The most important principle of odor control is avoiding anaerobic conditions by keeping (a) manure and other organic materials as dry as practical, (b) manure storages and surfaces exposed to oxygen, and (c) corral surfaces hard, smooth, and free of uncompacted manure.

## Elements of an Odor Management Plan (OMP) for Open Lot Livestock Facilities

Odor management plans have not yet been standardized nationally. Some states now require an OMP under special conditions (e.g., Texas, when requesting a waiver from the minimum setback distance from neighbors), but the elements of an acceptable OMP are typically defined on a case-by-case basis. The most important principle of odor control is avoiding anaerobic conditions by keeping (a) manure and other organic materials as dry as practical, (b) manure storages and surfaces exposed to oxygen, and (c) corral surfaces hard, smooth, and free of uncompacted manure. The following elements should constitute a broadly acceptable OMP for open lot facilities such as cattle feedlots and open lot dairies and may be used as a self-assessment checklist.

### Corral design

Although AFO design may not appear a realistic place to begin for existing facilities, well-designed AFOs should take credit for aspects of the original design that are known to reduce odor, either directly or indirectly. In preparing an OMP, operators should first highlight any of the following design criteria that apply:

1. The corral slopes between 3% and 5%, down away from the feed apron. A 3% to 5% slope sheds rainfall more rapidly than a flatter corral, reducing the likelihood of puddles that go anaerobic. Where these slopes are not practical or where they are thought to impair livestock performance, drainage should be enhanced through the use of feedlot mounds (Sweeten 1982).
2. Pen-to-pen drainage of rainfall runoff has been minimized. Corrals that drain discretely and directly into a runoff conveyance are seldom likely to detain water behind the manure ridges that develop under fence lines between corrals.
3. Access to the corrals by manure-harvesting equipment is convenient. Frequent manure harvesting is vital to ensuring rapid, complete drainage. If access by manure-removal equipment is difficult or awkward, the corral surface will be difficult to manage.
4. Corral soils are firm, stable, and not easily eroded into rills and gullies. Eroded corrals are prone to detain water.
5. A supply of fill dirt is abundant and convenient. When gouging or erosion occurs in a corral, rapid maintenance reduces the likelihood of puddles developing from rainfall or spilled drinking water.
6. Pen shape is conducive to edge-to-edge manure removal. Pens that are irregularly shaped cannot be maintained in the hard, smooth conditions that are central to effective manure removal.
7. The potential for backwater from major drainage channels is low. In some older feedlots, the downstream edges of the corrals are prone to temporary flooding. Stagnant water in a corral is a major contributor to intense, disagreeable odors. Ensure that runoff channels are well maintained and do not create backwater, especially within corral boundaries.
8. Clean rainfall runoff is diverted around corrals and manure storages, relieving pressure on the holding pond and reducing the amount of water that is potentially detained on the corral surface or around the base of manure stockpiles.

## Self-Assessment Tool: Question and Answer

1. The State Air Pollution Regulatory Agency (SAPRA) in my state is:

Agency Name: _____

Address/City/State/Zip: _____

_____

Telephone: _____

Nearest Local Field Office Address: _____

City/State/Zip Code: _____

Telephone: _____

Name of Field Representative: _____

2. The prevailing winds in my location come from the following directions. Circle all that apply:
   W NW N NE E SE S SW
3. My facility is located in a federal nonattainment area with respect to the NAAQS? Circle one:
   Yes No Don't Know
   If "yes," for which regulated pollutant? _____
4. Are agricultural operations exempt from air quality regulations in my state? Circle one:
   Yes No Don't Know
5. Neighbors (businesses, homes, schools, churches, other public venues) nearest my facility in any direction are within ___ miles of my property line.
6. Neighbors nearest my facility in the downwind direction with respect to the prevailing winds are within _____ miles of my property line.
7. Is my facility near topographical features (ravines, canyons, draws etc.) that are prone to transport air pollution over large distances and/or in directions other than those regional air currents? Circle one:
   Yes No Don't Know
8. My facility's property line is within ___ miles of the nearest major highway (truck route, divided highway) and ___ miles of the nearest public roadway (county roads, farm-to-market highways, other lightly traveled thoroughfares).
9. Are fugitive emissions included in the emissions inventory in my state? Circle one:
   Yes No Don't Know
10. My facility would be considered a major source subject to a Federal Operating Permit (FOP) under Title V of the Clean Air Act Amendments (CAAA)? Circle one:
    Yes No Don't Know
11. My facility is required to get a State Operating Permit (SOP) either by itself or in conjunction with a water permit? Circle one:
    Yes No Don't Know
12. Does the county or parish in which my facility is located have ordinances specifying maximum property line odor intensities or other numerical air quality standards? Circle one:
    Yes No Don't Know

...the key is to keep the corral surface hard, smooth, and as dry as possible... . Corrals that shed water rapidly and completely have the least potential to create odors.

## Corral maintenance

No matter how well an open lot AFO has been designed, corral maintenance will make or break the AFO with respect to odorous emissions. Again, the key is to keep the corral surface hard, smooth, and as dry as possible, maintaining a firm 1- to 2-inch base of compacted manure above the mineral soil. Corrals that shed water rapidly and completely have the least potential to create odors.

**Frequent, proper manure harvesting**. Open lot dairies are frequently capable of daily manure removal while the cows are in the milking parlor. Daily manure removal may be too frequent, however, especially if manure-removal equipment cannot be adjusted to maintain a 1- to 2-inch layer of compacted manure above mineral soil. Weekly manure removal may be a better option, both operationally and economically. In cattle feedlots, on the other hand, manure removal typically occurs only after each corral of cattle is emptied for slaughter or transfer, an interval of 120 to 180 days. In flat feedlots or where rainfall is plentiful, an interval of 120 days or more between manure removal activities will almost certainly lead to corral conditions that generate odor. A few modern, large (capacity > 35,000) feedlots in Texas have experimented with continuous manure harvesting in which two or three tractors with box scrapers operate continuously across the yard, even with cattle present. Corral conditions are excellent, and managers report little to no depression in feed-to-gain performance or increased cattle stress.

**"Pull" blade vs. "push" blade.** It is physically more difficult to ensure that a pushed scraper blade (e.g., front-end loader) leaves an even, smooth surface than a pulled blade (e.g., box scraper). Blades that gouge and scar the corral surface reduce the corral's water-shedding efficiency.

**Operator training in manure-harvesting objectives and techniques.** As with any essential AFO function, employees need to be trained both in the techniques of manure harvesting and in the justification, motivation, and objectives of the manure-harvesting function. Machinery operators who understand both the "what" and the "why" will be more apt to make sound decisions when managers are not around to answer questions.

**Frequent inspection for and correction of pits, holes, and wallows**. Bunk readers, feed-truck drivers, pen riders, and nighttime security providers employed by a feedlot or dairy should be trained and equipped to note pits and holes developing in the corrals. Such corral damage should be corrected with compacted fill dirt as soon as practical. Managers should assign higher priority to holes and wallows near water troughs and feed aprons, where spilled and excreted water may collect even during dry weather.

**Manure mounds for flat corrals.** Construction of manure mounds serves a threefold purpose: (1) a temporary storage for excess manure, (2) a cattle refuge from muddy, wet, and cold conditions and (3) a means of enhancing the water-shedding efficiency of corrals with little or no slope.

**Rigorous maintenance of overflow waterers, misters, and water distribution systems.** Water leakage in corrals, near feed bunks, and near manure storage areas can contribute significantly to odor. Feedlot employees should be trained to look for signs of leaky distribution systems and water troughs.

**Frequent inspection of fence lines for manure ridges, especially before rainfall events**. The moist manure that accumulates under fence lines as a result of hoof action is a fertile breeding ground for flies. When rainfall

occurs, these ridges also function as dams, creating puddles and wet spots that generate odors. Especially when rainfall is expected or when flies are becoming a major nuisance, these ridges should be knocked down and the manure spread out across the corral to dry.

## Feeding strategies

**Balance nitrogen (N) in ration; avoid overfeeding protein**. Of the 170 or more compounds known to contribute to livestock odor, many contain N and/or sulfur. Balancing the ration with respect to N may reduce the amount of N excreted in manure and urine. Balancing the ration will not eliminate odors, but it makes sense economically and contributes to a conscientious odor management regime.

**Balance sulfur in ration, avoid overfeeding sulfur, and account for dissolved sulfate in drinking water.** The same principles apply for sulfur (S) as for N. In addition to feedstuffs, excess S may be unwittingly "fed" in the form of high-sulfate drinking water. Nutritionists retained by the AFO should be aware of high-sulfate water and should consider the additional S when formulating rations.

**Investigate innovative feeding strategies (cyclical rations, grouping methods).** Although these strategies still await conclusive experimental verification with respect to feed-to-gain efficiency or milk production, any feeding strategies that result in more efficient nutrient use should also reduce nutrient excretion and may improve overall profitability. Contact animal scientists at your land-grant university for options appropriate to your region.

## Drainage structures and runoff holding ponds (design, operation, and maintenance)

Management of treatment lagoons and other wastewater retention structures has been covered in great detail in other lessons. This simple checklist fills in some gaps concerning runoff control structures.

1. Corrals, settling basins, and open channels should not be prone to clogging, backwater, or poor drainage.
2. Where settling channels are used to reduce solids loading in holding ponds, machinery access for solids removal should be convenient under all weather conditions.
3. Consistent sludge monitoring and timely removal of excess sludge will improve long-term lagoon performance and reduce long-term odor potential.
4. Shallow holding ponds (< 4 ft., where feasible using natural topography) are less prone to go anaerobic than deep ponds. This option is probably not feasible in high rainfall areas.
5. When weather permits, holding ponds should be pumped down soon after storms.

## Mortality management

1. Carcasses should be quickly removed from corrals followed by proper disposal, especially in warm weather.
2. Short-term mortality storage should not be visible from off-site and should not be located near the property line.
3. The same principles apply as for other species and AFO configurations (see Lesson 51, Mortality Management).

## Manure stockpiles and composting operations

**Avoid long-term stockpiling of manure, if possible**. Unmanaged stockpiles will eventually exclude oxygen, and even if the stockpiles are not odorous, old, stockpiled manure releases more odor upon land application than manure exposed to oxygen. If stockpiling is necessary, minimize stockpile size.

**To avoid overheating**, **put manure up dry (< 45% moisture).** When land applied, charred stockpiles release intense, uniquely disagreeable odors.

**Locate stockpiles and composting operations upwind relative to prevailing winds and the AFO center**. Because of the odor potential of stockpiles and storage areas, they should be located as far upwind of the principal downwind property line as topography or other operational considerations permit.

**Provide supplemental carbon for composting**. A proper carbon-to-nitrogen ratio in a compost pile or windrow encourages faster composting and reduces odors over the long term (see Lesson 25, Manure Treatment Options).

**Aerate compost piles at a frequency appropriate to their moisture content and composition**. In general, for wet manure put up for composting, aerate at 2-day intervals until the moisture content is reduced to 65% or less, then weekly or bi-weekly thereafter. High moisture content reduces the oxygen content of the pore spaces in a compost pile.

**Preferably use drier manure for land application.** Dry manure spreads more uniformly than moist manure, and because it has probably been exposed to more oxygen than manure with more moisture, dry manure releases less odor upon land application.