Small Feedlot Runoff Management Using Low-Pressure Flood Irrigation

Runoff from small open feedlots often has settleable manure solids removed and the resulting water (settled effluent) is subsequently discharged to drainage pathways, posing the risk of negative impact to receiving lakes and streams. Larger open feedlots requiring National Pollutant Discharge Elimination System (NPDES) permits are required to capture and land apply this settled effluent, often using high-pressure sprinkler irrigation. Small feedlots not subject to NPDES permit requirements and precise nutrient management plans may be able to capture and land apply settled effluent using low-pressure flood irrigation systems with very low installation and operating cost.

System Design

System components include solids separation, settled effluent storage, effluent pump(s), and an effluent distribution system.

Solids Separation

Settleable manure solids should be removed prior to pumping or transferring effluent and prior to any discharge that may reach water resources. Solids separation is most often done by gravity in a settling basin (debris basin). Some states (including Iowa) have regulations prescribing solids settling basin design.

Iowa regulations require that runoff flow velocity resulting from the ten-year recurrence, one-hour rainfall be reduced to less than 0.5 feet per second for a minimum of five minutes.

Solids separation designs are also available in resources such as:

- *Designing Settling Basins for Open Feedlots* (PM 3059, Iowa State University) ***https://store.extension.iastate.edu/***
- *Livestock Waste Facilities Handbook* (MWPS 18, Midwest Plan Service) ***https://www-mwps.sws.iastate.edu/catalog/manure-management/livestock-waste-facilities-handbook***
- *Solid/Liquid Waste Separation Facility* (NRCS Practice Standard 632) ***http://efotg.sc.egov.usda.gov/references/public/IA/Waste_Separation_Facility_632_STD_2013_05.pdf***

Settled Effluent Storage

Settled effluent from small (no NPDES permit) feedlots can be stored in the solids settling basin or in a separate storage basin (holding pond) following solids settling. Some states may have regulations prescribing

Iowa State University
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PM 3060 November 2013

design of settled effluent storage. Iowa regulations allow settled effluent to be stored in a solids settling basin for no more than seven days. Iowa regulations do not require that settled effluent storage for small (no NPDES permit) feedlots follow the design standards used for permitted feedlots.

Settled effluent storage capacity depends on the contributing runoff area, the desired storm size to capture, and the desired storage time before emptying the storage. Liquid storage volume in solids settling basins is generally quite small, commonly capturing less than 1.5 inches of rainfall on the feedlot, sometimes as little as 0.5 inches.

A typical year in Iowa will include about ten days with rainfall greater than one inch, three days with rainfall greater than two inches, and one day with rainfall surpassing three inches. Maximum expected daily rainfall is about three inches for one-year recurrence, five inches for ten-year recurrence, and six inches for twenty-five-year recurrence.

For storage of storms and pumping on subsequent days, design settled effluent storage capacity for runoff from the desired rainfall event and recurrence. If pumping during the rainfall event is acceptable, storage capacity can be reduced significantly, to very small volumes if the pumping capacity is equal to the storm runoff rate.

Effluent Pumps

Distributing effluent through sprinkler systems requires relatively clean effluent to avoid plugging nozzles and high pressure to create wide sprinkler patterns. Filters and high-pressure (50 psi or greater) pumps are typically used. Distributing effluent through flood irrigation methods requires less filtration and lower pressures from the pump. Pressures need only overcome transfer pipe friction and elevation lift (head) between the storage and distribution point. For systems with lift limited to 10 feet or less, low-cost (less than $300) fractional horsepower electric sewage pumps may be sufficient. Flow rates for these pumps are typically in the range of 3,000 to 5,000 gallons per hour. For lift up to 50 feet, moderately priced ($500 to $1,000) sewage or semi-trash pumps are available in 1-3 horsepower electric or 3-8 horsepower engine-driven models with flow rates of 5,000 to 15,000 gallons per hour.

Electric pump

Gas pump

When AC electric power is available, electric pumps are reliable and easy to automate with float switches and/or timers. When AC power is not available, gas or diesel engine pumps, or electric pumps powered with portable generators are an alternative. Engine-powered pumps can be easily equipped for automatic shut-off with a float/kill switch, but are more difficult to equip for automatic start.

Effluent Distribution

Distribution for low-pressure flood irrigation at large feedlots is commonly done with gated irrigation pipe. For small feedlot effluent distribution, similar distribution systems can be made using plastic pipe and/or flexible distribution (lay-flat) hose. Holes can be drilled or cut into the distribution pipe/hose to perform the same function as gated pipe, although not adjustable; ¾-inch holes have worked well for distributing settled effluent. Smaller holes are prone to plugging with manure solids and grass or hay residues.

The number of distribution holes must be matched to the system pumping rate. Too few holes results in higher back-pressure against the pump and excessive liquid speed at the distribution holes, which can cause pockets of soil erosion. Too many holes leads to uneven flow across the distribution holes, with those near the end of the pipe receiving considerably less effluent than those nearer the pump. For planning purposes, plan approximately 5 gallons per minute for each ¾-inch hole (3 holes for every 1,000 gallons per hour). Adjust the number of holes as needed once the system is operating under actual pumping conditions.

Close-up of hole

Distribution pipe with effluent exiting

The diameter of distribution and supply pipes depends on the system pumping rate and length of the pipe. For precise design or long pipe lengths, consult pipe friction loss tables and size the pipe so that it doesn't limit pumping capacity. For short lengths (less than 200 feet) and reasonable pressure loss, plastic pipe or hose can carry approximately 2,500 gallons per hour in 2-inch pipe, 5,000 gallons per hour in 3-inch pipe, and 8,000 gallons per hour in 4-inch pipe.

Flood irrigation distribution can be made onto flat to gently sloping (less than 5%) vegetated areas or crop fields. With careful design and management, distribution onto steeper land may also be successful, but care must be taken to avoid runoff and erosion. Controls that allow for repeated small doses of application may be needed if the distribution area is small or steep. Moving the distribution pipe after significant rainfall and pumping events will aid in distributing nutrients and water over a larger infiltration area, gaining additional benefit from the nutrients and reducing the chance of overloading one area to the point of effluent runoff. Additional supply pipe lengths with quick couplers can aid in this process.

Lay-flat hose with quick coupler

The goal of successful application is uniform distribution of water and nutrients, while avoiding any effluent discharge from the application area. Different soil slopes, vegetation cover, infiltration rates and moisture conditions will impact application planning and management decisions. Larger systems or sensitive landscapes may require professional design. Small systems in less sensitive areas can often be designed by trial and adjustment.

One example of a design for runoff management with low-pressure flood irrigation is outlined in a 2013 research report from Iowa State University. More details about this demonstration project are available at ***https://www.iowabeefcenter.org/information/IBC52.pdf***

More Resources

Low-pressure flood irrigation systems can successfully distribute settled open feedlot effluent from small (no NPDES permit) open feedlots to make better use of manure nutrients and reduce the risk of effluent discharge to streams. Larger operations and operations in sensitive landscapes may benefit from more precisely designed flood and sprinkler irrigation systems described in the Nebraska Livestock Producer Environmental Assistance Project, ***http://afo.unl.edu/lpeapj/pages/index.jsp***

Dedicated areas for effluent application (Vegetated Treatment Systems) may be needed in some cases, especially larger systems and systems in environmentally sensitive areas. More details on these systems are discussed in this document ***http://www.extension.org/sites/default/files/w/6/61/8_VTS.pdf***

For more information on environmental management for small open feedlots and dairies, see ***http://www.agronext.iastate.edu/immag/smallfeedlotsdairy.html***

Production of this publication is part of the Water Quality Initiatives for Small Iowa Beef and Dairy Feedlot Operations project, supported in part by a section 319 grant through the Iowa Department of Natural Resources and the U.S. Environmental Protection Agency, Region 7.

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