is typically between 10 and 20 years. Tensioning systems vary from wire rope to mechanical systems.

Water quality can be impacted by reduced dissolved oxygen, light penetration and change in water temperature, but this will reduce algal growth.

Disadvantages of floating covers are the relatively high capital outlay, difficulty in installation on large storages and potential high repair and maintenance costs, especially following storms and winds.

Supply and installation is usually carried out by accredited installers. This involves the supply and welding of the materials to correct lengths, with final joining and fastening taking place in-situ.

Shade structures

Shade structures reduce solar radiation and wind speed and affect evaporation, by trapping humid air between the structure and the water surface.

Shade structures are generally suspended above the water surface using a web-like structure of cables with shade cloth fitted between the cables.

The shade cloth can come in a range of UV ratings (See *Section 16 – Shade*).

Shade structures are generally less effective in reducing evaporation than floating covers, but evaporation savings of 70–80% have been demonstrated in trials.

Although shade structures allow free flow of oxygen to the water, algae growth may be reduced by the lower light penetration.

Most of these products have high capital and low maintenance costs, but all have a limited life. They are more appropriate to small storages given the need to suspend the shade cloth above the water with a cable structure.

Similar shade cloth and fixtures as used for pen shade may be used.

Storage lining

Failure to hold water is the most common problem with earthen water storages. Water seepage may be mitigated by lining with

- natural or engineered in-situ low hydraulic conductivity soils
- clay liners
- synthetic liners.

Section 8 – Bulk earthworks provides further information on clay and synthetic liner systems.

Safety considerations with water storage

Safety is always a concern around open water storages but slippery plastic covers can present an extreme danger to anyone who might fall in and be unable to clamber out.

Actions to minimise the risk associated with emergency water supply storages include

- educating employees and visitors about the hazards around emergency water supply storages.
- installing and maintaining appropriate safety signs, safety fence, gates, locks and barriers.
- using a safety harness when working near embankments of plastic-lined open storages.
- having rescue equipment, such as floatation devices and rope nets, available at plastic-lined open water storages.
- advising people not to enter enclosed spaces.



Livestock-proof or security fencing will keep livestock or visitors from open storages.



Restricted area sign near water storage

Quick tips

- All feedlots must have a secure water supply; this will have a primary and a secondary supply source.
- The site and proposed sources of water must be carefully assessed from both a physical and legal perspective.
- Surface water supplies are highly variable seasonally and annually. How much water is available and when it may be available must be reliably assessed.
- Review the regulatory requirements for reliably obtaining the required volume of water from a particular source.
- Assess the water quality concerns of water supply sources to determine if any additional treatment is needed before its intended use.
- An emergency water supply source and onsite storage should be provided to meet water demand in the event of unusual circumstances.
- As emergency water supply storage is expensive, its location (topography, gravity versus pumping, additional storage, soils suitability) and type of storage (e.g. concrete tank versus earthen storage) warrant careful consideration.
- Calculation of water demand incorporates evaporative (and seepage) losses for open earthen storages.

Further reading

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