Department of
Primary Industries and
Regional Development
GOVERNMENT OF
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Current as of 6 March 2024

Factsheet

Cattle Feedlot Runoff

Department Position

The preferred method of calculating rainfall runoff from beef cattle feedlot pads is done on a daily time step using location specific rainfall and evaporation data. The manure interface layer on a beef cattle feedlot's impermeable pad is assigned a runoff threshold, which is the total amount of moisture the interface layer can hold before it sheds water.

The runoff threshold was determined to be 13mm with a Curve Number (CN) equating to a value of 95 (Hatfield & Stewart, 1997; Walker & Turner, 1980; Conrad et al., 1980). Watts et al. (2016) illustrates wet manure conditions to have a potential maximum threshold of 13.4mm; thus, the conservative 13mm threshold represents conditions in Western Australia's South West with sustained rainfall in winter months, potentially causing a saturated interface layer.

Context

Many methods used to calculate retention and evaporation pond sizes are based on storm events. This causes undersized ponds in the South-West (SW) of Western Australia (WA) where the bulk of rainfall comes from extended light drizzle in the months of May to October.

Calculating the yearly runoff from catchments should consider rainfall, evaporation, and antecedent moisture conditions of the catchment. Outside of fit for purpose modelling software packages, rainfall runoff from impermeable catchments such as feedlots can be calculated based on a daily time step weather data and a runoff threshold.

This factsheet offers a conservative runoff threshold for beef cattle feedlots, from which location specific runoff can be calculated.

Introduction

The main contaminants found in beef cattle feedlot wastewater are nitrogen, soluble phosphate, ammonia, heavy metals, pathogens, and nonsteroidal hormones (Conrad et al., 1980; Watts et al., 2016). The volume of wastewater entering feedlot evaporation ponds is estimated by threshold values of the Curve Number (CN) characterising runoff potential of a substrate. High CN values indicate a higher amount of runoff and low filtration into the substrate (Mack, 1995). This can then be used for the accurate sizing of holding pond designs for farmers and planners to use in the construction of wastewater evaporation ponds. The South-West region of WA is the primary area of focus, characterised by a temperate climate consisting of cool wet winters with more reliable rainfall and hot dry summers. The agricultural beef production region in SW-WA typically receives on average between 400-1000 mm of rainfall annually.

Rationale

In relation to the literature cited, **a conservative runoff threshold would be approximately 13mm** equating to a CN value of 95 (Hatfield & Stewart, 1997; Walker & Turner, 1980; Conrad et al., 1980). This means the equivalent amount of precipitation landing on the feedlot pad will result in more runoff to the evaporation pond than previously assumed (20 mm). However, the USDA Soil Conservation Service (SCS) equation (see Appendix 1) does not consider that there is no runoff when rainfall is less than 13mm. Additionally, manure evaporation and antecedent moisture are not accounted for in the equation. The equation is primarily used for the estimation of storm rainfall and direct runoff for 1 day or less (Kent, 1973). Considering that in Western Australia rainfall events are mostly extended light drizzle over many days rather than a 24hour storm event; the USDA SCS runoff calculator method isn't used.

Watts et al. (2016) uses K values to represent dry, normal and wet manure conditions in the curve number equation with corresponding potential maximum retention or runoff threshold numbers of 22mm, 19.1mm and 13.4mm, respectively (see Appendix, points 2 and 3). The threshold may further increase by up to 8mm when pugged by cattle hooves as shown by a southern Queensland study (Lott, 1997). These values reinforce a conservative runoff threshold of 13mm as the wet manure of 13.4mm would be near its limit for how much more moisture it can retain and amount of water infiltration. Walker & Turner (1980) noted that many studies expected little runoff at total rainfalls less than 13mm. Further, MEDLI field model validation results reported by Atzeni et al. (2001) showed low runoff for rainfall less than 15mm, and a linear rainfall-runoff relationship for rainfall exceeding 20mm.

Another study by Dickey & Vanderholm (1977) found through calculating a linear relationship between runoff and rainfall that runoff was expected after approximately 7.5mm of rainfall in their paved feedlots. They went on to add they had rainfall events up to 10.9mm that didn't produce runoff. Conrad et al. (1980) uses a SCS curve number of 94-96 in paved lots and 90 in unpaved lots, illustrating a slightly higher runoff and lower threshold from corresponding rainfall in the paved lots and how the threshold is influenced by multiple factors.

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Important disclaimer

Important Disclaimer

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Appendix

1. $Q = (P - 0.2S)^2/(P + 0.8S)$

   Q - runoff
   P - precipitation
   S - potential maximum retention (mm) or runoff threshold (mm)

2. $CN = 1000/(10 + (S/25.4))$

   S - potential maximum retention (mm)
   CN - curve number

3. Suggested values for K1, K2 and K3 in the USDA rainfall runoff model (MLA, 2016).

Catchment	Dry K_1 (S)	Normal K_2 (S)	Wet Soil/Manure K_3 (S)
Pens	92 (22 mm)	93 (19.1 mm)	95 (13.4 mm)
Hard Catchment	96	96	96
Soft Catchment	57	75	88