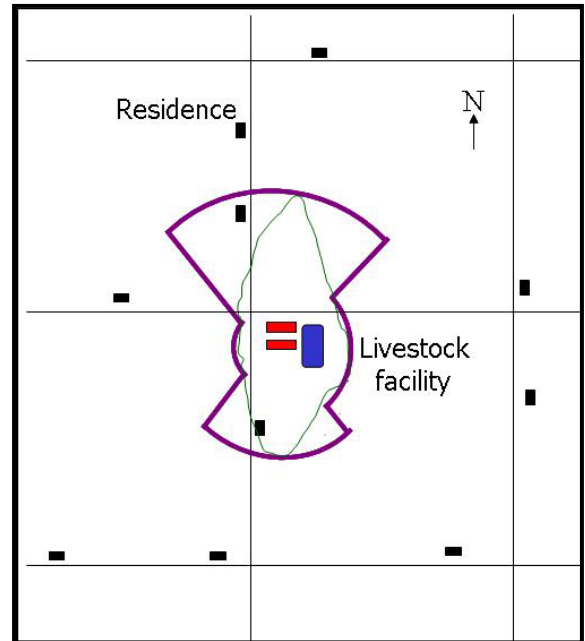


Understanding Odor Footprints and the Odor Footprint Tool

Q. What is an *odor footprint*?

A. An odor footprint is a visual picture (top view) of the risk-based odor impact of livestock facilities. Specifically, it outlines the area that is not expected to meet a selected target for avoiding odor annoyance. The minimum separation (or ‘setback’) distance needed from the livestock facility in a given direction is the extent of an odor footprint in that direction.

Odor footprints generated directly from dispersion modeling show the extent of risk-based odor impact in precise detail, but require specialized resources and expertise. Once baseline modeling is performed for a location, simplified footprints can be developed fairly readily for the region using commonly available resources and expertise. Simplified footprints show risk-based impact areas based upon the largest setbacks needed in one or more directions. The resulting footprints typically show fairly conservative pictures of risk-based impact areas.



Odor footprints illustrate the risk-based odor impact of livestock

Q. What is the *Odor Footprint Tool*?

A. The Odor Footprint Tool is a worksheet/spreadsheet that provides objective, science-based information on the risk-based impact of odors generated by livestock facilities. The user enters information about the livestock facilities for a given site, the site location (for getting weather data), use of supplemental odor control, and special terrain. After using the Odor Footprint Tool, the user obtains minimum setback distances in four directions (matching up with targets for avoiding odor annoyance).

NEBRASKA ODOR FOOTPRINT TOOL Setback Distance Results			
Project title:	Example	Prepared for:	
Site location:	Southeast, NE	Prepared by:	
		Date prepared:	
		Source Facility 1	Source Facility 2
Type of facility:		Swine, Finishing Bldg Deep pit	Swine, Nursery Bldg Deep pit or Shallow pit
		Manure Storage Steel/concrete tank	
Number of identical facilities:		4	1
Total plan area:	(sq. ft.)	32,000	6,000
Total number of animals:		4,000	1,500
Base odor control:		No supplemental odor control implemented	No supplemental odor control implemented
Alternate odor control:		Biofilter: All cool season air is vented.	Geotextile cover (at least 2.4 mm thick)
Terrain:		North Flat terrain	East Flat terrain
			South Flat terrain
		Terrain Adjusted Separation Distance (miles)	
BASE PLAN		North	East
	90%	0.33	0.07
	94%	0.45	0.14
	96%	0.62	0.26
	98%	1.12	0.41
	99%	1.97	0.69
			South
			0.24
			0.39
			0.52
			0.98
			1.84

An example of information provided and results obtained when using the Odor Footprint Tool.

Q. What do the results mean?

- A. The separation distances produced using the Odor Footprint Tool correspond to levels of risk – or more accurately, risk avoidance. The Odor Footprint Tool is used to predict separation distances based on user-selectable frequencies of hours during which odor levels will be below the cutoff or threshold for annoyance (see following question on what constitutes an annoying odor). Odor annoyance-free frequencies listed in Nebraska’s version of the tool are 90%, 94%, 96%, 98% and 99%.

For example, a 94% odor annoyance-free frequency means that at least 94% of the time, on an hourly basis, the odor level at locations the specified distance away from the livestock operation will either be undetectable or below the established threshold. The rest of the time (up to 6% or about 6 hours, on average, over a 4-day period), odors may exist at levels above the threshold. To reduce the risk that neighbors will experience annoying odor levels, either more separation is needed or some form of proven odor control needs to be implemented.



Setbacks are related to a frequency of annoyance.

Q. What is an annoying odor?

- A. What primarily defines an annoying odor is the likelihood that it will negatively influence behavior. When evaluating threshold levels for odor annoyance, the main question asked is “would this state of odor make more than one or two people in a large group want to change what they were doing to lessen their exposure to the odor?” For the modeling behind the Odor Footprint Tool, an annoying odor is ‘a faint odor that the average person might detect if attention was called to it, but would not otherwise attract attention’.



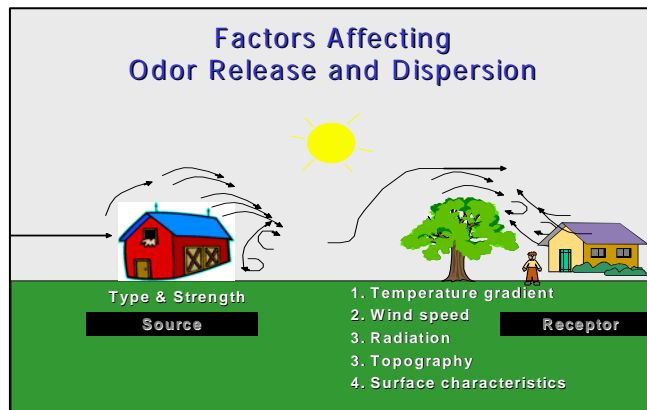
Odor intensity is used to define an annoying odor.

In measurable terms, annoying odors have an intensity of 2 or stronger on a standardized 0-to-5 reference scale. The nonlinear reference scale is designed so an odor intensity of 4 is much more than twice as concentrated as an intensity of 2. When someone asks if you like their new perfume or cologne, and you had not even noticed the smell until you were asked about it; the odor very likely had an intensity of 2. Since many people consider odors from livestock facilities unpleasant, a reasonably conservative intensity threshold was desired. In a Nebraska field study conducted near a swine finishing facility, the threshold intensity of 2 accounted well for the vast majority of odor conditions that would have made the non-partisan assessors modify plans for an outdoor gathering.

Q. What’s the science behind the Odor Footprint Tool?

A. The Odor Footprint Tool is based upon atmospheric dispersion modeling; specifically, a model developed and approved by the U.S. EPA for predicting the movement of airborne pollutants. Dispersion modeling is based upon the physics of atmospheric processes and requires access to quality meteorological data [weather records].

Dispersion modeling is not new, but has become more useful with dramatic improvements in computer capabilities. Advances in processing of data have also contributed to there being much more and higher quality weather information available.



Dispersion models consider the primary factors that influence odor movement and concentrations at neighboring locations.

Q. What has been done to ensure that the modeling / Odor Footprint Tool really works?

A. Modeling odor dispersion requires research-based information on odors. This research includes developing sound methods for measuring odors and a database of odor emission rates from animal production and manure handling facilities. Land-Grant Universities and other public organizations have conducted research and obtained emissions data for several types of animal housing and manure storage facilities.

Modeling’s credibility ultimately depends on there being a good correlation between predicted and observed odor events. The modeling behind the Odor Footprint Tool has successfully undergone field validation (ground-truthing) using trained odor assessors and local residents.



The credibility of the Odor Footprint Tool comes largely from comparisons of people’s field measurements with model predictions.

Q. How is the Odor Footprint Tool intended to be used?

A. The Odor Footprint Tool is intended to be used as a planning and screening tool to help make timely, well-informed decisions when siting livestock facilities and evaluating odor control options. Producers, their advisors, local officials, and interested rural residents should all find utility in using the Odor Footprint Tool on an informational basis. There are pros and cons of including the Odor Footprint Tool as part of local/county ordinances, and considerable thought needs to be given as to how this can be done expediently and fairly across differing types of animal production operations.

Q. What is the *right* annoyance-free frequency to use?

A. It depends. While the Odor Footprint Tool is based upon science and best-available research information, selection of the annoyance-free frequency involves a judgment of acceptable risk. Generally speaking, the annoyance-free frequency should match up with the best interests of the rural community. Ideally, a community will determine its best interests by realistically considering its economic, environmental, and social visions for the future in advance of making official decisions about setbacks (e.g. a proposed livestock expansion becomes a ‘lightning rod’ event).

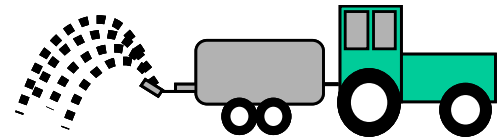
As a general guide, when local residents have a strong affiliation with animal agriculture and are accustomed to modern production practices, using an odor annoyance-free frequency near 94% may suit the local needs. When most residents are unaffiliated with animal agriculture, or when avoiding odor conflicts is a top priority, an annoyance-free frequency closer to 98% may be more appropriate.

The odor annoyance-free frequency selected greatly affects the resulting separation distances. Wanting to be free of annoying odors 99% of the time may be unrealistic for some areas due to limited options for finding enough land to meet large required setbacks and challenges of applying this high standard to existing operations wanting to expand. On the other hand, having annoying odor levels 6-10% of the time is unrealistic in many areas if good neighbor relations are desired.

Q. How does the Odor Footprint Tool account for spreading of manure on fields?

A. The Odor Footprint Tool presently does not account for odors that may result from land application of manure. These infrequent, but not inconsequential events need to be considered separately for their additional odor impact.

Incorporating material directly into the soil is known to produce much less odor than does surface spreading of the same material. Beyond this, though, it is very challenging to account for application of manure at varying times on potentially differing fields, especially using a “simple tool”.



Odors from manure application need to be accounted for separately.

Q. What other clarifications should be made when discussing odor footprints?

A. Like most good information, there are ways in which the information from the Odor Footprint Tool can be given unintended or inaccurate meanings. It may be helpful to consider the following:

- ***The Odor Footprint Tool does not report how far odor will travel.*** This information seems interesting to many people, but has little useful value in assessing odor impact. Under certain weather conditions, odors from even the smallest of farm operations or companion animal facilities will travel relatively long distances.
- ***The separation distances correspond to odor annoyance-free frequencies, not odor-free frequencies*** – a subtle, but important distinction. Rural areas are seldom, if ever, truly odor free. A key element of odor modeling is distinguishing between annoying and non-annoying states of odor, in this case, odor associated with animal production. Most people do not find barely detectable odors to be annoying, so very faint odors are considered inconsequential.

- ***Odor footprints show areas of ‘risk-based odor impact’.*** Residents living beyond specified setbacks (outside an odor footprint) always have a small risk that they may be exposed to annoying odor levels, so use of phrases like “no odor impact” or “no risk” are not accurate or recommended. By analogy, someone who lives outside a 50-year floodplain may reside within the 100-year floodplain, so they should not be told that it will “never flood” on the property.
- ***The Odor Footprint Tool is not used to forecast when odor events will occur.*** Setback information is based upon looking at weather over long periods of time. Fairly consistent weather trends will develop over time within a given region, which helps make risk-based odor footprints more reliable than the weekend weather forecast.
- ***Odor footprints are generally produced for a portion of the year corresponding to an ‘odor season’.*** The odor season includes warm conditions when rates of odor generation are higher and people are more likely to be outdoors. The Odor Footprint Tool considers the odor season to extend from April 15th to October 15th. Excluding cold weather conditions and associated low generation rates for odor should result in conservative frequencies of odor annoyance (on a percentage basis) and larger setbacks compared to considering full calendar years.

Prepared by:

Chris Henry, P.E., Extension Engineer, University of Nebraska–Lincoln
217 LW Chase Hall, Lincoln NE 68583-0726
402-472-6529 chenny1@unl.edu

Rick Stowell, Ph.D., P.E. ,Associate Professor, Extension Engineer, University of Nebraska–Lincoln
213 LW Chase Hall, Lincoln NE 68583-0726
402-472-3912 rstowell1@unl.edu