memorandum

To: Town Board

From: Dustin Wolff, AICP, Town Planner

Cc: Sarah Burdette, Town Clerk-Administrator
Scott Brosteau, Town Engineer

Date: November 20, 2017

RE: Livestock Facility Siting Update for Town Board Meeting

The following are recommendations made by the Zoning & Planning Commission to the Board.

Zoning Code Revisions to Address Livestock Facility Siting
These proposed updates follow the code amendments made at the August 22nd Town Board meeting. The Town has been advised by DATCP that some additions and clarifications are needed to the previous amendment. Of specific concerns were the following:

Findings

As the Town's regulations for livestock siting and animal waste storage facilities exceed the regulations of DATCP (ATCP 51), regulations and standards created by the Town must be based upon reasonable and scientifically defensible findings of fact which are adopted and incorporated. The ordinance as adopted in August did not clearly delineate the studies or reports to support/substantiate the need for greater setback restrictions than the state would require. The studies detail the impact of CAFOs on both the value and marketability of properties, as well as health of residents, located nearby such an operation. These reports were discussed by the Board at as part of their decision-making, but were not listed in ordinance form. The ordinance now includes brief case study summaries in Wisconsin, Minnesota, Iowa, and Indiana.

Leachate Containment

DATCP staff also informed the Town that the issue of agricultural leachate and contaminated run-off may not be satisfactorily addressed in the recently adopted ordinance. We needed to better define what leachate is, and how it is handled. The same is true of contaminated run-off. These issues are not addressed in the same manner as animal waste storage facilities. Moreover, they are regulated by different areas of the Wisconsin Statutes and Administrative Code.

We have added language that defines agricultural leachate, contaminated run-off, and feed storage run-off control systems. Also, we have distinguished control or management facilities for leachate and contaminated run-off differently than animal waste or typical stormwater management.

Upon review and approval of these Code changes, the updated ordinances will again be submitted to DATCP for incorporation into their regulatory framework.

AFFIDAVIT OF POSTING

STATE OF WISCONSIN)
Town of Ledgeview)
Brown County)

I, Charlotte K. Nelson, Deputy Town Clerk of the Town of Ledgeview, Brown County, Wisconsin, attest and affirm all of the following:

1. That the following action was posted pursuant to s. 60.80, Wis. stats:
The Ledgeview Notice of Public Hearing for the CAFO Ordinance amendment for Tuesday, November 21, 2017 at 4:30 p.m., a copy here onto attached;

2. That the above-noted action was posted as required in the following 3 places in the Town of Ledgeview, Brown County, Wisconsin:

Ledgeview Town Hall, 3700 Dickinson Road, De Pere, WI 54115

Piggly Wiggly, 575 Swan Road, De Pere, WI 54115

I-43 Shell Station, 3285 Cedar Hedge Lane, Green Bay, WI 54311

Town of Ledgeview website at www.ledgeviewwisconsin.com

3. That the posting of this action occurred at the following times and dates:

Prior to 5:00 a.m. on Thursday, November 2, 2017.

That I filed this affidavit in the records of the town clerk for the Town of Ledgeview on November 3rd, 2017.

Dated this 3rd day of November, 2017.

Charlotte Nelson
Charlotte K. Nelson, Deputy Town Clerk
Town of Ledgeview, Brown County, WI

Subscribed and sworn to before me this 3rd day of November, 2017.

Sarah K Burdette
Sarah K. Burdette
Town Clerk/Administrator
Town of Ledgeview, Brown County, WI

Ledgeview
Set your sights high

NOTICE OF PUBLIC HEARING
TOWN OF LEDGEVIEW

Tuesday, November 21, 2017 at 4:30 p.m.
or as soon thereafter as can be heard
3700 Dickinson Road, De Pere, WI 54115

Notice is hereby given the Ledgeview Town Board will be holding a public hearing on **TUESDAY, November 21, 2017 AT 4:30 P.M. or as soon thereafter as can be heard** at the Ledgeview Municipal Building, 3700 Dickinson Road, De Pere, WI 54115. The purpose of the public hearing is to hear comment on the proposed ordinance amendment 2017-13 to Chapter 135 Zoning, Article III – Definitions and Word Usage, Article IV – General Provisions, Article X - AG FP – Farmland Preservation, and Article XXIV – Man Made Bodies of Water. A copy of the proposed ordinance amendment is available on the town's website at www.ledgeviewwisconsin.com.

All persons interested are invited to attend this hearing and be heard. Written comments may be submitted in lieu of public appearance to the Town Clerk/Administrator, 3700 Dickinson Road, De Pere, WI 54115. The Town Board may discuss and act on the amendment after the public hearing.

Charlotte K. Nelson
Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview

Signed, dated and posted: November 2, 2017
Published: November 2 & November 13, 2017

Charlotte Nelson

From: GRSC-West-Legals mbx <GRSC-West-Legals@gannett.com>
Sent: Wednesday, November 01, 2017 8:44 AM
To: Charlotte Nelson
Subject: RE: 2510526 Ledgeview PH Ordinance 2017-13

Hello,

Please find attached your order confirmation and proof of the ad.

Your ad is set to run in:

The Green Bay Press Gazette on November 2nd and 13th.

The total cost is $70.81 which includes an affidavit which will be mailed to you after the ad publishes.

NOTICE OF PUBLIC HEARING
TOWN OF LEDGEVIEW
Tuesday, November 21, 2017
at 4:30 p.m.
or as soon thereafter as can be heard
3700 Dickinson Road, De Pere, WI 54115

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Charlotte K.Nelson
Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview
Signed, dated and posted: November 2, 2017
RUN: Nov. 2 & 13, 2017 WNAXLP

Thank you,
Jenny Tyczkowski
Administrative Support Specialist

P: 877-943-0444
www.gannettwisconsinmedia.com

From: Charlotte Nelson [mailto:cnelson@ledgeviewwisconsin.com]
Sent: Wednesday, November 1, 2017 8:12 AM
To: GPG-legals mbx <legals@greenbaypressgazette.com>
Subject: 2510526 Ledgeview PH Ordinance 2017-13

Greetings,

Attached is a public hearing notice for ordinance 2017-13 for publication in the November 2nd & 13th 2017 Green Bay Press Gazette. Please confirm publication dates.

Thank you!

Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview

3700 Dickinson Road
De Pere, WI 54115
Telephone: (920) 336-3360, Ext. 104
Fax: (920) 336-8517
cnelson@ledgeviewwisconsin.com
Population: 7,431

This message originates from the Town of Ledgeview. It contains information that may be confidential or privileged and is intended only for the individual named above. It is prohibited for anyone to disclose, copy, distribute or use the contents of this message without permission, except as allowed by the Wisconsin Public Records Laws. If this message is sent to a quorum of a governmental body, my intent is the same as though it were sent by regular mail and further distribution is prohibited. All personal messages express views soley of the sender, which are not attributed to the municipality I represent, and may not be copied or distributed without this disclaimer. If you receive this message in error, please notify me immediately.

AFFIDAVIT OF POSTING

STATE OF WISCONSIN)
Town of Ledgeview)
Brown County)

I, Charlotte K. Nelson, Deputy Town Clerk of the Town of Ledgeview, Brown County, Wisconsin, attest and affirm all of the following:

1. That the following action was posted pursuant to s. 60.80, Wis. stats:
The Ledgeview Town Board Agenda for Tuesday, November 21, 2017 at 4:30 p.m., a copy here onto attached;

2. That the above-noted action was posted as required in the following 3 places in the Town of Ledgeview, Brown County, Wisconsin:

Ledgeview Town Hall, 3700 Dickinson Road, De Pere, WI 54115

Piggly Wiggly, 575 Swan Road, De Pere, WI 54115

I-43 Shell Station, 3285 Cedar Hedge Lane, Green Bay, WI 54311

Town of Ledgeview website at www.ledgeviewwisconsin.com

3. That the posting of this action occurred at the following times and dates:

Prior to 5:00 p.m. on Thursday, November 16, 2017.

That I filed this affidavit in the records of the town clerk for the Town of Ledgeview on November 16, 2017.

Dated this 16th day of November, 2017.

Charlotte K. Nelson
Charlotte Nelson, Deputy Town Clerk
Town of Ledgeview, Brown County, WI

Subscribed and sworn to before me this 16th day of November, 2017.

Sarah K Burdette
Sarah K. Burdette
Town Clerk/Administrator
Town of Ledgeview, Brown County, WI

Ledgeview
Set your sights high

LEDGEVIEW TOWN BOARD AGENDA
Tuesday, November 21, 2017 at 4:30 p.m.
or as soon thereafter as possible
Ledgeview Municipal Building
3700 Dickinson Road, De Pere, WI 54115

The Town Board may discuss and act on the following:

Town Board
Philip J. Danen, Chairman
Andy Schlag, Supervisor
Renee Van Rossum, Supervisor
Ken Geurts, Supervisor
Cullen Peltier, Supervisor

A. CALL TO ORDER
B. PLEDGE OF ALLEGIANCE
C. ROLL CALL
D. AGENDA APPROVAL

CONSENT AGENDA
1. Regular Board Meeting Minutes:
   a. November 1, 2017 Town Board Minutes.
2. Routine Reports: None.
3. Committee/Commission Reports: None.
4. Operator's Licenses: November 3, 2017 – November 20, 2017.
5. Other Committee minutes. Accept and place on file:
   a. October 11, 2017 Zoning & Planning Minutes.
   b. August 8, 2017 Park & Recreation Committee Minutes.
   c. September 27, 2017 Park & Recreation Committee Minutes.
   d. October 25, 2017 Park & Recreation Committee Minutes.
6. Pay Requests: None.
7. Special Event & Street Closure Permits: None.

All items listed under "Consent Agenda" are considered to be routine and non-controversial by the Town Board and will be approved by one motion. There will be no separate discussion. If discussion is desired by members, that item will be removed from the consent agenda and discussed separately immediately after consent agenda is approved.

PUBLIC COMMENT:

PUBLIC HEARING: The Board will hear comments and may take action on any of the following items:
1. The Original Alcohol Beverage License Application for Kwik Trip, Inc., Brad Brennenstuhl, Agent, for a Class A Liquor and Class A Beer Combination License doing business as Kwik Trip 594, 1328 O'Keefe Road, De Pere, WI, 54115. An Application for Cigarette and Tobacco Products Retail License for said business and location will also be heard.
2. The proposed ordinance amendment 2017-13 to Chapter 135 Zoning, Article III – Definitions and Word Usage, Article IV – General Provisions, Article X - AG FP – Farmland Preservation, and Article XXIV – Man Made Bodies of Water.

ZONING & PLANNING:
1. Recommendation from Zoning & Planning on the request by Scott Smet of Smet Investments, agent for Gambini America, owner, for a Building, Site, & Operations Application for a business office/storage facility located on unit 6 of Olde School Square, corner of Dickinson Road and Creamery Road.

NEW BUSINESS:

1. Recommendation from Park & Rec on the Ledgeview Bicycle and Pedestrian Plan Scope of Services from WE Bike, etc LLC.
2. Recommendation from Park & Rec on the playground design and purchase from Minnesota-Wisconsin Playground for Zelten Family Park and Dollar Park.
3. Confirm Town Chair's Appointments to the Personnel & Finance Committee to fill a vacancy for a two (2) year term ending May, 2018.
4. Review and approve the Storm Water Utility Rates for 2018.

OLD BUSINESS:

1. Discuss and act on recommendation from Personnel & Finance Committee regarding the recruitment process for the Director of Public Works position.

COMMUNICATIONS: None.

ORDINANCES: None.

REPORTS: Clerk/Administrator, Deputy Clerk, Treasurer, Engineer, Planner, Public Works, Code Enforcement, Fire Chief and Board Comments.

APPROVAL OF THE VOUCHERS:

ADJOURNMENT:

NEXT REGULAR MEETING MONDAY, DECEMBER 4, 2017 AT 6:00 PM

BY THE DIRECTION OF THE TOWN BOARD CHAIRMAN:

Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview, Brown County, WI
Signed, dated and posted: November 16, 2017

Notice is hereby given that the Ledgeview Town Board may take action on any specific item listed within this agenda. Where citizens provide input to the Ledgeview Town Board on items not specifically listed within this agenda, the only appropriate action is referral to a Committee or to a subsequent Town Board meeting. Any person wishing to attend who, because of disability, requires special accommodations should contact the Town Clerk at (920) 336-3360, 3700 Dickinson Road, at least 48 hours prior to the meeting so arrangements can be made.

Charlotte Nelson

From:	Charlotte Nelson <cnelson@ledgeviewwisconsin.com>
Sent:	Thursday, November 16, 2017 2:49 PM
To:	'metro@greenbaypressgazette.com'; 'janderson9@greenbay.gannett.com'
Subject:	Ledgeview Agendas
Attachments:	17-11-21 Town Board Meeting - FINAL.pdf; 17-11-21 Special Meeting of Electors & Special TB Meeting Agenda APPROVED.pdf

Greetings,

Attached are the following Ledgeview Agendas:

- Town Board Meeting, Tuesday, November 21, 2016 at 4:30 p.m.
- Budget Public Hearing, Special Meeting of Electors, & Special Town Board Meeting, Tuesday, November 21, 2017 at 6:00 p.m.

Sincerely,

Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview

Ledgeview
Set your sights high

3700 Dickinson Road
De Pere, WI 54115
Telephone: (920) 336-3360, Ext. 104
Fax: (920) 336-8517
cnelson@ledgeviewwisconsin.com
Population: 7,431

Proud Member of the WMCA Wisconsin Municipal Clerks Association

This message originates from the Town of Ledgeview. It contains information that may be confidential or privileged and is intended only for the individual named above. It is prohibited for anyone to disclose, copy, distribute or use the contents of this message without permission, except as allowed by the Wisconsin Public Records Laws. If this message is sent to a quorum of a governmental body, my intent is the same as though it were sent by regular mail and further distribution is prohibited. All personal messages express views soley of the sender, which are not attributed to the municipality I represent, and may not be copied or distributed without this disclaimer. If you receive this message in error, please notify me immediately.

Charlotte Nelson Tom Cuns, Greg Breadel & Mike Denor

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To: 'Charlotte Nelson'
Subject: Ledgeview Agendas
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PRESS-GAZETTE media
A GANNETT COMPANY

STATE OF WISCONSIN
BROWN COUNTY

TOWN OF LEDGEVIEW , LEGALS

3700 DICKINSON RD
DE PERE WI 541158797

Being duly sworn, doth depose and say that she/he is an authorized representative of the Green Bay Press Gazette, a newspaper Green Bay, Wisconsin, and that an advertisement of which the annexed is a true copy, taken from said paper, which was published therein on

Public Notices

NOTICE OF PUBLIC HEARING
TOWN OF LEDGEVIEW
Tuesday, November 21, 2017
at 4:30 p.m.
or as soon thereafter as can be heard
3700 Dickinson Road, De Pere, WI
54115

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hearing on TUESDAY, November 2
2017 AT 4:30 P.M. or as soon thereaft
as can be heard at the Ledgeview M
nicipal Building, 3700 Dickinson Roa
De Pere, WI 54115. The purpose of t
public hearing is to hear comment on t
proposed ordinance amendment 201
13 to Chapter 135 Zoning, Article III
Definitions and Word Usage, Article IV
General Provisions, Article X - AG FP
Farmland Preservation, and Article XX
– Man Made Bodies of Water. A co
of the proposed ordinance amendmen
available on the town's website at ww
edgeviewwisconsin.com.
All persons interested are invited to
tend this hearing and be heard. Writ
comments may be submitted in lieu
public appearance to the To
Clerk/Administrator, 3700 Dickins
Road, De Pere, WI 54115. The To
Board may discuss and act on
amendment after the public hearing.
Charlotte K.Nelson
Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview
Signed, dated and posted: Novembe
2017
RUN: Nov. 2 & 13, 2017 WNAXLP

Account Number:	GWM-281504
Order Number:	0002510526
No. of Affidavits:	1
Total Ad Cost:	$70.81
Published Dates:	11/02/17, 11/13/17

(Signed) ______________ **(Date)** 11/17/17
Legal Clerk

ERIN DUFFY
NOTARY PUBLIC
STATE OF WISCONSIN

Signed and sworn before me

____

My commission expires 5-25-18

TOWN OF LEDGEVIEW , LEGALS
Re: Hearing for Ord. 2017-13

GANNETT WI MEDIA
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PO BOX 23430
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Ordinance No. 2017-13

Town of Ledgeview
Brown County, Wisconsin
Ordinance amendment revising Chapter 135 - Zoning,
Article III – Definitions and Word Usage, Article IV – General Provisions,
Article X - AG FP – Farmland Preservation, and
Article XXIV – Man Made Bodies of Water.

The Town Board of Supervisors of the Town of Ledgeview, Brown County, Wisconsin does ordain as the follows:

Section 1: Chapter 135, Zoning, of the Town of Ledgeview Code of Ordinances is hereby amended as follows:

CHAPTER 135: ZONING

Article III: Definitions and Word Usage

§ 135-8 Definitions

LIVESTOCK FACILITY

A feedlot, dairy farm or other operation where livestock are or will be fed, confined, maintained or stabled for a total of 45 days or more in any 12–month period. A "livestock facility" includes all of the tax parcels of land on which the facility is located, but does not include a pasture or winter grazing area. Related livestock facilities are collectively treated as a single "livestock facility" for purposes of this chapter.

AGRICULTURAL LEACHATE

Any liquid material from the production area directly or indirectly used in the operation of animal feeding operation that results from any or all of the following:

(a) Spillage or overflow from animal or poultry watering systems.

(b) Washing, cleaning, or flushing pens, barns, manure pits, or other animal feeding operation facilities.

(c) Direct contact swimming, washing, or spray cooling of animals or dust control.

(d) Water that comes into contact with any raw materials or animal byproducts including manure, feed, milk, eggs or bedding.

CONTAMINATED RUNOFF

The drainage that has come through or across a feed storage or manure storage area. Contaminated runoff includes the liquid and any sediment, manure, feed, or other material carried in the liquid. Contaminated runoff contains lower concentrations of contaminants than agricultural leachate from feed or manure.

FEED STORAGE RUNOFF CONTROL SYSTEM

A system of facilities or practices to contain, divert, retard, treat, or otherwise control the discharge of leachate and contaminated runoff from livestock feed storage areas.

Article IV: General Provisions

§ 135-11 Building and use restrictions.

G. Accessory buildings shall not occupy more than 30% of the rear yard. These restrictions shall apply in all districts, except as provided for in Subsection G(1) through (5) below: [Amended 11-14-2000; 7-1-2002; 7-3-2003; 6-4-2007 by Ord. No. 2007-010; 9-18-2007 by Ord. No. 2007-016; 4-19-2016 by Ord. No. 2016-008]

  (1) Farm structures. The above regulations shall not apply to accessory buildings located in the AG-FP Farmland Preservation District, A-2 Agriculture District or R-R Rural Residential District if said accessory building is used as a part of a legitimate agricultural operation located on a minimum farm site of 10 acres.

U. Animal unit calculations. [Added 10-20-2009 by Ord. No. 2009-038]

  (1) General provisions.

    (a) No livestock will be allowed on lots or parcels of less than 1.99

acres in the Town of Ledgeview, except chickens as outlined in Subsection V. [Amended 4-7-2014 by Ord. No. 2014-006]

(b) These provisions shall apply to all parcels of land zoned RR and AG2, in the Town of Ledgeview. The keeping of livestock within other zoning districts except AG-FP or A-2 is hereby prohibited. Parcels of land zoned AG-FP are exempt from this subsection and shall be regulated as outlined in Article X: AG-FP Farmland Preservation District.

(c) Parcels or lots within districts zoned RR or AG2 having a larger number of livestock at the time of adoption of this subsection may continue to maintain that number of animal units, provided that no expansion of the facility shall be permitted without an approved conditional use permit from the Town of Ledgeview.

Article X: AG-FP Farmland Preservation District

§ 135-79 Introduction.

A. Purpose. The purpose of this District is to preserve and enhance land for agricultural uses, and to incorporate and apply the livestock facility siting law requirements found in Wis. Stats. 92.16 and 93.90, and ATCP 51 of the Wisconsin Administrative Code and to regulate the siting of new livestock facilities (with an excess of 500 animal units) and the expansion of existing livestock facilities by more than 20% (and over 500 animal units) in any other zoning district other than the Farmland Preservation Zoning District within the Town of Ledgeview.

B. Authority. This Ordinance is adopted pursuant to the Town's zoning powers found in Wis. Stats. 60.62, 62.23(7), 92.16 and 93.90, together with the administrative provisions set forth in ATCP 51 of the Wisconsin Administrative Code, inclusive of all future amendments to any provisions of these statutes and administrative rules. The livestock facility siting standards established in Wis. Admin. Code Ch. ATCP 51, including all appendixes, worksheets, and any future amendments to that chapter, are incorporated by reference and adopted.

C. Incorporation of State Law. Pursuant to the provisions of Wis. Stats. 93.90, the Town of Ledgeview does hereby adopt and incorporate into its existing Zoning

Ordinance the provisions of Wis. Stats. 92.16 and 93.90 and ATCP 51 of the Wisconsin Administrative Code, inclusive of all future amendments to any provisions of Wis. Stats. 93.90 and ATCP 51 of the Wisconsin Administrative Code. The Town of Ledgeview's Zoning Ordinance hereby reflects the provisions of Wis. Stats. 92.16 and 93.90, and ATCP 51 of the Wisconsin Administrative code as if said statutory and administrative provisions were set forth in their entirety within the text of the Town's Zoning Ordinance.

D. Findings. The livestock siting, animal waste storage, and c**ontaminated runoff storage facilities** regulations and standards created by the Town are based upon the following reasonable and scientifically defensible findings of fact which are adopted and incorporated herein by reference:

(1) The Report of the Livestock Facility Siting Technical Expert Committee Recommendations, dated December 21, 2010, including a recommendation on "Setbacks" that states: "Among other options for managing the offsite impacts of larger livestock operations, DATCP should evaluate augmenting the current road and property line setbacks by requiring separation distance between livestock structures and neighboring occupied residences and high use buildings."

(2) A two-year study by the Wisconsin Department of Agriculture, Trade and Consumer Protection and the Wisconsin Department of Natural Resources entitled Final Report On Wisconsin's Dairy And Livestock Odor And Air Emission Project, dated September 2009, including a recommendation found at page 5 that states: "Separation distance is a simple, yet affective, tool you can use to reduce impacts on your neighbors. When planning for new facilities, and especially manure storage lagoons, site them as far from neighbors as possible, and with consideration for prevailing winds. Odors are far less noticeable at 800 feet than they are at 200 or even 400 feet. If adjacent properties go up for sale, consider buying them as a buffer against future encroachment by development."

(3) An article in the July 1, 2001 Appraisal Journal, pages 301 – 306, titled, "Concentrated Animal Feeding Operations and Proximate Property Values" by John A. Kilpatrick, a partner and senior analyst with Mundy Associates, LLC, an economic, market, and valuation firm specializing in complex real estate matters. The study found that property located near a concentrated animal feeding operation (CAFO) will be negatively impacted by this externality. The degree of impairment depends on proximity and property type and use. Properties with higher unimpaired values are probably impacted more than otherwise lower valued

properties.

(4) A University of Minnesota Extension publication written by Larry Jacobson, David Schmidt, and Susan Wood, Offset Odor From Feedlots Setback Estimation Tool, www.extension.umn.edu/distributionllivestocksystems/DI7680.html.

(5) A Purdue University project, presented by the Purdue Agricultural Air Quality Laboratory, Odor Based Setbacks. http://engineering.purdue.edu/~odor/setback.htm that developed setback guidelines for swine production operations. The guidelines considered facility size, orientation and shape, wind frequency, land use, topography, building design and management, manure handling characteristics, and odor design effectiveness.

(6) A research article by Susan S. Schiffman, Clare E. Studwell, Lawrence R. Landerman, Katherine Berman, and JohnS. Sundy, Symptomatic Effects of Exposure to Diluted Air Sampled from a Swine Confinement Atmosphere on Healthy Human Subjects, Volume 113, Number 5, Environmental Health Perspectives, pages 567-576, (2005). The study concludes at page 574 as follows: "In this study that evaluated healthy volunteers, no statistical differences on objective physical measures, mood, or attention were found from a 1-hr exposure in an environmental chamber to air emissions from a swine house when compared with clean air. However, self-reported symptoms of headache, eye irritation, and nausea were significantly higher in the swine air (experimental) condition than the clean air (condition)."

(7) A research mini-monograph by Kelley J. Donham, Steven Wing, David Osterberg, Jan L. Flora, Carol Hodne, Kendall M. Thu, and Peter S. Thorne, Community Health and Socioeconomic Issues Surrounding Concentrated Animal Feeding Operations, Volume 115, Number 2, Environmental Health Perspectives, pages 317-320 (2007). A brief summary of this research project provides: 'This workshop evaluated impacts of the proliferation of concentrated animal feeding operations (CAFOs) on sustaining the health of rural communities. Recommended policy changes include a more stringent process for issuing permits for CAFOs, considering bonding for manure storage basins, limiting animal density per watershed, and enhancing local control, and mandating environmental impacts statements "

(8) A study by Steven J. Taff, Douglas Tiffany, and Sanford Weisberg, "Measured Effects of Feedlots on Residential Property Values in Minnesota: A Report to the Legislature," University of Minnesota Staff Paper Series (July, 1996). The study found a statistically significant pricing impact related both to the existence of a CAFO as well as the distance from the CAFO. In other words, not only does a CAFO have a significant impact on property value, but the nearer the CAFO, the greater the impact.

§ 135-79.5 Permitted uses.

The following activities are permitted by right in the Farmland Preservation Zoning District as specified in § 91.44, Wis. Stats.:

A. The following agricultural uses on farms conducted for the purpose of producing an income or livelihood:
    (1) Crop or forage production.
    (2) The keeping of less than 500 animal units (<500 AU) of cattle, swine, poultry, sheep, or goats.
    (3) Beekeeping.
    (4) Nursery, sod, or Christmas tree production.
    (5) Floriculture.
    (6) Aquaculture.
    (7) Fur farming.
    (8) Forest management.
    (9) Enrolling land in a federal agricultural commodity payment program or a federal or state agricultural land conservation payment program.
B. Farm residences.
C. Accessory uses as outlined in § 135-80.
D. Agriculture-related uses.
E. Undeveloped natural resource and open space areas.
F. Transportation, utility, communication, or other uses that are required under state or federal law to be located in a specific place or that are authorized to be located in a specific place under a state or federal law that preempts the requirement of a conditional use permit for that use.
G. Other uses identified by DATCP by rule.

§ 135-80 Accessory uses.

The following land uses shall be permitted accessory uses in the Farmland Preservation Zoning District:

A. A building, structure, or improvement that is an integral part of, or is incidental to, an agricultural use, including:
    (1) A facility to store or process raw agricultural commodities, all of which are produced on the farm.

(2) A facility used to keep or house livestock on the farm if the proposed livestock housing structure meets the standards prescribed in Wis Stats 93.90 and Ch. ATCP 51, Wis. Adm. Code.
(3) A facility used to store or process inputs primarily for agricultural uses on the farm.
(4) A facility used to keep or service vehicles or equipment primarily employed in agricultural uses on the farm.

B. An activity or business operation that is an integral part of or incidental to an agricultural use.
C. A farm residence, including normal residential appurtenances such as a pool, deck, or patio.
D. A home business, activity, or enterprise, whether or not associated with an agricultural use, which meets all of the following requirements:
(1) It is conducted on a farm by an owner or operator of that farm.
(2) It requires no buildings, structures, or improvements other than those described in Subsection A or C of this section.
(3) It employs no more than four full-time employees annually.
(4) It does not impair or limit the current or future agricultural use of the farm or other protected farmland.

E. Roadside stands for the sale of agricultural products only, provided that the structure does not cover more than 300 square feet in ground area and does not exceed 10 feet in height.
F. Any other use that DATCP, by rule, identifies as an accessory use.

§ 135-81 Conditional uses.

A. Finding. The Town may issue a conditional use permit for the certain agricultural and agriculture-related uses for the farmstead under § 135-251 if all of the following findings of fact apply:
(1) The use and its location in the Farmland Preservation Zoning District are consistent with the purposes of the Farmland Preservation Zoning District.
(2) The use and its location in the Farmland Preservation Zoning District are reasonable and appropriate, consider alternative locations, or are specifically approved under state or federal law.
(3) The use is reasonably designed to minimize conversion of land, at and around the use site, from agricultural use or open space use.

(4) The use does not substantially impair or limit the current or future agricultural use of other protected farmland.
(5) Construction damage to land remaining in agricultural use is minimized and repaired to the extent feasible.

B. The Town may issue a conditional use permit for any of the following uses if that use meets applicable provisions under Subsection A and Section 135-251:
(1) Additional second farm residence.
(2) Riding stables and/or equine boarding facilities in accordance with § 91.01(1), Wis. Stats.
(3) Farmstead food processing facilities in accordance with § 91.01(1), Wis. Stats.
(4) Farmstead retail outlets in accordance with § 91.01(1), Wis. Stats.
(5) Farmstead fuel or agrichemical storage facilities in accordance with § 91.01(1), Wis. Stats.
(6) Farmstead manure digester, pelletizing plant or other facility that processes raw agricultural commodities, agricultural by-products or agricultural wastes to produce bulk fuel or other bulk products for use on the farmstead.
(7) A wind turbine or solar energy facility that collects wind or solar energy on the farm and uses or transforms it to provide energy for use only on the farmstead.
(8) A manure digester, biofuel facility, or other facility that produces energy primarily from materials grown or produced on the farm for use only on the farmstead.
(9) A waste storage facility used to store or process animal waste produced solely from livestock kept on the farmstead if the proposed facility meets the standards prescribed in ch. ATCP 51, Wis. Adm. Code.
(10) Agronomic or veterinary services to agriculture operations.
(11) Transportation uses, including rail facilities, and agricultural aeronautic facilities.
(12) Communication uses, including cell towers, antennas and broadcast towers in accordance with Chapter 135, Article XXV.
(13) Man-made bodies of water in accordance with Article XXIV.
(14) Public utility installation on Town property or right-of-way.
(15) Government and nonprofit community conditional uses include:

(a) Fire stations, police stations, post offices, and other government administration buildings.
(b) Schools, colleges, and universities.
(c) Religious institutions, including cemeteries and mausoleums.
(d) Public parks and recreation areas.

(16) Distribution lines, telephone and cable television lines and public utility installations, public streets, street rights-of-way and street improvements to the service area unless otherwise regulated by § 91.44(1)(f), Wis. Stats.

(17) Nonfarm residences that qualify under § 91.46(1)(d), Wis. Stats.

(18) Nonfarm residences constructed in a rural residential cluster in accordance with an approval of the cluster as a conditional use under § 91.46(1)(e), Wis. Stats.

(19) A new or expanded facility that will be used to keep cattle, swine, poultry, sheep or goats, and that will have more than 500 animal units, if the proposed facility meets the standards prescribed in Wis. Stats. 92.16 and 93.90, Ch. ATCP 51, Wis. Adm. Code, and Section 135-85 of the Town of Ledgeview Zoning Code.

§ 135-82 Rezoning land out of Farmland Preservation Zoning District.

A. Except as provided in Subsection B below, the Town may not rezone land out of a Farmland Preservation Zoning District unless the Town finds all of the following in writing, after public hearing, as part of the official record of the rezoning, before granting the rezone:
   (1) The rezoned land is better suited for a use not allowed in the Farmland Preservation Zoning District.
   (2) The rezoning is consistent with any Comprehensive Plan, adopted by the Town, which is in effect at the time of the rezoning.
   (3) The rezoning is substantially consistent with the Brown County Farmland Preservation Plan, certified under Ch. 91, Wis. Stats., which is in effect at the time of the rezoning.
   (4) The rezoning will not substantially impair or limit current or future agricultural use of other protected farmland.

B. Subsection A does not apply to any of the following:
   (1) A rezoning that is affirmatively certified by the Wisconsin Department of Agriculture, Trade and Consumer Protection under Ch. 91, Wis. Stats.

(2) A rezoning that makes the Farmland Preservation Zoning Ordinance Map more consistent with the Brown County Farmland Preservation Plan Map, certified under Ch. 91, Wis. Stats., which is in effect at the time of the rezoning.

§ 135-83 Parcel requirements.

Parcel requirements shall be as follows:

A. Area: minimum 35 aggregate acres controlled by the property owner, family, or trust.
B. Zoning lot frontage: 150 feet minimum.
C. Lot width: 150 feet minimum.

§ 135-84 Height regulations.

Height regulations shall be as follows, except as provided by § 135-13, Height regulations:

A. Farm structures: 40 feet maximum.
B. Farm silos: 90 feet maximum.
C. Residential dwellings: 35 feet maximum.

§ 135-85 Required setbacks.

The following setbacks shall be applied to improvements:

A. Principal structure
    (1) Setback from property lines. The principal structure must be located a minimum of 25 feet from side and rear property lines.
    (2) Setback from public right-of-way. The front setback for a principal structure must be a minimum of 35 feet from the public right-of-way. On a corner lot, the side setback must be a minimum of 50 feet from the public right-of-way.
B. Accessory structures
    (1) Setback from property lines. All accessory structures must be located a minimum of 25 feet from side and rear property lines.
    (2) Setback from public right-of-way. The front setback for all accessory structures must be a minimum of 35 feet from the public right-of-way. On a corner lot, the side setback must be a minimum of 50 feet from the public right-of-way.
C. Livestock housing structures.
    (1) Setback from property lines. Livestock housing structures may not be

located within:

(a) 400 feet of any property line, if the livestock facility will have fewer than 1,000 animal units (<1,000 AU).

(b) 700 feet of any property line if the livestock facility will have 1,000 to 2,500 animal units (1,000 – 2,500 AU).

(c) 1,000 feet of any property line, if the livestock facility will have 2,500 to 4,000 animal units (2,500 – 4,000 AU).

(d) 1,200 feet of any property line, if the livestock facility will have more than 4,000 animal units (>4,000 AU).

D. Manure or animal waste storage facilities

(1) A new or expanded animal waste storage facility or structure may not be located within 1,320 feet of any property line, if the livestock facility will have more than 500 animal units (>500 AU) .The animal waste storage structure setback requirement does not prevent the continued use of an animal waste storage structure that was located within the setback area prior to the effective date of the setback requirement.

E. Contaminated runoff storage facilities

(1) A new or expanded facility, structure, or container designed to store contaminated runoff, including leachate, may not be located within 1,320 feet of any property line, if the livestock facility will have more than 500 animal units (>500 AU).

§ 135-86 Building size.

The minimum size of a residential dwelling shall be 1,200 square feet ground floor area for a one-story dwelling and 875 square feet minimum ground floor area with a total minimum 1,400 square feet for dwellings having more than one story.

§ 135-87 Accessory buildings.

Accessory uses shall conform to district requirements and those set forth in § 135-11, Building and use restrictions.

§ 135-88 Parking.

Parking shall conform to the requirements as set forth in Article XXI, Off-Street Parking Requirements.

§ 135-89 Reporting requirements.

A. The Town shall, by March 1 of each year, provide a report to DATCP of the number of acres that have been rezoned out of the Farmland Preservation Zoning District under § 135-82 during the previous year and a map that clearly shows the location of those acres.

B. The Town shall, by March 1 of each year, submit a copy of the information that it reports to DATCP under Subsection A to Brown County.

§ 135-90 Other requirements.

A. Existing nonconforming residences located in the Agricultural-Farmland Preservation District at the time of passage of this chapter may be continued in residential use and may be exempted from any limitations imposed or authorized under § 59.69(10), Wis. Stats.

B. Other structures or buildings allowed within the AG-FP District shall meet the requirements of the district and remaining articles of this chapter as determined by the Town Building Inspector or designee. Buildings shall be maintained structurally and kept in good repair. Outside appearance shall be maintained in accordance with originally approved appearance and design.

C. The livestock facility siting standards established in Wis. Admin. Code Ch. ATCP 51, including all appendixes, worksheets, and any future amendments to that chapter, are incorporated by reference and adopted. A new or expanded facility that will be used to keep cattle, swine, poultry, sheep or goats, and that will have more than 500 animal units must complete the application form and worksheets prescribed by Ch. ATCP 51, Wis. Admin. Code. A non-refundable application fee of $1,000 must accompany the application.

Article XXIV: Man-Made Bodies of Water

§ 135-221 Purpose.

The following is an article defining the term "man-made body of water"; regulating the design, maintenance and the use thereof; and providing a penalty for the violation thereof.

§ 135-222 Term defined.

A. The term "man-made body of water" as used herein shall mean any excavation or mounding of earth or other material which would create a reservoir or artificial body of water in which water can collect or travel and which is created after the effective date of this chapter.

B. Man-made bodies or artificial bodies of water will be referred to, from here on, as a "pond." This shall not limit the scope of this chapter but shall be for ease of use only. Facilities or structures designed to contain or manage animal waste or manure shall be referred to, from here on, as “animal waste storage facilities.” Facilities or structures designed to contain drainage that has come through or across a feed storage or manure storage area, including leachate, shall be referred to, from here on, as “contaminated runoff storage facilities.”

§ 135-223 Conditional use required.

A. Ponds shall be a conditional use in all zoning districts.

B. New or expanded waste storage facilities shall require a conditional use.

§ 135-224 Exemptions.

Exemptions shall be as follows:

A. Family swimming pools as defined in § 135-16.

B. Stormwater management facilities as regulated by Chapter 90 of the municipal code.

§ 135-225 Approvals and submittals.

A. A permit is required from the Town of Ledgeview for all excavations or mounding which will result in a man-made body of water as defined herein. To obtain such a permit, an application shall be made to the Town of Ledgeview Building Inspector on the proper forms provided by the Town. Applications shall include a site plan scaled to at least one inch equaling 200 feet, with the following:

   (1) A map showing the location of the premises and the adjoining properties within 500 feet.
   (2) Any existing or future buildings, easements, property lines and setbacks.
   (3) Any existing waterways or floodway.
   (4) A scaled section view of the pond with slopes, depths and high and low water levels.
   (5) Outflow design with calculations.
   (6) Fencing.
   (7) Methods of maintaining low water levels.

(8) Proposed truck and machinery access to the site.
(9) Approximate amount of earth material to be excavated or removed at the site.
(10) Proposed regrading and revegetation of the site after completion of the excavating.
(11) Designated hours of operation.
(12) Contour intervals of the proposed site at intervals of 20 feet, when available.

B. If the excavation site shall fall within a county floodplain, shoreland or conservancy zone district, the regulations as set forth in the Shoreland-Floodplain Protection Ordinances for Brown County shall apply. Brown County and Department of Natural Resource permits must accompany the application, if required.

C. Applications shall be approved or denied within 60 days from the date all information is received in order. No application shall be processed or approved without adequate information.

§ 135-226 Design standards.

A. Ponds

(1) All ponds shall be designed within the scope of this chapter. Where no minimum water level is to be maintained, the slope of the pond bottom may not exceed 3 to 1. In all cases where a portion of the pond will have a slope of greater than 3 to 1, a slope of no greater than 3 to 1 shall be maintained around the entire perimeter of said pond to a minimum water depth of 48 inches before the greater slope may occur.

(2) All ponds shall have an outflow to maintain the maximum normal water level; the size of this outflow shall be determined by design and shall be capable of removing one inch of water from the surface of the entire pond every 12 hours. The minimum size of outflow pipe shall not be less than eight inches in diameter. Calculations shall be provided with the permit application. Outflows shall not flow directly onto adjacent parcels of property. Outflow discharge may cross adjacent parcels through a natural existing waterway only, but in no case shall this discharge create a waterway or a nuisance. A safety buffer area with a slope of 3 to 1 or less shall be established and maintained from the normal high-water level; this area shall be no less than three feet measured from the water's edge.

(3) All ponds which shall have minimum water levels established as a result of slope angles greater than 3 to 1 shall seal the bottom and sides to prevent excess seepage. This seal shall be provided in one or more of the

following ways:

(a) Existing clay soils.

(b) Clay blanket.

(c) Compaction.

(d) Waterproof liners.

(4) The minimum side and rear setback shall be 25 feet; front setbacks and corner side setbacks shall be 50 feet.

B. Animal waste storage facilities

(1) All animal waste storage facilities shall be designed in accordance with Wis. Stats. 92.16 and 93.90, and ATCP 51.18, Wis. Adm. Code.

(2) The required setbacks for animal waste storage facilities shall comply with the regulations outlined in Article X AG-FP Farmland Preservation District.

C. Contaminated runoff storage facilities

(1) Facilities designed or intended to store contaminated runoff, including leachate, shall be designed in accordance with Wis. Stats. 92.16 and 93.90, and ATCP 51.20, Wis. Adm. Code.

(2) The required setbacks for contaminated runoff storage facilities shall comply with the regulations outlined in Article X AG-FP Farmland Preservation District.

§ 135-227 Other requirements.

A. The Town of Ledgeview Zoning and Planning Committee may, at its discretion, require fencing. Where such fencing is required, the following criteria shall be used:

(1) A structural fence no less than four feet in height and no less than four feet from the water's edge at the high-water line shall be provided. It shall be constructed as not to have openings, holes or gaps larger than four inches in any dimension except for doors or gates. If a picket fence is erected or maintained, the horizontal dimension shall not exceed four inches. All gates or doors 48 inches or less in width opening through such enclosure shall be equipped with a self-closing and self-latching device for keeping the gate or door securely closed at all times when not in actual use. All gates or doors over 48 inches in width opening through such enclosure shall be kept securely latched at all times when unsupervised.

B. The groundwater table in the surrounding area and adjacent to the pond or animal waste storage facilities shall be protected.

C. Town and state permits shall be required if high-capacity wells are drilled on the site. Location of all wells shall be provided on the site plans; well logs shall be provided to the Town after completion of the well.
D. The Division of Environmental Health requirements shall be met to ensure proper safety of swimmers.
E. Temporary fencing shall be provided as soon as slopes of greater than 3 to 1 are developed during construction and shall be maintained until minimum water level is obtained.
F. No screening, sifting, washing, crushing or other forms of processing shall be conducted upon the premises unless it is located more than 500 feet from a residential dwelling.
G. At all stages of operations, proper drainage shall be provided to prevent the collection and stagnation of water and to prevent harmful effects upon surrounding properties.
H. The premises shall be excavated and graded in conformity with the plan as approved. Any deviation from the plan shall be cause for the Town to revoke the permit.
I. Trucks and machinery. No fixed machinery shall be erected or maintained within 200 feet of any property or street line. Truck access to the excavation shall be so arranged as to minimize danger to traffic and nuisance to surrounding property.
J. The perimeter of the pond/lake/body of water shall be landscaped and seeded with a perennial ground cover within three months after completion of the excavation.
K. The Town of Ledgeview retains the right to require any other and/or future restrictions as deemed necessary to protect the health, safety and welfare of the community.

§ 135-228 Inspections.

A. The owner/agent shall call for the following required inspections 24 hours in advance. Other periodic inspections shall be granted to the Town of Ledgeview Building Inspector, Town Board and Zoning and Planning Committee during normal working hours.
B. A site inspection shall be made prior to any excavation. Property lines adjacent to the excavation, proposed excavation boundaries and outflow termination point shall be marked clearly for site approval.
C. An excavation inspection shall be made after all slopes are established.

D. Final inspection shall be made when all fencing is in place and the pond has reached its minimum water level.

§ 135-229 Maintenance.

The owner of any land on which a man-made body of water shall exist is required to maintain that land and body of water within the limits of this chapter.

§ 135-230 Permit fees.

Permit fees shall be established and charged as per the fee schedule.

§ 135-231 Construction deposit.

A construction deposit shall be required.

§ 135-232 Performance bond required; exception.

A. A performance bond shall be required. The following schedule shall be used:

Surface Area	Amount
0 to 1,000 square feet	$500
1,001 to 2,500 square feet	$1,000
2,501 square feet to one acre	$5,000
One acre and up	$5,000/acre or fraction thereof

§ 135-233 Violations and penalties.

A. Any person, firm, company or corporation who violates, disobeys, omits, neglects or refuses to comply with or who resists the enforcement of any of the provisions of this article shall, upon conviction thereof, forfeit an amount as determined by the Town Board in Chapter 1, General Provisions, Article II, Fees and Penalties, together with the costs of the prosecution; and in default of payment of such forfeiture and costs, shall be imprisoned in the county jail of Brown County, Wisconsin, for a period of not more than 30 days for each violation or until such forfeiture and costs of prosecution have been paid. Each day that a violation is permitted to exist shall constitute a separate offense and may be punishable as such.

B. This section shall not preclude the Town of Ledgeview from maintaining any appropriate action to prevent or remove a violation of this article.

Section 2: Repeal of inconsistent ordinances. All existing town ordinances, parts of ordinances, and amendments thereto in conflict with any of the provisions of this ordinance are hereby repealed.

Section 3: Severability. If any section, clause, provision or portion of this ordinance is adjudged unconstitutional or invalid by a court of competent jurisdiction, the remaining provision shall not be affected hereby.

Section 4: Effective date. This ordinance shall take effect upon passage, postage, and publication.

Approved: 21 November, 2017.

Philip J. Danen, Town Chairman

ATTEST:

I, Sarah K. Burdette, Clerk/Administrator of the Town of Ledgeview, Brown County, hereby certifies that the above is a true copy of an Ordinance adopted by the Town Board of the Town of Ledgeview on November 21, 2017.

Sarah K. Burdette, Town Clerk/Administrator

Posted: November 22, 2017

Published: November 24, 2017

AFFIDAVIT OF POSTING

STATE OF WISCONSIN)
BROWN COUNTY)
TOWN OF LEDGEVIEW)

I, Sarah K. Burdette, Clerk/Administrator of the Town of Ledgeview, do hereby certify that the attached Ordinance 2017-13 An Ordinance to Amend Chapter 135 Zoning, Article III-Definitions and Word Usuage, Article IV-General Provisions, Article X-AG FP-Farmland Preservation, and Article XXIV-Man Made Bodies of Water is the original required by law to be in my custody. This ordinance was adopted by the Ledgeview Town Board at a legally posted open meeting held November 21, 2017.

In compliance with §60.80, a true and correct summary of this ordinance was posted at the town's three designated posting locations in the Town of Ledgeview on the 22nd day of November, 2017.

1. Town of Ledgeview Municipal Hall, 3700 Dickinson Road, De Pere, WI 54115
2. Larry's Piggly Wiggly, 575 Swan Road, De Pere, WI 54115
3. I-43 Shell, 3285 Cedar Hedge Lane, Green Bay, WI 54311
4. www.ledgeviewwisconsin.com

Set by my hand and official seal this 22nd day of November, 2017

Sarah K Burdette
Sarah K. Burdette, Clerk/Administrator

Subscribed and sworn to before me this

22nd day of November, 2017

Charlotte K. Nelson
Notary Public
My commission expires 10-18-19

Ledgeview
Set your sights high

NOTICE OF ORDINANCE & RESOLUTION ADOPTION
TOWN OF LEDGEVIEW
BROWN COUNTY, WISCONSIN

Notice is hereby given that the Ledgeview Town Board enacted the following ordinance on November 21, 2017:

- Ordinance No. 2017-13 – An Ordinance Amending Chapter 135 Zoning, Article III-Definitions and Word Usage, Article IV-General Provisions, Article X-AG FP-Farmland Preservation, and Article XXIV-Man Made Bodies of Water. The ordinance amendment addresses recommendations by the Department of Agriculture, Trade, and Consumer Protection in reference to ordinance amendment 2017-08 which refers to building and use restrictions, incorporates livestock facilities siting law requirements, and addresses animal waste storage facilities as a conditional use.

Notice is further given that the Ledgeview Town Board adopted the following resolution on November 21, 2017:

- Resolution No. 2017-11 Adopting the 2018 Annual Budget and Establishing the Property Tax Levy for the Town of Ledgeview. The necessary 2017 property tax levy is $2,469,018 to be paid in 2018.

The full text of the above stated ordinance and resolution may be obtained at the town clerk's office, located in the Ledgeview Municipal Building, 3700 Dickinson Road, De Pere, WI 54115 or via the town's website at www.ledgeviewwisconsin.com. For additional information contact the town clerk's office at 920-336-3360 ext. 104.

Charlotte K. Nelson
Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview, Brown County, WI

Posted: November 22, 2017
Published: November 24, 2017

Charlotte Nelson

From: GRSC-West-Legals mbx <GRSC-West-Legals@gannett.com>
Sent: Wednesday, November 22, 2017 11:23 AM
o: Charlotte Nelson
Subject: RE: 2558907 Ledgeview - Ordinance & Resolution Adoption Notice

Hello,

Please find attached your order confirmation and proof of the ad.

Your ad is set to run in:

The Press Gazette on November 24th.

The total cost is $47.38 which includes an affidavit which will be mailed to you after the ad publishes.

NOTICE OF ORDINANCE & RESOLUTION ADOPTION
TOWN OF LEDGEVIEW
BROWN COUNTY, WISCONSIN

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Charlotte K. Nelson
Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview, Brown County, WI
Posted: November 22, 2017
RUN: November 24, 2017 WNAXLP

Thank you,
Jenny Tyczkowski
Administrative Support Specialist

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Proud Partner of the Green Bay Packers

P: 877-943-0444
www.gannettwisconsinmedia.com

From: Charlotte Nelson [mailto:cnelson@ledgeviewwisconsin.com]
Sent: Wednesday, November 22, 2017 10:21 AM
To: GPG-legals mbx <legals@greenbaypressgazette.com>
Subject: 2558907 Ledgeview - Ordinance & Resolution Adoption Notice

Greetings,

Attached is a Notice of Ordinance & Resolution Adoption for 2017-13 & 2017-11 for publication in the November 23, 2017 edition of the Green Bay Press Gazette. Please confirm publication date.

Happy Thanksgiving!

Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview

Ledgeview
Set your sights high

3700 Dickinson Road
De Pere, WI 54115
Telephone: (920) 336-3360, Ext. 104
Fax: (920) 336-8517
cnelson@ledgeviewwisconsin.com
Population: 7,431

Proud Member of the WMCA
Wisconsin Municipal Clerks Association

This message originates from the Town of Ledgeview. It contains information that may be confidential or privileged and is intended only for the individual named above. It is prohibited for anyone to disclose, copy, distribute or use the contents of this message without permission, except as allowed by the Wisconsin Public Records Laws. If this message is sent to a quorum of a governmental body, my intent is the same as though it were sent by regular mail and further distribution is prohibited. All personal messages express views soley of the sender, which are not attributed to the municipality I represent, and may not be copied or distributed without this disclaimer. If you receive this message in error, please notify me immediately.

PRESS-GAZETTE media
A GANNETT COMPANY

STATE OF WISCONSIN
BROWN COUNTY

TOWN OF LEDGEVIEW , LEGALS

3700 DICKINSON RD
DE PERE WI 541158797

NOTICE OF ORDINANCE & RESOLUTION ADOPTION
TOWN OF LEDGEVIEW
BROWN COUNTY, WISCONSIN

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Charlotte K. Nelson
Charlotte K. Nelson, Deputy Clerk
Town of Ledgeview, Brown County, WI
Posted: November 22, 2017
RUN: November 24, 2017 WNAXLP

Being duly sworn, doth depose and say that she/he is an authorized representative of the Green Bay Press Gazette, a newspaper Green Bay, Wisconsin, and that an advertisement of which the annexed is a true copy, taken from said paper, which was published therein on

Account Number:	GWM-281504
Order Number:	0002558907
No. of Affidavits:	1
Total Ad Cost:	$47.38
Published Dates:	11/24/17

(Signed) Vonderin K Stephens **(Date)** 11/24/2017
Legal Clerk

Signed and sworn before me M Rome

MELISSA ROME
NOTARY
PUBLIC
STATE OF WISCONSIN

My commission expires 1-12-2021

TOWN OF LEDGEVIEW , LEGALS
Re: Ord. No. 2017-13 and Res. 2017-11

State of Wisconsin
Governor Scott Walker

Department of Agriculture, Trade and Consumer Protection
Ben Brancel, Secretary

DATE: July 7, 2017

TO: Board of Agriculture, Trade and Consumer Protection

FROM: Ben Brancel, Secretary
John Petty, Administrator, Agricultural Resource Management Division

SUBJECT: **Wisconsin Livestock Facility Siting, modifies Wis. Admin. Code Ch. ATCP 51 (Hearing Draft Rule)**

PRESENTED BY: Agricultural Resource Management Division

REQUESTED ACTION:

At the July 20, 2017 meeting of the Board of Agriculture, Trade and Consumer Protection ("Board"), the Department of Agriculture, Trade and Consumer Protection ("Department") will ask the Board to authorize public hearings on a proposed rule revising ch. ATCP 51, related to livestock facility siting.

SUMMARY

Background

First adopted in May of 2006, Wis. Admin. Code ch. ATCP 51 ("ATCP 51") established the statewide framework of standards and procedures required to implement Wisconsin's livestock facility siting law, Wis. Stat. § 93.90. The requirements only apply to livestock operators located in jurisdictions that have adopted ordinances requiring permits for new or expanding livestock facilities that exceed a certain size (commonly 500 animal units).

The Department of Agriculture, Trade and Consumer Protection ("Department") is required to review Wis. Admin. Code Ch. ATCP 51 every four years in accordance with Wis. Stat. § 93.90(2)(c). To this end, the Department convened a Technical Expert Committee that provided recommendations regarding changes to ATCP 51.

The proposed rule is intended to ensure consistency among related rules (Wis. Admin. Code chs. NR 151 and ATCP 50, respectively referred to as "NR 151" and "ATCP 50"), which were revised to implement a new nutrient management technical standard and additional farm runoff standards designed to better control discharges of process wastewater, and meet phosphorus index targets for nutrient management. The ATCP 51 revision also addresses issues arising out of the mandatory four year review of this rule. The proposed revision retains the essential regulatory framework, including the core water quality standards. Improvements in standards are intended to advance the statutory goal of "providing uniform regulation of livestock facilities" and better balance the factors listed in Wis. Stat. § 93.90(2)(b), which the Department must use to establish state standards.

Rule Content

General Background

This rule:

- Updates the water quality standards, including related Natural Resources Conservation Service ("NRCS") technical standards, to ensure consistency with provisions in NR 151 and ATCP 50, including incorporation of the 2015 NRCS standard for nutrient management, and the 2016 NRCS standards for waste treatment and vegetated treatment areas.
- Modifies standards (subch. II of ATCP 51) consistent with the requirements in Wis. Stat. § 93.90(2), based on the technical recommendations of the 2014 Technical Expert Committee and stakeholder input. Key changes include modifications to setback and odor standards.
- Modifies the procedures (subchs. I and III of ATCP 51) that local governments must follow in issuing a siting permit under a zoning or licensing ordinance including those used to determine completeness of siting applications, modifications to siting permits, the use of checklists to monitor facility compliance, and the fees local governments charge for permit modifications.
- Modifies local permit application forms and worksheets to reflect changes in requirements and to ensure that they are clear, complete, and elicit information that documents compliance with applicable siting standards.
- Makes other changes, clarifications, and updates as necessary to improve implementation of the siting rule, consistent with the requirements in Wis. Stat. § 93.90(2).

Contents of this Rule

The following provides a more detailed analysis by topic.

Livestock Facilities, Structures, and other Definitions

This rule clarifies that a livestock facility includes the livestock, livestock structures, and parcels on land upon which livestock facility is located, except for pastures and winter grazing areas. It excludes a concentration of 50 or fewer calf hutches from the definition of an animal lot. Concentrations of more than 50 hutches must meet setback and runoff management standards. Storage structures designed exclusively for process wastewater are excluded from the design and setback requirements that apply to manure storage structures.

This rule eliminates definitions related to the prior odor standard, including affected neighbor and high use building.

The definition of related facilities is expanded to cover process wastewater storage and transfer using or sharing the same structures, or same field, for land application.

To achieve consistency with the nonpoint rules (ATCP 50 and NR 151), this rule adds or adjusts definitions of key terms such as manure, pasture, process wastewater, significant discharge, and waste transfer system.

Ordinances and Permits Filed with the Department

This rule will require local governments to electronically submit new or revised ordinances or permits to the Department whenever it incorporates standards from this rule in a local ordinance, enacts more stringent local ordinance standards, or takes official action on a permit application.

Duration of Local Approval

A livestock operator must begin constructing all new or expanded livestock housing or waste storage structures within 2 years after the local approval is granted, except where the construction of a proposed structure is required to control a discharge, in which the construction must be completed within 6 months of a permit approval.

Application for Local Approval

To obtain local approval, an operator must complete the *application form* and *worksheets* that are made part of this rule. The application materials have been modified to incorporate the changes described in this rule summary.

Key changes to the application materials include:

- On the site map, the applicant must assign unique identifiers to show all existing and proposed livestock structures, and use these unique identifiers when referencing livestock structures in the application worksheets.
- Odor Management Plans will be retooled and the application will contain new criteria for developing acceptable plans.
- The applicant's acknowledgement of other laws will be removed from the application.
- Odor management standard (worksheet 2) will be modified to reflect the new system for managing odor.
- Waste and nutrient management (worksheet 3) will change to reflect the method for estimating the amount of manure generated from a facility to better correspond with nutrient management planning, will add cropland performance standards, and eliminate the nutrient management planning exemption for operations under 500 Animal Units ("AUs").
- Waste storage facilities (worksheet 4) will change requirements regarding closure of manure storage structures.
- Runoff management (worksheet 5) will be revised to reflect changes in managing runoff related to animal lots, feed storage, and milking center wastewater.

State Standards

This rule clarifies that a local government may not grant a variance to exempt a livestock facility from complying with the state standards, except that it may reduce setback requirements.

Property Line and Road Setbacks

This rule retains property line and road setback requirements for livestock structures, except manure storage and certain types of housing.

This rule:

- Establishes minimum property line setbacks for manure storage structures based on the size of the livestock facility.
- Establishes minimum property line setbacks for certain types of livestock housing based on the size of the livestock facility.

If a livestock facility is organized in one or more clusters (a grouping of livestock structures separated from another grouping by a 1,000 or more feet), the livestock facility may follow the setback requirements based on the AUs in each cluster. This option is not available if manure is comingled among clusters.

This rule retains provisions that allow expansion of manure storage and housing structures within setback areas, as long as the expansion is away from the property line or public road right-of-way to which the local setback applies. In addition, as noted below, this rule allows operators to reduce setbacks for new and expanding manure storage and certain types of housing structures through the installation and maintenance of odor control practices.

Odor Management; Livestock Structures

This rule provides for the phase out of the odor standard, originally adopted in 2006. In its place, this rule adopts a system of setbacks for high odor sources (manure storage and certain types of housing). Under the new system, operators will not be required to address odor from low odor sources such as animal lots. With its emphasis on setbacks, the new system is similar to odor management approaches implemented in surrounding states and continues to use odor control practices originally developed for the 2006 odor standard.

For livestock operations issued a permit prior to the effective date of this rule revision, they must continue to meet the requirements of the odor standard in their permits. They are released from these requirements if they are granted a new local approval. However, they need to develop an odor management plan if they have manure storage located within 600 feet of the facility's property line or livestock housing located within 400 feet of the facility's property line. Livestock facilities seeking local approval for the first time after adoption of this rule revision will not need to complete an odor management plan for existing manure storage and livestock housing, unless these structures are located within the separation distances discussed above.

For new and expanding manure storage structures and certain types of livestock housing, the new odor standard provides operators credit for odor control practices in the form of a reductions to setback requirements. Livestock operators may use these reductions to allow construction within the new setback areas. Worksheet 2 has been modified to enable operators to document odor control practices and calculate the reduced setbacks based on installation and maintenance of these practices. Worksheet 2 includes revised specifications for the odor control practices that the operator must meet to claim a credit.

Waste and Nutrient Management

To achieve maximum consistency with nonpoint rules, this rule will require operators to have and follow a nutrient management plan that complies with ATCP 50. The 2015 NRCS 590 Standard is now the basis for nutrient management plans. In addition, this rule adds requirements that livestock operators comply with NR 151 cropland performance standards related to soil erosion, a tillage setback, and the phosphorus index.

Regarding nutrient management plans, this rule clarifies that a plan must account for all land applications of manure and related waste generated by the maximum number of animal units authorized by a permit or other local approval. For the purposes of determining waste generation, this rule and related Worksheet 3 now use the Wisconsin Conservation Planning Technical Note WI-1 (February, 2016) to estimate quantities of manure.

Worksheet 3 will require that operators attach map(s) showing the land where waste will be applied and any restrictions limiting the application of waste to that land. Additional documentation may be required by the local government to verify that rental land is available.

A new nutrient management checklist is incorporated into the rule to document compliance with the 2015 NRCS 590 Standard.

This rule eliminates the option for livestock facilities under 500 AUs to avoid a nutrient management plan if the operation has an adequate land base.

This rule clarifies that local governments may require all operators with siting permits (including livestock facilities with over 1,000 AUs known as Concentrated Animal Feeding Operations "CAFOs") to submit documentation related to annual nutrient management updates, and monitor an operator's compliance with a nutrient management plan. Under Wis. Admin. Code § ATCP 50.04(3)(gm), a nutrient management plan must be reviewed annually to determine whether the plan accurately reflects the planned cropping, tolerable soil loss, nutrient application rates, and application methods. The plan shall be updated by a nutrient management planner when necessary to reflect changes to planned activities.

Waste Storage Facilities

This rule clarifies that new or expanded waste storage structures designed solely for storage of process wastewater must meet NRCS technical guide manure storage facility standard 313 or ch. NR 213, whichever applies.

Changes to the waste storage facility Worksheet 4 require the operator to identify all existing, modified, and new storage facilities by a unique identifier.

For existing storage facilities, which can only be used if properly certified, this rule provides more flexibility for certification by creating a document-only option (e.g. manure storage ordinance certification) for a facility constructed within the last 3 years according to then-existing NRCS standards, as well as visual inspections for any facility constructed within the last 10 years according to then-existing NRCS standards. However, more extensive inspection and documentation requirements apply to older storage facilities including the need to empty the facility before inspection. If there is no reliable documentation, a full inspection including test pits may be required.

New or substantially altered waste storage structures and transfers systems must be designed and constructed according to these:

- NRCS technical guide manure storage facility standard 313 (January 2014).
- NRCS technical guide manure transfer standard 634 (January 2014).

This rule will require that an operator close an existing waste storage facility that cannot be certified as safe to use.

This rule clarifies the options for a local government to monitor compliance including verification that a new or modified waste storage facility is constructed according to specifications. In addition to inspections, the local government may require applicants to submit documentation verifying that new and substantially altered facilities are constructed according to technical standards.

Runoff Management

Every new or substantially altered animal lot must be designed and constructed according to NRCS technical guide vegetated treatment area standard 635 (January, 2016). This standard may require operators to install roofing or route runoff to storage in place of using a vegetated treatment area.

Existing animal lots may still use the *BARNY* runoff model to predict annual phosphorus runoff from the animal lot. A lot may still qualify as existing with minor alterations, which are now more clearly defined in this rule. Under this rule, operations must meet the more demanding annual discharge standard of less than 5 lbs. of phosphorus, if the animal lot is located within:

- 1500 feet from navigable lakes, ponds and flowages
- 450 feet from wetlands and navigable streams and rivers
- 750 feet from conduits to groundwater
- 450 feet from surface inlets that discharge to navigable waters,
- 225 feet from channelized flow (i.e., a drainage area of $\geq$ 5 acres)
- 225 feet from subsurface drains

Structures located outside the boundaries indicated above may meet the runoff standard by documenting a discharge of less than 15 lbs. of phosphorus annually.

This rule clarifies the prohibition against direct runoff from animal lots to any direct conduit to groundwater (such as a sinkhole) and now includes runoff to surface waters of the state.

While this rule holds livestock operations to a standard of no significant discharge, it does make changes in runoff standards for animal lots, as well as feed storage areas, to account for the U.S. Environmental Protection Agency's "no discharge" standard for animal feeding operations, and changes in the NRCS technical standards designed to implement the federal "no discharge" standard.

This rule substantially changes requirements for feed storage facilities. Existing buildings, bunkers, or paved areas used to store feed must be evaluated to determine whether they meet technical standards, are in good repair, and do not have signs of a significant discharge. New operating requirements for existing feed storage include the diversion of clean water and collection and storage of leachate and initial runoff.

Every new or substantially altered feed storage structure, including any unroofed building, bunker, or paved area used for feed storage or handling, now must be designed, constructed, and maintained in accordance with NRCS technical guide waste treatment standard 629 (January, 2017), with the leachate and contaminated runoff from such storage structures being collected and stored for future land application, or treated in accordance with NRCS technical guide vegetated treatment area standard 635 (September, 2016). The use of simple vegetated treatment areas to manage runoff is a less viable option for operations over 500 AUs.

If a new or expanded feed storage structure is less than one acre and not located in or near a sensitive area, the new or altered portions of feed storage structure must meet design requirements for the floor of the structure, but may manage runoff in any manner that avoids a significant discharge. This is a low-cost option that is intended to hold down costs for non-CAFOs that build new or expanded feed storage structures.

To ensure consistency with the prohibition against significant discharges in the nonpoint rules (see Wis. Admin Code § NR 151.055), this proposed rule reflects current standards and practices for managing milkhouse wastewater. Storing waste is required except for small operations that generate less than 500 gallons of milking center wastewater daily.

Existing clean water diversion requirements have been expanded to require diversion if structures are located within 300 feet of wetlands and 500 feet from any conduit to groundwater.

CAFO Permit Substitutions

This proposed rule more clearly defines how CAFOs can demonstrate compliance with siting standards based on a Wisconsin Pollutant Discharge Elimination System ("WPDES") permit. Because the Department of Natural Resources ("DNR") does not issue CAFO permits with a maximum number of animal units, this rule eliminates the requirement that CAFOs provide

WPDES permits documenting the same number of animal units as sought for local approval under the siting rule. This rule still allows CAFOs to demonstrate compliance with the nutrient management requirements based on a WPDES permit, but imposes more specific requirements to submit a nutrient management checklist that was previously submitted to DNR as long as the nutrient management plan covers the same or greater number of animal units than the number for which the operator seeks local approval. CAFOs also must demonstrate compliance with the siting standards related to manure storage and runoff management by submitting plans and specifications approved by DNR for relevant livestock structures. Also, the applicant must certify that the livestock facility has met all WPDES permit conditions, and does not have any WPDES permit violations.

Permit Modifications

This rule establishes a clear framework to allow permit modifications for expanding livestock facilities previously granted local approval. This rule specifically:

- Limits the fee to $500 or less.
- Sets criteria to qualify for a permit modification (e.g. operation does not exceed 30 percent, cumulatively, of the maximum number of animal units authorized in the most recent full application approved by the local government).
- Requires compliance with all standards contained in each worksheet except for Worksheet 5 where a livestock operator may complete only those parts of the worksheet that apply to the changes being planned for proposed livestock operation.
- Establishes a procedure for processing modifications that simplifies the steps (e.g. no written decision with findings) and reduces the waiting time to no more 45 days.

Complete Application

In making a completeness determination regarding an application for local approval, a local government will be required to use a Department-approved form to document specific items that are missing from the application. Items on the checklist not identified by the local government are deemed complete, and an applicant is only required to submit additional materials identified by the local government on the checklist to receive a completeness determination.

Terms of Approval

After a local government receives an application, the local government shall notify the applicant that prior to a final decision on the application construction activities at the livestock facility shall be limited to grading.

Upon approval of an application, a local government may only impose conditions related to an operator's compliance with the standards authorized in subch. II of ATCP 51. Any conditions attached to a local approval must be described in the final written decision granting the approval.

Compliance Monitoring

This rule clarifies the options for a local government to monitor compliance, including verification that a new or modified waste storage facility is constructed according to specifications. In addition to inspections, the local government may require submission of a construction plan, drawings reflecting design changes made during construction, and documentation certifying that the facility was installed in accordance with technical standards.

Standards Incorporated by Reference

Pursuant to Wis. Stat. § 227.21, the Department intends to request permission from the Attorney General to incorporate the following standards by reference in this rule, without reproducing the complete standards in this rule:

- NRCS technical guide manure storage facility standard 313 (January, 2014).
- NRCS technical guide composting facility standard 317 (January, 2017).
- NRCS technical guide waste facility closure standard 360 (March, 2013).
- NRCS technical guide anaerobic digester standard 366 (August, 2011).
- NRCS technical guide roofs and covers standard 367 (April, 2016).
- NRCS technical guide windbreak/shelterbelt establishment standard 380 (October, 2016).
- NRCS technical guide nutrient management standard 590 (December, 2015).
- NRCS technical guide feed management standard 592 (July, 2016).
- NRCS technical guide waste treatment standard 629 (January, 2017).
- NRCS technical guide waste separation facility standard 632 (April, 2014).
- NRCS technical guide waste transfer standard 634 (January, 2014).
- NRCS technical guide vegetated treatment area standard 635 (September, 2016).
- NRCS Wisconsin Conservation Planning Technical Note WI-1, "Nutrient Management" (February, 2016).

Copies of these standards may be obtained from NRCS, and will be on file with the Department and Legislative Reference Bureau. Copies are not reproduced in this rule.

Economic Impact

The rule will primarily impact new or expanding livestock operations that must receive local approvals ("permits") under siting ordinances currently administered by 120 local governments (mostly towns). Based on the issuance of 150 permits during the first 11 years of ATCP 51 implementation, the Department anticipates that 150 livestock facilities, many of which qualify as "small businesses," will need first-time permits or permit renewals over the next 10 years. Among this group, the most significantly impacted will be approximately 55 operations that average 800 animal units in size, but are too small to be regulated as Concentrated Animal Feeding Operations ("CAFOs") under DNR WPDES permits.

This rule will have no more than a moderate impact on farmers, including "small businesses." To a limited extent, increased costs for non-CAFOs will be offset by the benefits from changes to the proposed rule, including permit modifications and protections against unfair use of completeness determinations. The rule will have a slight but positive impact on businesses that work with livestock operations, including nutrient management planners, farm supply and service businesses, soil testing laboratories, agricultural engineers, and contractors installing farm conservation practices.

Environmental Impact

The environmental effects of this rule are positive but small in scope given the limited number of livestock operations affected. This rule retains the features of original version of ATCP 51, including a local option to adopt more stringent standards to address local conditions. In addition, it includes new and modified standards, including the most current technical standards developed by NRCS, designed to better protect water quality and prevent soil loss. These updates, along with other changes, will:

- Implement stronger protections for surface and groundwater when applying manure, as required by the 2015 version of the NRCS 590 nutrient management standard ("NRCS 590 standard").
- Incorporate cropland performance standards related to the phosphorous index and the tillage setback incorporated into NR 151 and ATCP 50.
- Require more effective evaluations of storage facilities to allow continued use.
- Require closure of manure storage facilities that cannot be safely operated incorporated into NR 151 and ATCP 50.
- More effectively control process wastewater discharges from feed storage structures consistent with the latest NRCS technical standards.
- More effectively control runoff from animal lots consistent with the latest NRCS technical standards.

The change in odor standard will simplify the management of odor without a measurable change in the level of odor protection. It will continue to support the use of odor control practices by farms. Odor management plans will offer a new feature to address verified complaints about odor problems. It is likely that increases in setbacks may reduce some nuisance impacts related to light, noise, and dust from certain livestock structures.

Federal and Surrounding State Programs

Federal Programs

Nearly half of livestock operations affected by this rule are also subject to regulation under the federal Clean Water Act. Under delegated authority from EPA, the DNR adopted Wis. Admin. Code ch. NR 243 ("NR 243"), to regulate water pollution discharges from livestock facilities. Under NR 243, CAFOs must obtain a DNR WPDES permit. CAFOs must meet standards designed to ensure that the proposed livestock facility will not pollute surface water or groundwater, and may use approvals from DNR to show compliance with Department standards for the issuance of local siting permits, including standards for nutrient management, waste storage facilities, and runoff management (the standards parallel WPDES permit standards, and have a similar purpose, although WPDES standards are stricter in some respects). To qualify for a siting permit, a WPDES permit holder must also demonstrate compliance with Department standards for location of livestock structures on property and odor management, which are not covered by a WPDES permit.

NRCS, a branch of the United States Department of Agriculture ("USDA"), develops technical standards for the design and installation of conservation practices, including the NRCS 590 standard for nutrient management. Modified for use in Wisconsin, these technical standards are the foundation for NRCS programs such as the Environmental Quality Incentives Program ("EQIP") and the Conservation Stewardship Program ("CSP"). To promote consistency, state and local governments have incorporated the same technical standards into cost-share, regulatory and other programs. Not only are these technical standards part of ATCP 51, they are critical to the nonpoint rules (ATCP 50 and NR 151) and DNR's WPDES permitting program for CAFOs.

In addition to EQIP and CSP, USDA operates the following programs that may provide incentive payments to help livestock producers implement conservation practices, including practices that may help livestock producers meet livestock facility siting standards under this rule:

- Conservation Reserve Program (CRP).
- Conservation Reserve Enhancement Program (CREP).
- Agricultural Conservation Easement Program (ACEP).

Federal law establishes reporting and other requirements for livestock facilities related to air emissions. For example, large operations must report certain types of releases to local and state agencies, as directed by the Emergency Planning and Community Right-to-Know Act. EPA also has authority to respond to citizen complaints or requests for assistance from state or local government agencies to investigate releases of hazardous substances from farms. Federal law does not directly cover odor management on livestock facilities.

Surrounding State Programs

Like Wisconsin, the four surrounding states each have state requirements for new and expanding livestock operations related to facility construction, runoff control, and manure management. Except for Minnesota, these states have enacted laws that pre-empt or standardize local regulation of livestock facilities with the goal of providing a more uniform and predictable regulatory environment for farm businesses.

<u>Illinois</u>
In 1996, Illinois enacted a Livestock Management Facilities Act ("LMFA") to create a state framework for regulation of livestock facilities. LMFA, which was updated in 1998, 1999, and 2007, was expressly adopted to provide a framework for the livestock industry to expand while establishing environmental and other safeguards. While Illinois law precludes counties from regulating agricultural uses such as livestock facilities, it allows a county to request a public informational meeting about a proposed livestock facility and submit advisory, non-binding recommendations related to the facility's compatibility with surrounding land uses, odor control, traffic patterns, and other factors. Depending on their size and other factors, livestock facilities may be subject to state requirements for waste storage design, setback distances, odor control for

certain structures, certification of livestock managers, waste management plans, and reporting of released wastes. Required setback distances for new facilities are scaled by size, starting at 1,320 feet for facilities under 1000 AUs.

Iowa

In 2002, Iowa enacted legislation requiring that proposed confined feeding operations meet state standards related to building setbacks, manure storage construction, manure management plans, and air quality (air quality standards are still being developed). In place of local permitting of livestock facilities, Iowa counties have the option of requiring that producers achieve a passing score on the state-approved "Master Matrix," an assessment tool that identifies practices designed to minimize to air, water, and community impacts. State standards for new and expanding facilities include different construction requirements for formed and unformed waste storage structures, and requirements involving manure application related to annual plan updates and phosphorus management. The size of the operation, and type of construction (new or expansion) determine applicable standards such as setbacks, which range from 750 to 3,000 feet.

Michigan

In 1999, the Michigan provided "right to farm" protections for farmers who meet "generally accepted agricultural management practices" ("GAAMPS"). The Right to Farm Act ("RFTA") prevents local governments from adopting ordinances that prohibit farming protected under state law, and protects farmers who comply with GAAMPS against nuisance actions. While other GAAMPs may apply to livestock operations, new and expanding livestock facilities must follow GAAMPs for site selection and odor control, and develop plans that comply with these standards. Most farms need to receive state verification of GAAMP compliance to maintain RFTA protections and avoid other state actions. Site planning includes meeting setback requirements and evaluation of odor management practices. Setbacks can range from 125 to 1,500 feet, depending on the facility size, type of construction (e.g. new or expansion) and type of neighbors, and may be reduced if odor management practices are employed. Odor management plans also may be required. Operations must have a plan to properly manage and utilize manure, and design storage facilities according to technical standards. Producers must also prepare emergency action and other plans. Michigan maintains a compliance system to verify and correct problems to ensure that farms remain in compliance with GAAMPs.

Minnesota

The Minnesota Pollution Control Agency administers rules regulating livestock feedlots, and may delegate authority to counties to administer this program. State feedlot standards cover liquid manure storage systems, water quality setbacks, expansion limitations, and air emissions. Operation and maintenance standards cover discharges from feedlots and feed storage, and land application of manure. The extent of a livestock facility's obligations depends on its size, and other factors such as pollution risks.

In addition, Minnesota is among the states that still allow local permitting of livestock facilities using conditional use permits. Permits issued under local ordinances may impose requirements related to facility size including size caps, minimum acreage requirements, setbacks from neighboring land uses, and odor management. According to a *2007 Summary of Animal-Related Ordinances*, 32 county zoning ordinances used simple setback standards, while 22 used a sliding scale. The most common setback from single family residences was ¼ mile, while ½ mile was the common setback for more dense land uses such as schools. Twelve counties addressed odor using the Odor From Feedlots Setback Estimation Tool ("OFFSET"), which estimates odor impacts based on livestock type, facility size and type, separation distances, and odor control practices. These counties either incorporated OFFSET into their ordinances or use OFFSET as part of their planning process to predict odor to help determine separation distances. The survey showed that 20 counties limited the number of animals housed in a feedlot, setting caps between 1,500 to 5,000 AUs. Minnesota has enacted legislation requiring reciprocal setbacks of non-farm land uses whenever a local jurisdiction requires livestock facility setbacks. Wisconsin has no comparable requirement. Reciprocal setbacks are designed to protect livestock facilities, once approved, against encroaching development.

Data and Analytical Methodologies

This rule incorporates and is consistent with performance and conservation practice standards developed as part of recent revisions to ATCP 50 and NR 151. In addition, this rule follows the practice of the nonpoint rules by referencing the most current technical standards developed by NRCS for installation of conservation practices, including the incorporation of the 2015 standard for nutrient management planning. In developing technical and other standards, the responsible government agencies have followed similar methodologies to ensure the use of the best available science, address feasibility considerations, and secure input from stakeholders. For example, the most recent nutrient management standard incorporated into ATCP 50 underwent a rigorous process of development spearheaded by NRCS with technical assistance from agronomists, farmers, UW scientists, and agency staff. The NRCS technical standards for managing runoff from animal lots and feed storage, which are incorporated into this rule, underwent the same rigorous and balanced process as part of their development. As with the original 2006 version of ATCP 51, this rule revision relies on OFFSET in developing the framework for managing odors and establishing setbacks. As mandated under Wis. Stat. § 93.90(2)(d), the Department received advice from an expert committee for improvement of the standards in the siting rule, and its recommendations included updating technical standards. While the experts approached their assignment from a scientific perspective, their recommendations considered economic and other factors listed in Wis. Stat. § 93.90 (2) (b) relevant to the development of siting standards.

Next Steps

If the Board authorizes public hearings on this rule, the Department will refer a copy of the rule to the Legislative Council Rules Clearinghouse and publish a hearing notice in the Wisconsin Administrative Register. Between September 7 and September 22, 2017, the Department plans to hold four public hearings with afternoon and evening sessions in the following locations: Eau Claire, Wausau, Oshkosh, Jefferson. Rule comments will be accepted up to two weeks after the last public hearing is held on the rule.

DATCP Docket No. 15-R-12
Clearinghouse Rule No.

Proposed Hearing Draft
July 7, 2017

**PROPOSED ORDER
OF THE STATE OF WISCONSIN DEPARTMENT OF AGRICULTURE,
TRADE AND CONSUMER PROTECTION
ADOPTING RULES**

The Wisconsin Department of Agriculture, Trade and Consumer Protection proposes the following permanent rule ***to repeal*** ATCP 51.01 (2) and (Note), ATCP 51.01 (13) (Note), ATCP 51.01 (16), ATCP 51.01 (26) (Note), ATCP 51.12 (6) (Note), ATCP 51.30 (3) (Note), and ATCP 51.34 (3) (a) (Note) ***to renumber*** ATCP 51.06 (2) (intro.), (a) and (b), ***to amend*** ch. ATCP 51 (intro.) (Note), ATCP 51.01 (3), ATCP 51.01 (5) (Note), ATCP 51.01 (7), ATCP 51.01 (19), ATCP 51.01 (21)(intro.), ATCP 51.01 (23), ATCP 51.01 (24), ATCP 51.01 (29), ATCP 51.01 (33), ATCP 51.01 (36) (b) and (c), ATCP 51.01 (42), ATCP 51.01 (43), ATCP 51.01 (44) (intro.), ATCP 50.02 (b) (Note), ATCP 51.04 (Note), ATCP 51.08 (1) (b) (Note), ATCP 51.10 (1) ATCP 51.10 (3) (d) (Note), ATCP 51.10 (4), ATCP 51.30 (5), ATCP 51.34 (3) (a), ATCP 51.34 (4) (intro.), ATCP 51.34 (4) (b) 2., and ATCP 51.34 (5) (a) 2. and 3.; ***to repeal and recreate*** ATCP 51.08 (2), ATCP 51.10 (2) and (Note), ATCP 51.12 (1) and (2), ATCP 51.14, ATCP 51.16, ATCP 51.18, ATCP 51.20, ATCP 51.30 (4) and (Note), ATCP 51.34 (4) (a), ATCP 51.34 (5) (b) and (c), Chapter ATCP 51, Appendix A, Application Form and Worksheets, Chapter ATCP 51, Appendix B, Request for Modification of a Local Approval, and Chapter ATCP 51, Appendix C, Notice To Adjacent Property Owners; ***and to create*** ATCP 51.01 (19m) and (Note), ATCP 51.01 (23m), ATCP 51.01 (33m), ATCP 51.01 (38m), ATCP 51.01 (44) (c), ATCP 51.01 (44m), ATCP 51.06 (b), ATCP 51.10 (4) (Note), ATCP 51.12 (2m) (a) and (b) and (Note), ATCP 51.30 (1) (Note), ATCP 51.30 (4m), ATCP 51.34 (4m), and ATCP 51.34 (5) (a) 3. (Note), ***relating to*** livestock facility siting and affecting small business.

Analysis Prepared by the Department of Agriculture, Trade and Consumer Protection

First adopted in May 2006, Wis. Admin. Code ch. ATCP 51 ("ATCP 51") established the statewide framework of standards and procedures required to implement Wisconsin's livestock facility siting law, Wis. Stat. § 93.90. The requirements only apply to livestock operators located in jurisdictions that have adopted ordinances requiring permits for new or expanding livestock facilities that exceed a certain size (commonly 500 animal units).

The Department of Agriculture, Trade and Consumer Protection ("Department") is required to review Wis. Admin. Code Ch. ATCP 51 every four years in accordance with Wis. Stat. § 93.90(2)(c). To this end, the Department convened a Technical Expert Committee that provided recommendations regarding changes to ATCP 51.

The proposed rule is intended to ensure consistency among related rules (Wis. Admin. Code chs. NR 151 and ATCP 50, respectively referred to as "NR 151" and "ATCP 50"), which were revised to implement a new nutrient management technical standard and additional farm runoff standards designed to better control discharges of process wastewater, and meet phosphorus index targets for nutrient management. The ATCP 51 revision also addresses issues arising out of the mandatory four year review of this rule. The proposed revision retains the essential regulatory framework, including the core water quality standards. Improvements in standards are intended to advance the statutory goal of "providing uniform regulation of livestock facilities" and better balance the factors listed in Wis. Stat. § 93.90(2)(b), which the Department must use to establish state standards.

Statutes Interpreted

Statutes interpreted: Wis. Stats. §§ 92.05(3)(c) and (k), 93.90 and 281.16(3)(b).

Statutory Authority

Statutory authority: Wis. Stats. §§ 93.07(1), 92.05(3)(c) and (k), 92.14(8), 93.90(2) and 281.16(3)(b).

Explanation of Agency Authority

The Department has general authority to adopt rules interpreting statutes under its jurisdiction (*see* Wis. Stat. § 93.07(1)). The Department is specifically authorized to adopt farm conservation standards (*see* Wis. Stats. §§ 92.05(3)(k) and 281.16(3)(b)). Under Wis. Stat. § 93.90, the Department must do all of the following by rule:

- Develop and update water quality, odor, setback, and other standards for new or expanding livestock facilities that require a permit or other local approval. The standards may incorporate, and may not conflict with, current statutes and rules regulating livestock operations including the performance standards, conservation practices, and technical standards that apply under nonpoint source pollution programs.

- Review ATCP 51 standards and other requirements at least every 4 years, in consultation with a committee of experts.
- Evaluate whether existing or proposed standards are: (1) protective of public health or safety; (2) practical and workable; (3) cost-effective; (4) objective; (5) based on scientific information; (6) designed to promote the growth and viability of animal agriculture; (7) designed to balance the economic viability of farm operations with natural resource protection and other community interests; and (8) usable by local officials.
- Develop and update application materials and other submissions that livestock operators must provide when applying for local approval, to show that a new or expanding livestock facility will comply with the standards adopted by the Department.
- Specify the information that a local government must include in its decision making record. A local decision must include findings of fact, and must be based on information in the record. This record will be important if an aggrieved party appeals the local government's decision.

Related Statutes and Rules

This rule is related to Wis. Stats. §§ 92.05 (3) (c) and (k), 92.14 (8), 92.15, 92.16, 281.16 (3), and ch. 283, and rules promulgated under these statutes including the nonpoint pollution control rules, ATCP 50 and NR 151.

Plain Language Analysis

General Background

This rule:

- Updates the water quality standards, including related Natural Resources Conservation Service ("NRCS") technical standards, to ensure consistency with provisions in NR 151 and ATCP 50, including incorporation of the 2015 NRCS standard for nutrient management, and the 2016 NRCS standards for waste treatment and vegetated treatment areas.
- Modifies standards (subch. II of ATCP 51) consistent with the requirements in Wis. Stat. § 93.90(2), based on the technical recommendations of the 2014 Technical Expert Committee and stakeholder input. Key changes include modifications to setback and odor standards.
- Modifies the procedures (subchs. I and III of ATCP 51) that local governments must follow in issuing a siting permit under a zoning or licensing ordinance including those used to determine completeness of siting applications, modifications to siting permits, the use of checklists to monitor facility compliance, and the fees local governments charge for permit modifications.
- Modifies local permit application forms and worksheets to reflect changes in requirements and to ensure that they are clear, complete, and elicit information that documents compliance with applicable siting standards.
- Makes other changes, clarifications and updates as necessary to improve implementation of the siting rule, consistent with the requirements in Wis. Stat. § 93.90(2).

<u>Contents of this Rule</u>

The following is an analysis of the rule by topics.

Livestock Facilities, Structures, and other Definitions

This rule clarifies that a livestock facility includes the livestock, livestock structures, and parcels on land upon which livestock facility is located, except for pastures and winter grazing areas. It excludes a concentration of 50 or fewer calf hutches from the definition of an animal lot. Concentrations of 50 or more hutches must meet setback and runoff management standards. Storage structures designed exclusively for process wastewater are excluded from the design and setback requirements that apply to manure storage structures.

This rule eliminates definitions related to the prior odor standard, including affected neighbor, and high use building.

The definition of related facilities is expanded to cover process wastewater storage and transfer using or sharing the same structures, or same field for land application.

To achieve consistency with the nonpoint rules (ATCP 50 and NR 151), this rule adds or adjusts definitions of key terms such as manure, pasture, process wastewater, significant discharge, and waste transfer system.

Ordinances and Permits Filed with the Department

This rule will require local governments to electronically submit new or revised ordinances or permits to the Department whenever it incorporates standards from this rule in a local ordinance, enacts more stringent local ordinance standards, or takes official action on a permit application.

Duration of Local Approval

A livestock operator must begin constructing all new or expanded livestock housing or waste storage structures within 2 years after the local approval is granted, except where the construction of a proposed structure is required to control a discharge, in which the construction must be completed within 6 months of a permit approval.

Application for Local Approval

To obtain local approval, an operator must complete the *application form* and *worksheets* that are made part of this rule. The application materials have been modified to incorporate the changes described in this rule summary.

Key changes to the application materials include:

- On the site map, the applicant must assign unique identifiers to show all existing and proposed livestock structures, and use these unique identifiers when referencing livestock structures in the application worksheets.

- Odor Management Plans will be retooled and the application will contain new criteria for developing acceptable plans.
- The applicant's acknowledgement of other laws will be removed from the application.
- Odor management standard (worksheet 2) will be modified to reflect the new system for managing odor.
- Waste and nutrient management (worksheet 3) will change to reflect the method for estimating the amount of manure generated from a facility to better correspond with nutrient management planning, will add cropland performance standards, and eliminate the nutrient management planning exemption for operations under 500 Animal Units ("AUs").
- Waste storage facilities (worksheet 4) will change requirements regarding closure of manure storage structures.
- Runoff management (worksheet 5) will be revised to reflect changes in managing runoff related to animal lots, feed storage, and milking center wastewater.

State Standards

This rule clarifies that a local government may not grant a variance to exempt a livestock facility from complying with the state standards, except that it may reduce setback requirements.

Property Line and Road Setbacks

This rule retains property line and road setback requirements for livestock structures, except manure storage and certain types of housing.

This rule:

- Establishes minimum property line setbacks for manure storage structures based on the size of the livestock facility.
- Establishes minimum property line setbacks for certain types of livestock housing based on the size of the livestock facility.

If a livestock facility is organized in one or more clusters (a grouping of livestock structures separated from another grouping by a 1,000 or more feet), the livestock facility may follow the setback requirements based on the AUs in each cluster. This option is not available if manure is comingled among clusters.

This rule retains provisions that allow expansion of manure storage and housing structures within setback areas, as long as the expansion is away from the property line or public road right-of-way to which the local setback applies. In addition, as noted below, this rule allows operators to reduce setbacks for new or expanded manure storage and certain types of housing structures through the installation and maintenance of odor control practices.

Odor Management; Livestock Structures

This rule provides for the phase out of the odor standard, originally adopted in 2006. In its place, this rule adopts a system of setbacks for high odor sources (manure storage and certain types of housing). Under the new system, operators will not be required to address odor from low odor sources such as animal lots. With its emphasis on setbacks, the new system is similar to odor management approaches in surrounding states and continues to use odor control practices originally developed for the 2006 odor standard.

For livestock operations issued a permit prior to the effective date of this rule revision, they must continue to meet the requirements of the odor standard in their permits. They are released from these requirements if they are granted a new local approval. However, they need to develop an odor management plan if they have manure storage located within 600 feet of the facility's property line or livestock housing located within 400 feet of the facility's property line. Livestock facilities seeking local approval for the first time after adoption of this rule revision will not need to complete an odor management plan for existing manure storage and livestock housing, unless these structures are located within the separation distances discussed above.

For new or expanded manure storage structures and certain types of livestock housing, the new odor standard provides operators credit for odor control practices in the form of a reductions to setback requirements. Livestock operators may use these reductions to allow construction within the new setback areas. Worksheet 2 has been modified to enable operators to document odor control practices and calculate the reduced setbacks based on installation and maintenance of these practices. Worksheet 2 includes revised specifications for the odor control practices that the operator must meet to claim a credit.

Waste and Nutrient Management

To achieve maximum consistency with nonpoint rules, this rule will require operators to have and follow a nutrient management plan that complies with ATCP 50. The 2015 NRCS 590 Standard is now the basis for nutrient management plans. In addition, this rule adds requirements that livestock operators comply with NR 151 cropland performance standards related to soil erosion, a tillage setback, and the phosphorus index.

Regarding nutrient management plans, this rule clarifies that a plan must account for all land applications of manure and related waste generated by the maximum number of animal units authorized by a permit or other local approval. For the purposes of determining waste generation, this rule and related Worksheet 3 now use the Wisconsin Conservation Planning Technical Note WI-1 (February, 2016) to estimate quantities of manure.

Worksheet 3 will require that operators attach map(s) showing the land where waste will be applied and any restrictions limiting the application of waste to that land. Additional documentation may be required by the local government to verify that rental land is available.

A new nutrient management checklist is incorporated to document compliance with the 2015 NRCS 590 Standard.

This rule eliminates the option for livestock facilities under 500 AUs to avoid a nutrient management plan if the operation has an adequate land base.

This rule clarifies that local governments may require all operators with siting permits (including livestock facilities with over 1,000 AUs known as Concentrated Animal Feeding Operations "CAFOs") to submit documentation related to annual nutrient management updates, and monitor an operator's compliance with a nutrient management plan. Under Wis. Admin. Code § ATCP 50.04(3)(gm), a nutrient management plan must be reviewed annually to determine whether the plan accurately reflects the planned cropping, tolerable soil loss, nutrient application rates, and application methods, and shall be updated by a nutrient management planner when necessary to reflect changes to planned activities.

Waste Storage Facilities

This rule clarifies that new or expanded waste storage structures, designed solely for storage of process wastewater, must meet NRCS technical guide manure storage facility standard 313 or ch. NR 213, whichever applies.

Changes to the waste storage facility Worksheet 4 require the operator to identify all existing, modified, and new storage facilities by a unique identifier.

For existing storage facilities, which can only be used if properly certified, this rule provides more flexibility for certification by creating a document-only option (e.g. manure storage ordinance certification) for a facility constructed within the last 3 years according to then-existing NRCS standards, and visual inspections for any facility constructed within the last 10 years according to then-existing NRCS standards. However more effective inspection and documentation requirements apply to older storage facilities including the need to empty the facility before inspection. If there is no reliable documentation, a full inspection including test pits may be required.

New or substantially altered waste storage structures and transfers systems must be designed and constructed according to these:

- NRCS technical guide manure storage facility standard 313 (January 2014).
- NRCS technical guide manure transfer standard 634 (January 2014).

This rule will require that an operator close an existing waste storage facility that cannot be certified as safe to use.

This rule clarifies the options for a local government to monitor compliance including verification that a new or modified waste storage facility is constructed according to specifications. In addition to inspections, the local government may require applicants to submit documentation verifying that new and substantially altered facilities are constructed according to technical standards.

Runoff Management

Every new or substantially altered animal lot must be designed and constructed according to NRCS technical guide vegetated treatment area standard 635 (January, 2016). This standard may require operators to install roofing or route runoff to storage in place of using a vegetated treatment area.

Existing animal lots may still use the *BARNY* runoff model to predict annual phosphorus runoff from the animal lot. A lot may still qualify as existing with minor alterations, which are now more clearly defined in this rule. Under this rule, operations must meet the more demanding annual discharge standard of less than 5 lbs. of phosphorus, if the animal lot is located within:

- 1,500 feet from navigable lakes, ponds and flowages
- 450 feet from wetlands and navigable streams and rivers
- 750 feet from conduits to groundwater
- 450 feet from surface inlets that discharge to navigable waters,
- 225 feet from channelized flow (i.e., a drainage area of ≥ 5 acres)
- 225 feet from subsurface drains

Structures located outside the boundaries indicated above may meet the runoff standard by documenting a discharge of less than 15 lbs. of phosphorus annually.

This rule clarifies the prohibition against direct runoff from animal lots to any direct conduit to groundwater (such as a sinkhole) and now includes runoff to surface waters of the state.

While this rule holds livestock operations to a standard of no significant discharge, it does make changes in runoff standards for animal lots, as well as feed storage areas, to account for the U.S. Environmental Protection Agency's "no discharge" standard for animal feeding operations, and changes in the NRCS technical standards designed to implement the federal "no discharge" standard.

This rule substantially changes requirements for feed storage facilities. Existing buildings, bunkers, or paved areas used to store feed must be evaluated to determine whether they meet technical standards, are in good repair and do not have signs of a significant discharge. New operating requirements for existing feed storage include the diversion of clean water and collection and storage of leachate and initial runoff.

Every new or substantially altered feed storage structure, including any unroofed building, bunker or paved area used for feed storage or handling, now must be designed, constructed and maintained in accordance with NRCS technical guide waste treatment standard 629 (January, 2017), with the leachate and contaminated runoff from such storage structures being collected and stored for future land application, or treated in accordance with NRCS technical guide vegetated treatment area standard 635 (September, 2016). The use of simple vegetated treatment areas to manage runoff is a less viable option for operations over 500 AUs.

If a new or expanded feed storage structure is less than one acre and not located in or near a sensitive area, the new or altered portions of feed storage structure must meet design requirements for the floor of the structure, but may manage runoff in any manner that avoids a significant discharge. This is a low-cost option that is intended to hold down costs for non-CAFOs that build new or expanded feed storage structures.

To ensure consistency with the prohibition against significant discharges in the nonpoint rules (see Wis. Admin Code § NR 151.055), this proposed rule reflects current standards and practices for managing milkhouse wastewater. Storing waste is required except for small operations that generate less than 500 gallons of milking center wastewater daily.

Existing clean water diversion requirements have been expanded to require diversion if structures are located within 300 feet of wetlands and 500 feet from any conduit to groundwater.

CAFO Permit Substitutions

This proposed rule more clearly defines how CAFOs can demonstrate compliance with siting standards based on a Wisconsin Pollutant Discharge Elimination System (WPDES) permit. Because the Department of Natural Resources ("DNR") does not issue CAFO permits with a maximum number of animal units, this rule eliminates the requirement that CAFOs provide WPDES permits documenting the same number of animal units as sought for local approval under the siting rule. This rule still allows CAFOs to demonstrate compliance with the nutrient management requirements based on a WPDES permit, but imposes more specific requirements to submit a nutrient management checklist that was previously submitted to DNR as long as the nutrient management plan covers the same or greater number of animal units than the number for which the operator seeks local approval. CAFOs also must demonstrate compliance with the siting standards related to manure storage and runoff management by submitting plans and specifications approved by DNR for relevant livestock structures. Also, the applicant must certify that the livestock facility has met all WPDES permit conditions, and does not have any WPDES permit violations.

Permit Modifications

This rule establishes a clear framework to allow permit modifications for expanding livestock facilities previously granted local approval. This rule specifically:

- Limits the fee to $500 or less.
- Sets criteria to qualify for a permit modification (e.g. operation does not exceed 30 percent, cumulatively, of the maximum number of animal units authorized in the most recent full application approved by the local government).
- Requires compliance with all standards contained in each worksheet except for Worksheet 5 where a livestock operator may complete only those parts of the worksheet that apply to the changes being planned for proposed livestock operation.
- Establishes a procedure for processing modifications that simplifies the steps (e.g. no written decision with findings) and reduces the waiting time to no more 45 days.

Complete Application

In making a completeness determination regarding an application for local approval, a local government will be required to use a Department-approved form to document specific items that are missing from the application. Items on the checklist not identified by the local government are deemed complete, and an applicant is only required to submit additional materials identified by the local government on the checklist to receive a completeness determination.

Terms of Approval

After a local government receives an application, the local government shall notify the applicant that prior to a final decision on the application construction activities at the livestock facility shall be limited to grading.

Upon approval of an application, a local government may only impose conditions related to an operator's compliance with the standards authorized in subch. II of ATCP 51. Any conditions attached to a local approval must be described in the final written decision granting the approval.

Compliance Monitoring

This rule clarifies the options for a local government to monitor compliance, including verification that a new or modified waste storage facility is constructed according to specifications. In addition to inspections, the local government may require submission of a construction plan, drawings reflecting design changes made during construction, and documentation certifying that the facility was installed in accordance with technical standards.

Standards Incorporated by Reference

Pursuant to Wis. Stat. § 227.21, the Department intends to request permission from the Attorney General to incorporate the following standards by reference in this rule, without reproducing the complete standards in this rule:

- NRCS technical guide manure storage facility standard 313 (January, 2014).
- NRCS technical guide composting facility standard 317 (January, 2017).
- NRCS technical guide waste facility closure standard 360 (March, 2013).
- NRCS technical guide anaerobic digester standard 366 (August, 2011).
- NRCS technical guide roofs and covers standard 367 (April, 2016).
- NRCS technical guide windbreak/shelterbelt establishment standard 380 (October, 2016).
- NRCS technical guide nutrient management standard 590 (December, 2015).
- NRCS technical guide feed management standard 592 (July, 2016).
- NRCS technical guide waste treatment standard 629 (January, 2017).
- NRCS technical guide waste separation facility standard 632 (April, 2014).
- NRCS technical guide waste transfer standard 634 (January, 2014).
- NRCS technical guide vegetated treatment area standard 635 (September, 2016).
- NRCS Wisconsin Conservation Planning Technical Note WI-1, "Nutrient Management" (February, 2016).

Copies of these standards may be obtained from NRCS, and will be on file with the Department and Legislative Reference Bureau. Copies are not reproduced in this rule.

Summary of, and Comparison with, Existing or Proposed Federal statutes and Regulations

Nearly half of livestock operations affected by this rule are also subject to regulation under the federal Clean Water Act. Under delegated authority from EPA, the DNR adopted Wis. Admin. Code ch. NR 243 ("NR 243") to regulate water pollution discharges from livestock facilities. Under NR 243, CAFOs must obtain a DNR WPDES permit. CAFOs must meet standards designed to ensure that the proposed livestock facility will not pollute surface water or groundwater, and may use approvals from DNR to show compliance with Department standards for the issuance of local siting permits, including standards for nutrient management, waste storage facilities, and runoff management (the standards parallel WPDES permit standards, and have a similar purpose, although WPDES standards are stricter in some respects). To qualify for a siting permit, a WPDES permit holder must also demonstrate compliance with Department standards for location of livestock structures on property and odor management, which are not covered by a WPDES permit.

NRCS, a branch of the United States Department of Agriculture ("USDA"), develops technical standards for the design and installation of conservation practices, including the NRCS 590 standard for nutrient management. Modified for use in Wisconsin, these technical standards are the foundation for NRCS programs such as the Environmental Quality Incentives Program ("EQIP") and the Conservation Stewardship Program ("CSP"). To promote consistency, state and local governments have incorporated the same technical standards into cost-share, regulatory and other programs. Not only are these technical standards part of ATCP 51, they are critical to the nonpoint rules (ATCP 50 and NR 151) and DNR's WPDES permitting program for CAFOs.

In addition to EQIP and CSP, USDA operates the following programs that may provide incentive payments to help livestock producers implement conservation practices, including practices that may help livestock producers meet livestock facility siting standards under this rule:

- Conservation Reserve Program (CRP).
- Conservation Reserve Enhancement Program (CREP).
- Agricultural Conservation Easement Program (ACEP).

Federal law establishes reporting and other requirements for livestock facilities related to air emissions. For example, large operations must report certain types of releases to local and state agencies, as directed by the Emergency Planning and Community Right-to-Know Act. EPA also has authority to respond to citizen complaints or requests for assistance from state or local government agencies to investigate releases of hazardous substances from farms. Federal law does not directly cover odor management on livestock facilities.

Comparison with Rules in Adjacent States

Like Wisconsin, the four surrounding states each have state requirements for new and expanding livestock operations related to facility construction, runoff control, and manure management. Except for Minnesota, these states have enacted laws that pre-empt or standardize local regulation of livestock facilities with the goal of providing a more uniform and predictable regulatory environment for farm businesses.

Illinois

In 1996, Illinois enacted a Livestock Management Facilities Act ("LMFA") to create a state framework for regulation of livestock facilities. LMFA, which was updated in 1998, 1999, and 2007, was expressly adopted to provide a framework for the livestock industry to expand while establishing environmental and other safeguards. While Illinois law precludes counties from regulating agricultural uses such as livestock facilities, it allows a county to request a public informational meeting about a proposed livestock facility and submit advisory, non-binding recommendations related to the facility's compatibility with surrounding land uses, odor control, traffic patterns, and other factors. Depending on their size and other factors, livestock facilities may be subject to state requirements for waste storage design, setback distances, odor control for certain structures, certification of livestock managers, waste management plans, and reporting of released wastes. Required setback distances for new facilities are scaled by size, starting at 1,320 feet for facilities under 1,000 AUs.

Iowa

In 2002, Iowa enacted legislation requiring that proposed confined feeding operations meet state standards related to building setbacks, manure storage construction, manure management plans, and air quality (air quality standards are still being developed). In place of local permitting of livestock facilities, Iowa counties have the option of requiring that producers achieve a passing score on the state-approved "Master Matrix," an assessment tool that identifies practices designed to minimize to air, water, and community impacts. State standards for new and expanding facilities include different construction requirements for formed and unformed waste storage structures, and requirements involving manure application related to annual plan updates and phosphorus management. The size of the operation, and type of construction (new or expansion) determine applicable standards such as setbacks, which range from 750 to 3,000 feet.

Michigan

In 1999, the Michigan provided "right to farm" protections for farmers who meet "generally accepted agricultural management practices" ("GAAMPS"). The Right to Farm Act ("RFTA") prevents local governments from adopting ordinances that prohibit farming protected under state law, and protects farmers who comply with GAAMPS against nuisance actions. While other GAAMPs may apply to livestock operations, new and expanding livestock facilities must follow GAAMPs for site selection and odor control, and develop plans that comply with these standards. Most farms need to receive state verification of GAAMP compliance to maintain RFTA protections and avoid other state actions. Site planning includes meeting setback requirements and evaluation of odor management practices. Setbacks can range from 125 to 1,500 feet, depending on the facility size, type of construction (e.g. new or expansion) and type of neighbors, and may be reduced if odor management practices are employed. Odor management plans also may be required. Operations must have a plan to properly manage and utilize manure, and design storage facilities according to technical standards. Producers must also prepare emergency action and other plans. Michigan maintains a compliance system to verify and correct problems to ensure that farms remain in compliance with GAAMPs.

Minnesota

The Minnesota Pollution Control Agency administers rules regulating livestock feedlots, and may delegate authority to counties to administer this program. State feedlot standards cover liquid manure storage systems, water quality setbacks, expansion limitations, and air emissions. Operation and maintenance standards cover discharges from feedlots and feed storage, and land application of manure. The extent of a livestock facility's obligations depends on its size, and other factors such as pollution risks.

In addition, Minnesota is among the states that still allow local permitting of livestock facilities using conditional use permits. Permits issued under local ordinances may impose requirements related to facility size including size caps, minimum acreage requirements, setbacks from neighboring land uses, and odor management. According to the *2007 Summary of Animal-Related Ordinances*, 32 county zoning ordinances used simple setback standards, while 22 used a sliding scale. The most common setback from single family residences was ¼ mile, while ½ mile was the common setback for more dense land uses such as schools. Twelve counties addressed odor using the Odor From Feedlots Setback Estimation Tool ("OFFSET"), which estimates odor impacts based on livestock type, facility size and type, separation distances, and odor control practices. These counties either incorporated OFFSET into their ordinances or use OFFSET as part of their planning process to predict odor to help determine separation distances. The survey showed that 20 counties limited the number of animals housed in a feedlot, setting caps between 1,500 to 5,000 AUs. Minnesota has enacted legislation requiring reciprocal setbacks of non-farm land uses whenever a local jurisdiction requires livestock facility setbacks. Wisconsin has no comparable requirement. Reciprocal setbacks are designed to protect livestock facilities, once approved, against encroaching development.

Summary of Factual Data and Analytical Methodologies

This rule incorporates and is consistent with performance and conservation practice standards developed as part of recent revisions to ATCP 50 and NR 151. In addition, this rule follows the practice of the nonpoint rules by referencing the most current technical standards developed by NRCS for installation of conservation practices including the incorporation of the 2015 standard for nutrient management planning. In developing technical and other standards, the responsible government agencies have followed similar methodologies to ensure the use of the best available science, address feasibility considerations, and secure input for stakeholders. For example, the most recent nutrient management standard incorporated into ATCP 50 underwent a rigorous process of development spearheaded by NRCS with technical assistance from agronomists, farmers, UW scientists, and agency staff. The NRCS technical standards for managing runoff from animal lots and feed storage, which are incorporated into this rule, underwent the same rigorous and balanced process as part of their development. As with the original 2006 version of ATCP 51, this rule revision relies on OFFSET in developing the framework for managing odors and establishing setbacks. As mandated under Wis. Stat. § 93.90(2)(d), the Department received advice from an expert committee for improvement of the standards in the siting rule, and its recommendations included updating technical standards. While the experts approached their assignment from a scientific perspective, their recommendations considered economic and other factors listed in Wis. Stat. § 93.90 (2) (b) relevant to the development of siting standards.

Analysis and Supporting Documents Used to Determine Effect on Small Business or in Preparation of an Economic Impact Analysis

In preparing its analysis and supporting documentation, the Department consulted with stakeholders, considered the 2015 final report of the Technical Expert Committee, and estimated costs using a methodology similar to the one used when ATCP 51 was originally adopted in 2006.

Effects on Small Business

The proposed rule changes will have a very limited impact on farms statewide, affecting less than 1 percent of livestock operations in the state. Based on past trends in the livestock industry and local permitting activity, which may not be predictive of future activity, it is estimated that in the next ten years the revised rule will impact no more 150 new or expanding livestock facilities statewide that are issued local permits for the first time or are reissued permits [100 new permits (10 per year) plus 70 permit reissuances (7 per year) minus 20 that will seek more than one permit reissuance]. Since this rule change will have virtually no impacts on 85 new and expanding livestock facilities that are CAFOs, and are required by their DNR permits to meet the higher water quality standards in the revised siting rule, its impact will be most significant for approximately 55 non-CAFOs. It is estimated that the affected livestock operations, nearly all of which are small businesses, will incur an additional $1.05 - $1.16 million in annual costs to comply with the changes in this rule revision over a 10 year period.

This rule will have a small, but positive impact on businesses other than livestock operators. Those businesses, many of which are small businesses, include nutrient management planners, soil testing laboratories, farm supply organizations, agricultural engineering practitioners, and contractors installing farm conservation practices.

The Initial Regulatory Flexibility Analysis, which accompanies this rule, provides a more complete analysis of the issue, including a detailed breakdown of increased costs for livestock operators.

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Place Where Comments Are To Be Submitted and Deadline for Submission

Questions and comments related to this rule may be directed to:

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Rule comments will be accepted up to two weeks after the last public hearing is held on this rule. Hearing dates will be scheduled after this draft rule is approved by the Board of Agriculture, Trade and Consumer Protection.

CHAPTER ATCP 51
LIVESTOCK FACILITY SITING

SECTION 1. Ch. ATCP 51 (intro.) (Note) is amended to read:

This chapter is adopted under authority of ss. 93.07 (1) and 93.90 (2), Stats. This chapter interprets Wisconsin's livestock facility siting law, s. 93.90, Stats., which is an enactment of statewide concern for the purpose of providing uniform regulation of livestock facilities. According to the livestock facility siting law, a county, town, city or village ("political subdivision") may not prohibit or disapprove a new or expanded livestock facility of any size unless one of the following applies:

The site is located in a zoning district that is not an agricultural zoning district.

The site is located in an agricultural zoning district where the livestock facility is prohibited. A prohibition, if any, must be clearly justified on the basis of public health or safety. The livestock facility siting law limits exclusionary zoning based solely on livestock facility size.

The proposed livestock facility violates a valid local ordinance adopted under certain state laws related to shoreland zoning, floodplain zoning, construction site erosion control or stormwater management.

The proposed livestock facility violates a local building, electrical or plumbing code that is consistent with the state building, electrical or plumbing code for that type of facility.

The proposed livestock facility will have 500 or more "animal units" (or will exceed a lower permit threshold incorporated in a local *zoning* ordinance prior to July 19, 2003), and the proposed facility violates one of the following:

- A state livestock facility siting standard adopted by the department under this chapter.
- A more stringent local ordinance standard enacted prior to the siting application. The more stringent local standard must be based on reasonable and scientifically defensible findings of fact, adopted by the local jurisdiction, which clearly show that the standard is necessary to protect public health or safety.

Some, but not all, political subdivisions require local approval of new or expanded livestock facilities. The livestock facility siting law *does not require* local approval. But *if* local approval is required, the political subdivision must grant or deny approval based on this chapter. A political subdivision may not consider other siting criteria, or apply standards that differ from this chapter, except as provided in the livestock facility siting law or this chapter.

The department must review the livestock facility siting standards under this chapter at least once every 4 years (see s. 93.90 (2) (c), Stats.). ~~The department will review the standards at least annually during the first 4 years of rule implementation. The department will track local siting applications and decisions (see s. ATCP 51.34 (5)), and will review that information at least monthly during the first year of rule implementation.~~

~~The livestock facility siting law includes the following statements of legislative intent:~~

> ~~"This [law] is an enactment of statewide concern for the purpose of providing uniform regulation of livestock facilities."~~

~~"...[T]he department shall consider whether [livestock facility siting standards] are all of the following:~~

- ~~Protective of public health or safety.~~
- ~~Practical and workable.~~
- ~~Cost–effective.~~
- ~~Objective.~~
- ~~Based on available scientific evidence that has been subjected to peer review.~~
- ~~Designed to promote the growth and viability of animal agriculture in this state.~~
- ~~Designed to balance the economic viability of farm operations with protecting natural resources and other community interests.~~
- ~~Usable by officials of political subdivisions."~~

SECTION 2. ATCP 51.01 (2) and (Note) is repealed.

SECTION 3. ATCP 51.01 (3) is amended to read:

"Animal lot" means a feedlot, barnyard or other outdoor facility where livestock are concentrated for feeding or other purposes. "Animal lot" does not include a pasture, <u>areas with concentrations of 50 or fewer calf hutches</u>, or winter grazing area. Two or more animal lots at the same livestock facility constitute a single animal lot, for purposes of this chapter, if runoff from the animal lots drains to the same treatment area under s. ATCP 51.20 (2) or if runoff from the animal lot treatment areas converges or reaches the same surface water within 200 feet of any of those treatment areas.

SECTION 4. ATCP 51.01 (5) (Note) is amended to read:

The BARNY model is a commonly used computer model that predicts nutrient runoff from animal lots. ~~Copies of the BARNY model are on file with the department, the secretary of~~

~~state and the legislative reference bureau~~. An Excel computer spreadsheet version is available at ~~www.datcp.state.wi.us.~~ livestocksiting.wi.gov

SECTION 5. ATCP 51.01 (7) is amended to read:

"Certified ~~agricultural engineering~~ conservation engineering practitioner" means a ~~agricultural engineering~~ person who is certified as a conservation engineering practitioner ~~who is certified~~ under s. ATCP 50.46 with a rating under s. ATCP 50.46 (5) that authorizes the practitioner to certify every matter that the practitioner certifies under this chapter.

SECTION 6. ATCP 51.01 (13) (Note) is repealed.

SECTION 7. ATCP 51.01 (16) is repealed.

SECTION 8. ATCP 51.01 (19) is amended to read:

"Livestock facility" means a feedlot, dairy farm or other operation where livestock are or will be fed, confined, maintained or stabled for a total of 45 days or more in any 12–month period. A "livestock facility" includes the livestock, livestock structures, and all of the tax parcels of land on which the facility is located, but does not include a pasture or winter grazing area. Related livestock facilities are collectively treated as a single "livestock facility" for purposes of this chapter, except that an operator may elect to treat a separate species facility as a separate "livestock facility."

SECTION 9. ATCP 51.01 (19m) and (Note) are created to read:

"Livestock housing" means a livestock structure with a roof and walls used to confine livestock but does not include calf hutches. For the purposes of ss. ATCP 51.12 and 51.14, livestock housing is classified as Category 1 or 2 based on estimated odor generation. Category 1 housing encompasses pork gestation / farrow / nursery with slatted floor, and pork finishing with slatted floor. Category 2 encompasses dairy housing with alley flush system; beef housing with slatted floor; pork finishing scrape systems to storage; pork pull plug to storage; and poultry (layers) and ducks.

Note: Housing classifications are based on the odor generation numbers for specific housing types in Appendix A of ch. ATCP 51, Worksheet 2, Chart 2 published in the Administrative Register, April 2006, No. 604.

SECTION 10. ATCP 51.01 (21)(intro.) is amended to read:

"Local approval" means an approval, required by local ordinance, of a new or expanded livestock facility. "Local approval" includes a license, permit, permit modification, special exception, conditional use permit or other form of local authorization. "Local approval" does not include any of the following:

SECTION 11. ATCP 51.01 (23) is amended to read:

"Manure" ~~means excreta from livestock kept at a livestock facility. "Manure" includes livestock bedding, water, soil, hair, feathers, and other debris that becomes intermingled with livestock excreta in normal manure handling operations~~ has the meaning given in s. ATCP 50.01(20).

SECTION 12. ATCP 51.01 (23m) is created to read:

"Manure storage structure" means a waste storage structure designed and operated primarily to store manure.

SECTION 13. ATCP 51.01 (24) is amended to read:

"Minor alteration" of ~~a livestock structure~~ an animal lot means a repair or improvement ~~in the construction of an existing livestock structure that does not result in a substantially altered livestock structure~~ that may include lot management such as cleaning; shaping, seeding and other non-structural changes to address flow issues; and installation of conservation practices such as roof gutters, diversions, surface inlets, underground outlets, and gravel spreaders.

SECTION 14. ATCP 51.01 (26) (Note) is repealed.

SECTION 15. ATCP 51.01 (29) is amended to read:

"Pasture" ~~means land on which livestock graze or otherwise seek feed in a manner that maintains the vegetative cover over all of the grazing or feeding area~~ has the meaning given in s. NR 151.015 (15m).

SECTION 16. ATCP 51.01 (33) is amended to read:

"Property line" means a line that separates parcels of land owned by different persons. For purposes of applying setbacks, property lines are measured from livestock structures to the parcel or other property boundary separating land owned by different persons.

SECTION 17. ATCP 51.01 (33m) is created to read:

"Process wastewater" has the meaning given in s. NR 243.03 (53).

SECTION 18. ATCP 51.01 (36) (b) and (c) is amended to read:

(b) They use or share one or more of the same livestock structures to collect, transfer or store manure, or process wastewater.

(c) ~~At least a portion~~ Any of their manure or process wastewater is applied to the same landspreading acreage.

SECTION 19. ATCP 51.01 (38m) is created to read:

"Significant discharge" means a discharge of process wastewater as defined in NR 151.055(3).

SECTION 20. ATCP 51.01 (42) is amended to read:

"Waste" means manure, milking center waste, leachate, contaminated runoff and other organic waste generated by a livestock facility.

SECTION 21. ATCP 51.01 (43) is amended to read:

"Waste storage facility" means one or more waste storage structures. "Waste storage facility" includes waste transfer systems consisting of stationary equipment and piping used to load or unload a waste storage structure if the equipment is specifically designed for that purpose and is an integral part of the facility. "Waste storage facility" does not include equipment used to apply waste to land.

SECTION 22. ATCP 51.01 (44) (intro.) is amended to read:

"Waste storage structure" means a waste storage impoundment made by constructing embankments, excavating a pit or dugout, or fabricating a structure. "Waste storage structure" does not include waste transfer systems and equipment used to apply waste to land. For purposes of ss. ATCP 51.12 (2) and 51.14, "waste storage structure" includes a manure storage structure but does not include any of the following:

SECTION 23. ATCP 51.01 (44) (c) is created to read:

(c) A structure designed, constructed and operated solely for the purpose of collecting and storing agriculture wastewater including leachate and contaminated runoff from stored feed.

SECTION 24. ATCP 51.01 (44m) is created to read:

"Waste transfer system" is a system of conduits or permanent equipment used to convey wastes from a source to another location such a waste storage structure, treatment facility, loading area or cropland. If a transfer system is designed to retain wastes for longer than 30 days, then the system shall be classified as a waste storage structure.

SECTION 25. ATCP 51.02 (b) (Note) is amended to read:

Some, but not all, political subdivisions require local approval of new or expanded livestock facilities. ~~The livestock facility siting law does not require local approval. But if~~ If local approval is required, the political subdivision must grant or deny approval based on this chapter. A political subdivision may not require local approval for new or expanded livestock facilities smaller than 500 animal units, except as specifically authorized by the livestock facility siting law and this chapter. This chapter does not grant authority nor limit a political subdivision's authority to regulate the raising of small numbers of livestock (i.e. hobby farms) for non-commercial purposes where the activity generates less than $6,000 in gross annual income. A political subdivision may not consider other siting criteria, or apply standards that differ from this chapter, except as provided in the livestock facility siting law or this chapter.

~~A political subdivision may not require local approval for new or expanded livestock facilities smaller than 500 animal units, except as specifically authorized by the livestock facility siting law and this chapter. A political subdivision may apply a lower size threshold adopted by ordinance prior to July 19, 2003 if that threshold is expressed as a specific number of animals or animal units. A local threshold expressed in locally-defined "animal units" may meet this test, because it effectively indicates a specific number of animals, even if the local ordinance definition of "animal units" differs from the definition in this chapter. However the local application and approval process must use the "animal units" definition in this chapter.~~

~~Local approvals under this chapter "run with the land." See s. ATCP 51.08. They normally continue to apply, despite changes in ownership, as long as subsequent owners do not violate the terms of the local approval. Some ordinances might require a pro forma permit transfer with each transfer of ownership, but that transfer may not ordinarily limit the scope of approval.~~

~~A livestock operator is not required to obtain local approval under this chapter for the construction, repair or improvement of livestock structures, unless the operator also adds "animal units" for which local approval is required (local building codes and manure storage ordinances may apply). However, a political subdivision may withdraw a local approval granted under this chapter if the livestock operator does any of the following (see s. ATCP 51.34 (4)):~~

~~• Without local authorization, alters the approved livestock facility in a way that materially violates the terms of the local approval.~~

~~• Alters the approved livestock facility so that the altered facility violates the standards in subch. II.~~

SECTION 26. ATCP 51.04 (Note) is amended to read:

This section accounts for normal day-to-day and seasonal variations in livestock numbers, as livestock are born, received, moved and marketed. See s. 93.90 (3) (f), Stats.

Under this chapter, an applicant for local approval must specify the number of "animal units" for which the applicant seeks authorization. If the application is approved, the approval authorizes that number of "animal units." The authorized number is the maximum number of "animal units" that may be kept on 90 or more days in any 12-month period. A livestock operator may not exceed that authorized number without further local approval.

~~"Animal unit" equivalents, for different species and types of livestock, are shown in Appendix A, worksheet 1 (animal units). The "animal unit" equivalents are based on s. NR 243.03 (3) as it existed on April 27, 2004 (the date on which the livestock facility siting law, 2003 Wis. Act 235, was published). See s. 93.90 (1m) (a), Stats., and s. ATCP 51.01 (4).~~

SECTION 27. ATCP 51.06 (2) (intro.), (a) and (b) are renumbered ATCP 51.06 (2) (a), 1. and 2.

SECTION 28. ATCP 51.06 (b) is created to read:

(b) A livestock operator may apply for modification under ss. ATCP 51.34(5) to expand a previously approved livestock facility

SECTION 29. ATCP 51.08 (1) (b) (Note) is amended to read:

For example, if a livestock operator gets local approval under this chapter to expand from 400 "animal units" (existing) to 900 "animal units", the livestock operator may implement the approved expansion over a period of time chosen by the livestock operator. The operator does not lose the approval merely because the operator implements the expansion in gradual stages, or fails to expand by the full amount authorized. ~~However, the operator must at least begin the expansion within 2 years, or face possible loss of approval. See sub. (2).~~ While the operator has flexibility in constructing livestock structures and populating with livestock, the operator is subject to the requirements in sub. (2).

SECTION 30. ATCP 51.08 (2) is repealed and recreated to read:

(a) Except as provided in par. (b), a political subdivision may withdraw a local approval granted under this chapter unless the livestock operator does all of the following within 2 years after a local approval is granted:

1. Begins populating the approved livestock facility.

Note: At the time an application for approval is submitted, a livestock operator must have the land base to implement a nutrient management plan for the maximum number of animal units requested in the application, and does not have two years to acquire the necessary land base through rental agreements or otherwise.

2. Begins construction on every new or expanded livestock housing structure, and every new or expanded waste storage structure, proposed in the application for local approval.

(b) Within 6 months of a local approval, a political subdivision may require an operator to complete construction of one or more conservation practices identified in the application if these practices are needed to control a documented discharge from an existing or altered animal lot or waste storage structure.

SECTION 31. ATCP 51.10 (1) is amended to read:

Except as provided in sub. (2) or (3), a political subdivision shall grant or deny local approvals and permit modifications covered by this chapter based on the standards in this subchapter

SECTION 32. ATCP 51.10 (2) and (Note) are repealed and recreated to read:

(a) STATE STANDARDS INCORPORATED IN LOCAL ORDINANCE. Beginning on November 1, 2006, a political subdivision may not deny a local approval covered by this chapter unless the political subdivision incorporates by local ordinance the standards in this subchapter and the application requirements in subch. III. A local ordinance may incorporate the standards and application requirements by reference, without reproducing them in full.

(b) Except as provided in s.ATCP 51.12, a political subdivision may not grant a variance to exempt a livestock facility from complying with the state standards required under this chapter.

SECTION 33. ATCP 51.10 (3) (d) (Note) is amended to read:

See ~~s. 93.90 (3) (ar)~~ s. 92.15, Stats. A political subdivision shall obtain separate state approval to impose requirements that exceed state water quality standards or practices.

SECTION 34. ATCP 51.10 (4) is amended to read:

Within 30 days after a political subdivision enacts an ordinance provision under sub. (2) or (3), the political subdivision shall electronically file a copy of the ordinance provision with the department. Failure to file the ordinance provision with the department does not invalidate the ordinance provision. ~~The political subdivision shall file the ordinance provision, by mail, fax or e-mail, at the following applicable address:~~

~~Wisconsin Department of Agriculture,~~

~~Trade and Consumer Protection~~

~~Agricultural Resource Management Division~~

~~Bureau of Land and Water Resources~~

~~P.O. Box 8911~~

~~Madison, WI 53708-8911~~

~~Fax: (608) 224-4615~~

~~E-mail: datcp.state.wi.us~~

SECTION 35. ATCP 51.10 (4) (Note) is created to read:

This website, livestocksiting.wi.gov, has instructions for electronic filing with the department.

SECTION 36. ATCP 51.12 (1) and (2) are repealed and recreated to read:

(1) PROPERTY LINE AND ROAD SETBACKS; GENERAL. Livestock structures shall comply with local ordinance requirements related to setbacks from property lines and public roads, except that no local setback requirement may do any of the following:

(a) Require a livestock structure to be set back more than 100 feet from any property line or public road right-of-way, except as provided in sub. (2), if the livestock facility will have fewer than 1,000 animal units.

(b) Require a livestock structure to be set back more than 200 feet from any property line, or more than 150 feet from any public road right-of-way, except as provided in sub. (2), if the livestock facility will have between 1,000 and 2,499 animal units or more.

(c) Require a livestock structure to be set back more than 300 feet from any property line, or more than 200 feet from any public road right-of-way, except as provided in sub. (2), if the livestock facility will have 2,500 animal units or more.

(d) Prevent the use of a livestock structure that was located within the setback area prior to the effective date of the setback requirement, except that operator may be required to address the livestock structure in an odor management plan under s. ATCP 51.14(1).

(e) Prevent the expansion of a livestock structure that was located within the setback area prior to the effective date of the setback requirement, unless the expansion:

1. Results in 20 percent or more increase in the area of the structure as it existed on the effective date of the rule [LRB inserts], or

2. Is toward the property line or public road right-of-way to which the local setback applies.

Note: Many local jurisdictions have established basic property line and road setback requirements by ordinance. Setbacks vary depending on local circumstances, and often reflect years of local experience. Subsection (1) honors local setback requirements, provided that the setbacks do not exceed the limits specified in sub. (1). Nothing in sub. (1) precludes a political subdivision from granting a variance to reduce setback requirements, provided the political subdivision's ordinance includes a variance provision adopted under authority other than 93.90, Stats. See, e.g. ss. 59.694, 60.10, 61.35, and 62.23, Stats.

(2) MANURE STORAGE AND LIVESTOCK HOUSING STRUCTURES; MORE RESTRICTIVE SETBACKS. (a) Except as provided in par. (d), a manure storage structure may not be located within:

1. 600 feet of any property line, if the livestock facility will have fewer than 1,000 animal units.

2. 1,000 feet of any property line, if the livestock facility will have between 1,000 to 2,499 animal units.

3. 1,400 feet of any property line, if the livestock facility will have between 2,500 to 3,999 animal units.

4. 1,700 feet of any property line, if the livestock facility will have between 4,000 to 4,999 animal units, and 200 additional feet for every 1,000 animal units above 4,000, but not to exceed 2,500 feet.

(b) Except as provided in par. (d), Category 1 livestock housing may not be located within:

1. 600 feet of any property line, if the livestock facility will have fewer than 1,000 animal units.

2. 1,000 feet of any property line, if the livestock facility will have between 1,000 to 2,499 animal units.

3. 1,450 feet of any property line, if the livestock facility will have between 2,500 to 3,999 animal units.

4. 1,700 feet of any property line, if the livestock facility will have 4,000 or more animal units.

(c) Except as provided in par. (d), Category 2 livestock housing may not be located within:

1. 400 feet of any property line, if the livestock facility will have fewer than 1,000 animal units.

2. 700 feet of any property line, if the livestock facility will have between 1,000 to 2,499 animal units.

3. 1,000 feet of any property line, if the livestock facility will have between 2,500 to 3,999 animal units.

4. 1,200 feet of any property line, if the livestock facility will have 4,000 or more animal units.

Note: To the extent that livestock structure is not covered by the more restrictive setback in sub. (2), it must meet the general requirements in sub. (1). For example, a dairy freestall barn at a livestock facility under 1,000 animal units must be 100 feet from the public road right of way unless political subdivision establishes a lower setback.

(d) A manure storage or housing structure may be located within the setbacks specified in pars. (a), (b) and (c) if any of the following apply:

1. The location of the manure storage and housing structure complies with a local ordinance or a variance granted under that local ordinance that specifies a shorter setback that is specific to manure storage or housing structures.

Note: If authorized, a political subdivision may grant a variance to reduce a manure storage setback under appropriate conditions. For example, a reduction may be granted if a manure storage structure is located on land adjacent to a separate parcel owned by a different person who consents to the reduction.

2. The manure storage or housing structure existed prior the effective date of the rule [LRB inserts], or the structure is expanded by no more than 20 percent of its surface area as it existed on the effective date of the rule [LRB inserts] and no part of expansion is closer to the property line to which the local setback applies.

3. A new or expanded manure storage or housing structure is located at a reduced setback distance authorized in Appendix A, Worksheet 2 based on the applicant's commitment to install and maintain odor control practices.

SECTION 37. ATCP 51.12 (2m) (a) and (b) and (Note) are created to read:

(2m) CLUSTERS. (a) Except as provided in par. (b), if the livestock structures in a livestock facility regulated under a single local approval are divided among 2 or more clusters, such that no cluster is located closer than 1,000 feet to any other cluster, an operator may determine the setback distances for livestock structures in each cluster based on the animal units kept at each location, rather than the animal units at for the entire livestock facility.

(b) This treatment does not apply to any cluster that handles or stores manure generated by animals located in another cluster.

Note: For example, a dairy operator may establish two setbacks for each cluster at a dairy facility that includes a milking operation (cluster 1) and a heifer facility (cluster 2) located 1,000 feet (or more) from each other. If the heifer facility has a manure storage facility for 200 animal units and accepts no manure from the 1200 head milking operation, the heifer facility may use the 600 foot setback for manure storage facilities on operations under 1,000 animal units.

SECTION 38. ATCP 51.12 (6) (Note) is repealed.

SECTION 39. ATCP 51.14 is repealed and recreated to read:

(1) PREEXISTING ODOR STANDARD. (a) A livestock facility operating under a local approval granted prior to the effective date of the rule [LRB inserts] must honor all commitments in its local approval to maintain the necessary odor control practices to achieve a passing odor score.

Note: The operator's commitments are documented in Appendix A of ch. ATCP 51, Worksheet 2, as published in the Administrative Register, April 2006, No. 604.

(b) If a previously approved livestock facility is granted a local approval including a permit modification on or after the effective date of the rule [LRB inserts], the livestock facility is released from its commitments under the preexisting odor standard for all livestock structures located at the livestock facility on the date of its application for subsequent local approval.

Note: A livestock facility released from its commitments may be required to prepare an odor management plan for existing structures under par. (c). All livestock facilities with new or expanded livestock structures must meet the setback requirements in s. ATCP 51.12. In addition, an applicant may complete Worksheet 2 to reduce setbacks for new or expanded waste storage facilities and housing.

Note: The spreadsheet equivalent of Appendix A, Worksheet 2, Table A available on the department's website at livestocksiting.wi.gov, may be submitted in place of Worksheet 2, Table A.

(2) ODOR MANAGEMENT PLAN. (a) A livestock facility must submit an odor management plan that addresses the following livestock structures located at the livestock facility at the time of its application for a local approval:

1. Any manure storage structure located within 600 feet of any property line.

2. Any livestock housing located within 400 feet of any property line.

(b) The odor management plan shall identify management practices that the livestock facility must follow to control odor from each manure storage structure and livestock housing located within the separation distance defined in par. (a) 1. and 2.

Note: The plan may include odor control practices identified in a local approval granted before the effective date of the rule [LRB inserts]. The plan also may include practices to reduce dust, practices to reduce odor from nearby livestock structures such as animal lots, practices used to reduce odor from dead animals, activities to reduce community conflict, and water conservation practices that control odor.

(c) A political subdivision may request that a livestock operator update an odor management plan if the political subdivision receives a verified odor-related complaint from a property owner adjacent to the livestock facility.

(3) NEW ODOR MANAGEMENT STANDARD. (a) In any application for local approval or permit modification submitted on or after the effective date of the rule [LRB inserts], a livestock operation must comply with the setback requirements in s. ATCP 51.12 for all new or expanded livestock structures identified in its application.

(b) All applicants must complete Appendix A, Worksheet 2 to establish setbacks for new or expanded manure storage and Category 1 and 2 livestock housing, and surface area of manure storage and Category 1 and 2 livestock housing located on the livestock facility at the time of the application for a local approval. This information will determine whether:

1. Existing livestock structures located within a setback area may be expanded, without the need for odor control practices. See ss. 51.12(1)(e) and (2)(d).

2. New or expanded livestock structures will need to implement odor control practices to reduce required setbacks. See sub. (3).

Note: The spreadsheet equivalent of Appendix A, Worksheet 2, Table A available on the department's website at livestocksiting.wi.gov, may be submitted in place of Worksheet 2, Table A.

(4) SETBACK REDUCTIONS FOR ODOR CONTROL PRACTICES. (a) In determining the setback for new or expanded manure storage and Category 1 and 2 livestock housing, an operator may reduce the required setback based on the following:

1. Odor control practices, identified in Appendix A, Worksheet 2, which the operator agrees to implement. For each odor control practice, the operator may claim the setback reduction specified in Appendix A, Worksheet 2.

2. An odor control practice not identified in Appendix A, Worksheet 2 if the department pre-approves a setback reduction for that practice. The operator shall claim the pre-approved setback reduction according to the procedure specified in par. (b).

(b) An operator seeking department approval under par. (a) 2. shall submit a written request to the department that includes:

1. A clear description of the odor control practice for which the operator seeks an approved credit.

2. Scientific evidence to substantiate the efficacy of the odor control practice under relevant conditions.

(c) The department may approve a setback reduction for an odor control practice under par. (a) 2. if, in the department's opinion, there is adequate scientific evidence to show that under relevant conditions the practice will result in odor reduction commensurate with the approved credit. The department shall grant or deny the request within 90 days after the department receives the request. The department's approval may include specifications for installation and operation of the innovative odor control practice.

(5) PRESUMPTION. For purposes of local approval, a livestock facility is presumed to comply with this section if the application for local approval complies with s. ATCP 51.30.

SECTION 40. ATCP 51.16 is repealed and recreated to read:

Nutrient management and cropland standards. (1) NUTRIENT MANAGEMENT STANDARD. (a) A livestock operator must have and follow a nutrient management plan that complies with s. ATCP 50.04(3).

(b) The nutrient management plan shall account for all land applications of manure and related waste generated by the maximum number of animal units authorized by a local approval.

Note: The Wisconsin NRCS technical guide nutrient management standard 590 (December, 2015) is incorporated into s. ATCP 50.04. The Wisconsin Conservation Planning Technical Note WI-1 (February, 2016) shall be used to estimate the quantity of manure generated. Appendix A, Worksheet 3 includes the Technical Note's estimation tool.

Note: While the application of process wastewater and other industrial wastes is regulated under ch NR.214, the nutrients from these sources when applied to fields must be accounted for in a nutrient management plan developed in accordance with this section.

(2) CROPLAND PERFORMANCE STANDARDS. (a) An operator shall implement conservation practices that achieve compliance with cropland performance standards under ss. NR 151.02, 151.03, and 151.04, in effect on the effective date of the rule [LRB inserts].

(b) An operator is required to establish a minimum tillage setback of five feet.

Note: A political subdivision may require a setback greater than 5 feet and less than 20 feet if it follows procedures the s. ATCP 50.04(4) but this increased setback is cannot be incorporated into a local approval.

(c) An operator may meet the phosphorus index standard under s. NR 151.04 by following s. ATCP 50.04(3).

(3) DEMONSTRATION OF COMPLIANCE (a) An applicant demonstrates compliance with the requirements of this section by submitting:

1. A waste and nutrient management worksheet (Appendix A, Worksheet 3) signed by the livestock operator.

2. A nutrient management checklist (Appendix A, Worksheet 3, Part D) signed by both the livestock operator and a qualified nutrient management planner other than the operator.

a. A nutrient management planner qualified under ATCP 50.48, other than the livestock operator, shall answer each checklist question. The planner shall have reasonable documentation to substantiate each answer, but neither the planner nor the operator is required to submit that documentation with the checklist.

b. A political subdivision may ask a nutrient management planner to submit the documentation that the planner relied upon to substantiate the planner's answer to one or more questions on the nutrient management checklist under par. (a) 2. The political subdivision may deny local approval if the planner's documentation does not reasonably substantiate the answer.

3. Maps of fields that will receive nutrient applications with NRCS standard 590 spreading restrictions identified on the maps.

(b) In lieu of submitting the checklist required by par. (a)2., an operator who holds a WPDES permit for the livestock facility may submit a nutrient management checklist previously submitted to DNR if the all of the following are met:

1. The nutrient management plan covers the same or greater number of animal units than the number for which the operator seeks local approval.

2. The WDPES permit and the nutrient management plan are current.

2. The livestock facility is in compliance with all WPDES permit conditions related to the nutrient management plan.

(4) PRESUMPTION. For purposes of local approval, an operator is presumed to comply with this section if the application for local approval complies with s. ATCP 51.30.

(5) NUTRIENT MANAGEMENT UPDATES. The political subdivision may:

(a) Require an operator to submit annual updates to a nutrient management plan as necessary, to maintain compliance with s. ATCP 50.04(3).

(b) Monitor an operator's compliance with a nutrient management plan.

Note: Political subdivisions may require operators to submit a DATCP-approved checklist to document nutrient management plan updates meeting the most current standards.

SECTION 41. ATCP 51.18 is repealed and recreated to read:

Waste storage facilities. (1) (a) DESIGN, CONSTRUCTION AND MAINTENANCE; GENERAL. All waste storage facilities for a livestock facility shall be designed, constructed and maintained to minimize the risk of structural failure, and to minimize the potential for waste discharge to surface water or groundwater. A waste storage facility may not lack structural integrity or have significant leakage. An unlined earthen waste storage facility may not be located on a site that is susceptible to groundwater contamination.

Note: A "site that is susceptible to groundwater contamination" is defined in s. ATCP 51.01 (39).

(b) The requirements in this section apply to facilities designed, constructed and used primarily for the storage of manure or primarily for the storage of agriculture wastewater including leachate and contaminated runoff from stored feed.

(2) DEMONSTRATION OF COMPLIANCE. (a) An applicant demonstrates compliance with the requirements of this section by submitting:

1. A waste storage facilities worksheet (Appendix A, Worksheet 4), signed by registered professional engineer or certified conservation engineering practitioner who:

a. Certifies that each existing storage facility meets applicable standards in sub. (4).

b. Submits construction plans and specifications for any new or substantially altered facility, and certifies that each substantially altered or new storage facility meets applicable standards in sub. (5).

c. Submits a plan for any waste storage facility that must be closed, and that plan meets applicable standards in sub. (6).

(b) In lieu of submitting the certification required by par. (a), an applicant may:

1. Rely on a WPDES permit issued for the livestock facility if the applicant:

a. Certify that the livestock operation's WPDES permit is current and the livestock operation is in compliance with all conditions and requirements in WPDES.

b. Submit DNR plan and specification approval for any new or substantially altered waste storage facility of the same size and type as those proposed for the new or expanded livestock facility.

c. Submit DNR approval or other determination authorizing continued use of any existing and unaltered waste storage facilities.

2. Submit a local approval granted under an ordinance adopted under s. 92.16, Stats., and engineering documentation showing that a facility was constructed within the last 3 years in accordance with then-existing NRCS standards.

3. Submit a DNR approval of a waste facility designed for storage of agricultural wastewater and other related products under ch. NR 213.

Note: If an applicant is not able to submit the documentation required in subd. 1., 2. or 3. for any storage facility located on the proposed livestock facility, the applicant must have a qualified person complete the certification in par. (a) for that facility.

(3) PRESUMPTION. For purposes of local approval, an operator is presumed to comply with this section if the application for local approval complies with s. ATCP 51.30.

(4) EXISTING FACILITIES. A registered professional engineer or certified conservation engineering practitioner shall certify that each existing waste storage facility (not including waste transfer systems) meets one of the following:

(a) The facility was constructed within the last 10 years according to then-existing NRCS standards, and a visual inspection of the facility shows no apparent signs of structural failure or significant leakage.

(b) The facility is older than 10 years, was constructed according to NRCS standards that existed at the time of construction, and a visual inspection of the emptied facility shows no apparent signs of structural failure or significant leakage.

(c) The construction standards for the facility cannot be verified from reliable documentation, a full investigation of the facility was performed, and this investigation established that the facility is in good condition and repair, shows no apparent signs of structural failure or significant leakage, and is located on a site at which the soils and separation distances to groundwater meeting the requirements for the appropriate liner type referenced in NRCS technical guide manure storage facility standard 313 (January, 2014).

Note: A full investigation includes emptying facilities of their contents, especially earthen-lined structures, to allow for complete inspection and evaluation. It also includes test pits or borings when there is no reliable documentation regarding a facility's separation distances to groundwater or bedrock.

(5) NEW OR SUBSTANTIALLY ALTERED FACILITIES. A registered professional engineer or certified conservation engineering practitioner shall certify that the design specifications for each new or substantially altered waste storage facility (including waste transfer systems) complies with applicable standards:

1. NRCS technical guide manure storage facility standard 313 (January, 2014).
2. NRCS technical guide manure transfer standard 634 (January, 2014).

Note: A political subdivision may accept a certification to a standard newer than those listed in sub. 1 and 2.

(6) CLOSED FACILITIES. (a) If an existing waste storage facility is not certified under sub. (4), and no design is submitted for its alteration, the applicant shall submit a closure plan that complies with par. (b), and must close the facility within two years of the issuance of a local approval unless the political subdivision requires an earlier closure based on imminent threat to public health, aquatic life, or groundwater.

(b) A registered professional engineer or certified conservation engineering practitioner shall certify that the closure plan complies with NRCS technical guide closure of waste impoundments standard 360 (March, 2013).

Note: Under s. NR 151.05 (3) and (4), an operator must normally close a manure storage facility if the facility has not been used for 24 months, or poses an imminent threat to public health, aquatic life or groundwater. If a waste storage facility is abandoned or not properly closed, a political subdivision may seek redress under s. 66.0627 or 254.59, Stats., as appropriate.

(7) FACILITY OPERATION. (a) All manure storage facilities in existence as of October 1, 2002 that pose an imminent threat to public health, fish and aquatic life, or groundwater shall be upgraded, replaced, or abandoned in accordance with NR 151.05(4)(b).

(b) Levels of materials in storage facilities may not exceed the margin of safety level as defined in NR 151.

(c) There shall be no mixing or storage of human waste or septage with animal manure on a dairy farm

Note: Worksheet 3 must document waste generation, including waste storage capacity, consistent with Worksheet 4. Capacity must be adequate for reasonably foreseeable needs.

(8) DEVIATION FROM DESIGN SPECIFICATIONS. (a) Local approval of a livestock facility does not authorize an operator to populate the approved livestock facility if the construction, alteration or closure of a waste storage facility deviates materially, and without express authorization from the political subdivision, from the design specifications or closure plan included in the application for local approval.

(b) A political subdivision may do all of the following to verify that waste storage facilities are constructed according to design specifications included in the application for local approval:

1. Conduct inspections consistent with legal authority.

2. Require submission of a drawing reflecting design changes made during construction and documentation certifying that the facility was installed in accordance with technical standards.

Note: See ATCP 50.56(3)(b)2. This chapter does not limit the application of local waste storage ordinances adopted under s. 92.16, Stats. If the operator's livestock facility has been approved under a siting ordinance, the operator is responsible for remaining in compliance with setback, odor and other standards in this chapter when building a manure storage structure. permitted under a local waste storage ordinance.

SECTION 42. ATCP 51.20 is repealed and recreated to read:

Runoff management. (1) NEW OR SUBSTANTIALLY ALTERED ANIMAL LOTS. Livestock operators with new or substantially altered animal lots shall collect and store manure and contaminated runoff for future land application, or construct animal lots to comply with NRCS technical guide vegetated treatment area standard 635 (September, 2016).

(2) EXISTING ANIMAL LOTS. (a) If manure and runoff from existing animal lots are not collected and stored for future land application, the applicant must document that the predicted average annual phosphorus runoff, from each existing animal lot to the end of the runoff treatment area, as determined by the BARNY model, shall be less than the following applicable amount:

1. Fifteen pounds if the edge of the animal lot is not located within any of the following:

a. 1,500 feet from navigable lakes, ponds and flowages

b. 450 feet from wetlands and navigable streams and rivers

c. 750 feet from conduits to groundwater

d. 450 feet from surface inlets that discharge to navigable waters

e. 225 feet from channelized flow (i.e., a drainage area of $\geq$ 5 acres)

f. 225 feet from subsurface drains

2. Five pounds if the edge of the animal lot is located within any of the features identified in subd. 1.

Note: The BARNY model is a computer model that predicts nutrient runoff from animal lots. An Excel computer spreadsheet version of BARNY is available at livestocksiting.wi.gov. Applicants must provide outputs from the BARNY model to document compliance with this requirement.

(b) A livestock operator may make minor alterations to an existing animal lot to meet the runoff standards in par. (a).

(c) Animal lots shall have no direct runoff to surface waters of the state or to a direct conduit to groundwater.

Note: See ss. NR 151.08 (4) and ATCP 50.04 (1). A direct conduit to groundwater may include, for example, a sinkhole.

(3) PROCESS WASTEWATER. (a) A livestock facility shall have no significant discharge of process wastewater to waters of the state or to a direct conduit to groundwater.

(4) FEED STORAGE (a) For the purposes of the requirements in this section, a feed storage structure includes any building, bunker, or paved area used for feed storage or handling, but does not include silos, storage bags, and grain bins.

(b) An existing feed storage structure may be used, without substantial alteration, to store or handle feed if a registered professional engineer or certified conservation engineering practitioner certifies that the structure:

1. Was constructed according to applicable NRCS standards that existed at the time of construction, or in the absence of documentation to support this, the structure is located on a site with soils and separation distances that comply with Tables 1, 2 or 3 in NRCS technical guide waste treatment standard 629 (January, 2017).

Note: The type of structure determines which table must be used to document compliance.

2. Is in good condition and repair.

3. Shows no apparent signs of structural failure, significant leakage, or significant discharges to surface water.

(c) An existing feed storage structure must be operated and maintained to:

1. Divert clean water from entering the structure or paved area.

2. Collect and store surface discharge of leachate from stored feed and initial runoff volume of 0.20 inches from each precipitation event before it leaves the structure or paved area, if the structure or paved area covers more than one acre. Collected leachate shall be stored and disposed of in a manner that prevents discharge to waters of the state.

3. Prevent leachate and contaminated runoff from infiltrating below the storage structure.

4. Avoid accumulation of debris in the loading area.

5. Ensure proper functioning of collection and treatment areas.

(d) A new or substantially altered feed storage structure shall comply with both of the following except as provided in par. (e):

1. The storage structure shall be designed, constructed and maintained in accordance with NRCS waste treatment technical standard 629 (January, 2017).

2. Leachate and contaminated runoff from storage structure shall be collected and stored for future land application, or treated in accordance with NRCS vegetated treatment area technical standard 635 (September, 2016).

(e) If a new or expanded feed storage structure is less than one acre, the design for the new structure, or the new portion of the expanded structure, is only required to meet the applicable Table 1, 2 or 3 of NRCS waste treatment technical standard 629 (January, 2017) if each of following are met:

1. The proposed structure is not located within any of the separation distances in sub. (2)(a)1.a.-f.

2. A registered professional engineer or certified conservation engineering practitioner certifies that:

a. The structure is designed to collect and store all leachate from stored feed and an initial runoff volume of 0.20 inches from each precipitation event.

b. The site area including the proposed structure and surrounding land is not located on soils with a high potential for leaching contaminants to groundwater.

c. Conditions at the site area and the design of storage area are such that runoff from a 25-year, 24-hour precipitation event will not result in a significant discharge to waters of the state.

Note: Runoff from feed storage must be controlled to prevent a significant discharge to waters of the state. Livestock operators are responsible for meeting this requirement if they follow the design standard in par. (d). In addition, livestock operators are subject to federal discharge standards that may be more restrictive than state standards.

(f) For the purposes of meeting the one acre size requirement in pars. (c) and (e), two or more feed storage structures at the same livestock facility shall be treated as a single storage structure if runoff from any structure converges or meets with runoff from another structure within the separation distances in sub. (2)(a)1.a.-f.. If two or more structures are related in this manner, each of structures must individually meet the separation distances in sub.(2)(a)1.a.-f.

(5) MILKING CENTER WASTEWATER. (a) For the purposes of the requirements in this section, milking center wastewater consists of wash water used to clean the milk harvesting and milk cooling equipment, and other contaminated sources of wastewater (water softener) and wash water used to clean the floors and walls. Wastewater from the floor of the holding area, clean discharge water sources (plate cooler, roof water) and sanitary wastewater (toilets, sinks, clothes laundry) must be excluded from the treatment system.

(b) Milking center wastewater shall be transferred to a waste storage facility or other structure that meets the design criteria of NRCS waste facility storage technical standard 313 (January, 2014) except as provided in par. (c).

(c) If a livestock facility generates less than 500 gallons of milking center wastewater daily and does not store the wastewater for an extended period, the livestock operation may use the treatment practices described in NRCS waste treatment technical standard 629 (January, 2014).

(6) CLEAN WATER DIVERSION. Clean water shall be diverted away from contacting animal lots, waste storage facilities, and manure piles within 1,000 feet of a navigable

lake, 300 feet of a navigable stream or wetlands, 300 feet from wetlands connected to navigable lake or stream, or 500 feet from a direct conduit to groundwater .

Note: See ss. NR 151.06 and ATCP 50.04 (1). Runoff may be diverted by means of earthen diversions, curbs, gutters, waterways, drains or other practices, as appropriate.

(7) OVERFLOW OF WASTE STORAGE FACILITIES. A livestock facility shall be designed, constructed and maintained to prevent overflow of waste storage facilities.

Note: Under s. ATCP 51.18 (5), waste storage capacity must be adequate to meet reasonably foreseeable storage needs, based on the operator's waste and nutrient management strategy under s. ATCP 51.16. See also ss. NR 151.08 (2) and ATCP 50.04 (1).

(8) UNCONFINED MANURE PILES. A livestock facility may not have any unconfined manure piles within 1,000 feet of a navigable lake or 300 feet of a navigable stream.

Note: See ss. NR 151.08 (3) and ATCP 50.04 (1).

(9) LIVESTOCK ACCESS TO SURFACE WATERS OF THE STATE. A livestock facility shall be designed, constructed and maintained to prevent unrestricted livestock access to surface waters of the state, if that access will prevent adequate vegetative cover on banks adjoining the water. This subsection does not prohibit a properly designed, installed and maintained livestock crossing or machinery crossing.

Note: See ss. NR 151.08 (5) and ATCP 50.04 (1).

(10) DEMONSTRATION OF COMPLIANCE. (a) An applicant demonstrates compliance with the requirements of this section by submitting a runoff management worksheet (Appendix A, Worksheet 5), signed by a registered professional engineer or certified conservation engineering practitioner and the applicant, certifying that the existing, substantially altered and new structures and practices meet applicable standards in subs. (1) - (9).

(b) In lieu of submitting certification required by par. (a), an operator who holds a WPDES permit may submit the following documentation from DNR to cover one or more structures:

1. Plan and specification approval for new or substantially altered animal lots or feed storage structures.

2. Compliance determinations for existing animal lots or feed storage structures.

(11) PRESUMPTION. For purposes of local approval, a livestock facility is presumed to comply with this section if the application for local approval complies with s. ATCP 51.30.

(12) DEVIATION FROM DESIGN SPECIFICATIONS. (a) Local approval of a livestock facility does not authorize an operator to populate the approved livestock facility if the construction or alteration of an animal lot or feed storage structure deviates materially, and without express authorization from the political subdivision, from design specifications included in the application for local approval.

(b) A political subdivision may do all of the following to verify that animal lots and feed storage structures are constructed according to design specifications included in the application for local approval:

1. Conduct inspections consistent with legal authority.

2. Require submission of a construction plan, a drawing reflecting design changes made during construction and documentation certifying that the facility was installed in accordance with technical standards.

Note: A deviation under sub. (12) does not invalidate a local approval, but does prevent the livestock operator from populating the approved livestock facility until the deviation is rectified or approved.

SECTION 43. ATCP 51.30 (1) (Note) is created to read:

The department-approved form is available at livestocksiting.wi.gov.

SECTION 44. ATCP 51.30 (3) (Note) is repealed.

SECTION 45. ATCP 51.30 (4) and (Note) is repealed and recreated to read:

LOCAL FEES. (a) A political subdivision may charge:

1. A full application fee established by local ordinance, not to exceed $1,000, to offset the political subdivision's costs to review and process an application under sub. (1).

2. A fee for permit modification under ATCP 51.34(4m) not to exceed $500.

Note: Under s. 66.0628, Stats., any fee imposed by a political subdivision must bear a reasonable relationship to the service for which the fee is imposed.

(b) A political subdivision may not require an applicant to pay any fee, or post any bond or security with the political subdivision, except as provided in par. (a).

SECTION 46. ATCP 51.30 (4m) is created to read:

PRE-APPROVAL SITE PREPARATION. After a political subdivision receives an application under sub. (1), the political subdivision may notify the applicant that prior to a final decision on an application for local approval, activities at the livestock facility shall be limited to grading and other site preparation.

SECTION 47. ATCP 51.30 (5) is amended to read:

COMPLETE APPLICATION. Within 45 days after a political subdivision receives an application under sub. (1), the political subdivision shall notify the applicant whether the application ~~contains everything required~~ meets the requirements under subs. (1) to (4). If the political subdivision determines that the application is ~~not complete, the notice shall specifically describe what else is needed.~~ incomplete, it must complete a department-approved checklist to identify every item needed to make the application complete and provide a copy of the completed checklist to the applicant. Items not identified in the checklist are deemed complete and an applicant is only required to submit additional materials identified in the checklist to receive a completeness determination. Within 14 days after the applicant has ~~provided everything required~~ met the requirements under subs. (1) to (4), the political subdivision shall notify the applicant that the application is complete. A notice of completeness does not constitute an approval of the proposed livestock facility.

SECTION 48. ATCP 51.34 (3) (a) is amended to read:

WRITTEN DECISION. (a) A political subdivision shall issue its decision under sub. (1) or (2) in writing. The decision shall be based on written findings of fact included in the decision. The findings of fact shall be supported by evidence in the record under s. ATCP 51.36. Findings may be based on presumptions created by this chapter. A political subdivision may only impose conditions related to an operator's compliance with the standards authorized in subch. II of ATCP 51. Any conditions attached to a local approval must be described in the final written decision granting the approval. Nothing in this chapter precludes a political subdivision from entering into a voluntary agreement with a permit applicant outside the scope of ch. ATCP 51.

SECTION 49. ATCP 51.34 (3) (a) (Note) is repealed.

SECTION 50. ATCP 51.34 (4) (intro.) is amended to read:

TERMS OF APPROVAL. (intro.) An approval under sub. (1) is conditioned on the operator's compliance with subch. II and representations made in the application for approval. ~~This chapter does not limit a~~ A political ~~subdivision's authority to do any of the following~~ subdivision may:

SECTION 51. ATCP 51.34 (4) (a) is repealed and recreated to read:

(a) Monitor compliance with applicable standards under subch. II using any of the following methods:

1. Require an operator to certify, on an annual or less frequent basis, compliance with applicable standards under subch. II. Political subdivisions shall provide livestock operators a department-approved checklist to self-certify compliance.

2. Inspect locally-approved livestock facilities consistent with legal authority. If conducting inspections, a political subdivision shall use a department-approved compliance checklist to document the results of inspections.

Note: A political subdivision may request documentation that manure and nutrients were applied according to a nutrient management plan, s. ATCP 51.16, a livestock structure was installed according to standards, ss. ATCP 51.18(8) and 51.20(11), and activities identified in a training and other required plan was conducted in accordance with that plan.

SECTION 52. ATCP 51.34 (4) (b) 2. is amended to read:

The operator, without authorization from the political subdivision, fails to honor relevant commitments made in the application for local approval. ~~A political subdivision may not withhold authorization, under this subdivision, for reasonable changes that maintain compliance with the standards in subch. II.~~

SECTION 53. ATCP 51.34 (4m) is created to read:

MODIFICATION (a) As an alternative to procedures to sec. ATCP 51.30 and 51.32, a livestock operator with a local approval granted in accordance with sub (1) may apply for a modification of that local approval.

(b) A livestock operator may apply for one or more modifications if the total increase in the number of animal units housed on the livestock operation does not exceed 30 percent of the maximum number authorized in the most recent local approval issued under sub. (1).

(c) A livestock operator may not request a modification if the modification would require that the operator complete four or more worksheets.

(d) The livestock operator requests modification by completing and submitting:

1. Request for Modification of a Local Approval (Appendix B).

Note: Appendix B contains instructions for completing the request for permit modification, including options to complete Worksheet 5. The department-approved form is available at livestocksiting.wi.gov.

2. Applicable worksheets from Appendix A documenting that the livestock facility, as modified, will maintain compliance with the standards in subch. II of ATCP 50.

3. Additional documentation to establish compliance with any local standards adopted in a political subdivision's in accordance with s. ATCP 51.10(3).

(e) The political subdivision may only charge the permit modification fee prescribed in ATCP 51.30(4) and may provide notice of the modification to adjacent property owners in accordance ATCP 51.30(6), but is not required to take any other actions under ATCP 51.30 to process a permit modification.

(f) A livestock operator may submit a full application under (1) to secure the right to a completeness determination and presumption of compliance established under s. 93.90(4)(d), Stats.

(g) A political subdivision must grant or deny a modification request within 45 days after the livestock operator's submission of a complete application, and is not required to follow the procedures in s. ATCP 51.32.

(h) A political subdivision shall record its decision on the requested modification by completing Appendix B, and is not required to issue a written decision under s. ATCP 51.34(3) unless it denies the requested modification.

(i) A political subdivision may not withhold approval of modification request for changes that maintain compliance with the standards in subch. II.

SECTION 54. ATCP 51.34 (5) (a) 2. and 3. are amended to read:

2. ~~File~~ Electronically file with the department a copy of the final application or permit modification granted or denied, if the political subdivision has granted or denied an application under this section. The copy shall include all of the worksheets, maps and other attachments included in the application, except that it is not required to include engineering design specifications.

3. ~~File~~ Electronically file with the department a copy of the political subdivision's final notice or order withdrawing a local approval under sub. (4) (b) or s. ATCP 51.08 (2), if the political subdivision has withdrawn a local approval.

SECTION 55. ATCP 51.34 (5) (a) 3. (Note) is created to read:

This website, livestocksiting.wi.gov, has instructions for electronic filing with the department.

SECTION 56. ATCP 51.34 (5) (b) and (c) are repealed and recreated to read:

(b) Failure to comply with par. (a) does not invalidate a political subdivision's decision to grant or deny an application for local approval, or to withdraw a local approval.

SECTION 57. Chapter ATCP 51, Appendix A, Application Form and Worksheets is repealed and recreated, as attached hereto.

SECTION 58. Chapter ATCP 51, Appendix B, NRCS nutrient management technical standard 590 (September, 2005) is repealed and recreated as Chapter ATCP 51, Appendix B, Request for Modification of a Local Approval, as attached hereto.

SECTION 59. Chapter ATCP 51, Appendix C, Notice To Adjacent Property Owners is repealed and recreated, as attached hereto.

SECTION 60. EFFECTIVE DATE AND INITIAL APPLICABILITY.

(1) Except as provided in sub. (2), this rule takes effect on the first day of the month following publication in the Wisconsin administrative register, as provided under s. 227.22(2)(intro.).

(2) This rule first applies to small businesses as defined in s. 227.114(1), Stats., on the first day of the third month commencing after the rule publication date, as required by s. 227.22(2)(e), Stats.

Dated this _______day of ___________, ________.

WISCONSIN DEPARTMENT OF AGRICULTURE,
TRADE AND CONSUMER PROTECTION

By ____
Ben Brancel, Secretary

Appendix A

Application for Local Approval

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive
P.O. Box 8911
Madison, WI 53708-8911
(608) 224-4630
(608) 224-4500

arm-lwr- 11/04

	Wisconsin Department of Agriculture, Trade and Consumer Protection 2811 Agriculture Drive, PO Box 8911, Madison WI 53708-8911 Phone: (608) 224-4630 or (608) 224-4500	**Permitting Authority must complete** **Application #:** **Date Application Received:** **Date Completeness Determined:** **Date Notice Sent to Applicant:** **Date Notice Sent to Adjacent Landowners:** **Decision Date:** **Approved or Disapproved:**

Application for Local Approval

Wis. Stat. § 93.90

New or Expanded Livestock Facility

Wis. Adm. Code ch. ATCP 51

1. Legal Name of Applicant (Business Entity):

2. Type of Business Entity: check one

☐Individual	☐Corporation	☐Partnership	☐Cooperative	☐LLC
☐Trust	☐Other	Describe:		

3. Other names, if any, under which applicant does business (list all):

4. Contact Individual:	Name:
Phone:	E-mail:

5. Business Address: Street Address:

City/Village/Town:	County:	State:	Zip:

6. Principal Owners or Officers (list if applicant is an entity other than an individual):

Name:	Title:	Phone:	
Address:	City:	State:	Zip:
Name:	Title:	Phone:	
Address:	City:	State:	Zip:
Name:	Title:	Phone:	
Address:	City:	State:	Zip:

7. Description of Proposed Livestock Facility

Check one: ☐ New Livestock Facility ☐ Expanded Livestock Facility | Premises ID ☐ Yes ☐ No

Address of Proposed Livestock Facility:

City/Village/Town:	County:	State:	Zip:
Town #	Range # (E or W)	Section #	¼ Section #

8. Total Animal Units

Enter total animal units from **worksheet 1:**

Total Animal Units: ___________. This is the maximum livestock facility size for which the applicant requests approval at this time. All worksheets must be prepared based on this maximum listed size.

9. Area Map of Livestock Facility

Attach a scale map or aerial photo of the proposed livestock facility and surrounding area. The map or photo must be appropriately sized and marked, so that it clearly and legibly shows all of the following:

- All existing and proposed (new or altered) livestock structures. Label each livestock structure with a unique identifier that includes a description of the structure type (manure storage, housing, lot, feed storage, waste transfer system), and if proposed indicates whether the structure is new or altered. For example, use the identifier "new manure storage 2" to indicate that a proposed manure storage structure is new and the second of a certain number of manure storage structures at the facility. The structure must be listed by its unique identifier in all relevant worksheets.
- The area lying within 2 miles of any of the livestock structures. Show all existing buildings, property lines, roadways, and navigable waters within that area.
- Topographic lines at 10 ft. elevation intervals.
- Map scale and north direction indicator.

10. Site Map of Livestock Facility

Attach a scale map or aerial photo of the proposed livestock facility site. The map or photo shall be appropriately sized and marked, so that it clearly and legibly shows all of the following:

- All existing and proposed (new or altered) livestock structures. Label each livestock structure with a unique identifier that includes a description of the structure type (manure storage, housing, lot, feed storage, waste transfer system), and if proposed indicates whether the structure is new or altered. For example, "existing manure storage 1" would identify that a manure storage structure is existing and the first of a certain number of manure storage structures at the livestock facility. Include the unique identifier for each structure, when completing all relevant worksheets.
- The area lying within 1,000 ft. of any of the livestock structures. Show all existing buildings, property lines, roadways, navigable waters, and known karst features within that area.
- Topographic lines, at 2 ft. elevation intervals, for the area within 300 feet of the livestock structures.

11. Location of Livestock Structures

The applicant certifies that:

- All livestock structures comply with applicable local property line and road setbacks. See ATCP 51.12(1). **Note**: *Includes storage structures designed, constructed and operated to collect non-manure waste.*
- All livestock structures comply with applicable local shoreland, wetland, and floodplain zoning ordinances (copies available from local government).
- Wells comply with the Wisconsin well code (NR 811 and 812). New or substantially altered livestock structures are separated from existing wells (including neighbors' wells) by setback distances required in NR 811 and 812.

12. Employee Training Plans (Required of all applicants)

Attach an Employee Training Plan for employees who will work at the *livestock facility.* Applicant determines plan contents, as long as the plan identifies all of the following:

- Training topics including, at a minimum, nutrient management, odor management, manure management and waste handling, maintenance of odor control practices, runoff management, and environmental incident response.(Training on employee safety should be included in these topics)
- The number and job categories of employees to be trained.
- The form and frequency of training, which at a minimum must include a plan for at least one training per year.
- Training presenters (these may include *livestock facility* managers, consultants or professional educators).
- A system for taking and recording attendance.
- A system for documenting and retaining records of completed trainings (Permitting authorities may request to inspect these records).

13. Environmental Incident Response Plan (Required of all applicants)

Attach an Environmental Incident Response Plan for the *livestock facility.* Applicant determines plans contents, as long as the plan identifies all of the following:

- Types of environmental incidents covered. These must include, at a minimum, overflows and spills from waste storage facilities, catastrophic system failures, manure spills during transport and application, movement of manure during or after application, catastrophic mortality disposal emergency, and odor complaints.
- The name and business telephone number of at least one individual who will handle public questions and concerns related to environmental incidents.
- The names and telephone numbers of first responders (e.g. DNR, fire departments, excavation contractors)
- Incident response procedures, including emergency response, recordkeeping and reporting requirements.
- A system for documenting and retaining records involving environmental incidents. (Permitting authorities may request to inspect these records).

14. Odor Management Plan

Attach an odor management plan if the livestock facility has any existing manure storage located within 600 feet of any property line or any existing livestock housing located within 400 feet of any property line.

- The plan shall identify management practices that the livestock facility must follow to control odor from each manure storage structure and livestock housing located within the separation distances. The plan may include odor control practices identified in a local approval granted before [the effective date of this rule revision].
- In the case of a new or expanded manure storage structure and livestock housing that cannot be constructed without odor control practices to reduce setback requirements, the operator may reference Worksheet 2 in place of describing the odor control practices in the plan.
- The plan also may include practices to reduce dust, practices to reduce odor from nearby livestock structures such as animal lots, practices used to reduce odor from dead animals, activities to reduce community conflict, and water conservation practices that control odor.

15. Narrative

Include narrative describing the new or expanded livestock facility, including the new or altered livestock structures using unique identifiers and the manure management system that will be implemented at the facility.

16. Worksheets

Complete worksheets as required (follow instructions on each worksheet) and attach to application.

Worksheet 1 – Animal Units.

Worksheet 2 – Odor Management.

Worksheet 3 – Waste and Nutrient Management. If you meet the requirements for an exemption, check the appropriate box on this worksheet, and provided necessary documentation and certification with this application.

Worksheet 4 – Waste Storage Facilities. If you meet the requirements for an exemption, check the appropriate box on this worksheet, and provided necessary documentation and certification with this application.

Worksheet 5 – Runoff Management. If you meet the requirements for an exemption, check the appropriate box on this worksheet, and provided necessary documentation and certification with this application.

Authorized Signature:

I (we) certify that the information contained in this application (including worksheets and all attachments) is complete and accurate to the best of my knowledge.

Signature of Applicant # 1 or Authorized Representative #1 ______ Date ______

Print Name ______ Title ______

Signature of Applicant # 2 or Authorized Representative # 2 ______ Date ______

Print Name ______ Title ______

arm-lwr-

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708-8911
Phone: (608) 224-4630 or (608) 224-4500

Worksheet 1 - *Animal Units*

Instructions: Use this worksheet to determine the number of animal units for which you request approval. You may request approval for a number that is large enough to accommodate current and potential future expansions. If the local government approves the requested number of animal units,that is the maximum number that you may keep for 90 days or more in any 12-month period. You may not exceed that number without additional approval.

To complete this worksheet:

1. Identify each type of livestock that you might keep at the proposed facility. Enter the maximum number of animals of each type that you might keep for at least 90 days in any 12-month period.
2. Multiply the number of animals of each type by the relevant Animal Unit Factor to obtain animal units of each type.
3. Sum the animal units for all livestock types to obtain the Total Animal Units for which you request approval.

Livestock Type		Animal Unit Factor	*Animal Units* For Proposed Facility
Example – Milking & Dry Cows			*1.4 x 800 = 1120 AU*
Dairy Cattle	Milking and Dry Cows	1.4	1.4 x =
	Heifers (800 lbs. to 1200 lbs.)	1.1	1.1 x =
	Heifers (400 lbs. to 800 lbs.)	0.6	0.6 x =
	Calves (up to 400 lbs.)	0.2	0.2 x =
Beef	Steers or Cows (600 lbs. to market)	1.0	1.0 x =
	Calves (under 600 lbs.)	0.5	0.5 x =
	Bulls (each)	1.4	1.4 x =
Swine	Pigs (55 lbs. to market)	0.4	0.4 x =
	Pigs (up to 55 lbs.)	0.1	0.1 x =
	Sows (each)	0.4	0.4 x =
	Boars (each)	0.5	0.5 x =
Poultry	Layers (each)	0.01	0.01 x =
	Broilers (each)	0.005	0.005 x =
	Broilers – continuous overflow watering	0.01	0.01 x =
	Layers or Broilers - liquid manure system	0.033	0.033 x =
	Ducks – wet lot (each)	0.2	0.2 x =
	Ducks - dry lot (each)	0.01	0.01 x =
	Turkeys (each)	0.018	0.018 x =
Sheep (each)		0.1	0.1 x =
Goats (each)		0.1	0.1 x =
Total *Animal Units* for Which Applicant Requests Approval			=

Signature of Applicant or Authorized Representative

Date

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708-8911
Phone: (608) 224-4630 or (608) 224-4500

Worksheet 2 – Odor Management

Instructions: This worksheet addresses property line setbacks for certain livestock structures with higher potential to generate odor.

In conjunction with this worksheet, an operator must certify that livestock structures proposed for the livestock facility comply with the property line and public road right-of-way setbacks established by local ordinance. (See Application, #11). These local setbacks apply to new or expanded livestock structures not covered by this worksheet including animal lots, feed storage, and livestock housing not covered under Categories 1 and 2. The certification also covers public road right-of-way setbacks for all livestock structures, a setback requirement not addressed by this worksheet.

More restrictive property line setbacks in this worksheet apply to new and expanded Category 1 and 2 livestock housing, and manure storage structures. These setbacks do not apply to livestock structures existing at the time of a permit application or to those structures expanding by less than 20 percent. Use this worksheet to determine if all manure storage structures, and Category 1 and 2 livestock housing structures meet property line setbacks. This worksheet enables livestock operators to reduce certain setback distances by installing and maintaining odor control practices according to the "Odor Control Practice Specifications." Also, this worksheet documents the baseline area for certain livestock structures to allow future expansion of less than 20 percent without requiring odor control practices

If livestock structures are located in clusters, an applicant may determine the setback distances for those structures based on the animal units kept at that cluster. This option is not available if the clusters are separated by less than 1000 feet or a livestock structure in one cluster receives manure from animals in another cluster.

In addition to this worksheet, livestock facilities must submit an odor management plan that covers the following structures existing at the time of application for local approval: manure storage located within 600 feet of a property line and livestock housing located within 400 feet of a property line. (See Application, #14 – Odor Management Plan for instructions.)

TO COMPLETE THIS WORKSHEET, FOLLOW THESE STEPS:

Step 1: Complete Table A for each Category 1 and 2 livestock housing and manure storage structure on the proposed facility.

Note: You may use a convenient automated spreadsheet of Table A if you prefer. The spreadsheet, which includes instructions for completing it, is available at the department's website: http://www.livestocksiting.wi.gov. Whether you use the paper version of Table A or its spreadsheet equivalent, you must submit a copy with this completed worksheet.

Step 2: Based on Table A, list (by the structure's unique identifier) each Category 1 and 2 livestock housing structure that meets the setback requirements in Chart 1:

A. Without odor control practices: ____________________

B. With odor control practices: ____________________

Step 3: Based on Table A, list (by the structure's unique identifier) each manure storage structure that meets the setback requirements in the Chart 4:

A. Without odor control practices: ____________________

B. With odor control practices: ____________________

By signing this worksheet, the applicant or authorized representative certifies that the information provided in this worksheet is true, complete, and accurate, and further agrees to install and maintain the odor control practices identified in Table A, in accordance with the specifications listed in this worksheet.

____ ____________
Signature of Applicant or Authorized Representative Date

Table A: Odor Management Spreadsheet, Version 1.0

Part 1. Number of Animal Units =

Part 2. Category 1 and 2 Livestock Housing

Column A: Unique ID	Column B: Housing description	Column C: Square Footage (Ft.2)	Column D: Pre-expansion Square Footage ($Ft.^2$)	Column E: Setback Distance (Ft.)	Column F: 1st Control Practice	Column G: Reduction (Ft.)	Column H: 2nd Control Practice	Column I: Reduction (Ft.)	Column J: 3rd Control Practice	Column K: Reduction (Ft.)	Column L: 4th Control Practice	Column M: Reduction (Ft.)	Column N: Reduced Setback (Ft.)	Column O: Distance To Property Line (Ft.)

Part 3. Manure Storage

Column A: Unique ID	Column B: Storage description	Column C: Surface Area (Ft.2)	Column D: Pre-expansion Surface Area ($Ft.^2$)	Column E: Setback Distance (Ft.)	Column F: 1st Control Practice	Column G: Reduction (Ft.)	Column H: 2nd Control Practice	Column I: Reduction (Ft.)	Column J: 3rd Control Practice	Column K: Reduction (Ft.)	Column L: 4th Control Practice	Column M: Reduction (Ft.)	Column N: Reduced Setback (Ft.)	Column O: Distance To Property Line (Ft.)

TO COMPLETE TABLE A <u>FOR CATEGORY 1 AND 2 LIVESTOCK HOUSING</u>, FOLLOW THESE STEPS:

Step 1: In Table A, Part 1, enter the number of animal units for which you are seeking local approval.

Step 2: In Table A, Part 2, enter basic information for all Category 1 and 2 livestock housing structures.

- Complete Column A by entering the unique identifier for each structure
- Complete Column B by writing "1" or "2" to note the category of housing, and "Existed" or "New" as of [date of rule]. (e.g. write "1 – New" for Category 1 housing built after [date of rule]).
- Complete Column C by entering the total square footage that will be occupied by livestock as proposed in the application for local approval. (Do not include feed alley, holding areas, or milking parlors.)
- Complete Column D only for each expanded structure, by entering the occupied square footage of the structure before expansion.

Step 3: For each structure that existed as of [date of rule] or square footage will be expanded less than 20 percent, enter the distance from the structure to the property line into Column O and stop here.

Step 4: For each structure that will be *newly constructed or expanded by 20 percent or more square footage*, enter the applicable setback distance.

- Using the number of animal units entered into Table A, Part 1, refer to Chart 1 (below) and select the appropriate setback distance.
- Enter that distance into Column E for each of these structures.

Chart 1: Category 1 and 2 Livestock Housing Minimum Setbacks

Type of Structure	Animal Unit (AU) Capacity	Property Line Setback
Category 1 livestock housing: • Pork gestation/farrow/nursery with slatted floor (includes floor and pit below) • Pork finishing with slatted floor (includes floor and pit below)	<1,000 AU	600 feet
	1,000 AU - <2,500 AU	1000 feet
	2,500 AU - <4,000 AU	1450 feet
	4,000 AU or more	1700 feet
Class 2 livestock housing: • Dairy housing with Alley Flush • Beef Housing with slatted floor • Pork Finishing scrape systems to storage and pull plug to storage • Poultry Layers • Ducks (liquid)	<1,000 AU	400 feet
	1,000 AU - <2,500 AU	700 feet
	2,500 AU - <4,000 AU	1000 feet
	4,000 AU or more	1200 feet

Step 5: If a structure will meet the setback requirement in Column E, enter the distance from the structure to the property line into Column O and stop here.
For structures without odor control practices, the distance to the property line in Column O shall be equal to or greater than the required setback distance in Column E.

Step 6: For any new or expanded structure, identify and list odor control practices, if needed, to reduce setback distances.
Please refer to the "Odor Control Practice Specifications" in this worksheet for details regarding installation and maintenance of each practice, including the level of effectiveness.

- Refer to Chart 2 (below) and select the practices you will install and maintain. For each structure, you may install up to four odor control practices.
- Write each practice into Columns F, H, J, and L; in order from high to medium to low level of effectiveness.

Chart 2: Category 1 and 2 Livestock Housing Odor Control Practices

Control Practice	Effectiveness	Level
Bio-filter / Bioscrubbers	High	1
Wet Scrubber with bleach or other chemicals	High	1
Vegetable oil sprinkling (for swine only)	High	1
Wet Scrubber with water	Medium	2
Recirculated flush water	Medium	2
Treated water flush	Medium	2
Poultry Dryer Belt System	Medium	2
Diet manipulation	Low	3
Air Dam (for swine only)	Low	3
Windbreak (includes manmade berms)	Low	3
Chemical or biological additives	Low	3
Frequent cleaning of animal housing area	Low	3

Step 7: Enter the setback reduction distances that apply to each odor control practice listed in Table A.

- Refer to Chart 3 (below) and write the setback reduction distances into Columns G, I, K, and M.

Chart 3: Category 1 and 2 Livestock Housing Setback Reductions

Type of Structure	Practice Effectiveness in Chart 2	Level 1 reduction distance	Level 2 reduction distance	Level 3 reduction distance
Category 1 livestock housing:* • Pork gestation/farrow/nursery with slatted floor (includes floor and pit below) • Pork finishing with slatted floor (includes floor and pit below)	Level 1, may combine with Level 2 and/or Level 3	250 feet	150 feet	50 feet**
	Level 2 may combine with Level 3		200 feet	50 feet**
	Only Level 3			75 feet**
Category 2 livestock housing:* • Dairy housing with alley flush • Beef housing with slatted floor • Pork finishing scrape systems to storage, and pull plug to storage • Poultry Layers • Ducks (liquid)	Level 1, may combine with Level 2 and/or Level 3	175 feet	100 feet	50 feet**
	Level 2 may combine with Level 3		125 feet	50 feet**
	Only Level 3			75 feet**

* Setbacks may not be reduced below the maximum allowable setback distances that apply to all livestock housing by a local ordinance (e.g. <1,000 AU = 100 feet; 1,000 AU - <2,500 AU = 200 feet; 2,500 AU or more = 300 feet).

** For each additional level 3 practice, the applicant may reduce the setback distance by 50 feet (e.g. up to 225 feet total if installing four Level 3 practices).

Step 8: Calculate the reduced setback requirement for each structure in Table A due to installing and maintaining odor control practices.

- Across each row listing odor control practices in Table A, add the individual setback reduction distances that are entered into Columns G, I, K, and M.
- Subtract the total distance (Columns G + I + K + M) from the Setback Distance in Column E.

- Enter the result into Column N **or** one of the following distances into Column N, **whichever is greater***:
  - For facilities <1,000 AU = 100 feet; for facilities 1,000 AU - <2,500 AU = 200 feet; and for facilities 2,500 AU or more = 300 feet. (*Setbacks may not be reduced below the maximum allowable setback distances that apply to all livestock housing by a local ordinance.)

Step 9: If a structure will meet the reduced setback requirement in Column N, enter the distance from the structure to the property line into Column O. For structures with odor control practices, the distance to property line in Column O shall be equal to or greater than the reduced setback distance in Column N.

TO COMPLETE TABLE A FOR MANURE STORAGE STRUCTURES, FOLLOW THESE STEPS:

Step 1: In Table A, Part 2, enter the number of animal units for which you are seeking local approval.

Step 2: In Table A, Part 2, enter basic information for all manure storage structures.
- Complete Column A by entering the unique identifier for each structure.
- Complete Column B by writing "Existed" or "New" as of [date of rule].
- Complete Column C by entering the total surface area of each structure as proposed in the application for local approval. Measure the exposed surface area of the manure when the structure is at its maximum operation level (do not include 2' free board).
- Complete Column D only for each expanded structure, by entering the total surface area of the structure before expansion.

Step 3: For each structure that existed as of [date of rule] or surface area will be expanded less than 20 percent, enter the distance from the structure to the property line into Column O and stop here.

Step 4: For each structure that will be *newly constructed or expanded by 20 percent or more surface area,* enter the applicable setback distance.
- Using the number of animal units entered into Table A, Part 1, refer to Chart 4 (below) and select the appropriate setback distance.
- Enter that distance into Column E for each of these structures.

Chart 4: Manure Storage Minimum Setbacks

Type of Structure	Animal Unit (AU) Capacity	Property Line Setback
Earthen or other storage	<1,000 AU	600 feet
	1,000 AU -2,500 AU	1000 feet
	2,500 AU - <4,000 AU	1400 feet
	>4,000 AU	1700 feet, plus 200 feet for every 1000 AU over 4,000 AU; but no more 2500 feet total setback

Step 5: If a structure will meet the setback requirement in Column E, you may enter the distance from the structure to the property line into Column O and stop here.
For structures without odor control practices, the distance to the property line in Column O shall be equal to or greater than the required setback distance in Column E.

Step 6: For any new or expanded structure, identify and list odor control practices, if needed, to reduce setback distances.

Please refer to the "Odor Control Practice Specifications" in this worksheet for details regarding installation and maintenance of each practice, including the level of effectiveness.

- Document the odor control practices you will install for structures listed in Table A.
  - Refer to Chart 5 (below) and select the practices you will install and maintain. For each structure, you may install up to four odor control practices.
  - Write each practice into Columns F, H, J, and L; in order from high to medium to low level of effectiveness.

Chart 5: Manure Storage Odor Control Practices

Control Practice	Effectiveness	Level
Wastewater Treatment	High	1
Impermeable cover	High	1
Compost	High	1
Natural crust	Medium	2
Bio cover	Medium	2
Geotextile cover	Medium	2
Anaerobic digestion	Medium	2
Manure Solids Separation and Reduction (Higher efficiency)	Medium	2
Bottom fill	Low	3
Chemical or biological additives	Low	3
Manure Solids Separation and Reduction (Lower efficiency)	Low	3
Windbreak (includes man-made berms)	Low	3

Step 7: Enter the setback reduction distances that apply to each odor control practice listed in Table A.

- Refer to Chart 6 (below) and write the setback reduction distances into Columns G, I, K, and M.

Chart 6: Manure Storage Setback Reductions

Type of Structure & Facility Size	Practice Effectiveness in Chart 5	Level 1 reduction distance	Level 2 reduction distance	Level 3 reduction distance
Uncovered earthen or other open manure storage structure for facility less than 4,000 AU*	Level 1, may combine with Level 2 and/or Level 3	500 feet	150 feet	75 feet**
	Level 2 may combine with Level 3		300 feet	75 feet**
	Only Level 3			100 feet**
Uncovered earthen or other open manure storage structure for facility 4,000 or more AU*	Level 1, may combine with Level 2 and/or Level 3	1000 feet	300 feet	100 feet**
	Level 2 may combine with Level 3		600 feet	100 feet**
	Only Level 3			150 feet**

* Setbacks may not be reduced below 350 feet for facilities under 1,000 AUs; for facilities 1,000 to <2,500 AUs, setbacks may not be reduced below 500 feet; and for facilities over 2,500 AUs, setbacks may not be reduced below 750 feet.

** For each additional level 3 practice, the applicant may reduce the setback distance by 75 or 100 feet, depending on the number of animal units (e.g. up to 325 or 450 feet total if installing four Level 3 practices).

Step 8: Calculate the reduced setback requirement for each structure in Table A due to installing and maintaining odor control practices.

- Across each row in listing odor control practices in Table A, add the individual setback reduction distances that are entered into Columns G, I, K, and M.
- Subtract the total distance (Columns G + I + K + M) from the Setback Distance in Column E.
- Enter the result into Column N **or** one of the following distances into Column N, **whichever is greater***:
    - For facilities <1,000 AU = 350 feet; for facilities 1,000 AU - <2,500 AU = 500 feet; and for facilities 2,500 AU or more = 750 feet. (*Setbacks may not be reduced below the preceding distances.)

Step 9: If a structure will meet the reduced setback requirement in Column N, enter the distance from the structure to the property line into Column O. For structures with odor control practices, the distance to property line in Column O shall be equal to or greater than the reduced setback distance in Column N.

Odor Control Practice Specifications

Odor control practices identified in Chart 3 and 6 must meet the following specifications, and must be operated and serviced as needed to maintain effectiveness over time. The following odor control practices are organized by the source of odor they are designed to control and include the level of effectiveness of the odor control practice. Livestock operators may seek DATCP approval for unlisted practices, and may include specifications for the practice as part of its approval.

Livestock Housing

Bio-filter (High) – Vent air from animal housing areas through a bio-filter consisting of compost and wood chips, mixed at a rate of 30:70 to 50:50 (ratio by weight of compost to wood chips). The mixture must be at least 40% moisture by weight. The bio-filter must be 10" to 18" thick, and must have an area of at least 50 to 85 sq. ft. per 1000 cu. ft. per minute (cfm) of airflow. If the bio-filter treats less than 100 percent of the exhaust air from a housing structure, the multiplier must be reduced proportionately. For example, if only half the total ventilation air passes through the filter, the odor control credit would be 45% (50% x 90% multiplier).

Bioscrubbers (High): Bioscrubbers work much like a bio-filter in that bacteria growing on biomass within the scrubber converts ammonia into nitrate and nitrite. Nitrogen in the water has to be kept below levels that will inhibit bacteria. They tend to use 8 to10 times more water than acid scrubbers. The ammonia removal efficiency averages approximately 70%, and the odor removal efficiency averages 50%. Appropriate maintenance includes skimming of solids and replacement of water.

Wet Scrubbers-Chemical Acid scrubbers (High): These scrubbers trap alkaline material, such as ammonia, in a sulfuric acid solution that is circulated over a packed bed at a pH of 2 to 4. The ammonia removal efficiency tends to be over 90%, while the odor removal rate is around 30%. This same technology can be used with a base solution if hydrogen sulfide was the targeted chemical for removal.

Vegetable oil sprinkling (High) – Sprinkle vegetable oil on floors in animal housing areas (swine) each day. Apply oil at start-up rate of approximately 40 milliliters per square meter per day (mL/m^2-day) in the first 1-2 days of each production cycle. During the remainder of each production cycle, apply oil at maintenance rate of 5 mL/m^2-day. Avoid oil applications to pens near fans, to areas near heaters, and to areas surrounding feeders.

Wet Scrubbers-Water (Medium) – Exhaust air filtration systems designed to remove dust particles and ammonia from animal housing and/or under building waste storage facilities. These systems consist of a treated paper or fabric media, minimally 6" thick, through which the exhaust air passes and over which recirculated water flows To adequately capture solid particles and absorb ammonia, the media (including film of water) must have a face area of at least 15 square feet for every 10,000 cubic feet per minute of exhaust air flow, and there must be a minimum of 3 gallons per minute of recirculated water flowing over that portion of the media to keep it continuously wetted. Accumulated solids must be skimmed off the recirculation water reservoir on a weekly basis, and the water must be replaced when its pH reaches 8.2. The discarded water must be sent to manure storage, and then land applied according to an approved nutrient management plan. If the web scrubber treats less than 100 percent of the exhaust air from a housing structure, the effectiveness level must be reduced. For example, if only half of the exhaust air is scrubbed, than the odor control credit would be 25% (50% x 50% multiplier).

Recirculated water flush (Medium) – Use fresh wastewater to flush manure from floors of animal housing areas into collection or waste storage facilities. Flush at least 3 times a day, and more often if necessary, to prevent manure from drying and sticking to floors. Flush velocity must be adequate to remove manure solids effectively. To qualify for an odor control credit of 50% (as compared to a conventional alley flushed barn), the wastewater must be returned to the flush alley immediately, or after being stored for no more than 3 days, such that it remains in an aerobic state.

Treated water flush (Medium) – Use treated manure effluent to flush manure from floors of animal housing areas into collection or waste storage facilities. Flush at least 3 times a day, and more often if necessary, to prevent manure from drying and sticking to floors. Flush velocity must be adequate to remove manure solids effectively. Flush with waste storage effluent must treated by a recognized means such as solid separation and reduction or other equally effective approach.

Poultry Dryer Belt System (Medium) – A manure conveyance and treatment system for poultry layer operations that consists of a series of conveyor belts configured to receive the litter and then immediately pass it through a positively ventilated air chamber. The residence time of the litter in the air chamber must be sufficient to thoroughly dry it, and thereby prevent it from becoming anaerobic when stored. The dried litter must be stored in a facility separate from the animal housing.

Diet manipulation (Low) –Develop and maintain a feed management plan in accordance with NRCS Feed Management Standard 592 (July 2016) that specifically identifies odor management as a planning goal, and describes specific feed management practices that will achieve this goal. The plan shall be periodically reviewed and revised based on measurement of a practice's effectiveness (e.g. testing for Milk Urea Nitrogen (MUN) levels to assess the actual nutrient uptake by the animal, for dairy operations).

Air Dam (Low) – Erect and maintain a wall placed at the end of positively ventilated animal housing, in close proximity to the exhaust. The barrier must be of sufficient height and width to deflect the exhaust air and odor plume (typically 10' x 10' for each fan).

Windbreak (Low) – Maintain a solid or porous windbreak, 10 to 50 feet from the odor source, which reduces forward momentum of airflow and vertically disperses the odor plume. The windbreak shall be extend at least 50' beyond both ends of the animal housing. A windbreak may be constructed of vegetation or other materials. Vegetation windbreaks must contain at least 3 rows of trees and shrubs, of both fast and slow-growing species, that are well suited for the site. Windbreaks must be designed and constructed according to NRCS Technical Guide Standard 380 – Windbreaks and Shelterbelts (October 2016).

Chemical or biological additives (Low) – Apply, to stored manure, chemical or biological additives that are scientifically proven to be effective in reducing odor from that manure when applied under applicable conditions and in applicable amounts. An additive's effectiveness must be supported by independent research or other credible evidence. Written documentation shall be prepared describing the amount and frequency of chemical or biological additions.

Frequent cleaning of animal housing area (Low) – Scrape and remove manure from animal housing areas at least 3 times a day.

Manure Storage

Wastewater Treatment (High) – Install and use a physical, chemical or biological process that removes the majority of contaminants from the waste stream, resulting in a liquid effluent meeting surface water discharge standards.

Impermeable cover (High) – Cover the entire surface of waste storage structure with an impermeable barrier that prevents gas from escaping. The cover must meet NRCS technical guide roofs and covers standard 367 (April 2016). Gas must be drawn off, and either treated, used for energy production, or flared off.

Compost (High) – Aerobically treat solid or semi-solid manure to create compost in accordance with NRCS Technical Standard Composting Facility 317 (January 2017). Compost must be sited and properly managed to control odors, including regular turnings, as detailed in the technical standard.

Natural crust (Medium) – Maintain a natural crust of dry manure on the surface of stored manure. The natural crust must cover 80% of the surface area of the stored manure, 80% of the time between the months of April and October. Organic bedding material must be used, sand bedding will not produce an adequate natural crust.

Bio-cover (Medium) – Cover the surface of waste storage structure with an 8" to 12" thick blanket of dry wheat, barley or good quality straw. The blanket must cover 80% of the waste surface 80% of the time between the months of April and October. Add to the blanket as necessary to maintain the required cover.

Geotextile cover (Medium) – Cover the surface of waste storage structure with a geotextile membrane that is at least 2.4 mm thick. The membrane must cover 80% of waste surface between the months of April and October.

Anaerobic digestion (Medium) – Subject manure to managed biological decomposition within a sealed oxygen-free container ("digester"). Anaerobic digestion must meet design and operational standards necessary to achieve adequate odor control as listed in NRCS Technical Standard Anaerobic Digester 366 (August 2011), including requirements for solids concentration, flow rates, retention time, and minimum temperatures.

Solids Separation and Reduction (Medium) – Reduce the solid content of stored manure with solid capture efficiency of more than 50% through mechanical separation, multi-tiered pits or other means. Mechanical separation systems must meet the requirements in NRCS Technical Standard Waste Separation Facility 632 (April 2014). Solids content in multi-tiered pits must be as measured after the stored manure has been thoroughly mixed.

Bottom fill (Low) – Add manure to a liquid *manure storage structure* from the bottom so as to limit disturbance to the surface of the stored manure.

Chemical or biological additives (Low) – Apply, to stored manure, chemical or biological additives that are scientifically proven to be effective in reducing odor from that manure when applied under applicable conditions and in applicable amounts. An additive's effectiveness must be supported by independent research or other credible evidence. Written documentation shall be prepared describing the amount and frequency of chemical or biological additions.

Solids Separation and Reduction (Low) – Reduce the solid content of stored manure with solid capture efficiency of less than 50% through mechanical separation, multi-tiered pits or other means. Mechanical separation systems must meet the requirements in NRCS Technical Standard Waste Separation Facility 632 (April 2014). Solids content in multi-tiered pits must be as measured after the stored manure has been thoroughly mixed.

Windbreak (Low) – Maintain a solid or porous windbreak, 10 to 50 feet from the odor source, which reduces forward momentum of airflow and vertically disperses the odor plume. The windbreak shall extend at least 50' beyond both ends of the *waste storage facility*. A windbreak may be constructed of vegetation or other materials. Vegetation windbreaks must contain at least 3 rows of trees and shrubs, of both fast and slow-growing species, that are well suited for the site. Windbreaks must be designed and constructed according to NRCS Technical Guide Standard Windbreaks and Shelterbelts 380 (October 2016).

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Worksheet 3 - Waste and Nutrient Management

Instructions. Complete and sign Parts A, B and C of this worksheet. Part D must be completed and signed by a *qualified nutrient management planner* (the applicant must also sign).

Exemption.

You do not need to complete Parts A and B if you check the box and initial the certification and acknowledgement.

□ In place of Worksheet 3, Part D, I enclose a copy of the most recent nutrient management plan checklist related to (an initial application) (an annual update) (a permit renewal) [Strike all that do not apply] of my *WPDES* permit.

_____ (Initial) By checking the box above and initialing this worksheet, the applicant certifies that the most current nutrient management plan covers the same or greater number of animal units than the number requested in this application, the *WDPES* permit and the nutrient management plan are current, and the livestock facility has met all *WPDES* permit conditions related to the nutrient management plan. The applicant further acknowledges that the applicant is responsible for providing supporting documentation to verify that the conditions for permit substitution are satisfied, and that the plan meets the applicable technical standards.

Part A. Waste Generation

Complete the following table[1] to provide an annual estimate of manure generated.

The estimate must be prepared a qualified nutrient management planner other than operator, and must be for maximum number of animal units that by livestock at the proposed facility. The planner must account for all waste generated, must determine the livestock facility's capacity to store waste, and develop a nutrient management plan that is adequate for available storage capacity and land base available for manure applications.

The table's source is the *Wisconsin Conservation Planning Technical Note WI-1* (Feb. 2016), which reproduced the table from another publication, *Midwest Plan Service publication number MWPS-18 "Manure Characteristics" Section 1 (2000).* Consult the *Technical Note* for guidance in completing this table. The guidance in the *Technical Note* includes the following:

> Solid volumes are as excreted. The liquid dairy and beef values are computed from the MWPS daily production and have approximately equal nutrient values annually as solid manure. MWPS liquid dairy and beef factors are multiplied by 1.8 and 3.2 respectively. Dilution on your operation may be substantially different. Use manure analysis and manure storage volumes to determine manure production whenever possible.

To the extent that the guidance in the *Technical Note* is not consistent with the requirements of the siting rule, the requirements of the siting rule should be followed.

[1] In lieu of completing this table, attach a manure tracking report prepared using SnapPlus http://snapplus.wisc.edu/.

Manure estimate using MWPS-18 "Manure Characteristics"

Animal	Size	Daily Manure Production To Apply						Annual Manure Production To Apply				
	Lbs	Solid		Liquid				Number x	Daily x	365 Day x	% =	Total
		Lbs/day	ft^3/day	MWPS ft^3/day x WI dairy & beef dilution factor	ft^3/day & WI dilution	MWPS gal./day x WI dairy & beef dilution factor	gal./day & WI dilution	of Head	Total **Tons or Gal.**	Total	Collected	Collected **Tons or Gal.**
Dairy												
Calf	150	13	0.200	.21*1.8=	.37	1.53*1.8=	2.80					
Calf	250	21	0.320	.33*1.8=	.60	2.47*1.8=	4.50					
Heifer	750	65	1.000	1.03*1.8=	1.85	7.70*1.8=	13.8					
Lact. Cows	1000	106	1.700	1.71*1.8=	3.07	12.7*1.8=	23.0					
	1400	148	2.400	2.38*1.8=	4.28	17.7*1.8=	32.0					
Dry Cows	1000	82	1.300	1.30*1.8=	2.35	9.7*1.8=	18.0					
	1400	115	1.820	1.82*1.8=	3.33	13.6*1.8=	25.0					
Beef												
Calf	450	26	0.420	.415*3.2=	1.3	3.1*3.2=	9.9					
High Forage	750	62	1.000	1.00*3.2=	3.2	7.5*3.2=	24.0					
High Forage	1100	92	1.400	1.48*3.2=	4.8	11*3.2=	35.0					
High Energy	750	54	0.870	.87*3.2=	2.7	6.5*3.2=	20.8					
High Energy	1100	80	1.260	1.27*3.2=	4.1	9.5*3.2=	30.5					
Beef Cow	1000	63	1.000	1.00*3.2=	3.2	7.5*3.2=	24.0					
Swine												
Nursery Pig	25	2.7	0.040		.04		.30					
Grow-Finish Pig	150	9.5	0.150		.17		1.20					
Gestating Sow	275	7.5	0.120		.14		1.00					
Sow & Litter	375	22.5	0.360		.42		3.00					
Boar	350	7.2	0.120		.14		1.00					
Poultry / Other												
Layers	4	0.26	0.004		.004		.03					
Broilers	2	0.18	0.003		.003		.02					
Turkeys	20	0.9	0.014		.015		.11					
Duck	6	0.33	0.005		.006		.04					
Sheep	100	4	0.060		.055		.40					
Horse	1000	50	0.800		.827		5.98					

Part B – Land Base for Applying Nutrients

1. What percentage of the manure and waste identified in Part A will be:
   a. Applied to land: _______________%.
   b. Processed and sold as commercial fertilizer, under a fertilizer license: ___________%.
   c. Disposed of in other ways: ____________%. Describe: ______________________________

2. Total acres of cropland currently available for land application (owned, rented, or landspreading agreement):
   ____

3. Attach map(s) showing the land where waste will be applied and any restrictions limiting the application of waste to that land. Additional documentation may be required by the political subdivision to verify that rental land is available.

Part C – Cropland Performance Standards

The applicant (operator) certifies that the livestock facility is in compliance, or shall implement conservation practices that achieve compliance, with the following requirements, and makes a commitment that the livestock facility will remain in compliance with these cropland performance standards:

1. Control soil erosion on all fields covered by the nutrient management plan to remain at or below the T-value as specified in ATCP 50.04(2).
2. Maintain of an average a phosphorus index of 6 or less over an accounting period and an annual phosphorus index of less than 12, as defined NR 151.04(2)(a), for all fields included in the nutrient management plan.

Part D – Nutrient Management Checklist

The checklist Part D must be completed, unless you claim the exemption by checking the box and initialing the certification and acknowledgement at the beginning of this worksheet. Part D must be completed and signed by a *qualified nutrient management planner* (the applicant must also sign).

Applicant affirms that the information provided in Parts A, B and C is accurate.

____ ____________
Signature of Applicant or Applicant's Authorized Representative Date

Wisconsin Department of Agriculture, Trade and Consumer Protection
Division of Agricultural Resource Management
Bureau of Land and Water Resources
PO Box 8911, Madison WI 53708-8911, Phone: 608-224-4605

Use this form to check nutrient management (NM) plans for compliance with the WI NRCS 2015-590 Standard.

Nutrient Management Checklist *Sec. 92.05(3)(k), Wis. Stats. ATCP 50.04(3) & 51 Wis. Admin. Codes*

COUNTY DATE PLAN SUBMITTED GROWING SEASON YEAR PLAN IS WRITTEN FOR (from harvest to harvest)

TOWNSHIP: (T. N.) RANGE: (R. E., W). CHECK ONE: ☐ Initial Plan or ☐ Updated Plan

NAME OF FARM OPERATOR RECEIVING NM PLAN First Name LastName	FARM NAME (OPTIONAL)		BUSINESS PHONE ( ) -	
STREET ADDRESS		CITY	STATE	ZIP

RELEVANT REASON THE PLAN WAS DEVELOPED: Click and choose. (Ordinance, NR 243 WPDES or NOD, DATCP-FP or cost share (cs), DNR-cs, USDA-cs, Other)	CROPLAND ACRES (OWNED & RENTED)
RENTED FARM(S) LANDOWNER NAME(S) AND ACREAGE: add sheet(s) if required	

WAS THE PLAN WRITTEN IN SNAPPLUS? ☐ YES ☐ NO If yes, which software version, if known?

CHECK PLANNER'S QUALIFICATION: Click and choose.
(1. NAICC-CPCC, 2. ASA-CCA, 3. SSSA-Soil Scientist, 4. DATCP approved training course, 5. Other approved by DATCP)

NAME OF QUALIFIED NUTRIENT MANAGEMENT PLANNER First Name Last Name		BUSINESS PHONE ( ) -	
STREET ADDRESS	CITY	STATE	ZIP

Use header sections to add comments. Mark NA in the shaded sections if no manure is applied.

1. Does the plan include the following nutrient application requirements to protect surface and groundwater?

This section applies fields and pastures. If no manure is applied, check NA for 1c., 1.h., 1.i., 1.n., 1.o., 1.q., 1.s.	Yes	No	NA
a. Determine field nutrient levels from soil samples analyzed by a DATCP **certified laboratory.**	☐	☐	☐
b. For fields or pastures with mechanical nutrient applications, determine field nutrient levels from **soil samples** collected within the last **4 years** according to Std. 590 and UW Pub. A2809, *Nutrient Application Guidelines for Field, Vegetable, and Fruit Crops in Wisconsin* typically collecting **1 sample per 5 acres** of 10 cores. Soil tests are not required on **pastures** that do not receive mechanical applications of nutrients if either of the following applies: 1. The pastures are stocked at an average stocking rate of one animal unit per acre or less at all times during the grazing season. 2. The pastures are winter grazed or stocked at an average stocking rate of more than one animal unit per acre during the grazing season, and a nutrient management plan for the pastures complies with 590 using an assumed soil test phosphorus level of 150 PPM and organic matter content of 6%.	☐	☐	☐
c. For **livestock siting permit approval**, the applicant must collect and analyze soil samples meeting the requirements above in 1. b., excluding pastures, within 12 months of approval and revise the nutrient management plan accordingly. Until then, either option below maybe used: 1. Assume soil test phosphorus levels are greater than 100 ppm soil test P. Or 2. Use preliminary estimates analyzed by a certified DATCP laboratory with soil samples representing > 5 ac/sample.	☐	☐	☐
d. **Identify all field's** name, boundary, acres, and location.	☐	☐	☐
e. Use the field's previous year's legume credit and/or applications, predominant soil series, and realistic yield goals to determine the crop's nutrient **application rates consistent with UW Pub. A 2809 for ALL forms of N, P, and K.**	☐	☐	☐
f. Make no **winter applications of N and P** fertilizer, except on grass pastures and winter grains.	☐	☐	☐
g. Document methods used to determine **application rates.** Nutrients shall not runoff during or immediately after application.	☐	☐	☐
h. Identify in the plan and narrative that **adequate acreage** is available for manure produced and/or applied.	☐	☐	☐
i. Apply a single phosphorus (P) assessment using either the **P Index** or **soil test P** management strategy to all fields within a tract when fields receive manure or organic by-products during the crop rotation.	☐	☐	☐
j. Use **complete crop rotations** and the field's **critical soil** series to determine that sheet and rill erosion estimates will not exceed **tolerable soil loss** (T) rates on fields that receive nutrients.	☐	☐	☐
k. Use contours; reduced tillage; adjust the crop rotation; or implement other practices to **prevent ephemeral erosion**; and maintain perennial vegetative cover to **prevent reoccurring gullies** in areas of concentrated flow.	☐	☐	☐
l. Make no nutrient applications within 8' of **irrigation** wells or where **vegetation is not removed.**	☐	☐	☐
m. Make no nutrient applications within **50' of all direct conduits to groundwater**, unless directly deposited by gleaning/pasturing animals or applied as starter fertilizer to corn.	☐	☐	☐

	Yes	No	NA
n. Make no **untreated manure applications** to areas within 1000' of a **community potable water well** or within 100' of a **non-community potable water well** (ex. church, school, restaurant) unless manure is treated to substantially eliminate pathogens.	☐	☐	☐
o. Make no manure applications to areas **locally delineated** by the Land Conservation Committee or in a conservation plan as areas contributing runoff to direct conduits to groundwater unless manure is substantially buried within 24 hours of application.	☐	☐	☐
p. Make no applications of **late summer or fall commercial N fertilizer** to the following areas UNLESS needed for establishment of fall seeded crops or to meet UWEX Pub. A2809 with a blended commercial fertilizer. N applied in a blended commercial fertilizer shall not exceed 36 lbs. N/acre on: • Sites vulnerable to N leaching **PRW Soils** (P=high permeability, R= bedrock < 20 inches, or W= wet < 12 inches to apparent water table); • Soils with depths of 5 feet or less to bedrock; • Area within 1,000 feet of a community potable water well. On **P soils, when commercial N is applied** for full season crops in **spring and summer,** follow A2809 and apply one of the following: 1. A split or delayed N application to apply a majority of crop N requirement after crop establishment. 2. Use a nitrification inhibitor with ammonium forms of N. 3. Use slow and controlled release fertilizers for a majority of the crop N requirement applied near the time of planting.	☐	☐	☐
q. Limit manure applications in late summer or fall using A2809 and the following 590 levels, whichever is less, on **PRW Soils.** ***<u>Use ≤ 120 lbs. available N/acre on:</u>*** **P and R soils** on *<u>all crops, except annual crops</u>*. Additionally, manure with ≤ 4% dry matter (DM) wait until after soil temp. < 50°F or Oct. 1. use either a nitrification inhibitor OR surface apply and do not incorporate for 3 days. **W soils or combo. W soils** on *<u>all crops.</u>* Additionally, manure with ≤ 4% DM on *<u>all crops</u>* use at least one of these practices: **1.** Use a nitrification inhibitor; **2.** Apply on an established cover crop, an overwintering annual, or perennial crop; **3.** Establish a cover crop within 14 days of application; **4.** Surface apply & don't incorporate for at least 3 days; **5.** Wait until after soil temp. < 50°F or Oct. 1. ***<u>Use ≤ 90 lbs. available N/acre on:</u>*** **P and R soils** on *<u>annual crops</u>* wait until after soil temp. < 50°F or Oct. 1. Additionally, manure with ≤ 4% DM use either a nitrification inhibitor OR surface apply and do not incorporate for 3 days. **W soils or combination W soils** manure with ≤ 4% DM on *<u>all crops</u>*.	☐	☐	☐
r. Use one or more of the following practices on **non-frozen soils** for all nutrient applications including manure, or organic by-products w/ >11% dry matter within **Surface Water Quality Management Area (SWQMA)** 1000' of lakes/ponds or 300' of rivers: **1.** Maintain > 30% cover after nutrient application; **2.** Effective incorporation within 72 hrs. of application; **3.** Establish crops prior to, at, or promptly following application; **4.** Install/maintain vegetative buffers or filter strips; **5.** Have at least 3 consecutive years no-till for applications to fields with < 30% residue (silage) and apply nutrients within 7 days of planting.	☐	☐	☐
s. Limit mechanical applications to **12,000 gals/acre of unincorporated liquid manure with 11% or less dry matter where subsurface drainage is present or within SWQMA** 1000' of lakes/ponds or 300' of rivers. Wait a min. of 7 days between sequential applications AND use one or more of the practices on non-frozen soils listed in (1.r. practices **1.** to **5.**).	☐	☐	☐

2. When frozen or snow-covered soils prevent effective incorporation, does the plan follow these requirements for winter applications of all mechanically applied manure or organic by-products? *This section does not apply to winter gleaning/pasturing meeting the 590 N and P requirements.*

If no manure is applied, check NA.	Yes	No	NA
a. Identify **manure quantities planned to be spread during the winter**, or the amount of manure generated in 14 days, whichever is greater. *For daily haul systems, assume 1/3 of the manure produced annually will need to be winter applied.*	☐	☐	☐
b. Identify manure storage capacity for each type applied and stacking capacity for manure ≥ 16% DM if permanent storage does not exist.	☐	☐	☐
c. Show on map and make no applications within the **SWQMA.**	☐	☐	☐
d. Show on map and make no surface applications of liquid manure during **February and March** where **Silurian dolomite** is within 60 inches of the soils surface <u>or</u> where **DNR Well Compensation** funds provided replacement water supplies for wells contaminated with livestock manure.	☐	☐	☐
e. Show on map and make no applications of manure within **300 feet of direct conduits to groundwater.**	☐	☐	☐
f. Do not exceed the P removal of the following growing season's crop when applying manure. Liquid manure applications are limited to **7,000 g/acre.** All winter manure applications are not to exceed **60 lbs. of P2O5/acre.**	☐	☐	☐
g. Make no applications of manure to fields where *<u>concentrated flow channels are present</u>* unless 2 of the following are used: **1.** Contour buffer strips or contour strip cropping; **2.** Leave all crop residue and no fall tillage; **3.** Apply manure in intermittent strips on no more than 50% of field; **4.** Apply manure on no more than 25% of the field waiting a minimum of 14 days between applications; **5.** Reduce manure app. rate to 3,500 gal. or 30 lbs. P2O5, whichever is less; **6.** No manure application within 200 feet of all concentrated flow channels; **7.** Fall tillage is on the contour and slopes are lower than 6%. Make no applications to **slopes greater than 6%** (C,D,E,F) unless the plan documents that no other accessible fields are available for winter spreading AND two of the options (2.g.1. through 2.g.5.) above are implemented.	☐	☐	☐

I certify that the plan represented by the answers on this checklist complies with Wisconsin's NRCS 2015-590 NM Standard or is otherwise noted.

Qualified NM planner signature   NAICC-*Certified Professional Crop Consultant*, ASA-*Certified Crop Adviser*, or SSSA-*Soil Scientist*   Date

Qualified NM farmer-planner or Authorized farm operator signature receiving and understanding the plan   Date   Signature if reviewed for quality assurance   Date

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Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708-8911
Phone: (608) 224-4630 or (608) 224-4500

Worksheet 4 - Waste Storage Facilities

Instructions. This worksheet must account for every structure that stores or transfers manure or process wastewater on the proposed livestock facility, and must be signed by the applicant. A registered engineer or conservation engineering practitioner must sign unless the applicant qualifies for an exemption for all structures. If an applicant is not able to submit the documentation required to claim an exemption for any storage facility located on the proposed livestock facility, each applicable section of the worksheet must be completed.

Exemptions.
_____ (Initial) By initialing this worksheet, checking one or more boxes below, and submitting the required documentation, the applicant is certifying:

☐ The following existing, substantially altered or new facilities were reviewed and approved by DNR as part of the *WPDES* permit (identify by unique identifiers listed on the site map: ___________________). In support of this submission, the applicant (1) provides copies of applicable plan and specification approvals or other determinations for waste storage facilities of the same size and type as those proposed for the new or expanded livestock facility, and (2) certifies that the WDPES permit is current, and that the livestock facility is in compliance with all WPDES permit conditions and requirements.

☐ The following existing, substantially altered or new facilities (list by unique identifier as noted on the site map: ________) was approved by DNR for storage of agricultural wastewater and other related products under NR 213. (DNR approval is attached.)

☐ The following existing facilities (list by unique identifier as noted on the site map: ________) was constructed within the last 3 years in accordance with then-existing NRCS standards, as documented by the attached as-built plan or local approval under a s. 92.16 ordinance.

Section A: New **or** ***Substantially Altered*** **Facilities.** The following storage facilities and transfer systems (identify by unique identifiers listed on the site map: ___________________) comply with applicable NRCS Technical Guide Standards: Standard 313 (January, 2014) for storage and Standard 634 (January, 2014) for transfer systems, as documented by the attached design specifications.

Section B: Existing Storage Facilities Retained. The following storage facilities will continue in use without being substantially altered. Each facility meets one of the following:

☐ The facility (identify by unique identifiers listed on the site map: ___________________) was constructed within the last 10 years according to then-existing NRCS technical standards, and a visual inspection of the facility shows no apparent signs of structural failure or significant leakage.

☐ The facility (identify by unique identifiers listed on the site map: ___________________) was constructed over 10 years ago according to then-existing NRCS technical standards, and a visual inspection of the emptied facility shows no apparent signs of structural failure or significant leakage.

☐ The construction standard of facility identify by unique identifiers listed on the site map: ___________________) cannot be verified from reliable document, a full investigation of the facility was performed, and this investigation established that the facility is in good condition and repair, shows no apparent signs of structural failure or significant leakage, and is located on a site at which the soils and separation distances to groundwater meeting the requirements for the appropriate liner type referenced in NRCS technical guide manure storage facility standard 313 (January, 2014).

Section C: Facilities That Must Closed. Closure is required for following facilities (identify by unique identifiers listed on the site map: ___________________), and the attached closure plans comply with NRCS Technical Guide Standard 360 (March, 2013).

Section D: Facility Operation. The applicant (operator) certifies that that livestock facility is in compliance with the following requirements and will remain in compliance as long as the facility is permitted:

1. All manure storage facilities in existence as of October 1, 2002 that pose an imminent threat to public health, fish and aquatic life, or groundwater shall be upgraded, replaced, or abandoned in accordance with NR 151.05(4)(b).
2. Levels of materials in storage facilities may not exceed the margin of safety level as defined in s. NR 243.03(37).

If not in compliance, the applicant must submit plans for achieving compliance (see previous sections).

______________________________ ________
Signature of Applicant or Applicant's Authorized Representative Date

Professional Engineer's
Embossed Seal

____
Print Name of Engineer (include WI License No.) or Certified Practitioner

______________________________ ________
Signature of Engineer or Practitioner Date

____
Name of Firm and Address

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Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708-8911
Phone: (608) 224-4630 or (608) 224-4500

Worksheet 5 - Runoff Management

Instructions. This worksheet must account for all sources of runoff including animal lots, feed storage structures, and milking centers on the proposed livestock facility, and must be signed by the applicant. A registered engineer or conservation engineering practitioner must sign unless the applicant qualifies for an exemption for all structures. If an applicant is not able to submit the documentation required to claim an exemption for any storage facility located on the proposed livestock facility, each applicable part of the worksheet must be completed.

Exemptions.
_____ (Initial) By initialing this worksheet, checking one or more boxes below, and submitting the required documentation, the applicant is certifying:
☐ The following existing, substantially altered or new facilities animal lots or feed structure structures were reviewed and approved by DNR as part of the WPDES permit (identify by unique identifiers listed in the site map):
__________________. In support of this submission, the applicant (1) provides copies of applicable plan and specification approvals or other determinations that cover animal lots or storage structures of the same size and type as those proposed for the new or expanded livestock facility, and (2) certifies that the WDPES permit is current, and that the livestock facility is compliance with all WPDES permit conditions and requirements.

Part A: Animal Lots[1]

1. ***New* or *Substantially Altered Animal Lots.*** The following new or substantially altered animal lots (identify by unique identifiers listed on the site map: __________________) will collect and store animal lot runoff for future land application or will be constructed according to the attached design specifications that comply with *NRCS* Technical Guide Standard 635 (September, 2016).

2. **Existing *Animal Lots* Near Sensitive Areas.** The following animal lots (identify by unique identifiers listed on the site map: __________________) are located within 1,500 feet of navigable lakes, ponds, and flowages; 450 feet of wetlands and navigable streams and rivers; 750 feet of conduits to groundwater; 450 feet of surface inlets that discharge to navigable waters; 225 feet of channelized flow; and 225 feet of subsurface drains (measured from the edge of the animal lot). According to the BARNY runoff model, each of these animal lots has (or with minor alterations[2] will have) predicted average annual phosphorus runoff of less than 5 lbs. per year (measured at the end of the treatment area).

3. **Other Existing *Animal Lots.*** The following animal lots (identify by unique identifiers listed on the site map: __________________) are NOT located within 1,500 feet of navigable lakes, ponds, and flowages; 450 feet of wetlands and navigable streams and rivers; 750 feet of conduits to groundwater; 450 feet of surface inlets that discharge to navigable waters; 225 feet of channelized flow; and 225 feet of subsurface drains (measured from the edge of the animal lot). According to the *BARNY runoff model*, each *animal lot* has (or with minor alterations[3] will have), a treatment area that reduces phosphorus runoff to an average of less than 15 lbs. per year (measured at the end of the treatment area).

4. The applicant (operator) certifies that no animal lot has direct runoff to surface waters of the state or discharges to any direct conduit to groundwater, and makes a commitment that the proposed livestock facility will have no such runoff or discharges from any animal lot. The engineer or certified practitioner certifies that any engineered designs to control runoff from animal lots meet NRCS or other applicable technical standards as noted above.

Part B: Process Wastewater

1. **General.** The applicant (operator) certifies that all existing livestock structures have no significant discharge of process wastewater to waters of the state or to a direct conduit to groundwater, and makes a commitment that the proposed livestock facility will have no such discharges from any livestock structure. The engineer or certified practitioner certifies that any engineered designs to control or manage process wastewater meet NRCS or other applicable technical standards as noted below.

---

[1] Treat multiple lots as one animal lot if runoff from the animal lots drains to the same treatment area or if runoff from the animal lot treatment areas converges or reaches the same surface water within 200 feet of any of those treatment areas.

[2] "Minor alterations" of an animal lot means a repair or improvement that may include lot management such as cleaning; shaping, seeding and other non-structural changes to address flow issues, and installation of conservation practices such as roof gutters, diversions, surface inlets, underground outlets, and gravel spreaders.

Part C: Feed Storage

1. Existing Feed Storage Structures.[1] The following feed storage structures (identify by unique identifiers listed on the site map: ____________________) meet the criteria for continued use:

(a) They been designed and constructed according to applicable NRCS standards that existed at the time of construction or in the absence of documentation to support this, they are located on a site with soils and separation distances that comply with Tables 1, 2, or 3 in *NRCS* Technical Guide Standard 629 (January, 2017).

(b) They are in good condition and repair.

(c) They show no apparent signs of structural failure, significant leakage, or significant discharges to surface water.

2. For each structure identified in the applicant (operator) agrees to operate and maintain structures as follows: divert clean water from entering each of the structures, collect and store surface discharge of leachate from stored feed and initial runoff volume of 0.2 inches from each precipitation event before it leaves structures or paved areas covering more than one acre, prevent collected leachate from discharging to waters of the state, prevent leachate and contaminated runoff from infiltrating below the storage structure, avoid accumulation of debris in the loading area, and ensure proper functioning of collection and treatment areas.

Note: Structures with roofs are not required to divert clean water as required, or collect and store runoff from precipitation events.

3. New and Substantially Altered Feed Storage Structures that are One Acre or More.

The following feed storage structures (identify by unique identifiers listed on the site map: ____________________)

(a) Are designed according to the attached specifications to comply with NRCS Technical Guide Standard 629 (January, 2017), and

(b) Will manage leachate and contaminated runoff by collecting and storing for future land application or treating the runoff in accordance with NRCS Technical Guide Standard 635 (September, 2016).

4. New and Expanded Feed Storage Structures Less than One Acre.

The following feed storage structures (identify by unique identifiers listed on the site map: ____________________) are:

(a) Less than one acre in size.

(b) **Not** located within 1,500 feet of navigable lakes, ponds, and flowages; 450 feet of wetlands and navigable streams and rivers; 750 feet of conduits to groundwater; 450 feet of surface inlets that discharge to navigable waters; 225 feet of channelized flow; and 225 feet of subsurface drains.

(c) Designed or constructed with storage floors that meet the applicable Table 1, 2, or 3 of NRCS Technical Guide Standard 629 (January, 2017),

(d) Designed or constructed to collect and store all leachate from stored feed and an initial runoff volume of 0.20 inches from each precipitation event.

(e) Located in areas that do not have soils with a high potential for leaching contaminants to groundwater.

(f) Located on sites with conditions such that runoff from a 25-year, 24-hour precipitation event will not result in a significant discharge to waters of the state.

(Attach design specifications or other documentation in support of the above.)

Part D: Milking Center Wastewater

☐ Check if all of the milking center wastewater is transferred to a waste storage facility or another structure that meets the design criteria of NRCS waste facility storage technical standard 313.

If any such wastewater is not stored, the applicant and engineer certify that the livestock facility generates less than 500 gallons of wastewater daily, does not store the wastewater for an extended period, and is implementing the treatment practices described in NRCS waste treatment technical standard 629 (January, 2014).

[1] For the purposes of the requirements in this section, a feed storage structure includes any building, bunker, or paved area used for feed storage or handling, but does not include silos, storage bags, and grain bins.

Worksheet 5 (continued)

Part E: Nonpoint Pollution Standards

The applicant (operator) certifies that that livestock facility is in compliance with the following requirements and will remain in compliance as long as the facility is permitted:

(a) Runoff is diverted from contact with animal lots, waste storage facilities, paved feed storage areas or manure piles within 300 ft. of a stream or 1,000 ft. of a lake.

(b) No unconfined manure pile are located within 300 ft. of a stream or 1,000 ft. of a lake.

(c) There is no overflow of waste storage facilities.

(d) Access of livestock is restricted to waters of the state, as necessary to maintain adequate vegetative cover on banks adjoining the water (this does not apply to properly designed, installed and maintained livestock or farm equipment crossings).

If not in compliance, the applicant may submit plans for achieving compliance (see previous sections).

Signature of Applicant or Applicant's Authorized Representative Date

Professional Engineer's
Embossed Seal

Print Name of Engineer (include WI License No.) or Certified Practitioner

Signature of Engineer or Practitioner Date

Name of Firm and Address

Appendix B

Request for Modification of a Local Approval

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive
P.O. Box 8911
Madison, WI 53708-8911
(608) 224-4630
(608) 224-4500

Introduction

Use this form to request a modification of a local approval ("permit") previously issued for a *new* or *expanded* livestock facility (cattle, swine, poultry, sheep or goats). Successive modifications of a local approval are permissible

You must meet eligibility requirements to request a modification of your local approval. You may not request a modification under any of these conditions:

- A livestock facility cannot use one or more modifications to increase the number of animal units by 30 percent or more above the maximum number authorized in the most recent full approval.
- The changes to the livestock facility require the completion of four or more worksheets to secure approval.

You may request a permit modification if your proposal fits into the following scenarios:

- Addition of animals, no construction of livestock structures, and increase land base for a nutrient management plan.
- Addition of animals, no construction, addition or change in odor control practices, and increase land base for a nutrient management plan.
- Addition of animals; construction or expansion of any two of structures-- housing, waste storage or transfer, or animal lots; and increase land base for a nutrient management plan.
- No addition of animals, and construction or expansion of any number of structures including housing, waste storage or transfer, or animal lots.
- No addition of animals, and addition or change in an odor control practice

A political subdivision may review and approve modification requests that vary from these scenarios as long as the requests do not violate the basic eligibility requirements.

Completing the Request

A livestock operator requests a permit modification by completing the request form and attaching the required application materials. As part of completing the request form, you must verify that the proposed expansion of the livestock facility meets the eligibility requires for a permit modification. You also must provide information related to the most recent full approval you received from the permitting authority including the number of maximum animal units authorized by the local approval. Your most recent full approval refers to a local approval based on the submission of a full application and approval under the procedures in subch. III of ATCP 51 (see ss. ATCP 51.30 through 51.36). In addition, you will need to account for previous modifications to your most recent full approval.

Your request must include all relevant worksheets from Appendix A, documenting that the livestock facility, as modified, will maintain compliance with the standards in subch. II of ATCP 50.

The permitting authority may request that you provide additional documentation showing that you meet any local standards adopted in their ordinance. A local government has *very limited* authority to modify the standards by local ordinance (modifications, if any, must be reflected in the local version of this application form).

Maps

You must submit updated area and site maps if there are changes in structures, buildings or other physical characteristics involving the area where your livestock facility is located. Indicate any changes by marking up the original map submissions you provided with your most recently approved full application for a permit for a new or expanded livestock facility.

If you are increasing land for spreading manure, you will need to submit additional maps showing the owned and rented land where manure will be applied (see Worksheet 3).

Plan submissions

You need to submit an *Odor Management Plan* if you do not have a plan on file that meets the new standard. You may also need to submit a modified *Employee Training Plan* if you have made changes in your operation that require an update. You should review your *Environmental Incident Response Plan* to determine if it is current.

Narrative

Complete a short narrative describing the proposed changes for which you are seeking local approval. The narrative should describe the changes that appear on the site and area maps and describe the operation's management of manure.

Worksheets

Complete and submit all relevant worksheets that apply to your modification request, following the instructions on each worksheet (except for the differences noted below):

Animal units (Worksheet 1)

You must complete this worksheet if your proposal includes the addition of animal units. You must specify the maximum number of *animal units* that you will keep at a new or expanded livestock facility. If the local government approves your requested number, this will be the maximum number that you may keep for 90 days or more in any 12-month period.

Odor management (Worksheet 2)

You must submit this worksheet but you are only required to complete what is needed based on the livestock structures that are part of the livestock facility. At minimum, worksheet 2 should be completed to document the surface area of existing manure storage structures and certain housing types. (This will allow you limited expansion of these facilities without adding odor control practices if these facilities are located within required setbacks.) If manure storage structures or certain housing structures are being built within setback requirements (see Charts 2 and 3 of Worksheet 2), Worksheet 2 must be completed to claim setback reductions. A livestock operator may submit a permit modification to voluntarily adopt the new standard for odor management. Note: Odor management plans may be required, in addition to this worksheet (see Request form, # 11).

Waste and nutrient management (Worksheet 3)

You must complete this worksheet if your proposal requires that you increase the land base for spreading manure as a result of an increase in animal units. You will need to include an updated nutrient management plan checklist that covers the manure generated from the maximum number of animal units authorized under your siting permit, as modified.

Waste storage facilities (Worksheet 4)

You must complete this worksheet if your proposal includes the construction or expansion of manure storage, waste transfer or other waste storage structures. You may be required to evaluate existing structures that have not been addressed in earlier applications.

Runoff management (worksheet 5)

You must complete one or more parts of this worksheet depending on the nature of the changes you are making to your livestock operation. For example, if you are only expanding an animal lot, then parts A and E need to be completed. You do not need to complete the parts that pertain to process wastewater, feed storage, milking center waste runoff system. Use the request for modification form to indicate which parts you completed.

If the Wisconsin Department of Natural Resources (*DNR*) has issued a Wisconsin Pollutant Discharge Elimination System (*WPDES*) permit for your proposed livestock facility, you may provide a certification and supporting documentation in lieu of completing Worksheets 3, 4 and 5 if you meet the requirements for substitution. A *WPDES* permit does not affect the requirements for completing Worksheets 1 and 2.

Fees

The fee for a permit modification cannot exceed $500. A local government may NOT charge any other fee, or require you to post any bond or security.

Review Process

As an alternative to submitting a full application for approval, a request for modification offers a streamlined process for updating a permit issued for your facility. There are fewer procedures to follow and a local government must grant or deny a request for a permit modification within 45 days after it receives the request. Permit modifications do not include procedural protections required when livestock operator submits a full application using Appendix A. In particular, permit modifications do not include a completeness determination and a presumption of compliance with siting standards that arise based on a completeness determination.

If the permit modification request is approved, a local government must indicate its approval in the section on the request form reserved for permitting authority to complete. The local government must provide a copy of the approved application, marked "approved."

Appeal of Local Decision

If you do not agree with local decision on your permit request, you may file a full application with the local government, and gain the protection of a completeness determination and possible hearing. You also may have appeal rights regarding the decision on your modification request; however, it is not clear that Livestock Facility Siting Board will have jurisdiction.

arm-lwr-

Wisconsin Department of Agriculture, Trade and Consumer Protection
2811 Agriculture Drive, PO Box 8911, Madison WI 53708-8911
Phone: (608) 224-4622 or (608) 224-4500

Request for Modification of Local Approval

Wis. Admin. Code ch. ATCP 51

Permitting Authority Completes

Date Request Received: __/__/____

Confirm Applicant Submissions:
Date of Most Recent Full Approval: __/__/__
Maximum AUs approved: ______
Modification Dates (complete all that apply): __/__/__ __/__/__

Date Notice Sent to Adjacent Landowners: __/__/__

Date of Decision Regarding Modification Request: __/__/____

Decision:
☐ Approved with conditions:
☐ Denied

1. Legal Name of Applicant (Business Entity):

2. Contact Person:	Name:
Phone:	E-mail:

3. Business Address: Street Address:

City/Village/Town:	County:	State:	Zip:

5. Description of Proposed *Livestock Facility*

Address of *Livestock Facility*:

5. Eligibility

The applicant verifies that the livestock facility is eligible for a permit modification (you are disqualified unless both boxes are checked):

☐ The proposed changes to the livestock facility, in combination with prior modifications, will not increase the number of animal units by 30 percent or more above the maximum number authorized in the most recent full approval issued by the political subdivision.

☐ The changes to the livestock facility do not require that the operator complete four or more worksheets to secure approval.

6. Permit Approval and Modifications

Date of must recent full approval: __/__/____	Permit number or identifier: ____________
Maximum number of animal units authorized at time of full approval: ________ AUs	
☐ First modification approved (check only if applies)	Date of modification: __/__/____
☐ Second modification approved (check only if applies)	Date of modification: __/__/____
☐ Third modification approved (check only if applies)	Date of modification: __/__/____

Application (continued)

7. Total Animal Units

If you are adding animal units, use **worksheet 1** to calculate total animal units:

Total Animal Units: ___________. This is the maximum livestock facility size for which the applicant requests approval at this time. All worksheets must be prepared based on this maximum listed size.

8. Area Map of Livestock Facility

If livestock structures are modified or added, update the scale map or aerial photo submitted with your most recent application for full approval. The updated map or photo must retain the scale and topographic lines of the original map submitted by the livestock operator, and clearly and legibly show all of the following:

- All existing and proposed livestock structures.
- The area lying within 2 miles of any of the livestock structures. Show all existing buildings, property lines, roadways, and navigable waters within that area.

9. Site Map of Livestock Facility

If livestock structures are modified or added, update the scale map or aerial photo submitted with your most recent application for full approval. The updated map or photo must retain the scale and topographic lines of the original map submitted, and clearly and legibly shows all of the following:

- All existing and proposed livestock structures. Label each livestock structure with a unique identifier that includes a description of the structure type (waste storage, housing, lot, feed storage, waste transfer system), and indicates whether the structure is proposed (new or altered). For example, "waste storage 1" would identify that a waste storage structure is existing and the first of a certain number of waste storage structures at the livestock facility. Include the unique identifier for each structure, when completing all relevant worksheets.
- The area lying within 1,000 ft. of any of the livestock structures. Show all existing buildings, property lines, roadways, navigable waters, and known karst features within that area.

10. Location of new or modified Livestock Structures

The applicant certifies that:

- All livestock structures (including storage structures that collect non-manure waste) must comply with applicable local property line and road setbacks. See ATCP 51.12(1). **Note**: Worksheet 2 must be completed to document the setbacks for all manure storage and Category 1 and 2 Livestock Housing.
- All manure storage and Category 1 and 2 livestock housing structures comply with setbacks in ATCP 51.12(2). ***Note:*** *Odor control practices documented in Worksheet 2 may reduce setbacks.*
- All livestock structures comply with applicable local shoreland, wetland, and floodplain zoning ordinances (copies available from local government).

  Wells comply with the Wisconsin well code (NR 811 and 812). New or substantially altered livestock structures are separated from existing wells (including neighbors' wells) by setback distances required in NR 811 and 812.

Application (continued)

11. Plans
Check all the following boxes that apply if you are submitting a modified or new plans. The plans must meet the requirements under each of the three sections.

☐ **Employee Training Plan**

Applicant determines plan contents, as long as the plan identifies all of the following:

- Training topics including, at a minimum, nutrient management, odor management, manure management and waste handling, maintenance of odor control practices, runoff management, and environmental incident response.(Training on employee safety should be included in these topics)
- The number and job categories of employees to be trained.
- The form and frequency of training, which at a minimum must include a plan for at least one training per year.
- Training presenters (these may include *livestock facility* managers, consultants or professional educators).
- A system for taking and recording attendance.
- A system for documenting and retaining records of completed trainings (Permitting authorities may request to inspect these records).

☐ **Environmental Incident Response Plan**

Applicant determines plans contents, as long as the plan identifies all of the following:

- Types of environmental incidents covered. These must include, at a minimum, overflows and spills from waste storage facilities, catastrophic system failures, manure spills during transport and application, movement of manure during or after application, catastrophic mortality disposal emergency, and odor complaints.
- The name and business telephone number of at least one individual who will handle public questions and concerns related to environmental incidents.
- The names and telephone numbers of first responders (e.g. DNR, fire departments, excavation contractors)
- Incident response procedures, including emergency response, recordkeeping and reporting requirements.
- A system for documenting and retaining records involving environmental incidents. (Permitting authorities may request to inspect these records).

☐ **Odor Management Plan** (submit if you do not have a plan on file that meets the new standard)

Odor management plans required if the livestock facility has manure storage located within 600 feet of any property line or animal housing located within 400 feet of any property line.

- The plan shall identify management practices that the livestock facility must follow to control odor from each manure storage structure and livestock housing located within the separation distances. The plan may include odor control practices identified in a local approval granted before [the effective date of this rule revision].
- In the case of a new or expanded manure storage structure and livestock housing that cannot be constructed without odor control practices to reduce setback requirements, the operator may reference Worksheet 2 in place of describing the odor control practices in the plan.
- The plan also may include practices to reduce dust, practices to reduce odor from nearby livestock structures such as animal lots, practices used to reduce odor from dead animals, activities to reduce community conflict, and water conservation practices that control odor.
- A system for documenting and retaining records concerning the operation and maintenance of odor control practices (Permitting authorities may request to inspect these records).

12. Narrative

Include a narrative describing the new or expanded livestock facility, including the new or altered livestock structures using unique identifiers and the manure management system that will be implemented at the livestock facility.

13. Worksheets

Check each of the following worksheets that are submitted with this application:

☐ **Worksheet 1 – Animal Units.**

☐ **Worksheet 2 – Odor Management.** This must be submitted, regardless of changes to the livestock operation, unless you previously submitted a worksheet meeting the new standard.

☐ **Worksheet 3 – Waste and Nutrient Management.** If you meet the requirements for an exemption, check the appropriate box on this worksheet, and provide necessary documentation and certification with this application.

☐ **Worksheet 4 – Waste Storage Facilities.** If you meet the requirements for an exemption, check the appropriate box on this worksheet, and provide necessary documentation and certification with this application.

☐ **Worksheet 5 – Runoff Management.** If you meet the requirements for an exemption, check the appropriate box on this worksheet, and provided necessary documentation and certification with this application.

Check all parts that you must complete based on the changes in your livestock operation:

☐ **Part A: Animal Lots**
☐ **Part B: Process Wastewater**
☐ **Part C: Feed Storage**
☐ **Part D: Milking Center Wastewater**
☐ **Part E: Nonpoint Pollution Standards**

Authorized Signature:

I (we) certify that the information contained in this application (including worksheets and all attachments) is complete and accurate to the best of my knowledge.

Signature of Applicant # 1 or Authorized Representative #1   Date

Print Name   Title

Signature of Applicant # 2 or Authorized Representative # 2   Date

Print Name   Title

Appendix C
NOTICE TO ADJACENT PROPERTY OWNERS
STATE OF WISCONSIN -- LIVESTOCK FACILITY SITING
Wis. Stats. § 93.90; Wis. Adm. Code ch. ATCP 51

______________________________ ("political subdivision") has received an application from ______________________________ ("applicant") to approve a new or expanded livestock facility located at

____.

The application form and worksheets, which are prescribed by state law, describe the proposed facility in detail including how the applicant will comply with applicable state siting standards relating to:

- Odor management.
- Property line and road setbacks.
- Manure management.
- Manure storage facilities.
- Runoff management.

The application materials may be viewed (by visiting this website: ________ (at this address during normal business hours: ___________) [strike what <u>does not</u> apply].

The boxes checked below describe the procedures for making a decision on this application:

☐ The political subdivision notified the applicant that its full application was complete on __________. Under state law, the political subdivision must normally grant or deny the application within 90 days after that date.

☐ Based on a completeness determination, the political subdivision must approve the application unless it finds, based on other clear and convincing evidence, that the application fails to meet state standards.

☐ A political subdivision must grant or deny a request to modify an existing local approval within 45 days after the livestock operator's submission of a complete application.

☐ Interested persons may submit comments and information, in writing, by ___________.

☐ The political subdivision will hold a public hearing on this matter, and will publish a hearing notice in the normal manner.

An applicant, or a person who resides or owns land within 2 miles of the proposed livestock facility, may appeal the political subdivision's decision to the Wisconsin Livestock Facility Siting Review Board. An appeal, if any, must be filed within 30 days.

On the back side of this notice, you will find a short summary of state livestock facility siting requirements. For more information, you may call ____________________ or visit the state website at http://livestocksiting.wi.gov

State Livestock Facility Siting Requirements (For New or Expanded Livestock Operations that Need a Local Permit)		
Requirement	Applies to	Provisions
Application and Worksheets	All applicants	• Describes proposed livestock operation in detail including a narrative • Shows number of "animal units" (AU) proposed • Documents compliance with state siting standards
Setbacks (see site map)	All applicants	• Requires that livestock structures meet local setbacks (cannot exceed state maximums of 100 to 300 feet depending on size) • Requires setbacks for new and expanding manure storage and certain housing types ranging from 400 to 2,500 feet depending on the facility size • Setbacks may be reduced by odor control practices. • Grandfathers existing structures and allows limited expansion away from property line • Must comply with existing water quality setbacks (wetland, floodplain, well setbacks)
Odor Management (see worksheet)	All applicants, with a focus on livestock operations that have: • Manure storage or housing structures near their property lines, or • New or expanded manure storage or housing structures that cannot meet setbacks without odor control practices	• Remain in compliance with odor standard incorporated into existing permit (released when a subsequent approval is granted for an expansion) • Must have an odor management plan if existing storage within 600 feet of property line or existing housing is within 400 feet • Update odor management plan if political subdivision receives verified odor complaint • Document reductions in setbacks for new and expanded manure storage and high odor housing structures based on odor control practices
Waste and Nutrient Management (see worksheet)	All applicants	• Documents amount of manure and other waste that will be generated. • Describes how wastes will be managed (e.g. composting, land spreading) • Identifies land for manure spreading including restrictions • Requires a checklist showing that the operation has a plan to manage the application of manure and other nutrients to meet crop needs while minimizing risks to water resources. • Comply with performance standards for tillage setbacks and phosphorus management
Waste Storage Facilities (see worksheet)	All applicants with manure storage structures	• Construct new and expanded storage structures according to technical standards. • Certify that existing structures are safe (not leaking or failing) • Close structures that are not safe • Operate structures according to performance standards
Runoff Management (see worksheet)	All applicants	• Prevent significant discharges from animal lots, feed storage, and milking center waste • Certify that feed storage are safe (not leaking or failing) • Meet discharge standards for existing animal lots • Design new and expanded animal lots, and feed storage to the latest technical standards (exceptions apply) • Meet state nonpoint pollution standards
Training and Response Plans	All applicants	• Develop incident response plan (spills and odor events) • Develop employee training (manure and odor mgmt.)

Wisconsin Department of Agriculture,
Trade and Consumer Protection

Initial Regulatory Flexibility Analysis

Rule Subject:	Livestock Facility Siting
Adm. Code Reference:	ATCP 51
Rules Clearinghouse #:	TBD
Department Docket #:	15-R-12

Rule Description

General

First adopted in May 1, 2006, Wis. Admin. Code Ch. ATCP 51 ("ATCP 51") established a uniform framework of standards and procedures required to implement Wisconsin's livestock facility siting law, Wis. Stat. § 93.90. The ATCP 51 requirements only apply to livestock operators located in jurisdictions that have adopted ordinances requiring permits for new or expanding livestock facilities that exceed a certain size (commonly 500 animal units). The Department of Agriculture, Trade and Consumer Protection ("Department") must review Wis. Admin. Code Ch. ATCP 51 every four years to ensure that the goals of the law are being achieved.

This proposed rule revision is intended to ensure consistency among related rules (Wis. Admin. Code Chs. NR 151 and ATCP 50), which were revised to implement a new nutrient management technical standard and additional farm runoff control standards designed to improve the control of discharges of process wastewater, and meet phosphorus index targets for nutrient management. The ATCP 51 revision also addresses issues arising out of the four year review of the rule. The proposed revision retains the essential regulatory framework, including the core water quality standards. Improvements in standards are intended to advance the statutory goal of "providing uniform regulation of livestock facilities" and better balance the factors listed in Wis. Stat. § 93.90(2)(b), which the Department must use to establish state standards.

Small Businesses Affected

The rule will primarily impact new or expanding livestock operations that must receive local approvals ("permits") under siting ordinances currently administered by 120 local governments (mostly towns). The proposed rule anticipates that 150 livestock facilities, many of which qualify as "small businesses", will need first-time permits or permit renewals over the next 10 years. The most significantly impacted among this group will be 55 operations that average 800 animal units in size, but are too small to be regulated as Concentrated Animal Feeding Operations ("CAFOs") by the Department of Natural Resources ("DNR"). The rule will have a slight but positive impact on businesses that work with livestock operations, including nutrient management planners, farm supply and service businesses, soil testing laboratories, agricultural engineers, and contractors installing farm conservation practices.

Livestock Operators

The proposed rule revision will have very limited impact on farms statewide, affecting less than 1 percent of Wisconsin livestock operations that raise cattle, swine, poultry, sheep and goats (2012 Census data: 46,034 farms with livestock, consisting of 29,908 farms with cattle and calves; 2,270 with hogs; 8,847 with layers and broilers; 2,590 with sheep and lamb; and 2419 with goats). Over the next ten years, it is estimated that the revised siting rule will impact no more than 150 new or expanding livestock facilities statewide that are issued local permits for the first time or are reissued permits [100 new permits (10 per year) plus 70 permit reissuance (7 per year) minus 20 that will seek more than one permit reissuance]. As noted above, the rule change will have virtually no impacts on 85 new and expanding livestock facilities [50 new permits and 35 of the permit reissuances] that are CAFOs, and are required by their DNR permits to meet the higher water quality standards in the revised siting rule.

The following considerations and assumptions were used in determining the nature and extent of impacts of this rule revision on new and expanding livestock operations:

1. Within the first 11 years of the siting rule's implementation, local governments approved 150 livestock facilities (24 facilities received more than one approval to cover expansions).
2. Based on past trends in the livestock industry and local permitting activity, which may not be predictive of future activity, it is estimated that the total number of permitted facilities in the next ten years will increase by 100 to reach a total of 250. In addition, 50 livestock facilities will seek at least one renewal of their permits based on facility expansions. The following assumptions support the forecasted slowdown in the rate of new permit issuances, and the increase in the rate of permit reissuances:
    a. While the number of siting ordinances adopted by local governments may grow to more than 175 within the next 10 years, most of the jurisdictions adopting ordinances will issue no permits or at most one permit.
    b. A limited number of counties including Jefferson, Manitowoc, Shawano, Trempealeau, and Walworth will issue 80 percent of permits, and in the future more of their activity will involve reissuance of permits for facilities seeking approval for expansions.
3. Of the estimated 100 new permits, 50 percent will involve livestock facilities with more than 1000 Animal Units "AUs" and 70 percent of the 50 facilities seeking permit reissuance will exceed 1000 AUs. By the terms of their DNR CAFO permits, these 85 facilities will be required to meet the nutrient management, manure storage and runoff management standards that meet or exceed those proposed in the siting rule, and will not incur additional costs to implement the new system for setbacks and odor management.
4. Of the estimated 65 non-CAFOs affected by the changes, 10 of the facilities will receive more than one permit during the 10 year period. Livestock operations

issued multiple permits will meet many of compliance obligations with their first permits, and will much lower burdens with successive permits. .

   a. Every applicant for a siting permit has submitted a nutrient management plan checklist and none have relied on the exemption from nutrient management plan requirements.

5. Over the next ten years, 55 non-CAFOs will have the greatest exposure to cost increases triggered by the rule revision.

Based on the assumptions listed above, it is estimated that the affected livestock operations will incur an additional $1.05-$1.16 million in annual costs to comply with the changes in the rule revision over a 10 year period. Appendix A details the annual breakdown of these costs. The rule revision includes specific accommodations to offset or limit the costs that may be incurred by the non-CAFOs that are most significantly impacted.

Recordkeeping and New Skills Required

In considering impacts, the Department must evaluate additional reporting or record-keeping requirements imposed on livestock operators. The rule revision adds no new standards that livestock operators must meet. The changes to some standards will reduce the burden on farmers. For example, the proposed rule revision simplifies the odor standard and reduce recordkeeping requirements related to documentation of odor control practices. Low odor sources such as animal lots and dairy housing are no longer included in worksheet calculations. Also, simplification of the odor standard will enable farmers to complete the worksheets, including an odor management plan, without the help of consultants. The availability of permit modifications should reduce the paperwork needed to obtain a permit for the expansion of livestock facility. The option to selectively implement the runoff standards should help farmers reduce the paperwork to secure local permits for a planned expansion.

In some cases, changes to certain standards such as the nutrient management standard will increase recordkeeping. Regarding nutrient management, the Department provides funding to maintain NM planning software, SNAP-Plus, which includes planning tools that will reduce time and expense needed to prepare a compliant plan.

Whether the challenge involves recordkeeping or new skills, the demands of this rule should be viewed in the larger context of the many programs in which farmers participate. In a world of ever increasing conservation requirements, all livestock operations, whether they are CAFOs or not, are accustomed to making changes to address new requirements imposed by a range of state and local programs affecting these businesses. With new requirements often come additional recordkeeping. Changes in common programs such as county manure storage permits and participation in the farmland preservation program have triggered increased recordkeeping related to the updated requirements for nutrient management plans. Cost-share and other programs regularly incorporate newer technical standards, raising the costs of conservation practices, and often triggering increased recordkeeping.

By its nature, the business of farming requires that farmers be skilled at managing changes triggered by the need to incorporate new technologies, respond to growing conditions, or modify production methods. In changing bedding and feeding systems for livestock, for example, a farmer must work through a challenging series of steps to deploy new equipment and change management practices, and may use adaptive management techniques to overcome challenges. The skills and experience gained in these settings help farmers manage newly installed conservation practices such as feed storage runoff control systems. Nonetheless, there is a learning curve that farmers must negotiate. In the case of nutrient management, farmers may need to build their skills with computers to take advantage of tools such as SNAP-Plus.

Overall Impact on Farmers

The changes in the siting rule will fall mostly on a small group of non-CAFOs that seek local permits for facilities with new or expanded animal lots and feed storage structures. The changes in the odor standard will simplify compliance with odor requirements for livestock operators. The Department believes that recordkeeping and other increased responsibilities will not place unreasonable demands on farmers, and will be offset by changes that reduce the burden on farmers. In general, livestock operators should be able to incorporate the costs as part of financing changes in their operations, and any additional requirements should not be a decisive factor in an operator's decision to build or expand their operations.

The Department has included the following provisions that will limit or offset costs created by the rule changes:

- Enhancements to authorize permit modifications that will reduce permitting steps and costs related to the expansion of a permitted livestock facility.
- Expanding livestock facilities may use permit modifications to defer costs related to runoff management upgrades until they must submit a full application for a siting permit.
- The fee structure retains the $1000 maximum charge for a full permit and adds a reduced fee of $500 for livestock operations seeking a permit modification.
- The transition to a new system of setbacks and odor control practices will be eased, because livestock facilities operating under the original odor management system have already increased setbacks beyond the minimum and installed odor control practices to obtain a passing odor score.
- The concept of clusters is repurposed to enable operations to use lower setbacks based on animal units within a cluster, and not based on the animals housed at the entire livestock facility.
- The revised Worksheet 2 (odor management) simplifies the process of determining compliance, no longer requires worksheet calculations for low odor sources such as animal lots and dairy housing, and allows farmers to use more flexible odor management plans to address odors from existing manure storage and other structures with higher odor sources.

- Grandfathering provisions will allow operators to expand manure storage and housing within a setback without the need to add additional odor control practices.
- Clarification of local authority to reduce setback requirements through the use of variances.
- As a result of uniform standards across conservation programs, livestock operators have opportunities to achieve compliance with the new siting standards through other programs. For example, a livestock operator may come into compliance with the 2015 nutrient management standard and other updated standards by participating in other programs such as the farmland preservation program.
- A low cost option is provided for existing animal lots to meet standards for barnyard runoff control, enabling minor alterations, and allowing continued use and improvement of vegetated treatment areas.
- A low cost option is provided for small feed storage facilities to meet runoff control standards.
- Delays in processing applications will be reduced by changes including tighter requirements for local governments to make determinations regarding an incomplete application for a siting permit.
- Clarification of the procedures for a CAFO to substitute its DNR permit in place of worksheets, and removed the requirement that the CAFO permit must be for the same size facility.
- All operators of non-CAFOs remain eligible for cost-sharing to install practices to comply with the siting rule. Enhancements to authorize permit modifications that will reduce permitting steps and costs related to the expansion of a permitted livestock facility.

Non-Farm Businesses

This rule has the following impacts on entities (a number of which qualify as "small businesses.") that do business with livestock operations coved by the siting rule.

Crop consultants and other professional planners, farm supply and service businesses, soil test laboratories, and manure-haulers. This proposed rule will minimally increase the demand for entities that provide cropland related services to farmers. It will require more extensive services from professional nutrient management planners who must help farmers implement a more complicated nutrient management plan. Only third-party planners qualified under Wis. Admin. Code § ATCP 50.48 may prepare nutrient management plans for livestock operations permitted under the siting rule. These consultants must understand and follow record keeping requirements related to soil types, soil tests, crop nutrient requirements including University of Wisconsin recommendations, nutrient applications, nutrient contents of manure, nutrient application scheduling, and other matters related to nutrient management. This rule will not necessarily change the demand for manure hauling services, but may increase demand for soil testing. Nutrient management plans must be based on soil tests conducted by certified laboratories.

Agricultural engineering and construction contractors. This proposed rule will marginally increase demand for engineered conservation practices. Operators of new and expanded livestock facilities may need more engineered solutions to deal with runoff from animal lots and feed storage. Operators of expanded livestock facilities will need engineering expertise to demonstrate that existing structures meet technical standards and to design modifications for structures to bring them into compliance.

Lenders. This proposed rule will benefit lenders working with livestock facilities that are subject to local regulation of new and expanded livestock facilities. In addition to removing the uncertainties related to local permitting, lenders will benefit by gaining greater security on their farm loans because livestock operations will meet standards that protect against environmental problems and avoid nuisance complaints based on odor.

Recordkeeping and New Skills Required for Non-Farm Businesses

This rule revision does not directly trigger increased reporting, bookkeeping or other procedures for non-farm businesses.

Business professionals will need to enhance their skills to help farmers implement the siting standards; however, these professionals will likely take these actions for reasons other than this rule. Engineers and nutrient management planners must keep pace with the latest technical standards to meet the needs of customers and protect themselves from liability. As noted previously, the rule changes will make standards consistent across government programs, making it inevitable that these professionals stay current. Moreover, certain professionals such as engineers and certified crop advisors are required to update their skills to retain their registration or certification.

Reporting, Bookkeeping and other Procedures

To the extent that this rule requires reporting, bookkeeping or other procedures, the Department's analysis is included in the prior sections covering impacts on farmers and non-farm businesses.

Professional Skills Required

To the extent that this rule requires changes in professional skills, the Department's analysis is included in the prior sections covering impacts on farmers and non-farm businesses.

Accommodation for Small Business

The Department has taken actions to identify compliance and reporting effects of these rule changes, including securing feedback from members of stakeholder groups (which included small business owners and organizations) and a technical advisory committee of professional who work with farms of all sizes. Regarding the group most significantly impacted, non-CAFOs, the rule includes accommodations previously described in the section summarizing the overall impacts on livestock operations.

Conclusion

This rule will have no more than a moderate impact on farmers, including "small businesses." To a limited extent, increased costs for non-CAFOs will be offset by the benefits from changes to the proposed rule, including permit modifications and protections against unfair use of completeness determinations. Other businesses may slightly benefit from these rule changes.

Dated this 14th day of July, 2017.

STATE OF WISCONSIN
DEPARTMENT OF AGRICULTURE,
TRADE AND CONSUMER PROTECTION

By
John Petty, Administrator
Division of Agricultural Resource Management

APPENDIX A: Estimate of Annual Costs Triggered by Siting Rule Changes over 10 Year Period			
Standard	**Annual Costs**	**Under 1000 Animal Units** (gray shading=no cost)	**Over 1000 Animal Units** (gray shading=no cost)
Odor Management-New and expanded facilities	$3,150-$37,500	The change in setbacks and odor management will not require many farms to add additional practices; however, 10 facilities will need to install a practice related to manure storage. The estimated costs will range between: ***Low***: Windbreak-$3,150 ($4.50/ft @ 700 ft) ***High***: Cover-$37,500.00 ($.75/sq. ft. x 50,000 sq ft) There is no cost associated with odor management plans, if required, since they can be prepared by landowners and do not mandate practices.	None of the facilities should incur additional costs to comply with the change in setbacks and odor management for the following reasons: 1. A number of livestock facilities do not need odor control practices to meet the setback requirements. 2. The livestock facilities would have had to install one or more odor practices to earn passing score under the previous odor standard.
Upgrade of Nutrient Management Plans	$9,000	25 livestock facilities will be directly impacted since they are not required by other laws or program participation (e.g manure storage ordinances or FPP tax credits) to follow the upgraded standard. Based on average of 800 animal units and 1200 acres of spreadable land, each of these facilities will spend $3 per acre more to comply or $3,600 per operation.	Required under CAFO permit and therefore no additional costs based on the siting rule
Waste Storage	$0	No changes to this standard, and no new costs associated with clarification of evaluation procedures.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Waste Storage-Closure	$12,000-$20,000	8 livestock facilities must spend between $15,000 and $25,000 to close substandard structures.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Animal Lot Runoff—New or substantial altered	$$100,000-$ 125,000	10 livestock facilities will need to meet the new runoff standards for new lots, and the estimated costs for a 10,000 square foot lot will range between: ***Low***: Roof to divert water-$100,000 ***High***: New or expanded storage to hold runoff-$125,000	Required under CAFO permit and therefore no additional costs based on the siting rule.
Animal Lot Runoff—Existing	$9,900-$46,200	33 (60 percent of 55) livestock facilities must add practices to pass the barnyard evaluation, and estimated upgrade costs for a 10,000 square foot lot will range between: ***Low***: Clean water diversion-$3,000 for berm ***High***: Roof gutters at $10,000 and VTA improvement at $4,000. No costs attributed to management changes such as added cleaning.	Required under CAFO permit and therefore no additional costs
Feed Storage-Pad and Runoff collection—New and expanded bunkers, paved areas and related structures but not bags	$860,810	35 livestock facilities must meet new standard, but 10 will qualify for the lower cost option based on 1 acre of feed storage, and 30 must meet higher standards based on 2.5 acres of feed storage. • 10 facilities would incur an additional $43,560 ($1.00 per sq ft. more based on 1 acre) to upgrade their pad surface compared to requirements in the previous rule, and $20,000 to collect and pump leachate. • 25 facilities would incur an additional $108,900 ($1.00 per sq ft. more based on 2.5 acres) to upgrade their pad surface compared to the requirements in the previous rule and $210,000 to add storage to collect leachate and runoff from 2.5 acres of feed storage.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Feed Storage—Existing bunkers, paved areas and related structures but not bags	59,800	Livestock facilities will incur the following costs to evaluate and upgrade their existing facilities: • 55 livestock facilities will incur costs engineering evaluation of storage at $600 per evaluation. • 20 facilities must install clean water diversion at $2,000 each. • 35 facilities must spend $15,000 each to enhance their system to collect runoff from feed storage over 1 acre.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Other Runoff Control Standards	0	Managing milkhouse wastewater should not incur additional costs. Nor are there additional costs to comply with the tillage setback. By complying with the NRCS 590 standard, operations will control soil erosion to T and meet the Phosphorus Index.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Annual Costs	**$1,054,660-$1,158,310**		
Ten year Costs	**$10,546,600-$11,583,100**		

Wisconsin Department of Agriculture, Trade and Consumer Protection

Preliminary Environmental Assessment

Rule Subject:	**Livestock Facility Siting**
Administrative Code Reference:	**ATCP 51**
Rules Clearinghouse #:	**TBD**
DATCP Docket #:	**15-R-12**

This environmental assessment is required by Wis. Admin. Code §ATCP 3.02.

Nature and Purpose of Proposed Rule

First adopted in May 2006, Wis. Admin. Code ch. ATCP 51 ("ATCP 51") established the statewide framework of standards and procedures required to implement Wisconsin's livestock facility siting law, Wis. Stat. § 93.90. The rule only applies to livestock operators located in jurisdictions that have adopted ordinances requiring permits for new or expanding livestock facilities that exceed a certain size (commonly 500 animal units). Every four years the Department of Agriculture, Trade and Consumer Protection ("Department") must review ATCP 51, including securing advice from a Department-appointed committee of experts, to ensure that this rule meets goals in Wis. Stat. § 93.90.

The proposed rule is intended to ensure consistency among related rules (Wis. Admin. Code chs. NR 151 and ATCP 50, respectively referred to as "NR 151" and "ATCP 50"), and will incorporate changes in related rules, which implement a new nutrient management technical standard and additional farm runoff control standards designed to better control discharges of process wastewater, and meet phosphorus index targets for nutrient management. The ATCP 51 revision also addresses issues arising out of the four year review of the siting rule. The proposed revision retains the essential regulatory framework, including the core water quality standards. Improvements in standards and permitting procedures are intended to advance the statutory goal of "providing uniform regulation of livestock facilities" and better balance the factors listed in Wis. Stat. § 93.90(2)(b), which the Department must use to establish state standards.

Foreseeable Environmental Effects

The environmental effects of this rule are positive but small in scope given the limited number of livestock operations affected. This rule retains key features of the original version of ATCP 51 including manure management standards that protect water quality and reduce odor, and a local option to adopt more stringent standards to address local conditions. In addition, this rule implements new and modified standards, including the most current technical standards developed by United States Department of Agriculture's Natural Resources Conservation Service ("NRCS"), designed to better protect water quality and prevent soil loss. These updates, along with other changes, will:

- Implement stronger protections for surface and groundwater when applying manure, as required by the 2015 version of the NRCS 590 Nutrient Management Standard ("NRCS 590 standard").
- Incorporate cropland performance standards related to the phosphorous index and the tillage setback.
- Require effective evaluations of storage facilities to allow continued use.
- Require closure of manure storage facilities that cannot be safely operated.
- More effectively control process wastewater discharges from feed storage structures, which is consistent with the latest NRCS technical standards.
- More effectively control runoff from animal lots consistent with the latest NRCS technical standards.

With the adoption of the newest NRCS 590 standard, nutrient management plans will address the following restrictions and prohibitions designed to protect water quality particularly in environmental sensitive landscapes:

- Prohibiting nutrient applications within 50' of all direct conduits to groundwater (previously only applied to wells) where only grazing and a limited amount of corn starter fertilizer may be applied.
- Prohibiting applications of manure within 100' of a non-community well, which includes schools, restaurants, churches, and within 1000' of a community well, unless the manure is treated to reduce pathogen content.
- Prohibiting winter nutrient applications within 300' of all direct conduits to groundwater, unless manure is directly deposited by gleaning or pasturing animals. This setback increased from the 200' setback in the 2005-590 NM Standard.
- Prohibiting liquid manure application in February or March on Well Compensation Areas designated by Department of Natural Resources ("DNR"), or on fields with Silurian Dolomite bedrock within 5' of the surface.
- Limiting manure nitrogen ("N") applications in late summer or fall using the lower application rate of either the current 2012 version of UW Pub. A2809 or 2015-590 NM Standard available N per acre rate for the situation on sites vulnerable to N leaching high permeability ("P") soils, or rock ("R") soils with < 20 inches to bedrock, or wet ("W") soils with < 12 inches to apparent water table ("PRW Soils").
- Limiting winter manure applications when frozen or snow-covered soils prevent effective incorporation. The NM plan must limit these applications when slopes are > 6% and if fields have concentrated flow areas using two crop management practices listed in the winter application section of the 2015-590 NM Standard.
- Prohibiting manure applications to areas locally delineated by a Land Conservation Committee as areas contributing runoff to direct conduits to groundwater, unless manure is substantially buried within 24 hours of application.
- Late summer or fall commercial N fertilizer applications are limited in regard to areas within 1,000 feet of a community well, 5 feet or less over bedrock, sites vulnerable to N leaching high permeability ("P") soils, rock ("R") soils with < 20 inches to bedrock, or wet ("W") soils with < 12 inches to apparent water table; rates needed for establishment of fall seeded crops or to meet UWEX Pub. A2809 with a blended fertilizer. The fall N rate was

increased from 30 to 36 lbs. of N per acre to match common blended fertilizers if other nutrients are needed.

The change in the odor standard will simplify the management of odor without a measurable change in the level of odor protection. It will continue to support the use of odor control practices by farms. Odor management plans will offer a new feature to address verified complaints about odor problems. It is likely that increases in setbacks may reduce some nuisance impacts related to light, noise, and dust from certain livestock structures.

Persons or Groups That May Be Affected by the Rule

Town, County, or other Political Subdivisions. This proposed rule affects only political subdivisions that voluntarily elect to regulate livestock facility siting through conditional use permits, licenses, and other forms of approval. As of 2017, 119 towns, counties, and other political subdivisions have adopted siting ordinances. Most towns that adopt ordinances will issue only one permit, with many issuing no permits. Over the next ten years, it is likely that no more than 30 local governments will adopt new siting ordinances. Over the next ten years, local governments are expected to issue the same number of permits issued during the first 11 years of ATCP 51's implementation.

See the *Fiscal and Economic Impact Analysis Estimate* for an analysis of costs that political subdivisions may incur as a result of this proposed rule.

Livestock Farmers. This proposed rule affects only a small subset of farmers who plan new or expanded livestock facilities in jurisdictions that require a local permit, license, or approval for such activity. Based on historical permitting by local governments, it is estimated that no more than 150 livestock facilities will be impacted over a 10 year period, and more than half of these operations are Concentrated Animal Feeding Operations ("CAFOs"), which must meet the new siting requirements to comply with their DNR permits. About 55 non-CAFOs will be most significantly impacted by this rule, and they may need to invest over $100,000 in new runoff management practices. The *Regulatory Flexibility Analysis* includes an analysis of costs for livestock farmers and the other affected businesses described below.

Crop Consultants and other Professional Planners, Farm Supply, and Service Businesses, Soil Test Laboratories and Manure-Haulers. This proposed rule will minimally increase business for entities that provide cropland related services to farmers. Nutrient management planners will spend more time and charge more for developing plans under this rule. This rule will not necessarily change demand for manure hauling services, but may increase demand for soil testing.

Agricultural Engineering and Construction Contractors. This rule will marginally increase demand for engineered conservation practices. Operators of new or expanded livestock facilities will have a need for more engineered solutions to deal with runoff from animal lots and feed storage. Operators of expanded livestock facilities will need engineering expertise to demonstrate that existing structures meet technical standards and to design modifications for structures to bring them into compliance.

Lenders. This rule will benefit lenders that do business with livestock facilities, because it eliminates uncertainties in siting new or expanded livestock facilities.

General Public. The general public will benefit from this rule as a result of increases in farm-focused natural resource protection.

Significant Economic, Social, or Cultural Effects

Economic Effects

Less than 1 percent of Wisconsin's livestock operators will be affected by the rule. The rule will not have a significant effect on agricultural production, the sale or distribution of agricultural products including dairy products, or on the overall economy of this state. While the rule's impact will fall on a small subset of livestock operators, the demands of this rule should be viewed in the larger context of the many programs in which farmers participate. Several new requirements are consistent with recent changes to state and local conservation programs. Changes in common programs such as county manure storage permits and participation in the farmland preservation program have triggered increased recordkeeping related to the updated requirements for nutrient management plans. Cost-share and other programs regularly incorporate newer technical standards, raising the costs of conservation practices, and often triggering increased recordkeeping. In general, livestock operators should be able to incorporate any increased costs resulting from this rule into their business plans and any additional costs should not be a decisive factor in an operator's decision to build or expand their operations.

The rule will result in a slight economic benefit for the businesses professionals such as engineers and nutrient management planners who assist operators with new or expanding livestock facilities.

Setbacks and odor control practices should reduce the nuisance impact of livestock operations on neighbors. While these improvements translate into economic benefits, they are not easily quantified, particularly in light of the small group of affected operators.

Social and Cultural Effects

The rule will be neutral in terms of social and cultural effects. The improvements in water quality protections and the continued use of odor control practices may make livestock operations more acceptable to communities. Increased setbacks may improve nuisance impacts related to light, noise, and dust from production area. The scope of the rule does not address high profile issues such as water usage and management of competing water needs, traffic and road impacts, separation of conflicting land uses (e.g. residential and farms), impacts on land values, and possible disruptions in rural communities created by fewer and larger farms and increased use of migrant labor.

Controversial Public Issues

By the nature of the rule's scope, rule changes primarily focus on new water quality standards which better manage manure from locally permitted livestock operations. While improved standards will protect water in areas immediately surrounding permitted farms, the improved standards on the whole will do little to make improvements statewide, because only livestock operations in jurisdictions that have adopted siting ordinances are required to comply.

As discussed above, the rule does not cover the full impacts of larger livestock operations, nor does it mitigate certain impacts at the level desired by some groups. Despite changes in setbacks, the siting law is a limited tool to manage land use conflicts. Some community members may believe the rule's enhanced standards related to manure and feed management are not sufficient to address local concerns. While ATCP 51 offers communities a pathway to adopt more stringent local standards, local groups may find this option challenging.

Some livestock operators may be frustrated by the increased management responsibilities, particularly if they have made a conscious effort to operate below the 1,000 animal unit threshold for CAFO permits. The new siting standards are getting closer to the standards that apply to CAFOs, and will require additional investments of time and dollars to implement.

The Department expects to receive public feedback during the hearing and comment process and will consider whether to make changes to the final rule to address public concerns.

Alternatives to this Rule

No Action

Not promulgating the rule would cause the Department to have performance standards and prohibitions, conservation practices, and technical standards in conflict with other related rules such as NR 151 and ATCP 50. Under Wis. Stat. § 93.90(2)(a), the Department is obligated to promulgate rules specifying standards for siting and expanding livestock facilities, and ensure that its rules are not in "conflict with rules promulgated under §§ 92.05 (3) (c) or (k), 92.14 (8), 92.16, or 281.16 (3) or ch. 283." Inconsistent standards would cause local governments to have requirements in their siting ordinances that are not in conformance with Wis. Stat. § 92.15, which authorizes local "regulations of livestock operations that are consistent with and do not exceed the performance standards, prohibitions, conservation practices and technical standards under s. 281.16 (3). Stats."

The Department would be falling short in its duty to develop and maintain the siting standards, which correctly balance the criteria identified in Wis. Stat. § 93.90(2)(b). For example, older standards incorporated into the siting rule in 2006 may be rooted in technically outdated concepts and not satisfy the criterion that requires that standards be based on the latest peer reviewed research and science.

Taking no action also disregards the results of the rule review the Department conducted to fulfill its duties under Wis. Stat. § 93.90 (2)(c). In addition, the Department would be dismissing the advice it was required to secure from a technical expert committee under Wis. Stat. § 93.90 (2)(d).

Lastly, local governments and livestock operators would be required to follow outdated rule provisions, including technical standards that do not provide improved environmental benefits, and may not adequately address stakeholder needs. Failure to update technical standards will result in inconsistent treatment of farmers who must follow one standard for one program and another standard for a different program.

Modify Rule Provisions

The Department could modify the proposed rule provisions. However, the Department is constrained by a number of factors. This rule was developed in consultation with government agencies, organizations, and industry groups. The rule is the product of an extensive review process. The statutory framework for the rule, including the consistency requirement, directs certain outcomes. Nonetheless, this rule includes specific accommodations to address the needs of the most impacted groups and represents a fair balance between the business concerns and the need for natural resource protection. The Department may make changes to the final version of the rule based on comments and testimony received during public hearings.

Additional Measures to Mitigate Adverse Environmental Effects

The Department does not anticipate any adverse environmental effects as a result of this rule. Therefore, no additional measures will be needed to mitigate any adverse environmental effects.

Conclusion

This rule is intended to ensure consistency among related rules (NR 151 and ATCP 50) resulting in uniform standards for protecting water quality, addressing issues arising out of the mandatory four year review of the siting rule, and making improvements to advance the statutory goal of "providing uniform regulation of livestock facilities" and better balance the factors listed in Wis. Stat. § 93.90(2)(b). Overall, this rule will have a positive effect on the environment. There are no preferable alternatives to this rule. This rule is not a "major action significantly affecting the quality of the environment," for purposes of Wis. Stat. § 1.11. No environmental impact statement is required under Wis. Stat. § 1.11, or Wis. Admin. Code Ch. ATCP 3.

Signed this 10th day of July, 2017.

WISCONSIN DEPARTMENT OF AGRICULTURE,
TRADE AND CONSUMER PROTECTION

By [signature]
John Petty, Administrator
Division of Agricultural Resource Management

STATE OF WISCONSIN
DEPARTMENT OF ADMINISTRATION
DOA-2050 (C04/2012)

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EXISTING ADMINISTRATIVE RULES
Fiscal Estimate & Economic Impact Analysis

1. Type of Estimate and Analysis
☐ Repeal ☒ Modification

2. Administrative Rule Chapter, Title and Number
ATCP 51, Livestock Facility Siting

3. Date Rule promulgated and/or revised; Date of most recent Evaluation

Wis. Admin. Code ch. ATCP 51 ("ATCP 51") first became effective on May 1, 2006, and has not been substantively modified since. In 2014, the department initiated a formal evaluation of the rule in accordance with s. 93.90 (2) (c), Stats., and the evaluation included recommendations from a technical expert committee provided in the fall of 2015.

4. Plain Language Analysis of the Rule, its Impact on the Policy Problem that Justified its Creation and Changes in Technology, Economic Conditions or Other Factors Since Promulgation that alter the need for or effectiveness of the Rule.

The siting rule established a uniform framework of standards and procedures required to implement Wisconsin's livestock facility siting law, Wis. Stat. § 93.90. The law is intended to provide a clear and predictable system of local regulation of livestock facilities that would protect communities and improve the business environment for the livestock industry. The rule requirements only apply to livestock operators located in jurisdictions that have adopted ordinances requiring permits for new or expanding livestock facilities that exceed a certain size (commonly 500 animal units).

In fulfillment of its duties prescribed under Wis. Stat. § 93.90(2)(c) and (d), the department conducted a review of ATCP 51 (receiving input from an expert technical committee). The review of ATCP 51 identified the need for consistency among related rules (chs. NR 151 and ATCP 50). The review, including input from stakeholders, also identified improvements in procedures and standards. The proposed revision retains the essential regulatory framework, including the core water quality and odor control practices. Improvements in standards are intended to advance the statutory goal of "providing uniform regulation of livestock facilities" and better balance the factors listed in Wis. Stat. § 93.90(2)(b), the department must use to establish state standards.

5. Describe the Rule's Enforcement Provisions and Mechanisms

The department is required by statute to develop and update standards and procedures that local governments must follow if they have ordinances requiring local permits for new and expanding livestock facilities. Specifically, Wis. Stat. § 93.90(2)(a), directs the department to develop state standards that are consistent with "rules promulgated under ss. 92.05 (3) (c) and (k), 92.14 (8), 92.16, and 281.16 (3) and ch. 283," and do not conflict with those rules. In developing and revising these standards, the department must properly balance the factors identified in Wis. Stat. § 93.90(2)(b), including protection of public health or safety, cost-effectiveness, and usability by local governments. Under Wis. Stat. § 93.90(2)(e), the department must develop application materials that local governments must use to determine if a proposed livestock facility complies with applicable state standards. Local governments are required to submit copies of local ordinances and permit approvals issued under their ordinances. While the department collects and reports on these submissions, it has no authority to address the legality of local actions. Since the siting rule is locally administered, and only implemented in jurisdictions that have adopted ordinances to require siting permits, there may be local variations regarding permit enforcement and appeal mechanisms. In addition, Wis. Stat. § 93.90(5) created the Livestock Facility Siting Review Board for livestock operators and aggrieved neighbors to appeal a local permit decision on the grounds that a local government incorrectly applied livestock facility siting standards under chapter ATCP 51 or violated the Livestock Facility Siting Law, Wis. Stat. § 93.90.

6. Repealing or Modifying the Rule Will Impact the Following (Check All That Apply)
☐ State's Economy
☒ Local Government Units
☒ Specific Businesses/Sectors
☐ Public Utility Rate Payers
☒ Small Businesses

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7. Summary of the Impacts, including Compliance Costs, identifying any Unnecessary Burdens the Rule places on the ability of Small Business to conduct their Affairs.

Impact on Business Sectors

The rule changes will have a very limited impact on farms statewide, affecting less than 1 percent of livestock operations in the state. Based on the issuance of 150 permits during the first 11 years of ATCP 51 implementation, the department estimates over the next ten years that the revised rule will impact no more than 150 new or expanding livestock facilities statewide that are issued local permits for the first time or are reissued permits [100 new permits (10 per year) plus 70 permit reissuances (7 per year) minus 20 that will seek more than one permit reissuance]. Since the rule change will have virtually no impacts on 85 new and expanding livestock facilities that are Concentrated Animal Feeding Operations ("CAFOs") and are required by their DNR permits to meet the higher water quality standards in the revised siting rule, its impact will be most significant for approximately 55 non-CAFOs. It is estimated that the affected livestock operations, nearly all of which are small businesses, will incur an additional $1.05-$1.16 million in annual costs to comply with the changes in the rule revision over a 10 year period.

The rule will have a small, but positive impact on livestock-related businesses. Those businesses, many of which are small businesses, include nutrient management planners, soil testing laboratories, farm supply organizations, agricultural engineering practitioners, and contractors installing farm conservation practices.

The Regulatory Flexibility Analysis, which accompanies this rule, provides a more complete analysis of the issue, including a detailed breakdown of increased costs for livestock operators, a copy of the analysis is attached in answer to question #14).

The department has made the following rule modifications to limit or offset any unnecessary burdens on livestock operators:

- Enhancements to authorize permit modifications that will reduce permitting steps and costs related to the expansion of a permitted livestock facility.
- Expanding livestock facilities may use permit modifications to defer costs related to runoff management upgrades until they must submit a full application for a siting permit.
- The fee structure retains the $1000 charge for a full permit and adds a $500 lower cost fee for livestock operations seeking a permit modification.
- The transition to a new system of setbacks and odor control practices will be eased because livestock facilities operating under the original odor management system have already increased setbacks beyond the minimum and installed odor control practices to obtain a passing odor score.
- The concept of clusters is repurposed to enable operations to use lower setbacks based on animal units within a cluster, and not based on the animals housed at the entire livestock facility.
- The revised Worksheet 2 (odor management) simplifies the process of determining compliance, no longer requires worksheet calculations for low odor sources such as animal lots and dairy housing, and allows farmers to use more flexible odor management plans to address odors from existing manure storage and other structures with higher odor sources.
- Grandfathering provisions that allow operators to expand manure storage and housing within a setback without the need to add additional odor control practices.
- Clarification of local authority to reduce setback requirements through the use of variances.
- As a result of uniform standards across conservation programs, livestock operators have opportunities to achieve compliance with the new siting standards through other programs. For example, a livestock operator may come into compliance with the 2015 nutrient management standard and other updated standards by participating in other programs such as the farmland preservation program.

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- A lower cost option is provided for existing animal lots to meet standards for barnyard runoff control, enabling minor alterations, and allowing continued use and improvement of vegetated treatment areas.
- A lower cost option is provided for small feed storage facilities to meet runoff control standards.
- Delays in processing applications will be reduced by changes including tighter requirements for local governments to make determinations regarding an incomplete application for a siting permit.
- Clarification of the procedures for a CAFO to substitute its DNR permit in place of application worksheets, and removal of the requirement that the CAFO permit must be for the same size facility.
- All operators of non-CAFOs remain eligible for cost-sharing to install practices to comply with the siting rule.

State and Local Government

This rule is expected to have no net impact on local and state governments. Since few local governments issue permits and counties are the most active permitting authorities, local governments should be able to absorb the changes as part of routine changes in program administration. On the state level, the initial requirement for staff can be handled by adjustments in assignments.

Local Governments

The net effect of the rule on local governments will produce no measurable fiscal impacts. For the limited number of jurisdictions that have adopted a local siting ordinance, few will issue more than one permit. However, everyone will need to understand changes in state requirements and make adjustments in their administrative process to implement changes required by this rule. Counties, which issue the most permits of all local governments, have access to conservation staff with experience in making adjustments to incorporate revisions in the technical standards as part of their administration of manure storage ordinances and implementation of state performance standards. Some changes such as the clarification of the process of permit modifications and simplification of the odor standard should reduce workload, while other changes including completion of compliance determination checklists add responsibilities. Rule changes will be incorporated into the required application forms used by local governments to process permit requests, simplifying implementation at the local level.

Local governments may be required to amend their ordinances to implement certain changes including permit modifications and setback changes. The department will provide statewide training to local government staff, livestock operators and consultants to properly apply the new standards and correctly use the new forms. County land conservation department staff and agricultural agents can incorporate information on livestock facility siting into their Land and Water Resource Management work plans, and use department staffing grants to cover some costs of program adminstration. The rule should simplify the process of permitting by eliminating the more complex standard related to odor management. There may be additional work to review compliance with updated standards related to feed storage and animal lots. For some local governments, the maximum fees may not adequate to recover their costs for processing permit applications. The proposed rule will reduce the uncertainty in the administration and enforcement of siting permits, facilitating local efforts to implement the siting requirements. In the end, local governments have the flexibility to determine the amount of work they will perform in processing applications and enforcing permits.

State Government

Because the proposed rule modifies requirements that are locally implemented, the department would provide targeted support to local governments. The proposed rule does not increase the workload or add new responsibilities related to the livestock facility siting review board. With short-term changes in work assignments, existing department staff can develop needed support materials, and provide education and technical assistance for local governments, farmers and

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consultants to implement the changes. No other increases in state costs are anticipated

8. List of Small Businesses, Organizations and Members of the Public that commented on the Rule and its Enforcement and a Summary of their Comments.

Ben Beardmore from Monroe commented that the rule needs to make livestock facilities accountable for road damage, depressed property values, and lost tourism and recreation, and should not be encouraging dairy expansions in a time of low milk prices.

Marathon County Conservation Planning and Zoning (CPZ) Department submitted technical comments on the proposed rule including concerns about the use of odor control practices to reduce setback requirements.

Kim Dupre of Saint Croix County commented that the proposed rule did not adequately account for the costs to the community from manure-contaminated water, noting that rural landowners have to spend their own money to pay for bottled water, new wells, and water filtration systems.

Saint Croix County Community Development Committee and Department identified proposed changes that improved the rule including increased standards for feed storage, closure of unsafe manure storage, cropland performance standards and incentives for greater odor control. The primary concern raised in the comment focused on the need for higher maximum fees: $1,000 for permit modifications, $2,000 for full permit applications.

These four comments raise economic issues, some of which are within the scope of DATCP's authority to address through the rule (e.g. fees) and some of which are beyond the DATCP's authority (e.g. depressed property values). Comments relating to procedural or technical issues are best addressed through the public comment process.

9. Did the Agency consider any of the following Rule Modifications to reduce the Impact of the Rule on Small Businesses in lieu of repeal?

☒ Less Stringent Compliance or Reporting Requirements
☐ Less Stringent Schedules or Deadlines for Compliance or Reporting
☐ Consolidation or Simplification of Reporting Requirements
☒ Establishment of performance standards in lieu of Design or Operational Standards
☐ Exemption of Small Businesses from some or all requirements
☒ Other, describe: Low cost compliance options for smaller livestock facilities and other accommodations described in answer to question # 7.

10. Fund Sources Affected	11. Chapter 20, Stats. Appropriations Affected
☐ GPR ☐ FED ☐ PRO ☐ PRS ☒ SEG ☐ SEG-S	20.115(7)(qd)

12. Fiscal Effect of Repealing or Modifying the Rule

☒ No Fiscal Effect	☐ Increase Existing Revenues	☐ Increase Costs
☐ Indeterminate	☐ Decrease Existing Revenues	☒ Could Absorb Within Agency's Budget
		☐ Decrease Cost

13. Summary of Costs and Benefits of Repealing or Modifying the Rule

The livestock facility siting law was designed to provide predictable, uniform and a less burdensome framework to site new and expanded livestock facilities while protecting water and air quality. With its changes, this rule strikes a fair balance among the competing goals listed in Wis. Stat. § 93.90(2)(b). The integrity, credibility and local acceptance of the rule depends on periodic updates to reflect the best science and capture other needed changes.

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By accommodating the needs of the livestock industry, the revised rule supports economic development, and sustains contributions from Wisconsin's agriculture sector, which generate more than $88.3 billion in economic activity and 413,500 jobs. (Contribution of Agriculture to the Wisconsin Economy: Updated for 2012 by Steven C. Deller, http://wp.aae.wisc.edu/wfp/contribution-of-agriculture-to-the-wisconsin-economy/). However, a small group of affected livestock operators will assume additional costs as identified in answer to question # 7.

The revised standards in the siting rule will ensure consistency among related rules (NR 151 and ATCP 50), provide improvements that may better protect water quality, manage odor using a less complex system, and shore up local administration of the law. Consistency among program requirements reduces complexity and improves compliance. The revised standards for managing runoff from animal lots and feed storage are more protective of natural resources. The new nutrient management standard will reduce the risks of spreading manure during the winter and in environmentally sensitive areas. The changes to the odor standard provide the same protection against odor but will be less complex, more transparent and easier to implement. A full discussion of environmental benefits is provided in the Environmental Assessment prepared in connection with this rule.

While local governments will need to make adjustments in their local siting programs to incorporate new requirements, in the end the changes in state requirements will simplify and clarify local administration of siting ordinances. As noted above, the odor standard will be simplified. By better defining permit modifications, the new rule will reduce the time needed to process permits for expanding livestock operations. Clarifications regarding variances and permit monitoring will improve local administration of siting laws.

14. Did the Agency prepare a Cost Benefit Analysis (if Yes, attach to form)

☒ Yes ☐ No

15. Long Range Implications of Repealing or Modifying the Rule

While the siting rule creates a positive operating environment for livestock facilities, livestock facilities will face implementation costs which the department has projected over 10 years (See attachment provided in answer to # 14). These costs are incremental, manageable, and can be absorbed as part of the costs of doing business for livestock operations. The additional costs are not triggered until a livestock facility is built or expanded, allowing operators to plan for added expenses. For every livestock facility over 1,000 animal units, the new siting standards for water quality are the same as the requirements for DNR CAFO permits, and will not impose any new requirements (see # 16 below). Several new requirements are consistent with recent changes to state and local conservation programs. A number of programs with significant farmer participation, from county manure storage permits to tax credits claimed under Farmland Preservation ("FPP"), require that farmers have nutrient management plans for their cropland. Federal and state cost-sharing and incentive payments regularly incorporate new technical standards as a condition for farmers to receive funding. The reality is that a livestock operation applying for its first permit under siting rule may already have been required to upgrade the farm's nutrient management plan to receive cost-sharing or claim a FPP tax credit under the Farmland Preservation Program. Many of the non-CAFOs operating under siting permits are closing in on a 1000 animal units and will need to make the investment in more effective runoff technology to meet the "no discharge" standard in a DNR CAFO permit.

16. Compare With Approaches Being Used by Federal Government

Nearly half of livestock operations affected by this rule are also subject to regulation under the federal Clean Water Act. Under delegated authority from U.S. Environmental Protection Agency ("EPA"), DNR adopted Wis. Admin. Code ch. NR 243 ("NR 243") to regulate water pollution discharges from livestock facilities. Under NR 243, livestock facilities with over 1,000 animal units, known as CAFOs, must obtain a DNR WPDES permit. CAFOs must meet standards designed to ensure that the proposed livestock facility will not pollute surface water or groundwater, and may use approvals from DNR to show compliance with department standards for the issuance of local siting permits, including standards for nutrient management, waste storage facilities and runoff management (the standards parallel WPDES permit standards, and have a similar purpose, although WPDES standards are more restrictive in certain key respects).

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To qualify for a siting permit, a WPDES permit holder must also demonstrate compliance with Department standards for livestock structures, location on property, and odor management, which are not covered by a WPDES permit.

The Natural Resources Conservation Service ("NRCS"), a branch of the United States Department of Agriculture ("USDA"), develops technical standards for the design and installation of conservation practices, including the NRCS 590 standard for nutrient management. Modified for use in Wisconsin, these technical standards are the foundation for NRCS programs such as the Environmental Quality Incentives Program ("EQIP") and the Conservation Stewardship Program ("CSP"). To promote consistency, state and local governments have incorporated the same technical standards into cost-share, regulatory and other programs. Not only are these technical standards part of ATCP 51, they are critical to the nonpoint rules (ATCP 50 and NR 151) and DNR's WPDES permitting program for CAFOs.

In addition to EQIP and CSP, USDA operates the following programs that may provide incentive payments to help livestock producers implement conservation practices, including practices that may help livestock producers meet livestock facility siting standards under this rule:

- Conservation Reserve Program ("CRP").
- Conservation Reserve Enhancement Program ("CREP").
- Agricultural Conservation Easement Program ("ACEP").

Federal law establishes reporting and other requirements for livestock facilities related to air emissions. For example, large operations must report certain types of releases to local and state agencies, as directed by the Emergency Planning and Community Right-to-Know Act. EPA also has authority to respond to citizen complaints or requests for assistance from state or local government agencies to investigate releases of hazardous substances from farms. Federal law does not directly cover odor management on livestock facilities.

17. Compare With Approaches Being Used by Neighboring States (Illinois, Iowa, Michigan and Minnesota)

Like Wisconsin, the four surrounding states each have state requirements for new and expanding livestock operations related to facility construction, runoff control and manure management. All four states except for Minnesota have enacted laws that pre-empt or standardize local regulation of livestock facilities with the goal of providing a more uniform and predictable regulatory environment for farm businesses.

Illinois

In 1996, Illinois enacted a Livestock Management Facilities Act (LMFA) to create a state framework for regulation of livestock facilities. LMFA, which was updated in 1998, 1999 and 2007, was expressly adopted to provide a framework for the livestock industry to expand while establishing environmental and other safeguards. While Illinois law precludes counties from regulating agricultural uses such as livestock facilities, it allows a county to request a public informational meeting about a proposed livestock facility and submit an advisory, non-binding recommendations related to the facility's compatibility with surrounding land uses, odor control, traffic patterns and other factors. Depending on their size and other factors, livestock facilities may be subject to state requirements for waste storage design, setback distances, odor control for certain structures, certification of livestock managers, waste management plans, and reporting of released wastes. Required setback distances for new facilities are scaled by size, starting at 1320 feet for facilities under 1000 Animal Units (AUs).

Iowa

In 2002, Iowa enacted legislation requiring that proposed confined feeding operations meet state standards related to building setbacks, manure storage construction, manure management plans, and air quality (air quality standards are still being developed). In place of local permitting of livestock facilities, Iowa counties have the option of requiring that

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producers achieve a passing score on the state-approved "Master Matrix," an assessment tool that identifies practices designed to minimize to air, water and community impacts. State standards for new and expanding facilities include different construction requirements for formed and unformed waste storage structures, and requirements involving manure application related to annual plan updates and phosphorus management. The size of the operation, and type of construction (new or expansion) determine applicable standards such as setbacks, which range from 750 to 3,000 feet.

Michigan

In 1999, the Michigan provided "right to farm" protections for farmers who meet "generally accepted agricultural management practices" (GAAMPS). The Right to Farm Act (RFTA) prevents local governments from adopting ordinances that prohibit farming protected under state law, and protects farmers who comply with GAAPS against nuisance actions. While other GAAMPs may apply to livestock operations, new and expanding livestock facilities must follow GAAMPs for site selection and odor control, and develop plans that comply with these standards. Most farms need to receive state verification of GAAMP compliance to maintain RFTA protections and avoid other state actions. Site planning includes meeting setback requirements and evaluation of odor management practices. Setbacks can range from 125 to 1500 feet, depending on the facility size, type of construction (e.g. new or expansion) and type of neighbors, and may be reduced if odor management practices are employed. Odor management plans also may be required. Operations must have a plan to properly manage and utilize manure, and design storage facilities according to technical standards. Producers must also prepare emergency action and other plans. Michigan maintains a complaint system to verify and correct problems to ensure that farms remain in compliance with GAAMPs.

Minnesota

The Minnesota Pollution Control Agency administers rules regulating livestock feedlots, and may delegate authority to counties to administer this program. State feedlot standards cover liquid manure storage systems, water quality setbacks, expansion limitations, and air emissions. Operation and maintenance standards cover discharges from feedlots and feed storage, and land application of manure. The extent of a livestock facility's obligations depends on its size, and other factors such as pollution risks.

In addition, Minnesota is among the states that still allow local permitting of livestock facilities using conditional use permits. Permits issued under local my impose requirements related to facility size including size caps, minimum acreage requirements, setbacks from neighboring land uses, and odor management. According to a 2007 Summary of Animal-Related Ordinances, 32 county zoning ordinances used simple setback standards, while 22 used a sliding scale. The most common setback from single family residences was ¼ mile, while ½ mile was the common setback for more dense land uses such as schools. Twelve counties addressed odor using the Odor From Feedlots Setback Estimation Tool (OFFSET), which estimates odor impacts based on livestock type, facility size and type, separation distances and odor control practices. These counties either incorporated OFFSET into their ordinances or use OFFSET as part of their planning process to predict odor to help determine separation distances. The survey showed that 20 counties limited the number of animals housed in a feedlot, setting caps between 1,500 to 5,000 AUs. Minnesota has enacted legislation requiring reciprocal setbacks of non-farm land uses whenever a local jurisdiction requires livestock facility setbacks (Wisconsin has no comparable requirement). Reciprocal setbacks are designed to protect livestock facilities, once approved, against encroaching development.

18. Contact Name	19. Contact Phone Number
Richard Castelnuovo, Section Chief, Resource Management and Engineering	608-224-4608

STATE OF WISCONSIN
DEPARTMENT OF ADMINISTRATION
DOA-2050 (C04/2012)

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EXISTING ADMINISTRATIVE RULES
Fiscal Estimate & Economic Impact Analysis

APPENDIX A: Estimate of Annual Costs Triggered by Siting Rule Changes over 10 Year Period			
Standard	**Annual Costs**	**Under 1000 Animal Units** (gray shading=no cost)	**Over 1000 Animal Units** (gray shading=no cost)
Odor Management- New and expanded facilities	$3,150-$37,500	The change in setbacks and odor management will not require many farms to add additional practices; however, 10 facilities will need to install a practice related to manure storage. The estimated costs will range between: ***Low***: Windbreak-$3,150 ($4.50/ft @ 700 ft) ***High***: Cover-$37,500.00 ($.75/sq. ft. x 50,000 sq ft) There is no cost associated with odor management plans, if required, since they can be prepared by landowners and do not mandate practices.	None of the facilities should incur additional costs to comply with the change in setbacks and odor management for the following reasons: 1. A number of livestock facilities do not need odor control practices to meet the setback requirements. 2. The livestock facilities would have had to install one or more odor practices to earn passing score under the previous odor standard.
Upgrade of Nutrient Management Plans	$9,000	25 livestock facilities will be directly impacted since they are not required by other laws or program participation (e.g manure storage ordinances or FPP tax credits) to follow the upgraded standard. Based on average of 800 animal units and 1200 acres of spreadable land, each of these facilities will spend $3 per acre more to comply or $3,600 per operation.	Required under CAFO permit and therefore no additional costs based on the siting rule
Waste Storage	$0	No changes to this standard, and no new costs associated with clarification of evaluation procedures.	Required under CAFO permit and therefore no additional costs based on the siting rule
Waste Storage- Closure	$12,000-$20,000	8 livestock facilities must spend between $15,000 and $25,000 to close substandard structures.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Animal Lot Runoff—New or substantial altered	$$100,000-$ 125,000	10 livestock facilities will need to meet the new runoff standards for new lots, and the estimated costs for a 10,000 square foot lot will range between: ***Low***: Roof to divert water-$100,000 ***High***: New or expanded storage to hold runoff-$125,000	Required under CAFO permit and therefore no additional costs based on the siting rule.
Animal Lot Runoff—Existing	$9,900-$46,200	33 (60 percent of 55) livestock facilities must add practices to pass the barnyard evaluation, and estimated upgrade costs for a 10,000 square foot lot will range between: ***Low***: Clean water diversion-$3,000 for berm ***High***: Roof gutters at $10,000 and VTA improvement at $4,000. No costs attributed to management changes such as added cleaning.	Required under CAFO permit and therefore no additional costs
Feed Storage-Pad and Runoff collection—New and expanded bunkers, paved areas and related structures but not bags	$860,810	35 livestock facilities must meet new standard, but 10 will qualify for the lower cost option based on 1 acre of feed storage, and 30 must meet higher standards based on 2.5 acres of feed storage. • 10 facilities would incur an additional $43,560 ($1.00 per sq ft. more based on 1 acre) to upgrade their pad surface compared to requirements in the previous rule, and $20,000 to collect and pump leachate. • 25 facilities would incur an additional $108,900 ($1.00 per sq ft. more based on 2.5 acres) to upgrade their pad surface compared to the requirements in the previous rule and $210,000 to add storage to collect leachate and runoff from 2.5 acres of feed storage.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Feed Storage—Existing bunkers, paved areas and related structures but not bags	59,800	Livestock facilities will incur the following costs to evaluate and upgrade their existing facilities: • 55 livestock facilities will incur costs engineering evaluation of storage at $600 per evaluation. • 20 facilities must install clean water diversion at $2,000 each. • 35 facilities must spend $15,000 each to enhance their system to collect runoff from feed storage over 1 acre.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Other Runoff Control Standards	0	Managing milkhouse wastewater should not incur additional costs. Nor are there additional costs to comply with the tillage setback. By complying with the NRCS 590 standard, operations will control soil erosion to T and meet the Phosphorus Index.	Required under CAFO permit and therefore no additional costs based on the siting rule.
Annual Costs	**$1,054,660-$1,158,310**		
Ten year Costs	**$10,546,600-$11,583,100**		

Charlotte Nelson

From:	Sarah Burdette <sburdette@ledgeviewwisconsin.com>
Sent:	Friday, July 28, 2017 9:24 AM
To:	'Charlotte Nelson'
Subject:	FW: Pansier Farm manure pit
Follow Up Flag:	Follow up
Flag Status:	Flagged

Can you please add this to the board's Dropbox for the next meeting?
Thank you.

Sarah K. Burdette
Clerk/Administrator
Town of Ledgeview

Ledgeview
Set your sights high

3700 Dickinson Road
De Pere, WI 54115
Phone: 920.336.3360, ext. 108
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From: Brooke Neville [mailto:office@nevillesales.com]
Sent: Tuesday, July 25, 2017 3:20 PM
To: sburdette@ledgeviewwisconsin.com
Subject: Pansier Farm manure pit

Hi Sarah,

I'm contacting you in regards to the proposed manure pit at the Pansier Farm. I thought it would be beneficial for the board to review http://ecode360.com/8434466, Chapter 68: Nuisances. We are the public and the manure pit **IS** a nuisance in many ways that are stated.

Thank you for your time,

Brooke Neville
3586 Beachmont Rd
De Pere, WI 54115
920-246-1102
office@nevillesales.com

Livestock Facility Siting Four-Year Review: Report and Recommendations from the Technical Expert Committee

September 22, 2015

Executive Summary

The Technical Expert Committee (TEC) was convened as part of the Department of Agriculture Trade, and Consumer Protection's (DATCP) required four year review of the livestock facility siting standards under ch. ATCP 51, Wis. Admin. Code (siting rule or ATCP 51). DATCP Secretary Ben Brancel appointed eight Members and nine Advisors to serve on the committee. Members with expertise in nutrient management, engineering, odor, setbacks, and public health were tasked with making recommendations on technical standards in the siting rule. Chaired by the DATCP's Deputy Secretary, the committee met on seven occasions from October 2014 to June 2015 to discuss the assigned questions and reach an agreement on the final recommendations presented in this report for consideration by the DATCP Secretary.

The TEC Members' recommendations are arranged according to topic areas: Consistency of water quality rules affecting livestock operations (NR 151, ATCP 50, ATCP 51), Engineering, Nutrient Management (including manure irrigation), Odor, and Setbacks. The main body of the report includes each of the questions asked of the TEC, and a list of considerations related to each recommendation:

Committee Recommendations

Consistency of Rules (Incorporation of NR 151 and ATCP 50 Standards)

- To be consistent with the state standards in chs. NR 151 Runoff Management (NR 151) and ATCP 50 Soil and Water Resource Management Program (ATCP 50), Wis. Admin. Codes, which are collectively referred to as the "nonpoint rules", ATCP 51 should include a requirement for livestock operators to manage their operations to avoid significant discharges of process wastewater to waters of the state.
- ATCP 51 should require livestock facilities with 500 or more animal units to meet NRCS waste treatment standard 629 (January 2014) (NRCS 629) for the design, construction and maintenance of new or substantially altered bunker silos, paved or other lined structures that store feed with as low as 40 percent moisture.
- ATCP 51 should allow livestock facilities under 1,000 animal units to design and construct new or expanded feed storage structures smaller than one acre in accordance with the appropriate Table 1, 2, or 3 in NRCS 629 (January 2014) if the proposed storage structures present low environmental risks not requiring a collection system or vegetative treatment areas. A clean water diversion would be required, if applicable.
- An operator must perform a site assessment, and where appropriate a structural assessment for expanded feed storage structures, to verify low environmental risk. The evaluation must document that any existing structure to be altered is not causing a substantial discharge, the site of the proposed structure has adequate separation distances to protect against surface water and groundwater contamination, and the soils surrounding the proposed structure do not have a high potential for leaching contaminates to groundwater. (This recommendation is similar to the evaluation required for existing feed storage structures; see page 4, Engineering: Feed Storage).
- ATCP 51 should require milking center wastewater be discharged to waste storage or other structure designed according to NRCS waste storage facility standard 313 (January 2014) (NRCS 313).

- ATCP 51 should create an exception to the milking center wastewater storage requirement to allow a livestock facility to manage wastewater using the treatment practices in NRCS 629 (January 2014) if the livestock facility produces less than 500 gallons of wastewater daily and does not store the wastewater for an extended period.
- ATCP 51 should require cropland covered by a permitted facility's nutrient management plan to have an average Phosphorus Index (PI) of 6 over a rotation and an annual PI not to exceed 12.
- A local government should be allowed to request nutrient management plan updates and other documentation to monitor a permitted livestock facility's compliance with the PI requirement, regardless of the livestock facility's size.
- ATCP 51 should incorporate the following standards: a) a requirement that pastures be managed to control erosion and be covered by a nutrient management plan if they have certain stocking rates consistent with ATCP 50, and b) a requirement that tillage not be conducted within a 5-20 foot setback between cropped fields and surface water.
- No adjustments should be made to the committee's earlier recommendations to account for differing standards imposed by NR 151 and ch. NR 243 Animal Feeding Operations (NR 243), Wis. Admin. Code. In light of DNR's current or future incorporation of the NR 151 performance standards into CAFO permits issued under NR 243, livestock facilities permitted under ATCP 51 will not be subject to requirements greater than those imposed on CAFOs under NR 243.
- To achieve consistency with the nonpoint rules, ATCP 51 should update all references to listed NRCS practice standards [i.e. NRCS waste storage facility standard 313 (January 2014), NRCS waste transfer standard 634 (January 2014), NRCS waste facility closure standard 360 (March 2013), NRCS vegetated treatment area standard 635 (October 2014)].

Engineering: Animal Lots

- ATCP 51 should retain the "BARNY" model as the tool used to predict runoff from animal lots.
- ATCP 51 should require a livestock facility to submit documentation (e.g. a printout of the BARNY model inputs and outputs) as part of its siting application to verify compliance with the runoff limits for animal lots.
- ATCP 51 should require applicants to document management or structural practices proposed as "minor alterations" to achieve compliance with ATCP 51.20(2) runoff thresholds for animal lots. The applicant must submit a design for the practice that meets the applicable NRCS or other technical standard.
- The rule should specify the following: lot cleaning, changes to provide laminar flow (e.g., shaping, seeding), roof gutters, diversions, underground outlets, and sediment basins, as minor alterations.
- ATCP 51 should be modified to require installation of "minor alterations" within one year of a permit approval, and authorize a local government to shorten that time if the unmanaged runoff presents an unacceptable risk of contamination to surface or groundwater.

Engineering: Waste Storage Structures

- While technically sound, the standards and procedures for evaluation of existing waste storage structures and waste transfer systems (Worksheet 4, Appendix A, 390-33 and Existing Manure Storage Evaluation Flowchart) should be clarified and improved to provide

more accurate guidance in assessing water quality risks. Specific areas of improvement include:
  - Recognizing waste storage structures as old as 10 years may be safely operated if an inspection reveals no problems, as long as they were designed according to the technical standards in effect at the time storage was constructed.
  - Establishing criteria for emptying storage structures, especially earthen-lined structures, to allow for proper inspection and identifying exceptions to those criteria.
  - Requiring test pits or borings to complete a facility evaluation if there is no documentation available regarding a facility's separation distances to groundwater or bedrock.

Engineering: Odor Management

- ATCP 51 and related worksheets should be updated to reference the most current technical standards for the following engineered and related practices used in connection with odor management and other siting standards:
  - For composting facilities, reference NRCS composting facility standard 317 (January 2012).
  - For anaerobic digesters, NRCS anaerobic digester standard 366 (August 2011).
  - For digester substrate storage, NRCS waste storage facility standard 313 (January 2014) or DNR industrial waste rules, such as ch. NR 213 Lining of Industrial Lagoons and Design of Storage Structures, Wis. Admin. Code, based on types and amounts stored.
  - For manure residual storage, NRCS waste storage facility standard 313 (January 2014).
  - For solid separation, NRCS waste separation facility standard 632 (April 2014).
  - For treatment of liquid waste, NRCS waste treatment standard 629 (January 2014), except for vegetated treatment areas covered under NRCS vegetated treatment area standard 635 (October 2014).
  - For sand settling lanes, NRCS waste separation facility standard 632 (April 2014).
  - For impermeable manure storage covers, NRCS roofs and covers standard 367 (October 2011).
  - For natural crust and bio-covers, DNR recommendations related to control practices for air emissions.
  - For treatment membranes, NRCS waste treatment standard 629 (January 2014).

Engineering: Feed Storage

- ATCP 51 should require permit applicants to evaluate existing bunker silos, paved or other lined feed storage structures from ½ to ¾ acre in size to determine if the structures are in good condition and do not present risks of discharging leachate or contaminated runoff to waters of the state.
- The evaluation process should be consistent with evaluation processes for manure storage and animal lots, and include a flowchart to outline the evaluation process.
- ATCP 51 should include management requirements for existing storage structures including those operated without modification.

Engineering: Monitoring Compliance

- ATCP 51 should provide more clarity regarding local government monitoring of a permitted facility's compliance with the siting standards, including local review of whether engineered practices are properly operated and maintained.

- DATCP should strongly encourage local governments to monitor compliance, and support these local efforts by developing effective tools and providing training and guidance. Checklists are effective tools to ensure accuracy, completeness, and consistency in monitoring livestock facilities for compliance.

Nutrient Management

- ATCP 51 should not exempt CAFOs from requirements to submit documentation to substantiate a nutrient management plan complies with NRCS nutrient management standard 590 (September 2005) (NRCS 590) and to submit annual plan updates if requested by a local government.
- ATCP 51 should retain the requirement that applicants submit nutrient management plans based on the maximum number of animal units for which they are seeking local approval.
- ATCP 51 should simplify the permit modification process to enable permitted livestock facilities to secure streamlined approval of nutrient management plans if they add animals in the future.
- Waste and Nutrient Management Worksheet 3 in ATCP 51 should be modified to require an applicant to identify rented and owned land spreading acres.
- Based on the concepts in the March 23, 2015 draft of the revised NRCS nutrient management standard 590, ATCP 51 should incorporate the revised NRCS 590 upon adoption. (For consistency within the agency, the updated NRCS 590 should be incorporated into ATCP 50 and 51.)
- DATCP should clarify how local governments may impose locally-identified nutrient application restrictions authorized in the current or revised version of NRCS 590 including restrictions in Section V.A. designed to protect surface and groundwater resources.
- DATCP should help local governments understand how they can meet current state requirements for adopting more stringent standards to protect groundwater.
- By incorporating the latest version of NRCS 590, the siting rule will include manure application setbacks and restrictions designed to protect surface and ground water quality.
- ATCP 51 should not incorporate the recommendations of the Manure Irrigation Workgroup, whose work will be completed in the summer of 2015.

Odor: Odor Generation

- Worksheet 2 (Chart 2) of ATCP 51 should retain the odor generation numbers for the 17 housing types, and make modifications, as specified in Appendix A, to increase the odor generation number for dairy/beef alley flush to storage, and to add a new lower generation number for poultry layer housing using dryer belts.
- Worksheet 2 (Chart 2) should retain the odor generation numbers for Waste Storage Facilities, but base the method for predicting odors on surface area, not storage duration, as specified in Appendix A.
- Worksheet 2 (Chart 2) should add odor generation numbers for sand and solids separation systems, as specified in Appendix A, to account for acres of active treatment area and storage of separated materials.

Odor: Odor Control

- Worksheet 2 (Chart 3) of ATCP 51 should retain the credits for 17 odor control practices for housing, manure storage and animal lots, and make modifications, as specified in Appendix

B, to add wet scrubbers and recirculated flush water as a Category B odor control practice for housing; replace fresh water flush with recirculated flush water as a Category B odor control practice for housing; increase the credit for housing windbreaks and geotextile covers; reduce the credit for anaerobic digestion, and solids separation and reduction; and eliminate the predetermined credit for aeration of storage.

- Worksheet 2 (Chart 3) should change the specifications, as detailed in Appendix B, for the following odor control practices for housing and manure storage: diet manipulation, bio-filter, treated flush water, anaerobic digestion, chemical and biological additives, compost, solids separation and reduction, and natural crust.
- ATCP 51 should continue to exempt the three categories of facilities from the odor standard (i.e. a new livestock facility with fewer than 500 animal units, an expanded livestock facility with fewer than 1,000 animal units, and a livestock facility in which all livestock structures will be located at least 2,500 ft. from the nearest affected neighbor).
- ATCP 51 should require all applicants to complete plans related to incident response, employee training, and odor management.
- Applicants who complete the required three plans should receive additional points, not to exceed 100, toward a passing odor score.

Odor: Odor Scoring

- In determining the number of points credited toward a passing odor score, DATCP should consider and balance the three approaches collectively used to manage odor in ATCP 51: management and other plans, modeling using Worksheet 2, and road and property line setbacks for livestock structures.
- To support compliance monitoring, DATCP should support local government efforts by developing checklists and providing other support to facilitate local review.

Setbacks

- For new or substantially modified manure storage structures located on livestock facilities over 1,000 animal units, ATCP 51 should require a greater road and property line setback than 350 feet.
- For livestock facilities under 1,000 AUs, DATCP should consider requiring greater setbacks for livestock structures, unless these facilities use established methods to document how they will manage odor to secure a passing odor score.
- To provide greater protection for neighbors, DATCP should consider increasing the property line/road setback distance for structures (such as feed storage) that may have nuisance impacts, applying increased setbacks to occupied buildings in addition to property line setbacks, and accounting for schools and other high density uses in establishing a setback.

Technical Expert Committee: Background and Process

This is the third iteration of the Technical Expert Committee (TEC) convened by DATCP (2004, 2010) to provide advice regarding the livestock facility siting standards under ch. ATCP 51 Wis. Admin Code (siting rule).

Under sec. 93.90, Stats. (siting law), the DATCP Secretary is required to appoint a committee of experts to review the technical standards in ATCP 51. In carrying out this requirement, DATCP committed to a process with an exclusive focus on scientific and technical matters and a committee composed of experts from the public and private sector selected based on their knowledge and experience with water quality, odor and other technical areas covered under ATCP 51.

Background: Groundwork for the TEC

Before convening the 2014-2015 TEC, DATCP first presented a four year evaluation report on implementation of the livestock facility siting rule in February 2014 to the Board of Agriculture, Trade and Consumer Protection (ATCP Board). The report addressed the appropriate areas for the agency's rule review and identified policy and other issues beyond the scope of the rule review. As follow-up, DATCP invited Farm/Livestock Groups, Government Agency Groups, and Environmental/Citizen Groups to participate in separate listening sessions. All participants were asked two questions:

1. What do you like/what is working in the siting rule?
2. What changes would you like to be made to the livestock siting rule?

Based on feedback from stakeholders, DATCP narrowed the issues appropriate for the committee, and developed the assignment questions for the committee to address. Specifically DATCP undertook these actions:

1. Identified issues within the committee's scope of review. The need to ensure consistency between water quality standards in ATCP 51 and the other water quality rules (NR 151 and ATCP 50).
2. Established sideboards for issues outside of the committee's scope, including but not limited to policy issues such as the potential lack of finality surrounding a local government's determination regarding the completeness of a siting application were deemed outside the TEC's scope.
3. Developed assignment questions with background information for the committee that allowed for maximum participation by all Members and Advisors.

TEC Process: Committee appointments

For the 2014-2015 TEC, DATCP appointed eight Members and nine Advisors (see page 10 for list). Drawn from both the public and private sectors, the participants were selected because they possessed expertise necessary to provide advice regarding permitting of livestock operations, air emissions, odor, livestock regulation, nutrient management, public health, runoff management, and agricultural engineering.

TEC Process: Review scope and criteria

The committee was charged with recommending options for adjusting the existing siting technical standards and related rule provisions to ensure the standards keep pace with changing agricultural practices and remain environmentally protective. The standards in the siting rule must be practical for producers to achieve and for local governments to implement, while continuing to meet the objectives of the siting law.

The scope of the committee was limited to technical issues related primarily to water quality and odors. Manure irrigation was not covered in detail by the committee since a UW-Extension workgroup was charged with evaluating research in that area. However, on June 11, 2015 the committee did receive a status report from the workgroup, whose work was nearly complete, and considered whether or not to incorporate into the siting rule any recommended standards related to manure irrigation.

The required review of the siting rule has multiple purposes:

- Maintain a viable rule by responding to new information.
- Balance responsible industry growth with community interests.
- Ensure the siting standards keep pace with and reflect changes in the size, technology, and complexity of livestock operations.
- Update the siting standards to incorporate important changes in technical standards.
- Respond to local experiences with permitted and non-permitted farms.
- Improve implementation of the siting rule through refinements to procedures.

These purposes were reflected in the questions posed to the committee. Assignment questions focused on the impacts of facility size, Natural Resources Conservation Service (NRCS) updates to technical standards, developments in research and new technologies, and implementation experiences including monitoring for compliance.

In addressing their assignment, the committee followed an objective and science-based approach consistent with their background and expertise. Deliberations focused on research, field studies, knowledge and experience of the nationally-recognized experts, and other credible sources of information related to water quality, odor and other impacts of livestock facilities. Also considered were changes in technical standards developed by NRCS and others. The group evaluated this information based on soundness of the methods used, validation using peer review, and other criteria to assess reliability.

The committee's considerations were informed to a degree by conditions and issues related to farms granted local siting permits in the last eight years. However, the committee was limited in its capacity to evaluate this information. First, due to the lack of verifiable data pertaining to conditions on existing permitted farms, the information did not fit within accepted scientific approaches used for evaluation. Second, the lack of data reported to DATCP concerning performance of permitted farms makes it difficult to interpret how the standards are working on the ground. The committee took a cautious approach to evaluation. Where there was uncertainty, the committee considered options to retain the status quo or make adjustments in the standard to reflect the lack of clarity in science supporting the standard.

While the primary focus was on objective, science-based information, the siting law required the committee also consider whether proposed changes to the standards are:

- Protective of public health or safety
- Practical and workable
- Cost-effective
- Designed to promote the growth and viability of animal agriculture in this state
- Designed to balance the economic viability of farm operations with protecting natural resources and other community interests
- Usable by officials of political subdivisions

TEC Process: Meeting framework and deliberative process

Committee meetings took place on September 18, October 15, November 18, and December 19, 2014, and January 27, March 24, and June 11, 2015. During these meetings, technical committee Members and Advisors answered all assignment questions, and then reviewed and vetted all recommendations for inclusion in this report.

To ensure a transparent and public process related to the committee's deliberations, DATCP committed to the following:

- Publicly notice and conduct each meeting according to the open meetings law.
- Prepare staff notes for each meeting.
- Maintain a website to share critical documents and information, such as the committee assignment, meeting agendas, and staff notes for each committee meeting: http://datcp.wi.gov/Environment/Livestock_Siting/Technical_Expert_Committee/index.aspx.

The committee followed ground rules intended to create an environment conducive to the free exchange of information and thoughtful deliberation on technical issues. Though the public did attend committee meetings, in accordance with state law, there were no presentations by the public. This structure recognized that there will be other occasions for the public to comment and share their ideas, during any rulemaking related to the committee's recommendations.

The committee utilized a consensus process to develop their recommendations. Although the turnaround time made it challenging to fully address all assignment questions and resolve every difference of opinion among TEC Members and Advisors, the process allowed the committee to complete its work in achieving final, consensus recommendations.

Livestock Siting Technical Expert Committee 2014-15

Committee Chair

Jeff Lyon – Deputy Secretary, DATCP

Technical Committee Members

Matt Ruark – Department of Soil Science, UW-Madison
Jerry Halverson – Manitowoc County Soil and Water Conservation Department
Charles McGinley, P.E. – St. Croix Sensory, Inc.
Tonya Gratz – Green County Land and Water Conservation Department
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Recommendations and Considerations

Livestock Siting Technical Expert Committee

The following captures the committee's response to the questions posed in assignments prepared by DATCP. These responses, which include specific recommendations and related considerations, are the product of seven committee meetings held from September 2014 to June 2015. The committee used a consensus process to reach agreement on its recommendations. Except for the last meeting on June 11, 2015, staff notes were prepared to summarize committee discussions, and were reviewed by the committee members at a subsequent meeting. At its last meeting, the committee reviewed in detail the cumulative set of staff notes in anticipation of preparing a final report.

The committee's recommendations are arranged by the five topic areas defined in the assignment: Consistency of water quality rules affecting livestock operations (NR 151, ATCP 50, ATCP 51), Engineering, Nutrient Management (including manure irrigation), Odor, and Setbacks. Within these topic areas, each of the committee's assignment questions is reproduced, followed by a bulleted list of committee recommendations and considerations.

Consistency of Rules (Incorporation of NR 151 and ATCP 50 Standards)

<u>Question #1</u>: Both NR 151 and ATCP 50 adopted a prohibition against significant discharges of process wastewater. What is the best way to accomplish incorporation of this standard into ATCP 51?

Recommendation

- To be consistent with the state standards in NR 151 and ATCP 50, which are collectively referred to as the "nonpoint rules", ATCP 51 should include a requirement for livestock operators to manage their operations to avoid significant discharges of process wastewater to waters of the state.

Considerations

In applying this new standard, ATCP 51 should use the definition of process wastewater and significant discharge in NR 151 and NR 243, but not the "zero discharge" concept in NR 243. Complying with this standard will depend on a number of factors including a farm's proximity to waters of the state. The siting application should be modified to better document current and future compliance with the process wastewater requirement.

<u>Question #2</u>: Consistent with NR 151 performance standards, ATCP 50 adopted NRCS 629 [January 2014] as the technical standard for the design, construction and maintenance of new and substantially altered feed storage runoff control systems. What is the best way to accomplish incorporation of NRCS 629 into ATCP 51?

Recommendations

- ATCP 51 should require livestock facilities with 500 or more animal units to meet NRCS 629 (January 2014) for the design, construction and maintenance of new or substantially altered bunker silos, paved or other lined structures that store feed with as low as 40 percent moisture.

- ATCP 51 should allow livestock facilities under 1,000 animal units to design and construct new or expanded feed storage structures smaller than one acre in accordance with the appropriate Table 1, 2, or 3 in NRCS 629 (January 2014) if the proposed storage structures present low environmental risks not requiring a collection system or vegetative treatment areas. A clean water diversion would be required, if applicable.
- An operator must perform a site assessment, and, where appropriate, a structural assessment for expanded feed storage structures, to verify low environmental risk. The evaluation must document that any existing structure to be altered is not causing a substantial discharge, the site of the proposed structure has adequate separation distances to protect against surface water and groundwater contamination, and the soils surrounding the proposed structure do not have a high potential for leaching contaminates to groundwater. (This recommendation is similar to the evaluation required for existing feed storage structures; see page 17, Engineering Question #5).

Considerations

These design and construction requirements apply to new or substantially altered storage areas holding commonly stored feeds, not just feed over 70 percent moisture (cannery, brewers and distillers byproduct feeds). The design and construction requirements do not apply to feed stored in bags, bins, or tower silos.

<u>Question #3</u>: ATCP 50 adopted NRCS technical standard 629 as the technical standard for control of milking center wastewater. What is the best way to incorporate this standard into ATCP 51 and achieve consistency with the nonpoint rules?

Recommendations

- ATCP 51 should require milking center wastewater be discharged to waste storage or other structure designed according to NRCS 313 (January 2014).
- ATCP 51 should create an exception to the milking center wastewater storage requirement to allow a livestock facility to manage wastewater using the treatment practices in NRCS 629 (January 2014) if the livestock facility produces less than 500 gallons of wastewater daily and does not store the wastewater for an extended period.

<u>Question #4</u>: Both NR 151 and ATCP 50 adopted a phosphorous management tool for croplands. What is the best way to accomplish incorporation of this component into ATCP 51?

Recommendations

- ATCP 51 should require cropland covered by a permitted facility's nutrient management plan to have an average Phosphorus Index (PI) of 6 over a rotation and an annual PI not to exceed 12.
- A local government should be allowed to request nutrient management plan updates and other documentation to monitor a permitted livestock facility's compliance with the PI requirement, regardless of the livestock facility's size (see Nutrient Management Question #1).

Considerations
A facility's required nutrient management plan, if it includes an appropriate phosphorus index (PI) calculation value, may be used to demonstrate compliance with these PI requirements. A livestock operator may meet the phosphorus management requirements in NRCS 590 (September 2005) by using a soil test management approach as an alternative to a PI calculation.

Question #5: Both NR 151 and ATCP 50 adopted the following standards: a) a requirement that pastures be managed to control erosion and be covered by a nutrient management plan if they have certain stocking rates, and b) a requirement that tillage not be conducted within a 5-20 foot setback between cropped fields and surface water. Should these requirements be included as a standard that must be implemented as a condition of a siting permit?

Recommendation
- ATCP 51 should incorporate the following standards: a) a requirement that pastures be managed to control erosion and be covered by a nutrient management plan if they have certain stocking rates consistent with ATCP 50, and b) a requirement that tillage not be conducted within a 5-20 foot setback between cropped fields and surface water.

Considerations
As a condition of their siting permits, livestock facilities would be responsible for maintaining compliance with these requirements on all cropland, including rented acres.

Question #6: Regarding recommendations for Questions #1-5, what, if any, adjustments should be made if full incorporation of NR 151 and ATCP 50 standards subjects livestock facilities permitted under ATCP 51 to requirements greater than those imposed on CAFOs under NR 243?

Recommendation
- No adjustments should be made to the committee's earlier recommendations to account for differing standards imposed by NR 151 and NR 243. In light of DNR's current or future incorporation of the NR 151 performance standards into CAFO permits issued under NR 243, livestock facilities permitted under ATCP 51 will not be subject to requirements greater than those imposed on CAFOs under NR 243.

Considerations
DNR does not currently enforce the tillage setback through its CAFO permits, but it may revise its rule requirements to incorporate this and other NR 151 requirements. While DNR does not currently enforce the PI standards in NR 151, it has other CAFO requirements that function in a similar manner and may include this particular requirement in a future rule update.

Question #7: To be consistent with ATCP 50, should ATCP 51 references be updated to reflect the following NRCS technical standards?
a. NRCS technical guide waste storage facility standard 313 (January, 2014).
b. NRCS technical guide, closure of waste impoundments standard 360 (March, 2013).
c. NRCS technical guide waste treatment standard 629 (January, 2014).
d. NRCS technical guide waste transfer standard 634 (January, 2014).

e. NRCS technical guide vegetated treatment area standard 635 (September, 2012).

Recommendation

- To achieve consistency with the nonpoint rules, ATCP 51 should update all references to the listed NRCS technical standards [i.e. NRCS waste storage facility standard 313 (January 2014), NRCS waste transfer standard 634 (January 2014), NRCS waste facility closure standard 360 (March 2013), NRCS vegetated treatment area standard 635 (October 2014)].

Considerations

The committee recognized that references to additional NRCS practice standards (e.g. NRCS 590) may need to be updated in ATCP 51.

Engineering

Question #1: The siting rule references a model for predicting animal lot runoff, the Wisconsin Barnyard Runoff Model (BARNY), that is not the most current model supported by NRCS, which now uses the Barnyard Evaluation Rating Tool (BERT). Should NRCS BERT replace BARNY as the model for predicting runoff under the siting rule? Does BERT include all the necessary functionality to model runoff for the siting rule? For example, does BERT need modification to confirm laminar (sheet) flow across the buffer? Whichever model is used, what documentation must an applicant provide to demonstrate compliance with the runoff limits (e.g. a printout of the model inputs and outputs)?

Recommendations

- ATCP 51 should retain the "BARNY" model as the tool used to predict runoff from animal lots.
- ATCP 51 should require a livestock facility to submit documentation (e.g. a printout of the BARNY model inputs and outputs) as part of its siting application to verify compliance with the runoff limits for animal lots.

Considerations

Despite its limitations, BARNY has a long history and wide acceptance as a barnyard evaluation and design tool. While the siting rule incorporates an older version, NRCS currently maintains BARNY as a worksheet in its Spreadsheet on Vegetated Treatment Areas. However, NRCS supports BERT as the barnyard evaluation tool and BARNY as the design tool for buffers. NRCS will be updating its Vegetated Treatment Area tool (which includes BARNY) to reflect the most recent NOAA rainfall data.

For evaluating animal lot runoff and design practices to meet targets for annual phosphorus runoff, BARNY is a more appropriate tool than the BERT or Annual Phosphorus Loss Estimator (APLE-Lots), although modifications to APLE-Lots may make this tool more useful.

Question #2: When an existing animal lot fails to meet the applicable runoff threshold in ATCP 51.20(2) it may be retained only if it, or an adjacent treatment area, is altered in some manner to control runoff. An applicant may be issued a permit based on a commitment in the application (e.g. submission of engineered design) to install practices to control the runoff. How can the rule be clarified or improved to support minor alterations to animal lots needed to meet the runoff thresholds in ATCP 51.20(2)? For example, can the rule better identify practices and related technical standards that constitute a minor alteration? Should applicants be required to submit designs or other documents to reflect their commitment to install water quality practices related to a minor alteration? If there is a significant discharge, or other problem that presents a significant risk to water quality, should a local government be able to impose a condition to correct the problem within a time period of less than two years?

Recommendations

- ATCP 51 should require applicants to document management or structural practices proposed as "minor alterations" to achieve compliance with ATCP 51.20(2) runoff thresholds for animal lots. The applicant must submit a design for the practice that meets the applicable NRCS or other technical standard.
- The rule should specify the following: lot cleaning, changes to provide laminar flow (e.g., shaping, seeding), roof gutters, diversions, underground outlets, and sediment basins, as minor alterations.
- ATCP 51 should be modified to require installation of "minor alterations" within one year of a permit approval, and authorize a local government to shorten that time if the unmanaged runoff presents an unacceptable risk of contamination to surface or groundwater.

Considerations

By fleshing out the requirements for "minor alterations," ATCP 51 will reduce the uncertainty about achieving compliance with runoff standards, without implementing the full set of requirements in NRCS 635 related to wastewater treatment. Clarification of these requirements will more firmly establish the boundary between "minor alterations" and "substantial alterations," which requires an operator to comply with NRCS 635 if the animal lot is "substantially altered," which is defined as "an increase of more than 20% in the area or capacity of a livestock structure used to house, feed or confine livestock."

With added requirements for documentation, an operator will make specific promises to perform work in the permit application, and local governments may enforce this commitment in the same manner as other permit requirements. In this and other areas requiring the submission of engineering designs, local governments should offer to review preliminary designs to provide guidance to siting applicants and their consultants.

<u>Question #3</u>: To continue to use existing manure storage structures and waste transfer systems, an applicant for a siting permit must document that these facilities were designed according to certain technical standards and do not present unacceptable risks of structural failure or leaking. How can the worksheet's [Worksheet 4] evaluation requirements be improved? For example, should the rule provide more concrete direction on how to conduct a visual inspection? Is there a way to make use of the evaluation processes used for NRCS Comprehensive Nutrient Management Plan (CNMP) and DNR Wisconsin Pollution Discharge Elimination System (WPDES) permits for animal feeding operations?

Recommendations

- While technically sound, the standards and procedures for evaluation of existing waste storage structures and waste transfer systems (Worksheet 4, Appendix A, 390-33 and Existing Manure Storage Evaluation Flowchart) should be clarified and improved to provide more accurate guidance in assessing water quality risks. Specific areas of improvement include:
  - Recognizing waste storage structures as old as 10 years may be safely operated if an inspection reveals no problems, as long as they were designed according to the technical standards in effect at the time storage was constructed.
  - Establishing criteria for emptying storage structures, especially earthen-lined structures, to allow for proper inspection and identifying exceptions to those criteria.
  - Requiring test pits or borings to complete a facility evaluation if there is no documentation available regarding a facility's separation distances to groundwater or bedrock.

Considerations

Additional guidance is critical for engineering professionals hired to evaluate these systems. As a general recommendation, storage structures should be emptied before inspection. There are circumstances where it is reasonable not to empty a facility. A number of factors may determine whether or not to act, including the structure's age, the results of visual inspection of its exposed area, and the likelihood that agitation may have compromised its liner. This approach is consistent with the procedures used by DNR in its evaluation of storage facilities under NR 243.

By definition, a manure storage facility includes the waste transfer portion of the facility. It is feasible to evaluate exposed portions of an existing waste transfer system. If the waste transfer system was installed according to technical standards, a professional engineer could review the design and "as-built" documentation. Reception tanks may be visually inspected, or assessed for leakage using soil borings. Likewise open channels and equipment such as pumps and valves can be visually inspected. The evaluation of conveyances, such as underground pipes, is more challenging; it may not be realistic to require pressure testing of pipes or digging test wells at various intervals along its length.

<u>Question #4</u>: When adopted in 2006, ATCP 51 did not include emerging technologies that were not in common usage, such as sand settling lanes, and also did not set technical standards for newly developed technologies in advance of standards set by NRCS and other custodians. Regarding the following, do you agree with the standards cited or do you have other recommended standards?

a. For composting facilities, reference NRCS Standard 317.
b. For anaerobic digesters, NRCS Standard 366.
c. For digester substrate storage, NRCS Standard 313 or DNR Industrial waste rules, such as NR 213, Wis. Admin. Code, based on types and amounts stored.
d. For manure residual storage, NRCS Standard 313.
e. For solid separation, NRCS Standard 632.
f. For treatment of liquid waste, NRCS Standard 629.
g. For sand settling lanes, NRCS Standard 632.

h. For manure storage covers, NRCS Standard 367 (does not include natural crust and bio-cover).

Are there other new technologies that are not adequately addressed in the rule or worksheets?

Recommendation

- ATCP 51 and related worksheets should be updated to reference the most current technical standards for the following engineered and related practices used in connection with odor management and other siting standards:
  - For composting facilities, reference NRCS composting facility standard 317 (January 2012).
  - For anaerobic digesters, NRCS anaerobic digester standard 366 (August 2011).
  - For digester substrate storage, NRCS waste storage facility standard 313 (January 2014) or DNR industrial waste rules, such as ch. NR 213 Lining of Industrial Lagoons and Design of Storage Structures, Wis. Admin. Code, based on types and amounts stored.
  - For manure residual storage, NRCS waste storage facility standard 313 (January 2014).
  - For solid separation, NRCS waste separation facility standard 632 (April 2014).
  - For treatment of liquid waste, NRCS waste treatment standard 629 (January 2014), except for vegetated treatment areas covered under NRCS vegetated treatment area standard 635 (October 2014).
  - For sand settling lanes, NRCS waste separation facility standard 632 (April 2014).
  - For impermeable manure storage covers, NRCS roofs and covers standard 367 (October 2011).
  - For natural crust and bio-covers, DNR recommendations related to control practices for air emissions.
  - For treatment membranes, NRCS waste treatment standard 629 (January 2014).

Considerations

NRCS standards such as practice standard 632 (April 2014) may need to be supplemented with provisions reflecting specific issues in the siting rule. For example, composting should include requirements to ensure adequate containment and treatment of contaminated runoff.

<u>Question #5</u>: While all existing feed storage must be managed to avoid significant discharges, the rule does not impose affirmative requirements for permitted livestock operations except those limited number of facilities that store high moisture feed. Should existing feed storage structures be required to meet certain minimum conditions to reduce runoff risks regardless of the moisture content of the feed being stored? What, if any, standards should be used to evaluate the water quality risks posed by existing storage at the time of a permit application? What, if any, structural and management requirements should apply to existing feed storage after the livestock facility is permitted? How do the following factors affect your answers to these questions: type of structure, the volume of feed stored, the type of feed stored?

Recommendations

- ATCP 51 should require permit applicants to evaluate existing bunker silos, paved or other lined feed storage structures from ½ to ¾ acre in size to determine if the structures

are in good condition and do not present risks of discharging leachate or contaminated runoff to waters of the state.
- The evaluation process should be consistent with evaluation processes for manure storage and animal lots, and include a flowchart to outline the evaluation process.
- ATCP 51 should include management requirements for existing storage structures including those operated without modification.

Considerations
For structures constructed within the last 10 years, the evaluation should determine if the facility was designed according to then-existing standards. To establish that a facility is in good working condition, a visual inspection should be performed looking for signs of failure (e.g. cracks) or discharge of leachate. The evaluation also should determine the separation distances of a facility from streams, lakes, areas of concentrated flow, wetlands, floodplains, and other surface waters susceptible to pollution risks. In terms of groundwater risks, the evaluation should determine the separation distances of a facility to bedrock and saturated soils, and any soils with a high potential for groundwater contamination. Tables 1 through 3 in NRCS 629 should be used as a starting point to determine adequate separation distances.

DATCP should develop a flowchart to outline the evaluation process. The draft flowchart should account for the risk of infiltration and runoff of leachate and contaminated runoff. Specifically, the flowchart should have one or more steps that take into consideration: 1) separation from groundwater, 2) permeability of soil, and 3) the likelihood of runoff reaching surface water. Based on evaluation of these factors, the operator may or may not need to perform repairs, install a leachate collection system, or make improvements to the treatment area.

For all feed storage facilities, livestock operators should be required to divert clean water and follow basic management practices such as waste feed cleanup and snow handling to minimize accumulations of waste feed that can lead to the discharge of contaminated runoff during spring thaw.

In addition, the requirement for leachate collection in ATCP 51.20(3) should be retained for existing paved facilities storing feed with 70% or more moisture content (cannery, brewers and distillers byproduct feeds). DATCP may want to consider lowered feed moisture levels, down to 40 percent, to be consistent with other recommendations (see Consistency of Rules, Question #2).

Question #6: ATCP 51 provides no guidance for conducting monitoring to determine whether engineered practices are properly operated and maintained. Do you agree that the following recommendations are technically sound or would you make other recommendations?

"Checklists are an effective tool to ensure accuracy and consistency in monitoring livestock facilities for compliance. Checklists need to be specific to either the producer, if self-certifying, or regulatory authority, if for a compliance review. Checklists should be practice specific and incorporate the operation and maintenance (O&M) requirements in NRCS technical standards. For example, animal lots should follow the O&M requirements in NRCS technical standard 635. Consideration should be given to a combination of self-certification with periodic review by an administering authority. Duplication should be avoided and existing compliance assurance measures (CAFOs) should suffice for most compliance objectives. DATCP should provide guidance and training to local authorities on checklist development and usage, and should work with these authorities to collect accurate information concerning the implementation of the siting law and the performance of permitted farms, including responding to changes in farming operations and documentation of monitoring results."

Recommendations

- ATCP 51 should provide more clarity regarding local government monitoring of a permitted facility's compliance with the siting standards, including local review of whether engineered practices are properly operated and maintained.
- DATCP should strongly encourage local governments to monitor compliance, and support these local efforts by developing effective tools and providing training and guidance. Checklists are effective tools to ensure accuracy, completeness, and consistency in monitoring livestock facilities for compliance.

Considerations

Checklists need to be specific to either the producer to support self-certification, or the local government to enable consistent review of compliance. Checklists should be practice specific and incorporate the operation and maintenance (O&M) requirements in NRCS practice standards. For example, animal lots should follow the O&M requirements in NRCS 635 (October 2014). (Regarding checklists, see Odor Question #4.)

While local governments are generally responsible for determining the nature and extent of monitoring activities performed on permitted farms within their jurisdiction, DATCP may consider the option of requiring that all permitted facilities complete and submit a self-certification checklist to local governments every two years. Monitoring of permitted facilities should be coordinated with DNR activities to avoid unnecessary duplication in the submissions required of CAFOs. DATCP should work with local authorities to collect accurate information concerning the implementation of the siting law and the performance of permitted farms, including responding to changes in farming operations and documentation of monitoring results. An additional fee to cover the monitoring costs incurred by local governments might be considered and could help encourage local implementation.

Nutrient Management

Question #1: Should local governments be given the ability to request additional documentation from WPDES permit applicants? What information and documentation would be helpful for local governments to request to substantiate compliance? For example: items included in the NRCS 590 NM plan and Checklist, nutrient application restriction maps, and/or NM database, and specific WPDES Permit Components?

Recommendation

- ATCP 51 should not exempt CAFOs from requirements to submit documentation to substantiate a nutrient management plan complies with NRCS 590 (September 2005), and to submit annual plan updates if requested by a local government.

Considerations

As part of their review of a permit application under ATCP 51, local governments should have access to documentation supporting a nutrient management plan, regardless of the size of the applicant's livestock facility. Local governments should be able to request documentation to substantiate that the applicant, who may also hold a WPDES permit, is meeting the requirements for a nutrient management plan under the siting law; namely, the livestock facility complies with NRCS 590 (September 2005) and has a plan covering the maximum number of animal units requested in the permit application.

In a typical case, applicants or their consultants can easily satisfy a local request for documentation by providing the applicant's SnapPlus database and NRCS 590 (September 2005) nutrient application restriction maps from the annual planning process. Local governments may deny approval if the documentation does not reasonably substantiate compliance with nutrient management planning requirements.

<u>Question #2</u>: Should the rule requirements for maximum Animal Unit planning remain as is, or should other options be explored? Is the permit modification process feasible, implementable, and reliable enough to be used as an option?

Recommendations

- ATCP 51 should retain the requirement that applicants submit nutrient management plans based on the maximum number of animal units for which they are seeking local approval.
- ATCP 51 should simplify the permit modification process to enable permitted livestock facilities to secure streamlined approval of nutrient management plans if they add animals in the future.

Considerations

The framework of the siting law requires applicants complete Waste and Nutrient Management Worksheet 3 and their nutrient management plans to account for the manure generated by the maximum number of animal units for which they are seeking approval. A livestock operator must have adequate land, either rented or owned, to spread manure produced by the maximum number of approved animal units. A livestock operator cannot phase in a nutrient management plan, including the land needed for spreading, as the operation adds animals to reach its maximum allowed number.

A permit modification offers an alternative to accommodate the needs of operators while maintaining the "maximum animal unit" concept fundamental to the permitting process under the livestock siting rule.

<u>Question #3</u>: When determining permit approval related to land base access for spreading, would it help local governments if applications identified the acres owned versus rented? If so, what is the best way to accomplish this?

Recommendation

- Waste and Nutrient Management Worksheet 3 in ATCP 51 should be modified to require an applicant to identify rented and owned land spreading acres.

Considerations
To support the information in Worksheet 3, local governments may request maps depicting the rented and owned land spreading acres. Also, local governments can request additional information regarding rental agreements for acres acquired for cropping and/or spreading manure.

Question #4: Should this committee identify the high risk conditions and risk-reducing practices that might be included in a siting rule standard related to winter spreading restrictions? Should the Committee wait until the NRCS 590 NM standard is revised before making recommendations since additional winter spreading restrictions are likely to be added as a statewide requirement?

Recommendations
- Based on the concepts in the March 23, 2015 draft of the revised NRCS nutrient management standard 590, ATCP 51 should incorporate the revised NRCS 590. (For consistency within the agency the updated NRCS 590 should be incorporated into ATCP 50 and 51.)
- DATCP should clarify how local governments may impose locally-identified nutrient application restrictions authorized in the current or revised version of NRCS 590 including restrictions in Section V.A. designed to protect surface and groundwater resources.
- DATCP should help local governments understand how they can meet current state requirements for adopting more stringent standards to protect groundwater.

Considerations
The Committee supports incorporation of the revised NRCS 590 based on its review of a March 23, 2015 draft that includes the following:
1. Additional winter spreading restrictions, including a new risk assessment tool and planning requirements, a prohibition on nutrient applications on frozen- and snow-covered fields locally identified as areas contributing direct runoff to ground water, and a prohibition on liquid manure applications on frozen- and snow-covered fields in DNR Well Compensation areas or on shallow Silurian dolomite soils.
2. Expanded nitrogen (N) application restrictions and prohibitions related to bedrock depth, soil types, and/or timing.
3. Enhanced nutrient application setbacks including a restriction on spreading untreated manure on cropland in locally identified areas as contributing direct runoff to groundwater conduits, unless the manure is substantially buried within 24 hours of application.
4. Additional restrictions related to N recommendations and rates, including restrictions on late summer and fall applications of commercial N in sensitive fields (e.g. within 5 feet of bedrock).
5. Increased phosphorus management (PI and Soil Test P limits and resulting restrictions).
6. Greater focus on erosion control.

When the standard is finalized, DATCP should evaluate the best approach to include the new requirements in the siting rule.

Question #5: What, if any, standards should be incorporated into the siting rule (ATCP 51) to address manure irrigation?

Recommendations

- By incorporating the latest version of NRCS 590, the siting rule will include manure application setbacks and restrictions designed to protect surface and ground water quality.
- ATCP 51 should not incorporate the recommendations of the Manure Irrigation Workgroup, whose work will be completed in the summer of 2015.

Considerations

With possible revisions, NRCS 590 will include some water quality setbacks and requirements more closely aligned with those imposed on CAFOs under NR 243. The Manure Irrigation Workgroup plans to prepare recommendations to address irrigation-related concerns involving public health with focus on airborne pathogens, drift, odor and nuisance, surface and ground water protection, and implementation and compliance. The recommendations will focus on factors such as siting (including setbacks), weather, waste characteristics, and equipment. The Workgroup has not considered application of manure stored with other wastes (e.g. septage) and the fate of volatile compounds when manure is irrigated. The TEC viewed the use of manure irrigation as another method to land spread manure. Best management practices recommended by the Workgroup to address this issue will evolve and may translate into NRCS practice standards or other future actions.

Odor

Question #1: Worksheet 2 (Appendix A, Chart 2, 390-25) calculates the odor generated by livestock structures using odor generation numbers developed in accordance with the best available science. What is your recommendation with respect to odor generation numbers? Should the numbers stay the same or should they be raised or lowered?

With respect to dairy housing types, should it be clarified whether this housing includes natural and power ventilated barns? With respect to poultry, there is currently only one category. Should two categories be created for layers with different odor generation numbers? For example, currently layers and litter in the same building have an odor generation number of 20. There is no category for layers in housing equipped with a dryer belt system where litter is stored separately from the birds. Currently, broilers in housing with litter have an odor generation number of 1.

With respect to waste storage facilities, should the method for predicting odors be switched from storage duration to storage surface area? Currently short term storage has an odor generation number of 28 and long term storage (6 months or longer) has a generation number of 13. If so, the current odor generation number of 28 could be used for structures less than one acre in size and the current odor generation of 13 for structures larger than 1 acre, when measured at the maximum operating level. Are the generation numbers correct? Is there a need to combine storage duration and surface area to properly predict odor?

Currently there is no category for sand and solid separation systems. First, should a category be established? If so, is it appropriate to distinguish between parts of the system used for separation and those used for storage of separated materials? It has been suggested that an odor generation number of 40 could be assigned to treatment areas (e.g. a lane where sand is separated or a building that houses mechanical separation equipment) and a generation number of 2 for the sand/solids storage area. For systems enclosed by buildings, the use of appropriate odor control practices, e.g. bio-filters could be used.

Do you have additional recommendations regarding any source listed in Chart 2 or sources that should be listed in Chart 2?

Worksheet 2 (Appendix A, Chart 3, 390-26) identifies odor control practices that reduce odor from livestock structures, and assigns an odor control percentage to each of the practices consistent with the best available science. In 2010, DNR developed a list of control practices for air emissions including a rating of the effectiveness of the practice in controlling odor.

In the area of housing there are several odor control practices that livestock operators can implement. Do any of the reduction factors/multipliers need to be adjusted for diet manipulation, bio-filters, fresh water flush, treated water flush, immediate return flush, air dams, or windbreaks. Also, should a new category for wet scrubber be added?

With respect to waste storage should the reduction factor/multiplier be adjusted for anaerobic digestion, chemical or biological additives, compost, solid separation and reduction, aeration, geotextile covering or natural crust? Should a category for poultry layer housing utilizing a dryer belt system be added?

Do you have additional recommendations regarding any source listed in Chart 3, or sources that should be listed in Chart 3?

Recommendations

- Worksheet 2 (Chart 2) of ATCP 51 should retain the odor generation numbers for the 17 housing types, and make modifications as specified in Appendix A, to increase the odor generation number for dairy/beef alley flush to storage, and to add a new lower generation number for poultry layer housing using dryer belts.
- Worksheet 2 (Chart 2) should retain the odor generation numbers for Waste Storage Facilities but base the method for predicting odors on surface area, not storage duration as specified in Appendix A.
- Worksheet 2 (Chart 2) should add odor generation numbers for sand and solids separation systems, as specified in Appendix A, to account for active treatment area and storage of separated materials.
- Worksheet 2 (Chart 3) of ATCP 51 should retain the credits for 17 odor control practices for housing, manure storage and animal lots, and make modifications, as specified in Appendix B, to add wet scrubbers and recirculated flush water as a Category B odor control practice for housing; replace fresh water flush with recirculated flush water as a Category B odor control practice for housing; increase the credit for housing windbreaks and geotextile covers; reduce the credit for anaerobic digestion, and solids separation and reduction; and eliminate the predetermined credit for aeration of storage.
- Worksheet 2 (Chart 3) should change the specifications, as detailed in Appendix B, for the following odor control practices for housing and manure storage: diet manipulation,

bio-filter, treated flush water, anaerobic digestion, chemical and biological additives, compost, solids separation and reduction, and natural crust.

Considerations
Considerations are included as part of the recommendations set forth in Appendices A and B.

Question #2: ATCP 51.14(2)(c) and Worksheet 2 (Appendix A, 90-22) exempts operators from the odor standard if their proposed livestock facilities are: 1) a new facility with fewer than 500 animal units, 2) expansions less than 1,000 animal units, or 3) have livestock structures at least 2,500 feet from the nearest affected neighbor. “Affected neighbors" (ATCP 51.01 (2)) are residences or "high-use buildings" (ATCP 51.01 (16)) other than those owned by the livestock operator or by persons who agree to a shorter setback. Is it appropriate from a technical standpoint to continue these exemptions from the odor standard?

Recommendation

- ATCP 51 should continue to exempt the three categories of facilities from the odor standard.

Considerations
From a technical standard, there is insufficient basis to change the exemptions to the odor standard in ATCP 51.14(2)(c) and Worksheet 2 (Appendix A, 90-22). Exempting livestock facilities by size (new facilities with fewer than 500 AUs and expansions under 1,000 AUs) can be justified. For example, smaller operations have fewer significant odor sources. Exempting operations with structures at least 2,500 feet from the nearest affected neighbor encourages good site selection. However, odor management is still encouraged even when the 2,500-foot setback is met.

Question #3: Livestock operators who complete required plans related to incident response and employee training and an optional odor management plan (Appendix A, Application for Local Approval, Nos. 12 and 13, p. 390-18) may claim additional points toward a passing odor score. Is it appropriate from a technical standpoint to award 80 points for the mandatory plans and 20 points for the optional plan? Can the plans be improved or strengthened to better control odor? If not, should the odor scoring system be adjusted and still include a requirement to have a mandatory plan to address odor practices?

In addition to a checklist, is it appropriate to allow for self-reporting by farm operators, requests by local governments for documentation, and on-site inspections of permitted facilities? Should DATCP provide guidance and training to local authorities on compliance monitoring?

Do you have other recommendations?

Recommendations

- ATCP 51 should require all applicants to complete plans related to incident response, employee training, and odor management.
- Applicants who complete the required three plans should receive additional points, not to exceed 100, toward a passing odor score.

- In determining the number of points credited toward a passing odor score, DATCP should consider and balance the three approaches collectively used to manage odor in ATCP 51: management and other plans, modeling using Worksheet 2, and road and property line setbacks for livestock structures.

Considerations
Increasing the planning requirements for applicants makes sense because planning is a critical component in successfully managing complex issues such as odor, and the most effective plans are all-encompassing.

There are conflicting arguments for setting point awards that count toward a passing odor score. If the full 100 points were to be awarded, planning requirements must be strengthened. For example, there will need to be enhanced requirements related to plan implementation and monitoring. If applicants are limited to earning only 50 points, they could be unnecessarily penalized, particularly if the rule is changed in other ways to increase setbacks or impose additional hurdles to securing a passing odor score.

In determining the points to award for the three plans, DATCP should consider and balance the three tools used to manage odor. In considering adjustments to one or more of these tools, DATCP's decisions should be informed by the overall goal of effectively combining these approaches to achieve acceptable levels of odor. Reaching this goal is complicated by the challenges presented by each tool. The odor standard ultimately is tied to an air dispersion model that does not fully capture how odors travel. Also, additional research is needed to shed more light on odor generation and control practices. In the case of setbacks, property line setbacks do not take into account the proximity of existing residences, schools, and other occupied buildings adjacent to a permitted livestock facility. However, applicants who must complete the odor management worksheet do measure and account for odor impacts on nearby residences.

Question #4: ATCP 51 provides no guidance to local governments for monitoring livestock operations to determine whether odor control practices are properly implemented and maintained. Should a checklist be developed similar to the one used for nutrient management that producers and local governments can use to verify a facility has installed, and continues to properly operate, odor control practices and management activities required under a siting permit?

Recommendation
- To support compliance monitoring, DATCP should support local government efforts by developing checklists and providing other support to facilitate local review.

Considerations
Regarding monitoring compliance with odor control practices, the committee believes it sufficiently addressed this issue in its recommendations related to engineering practices (see Engineering Question # 6 above).

Setbacks

Question #1: ATCP 51.12 establishes the maximum setback distance that local governments may impose on permitted livestock facilities through a local siting ordinance. They are:

- No more than 350 feet for manure storage structures from the property line and road right of ways for all sized livestock facilities.
- No more than 100 feet to 200 feet, depending on the size of the livestock facility, for other structures including animal housing, animal lots, milking parlors and feed storage from property line and road right of ways.

Do current road and property line setbacks provide adequate protection to residences, high use buildings, parks, seasonal residences for hunting, and public spaces while still allowing for new and expanded livestock operations?

Could structure-to-structure setbacks more effectively protect certain land uses from the impacts of livestock facilities, or does the odor standard adequately address potential odor impacts while still providing options for producers?

Recommendations

- For new or substantially modified manure storage structures located on livestock facilities over 1,000 animal units, ATCP 51 should require a road and property line setback greater than 350 feet.
- For livestock facilities under 1,000 AUs, DATCP should consider requiring greater setbacks for livestock structures, unless these facilities use established methods to document how they will manage odor to secure a passing odor score.
- To provide greater protection for neighbors, DATCP should consider increasing the property line and road setback distances for structures (such as feed storage) that may have nuisance impacts, applying increased setbacks to occupied buildings in addition to property line setbacks, and accounting for schools and other high density uses in establishing a setback.

Considerations

If setbacks are increased beyond 350 feet, DATCP should allow the use of effective odor control practices to reduce setbacks larger than 350 feet. Local governments should check the implementation of these odor control practices as part of any monitoring activities.

If DATCP increases the setback requirements for manure storage, it should consider exemptions in the rule reducing setbacks from property lines where minimum distances from manure storage to residential and other occupied buildings are met.

Appendix A: Odor Generation Recommendations (Worksheet 2, Chart 2)		
Odor Source: Type of livestock structure	*Current odor generation number*	*Recommendation*
Housing: Dairy Free Stall and Beef and Dairy Heifers	Slatted floor including floor and pit below (6); scrape (4) and bedded pack (2)	Retain generation numbers but modify the definition of housing types to include naturally-ventilated (which is wind-driven and random) and power-ventilated (which is controlled and adjustable). In the case of power-ventilated housing, if ventilation is located on the side further from the property line, this additional separation may be included in the calculation of the odor generation number.
Housing: Dairy Free Stall and Beef and Dairy Heifers (Alley flush to storage),	10	Increase to 20, clarify this housing type includes natural and power-ventilated housing, and define in the specification the baseline related to flush water used in the system (e.g. untreated water drawn from manure storage). This recommendation is supported by observational data, the anaerobic quality of the flush water, and findings from the National Air Emissions Monitoring Study (NAMS), http://www.epa.gov/agriculture/airmonitoringstudy.html, a two-year examination of air emissions from poultry, swine and dairy animal feeding operations sponsored by the US Environmental Protection Agency. The odor control practices for these flush systems will be reviewed to ensure operators have the full benefit of the latest technologies and treatments.
Housing: Poultry layer housing utilizing a dryer belt system	Not currently included	Create a second category for layers, in addition to Poultry layers with generation number of 20. Belt system housing (litter stored separately from birds) should be assigned a number of 1, which is the same number used for broiler housing with litter. This recommendation is supported by observational data and inference and analogy based on the removal of manure before it goes anaerobic.
Waste Storage Facilities	Short term-less than 6 months, 28; Long term-6 months or more, 13	Retain the generation numbers of 13 and 28, but the method for predicting odors should be based on surface area, not storage duration. The odor generation number of 28 should be assigned to structures less than one acre and the number of 13 to structures larger than 1 acre. One acre of storage, at average depth, holds manure from a 500 cow dairy for six months. Surface area should be determined based on a measurement of the stored waste with the structure at its maximum operating level (MOL). This recommendation is supported by the science of odor generation, observational data, and opinions of experts. In addition, surface area is less challenging to measure than duration. A higher odor generation number should not be assigned to storage of manure from swine vs. dairy or poultry.
Sand and Solids Separation Systems, including sand separation lanes (a.k.a. sand channels) and mechanical separation systems (e.g. screen, friction dryers, and screw presses	Not currently included	Create a new odor generation number of 40 for areas of active treatment (e.g. lane where sand is separated, or a building housing mechanical separation equipment) and a generation number of 2 for the sand/solids storage areas. A lower generation score of 20 might be assigned to settling lanes and other separation systems that do not use water drawn from manure storage. In counting the area of sand lanes, the new standard should distinguish between intermittent vs. continuous use and not double count a second lane if it used in alternation with the first lane. The idle lane should be treated as sand or solids storage. This recommendation is supported by a published study, and analogy to similar structures. For systems enclosed by buildings, appropriate odor control practices, e.g. bio-filters, should be recognized.

Appendix B: Odor Control Practice Recommendations (Worksheet 2, Chart 3)			
Odor Source and Control Practice	*Reduction Credit*	*Cannot combine with*	*Recommendation*
Housing: Diet Manipulation (A1)	20% (0.8 multiplier)	None	Retain credit but improve the specification to include odor control as a feed nutrition management goal and require applicants to document the specific feed ration for verification of its effectiveness. Milk urea nitrogen (MUN), commonly used to monitor feed nitrogen efficiency, can be used to track the control of nitrogen emissions from a dairy farm, http://ars.usda.gov/SP2UserFiles/Place/36553000/pdf's/30_MUN_2nd_study.pdf
Housing: Bio-filter (B1)	90% (0.1 multiplier)	B2, B3, B4, B5	Refine the specification to apply credit only to the portion of the total ventilation air that is treated, which typically only involves air from the under floor pit. The specification should include a scheduled bio-filter maintenance component.
Housing: Fresh Water Flush (B3)	60% (0.6 multiplier)	B1, B2, B4, B5	Eliminate this practice, and replace with the immediate return flush water practice (see below).
Housing: Recirculated Flush Water (Replaces B3)	Not currently included		Replaces (B3), and should be assigned a credit of 50%. A specification must be developed that accurately captures the practice of using gray water and re-circulating flush liquids stored for less than 7 days. Some treatment may be needed to remove solids. This new practice cannot be combined with practices from Chart 3, Category B.
Housing: Treated Water Flush (B4)	30% (0.7 multiplier)	B1, B2, B3, B5	Refine the specification to ensure adequate treatment. If separately treated in a small basin, for example, wastes from manure storage could be aerated without excessive power requirements. Treatment should not include anaerobic digestion as an option. DATCP may need to more clearly identify appropriate treatment methods. A minimum of 2 mg/l dissolved oxygen should be required when aeration is used as the treatment method.
Housing: Air Dam (B5)	20% (0.8 multiplier)	B2, B3, B4	Allow air dam as a control practice applicable to all types of positively ventilated animal housing (not just swine). Merge the windbreak and air dam practices; a separate air dam control practice is not needed.
Housing: Wet Scrubber	Not currently included		Create a new odor control practice with two parts: one that provides 90% credit if bleach or other chemicals are used, and another that provides 50% credit if only water is used. Like bio-filter, the credit should only be applied to the portion of the total ventilation air that is treated. This practice cannot be combined with practices in Chart 3, Category B.
Housing: Windbreak (C1)	10% (0.9 multiplier)	None	Retain the current 10% credit but consider offering additional credit if certain conditions are met (such as a plantings exceeding the minimum standard).
Waste Storage: Anaerobic Digestion (E1)	80% (0.2 multiplier)	E2, E3, E4, E5	Reduce credit 50% to more realistically reflect the odor control from this practice. This approach accounts for the best available research (e.g. Manure Storage & Handling - Anaerobic Digestion Overview, https://store.extension.iastate.edu/Product/AMPAT15), and recognizes the variables in the digestion process (e.g. reduced retention times). The specification, which will draw on NRCS 366, should be modified to cover use of off-farm feed stocks to avoid compromising odor control. This practice should not be combined with other practices in Chart 3, Category E.

Appendix B: Odor Control Practice Recommendations (Worksheet 2, Chart 3)			
Odor Source and Control Practice	*Reduction Credit*	*Cannot combine with*	*Recommendation*
Waste Storage: Chemical Or Biological Additives (E2)	20% (0.8 multiplier)	E1, E3, E4, E5	Refine the specification, in a manner similar to the recommendation for diet manipulation, to require applicants to identify the additive to be used, and provide documentation to show it is effective. DATCP should allow applicants to claim a higher credit by meeting the requirements for an innovative odor control practice. Applicants should not be allowed to combine this practice with others listed in Chart 3, Category E.
Waste Storage: Compost (E3)	80% (0.2 multiplier)	E1, E2, E4, E5	Refine the specification by incorporating the NRCS practice standard 317, and include requirements to ensure adequate containment and treatment of contaminated runoff.
Waste Storage: Solids Separation And Reduction (E4)	40% (0.6 multiplier)	E1, E2, E3, E5	Reduce the credit to 20%, and refine the specification to limit this practice to manure separation (as opposed to sand separation), to apply odor control practices separately to each chamber of a storage facility, and to include periodic checks (e.g. after agitation) to document compliance with the 2% or less solids requirement.
Waste Storage: Aeration (F1)	70% (0.3 multiplier)	F2, F3, F4, F5, F6	Eliminate the predetermined credit of 70% and require applicants to seek individual DATCP approval for innovative practices and to receive a credit consistent with the documented effectiveness for the proposed technology. This approach recognizes the variety of practices being installed and the risks of increased odor from under-designed systems.
Waste Storage: Geotextile Cover (F3)	50% (0.5 multiplier)	F1, F2, F4, F5, F6	Increase the credit to 60% based on the most current scientific research on odor control.
Waste Storage: Natural Crust (F5)	70% (0.3 multiplier)	F1, F2, F3, F4, F6	Refine the specification to include more measurable criteria for coverage, e.g. "80% of the surface, 80% of the time."

Appendix L

Final Report on Wisconsin’s Dairy and Livestock Odor and Air Emission Project

FINAL REPORT

ON

WISCONSIN'S DAIRY AND LIVESTOCK ODOR AND AIR EMISSION PROJECT

SUPPORTED BY USDA NRCS

CONSERVATION INNOVATION GRANT

NRCS 68-3A75-5-157 WI DAIRY AND LIVESTOCK AIR EMISSION/ODOR PROJECT

September 2009

Madison, Wisconsin

EXECUTIVE SUMMARY

BACKGROUND

Supported by a U.S. Department of Agriculture Conservation Innovation Grant, this project investigated the air impacts of different manure management practices on typical large animal feeding operations. Over the course of two years, staff from the Wisconsin Department of Agriculture, Trade and Consumer Protection and the Wisconsin Department of Natural Resources measured odors and airborne concentrations of ammonia and hydrogen sulfide, both on and around manure storage lagoons on farms employing these different practices. It should be noted that our sampling was not intended to measure emissions or determine emission factors.

The subject farms for this project were selected through a statewide request for study participation. Interested farms were reviewed by a steering committee consisting of a number of representatives of agriculture, state agency, and environmental groups. Participants in the study were given the incentive of cost sharing for practices they installed on their farms, or a participation stipend in the event that no practices were installed. The steering committee selected six study farms (five dairies and one heifer raising facility), and four control practices to evaluate.

The four practices tested were anaerobic digesters; an impermeable cover; a permeable cover; and a solids separation and aeration system. Two types of digesters were studied, a mesophilic (low temperature) digester and a thermophilic (high temperature) digester. The impermeable cover was a gas-tight HDPE material that is characteristic of those used to line earthen storage lagoons. The permeable cover was a floating geotextile membrane, which acted like an artificial crust to break up the air/liquid interface, yet allowed precipitation and gasses to pass through. The solids separation and aeration was a proprietary system that consisted of two screen roller press filters followed by two waste storage lagoons equipped with floating aerators. The aerators were installed such that they forced air into the upper layer of the stored manure. The theory behind this is to allow the deeper wastes to breakdown anaerobically, but to control the gases being generated by passing them through a top aerobic layer.

A total of 28 sampling trips were conducted on 6 different farms, three of which installed potential control practices during the course of the project, allowing pre- and post- installation sampling. Two of the farms had anaerobic digesters already installed, allowing us to make comparisons to a similar farm without a digester. And the sixth farm was an open feedlot, which provided us with baseline data only. During these trips, a total of over 2,000 air samples for ammonia and hydrogen sulfide were collected, mostly from the perimeters of the manure storage lagoons. Samples were also collected from the lagoon surface. During these trips, 103 odor transects were conducted using a field olfactometer. This report documents the air and odor sampling procedures and compiles the results.

The project focus on lagoons required skilled knowledge of other potential sources of odors on farms, such as barns and sand channels. Where appropriate, these areas were also sampled to facilitate a better understanding of the impact these areas might have on measurement and analysis of data.

KEY FINDINGS

Ambient NH_3 and H_2S Concentrations

Concentrations of ammonia and hydrogen sulfide tended to vary as much or more widely between visits to the same farm as they did between two different farms. This variability, compounded by the relatively few trips made to each individual farm, yielded a situation where we were not able to collect a statistically significant quantity of samples, and our results therefore contain some ambiguity. Samples were collected at the edge of each practice being studied to minimize the interference from other on-farm sources, and to factor out the effect of atmospheric dispersion. For this reason, all results are reported as "near", however it is logical that concentrations away from these practices would follow the same trends as those nearby.

The following statements appear to be supported by our data:

1) In general, higher ambient concentrations of hydrogen sulfide will be observed around agitated manure storage and treatment system surfaces (either during pumping, or along sand channels, and near outfalls and spillways).
2) Installing an impermeable cover will significantly reduce near lagoon ambient concentrations of ammonia and hydrogen sulfide.

The statements below are less conclusively supported, although they are likely to be true:

3) Installation of a semi-permeable cover is likely to reduce near lagoon ambient concentrations of ammonia and hydrogen sulfide; however, later exposing the covered wastes to air (as is done in a sand separation channel) may lead to significant increases near the uncovered areas, when compared to pre-covered levels.
4) Lagoon aeration may reduce manure surface concentrations of hydrogen sulfide. However, in our test case, surface ammonia concentrations, as well as general nearby ambient concentrations of both compounds increased following aeration.

The following points of interest may have important manure management implications:

5) Digested manure appears to generate lower hydrogen sulfide concentrations near the lagoons than undigested manure, although further study would be necessary to state this conclusively. There appears to be no similar reduction in ammonia concentrations.
6) Hydrogen sulfide concentrations around undigested manure surfaces appear to increase at night relative to daytime concentrations. Whether this is due to overnight inversions allowing the compound to concentrate, or is due to some intrinsic property of the dynamics of exchange across the air/manure interface is unknown.
7) Ammonia concentrations, in contrast, appear to peak during the daylight hours, around both digested and undigested manures.
8) Most near lagoon concentrations of hydrogen sulfide are below air toxics limits for property lines. However, our data shows the presence of highly concentrated and compact plumes near areas of agitation which could potentially travel significant distances before fully dispersing.

Odor Sampling

Downwind odor measurements were taken at 200-foot intervals both before and after the control practices were installed. The general trend in these odor measurements was used to determine the estimated overall odor control performance of each practice. The study focused on odors emitted from manure storage lagoons, since these are typically the single most significant source of odors from concentrated animal feeding operations. Odor levels were measured using a Nasal Ranger™ field olfactometer, produced by St. Croix Sensory of Lake Elmo, Minnesota.

Although a limited number of odor transects were conducted, and conditions varied throughout the study, general trends were observed for each of the control practices tested. The results of that testing are summarized below, and described in greater detail throughout the report. Caution should be exercised when extrapolating these results to other farming operations.

Anaerobic Digesters

The storage lagoon receiving wastes from the low temperature digester produced about 15% less ambient odors than a similar lagoon storing undigested wastes. On the other hand, the storage lagoon receiving wastes from the high temperature digester produced about 15% more ambient odors than did the lagoon storing undigested wastes. Because of the inherently subjective nature of this type of testing, plus or minus 15% should not be considered statistically significant. Factors such as retention time, operational reliability, and addition of substrate material can all influence the performance of an anaerobic digester, and therefore its effectiveness at controlling odors.

Impermeable Cover

Installing an impermeable cover on the manure storage lagoon effectively controlled all ambient odors that had been emitted prior to the installation of the cover (100% reduction). This result can logically be applied to other lagoons, assuming that the covers remain air-tight and that the gasses that form under the cover are collected and burned in a flare or generator set, as was the case with our demonstration farm.

Permeable Cover

Installing a permeable cover on the manure storage lagoon resulted in about an 80% reduction in ambient odors from that source in the first year, and about a 60% reduction in the second year.

Solids Separation and Aeration

Installing this proprietary system resulted in about a 20% reduction in odors in the first year and about a 25% reduction in the second year

CONCLUSIONS

It can be concluded that covers are effective at controlling odors and ambient air concentrations of NH_3 and H_2S from manure storage lagoons. Of these, impermeable covers are very effective (100% reduction), and permeable covers are quite effective (about 70% reduction).

Solids separation and aeration appear to reduce odors somewhat (about 25%) as well as H_2S concentrations, however NH_3 concentrations could be increased.

Anaerobic digesters do not predictably reduce odors or ambient NH_3 concentrations near manure storage lagoons, however they may reduce H_2S concentrations. Advances in H_2S control have been made in Europe that reduce concentrations even further, and these are now being adopted by some U.S. firms.

The odor model used by Livestock Facility Siting rule (ATCP 51) accurately predicts the odors from averaged sized manure storage lagoons (around 4 acres), however it under predicts odors from small lagoons (0.4 acre). The credit given in the odor model for covers, both impermeable and permeable, seems appropriate. Too great a credit may be provided for anaerobic digesters, as well as solids separation and aeration systems. And finally, the odor model may not be applicable for large, lightly stocked earthen feedlots.

This study yielded important insights into controlling odors from manure storage lagoons, and these are detailed in the Lessons Learned and Improving Farm Practices sections of this report. However, it also leaves many questions unanswered, and has raised new questions we did not anticipate beforehand. It will facilitate future investigations by highlighting the challenges in such evaluations, including the dynamic nature of farms. The information gathered by this study should aid in making future decisions regarding the control practices studied, as well as helping to guide future studies into the air impacts of CAFOs.

IMPLICATIONS AND RECOMMENDATIONS

Improving Farm Practices

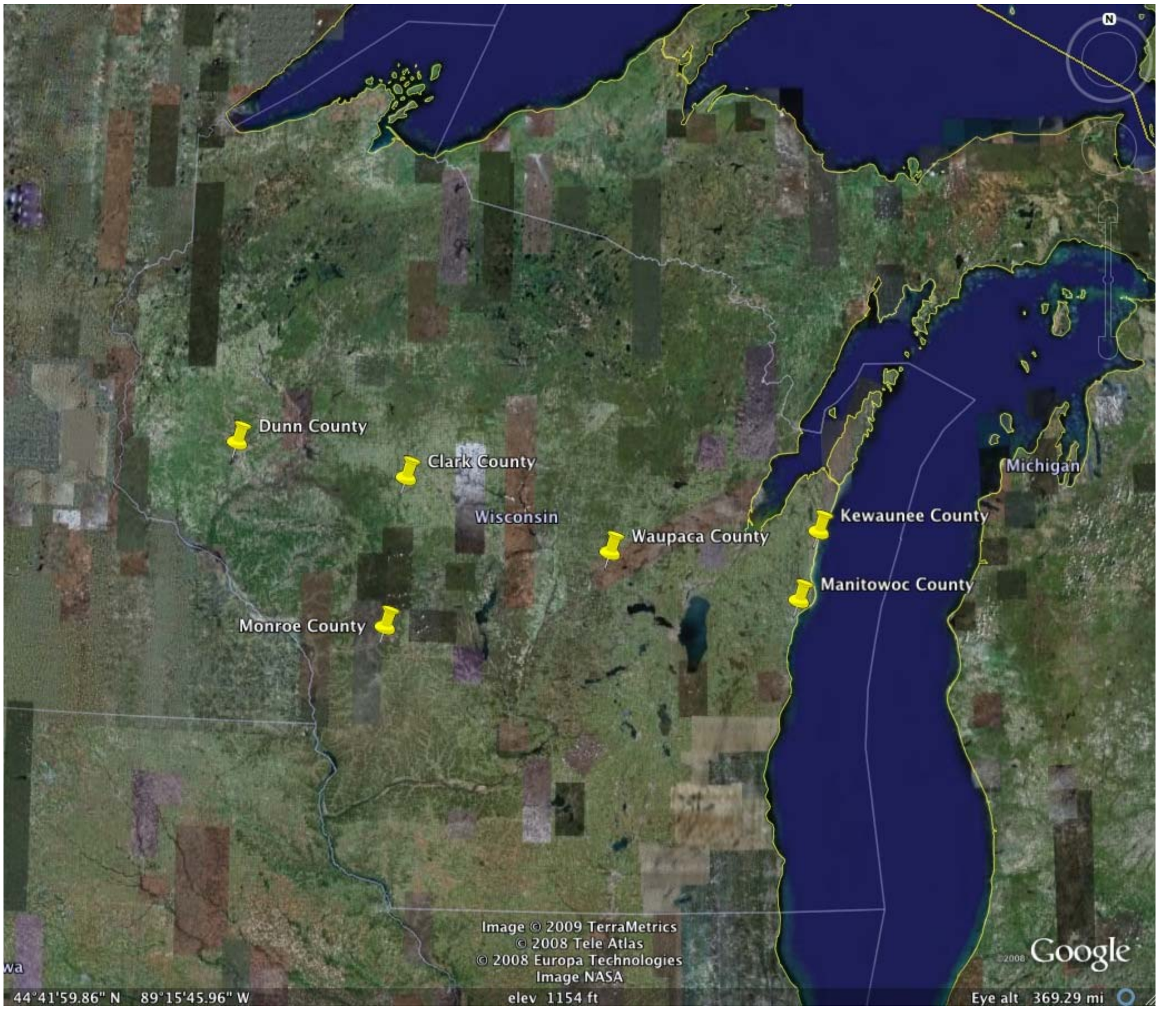
Throughout the course of this study, 28 visits were made to the six study farms over a two year period. This allowed for observations to be made regarding the overall management of the farms, and how that management affected odors and concentrations of ammonia and hydrogen sulfide. Based on those observations, the following suggestions are offered to farmers wishing to reduce odors from their farms:

1. Minimize surface agitation of waste storage lagoons and exposure to the air. This includes using submerged inlets, subsurface versus above surface jets for mixing, and incorporating wastes when land applying. These practices will also minimize the volatilization of ammonia, thus maximizing the amount of nitrogen supplied to your crop. This change alone eliminated neighbor complaints at the low temperature digester farm.
2. If installing a manure digester, maximize the retention time. More thorough digestion of the wastes will reduce odors from the lagoon, and incomplete digestion can actually increase odors. Also install a high quality flare with a reliable igniter and a large wind baffle. This will avoid the unintentional release of unburned digester gas to the air.
3. If installing a new waste storage lagoon, consider incorporating an impermeable cover. A cover greatly reduces odors and other impacts on neighbors. Also, the reduction in greenhouse gasses could qualify you for cost-sharing through a carbon credit program.

The savings in not having to haul precipitation can be significant. And lastly, it is far more economical to add a cover to a new storage lagoon than it is to retrofit one on later.

4. Consider installing a permeable cover on your existing waste storage lagoon. Although not as effective at controlling odors and greenhouse gasses as an impermeable cover, it will provide significant benefits at far less cost. If doing so, be certain to provide a number of well spaced openings for agitation and pumping.
5. Keep stored feed clean and dry. This will reduce odors as well as protect feed quality.
6. Consider the installation of a solids separator to produce your own bedding. Composted manure solids can provide a safe supply of bedding, when moisture levels are properly managed. The cost savings over other types of bedding material, such as sand, can be substantial.
7. Keep animal densities low on open feedlots. High stocking rates can increase odors, as well as runoff and erosion. Ideally, consider going to a rotational grazing set-up. This will bring things into balance with your land base, reducing inputs and impacts on the environment.
8. Separation distance is a simple, yet effective, tool you can use to reduce impacts on your neighbors. When planning for new facilities, and especially manure storage lagoons, site them as far from neighbors as possible, and with consideration for prevailing winds. Odors are far less noticeable at 800 feet than they are at 200 or even 400 feet. If adjacent properties go up for sale, consider buying them as a buffer against future encroachment by development.

STATE MAP WITH COUNTY OF PROJECT SITES IDENTIFIED



ACKNOWLEDGEMENTS

We would like to extend our appreciation to the following individuals and agencies for their support and dedication for funding, involvement and guidance for the DATCP Conservation Innovation Grant project and report you are reading.

USDA for funding this CIG project:
Without their financial support, this project would have never been implemented. The cost of such a project is far beyond what state agencies would normally even consider funding.

DATCP Administration – Rod Nilsestuen, Matt Tompach, Kathy Pielsticker, and Dave Jelinski:
The State of Wisconsin has created state guidelines for siting new and expanding livestock operations. During the process of creating the guidelines, odor and air quality became a major focal point. Their concern of acceptable odor and air quality emitting from livestock operations and the lack of information for such issues being evident, they realized the need for such a study and wholeheartedly endorsed the study concept. They have provided consistent support before, during, and after the life of the project.

DNR Administration – Al Shea, Lloyd Eagan, and Eileen Pierce:
The Wisconsin DNR regulates air quality and odors under SS. 445 and supported the study with dedicated personnel and resources to accomplish this project.

NRCS – Don Baloun and Pat Leavenworth:
NRCS became the conduit of funds from USDA to DATCP, and Don provided support for the administrative process that was involved, and also provided valuable insight on project management.

University of Minnesota – Larry Jacobson and David Schmidt:
Larry and his staff at Minnesota have done a significant amount of work studying air quality and odor emissions from livestock units in the Upper Midwest. They provided invaluable technical assistance that made the project more feasible to accomplish and more relevant to the original focus of the grant.

Environmental Intelligence, Inc. – Douglas B. Johnson:
Doug was brought on board to compile, arrange, and write this report and we appreciate his efforts in accomplishing the task. His patience and skill to produce this report was sorely needed.

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INTRODUCTION

PURPOSE

RATIONALE AND PROJECT HISTORY

Agricultural practices in the past 30 years have led to increasingly concentrated animal populations, which in turn have increased the amount of waste generated on each farm. Not only does this complicate waste handling for the farmer, but also it increases the chance that emission of odors and biogenic compounds may cause at least the perception of problems. Whether or not agricultural emissions of such compounds as hydrogen sulfide and ammonia are of legitimate regulatory or health concern is a current research topic.

In 2004, Wisconsin DNR adopted a set of revised rules governing the emission of toxic chemicals of concern (NR 445). Among the chemicals regulated under this rule are several known to be associated with animal manures. At that time, however, there was not enough information available to determine whether or not large animal operations would exceed regulatory limits. As such, a moratorium on the application of the rule to these operations was put in place, until more information could be obtained.

Separately, the Department of Agriculture, Trade and Consumer Protection (DATCP) became interested in examining different manure handling practices in light of whether or not they would have a perceptible impact on odor and emissions. DATCP, in cooperation with DNR, applied for and obtained a Conservation Innovation Grant (CIG) from the United States Department of Agriculture (USDA) in October 2005. The purpose of the study was to implement several different practices on different farms and study the before and after differences observed.

DATCP's role in the study was to choose the farms and oversee the implementation of the test practices, to collect odor samples and data, to collect manure samples, and to collect farm operation information (number of animals, feed information, etc). DNR's role was to provide air sampling support, and to collect and analyze air samples for the chosen parameters. This report covers the air sampling portion of the project.

At the time of the application for project funds, the DATCP-DNR project team proposed that implementing the CIG would improve the understanding of livestock producers and local governments related to ambient air concentrations, odor, and water quality improvements as a result of installing various BMPs. Currently, Wisconsin has very little experience and limited on-the-ground knowledge related to ambient air concentrations and odors from livestock operations. While the state has not aggressively enforced air monitoring and air quality regulations on livestock operations, their location and the air quality surrounding them have been regulated through conditional zoning permits. These generally include setbacks of livestock operations, but do not directly consider the impact of BMPs on ambient air concentrations and odor.

The project team recognized there was a need for a replicable study with potential transferability of results to other agricultural odor related problems in Wisconsin and elsewhere. The team proposed to undertake this project with reasonable expectations that the following benefits would accrue to producers, neighbors and communities, the environment, and animal agriculture industries while providing guidance for policymakers and the regulatory community:

- Documentation of the relative ambient air concentrations resulting from dairy and other livestock operations based on current practices before BMPs are installed would provide a baseline against which to measure potential improvements that might be realized after BMP installation.
- Establishing the costs to implement various best management practices the research shows should reduce ambient air concentrations, odor, and runoff of nutrients to the state's waters would provide a basis for cost-benefit analysis based on implemented cost instead of reliance on cost models that are commonly found in published research.
- Establishing a dialogue between producers, neighboring citizens, and local governments related to ambient air concentrations and water quality would provide a basis to enhance shared understanding of BMPs and their potential to resolve issues.
- A comparison of pre and post installation of BMPs related to the odor estimates and Nasal Ranger odor measurements to further calibrate the odor standards and evaluate the tool established under the state's Livestock Siting Administrative Rule, ATCP 51 would improve the effectiveness of legislative initiatives developed to address issues with livestock siting.
- Documentation of the reduction of ambient air concentrations, odors, and runoff of nutrients as a result of installing BMPs would provide a scientific basis for decision-making by dairy producers and other stakeholders involved with siting and operation of dairies.
- An evaluation of the cost effectiveness of the BMPs based on the degree of reduction would provide producers and others with data to guide and inform decisions on which BMP or technology might yield the most reduction in odors for a given dollar of investment.
- An evaluation of the reductions in ambient air concentrations and odors as a result of implementing a manure digester system would better enable producers and policymakers to make decisions on the policies and practices that impact adoption of manure digesters in Wisconsin and elsewhere.

REGULATORY DRIVERS

Several regulations at the state and local level are driving a need for scientific study and evaluation of ambient air concentrations. Hazardous air pollutant emissions are regulated under ch. NR 445, Wis. Adm. Code. This rule establishes ambient air standards for specific hazardous air pollutants, off the source's property. The acceptable ambient concentration standards for ammonia and hydrogen sulfide are 418 and 335 micrograms per cubic meter, respectively, both on a 24-hour average basis.

NR 445, Wis. Adm. Code was updated in 2008 to extend an exemption period for livestock operations to July 31, 2011. Existing livestock operations are required to achieve compliance by July 31, 2011. After July 31, 2011, new livestock operations are required to comply upon start up. The rule provides several compliance options. A special compliance option for livestock operations is established in the rule, specifically, the implementation of best management practices as approved by the Department of Natural Resources. This study was designed in part to provide information to support department decisions on best management practices for the control of hazardous air pollutant emissions, as proposed under this rule.

There is increasing attention placed on the impact of livestock operations on odor and ambient air concentrations. Wisconsin has promulgated NR 445, Wis. Adm. Code, Control of Hazardous Pollutants. This code establishes best management practices as the method to secure compliance for emission sources involving agricultural waste. Implementation is delayed until July 31, 2011 to allow development of the BMPs to regulate and control emissions from these sources. Wisconsin is experiencing increased conflicts between livestock operations and developing rural communities related to odor and water quality issues.

A number of local governments are regulating the location and expansion of livestock operations through local zoning and issuing of conditional use permits. In 2003, Wisconsin passed the Livestock Facility Siting Law, and in 2006, promulgated ATCP 51, Wis. Adm. Code, to implement the law. The state developed an odor standard to estimate the impact of various farming practices on odor. Since this is the first attempt to set statewide standards related to odors, the effort was relatively controversial. The issue of whether livestock operations are a threat to public health and welfare will continue, especially as the livestock industry transitions to larger size operations.

PARAMETERS OF INTEREST

There are literally hundreds of volatile compounds that have been found associated with manures. Of these, quite a few are listed in NR445. Choosing which parameters to include within this study was a process which balanced the available budget with the existence of testing methods, the perceived likelihood that any particular compound might actually be present in levels approaching those listed in NR445, and the probability that the presence of the compounds is actually associated with the agricultural operation.

Based on these factors, this study focuses on ammonia and hydrogen sulfide as the compounds most likely to be present at almost all farms. Several other compounds that are likely to be present (such as benzene and formaldehyde) were rejected because of their ubiquitous occurrence in the atmosphere, and thus the difficulty of associating their presence with the operation in question. While ammonia and hydrogen sulfide have other sources, both natural and anthropogenic, their concentrations in the vicinity of farms will most likely be driven by the farm itself.

Ammonia is a by-product of the decay of urea, and is present around the urine of all animals. Hydrogen sulfide is a product of the anaerobic decay of organic materials, which in the case of animal feeding operations is the manure.

PROJECT OBJECTIVES

The CIG project will compare the pre and post installation of best management practices and the resulting impact on the measured and estimated odors and the measured ambient air concentrations. The specific project objectives are to:

- Establish and expand cooperative relationships between USDA, Wisconsin DNR, Wisconsin DATCP, UW Extension, the Wisconsin Agricultural Stewardship Initiative

(WASI), Dairy Business Association (DBA), Professional Dairy Producers of Wisconsin (PDPW), WI Farm Bureau Federation, Dairy Gateway project, and the WI Cattleman's Association;[1]

- Estimate odors produced by dairy and other livestock operations utilizing the odor standards in ATCP 51 and other methods to address odor, and to measure odors using a Nasal Ranger;
- Develop a list of best management practices and work with neighborhood citizens, local government, and livestock producers, to reduce odor, ambient air concentrations and improve water quality, within the Dairy Gateway Project and at least one other project area,
- Evaluate the impact of installing livestock related best management practices on participating livestock operations related to ambient concentrations of hydrogen sulfide and ammonia, and odor. The targeted BMPs may include manure storage covers, increased scraping of animal lots, surface-applying manure versus injection and other practices now being used nationwide.
- Evaluate the pre and post installation ambient air concentrations and odors for a manure digester (biogas).
- Prepare nutrient management plans utilizing the new phosphorus based nutrient management standard.
- Communicate the results of the project to DBA, PDPW, WI Farm Bureau, WI Cattleman's Association, and in the Dairy Gateway Project with citizens and local governments, all utilizing the WASI network.

These project objectives will significantly aid producers in furthering the implementation of best management practices to reduce ambient air concentrations, odor, and impacts on the transport of nutrients into the environment. The project will aid in furthering the understanding and adoption of best management practices to reduce the environmental impacts from dairy and other livestock operations.

There had not been a perceived need prior to the livestock siting rules in Wisconsin to address air quality issues related to agricultural operations. As livestock operations transition into larger operations where adjoining land uses are sensitive to the odors, ambient air concentrations, agricultural runoff, and other impacts on the environment; the livestock operations must utilize best management practices to offset these impacts. The project brings additional focus to the problem of manure-related odors and provides producers, regulators, neighbors and others with an evaluation of the solutions by communication of the results to the livestock producers and the public.

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[1] The following links are provided for reader's convenience: www.usda.gov; www.dnr.state.wi.us/; www.datcp.state.wi.us/; www.uwex.edu/; www.uwplatt.edu/pioneerfarm/wasi/index.html; www.widba.com/; www.pdpw.org/; www.wfbf.com/; www.dnr.state.wi.us/org/caer/cea/assistance/agriculture/dairy.htm; www.wisconsinbeef.com/

WORK PERFORMED

The Project Team:

- Developed and implemented a plan to evaluate the odor standards in ATCP 51, Wis. Adm. Code, through odor measurements and the relationship with measured ambient air concentrations on six to eight dairy/livestock farms.
- Oversaw the installation of best management practices meant to control ambient air concentrations, odors and runoff.
- Evaluated installation of a manure digester to produce methane for production of electricity.
- Evaluated post implementation impacts on ambient air concentrations, odors, and water quality.
- Communicated the results through WASI.

PROJECT DURATION

The project commenced in August 2005. Initially scheduled for completion in August 2008, the project was extended through June 2009.

Project Action Plan and Timeline

1. Initiation

   Upon signing of the CIG funding contract with USDA in summer 2005, the Project Team began selection of participating livestock producers and development of air sampling protocols. In Dairy Gateway, at the Kewaunee County participating farm, the Project Team surveyed and presented information to neighboring citizens, local governments and producers regarding BMPs and project objectives.

2. Baseline air emissions monitoring

   Beginning in October 2006 and continuing through October 2007, the Project Team conducted air emission monitoring to establish "before" levels of ambient air concentrations of key parameters of interest to the study.

3. Installation of Best Management Practices

   With the exception of the digesters, Best Management Practices described in more detail later in this report, were installed beginning in June 2007 through September 2008.

4. Post-BMP air emissions monitoring

   Beginning in May 2008 and continuing through fall of 2008 the Project Team conducted air emissions monitoring to document "after" levels of ambient air concentrations, including completion of odor score sheets and Nasal Ranger™ testing of livestock operations. Additional sampling took place the spring of 2009.

5. Project Extension (Waiver)

   In September 2008, the Project Team requested an extension to allow data collection with a project site that experienced a delay in adoption of a BMP.

6. Data Analysis and Final Report Development

   Data analysis and final report development commenced in Spring of 2008. The extension of the project also allowed for an extended internal analysis and discussion of the data and key project outcomes.

7. Outreach

   A post BMP survey was conducted in late summer 2008, and post-project BMP installation follow-up meetings with neighboring citizens, local governments and producers in the designated project areas commenced in Fall of 2008. These activities continued through early Summer of 2009.

PROJECT MANAGEMENT

PROJECT CO-DIRECTORS

Ed Odgers, Chief, Conservation Engineering Section, Wisconsin DATCP, 2811 Agriculture Drive, Madison, WI 53708-8911. Email: ed.odgers@wisconsin.gov, Phone 608-224-4630

Steve Struss, Livestock Siting Engineer, Wisconsin DATCP, 2811 Agriculture Drive, Madison, WI 53708-8911. Email: steve.struss@wisconsin.gov, phone: 608-224-4629

PROJECT COLLABORATORS

Timm Johnson, Executive Director, Wisconsin Agricultural Stewardship Initiative (WASI)
Paul Zimmerman, Wisconsin Farm Bureau Federation (WFB)
Laurie Fischer, Executive Director, Wisconsin Dairy Business Association (DBA)
Shelly Mayer, Executive Director, Wisconsin Professional Dairy Producers of Wisconsin (PDPW)
Eileen Pierce, South Central Region Air & Waste Leader, Wisconsin Department of Natural Resources (DNR)

Three organizations collaborated to sponsor the project.

- The Wisconsin Department of Agriculture, Trade and Consumer Protection had overall responsibility for managing the project with technical responsibility for developing the Odor scores assigned to DATCP's Conservation Engineering Section.
- The technical responsibility for conducting the air emission monitoring is within the purview of the Wisconsin Department of Natural Resources' Bureau of Air Management.
- The Wisconsin Agricultural Stewardship Initiative had lead responsibility for working with the producers, neighboring citizens, and the local governments who agreed to collaborate on the project, and served as the liaison between the groups and the other project sponsors.

The final report represents a team effort between DATCP, DNR, and WASI. Also, WASI representatives made arrangements for printing outreach and educational outputs, evaluating the success of the project and making sure that the results are transferred to producers and the public.

PROJECT TEAM BIOS

Initiated by (Co-Director) Ed Odgers, Chief of the Conservation Engineering Section of the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP), Steve Struss (Co-Director) provided direct management of the project.

Steve Struss obtained a B.S. in Civil (Environmental) Engineering from the University of Illinois in 1975. He spent the next eight years as an Environmental Researcher in air and water pollution control with the Army Corps of Engineers, and as a Project Engineer for an engineering consulting firm designing wastewater treatment plants. He moved to Wisconsin in 1983 where he became a registered professional engineer and worked as a Design Engineer and Project Manager for a mechanical contractor, a Staff Engineer for an accident reconstruction firm, and a Sole Proprietor of his own wastewater treatment business. In 1991 he began working as an Agricultural Engineer for the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). For 16 years he worked in the areas of erosion control and animal waste management. He has served on a number of statewide technical committees, and was instrumental in developing the odor standard and the livestock facility siting rule (ATCP 51). He is currently the state's Livestock Facility Siting Engineer.

Eileen Pierce is the DNR South Central Region Air & Waste Leader in Fitchburg, Wisconsin. At the inception of the project, she served as the Air Monitoring Section Chief in Madison, Wisconsin. Ms. Pierce has a Bachelor's Degree in Chemical Engineering from the University of Notre Dame. She has worked for the DNR for over 20 years.

David Grande was the DNR lead worker on the project. Mr. Grande has a Bachelor's Degree in Chemistry from the University of Nebraska at Lincoln. He has worked in the air monitoring field for most of the past 24 years, including more than 14 years in his current position as a Toxic Air Monitoring Chemist. Notable projects include ammonia monitoring around a wastewater solids composting facility in western Wisconsin, and PCB monitoring during sediment remediation on the Fox River.

Timm Johnson, is the Executive Director of the Wisconsin Agriculture Stewardship Initiative (WASI). Mr. Johnson has a Bachelor's Degree in Dairy Science from UW Madison. He owned and operated his own dairy farm and was a partner in a dairy farm with a total of 25+ years experience prior to becoming the executive director of WASI in 2002. Mr. Johnson also serves as the Dairy Ombudsman for DATCP Secretary Rod Nilsestuen.

PROJECT STEERING COMMITTEE

Department of Agriculture, Trade and Consumer Protection Secretary Rod Nilsestuen appointed a CIG project steering team in October 2005. The steering committee met six times and provided recommendations related to the types of control technologies and livestock operations to evaluate and helped the project sponsors to evaluate the applications received to participate in the project. In addition, a technical team was assembled to provide guidance on technical issues related to the project.

The members of the Steering Committee and Technical Team are listed below.

Project Steering Committee

Kathy Pielsticker	Administrator, Ag. Resource Mgmt. Division, DATCP
Paul Zimmerman	WI Farm Bureau Federation
Laurie Fischer	Dairy Business Association
Al Koepke	Professional Dairy Producers of Wisconsin
Al Shea	Administrator, Air and Waste Division, DNR
Eileen Pierce	DNR South Central Region Air & Waste Leader, DNR
Timm Johnson	Wisconsin Ag. Stewardship Initiative
Duane Ford	Dean, Business, Industry, Life Sciences & Ag., UW Platteville
Tom Hunt	UW Platteville Pioneer Farm
Rick Klemme	Associate Dean, UW Extension, UW Madison
Dennis Frame	UW Discovery Farm
Jordan Lamb	Wisconsin Pork Producers and WI Cattlemen's Association
Andrew Hanson	Midwest Environmental Advocates
Ed Odgers	Chief, Conservation Engineering Section, DATCP
Keith Foye	Chief, Land Management Section, DATCP
Tom Krapf	NRCS - Madison

Project Technical Advisory Team *

Ed Odgers	Chief, Conservation Engineering Section, DATCP
Bob Wilson	Agricultural Engineer, DATCP, Appleton
Eileen Pierce	DNR South Central Region Air & Waste Leader, DNR
Steve Struss	Livestock Siting Engineer, DATCP
Vid Grande	Air Monitoring Chemist, DNR
Timm Johnson	WASI
Tom Hunt	UW Platteville Pioneer Farm
Fred Madison	UW Discovery Farm
Brian Holmes	UW Biosystems Engineering and UW Extension
Mark Powell	USDA – Agricultural Research Service and UW Soils
Pat Murphy	USDA Natural Resource Conservation Service

KEY PROJECT COSTS

TOTAL PROJECT COST AND TOTAL PROJECT FUNDS REQUESTED

The project was projected to cost a total of $1,386,545. The project sponsors requested $646,945 from the Conservation Innovation Grant Program.

COSTS – COOPERATOR BMP SOLUTIONS

Potential project participants were offered an incentive payment to offset some of the capital and operational costs related to adoption and evaluation of technologies. Six farms agreed to participate in the study. Two of these farms were chosen to provide “background,” or control data, which, in theory, would provide a control reference for farms that elected to install one of the technologies under evaluation. Where appropriate, project participants were also offered an incentive to invest in a Nutrient Management Plan or a Comprehensive Nutrient Management Plan. Table A below provides a summary of the cost to the project for planning, control and incentive payments to producer participants in the project.

Case Study ID	Type of Project	County Location	Incentive Payment ($)	Control Technology Cost ($)	NM Plan or CNMP Cost ($)	Total Cost ($)*
1	**Manure Digester**	Waupaca	5,000	NA	4,350	9,350
2	**Manure Digester Impermeable Manure Storage Cover**	Dunn	NA	294,287	11,438	305,725
3	**Permeable Manure Storage Cover**	Kewaunee	NA	196,195	4,400	200,595
4	**Manure Solids Separation and Storage Aeration**	Monroe	NA	140,668	704	141,372
5	**Background for Animal Lot**	Clark	5,000	NA	NA	5,000
6	**Background for Manure Storage**	Manitowoc	5,000	NA	7,500	12,500

* The participating farms were paid 75% of the total cost of the control technologies and the nutrient management plan or comprehensive nutrient management plan.

Table A

Summary – Planning, Control and Incentive Payments to Producers Participating in the Conservation Innovation Grant (CIG) Wisconsin’s Dairy Air Emission Odor Project

DATA GATHERING, ANALYSIS, ADMIN AND REPORTING COSTS

CONSERVATION INNOVATION GRANT (CIG)
BMP INSTALLATION, DATA GATHERING, ANALYSIS, ADMINISTRATIVE AND REPORTING COSTS*

CIG Activity	CIG Funds Requested	Funds from CIG Partners	Source of the Partner Funds	Total Project Funds
Installation and Operation of BMPs	$ 8,263 (W) 137,696 (K) 5,000 (C) 10,625 (Ma) 229,294 (D) 100,528 (Mo) $ 491,406 Total	$ 1,087 (W) 62,899 (K) 0 (C) 1,875 (Ma) 76,431 (D) 40,844 (Mo) $ 183,136 Total Grand Total = $821,765	Producers Cash For Digester Operation $ 629,129 Producers Cash For Other BMPs $ 183,136 Producers In-kind For Digester Operations $ 9,500 Producer In-kind For Other Practices $ 0 Total Cash From Producers $ 812,265 Total In-kind From Producers $ 9,500 Total Producer Funds $ 821,765	$1,313,171
Air Sampling/Odor Evaluation and Sampling/ Technical Assistance Cost of Sampling-Equipment Š staff	$20,123	$213,300	Total WI Cash $ 56,601 Total WI In-kind $ 156,699 Total WI Funds $ 213,300	$233,423
Outreach Materials & Printing Š WASI	$10,000	$0		10,000
WASI - Staff Costs	$15,000	$0		$15,000
Subtotal	$536,529	$1,035,065		$1,571,594
DATCP Indirect Costs	$91,200	$0		$91,200
Total	$627,729	$1,035,065		$1,662,794

* Original NRCS Grant Agreement amount was $646,945.
(C) = Clark County site (D) = Dunn County site (K) = Kewaunee County site
(MA) = Manitowoc County site (Mo) = Monroe County site (W) = Waupaca County site

Table B
Project Cost Overview

METHODS

STUDY DESIGN AND LIMITATIONS

The determination of emissions from a pollution source requires collection of both contaminant concentrations, and the air flow of the exhaust they are associated with. At a traditional industrial source, the contaminants are most often associated with discrete vents from which both of these parameters may readily be measured. In addition, industrial operations typically operate at near steady state, so that measurements made at any time during typical conditions are widely applicable.

Agricultural operations present formidable difficulties in determining actual emissions associated with them. Most of the emissions from these operations are from multiple large complex area sources (barns, lagoons, feed stocks, etc). Emissions are highly influenced by local conditions (manure surface crust, wind speed and direction, humidity, solar radiation, and temperature, to name a few). As they are not constrained to discrete vents or stacks, and do not have specific air flows associated with them, measuring them is a difficult and time-consuming prospect.

There are several studies underway on a national level, which are attempting to measure emissions from large farming operations. One of these, conducted under the auspices of the EPA, is attempting to measure emissions from barns, using a variety of real time instrumentation over the course of a 2-year study period. Concentrations for a number of parameters as well as air flow measurements made at representative fans are to be used to estimate the emissions. It is anticipated that this study will help refine emission factors used to estimate emissions.

A second study, sponsored by the USDA, is attempting to measure whole farm emissions by using laser technology across transects downwind of the farm and extrapolating emissions from a combination of observed concentrations and meteorological information. In addition to requiring the use of specialized and delicate equipment, this type of test of extremely sensitive to ambient conditions, such that a sampling event covering 10 days may result in 4 or 5 days worth of usable data.

Rather than attempting to emulate these better supported studies and trying to determine actual emissions associated with the farms in this study, the DNR has adopted a simpler and more limited approach. Our goal is to measure concentrations around the waste handling facilities in an effort to determine whether there are observable differences between the different farms that can be attributed to the waste management practices.

To meet this goal, a relatively large number of samplers are deployed around the lagoons at each farm, and two sets of samples collected (one during the day, and one overnight). While up to a hundred samples may be collected during each sampling event, this does not necessarily represent a statistically significant sample set, as each sampler measures concentrations in a limited area, and the samplers are deployed around lagoons, which are frequently several acres in extent.

In addition to the ambient sampling, a limited number of samples are collected directly above the manure surface using a flux chamber flushed with a stream of clean air. These samples are being collected to more directly compare the emission potential of different manures. It should be noted that the flux chamber being used is approximately 1 foot in diameter, and thus is not representative of the entire surface of a several acre waste lagoon.

Another limitation of our study design is that we are constrained to relatively few visits to each farm (3 – 6 over the course of a year and a half). Given the wide variability that can be expected to occur naturally at each farm during the course of a year, these trips do not guarantee representative measurements. For ambient measurements, EPA typically requires a sampling frequency of once every six or twelve days to ensure representativeness (60 or 30 sampling events per year).

In addition to the design limitations discussed above, several other factors affect the utility of our data. Scheduling conflicts preclude the ability to readily re-schedule sampling trips to avoid less than ideal sampling days. Because of this, several of our trips have been affected by rain, which not only changes the ambient concentrations of the chemicals of interest, but which also reduces our ability to obtain valid usable samples.

Finally, the length of each sampling period (6 – 14 hours) stretches our equipment to the limit, and leads to the potential for sampling losses related to power failures. While we have made significant progress in overcoming both of these difficulties, by providing weather shelters for the samplers and equipping them with timers, we have still not achieved 100% sampling success on any of our trips. As such, our already design limited sampling protocol has suffered from the loss of additional samples.

Because of these limitations, our data should not be used to represent typical ambient conditions, nor should our results be used to extrapolate annual average concentrations for the purposes of comparison to NR445. Our data does not yield emission factors, or overall emissions from the lagoons at the farms studied.

As a final note, except in a very few specialized situations, barn associated measurements are not being made. The primary reason for this is that the management practices being compared relate to the handling of the waste after it leaves the barn, so our measurements concentrate on the waste handling end. As such, our data do not attempt to measure the total air impact of these large agricultural operations.

In spite of these difficulties, our data set is unique in its size and scope. It does provide a means to compare pre- and post- installation concentrations of ammonia and hydrogen sulfide on and around manure storage lagoons. As long as care is taken with applying the data, some comparisons are possible between the different operations sampled.

FARM SELECTION PROCESS

DATCP appointed a steering committee to work with staff to develop criteria for selecting livestock operations for participating in the study. The original application of the funding included specific mention of studying the impact on air emissions and odor from at least one anaerobic manure digester, various methods of manure application or injection, and other appropriate control technologies. The steering committee recommended, and the department agreed, to give priority to evaluating the following types of control technologies: anaerobic digestion, covered manure storage, reduced solids in manure storage, animal lot design and management, and freestall alley scraping. The evaluation of various types of manure applications was not included in the recommended project because the final version of ATCP 51, Wis. Adm. Code, the livestock siting rule did not include evaluation of manure spreading relative to odors and siting of livestock operations.

The department published an application for the CIG project funds on March 9, 2006, with applications due back by March 29, 2006. WASI received 15 applications, including one from a “community project” in Richland County from several landowners. The CIG Technical Committee reviewed the applications and actually visited the sites. An application was returned representing each of the categories included in the request for proposals. The technical committee gave a passing score and recommended 7 projects to the CIG Steering Committee. The CIG Steering Committee provided a ranked order recommendation to further review nine of the applications. The review would include a better estimate of the cost of the project and ability to complete the project in the allowed timeframe.

The department ultimately selected six projects for the study, including evaluations of existing manure digesters in Dunn and Waupaca Counties, solids separation and aeration of a manure storage pond in Monroe County, animal lot improvements in Clark County, a manure storage cover in Kewaunee County, and to collect background information to compare with the farms with digesters in Manitowoc County. As the project unfolded, a decision was made by the producer in Clark County not to implement animal lot improvements, and the Dunn County producer with the existing digester decided to place an impermeable cover on the operations manure storage pond. The cover was included in the original application.

The department completed contracts with all six livestock operations for the project.

PRE- AND POST-PROJECT SURVEY METHODS

As part of the study, we tried to gauge neighbor’s perceptions dealing with air quality and odors from a dairy operation in the study group. A survey form was created using basic questions that would show actual impact on outdoor activities as well as perceived nuisances that may be a result of bias towards larger dairy operations. Neighbors were identified within approximately 1.5 miles of the operation in all directions, and each residence received the questionnaire. The survey form used is included in the attachments, with the results from both the pre installation of the lagoon covers and after the installation of the covers. There is a time lag between the two surveys of nine (9) months, and the post installation survey results reflect the experience of neighbors in warmer seasons with outdoor family activities.

LABORATORY SELECTION

Discrete air samples collected for chemical analysis were submitted to the Wisconsin Occupational Health division of the State Laboratory of Hygiene located in Madison, Wisconsin. This lab is fully accredited by the American Industrial Hygiene Association for all aspects of industrial hygiene analysis, and has a long term working relationship with the DNR. In addition to providing sampling materials and analytical services, they provided the pumps used for air sampling. Air samples taken for laboratory odor analysis were submitted to the University of Minnesota, Department of Bioproducts and Biosystems Engineering, St. Paul, Minnesota. Manure samples were analyzed by AgSource Soil & Forage Laboratory, a state certified lab with headquarters in Bonduel, Wisconsin.

TECHNOLOGY SELECTION CRITERIA AND RATIONALE

There are not specifically defined methods required for the sampling performed in the course of this study, and as such there is considerable latitude in the choices of equipment. In general, sampling equipment employed has been chosen because of its ready availability (previously owned equipment or borrowed from other institutions) and applicability to the sampling employed.

FIELD EQUIPMENT

Flux Chamber

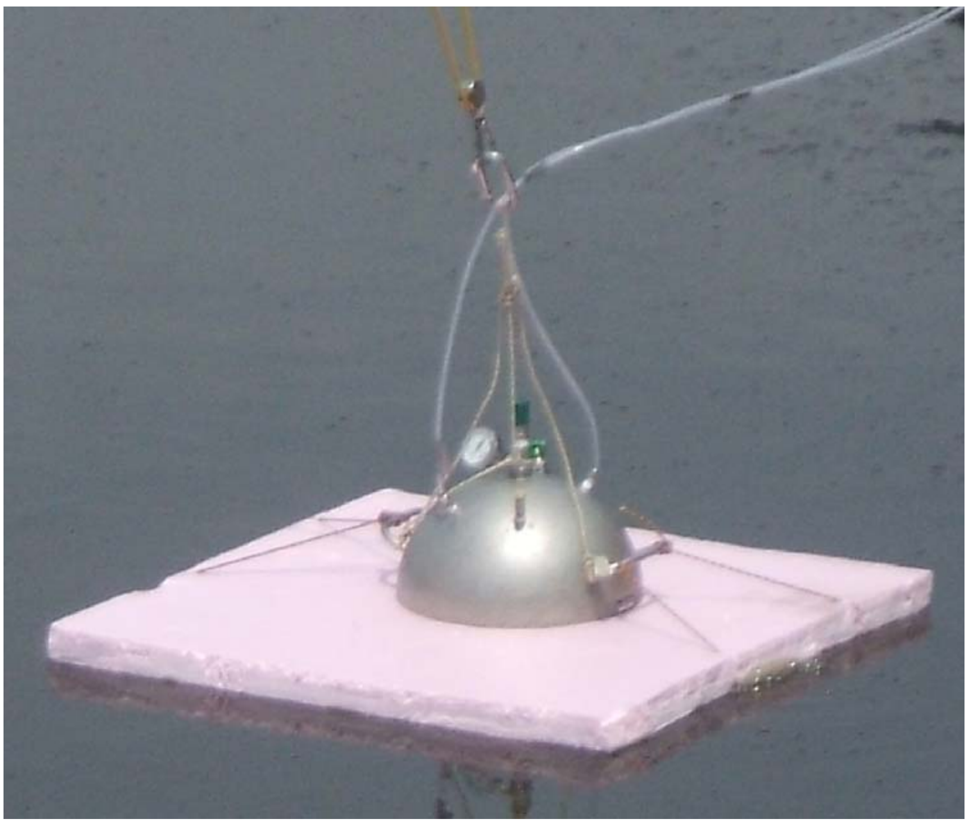

Figure A
Flux Chamber

The flux chamber is a device intended to obtain samples of gases generated by a surface. The particular chamber employed by the DNR is a stainless steel dome about a foot in diameter, with fittings to attach sweep air and a sampling line. Clean air is introduced to the chamber through the sweep air port, and samples collected off the sampling line. The equipment was designed for use with solid surfaces loose enough to dig the rim into. A draw back of this system with a liquid surface is that not all of the air introduced through the sweep air line is returned through the sampling line; there are significant losses through leaking out the bottom of the chamber and possibly aerating the surface of the manure.

Jerome Hydrogen Sulfide Meter

Figure B
Jerome Hydrogen Sulfide Meter

Real time measurements of hydrogen sulfide are made using a Jerome Hydrogen Sulfide meter. This portable instrument provides near instantaneous measurements of the gas, and is used in surveys around the property that are intended to help locate high concentration locations for samplers and to provide some information which can be used to help validate the time weighted average samples. The principle of operation involves measuring electrical potential across a gold foil, which changes as the quantity of hydrogen sulfide that it encounters changes. Display indicates hydrogen sulfide concentration in ppm, with a range from 0.001 – 50 ppm.

Nasal Ranger™

Figure C
Using a Nasal Ranger™ and GPS Unit to Take an Odor Measurement in the Field

The Nasal Ranger™ is a field olfactometer developed by St. Croix Sensory of Lake Elmo, Minnesota. An olfactometer is a device used to quantify ambient odors using the human olfactory (nose and sinuses) as the detector. Figure C shows a Nasal Ranger™ in use in the field. It functions by filtering ambient air through activated carbon filters to provide a "zero-odor" baseline and clearing the operator's sinuses. Once initialized, the operator then introduces incremental amounts of unfiltered air by rotating a dial with calibrated openings. As the opening sizes increase, a greater percentage of unfiltered air is blended with the filtered air stream. The point at which the odor is first detected is then a direct function of the odor's intensity. The openings are sized to provide dilution ratios of 60:1, 30:1, 15:1, 7:1, 4:1, and 2:1. The units of measurement are expressed as "Dilution-to-Threshold" (D/T). Logically, a strong odor is detectable even in very dilute form and will register a high D/T. Likewise, a weak odor will not be detectable until it is in a more concentrated form and will register a low D/T. The Nasal Ranger™ is also equipped with an electronic flow meter to assure that all operators are "sniffing" in a consistent manner.

The science of measuring odors is complex. For example, odors from agricultural operations result from a combination of over 200 individual compounds. Everything from ammonia and hydrogen sulfide to butyric acid and methyl mercaptan contribute to the overall tone and intensity of "country air". To empirically classify any given odor would require an accurate measurement of all 200 plus compounds simultaneously – a monumental task. Fortunately (or at times unfortunately) the human olfactory can detect upwards of 10,000 different compounds, and all their synergistic interactions. By taking advantage of this amazing detector, and calibrating it, the Nasal Ranger™ provides as accurate a means of quantifying odors in the field as is currently practicable. According to product literature, when used by trained staff the Nasal Ranger™ provides results with +/- 10% accuracy and +/- 2% repeatability.

For the above reasons, the Nasal Ranger™ was chosen to take field odor measurements for this study. Because our primary interest was in collecting before-and-after data sets, we needed a device that could provide us with valid comparative results. To further assure this validity we used the same operator for the before and after sampling on any given farm. All the operators were trained and certified in the proper use of the Nasal Ranger™. Each operator was also tested for odor sensitivity periodically throughout the study. A sample odor sensitivity test data sheet is provided in Appendix B.

Solar Powered Meteorological Station

Meteorological information is collected using a portable solar powered met station on loan from the University of Minnesota. The met sensors are mounted on a 6 – 8 foot tripod, which is set up at a prominent point around the lagoons upon arrival at the site. Parameters include wind speed and direction, ambient temperature, relative humidity and solar radiation. Data is recorded on a fifteen-minute average basis.

Figure D
Solar Powered Meteorological Station

Weather Shelters, Timers and other

The sampling pumps employed in this study are intended for industrial hygiene sampling, the majority of which occurs indoors and is attended throughout. As such, they came without provisions for protection from weather or power outages. During the first few sampling trips for this study, it became apparent that protection from weather and a means for measuring how long samplers ran before the batteries expired would be needed. For the majority of the project, samplers had been equipped with run-time meters and housed in plastic weather shelters constructed for this purpose. Most often a single shelter contained a pump with a splitter, allowing the collection of both a hydrogen sulfide and an ammonia sample.

Figure E
Sampling Equipment Weather Shelter

SAMPLING METHODS & TESTING PROTOCOLS

FIELD METHODS

Hydrogen sulfide and ammonia samples are collected using modified Occupational Safety and Health Organization (OSHA) methods. The basic methods involve sampling air by drawing it at a measured rate through adsorbent tubes, which are then submitted to the Wisconsin Occupational Health Laboratory in Madison for analysis. Most samples are collected at a flow rate of about 0.5 liters per minute, for between 6 and 14 hours. As such, they represent time weighted average concentrations at each of the sampler locations.

Hydrogen sulfide is collected on charcoal tubes, desorbed using peroxide, which oxidizes the sulfide to sulfate, and then measured using ion chromatography. The adsorption onto the charcoal is a physical process, and can be reversed under adverse conditions. These conditions can potentially include high humidity and heat.

Ammonia is collected onto carbon beads, which have been treated with sulfuric acid. The ammonia reacts with the sulfuric acid to form a chemical bond on the tube, which is then reversed in the lab. The resulting solution is then measured using ion chromatography. The chemical nature of the absorption makes these samples more stable to external conditions than the hydrogen sulfide samples.

LABORATORY METHODS

Manure samples were collected and shipped for analysis by AgSource Cooperative Services.[2]

SAMPLE CHAIN OF CUSTODY

Sample records are maintained on a chain of custody form, which documents all pertinent field data necessary, to determine sample validity and calculate air volume sampled. Following sample collection, all samples are sealed with end caps, placed in a sealed plastic bag with all other samples of the same type, and stored in a cooler until submission to the laboratory. Samples are usually submitted within 24 hours of collection.

ODOR STUDY METHODS

The approach taken to evaluate odors downwind of each of the practices studied was to stand adjacent to the practice and set a waypoint on a hand-held GPS unit. Then using that point as a reference, the tester walked downwind from the practice a distance of 1,000 feet. Another waypoint was set and the tester took the first of six Nasal Ranger™ odor readings, after first "zeroing" his olfactory by breathing 100% filtered air for two minutes. The tester then proceeded back toward the practice setting additional waypoints and taking additional readings every 200 feet, the last of which was back at the downwind edge of the practice. If the wind shifted during a sample run, the tester would move laterally until he was back within the odor plume. Weather permitting, four separate runs were made on each visit to a farm, representing early AM, AM, PM, and late PM time frames. This was done in an attempt to learn how changes in weather conditions throughout the day affect odor transport and dissipation.

The Nasal Ranger™ odor readings ranged from a low of 2 to a high of 60 in the following sequence: 2, 4, 7, 15, 30, and 60. Each reading represents an approximate doubling in odor intensity from the reading before it, creating a logarithmic scale. If no odors were detected, a reading of <2 was recorded. And at times the odors may have been so intense that they would have exceeded 60, however that was the highest reading available on the Nasal Ranger™ units being used in this study. A notation was made if odors other than manure were detected, such as feed, freestall, cut hay, etc. No attempt was made to characterize the manure odors, as this would have increased the subjectivity of the data. If lagoon odors were detected they were simply noted as such, along with the Nasal Ranger™ reading at that location.

To aid in the analysis of the odor data, as well as to better display the data for this report, aerial photos of the farms were used with the GPS odor sampling waypoints and the associated odor

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[2] Upon Request, AgSource will provide a copy of their laboratory methods reference document, Recommended methods of manure analysis A3769.pdf. Contact AgSource at: http://agsource.crinet.com/

readings superimposed on them using ArcMap software. The four odor runs were depicted using four different colors, and the size of each color dot was scaled relative to the odor reading at that location (see the Project Data Supplement for Nasal Ranger^{TM} data display graphics). This provided us with a "snapshot" of the odor conditions on each farm during each visit. By comparing the before and after figures for each practice, a fairly clear picture emerged of the overall effect that the practice had on odor.

In addition to the visual representation of the odor readings, some numerical analyses were conducted as well. For this, the odor readings for each distance from a practice were averaged across all runs, both prior to a practice being installed, and after. By comparing these averaged values, an estimate of the percent change in odor levels was determined. These numerical results were then depicted on graphs to help illustrate the changes in odor levels each practice provided. It must be cautioned that the data collected for this study was very limited, and as such should be used with caution. The results may not be typical when extrapolated to other farms.

In an effort to characterize odor emission rates, as well as to verify our Nasal Ranger^{TM} findings, a flux chamber was used to sample the gasses being released by a one square foot area of the lagoon surface (see the Field Equipment section of this report for details on the flux chamber). The samples thus collected were sealed in Tedlar bags and shipped overnight to a lab at the University of Minnesota. The next morning a panel of trained experts would rate the odor intensity of each sample using a laboratory olfactometer per CEN Standard 13725.2003. This provided a more controlled procedure than what was possible using a field olfactometer. The findings from these flux chamber samples are described in each of the case studies below.

The final piece of odor-related information, which was gathered during each trip, was to collect manure samples from each farm. These were taken from the lagoons being studied, and occasionally from manure reception pits as well. These samples were packed on ice and shipped overnight to a lab for testing. The lab ran a standardized set of manure analysis on each sample, including solids content, pH, nutrient levels, COD, and volatile fatty acids. These data were collected in an attempt to identify which characteristics of manure contribute most to its rate of odor generation, as well as to see how the installed practices may affect the manure make-up. The result of this testing is described in the case studies below, whenever relevant.

DATA ANALYTICAL METHODS

DATA PRESENTATION

Meaningful representation of the data collected during this project proved to be challenging. Not only are the numeric concentration results important, but the spatial distribution of the samples and the wind conditions as well. Intercomparison between the different sampling episodes is essential. All of these elements are combined into a visual form using ArcMap to plot the sample points, with the results presented both as bar graphs associated with the points and as numeric values in a table.

Incorporating the wind rose directly into the figure enhances further data interpretation. A wind rose indicates the wind speed and direction during the sampling period. The color of the wind rose bars indicates the speed of the wind, while the direction the bars point towards indicate the direction from where the wind was blowing. The length of the bar is measured against circular lines labeled with percentage values, which indicate what percentage of the time winds were blowing from that direction.

Note that sample location numbers are compiled from all sampling runs. Prevailing winds at the time of setup and number of functioning pumps, as well as other factors may affect the placement of sampling locations, so that not all locations are used in any single run. Many of them are used only in a single run.

Almost all bar graphs are scaled to the same values, so that sampling runs can be directly compared with each other visually. The single exception to this are the results obtained around the Manitowoc County Sand Channel (Case Study 6.1), which were significantly higher than those observed elsewhere.

DATA COMPARISONS

Direct quantitative comparisons between the different farms are not really possible with our data. This is in part because of the relatively few trips made to each farm throughout the project (we do not know whether or not we sampled during "typical" conditions at any particular facility). In addition, our data generally shows variations between trips to the same farm that are as great as the variations we observe between farms, thereby raising the question of whether the differences we see are actually the result of different management practices, or part of the natural variability associated with large area pollutant sources. We did not collect a statistically significant quantity of data from any single farm, much less from the whole spectrum of farms included in the project.

There is a natural tendency to want to compare results from the different farms, however. A couple of methods have been employed to attempt comparison. The first of these is through the manure surface sampling. Under ideal circumstances, this sampling is theoretically representative of concentrations at the manure/air interface. It should be noted, however, that there are significant physical challenges to obtaining valid samples using these techniques. For example, sweep air could frequently be seen bubbling out of from underneath the flux chamber, raising the question of whether or not the air being sampled was truly representative of the air at the surface.

In spite of these difficulties, the assumption that our manure surface samples are generally comparable has been made with the idea that the various challenges for collecting the samples would be comparable between the different sites. As such, charts and tables comparing the surface sample results from the different farms have been included in the Discussion and Lessons Learned section following the case studies.

Comparisons between the ambient samples collected around the manure lagoons and sand channels are somewhat more difficult to accomplish. Given the approach to sampling we adopted, a percentage of samples at any site are going to contain non-detectable quantities of ammonia and hydrogen sulfide. How many of the samples deployed yield non-detects is going to vary not only on the emissions of the facility being tested, but on the basis of wind direction and speed as well as a host of other factors not well understood.

Likewise, the magnitude of any detected quantities of these compounds is going to be dependent on a variety of factors beyond the variables we are attempting to test for (i.e., the management practices). The relative paucity of data we collected essentially ensures that we will observe as great or greater variability between visits to a single farm than we do between farms, thus greatly complicating interpretation and comparison of our data.

However, comparison of data between sampling visits and farms is desirable, even with these caveats, and as such an approach has been adopted wherein concentrations observed on the downwind side of the lagoons are compiled for comparison between runs. In general, the highest three concentrations observed are used for the comparison purposes.

These values are reported in tables and figures, with the maximum, minimum and average values shown for each individual run, for the overall data set, and for all daytime and all nighttime samples. Intra-farm comparisons between runs and before and after installation of practices are included with the case studies, while inter-farm comparisons are included with the Discussion and Lessons Learned section following the case studies.

DISCRETE SAMPLE DATA MANAGEMENT AND BASIC CALCULATIONS

All field samples collected for ammonia and hydrogen sulfide require a number of parameters to be recorded. These include a unique identifying sample number, start and stop times, start and stop flow rates, and location for field data, and the amount of analyte collected and whether or not this amount represents a detect for the lab data.

All data collected for these samples is maintained in an Access database, set up with a number of built in calculations to facilitate data analysis. The basic concentration observed is calculated using the following equations:

Elapsed Time (in minutes) = (Stop Time) – (Start Time) OR
(Elapsed Timer End) – (Elapsed Timer Start)

Note: Clock start and stop times are preferred. Elapsed timer values are used in cases where the batteries died during the run and no observed stop time was recorded.

Average Sampling Rate (in Liters/Minute) = ((Start Rate) + (Stop Rate)) / 2

Sample Volume (in m^3) = ((Elapsed time) X (Average Sampling Rate)) / 1,000

Note: The factor of 1,000 is to convert liters to cubic meters (m^3).

Concentration ($\mu g/m^3$) = (Lab Result) / (Sample Volume)

Note: Lab Result is the reported lab value in μg/sample.

The resulting concentration values are used in further evaluation by incorporating them into site maps showing bar graphs representing the results obtained at each location. These representations generate a visual aid to interpreting the results.

TREATMENT OF LOD AND LOQ SAMPLES

A common misperception about analytical results such as are reported here is that a number reported as a result represents reality in the way that one can count ten apples in a basket and say there are ten apples. Trace analysis doesn't really work this way. Results reported represent the most probable value obtained at a particular time and place, given the constraints of the methods used to collect the values. Each phase of the sampling and analysis provide potential sources of error to the overall determination.

Many samples, however, can be treated in the short hand as if the chemical of interest was counted like the apples. This is because limits of error associated with the analysis are established and within the acceptable parameters defined by the standard methods in use, and because it is simpler to consider the results at face value.

There are two important statistically determined values called the Limit of Detection (LOD) and the Limit of Quantitation (LOQ). The LOD is the lowest amount of the compound of interest that can be clearly distinguished from the analytical background. A non-detect means the observed concentration was less than the statistically determined LOD, not that there was none of the compound of interest present.

The LOQ is the lowest amount of analyte that can be definitely quantified, and is conventionally set at three times the LOD. Results between the LOD and LOQ are technically considered estimates, with less assurance that the values are “correct” as reported than for results above the LOQ. In a sense, any result obtained in this range could actually be any concentration within the range, with approximately equal probability.

Ideally, all results obtained from a test of this nature would be above the LOQ, thereby removing any difficulty arising from evaluating values with less confidence. However, samples with either non-detectable or barely detectable results are obtained, and evaluation of these results is necessary.

The problem of incorporating non-detects into a numerical data set is one with several answers. One approach is to simply disregard non-detected values entirely. This approach has the advantage of averaging only clearly determined values. The problem with this method is that the information provided by the presence of non-detect samples is lost, and resulting averages generated may be artificially high.

Pretending that the non-detects represent samples where there was none of the analyte present, and setting the value of such samples at zero is another option, but this approach doesn’t necessarily reflect reality very well either. The most that can be said about non-detects is that ambient concentrations are less than the detection limit. This particular study has generated a relatively large number of non-detects, in part because samplers have been deployed on both the upwind and downwind sides of the lagoons, both in an effort to determine how much of each compound has been added to the atmosphere by passing over the lagoon, and to compensate for potential changes in wind direction during the sampling period.

Because we are not interested in averaging all samples together to determine an overall average concentration, but rather are interested in the amount added by passage across the lagoons, non-detects are incorporated into the dataset as if they were zero, to provide a maximum added value when evaluating the data. The rate of detection (number of detects / number of samples) provides an additional, qualitative method with which to compare the different operations.

Similarly, there are different approaches to rationally incorporating results obtained between the LOD and LOQ. For simplicity’s sake, these values are treated in the same way as values above the LOQ, in other words, as if they represent the most probable concentration during the sampling period. The variable rate of samples exceeding the LOQ at the different sites provides an additional tool for comparing results.

DATA QUALITY ANALYSIS, BLANK SAMPLES

The collection of blank and duplicate samples for quality control purposes was an integral portion of the project. Blanks are samples prepared as though they were ambient samples, except that they are packaged without sampling. They provide a measure of potential contamination encountered by the sampling media during the setup process, and thus are an indicator of potential problems. If material is detected in the blank, the laboratory will usually use the field blank value to correct the ambient samples associated with it.

The table below summarizes all blanks submitted during this project. In general, two blanks for each parameter were submitted for each sampling trip. The preferred result for a blank is a non-detect. This table shows the number of blanks collected (approximately 5% of all samples), how many of the blanks had detectable quantities of material on them and what percentage of the total that represents. The maximum detected value in micrograms is shown, and for hydrogen sulfide, the average of all detected quantities, the number of results greater than 10 μg, and the average excluding the maximum value.

Note that the maximum value returned for hydrogen sulfide was associated with an alternate sampling media supplier, which was used for only a few samples, and is therefore not indicative of general sampling. That a significant percentage of the H_2S blanks returned detectable results is not particularly surprising, because the charcoal used as an absorbent contains a small amount of sulfur naturally. When the maximum value is excluded, the average blank value is less than two times the detectable limit (4.0 μg), which is reasonable for this method.

The ammonia sampling tubes were generally clean, with the single detect only slightly above the detection limit of 7 μg.

	Total Blanks	Detects	% Detect	Max (μg)	Avg (det)	>10	Avg (det, - max)
H2S	54	20	37.0%	69	9.6	1	6.5
NH3	54	1	1.9%	8.3			

Table C
Blank Sample Results

DATA QUALITY ANALYSIS, DUPLICATE SAMPLES

Duplicate sampling is collecting two samples for the same parameter side by side for the purpose of comparing the results to determine an overall sampling precision. Not all duplicate collection efforts are successful; one or both of the pumps for the samples may fail during sampling, or some other mishap may affect the process. Because of this, not all sampling runs have a successful duplicate sampling pair associated with them.

The pertinent quality parameter is the relative percent difference (RPD), which is the difference between the samples divided by the average of the results expressed as a percent. Ideally, this type of sampling should generate RPDs of less than 30%.

RPD can only be calculated if both samples have detectable results. In cases where one or both samples return non-detects, the duplicates are considered to either qualitative agree or disagree. Duplicate samples showing qualitative agreement are considered to have passed, but they are not included in the RPD calculation.

Results for successfully sampled duplicates are shown in the table below. The table shows the number of duplicate pairs analyzed, how many are in Qualitative Agreement (QA) or Disagreement (QD); how many pass or fail the numeric criteria (RPD < 30%), and then what the average, maximum and minimum RPDs are far each parameter. In addition, the percentage of duplicate pairs that are in each category (QA, QD, Pass or Fail) is shown.

This analysis shows that when our duplicate sampling efforts were successful in the field (both samples submitted to the laboratory), the sample pairs passed quality assurance criteria 82% of the time for H_2S (QA plus Pass) and 75% of the time for NH_3. The overall RPDs of 25.0% and 28.2%, respectively, are within sampling criteria as well.

While a zero fail rate for these efforts would be preferable, these results are not entirely unexpected given the difficult nature of the sampling conditions. Specific tests wherein individual duplicate sampling pairs were outside of quality limits are noted during discussion of their results.

	Pairs	QA	QD	Pass	Fail	RPD	Max RPD	Min RPD
H2S	48	18	2	21	8	25.1%	144.3%	0.0%
		39%	4%	43%	15%			
NH3	54	3	4	37	10	28.2%	180.5%	2.0%
		6%	6%	69%	19%			

Table D
Duplicate Sample Results

METEOROLOGICAL DATA MANAGEMENT

All meteorological parameters are collected on a data logger and downloaded to the central project database. The wind data is used to help decipher sampling results by enabling a determination of whether a particular sampling location was upwind or downwind of the different potential sources. Rather than averaging all wind data to generate a vector mean average wind speed and direction, each individual 15 minute average set of values is used to generate a wind rose using a freeware program developed by Lakes Environmental, known as WRPlot.

Each individual sample run has a unique wind rose containing all 15-minute data points from the inception of sampling to the collection of the final sampler. The wind roses generated from this data are included on the site map results representations to improve the effectiveness of the display.

RESULTS

The Project Team proved successful at enlisting the participation of six farms in the study. While each of the case study farms is unique, and each of the six cases is focused on odors emanating from a manure lagoon, two of these farms also used sand channels as part of their manure management system. Field data measurement and analysis indicated that the presence of sand channels impacted data collection and results sufficiently to justify an extended analysis and a separate, additional write up to discuss sand channels and their potential role as sources of odors from dairies.

CASE STUDIES: SIX PARTICIPATING FARMS

OVERVIEW

The six farms used in this study were selected based on their size and animal type, which made them representative of Wisconsin farms, and their layouts, which made them good candidates for air monitoring. These farms ranged in size from 400 to over 2,500 head of cattle. Five of the farms were freestall dairies and one was an open feedlot heifer raising operation. Odor control practices were installed on four of the farms and two were used for baseline data collection.

This study centered around four odor control practices. These were:

1. Anaerobic digestion
2. Impermeable cover on waste storage
3. Permeable cover on waste storage
4. Solids separation and aeration

Due to the time required to construct an anaerobic digester, it was not possible to conduct a before-and-after study on one farm within the length of the project. Therefore, two similar farms were selected, one with a digester already installed, and the other without. The Manitowoc County farm was the baseline "before" farm, and the Waupaca County farm was the "after" farm. Three sampling trips were made to each of these farms throughout the study.

The impermeable high-density polyethylene cover was installed on the Dunn County farm. Three trips were made prior to cover installation, and two trips were made once the cover was installed.

The permeable geotextile cover was installed on the Kewanee County farm. Three sampling trips were made prior to cover installation, and three trips were made the first year after the cover was in place, and two the second.

The solids separation/aeration system was installed at the Monroe County farm. Although some of the equipment was already in place early in the study, two of the trips were made before the system was operational, and two trips were made each year for two years after all equipment was installed and running.

No practices were installed at the Clark County farm. This was an open feedlot heifer operation that served to provide baseline data only. The initial plan was to install control practices to reduce ambient air concentrations of NH_3 and H_2S, however sampling during the two "before" trips detected negligible levels of these gases. Therefore, this site was a poor candidate for testing control practices.

GENERAL CASE STUDY FORMAT

Data from each case study is examined in detail in the following sections. The basic format of the examination provides a general background explanation of the farm and what the testing was intended to measure, followed by a discussion of the results. Results are presented visually in graphics, some of which are contained within the Project Data Supplement. This material is provided separately so that those who wish may refer to both documents at the same time, without having to turn pages back and forth to examine figures discussed in the text.

Each of the discussion sections is divided into a General Sampling Overview which provides an outline of sampling which occurred on the facility; a section on Ambient Sampling, wherein the results of most samples are discussed; and a section on Manure Surface Sampling, which presents the results of flux chamber sampling on the lagoon surfaces. The final section pertaining to the ammonia and hydrogen sulfide sampling from each case study is a summary of key findings, where any conclusions that we can draw from our data are presented.

It should be noted that the majority of the discussion regarding ammonia and hydrogen sulfide results is based on the time integrated samples collected at the site. The readings collected on a real-time basis for hydrogen sulfide using the Jerome meter are only brought into the discussion when they help clarify results of the ambient sampling. The survey results are not comprehensively reported herein.

Discussion of the odor sampling and analysis is included following each key findings summary, in the Project Focus Key Comparison sections. Comparisons between odor on different farms are made in these sections.

One of the goals of this study was to ground-truth the odor standard contained in the Livestock Facility Siting rule (ATCP 51). Farms that are applying for a Siting permit within Wisconsin must comply with the odor standard, if they are expanding beyond 1,000 animal units, or building new facilities for over 500 animal units. To comply, they must show that their planned facility is not predicted to create unacceptable odor levels for their nearest neighbor. Filling out the odor score worksheet (or an electronic spreadsheet) provides them with their predicted odor score. A farm must achieve an odor score of 500 or more to pass. An analysis of how the Nasal Ranger™ field data compared to the calculated odor score for the control practices being demonstrated is included in each of the six case studies.

Following the case studies is a comparison section wherein the chemical data that can be compared is discussed. It should be noted that not all of our data is readily comparable between the different facilities, and that extreme variations encountered between trips to the same farm lead to a situation where often the magnitude of variation within a farm is greater than the difference between farms. This situation greatly reduces confidence that we can distinguish between the different farms and the manure management practices employed on them.

PROJECT FOCUS: SIX CASE STUDIES OF LAGOON/PIT ODOR CONTROL MEASURES

Case Study 1: Anaerobic Digester (Waupaca County)

Background

The Waupaca County farm was our digester test site. It was a large modern dairy built adjacent to an older existing operation. The separation between the two operations, and the open, flat terrain in the area, made it possible to isolate the new operation for our study (see Figure 1.0).

Figure 1.0
Waupaca County Farm Layout

At the start of our study 1,540 cows were being housed in the new freestall barns. All manure and wastewater was being sent to a 22 million gallon HDPE lined storage lagoon after passing through a below-grade anaerobic digester. Gasses from the digester were being used to fuel a 270 kW generator set. The electricity produced was used on farm, with excess capacity being sold back to the local utility. Digested solids were dewatered using FAN separators and stockpiled for use as bedding material in the freestall barns, at a great savings over purchased bedding. The freestall barns were manually scraped three times each day. The wastes flowed by gravity through cross channels to a reception tank, where they were then pumped to the digester inlet.

At the conclusion of our study 310 more cows had been added to the operation, for a total of 1,850 cows being housed and milked. A new freestall barn had been constructed for these additional animals, and plans were underway to build up to two more. Other than this change, however, the basic layout and operation of the farm remained the same throughout our study.

Case Study 1 Results Discussion

General Sampling Overview

A total of three sampling runs have been conducted at the Waupaca County site. A total of 112 samples for each of NH_3 and H_2S have been collected, with 100 and 101 respectively being submitted to the lab for analysis. The invalid samples are evenly distributed between the sampling trips, and no single run experienced sufficient sample loss to invalidate it. Standard sampling protocols have been followed for all tests conducted at this site.

A summary of the test dates and general conditions is shown in the following table. Parameters include the testing start date and the vector mean wind speed, wind direction and temperature (in degrees Celsius) for both the daytime (AM) and nighttime (PM) sampling runs. Note that the test continued to the day following the test date.

Date	AM			PM		
	VMWS	VMWD	T(C)	VMWS	VMWD	T(C)
06/06/2007	11.0	200	18.0	9.0	170	17.1
08/13/2007	4.0	160	26.7	7.6	220	19.4
09/04/2007	8.1	220	29.5	3.8	210	21.2

Table 1.0
Waupaca County Test Dates and Basic Meteorology

This site proved to be ideal for comparison between digested and undigested manure storage pits. Unfortunately, it was not until late in the second run that the existence of the undigested manure pit was recognized, so samples were only collected around it during the third and final run. No additional manure surface sampling was conducted on this pit.

Several non-lagoon samples were collected at this facility, including an upwind/downwind series of samples were collected around the barns when they were upwind of the main lagoon; an upwind sample on the fenceline during the second run and a sample collected downwind of the feed area during the third run. The final location was sampled because feed was being harvested and added to storage during sampling. All samples from the latter two locations were non-detects. The samples collected around the barns are discussed with the ambient results following.

Only four successful duplicate pairs were collected at Waupaca (two of both H_2S and NH_3 pairs). All sampling pairs passed quality criteria. One of the H_2S duplicate samples showed qualitative agreement, while the other yielded identical results (RPD of 0.0%). The average RPD of the NH_3 samples is 7.2%, well within quality criteria.

Two blanks collected show detectable quantities of H_2S, with an average of 4.8 µg/sample. The blank levels were subtracted from the results reported by the lab. All other blanks contained non-detectable levels of the parameters.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

Concentrations around the main pit (digested manure) during our sampling visits showed significantly elevated ammonia concentrations on the downwind side. On two out of the three trips, a significant number of samples yielded results in excess of 1,000 micrograms per cubic meter (µg/m^3) for this compound. Ammonia concentrations around the smaller, undigested manure pit were generally similar to those around the main pit during that sampling visit, although the highest concentration observed during the entire study was obtained on the downwind side during the overnight sample.

Hydrogen sulfide levels around the main lagoon, however, were frequently undetectable. Of a total of 65 samples collected around this lagoon, 37 were non-detects, and only two showed concentrations in excess of 150 µg/m^3. With the low levels observed, no day/night pattern was discernable with results from this pit. Results for both parameters tended to show widespread elevation on the downwind side of the pit, indicating that there probably were no significant localized hotspots.

In contrast, the results around the smaller, undigested manure pit yielded a definite day/night difference in hydrogen sulfide concentrations. Levels during the day are comparable to those obtained around the main pit during that day, but the night time downwind samples are elevated by about a factor of five on the smaller pit. This hints at the possibility of the same type of day/night pattern observed with the hydrogen sulfide concentrations at the Manitowoc County farm.

Whether the limited observations comparing the digested and undigested manures represent a true difference, or is the result of variability in our sampling is unknowable based on our data set. It seems significant, however, that the undigested lagoon, with its smaller surface area, was able to generate higher concentrations around it than the larger, digested manure lagoon.

The tables following summarize the top three observed concentrations on the downwind side of the lagoons. Reported parameters include the average, maximum and minimum values, as well as the relative standard deviation (RSD), a measure of the variability of our results. In addition to a summary for each sampling period, the tables for the digested manure lagoon show an overall summary of results, as well as a day and night sample comparison. The small undigested manure results are not summarized, as only the single day/night series of samples was collected. Note that the larger variability in the results from the smaller lagoon is a direct result of the limited number of samples collected around it (the three most concentrated samples were not always directly downwind).

	Run 1	Run 1e	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Average	760	633	1557	737	2085	1843	1269	1467	1071
Max	913	720	2205	801	2293	2233	2293	2293	2233
Min	587	518	994	683	1860	1485	518	587	518
RSD	21.6%	16.4%	39.2%	8.2%	10.4%	20.4%	51.6%	45.5%	57.3%

Table 1.1
Downwind Ammonia Concentrations Near the Digested Manure Pit

	Run 1	Run 1e	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Average				120	162	115	111	117	106
Max	63	37	36	126	262	206	262	262	206
Min	ND	ND	ND	111	93	54	36	36	37
RSD				6.6%	54.6%	70.4%	61.2%	75.3%	52.9%

Table 1.2
Downwind Hydrogen Sulfide Concentrations Near the Digested Manure Pit

NH3	Run 3	Run 3e	H2S	Run 3	Run 3e
Average	1186	1614	**Average**	165	495
Max	1606	3070	**Max**	207	1129
Min	902	384	**Min**	119	50
RSD	31.3%	84.0%	**RSD**	26.6%	114.0%

Table 1.3
Downwind Concentrations Near the Un-digested Manure Pit

The figures on the following pages represent this data in max/min charts. The value (Y) axis is in micrograms per cubic meter. The scale for the ammonia results has been equalized for the larger and smaller lagoons; however, the hydrogen sulfide values vary too significantly and have separate scaling values. Note that the variation between the test runs is significant enough that no statistically significant patterns are clear.

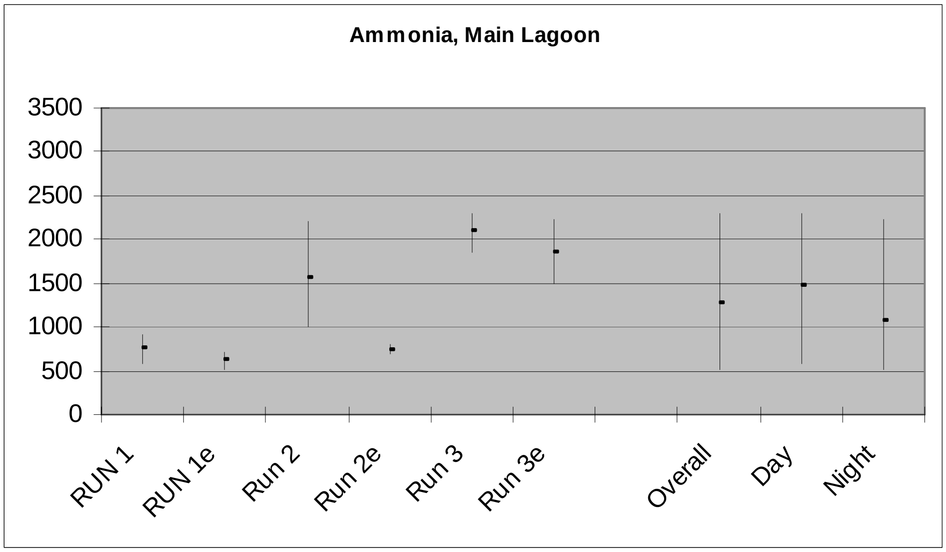

Figure 1.1
Ammonia, Main Lagoon (Waupaca County)

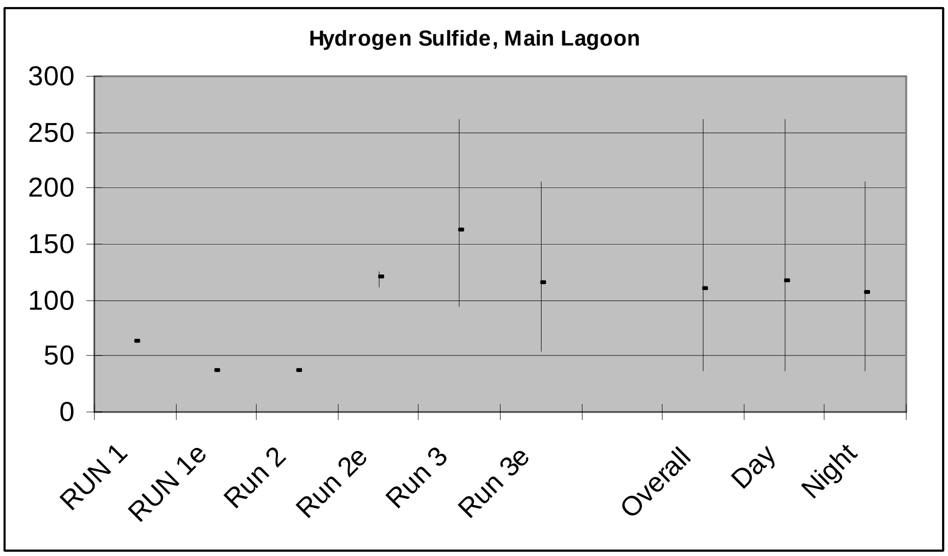

Figure 1.2
Hydrogen Sulfide, Main Lagoon (Waupaca County)

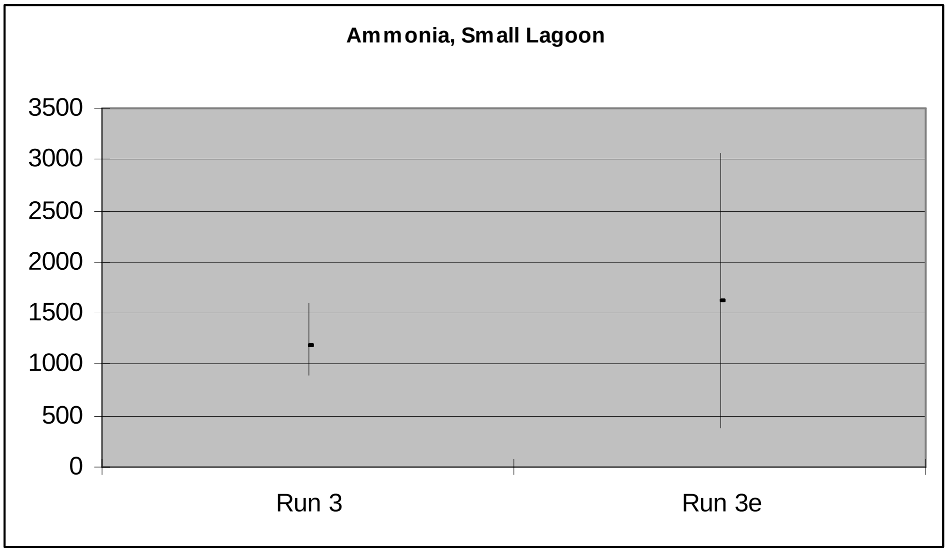

Figure 1.3
Ammonia, Small Lagoon (Waupaca County)

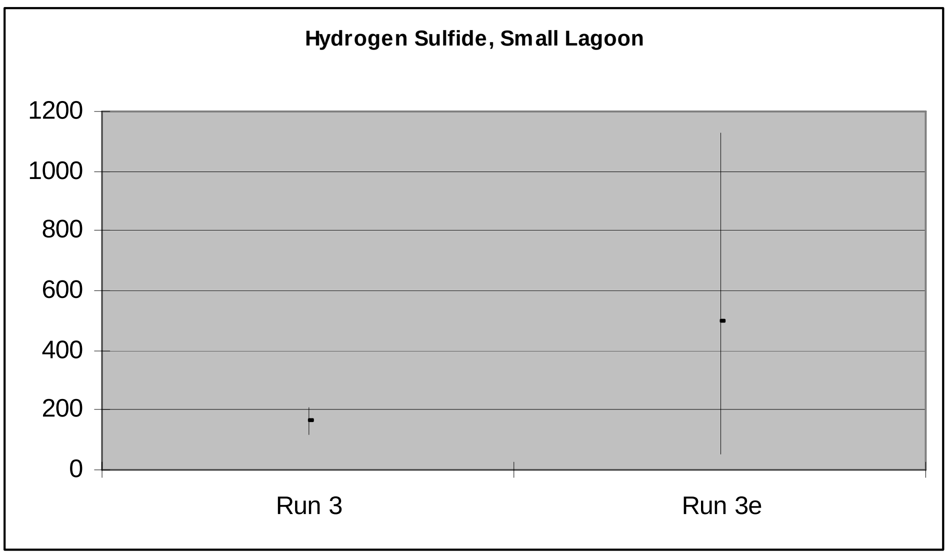

Figure 1.4
Hydrogen Sulfide, Small Lagoon (Waupaca County)

During the setup for the June 4, 2007 sampling run, the barns were directly upwind of the main lagoon, and so a series of barn oriented samples were collected to account for any potential influence they may have on the concentrations observed around the lagoon. Two upwind and two downwind locations were established and sampled during both the day and nighttime sampling periods. The downwind locations were about halfway between the barns and the lagoon edge.

All hydrogen sulfide samples, both upwind and downwind of the barns, were non-detects and are not further discussed. The ammonia results, however, clearly show the barns influencing downwind concentrations. Both day and night upwind samples are non-detects, but downwind concentrations range from 174 to 352 micrograms per cubic meter. Samples collected on the upwind side of the lagoon at the same time show concentrations elevated above background as well. These results clearly indicate that dairy housing is an ammonia source that can have downwind implications.

It should be noted that although this first series of barn oriented samples are the only successful ones collected from this facility, there are indications on other sampling days that the barns may have been impacting the upwind side of the lagoon. Locations 6 and 7 on the south side of the lagoon frequently show elevated ammonia concentrations, even though the winds during our sampling trips were generally from the south or southwest.

These results are documented in the following table. Results are expressed as micrograms per cubic meter.

Daytime			Nighttime		
Upwind	Downwind	Pitside	Upwind	Downwind	Pitside
ND	174	48	ND	308	70
	352	48		256	92

Table 1.4a
Ammonia Concentrations in Barn Oriented Samples, June 4, 2007

Manure Surface Sampling

Sampling was, unfortunately, conducted on the surface of the digested manure lagoon only. This facility would have been ideal for the comparison of undigested and digested manure storage. However, the fact that there was a second lagoon containing undigested manure was not apparent until late in the second sampling visit. Logistical difficulties during the third sampling trip made collecting extra samples from the small pit surface impractical.

The figures below display the results obtained from these tests. Concentration units are micrograms per cubic meter, presented on a logarithmic scale. Note that results from this site track well between visits, with relatively consistent results obtained throughout the study.

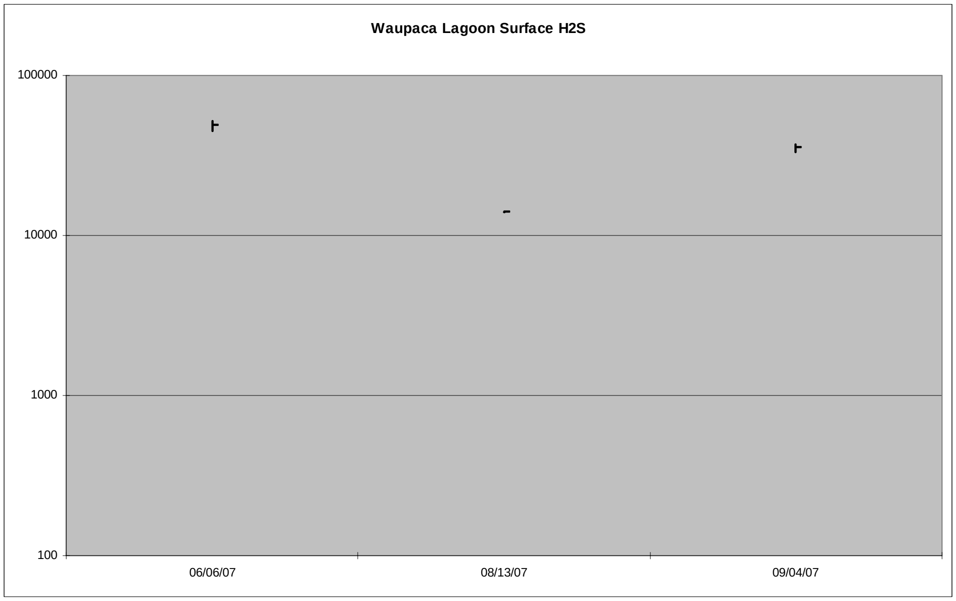

Figure 1.5
Lagoon Surface H_2S (Waupaca County)

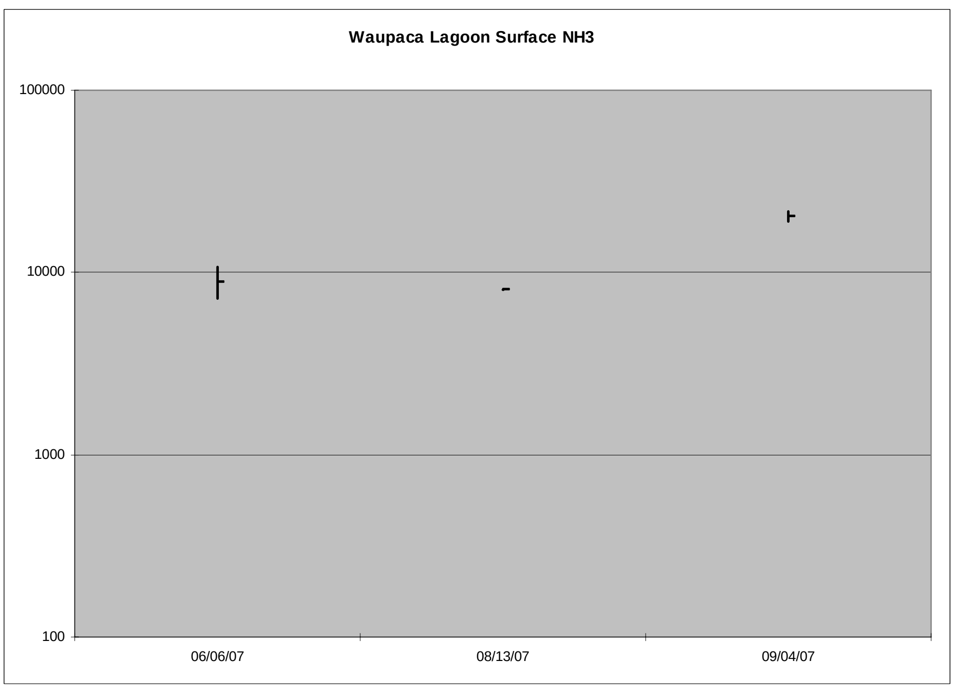

Figure 1.6
Lagoon Surface NH_3 (Waupaca County)

Case Study 1 Key Findings Summary Statements

Ammonia levels were observed to be more generally elevated than hydrogen sulfide around the digested manure lagoon at this facility. Elevated ammonia concentrations were more widespread and consistent than H_2S, and the maximum concentrations observed exceed the maximum H_2S significantly.

This situation was different around the smaller, undigested manure lagoon. The concentrations of ammonia and daytime H_2S observed around this pit were generally similar to those around the main pit, but the nighttime hydrogen sulfide concentrations were significantly elevated. The highest lagoon oriented ammonia concentration observed anywhere during this study was collected around the undigested manure pit at this facility.

The lagoon surface concentrations observed at this facility were generally consistent between visits. Whether this represents an actual consistency in surface conditions, or simply more consistent sampling technique is unknown.

Project Focus Key Comparison ~ Case Study 1: Anaerobic Digester (Waupaca County) vs. Case Study 6: Manure Storage Lagoon (Manitowoc County)

A key objective of this project is to assess whether process changes wrought on manure processed by anaerobic digestion can have a measurable impact on odors associated with manure in storage lagoons. The discussion that follows presents an analysis and comparison of our findings from the study of odors from a lagoon which is storing manure that has been processed through a mesophilic (low temperature) anaerobic digester, which is best compared to a lagoon storing undigested wastes, presented in more detail later in this report. See the Project Focus Case Study Comparison ~ Case Study 2 for discussion related to thermophilic digestion and manure storage.

The figures representing the odor transects conducted on the three trips to the Waupaca County farm (with digester) and to the Manitowoc County farm (no digester) are presented in the Project Data Supplement for each of the case studies.

Comparing these two sets of figures, it is difficult to conclude with any certainty that the lagoon containing digested manure generates any less odor than the lagoon containing undigested wastes. This is counter-intuitive, and yet seemed to be the case during all our trips.

Graphing the odor readings from these two lagoons, some reduction in odor appears to be provided by the digester, especially near the lagoon (see Figure 1.7). By averaging the results from each set of trips, this difference is about a 15% reduction in odors overall. Since the accuracy of data provided by the Nasal Ranger^{TM} is typically +/-10%, this would not be considered a statically significant decrease. Note that the variability of the data, represented through the vertical bars in the following graph, shows considerable overlap at most of the distances tested.

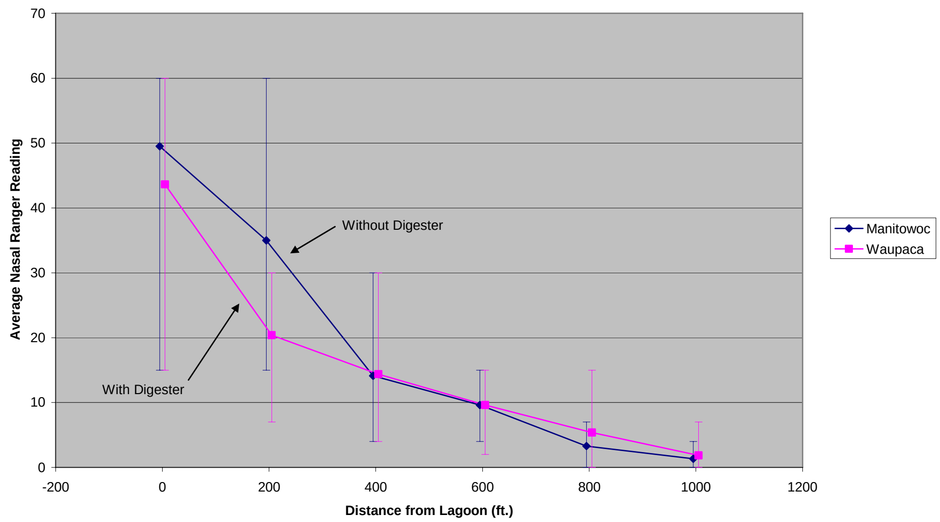

Figure 1.7
Average Nasal Ranger^{TM} Reading at 200 ft Intervals
Mesophilic Digester Fed Lagoon (Waupaca County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

An explanation for this might be that although a digester breaks down the organic compounds in manure, it does so only partially, based on residence time. The economically optimum throughput is higher than what would be needed for complete digestion. Also, the digester does nothing to the sulfur content of the manure, and actually shifts the nitrogen to a more highly volatile form. Lastly, because the digester operates under anaerobic conditions, the discharge from it can be quite odiferous.

The landowner recognized that odors continued to impact his neighbors after the installation of the digester, and being an innovative manager, he engineered a gas treatment system to address this. This system uses a blower to capture the fugitive emissions from the digester outlet and sends them to a tank where they are bubbled through water. This causes the H_2S to be absorbed by the water, forming a weak acid solution that is then combined with other wastes in the storage lagoon. Although fairly simple in design, this system is very effective at controlling gaseous emissions from the digester. He has made other modifications as well, such as installing a more reliable gas flare. These improvements are described in more detail later in the Lessons Learned section of this report.

The flux chamber tests from these two farms did not mirror our Nasal Ranger^{TM} readings. Figure 1.8 below is a bar graph depicting the laboratory-determined odor intensities of our flux chamber samples. The first three bars are for samples taken from the control farm (no digester – Manitowoc County) and the last three are from the mesophilic digester farm (Waupaca County).

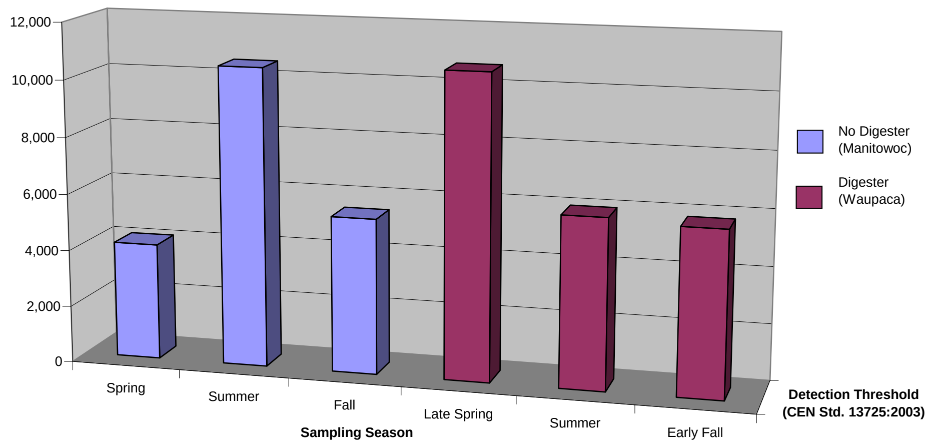

Figure 1.8
Flux Chamber Seasonal Average Detection Threshold
Mesophilic Digester Fed Lagoon (Waupaca County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

These data indicate that odor generation rates are about the same, or perhaps slightly higher from the lagoon receiving digested manure than they are from the lagoon receiving undigested manure. Due to variables beyond the control of this study, these differences are probably not statistically significant. One of these variables is the inconsistency in surface conditions across the lagoons. At times the surface appeared very uniform and selecting a representative spot to sample was possible. At other times, areas of foam or floating solids created variable surface conditions, making a representative sample very difficult to obtain.

To further determine how a digester may influence odor from waste storage, we compared the volatile fatty acid (VFA) levels in the lagoons on these two farms. It has been well documented that VFAs can contribute significantly to the odors generated by stored manure. Figure 1.9 below depicts the findings of the VFA analyses.

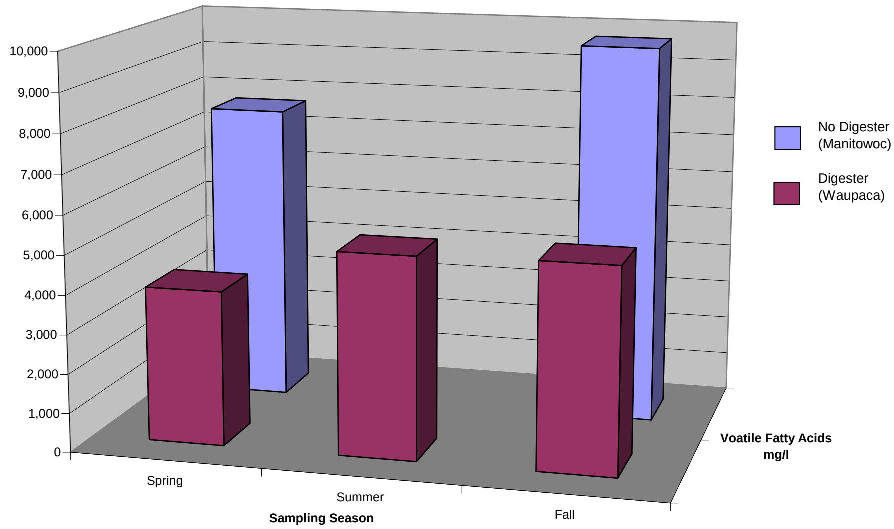

Figure 1.9
Volatile Fatty Acids, mg/l
Mesophilic Digester Fed Lagoon (Waupaca County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

It appears from these results that the digested manure has significantly lower VFA levels than the undigested manure, and therefore should generate less odor. However, due to other factors, such as the increased volatility of ammonia in digested manure, a reduction in odor cannot be determined from these data alone.

Figure 1.10 below shows the comparison of Nasal Ranger™ readings taken in the field at our Manitowoc and Waupaca study farms, to the odor scores for the waste storage lagoons, as determined using the odor model in ATCP 51. The odor score was calculated for the lagoons assuming the nearest neighbor was located at various distances downwind. These scores were plotted against separation distance to create an odor score curve. The Nasal Ranger™ odor results were then plotted against distance on the same graph. This allowed us to determine the actual average odor level at the distance that corresponds to a passing odor score of 500.

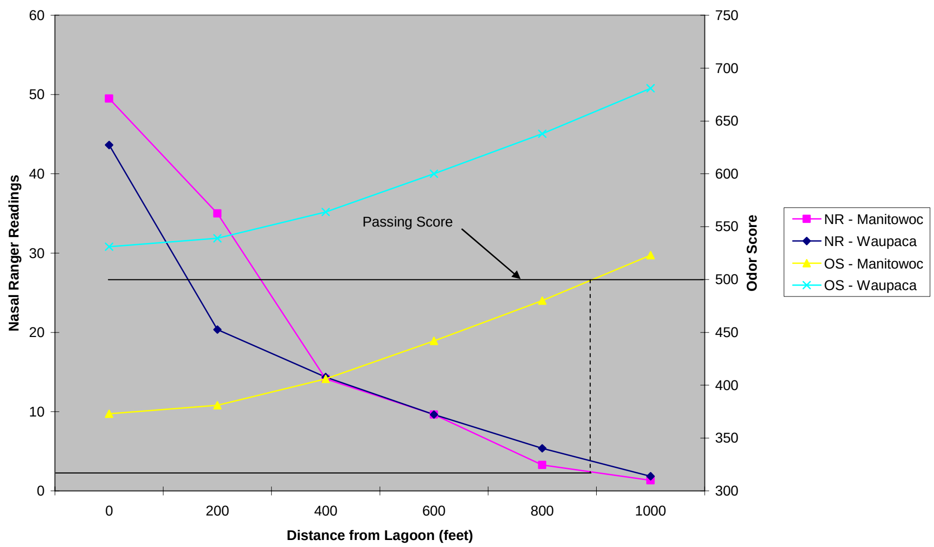

Figure 1.10
Comparison of Nasal RangerTM Readings to the Odor Score
Mesophilic Digester Fed Lagoon (Waupaca County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

Looking at these results, we see a very good correlation between the field readings and the predicted odor score at the Manitowoc farm. The yellow line with triangles is the odor score curve, and the red line with squares is the Nasal Ranger^{TM} field readings curve. Drawing a horizontal line at a passing odor score of 500, and then dropping down from where that line intersects the odor score curve, we see that the point corresponds with a separation distance of just under 900 feet. At this distance the Nasal Ranger^{TM} field readings averaged about 2, the lowest measureable reading. This result indicates that for medium sized waste storage lagoons (4.2 acres) the odor standard was collaborated by our field odor measurements.

Unfortunately, this is not the case for the digested lagoon at the Waupaca County farm. There was a poor correlation between the field readings and the predicted odor score for that lagoon. The blue line with X's is the odor score curve, and the black line with diamonds is the Nasal Ranger^{TM} field readings curve. Nowhere does the odor score curve drop below 500, indicating that a passing score can be achieved at any separation distance, a significant improvement over the undigested lagoon. In the field, however, the Nasal Ranger^{TM} readings showed virtually no improvement in odors over the undigested lagoon at distances of 400 feet and beyond. This indicates the need to further investigate the odor control potential of digesters and possibly adjust the credit given to them in the odor standard.

Case Study 2: Impermeable Cover (Dunn County)

Background

Our Dunn County farm was the site where an impermeable cover was installed on a manure storage basin. Drumlins and moderately sloped fields created a more challenging site for air monitoring, however, separation distances between structures were favorable (see Figure 2.0).

Figure 2.0
Dunn County Farm Layout

At the start of our study, this farm housed about 875 milking and dry cows in two large freestall barns bedded on separated digester solids. The freestalls are manually scraped three times each day. The wastes flow by gravity through cross channels to a reception tank, where they are then pumped to the digester inlet. Although his farm has an anaerobic digester, some of the time it was inoperable, therefore the wastes in the 10 million gallon storage lagoon were a combination of digested and undigested wastes. The landowner wished to install a cover not only to control residual odors, but also to capture more gas for use in the 775 kW generator.

The cover that was installed is 60 mil. high density polyethylene (HDPE), similar to what is used for lining manure storage lagoons. It is sealed around its perimeter, making it airtight, and trapped gases are piped to the digester generator set, or optionally to a flare. The cover is also fitted with two surface pumps to remove captured rainwater and send it to drainage swales.

By the end of our study, an additional freestall barn had been built on site to accommodate 300 heifers that had previously been raised on a satellite farm. However, the barn had not yet been populated, therefore this change did not impact our study.

Case Study 2 Results Discussion

General Sampling Overview

A total of 5 sampling runs were conducted at the Dunn county site; three before installation of the impermeable cover, and two following. During these tests, a total of 157 samples for ammonia and 145 samples for hydrogen sulfide were collected, with 14 hydrogen sulfide and 15 ammonia samples invalidated in the field. Invalid samples were somewhat evenly distributed between several runs, and no single run experienced sufficient sample loss to invalidate it.

A summary of the test dates and general conditions is shown in the following table. Parameters include the testing start date and the vector mean wind speed, wind direction and temperature (in degrees Celsius) for both the daytime (AM) and nighttime (PM) sampling runs. Note that, with the exception of the first run, the tests continued to the day following the test date.

In addition, note that the on-site meteorological station malfunctioned during the initial part of the second test, and during the entire test on 9/23/2008. Filling this data was accomplished through first comparing existing on site data with data available on the Internet from nearby airports (Menomonee and Eau Claire). The comparison showed that the Menominee data was more consistent with that from on site, and thus it was used.

Date	AM			PM		
	VMWS	VMWD	T(C)	VMWS	VMWD	T(C)
10/31/2006	15.8	260	0.6			
05/07/2007				3.7	250	16.6
07/09/2007	4.4	200	20.1	0.2	220	17.7
09/23/2008	7.8	200	23.8	4.4	210	17.7
10/07/2008	1.2	280	12.9	7.5	290	9.3

Table 2.0
Dunn County Test Dates and Basic Meteorology

The first trip to this facility was the initial sampling run of the entire project, and numerous details of the sampling protocol were still being evaluated at that point. Results from this run helped clarify the final standard procedures. Major specific differences between this first run and all subsequent runs at all farms include using a lower sample flow rate and only sampling during the daytime.

The effect of the lower sampling rate was to lead to higher detection limits and far fewer samples with detectible quantities of the species of interest. The effect of increasing the sample rate was checked on a limited sampling run to Kewaunee County prior to the official start of sampling at that location, where several samplers at different flow rates were run side by side at a single high concentration location. Results from this showed that increasing the flow rate would enhance sample collection.

An additional measure to increase the number of samples with detectible quantities of NH_3 and H_2S was to increase sampling time as well. This two fold approach resulted in a greater than 10 fold increase in sample volume, with a correspondingly significant decrease in detection limits, thereby greatly increasing the utility of the data collected for this study.

An additional effect of running the samples later in the day was to make collecting a second series of samples overnight during the same trip practical, thereby doubling the overall potential number of samples.

In addition to the samples collected directly around the manure pit, a number of other locations were sampled during these tests, including fenceline locations to the north and south of the pits, and inside the separator room. The former locations were sampled to provide an indication of how diffuse concentrations become over the distance to the fenceline, while the separator room samples were obtained to provide an estimate of the worst case on-farm concentrations.

There were four successful H_2S duplicate sampling pairs submitted to the laboratory, all of which showed qualitative agreement (both samples were non-detects). A total of 9 NH_3 sample pairs were submitted of which 3 show qualitative agreement, while one showed disagreement (one sample a detect, the other a non-detect). Of the remaining 5 NH_3 pairs, one failed at 35.2% RPD, while the other four passed with RPDs below 12%. The average RPD for these samples is 6.0%.

A total of 8 H_2S and 8 NH_3 blanks were submitted from sampling efforts at this facility. Of these, 6 of the H_2S blanks showed detectible quantities, including the highest detect of 69 micrograms per sample. This particular blank was from a lot obtained from a separate manufacturer from which a few samples were deployed during run 2, when the primary sampling media source was temporarily back ordered. While it is not known which of the samples were collected using the alternate media, there are no results that stand out as being anomalous during this run. The average H_2S amount detected in the blanks, when the anomalous high value is excluded, was 6.1 micrograms per sample. There was no NH_3 detected in the blank samples.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

Samples collected along the side of the lagoon at this facility tended to show little to no hydrogen sulfide, before or after installation of the impermeable cover. Out of a total of 38 valid pit-side H_2S samples collected before installation, and 44 afterwards, only 6 detected the compound before, and 3 afterwards. Of these, 5 of the pre-cover detects and all of the post-cover detects were in single sampling runs (specifically the night-time samples on May 7-8, 2007, and the daytime samples on October 7, 2008).

What differed about those runs is not known, and the possibility of widespread sampling error must be considered for the large number of non-detects in an area where the presence of hydrogen sulfide would be expected (alongside a manure lagoon). However, there is support for the observed results among the Jerome survey results.

There was hydrogen sulfide detectable to the instrument during almost every Jerome survey. The separator room and its outfall to the pit is where the highest concentrations were observed. Instantaneous values observed near this location ranged widely, with maxima frequently in excess of 10 ppm. Away from this location, detectible quantities were generally sporadic, and frequently did not exceed the charcoal tube sample detection limits, even on an instantaneous basis.

The one significant exception to this general rule was during the morning of May 8th, 2007, where an extensive area along the north side of the lagoon showed instantaneous Jerome meter concentrations in excess of 1 ppm. Correspondingly, all time integrated samples collected from locations on that side of the lagoon were positive for hydrogen sulfide.

On July 9 and 10, 2007, however, observed real-time values at the outfall did not exceed 0.2 ppm during any of the Jerome surveys, and levels throughout the facility were generally low. Correspondingly, there were no detects among the ambient hydrogen sulfide samples collected on this run.

Following installation of the cover (which included piping the separator outfall underneath the cover without exposure to the air), hydrogen sulfide was typically only observed around the separator room using the Jerome meter. The very few ambient detects following installation are consistent with the real time results observed while on site. However, there was not a dramatic drop in observed values before and after installation, because the pre-installation values were already low.

Ammonia results show a much more dramatic difference before and after installation of the impermeable cover. Prior to installation, ammonia was detected in the majority of samples, with the July 9 and 10, 2007 sample runs returning many samples with concentrations in excess of 1000 micrograms per cubic meter. Following installation, there were far more non-detects than detects, and most of these were barely above the detection limits (which are typically around 30 – 35 $\mu g/m^3$).

Summaries of the downwind samples for each parameter are presented in the following tables. Values documented in the tables are the averages, maxima and minima of the three highest downwind results, as well as the relative standard deviation (RSD), which is a measure of the variability of the results. Note that “ND” indicates that no samples showed detectable quantities of the parameter of interest. In determining the overall average, tests with no detects are averaged in at zero.

	Run 1	Run 2	Run 2e	Run 3	Run 3e	Overall
Average	455	446	482	2076	1645	1059
Max	565	464	619	2279	1960	2279
Min	357	426	345	1864	1016	345
RSD	23.0%	4.3%	40.3%	10.0%	33.1%	73.0%

Table 2.1
Dunn County Pre-Installation Downwind NH_3 Concentrations

	Run 4	Run 4e	Run 5	Run 5e	Overall
Max	33	157	ND	ND	157
Min		97			ND
Avg		127			69
RSD		23.6%			97.7%

Table 2.2
Dunn County Post-Installation Downwind NH_3 Concentrations

H2S Pre	Run 1	Run 2	Run 2e	Run 3	Run 3e	Overall
Max	97	ND	174	ND	ND	174
Min			96			ND
Avg			123			66
RSD			35.9%			102.0%

Table 2.3
Dunn County Pre-Installation Downwind H_2S Concentrations

H2S Post	Run 4	Run 4e	Run 5	Run 5e	Overall
Max	ND	ND	93	ND	93
Min			21		ND
Avg			60		30
RSD			61.3%		134.2%

Table 2.4
Dunn County Post-Installation Downwind H_2S Concentrations

Results tabulated above are shown in the following graphs. Note that the y-axis scale of the graphs represent $\mu g/m^3$, and the before and after scales have been set the same to allow direct comparison of the difference in results.

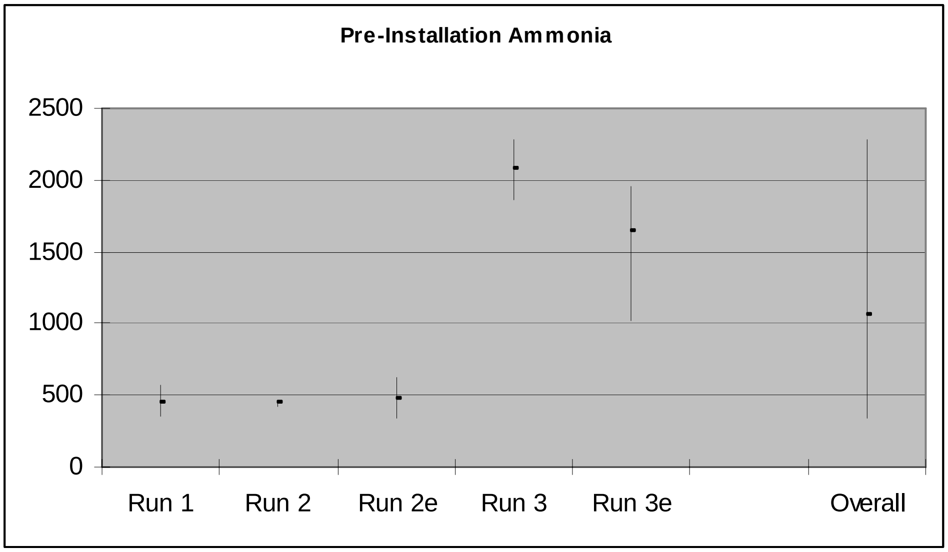

Figure 2.1
Pre-Installation Ammonia (Dunn County)

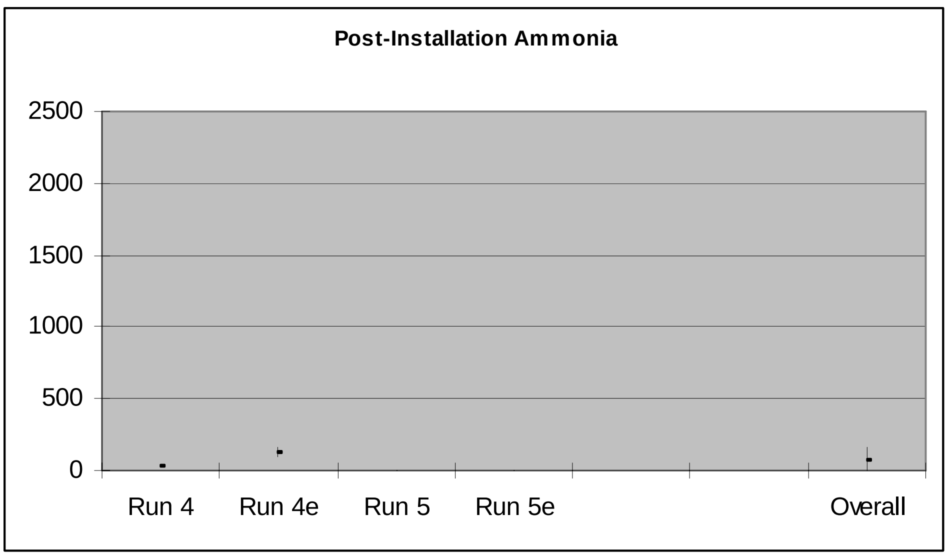

Figure 2.2
Post-Installation Ammonia (Dunn County)

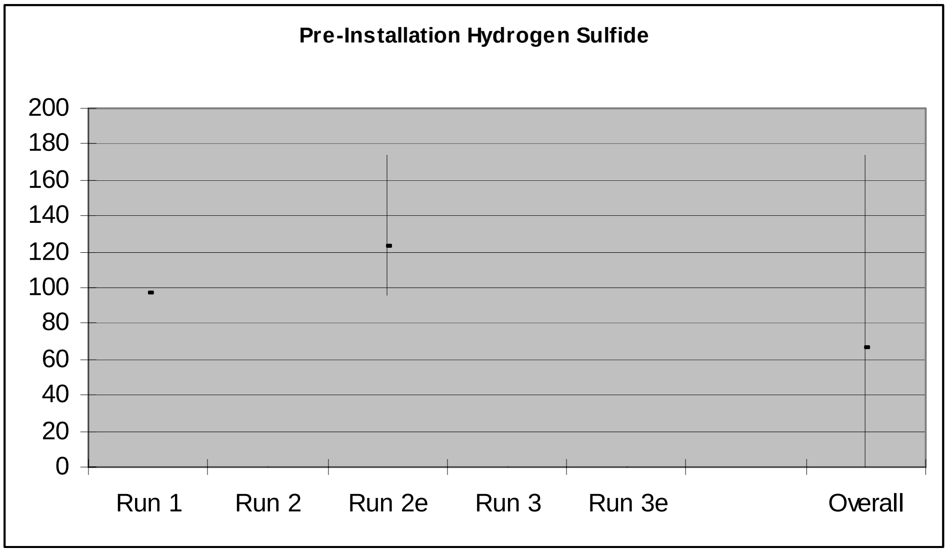

Figure 2.3
Pre-Installation Hydrogen Sulfide (Dunn County)

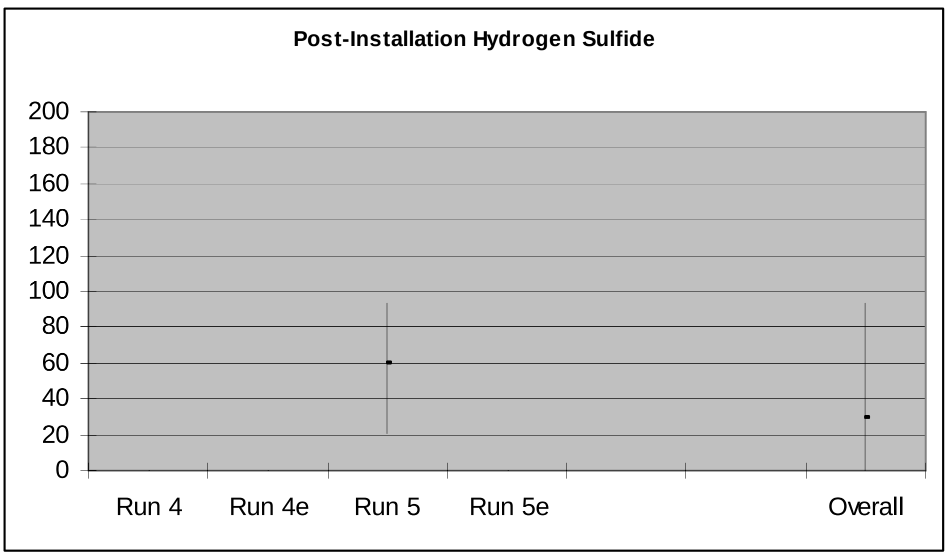

Figure 2.4
Post-Installation Hydrogen Sulfide (Dunn County)

Manure Surface Sampling
The graphs below show the maximum, minimum and average values from flux samples collected from the manure surface before and after the installation of the permeable cover. Samples to the left and right represent those collected before and after installation of the cover, respectively. It should be noted that following installation of the cover, there were significant challenges in maintaining a seal between the flux chamber and the surface sufficient to allow collection of samples. Sampling on the cover was actually conducted in puddles of accumulated water to enable a seal to develop.

Note that a logarithmic scale is used for the value axis, which is in micrograms per cubic meter. Both H_2S and NH_3 results following installation were non-detects, so that the graph shows the maximum possible values. Sampling flow rates were increased for these samples to decrease the detection limit and improve the quality of the data.

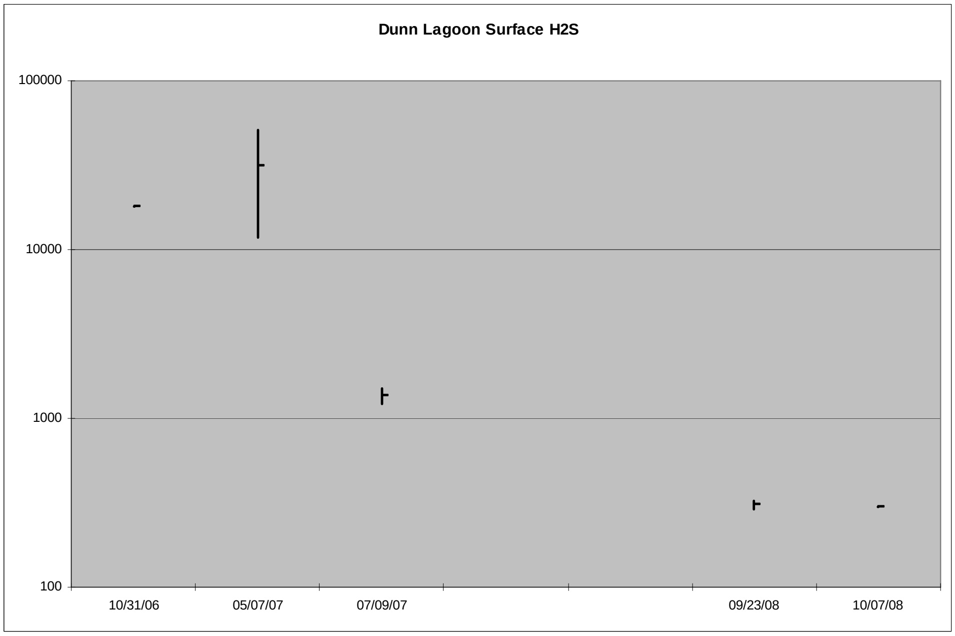

Figure 2.5
Lagoon Surface H_2S (Dunn County)

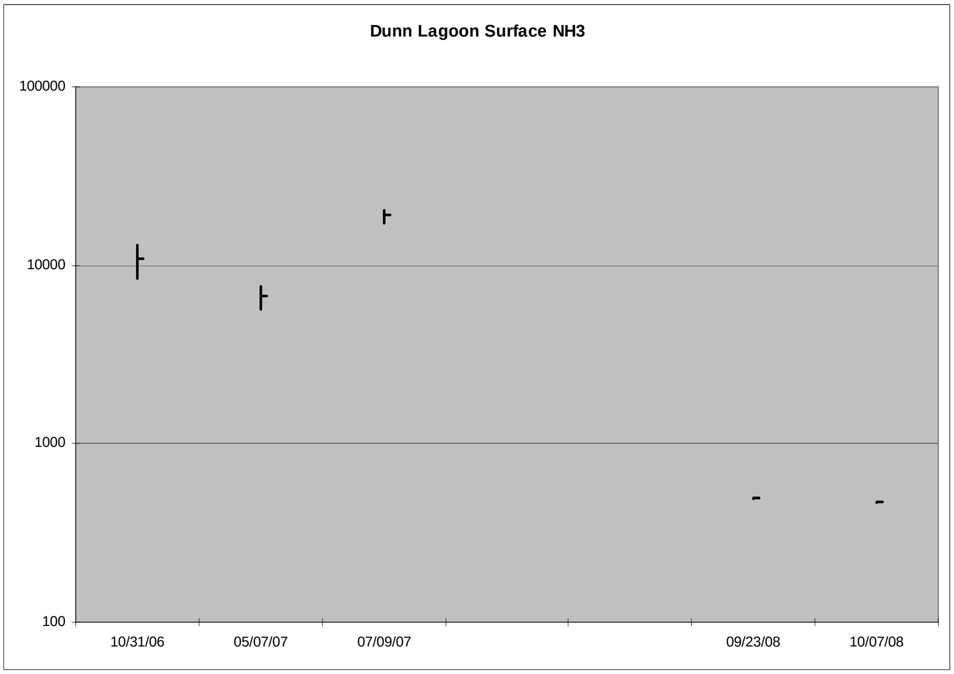

Figure 2.6
Lagoon Surface NH_3 (Dunn County)

Case Study 2 Key Findings Summary Statements

This facility represents two practices; both manure digestion (with added substrate) and an impermeable cover. Pre-installation results represent digested manure, while post-installation results represent both digestion and the cover.

Both prior to and following installation of the cover, ambient hydrogen sulfide results were quite low, with only sporadic detectable quantities. The low levels make it difficult to truly evaluate the effect of the cover on the basis of these samples, however, the low levels observed before installation may demonstrate the effectiveness of the digestion process in reducing hydrogen sulfide concentrations. Hydrogen sulfide concentrations observed at the lagoon surface through the flux chamber samples did show a dramatic drop following installation of the cover.

Ammonia samples collected both around the lagoon and from the surface show a dramatic difference, with an obvious and significant drop in concentration following installation of the cover.

Overall, installation of the impermeable cover has been unambiguously shown to reduce on-farm concentrations of hydrogen sulfide and ammonia significantly. However, our tests do not allow conclusions to be drawn concerning the entire life cycle of the manure, as we did not collect any samples during spreading of the manure. Differences in air quality impacts of manures from covered storage versus uncovered are unknown and outside of the scope of this study.

Odor Control Results

The outcome of the odor transects conducted on the three follow-up trips to the Dunn County farm is depicted in three graphics in the data supplement. These represent the odors being generated by the same lagoon, however with an impermeable (HDPE) cover installed.

Comparing these three "with cover" figures with the three "without cover" figures it becomes clear that the cover was highly effective at controlling odors. The significant odors observed coming from the lagoon initially were virtually non-existent during the later visits. The dominant odors on the farmstead after the cover was installed were identified as feed or freestall rather than lagoon odors. This is not surprising since now all gases generated by the lagoon were being contained.

Graphing the odor readings from this lagoon, both with and without the cover, it becomes clear how effectively the cover controls odors (see Figure 2.7). By averaging the results from each set of the trips, the overall reduction in odor is virtually 100%.

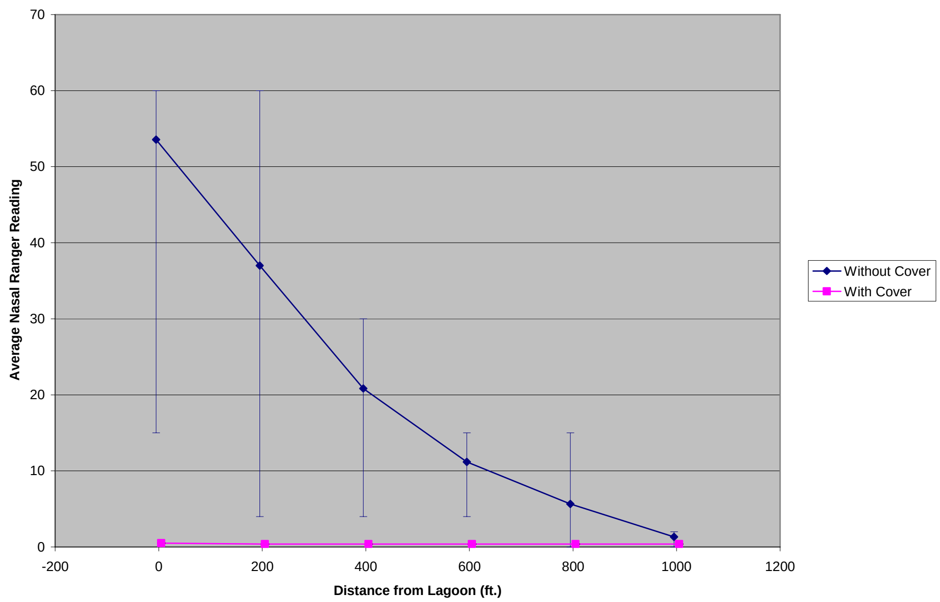

Figure 2.7
Average Nasal Ranger™ Reading at 200 ft Intervals
Thermophilic Digester Fed Lagoon (Dunn County)

The flux chamber testing from this lagoon, with and without the cover, mirrored our Nasal Ranger™ readings. Figure 2.8 below is a bar graph depicting the laboratory-determined odor intensities of our flux chamber samples. The first two bars are for samples taken from the lagoon before the cover was installed, and the second two bars are for samples taken directly off the HDPE cover.

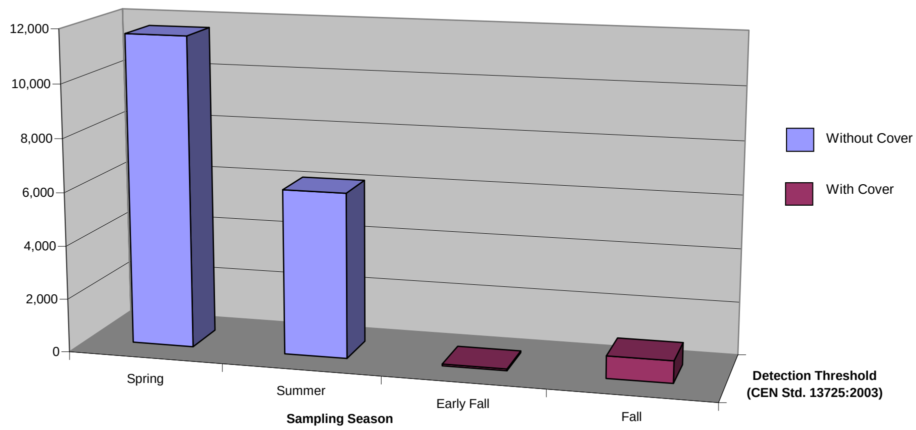

Figure 2.8
Flux Chamber Seasonal Average Detection Threshold
Thermophilic Digester Fed Lagoon (Dunn County)
With Impermeable Cover vs. Without Cover

Not surprisingly, these data support the findings that an impermeable cover provides virtually 100% odor control. Of course, other factors come into play when considering installing a cover for odor control, such as cost and impacts on the operation and maintenance of the lagoon. These items are discussed further in the Lessons Learned section of this report.

Figure 2.9 below shows the comparison of Nasal Ranger™ readings taken in the field at our Dunn County farm (with cover in place), to the calculated odor score for the covered waste storage lagoon, using the odor model in ATCP 51. The odor score was calculated for the covered lagoon assuming the nearest neighbor was located at various distances downwind. These scores were plotted against separation distance to create an odor score curve. The Nasal Ranger™ odor results were then plotted against distance on the same graph. This allowed us to determine the actual average odor level at the distance that corresponds to a passing odor score of 500.

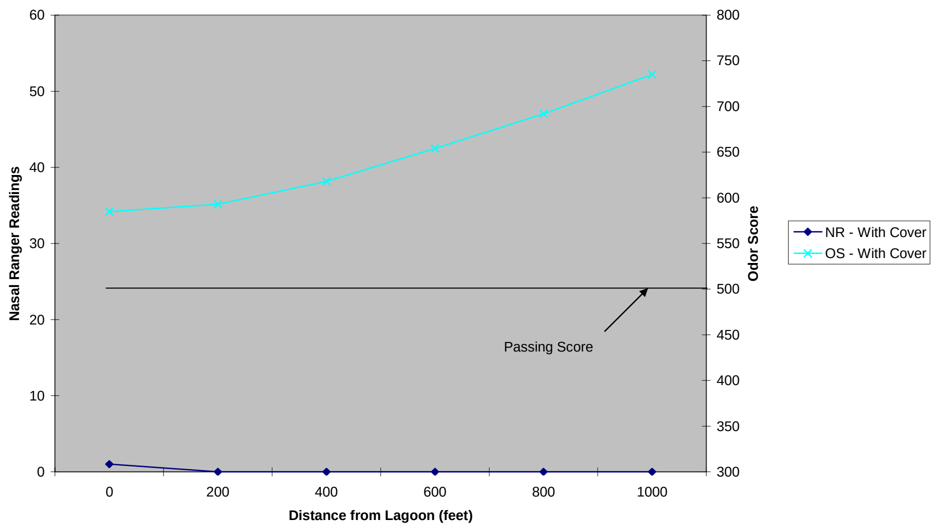

Figure 2.9
Comparison of Nasal Ranger™ Field Readings to the Odor Score
Thermophilic Digester Fed Lagoon (Dunn County)
With Impermeable Cover Installed

Looking at these results, we see a very good correlation between the field readings and the predicted odor score. The blue line with X's is the odor score curve with the cover installed, and the black line with diamonds is the field odor readings curve. Drawing a horizontal line at a passing odor score of 500, we see that at no point does the odor score curve drop below 500, meaning that the system passes at any separation distance. We also see that all Nasal Ranger™ readings are 1 or below, a very acceptable level. This indicates that for waste storage lagoons with impermeable covers the odor control credit in the odor standard was collaborated by our field odor measurements.

Project Focus Key Comparison ~ Case Study 2: Anaerobic Digester (Dunn County) vs. Case Study 6: Manure Storage Lagoon (Manitowoc County)

Our second case study farm, in Dunn County, was unique in that it allowed us to evaluate two separate practices. This farm was selected because, like the Waupaca farm, it had an anaerobic digester already installed and fully operational. Unlike Waupaca, however, this digester was a *Microgy* design, which operated in a warmer (thermophilic) temperature range. This gave us the opportunity to observe differences between these two types of digesters.

Similar to the situation in Waupaca County, the landowner in Dunn County continued to receive occasional odor complaints after the digester was installed. Because of this, he was considering installing an impermeable cover on his lagoon. His hope was that a gas-tight cover would provide him with multiple benefits. First, it would control all odors from his lagoon, second, it would capture additional gasses to power his generator, and third, it would keep precipitation out of his manure to save on hauling costs. By assisting him with installing an impermeable cover, we could test in a real world setting how well it met these expectations.

The outcome of the odor transects conducted on the three initial trips to the Dunn County farm are depicted in the data supplement. These represent the odors being generated by a lagoon that is storing manure that has been processed through a thermophilic (high temperature) anaerobic digester. And as with case study #1, we compared this to our control lagoon in Manitowoc County. The outcome of the odor transects conducted on the three trips to that farm are also depicted in the data supplement. These represent the odors being generated by a lagoon that is storing manure that has not been processed through a digester.

Comparing these two sets of figures, it appears that odors may be somewhat increased by the digester rather than being decreased as was expected. As with the Waupaca farm, all our initial trips to Dunn County seemed to bear this out.

Graphing the odor readings from these two lagoons, an increase in odor appears to be caused by the digester (see Figure 2.10). By averaging the results from each set of trips, this difference is about a 15% increase in odors overall. Since the accuracy of data provided by the Nasal Ranger™ is typically +/-10%, this would not be considered a statically significant increase. Note that the vertical lines representing the range of values observed at each data point display considerable overlap.

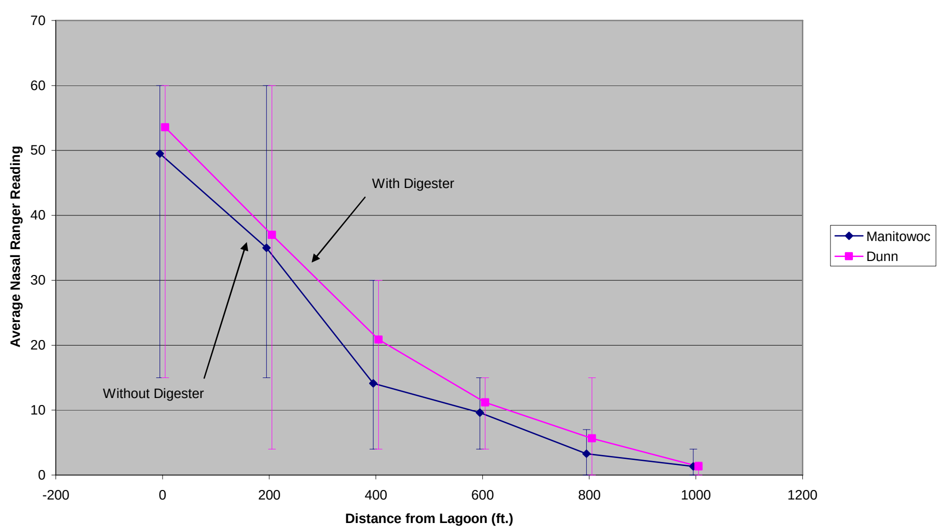

Figure 2.10
Average Nasal Ranger™ Reading at 200 ft Intervals
Thermophilic Digester Fed Lagoon (Dunn County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

The flux chamber testing from these two farms mirrored our Nasal Ranger™ readings. Figure 2.11 below is a bar graph depicting the laboratory-determined odor intensities of our flux chamber samples. The first three bars are for samples taken from the control farm and the last two are from the thermophilic digester farm.

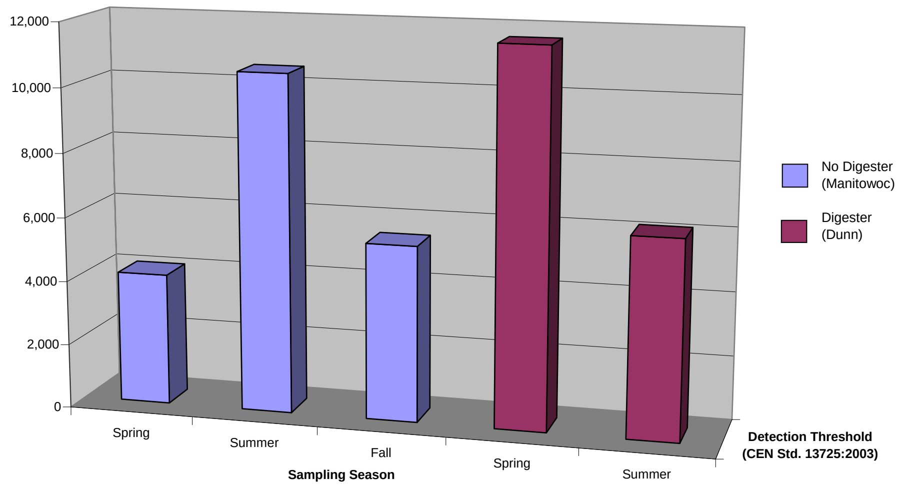

Figure 2.11
Flux Chamber Seasonal Average Detection Threshold
Thermophilic Digester Fed Lagoon (Dunn County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

These data seem to verify our Nasal Ranger™ readings of a slight increase in odor from the lagoon receiving digested manure as compared to the lagoon receiving undigested manure.

We theorized that the main reason for this was incomplete digestion, as with the Waupaca digester, but other factors were at play here as well. For one, because this digester operated at a higher temperature, the discharged manure exited at about 120^{o} F. Odors in and around the discharge point were quite elevated, which may have affected the downwind Nasal Ranger™ readings. Also, there had been times when the digester was shut down for repairs. During this downtime undigested manure was sent directly to the lagoon. Also, substrate fats and oils were being added to this digester on a regular basis. This is a common practice with many digesters to help boost gas production. Our sampling indicated that the volatile fatty acid levels in the digested manure were occasionally higher than in the feed manure (see Figure 2.12 below). The added fats and oils could account for this finding. All of these factors; partially undigested manure, higher temperatures, gas flare failures, and elevated VFAs could help to explain why odor levels were slightly higher than what we observed at the control farm.

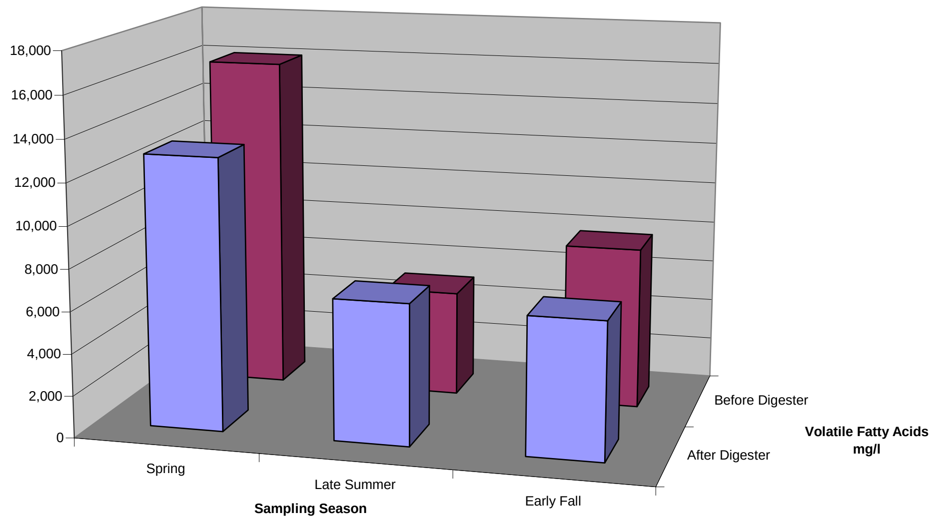

Figure 2.12
Volatile Fatty Acids, mg/l
Seasonal Sample Results, Thermophilic Digester Fed Lagoon (Dunn County)
Before Digester vs. After Digester

Comparing the volatile fatty acid levels in the lagoon at this farm to the levels in the lagoon on our control farm also supports our findings that thermophilic digestion can lead to increased odors (see Figure 2.13 below). Although these results are not as consistent as what was found at the Waupaca farm, it is clear that VFA levels are not always reduced. Again, this may be due to the addition of the fats and oils as a substrate material.

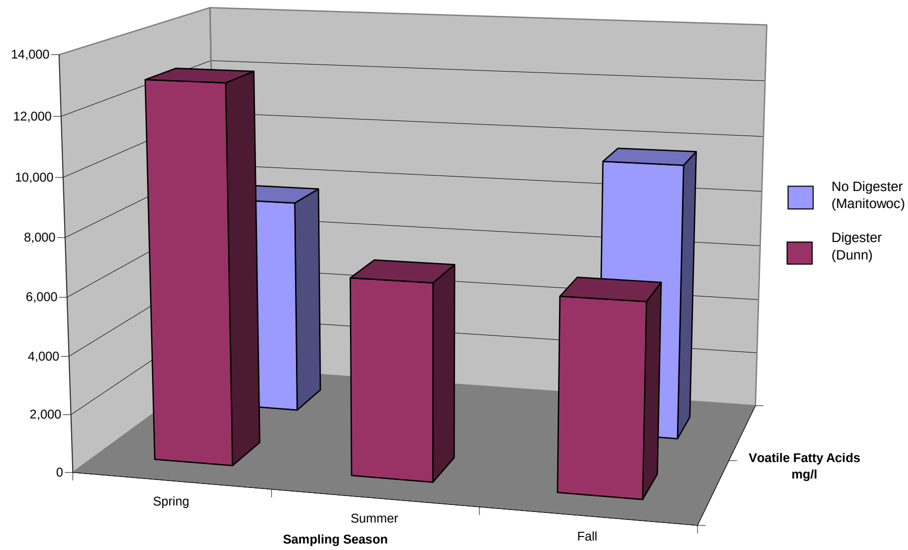

Figure 2.13
Volatile Fatty Acids, mg/l
Thermophilic Digester Fed Lagoon (Dunn County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

Taking all this information into account, it appears that this thermophilic digester did not reduce odors, when compared to a lagoon receiving undigested manure, and may actually have resulted in a slight (15% +/-10%) increase in odors.

Figure 2.14 below shows the comparison of Nasal Ranger™ readings taken in the field at the Manitowoc and Dunn County farms, to the odor scores for the waste storage lagoons on those same farms, using the odor model in ATCP 51. The odor score was calculated for the lagoons assuming the nearest neighbor was located at various distances downwind. These scores were plotted against separation distance to create an odor score curve. The Nasal Ranger™ odor results were then plotted against distance on the same graph. This allowed us to determine the measured average odor level at the distance that corresponds to a passing odor score of 500.

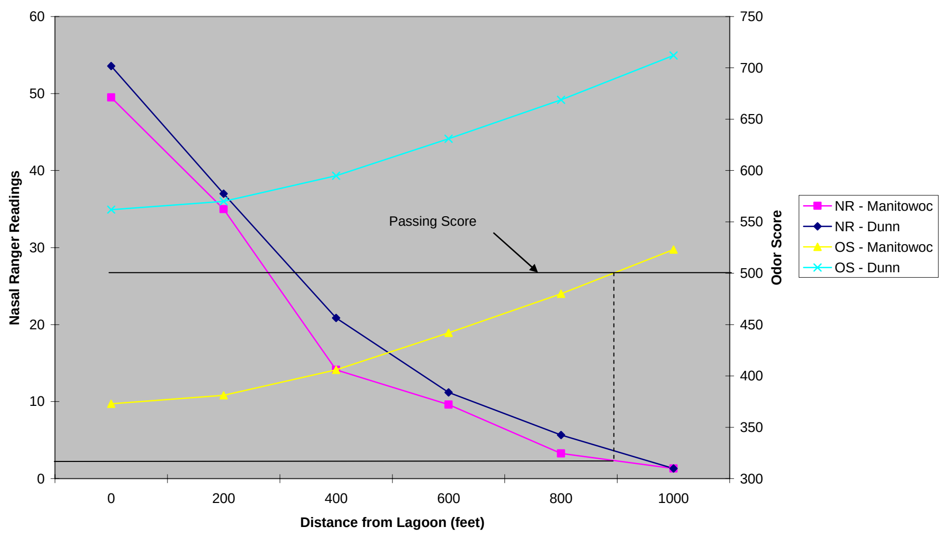

Figure 2.14
Comparison of Nasal RangerTM Readings to the Odor Score
Thermophilic Digester Fed Lagoon (Dunn County) vs.
Manure Storage Lagoon – No Digester (Manitowoc County)

Looking at these results, we see a very good correlation between the field readings and the predicted odor score at the Manitowoc farm. The yellow line with triangles is the odor score curve, and the red line with squares is the Nasal Ranger™ field readings curve. Drawing a horizontal line at a passing odor score of 500, and then dropping down from where that line intersects the odor score curve, we see that the point corresponds with a separation distance of just under 900 feet. At this distance the Nasal Ranger™ field readings averaged about 2, the lowest measureable reading. This result indicates that for medium sized waste storage lagoons (4.2 acres) the odor standard was collaborated by our field odor measurements.

Unfortunately, this is not the case for the digested lagoon at the Dunn County farm. There was a poor correlation between the field readings and the predicted odor score for that lagoon. The blue line with X's is the odor score curve, and the black line with diamonds is the Nasal Ranger™ field readings curve. Nowhere does the odor score curve drop below 500, indicating that a passing score can be achieved at any separation distance, a significant improvement over the undigested lagoon. In the field, however, the Nasal Ranger™ readings showed a slight increase in odors over the undigested lagoon at all distances up to 1,000 feet. This indicates the need to further investigate the odor control potential of digesters and possibly adjust the credit given to them in the odor standard.

Case Study 3: Permeable Lagoon Cover (Kewaunee County)

Background

Our Kewaunee County farm was a large dairy situated on very open and flat terrain. The manure storage lagoons were separated from all other farm structures by over 400 feet. This arrangement made for almost ideal conditions for an air sampling study. For most wind conditions it was possible to isolate the lagoons from the other sources on the farm and thus minimize background interference (see Figure 3.0).

Figure 3.0
Kewaunee County Farm Layout

At the start of the study, the farm housed 1,500 milking cows in two large sand-bedded freestall barns. These barns were manually scraped three times daily into cross gutters that were flushed with recirculated wastewater pumped from the second waste storage lagoon. A sand separation channel was used to reclaim a majority of the sand for reuse as bedding. After passing through the sand channel the wastes went to a 2 million gallon primary waste storage lagoon, where the remainder of the sand was allowed to settle out, and then overflowed to a 13 million gallon secondary lagoon. Our study treated the two lagoons as one larger one. Since only a narrow berm separated the two, it was not possible to isolate one from the other, especially under variable wind conditions.

At the end of our study, the farm had undergone an expansion of 500 animals, added a new freestall barn, and dug a new 15 million gallon waste storage lagoon adjacent to the second lagoon. Despite these changes, it was still possible to monitor the existing lagoons without interference from the added structures, due to favorable wind conditions during our follow-up visits.

The odor control practice that was evaluated at this farm was a permeable geotextile membrane cover on the waste storage lagoon (see Figure 3.1). Both the large secondary lagoon and the newly built lagoon were fitted with covers. The small primary lagoon was not, however that lagoon consistently had a thick organic crust on it, making a cover unnecessary. The theory behind permeable covers is that they should function much like a natural crust. Gases and precipitation pass through, however the waste/wind interface is broken up, reducing the rate at which gases are stripped from the manure. These covers may also serve as a medium for aerobic breakdown of the wastes near the surface of the lagoon.

Figure 3.1
Permeable Cover on Lagoon #2, Kewaunee County Farm

During our first monitoring visit to this farm, we observed that the sand separation channel was a source of odors. Spot checks with the Jerome meter verified that there were significant H_2S concentrations around this structure. On subsequent visits, air samplers were positioned around the sand channel, in addition to the ones placed around the waste storage lagoon, in an attempt to quantify our observations.

This is also the farm that we selected to conduct a survey of the surrounding neighbors. Survey forms were mailed out to all nearby neighbors before the cover was installed, and then again after installation. The survey particulars and results are described in Appendix C to this report.

Case Study 3 Results Discussion

General Sampling Overview

A total of eight sampling runs have been conducted at the Kewaunee County site to date: three before installation of the permeable cover, three during the first year following, and two during the second year following. During these tests, a total of 361 samples for each parameter have been collected, with 13 H_2S and 14 NH_3 being invalid for reasons in the field. The majority of the invalid samples were collected during the evening of the first sampling trip, which was subject to a rain event without the protection provided by the shelters. The entire evening run for the first sampling trip has been declared invalid because of the paucity of results, and is not considered further.

A summary of the test dates and general conditions is shown in the following table. Parameters include the testing start date and the vector mean wind speed, wind direction and temperature (in degrees Celsius) for both the daytime (AM) and nighttime (PM) sampling runs.

Date	AM			PM		
	VMWS	VMWD	T(C)	VMWS	VMWD	T(C)
06/18/2007	15.6	190	28.8	8.7	240	18.5
08/27/2007	11.9	170	21.9	9.4	180	21.2
09/17/2007	14.2	170	18.6	12.4	170	17.0
05/12/2008	5.5	90	11.6	5.2	160	6.4
06/23/2008	3.7	90	22.2	1.5	170	14.9
07/21/2008	3.5	40	21.3	5.2	0	17.0
05/05/2009	13.0	174	14.0	11.8	180	11.0
06/02/2009	5.5	182	16.9	5.1	35	11.8

Table 3.0
Kewaunee County Test Dates and Basic Meteorology

Standard sampling protocols have been followed for all tests conducted at this site. Additional sampling was conducted around the sand channel on all sampling runs except the first, with results included separately in Section 3.1 following. In addition, sampling was conducted along the berm between the primary and secondary manure storage lagoons (locations 32 and 33) during most sampling runs. Results from these samples are discussed separately from the majority of the ambient samples, as they represent a special case and are less directly comparable to other facilities. No other additional sampling was practical at this facility.

A significant fraction of all successful duplicate samples were collected at Kewaunee (17 of both H_2S and NH_3 pairs) Of these, five H_2S and two NH_3 sampling pairs failed quality criteria. The average RPD of all H_2S duplicate samples is 42.9%, while excluding the worst of these samples (144.3% RPD) results in an average RPD of 30.3%, which is slightly outside of quality limits. The effect of this is to reduce confidence in our data somewhat. The average RPD of the NH_3 samples is 14.7%, well within quality criteria.

Two blanks collected during the 6th sampling run, and one during the 8th, showed detectable quantities of H_2S, with an average of 8.2 µg/sample. The blank levels were subtracted from the results reported by the lab. All other blanks contained non-detectable levels of the parameters.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

Ambient sampling around this facility yields some contradictory and ambiguous results. In this section, results collected around the manure pits are documented. This includes samples collected around the perimeter of the primary and secondary pits, as well as samples collected on the berm between the two. Results from the latter samples will be discussed separately following presentation of the perimeter sample results. Results from additional samples collected along the sand channel are discussed in section 3.1 following.

Ammonia was consistently detected on the downwind perimeter of the manure storage lagoons throughout the project. Concentrations observed were generally consistent within most runs across the downwind edge of the lagoon, as shown by the relatively low relative standard deviations presented in the results tables following. This implies a general source (i.e., the lagoon surface), rather than a strong point source. An exception to this is seen in the nighttime run on September 17-18, 2007, where the sample at location 11 is significantly elevated above those collected elsewhere, as well as being the highest ammonia concentration observed along the perimeter of the lagoon at this facility. It is unknown why the ambient concentration at that point was so high at that particular time.

Concentrations observed after installation of the cover are generally less than those observed beforehand. In fact, the maximum downwind concentrations from each sampling run following installation are less than all of the pre-installation sampling run downwind averages, and most of them are less then the minimum values. We have too small a sample size for the differences to be statistically significant, however, so even though there is an apparent reduction, it is difficult to quantify it with assurance.

Similarly, the perimeter hydrogen sulfide results show an apparent drop. Prior to the cover installation, all sampling runs yielded detectable quantities of this substance. Afterwards, the number of detects is reduced, with several runs returning either one or no detects. This observation is generally supported by the real time Jerome Meter readings recorded during the H_2S surveys. Note that one run, the daytime 6th run, returned a single detect at a relatively high level. This sample appears anomalous, however, because it was not downwind of the lagoon or the sand channel, and is the highest result for this compound on the perimeter of the lagoon. With the exception of this sample, the magnitude of detected hydrogen sulfide along the perimeter of the lagoon appears to drop somewhat as well. Note that results obtained during the second year after installation of the cover show consistently low levels of H_2S.

The sampling runs during the nights of July 21 and 22, 2008 and June 2 and 3, 2009 present another anomalous note. These runs are the only ones during which consistent winds from the north were recorded. Under these conditions, the upwind side of the lagoon is downwind of the sand channel, which is across the road to the north of the lagoons. During these runs, the upwind locations (#'s 12, 14 and 15) showed detectible quantities of both parameters, and two of the H_2S results were equal to or greater than 2 of the three most concentrated downwind concentrations.

The implication of this is that the sand channel has as much or more of an impact 100 meters or more downwind than does being right next to the lagoon. Whether or not this situation existed prior to installation of the cover is not known, as there were no sampling runs conducted under northerly winds at that time. Further discussion is included in section 3.1 following.

Summaries of the downwind samples for each parameter are summarized in the following tables. Values documented in the tables are the averages, maxima and minima of the three highest downwind results, as well as the relative standard deviation (RSD), which is a measure of the variability of the results. Note that "ND" indicates that no samples showed detectable quantities of the parameter of interest. In determining the overall average, tests with no detects are averaged in at zero. The suspect H_2S result from the 6th run is marked with asterisks (*), and not included in the overall calculations.

	Run 1	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Avg	471	416	429	747	818	576	545	624
Max	624	432	507	848	1384	1384	848	1384
Min	390	405	311	649	467	311	390	311
RSD	28.2%	3.4%	24.2%	13.3%	60.4%	46.5%	32.0%	61.6%

Table 3.1
Downwind Ammonia Concentrations Near the Manure Pit, Pre Installation

	Run 4	Run 4e	Run 5	Run 5e	Run 6	Run 6e	Overall	Day	Night
Avg	299	199	344	268	164	215	248	269	227
Max	328	234	429	331	327	309	429	429	331
Min	271	152	186	236	79	131	79	79	131
RSD	9.4%	21.2%	39.7%	20.5%	86.7%	41.5%	40.6%	47.8%	28.3%

Table 3.2
Downwind Ammonia Concentrations Near the Manure Pit, Post Installation

	Run 7	Run 7e	Run 8	Run 8e	Overall	Day	Night	ALL Post Install
Avg	129	98	209	61	124	169	79	198
Max	181	132	369	102	369	369	132	429
Min	95	73	56	37	37	56	37	37
RSD	35.5%	31.1%	74.9%	59.3%	74.4%	66.5%	45.7%	57.4%

Table 3.2a
Downwind Ammonia Concentrations Near the Manure Pit, Post Installation 2nd Year and Overall

	Run 1	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Avg	36	68	157	133	90	104	89	124
Max	65	155	173	262	132	262	262	173
Min	ND	24	136	65	68	ND	ND	68
RSD	91.3%	111.8%	12.1%	84.4%	40.0%	65.8%	91.6%	36.2%

Table 3.3
Downwind Hydrogen Sulfide Concentrations Near the Manure Pit, Pre Install

	Run 4	Run 4e	Run 5	Run 5e	Run 6	Run 6e	Overall	Day	Night
Avg			31	97	ND	57	52	18	66
Max	ND	ND	39	137	*330*	90	137	31	137
Min			25	62		40	ND	ND	ND
RSD			22.7%	39.0%		48.5%	84.2%	88.2%	67.2%

Table 3.4
Downwind H_2S Concentrations Near the Manure Pit, Post Installation

	Run 7	Run 7e	Run 8	Run 8e	Overall	Day	Night	ALL Post Install
Avg	25	51	38	35	37	31	43	46
Max	28	54	59	37	59	59	54	137
Min	23	45	24	31	23	23	31	0
RSD	11.4%	9.4%	48.5%	9.8%	34.3%	43.9%	22.3%	65.6%

Table 3.4a
Downwind H_2S Concentrations Near the Manure Pit, Post Installation 2nd Year and Overall

Results tabulated above are shown in the following graphs. Note that the y-axis scale of the graphs represent µg/m^3, and the before and after scales have been set the same to allow direct comparison of the difference in results. The anomalous H_2S result from the 6th run is included in figure 3.5.

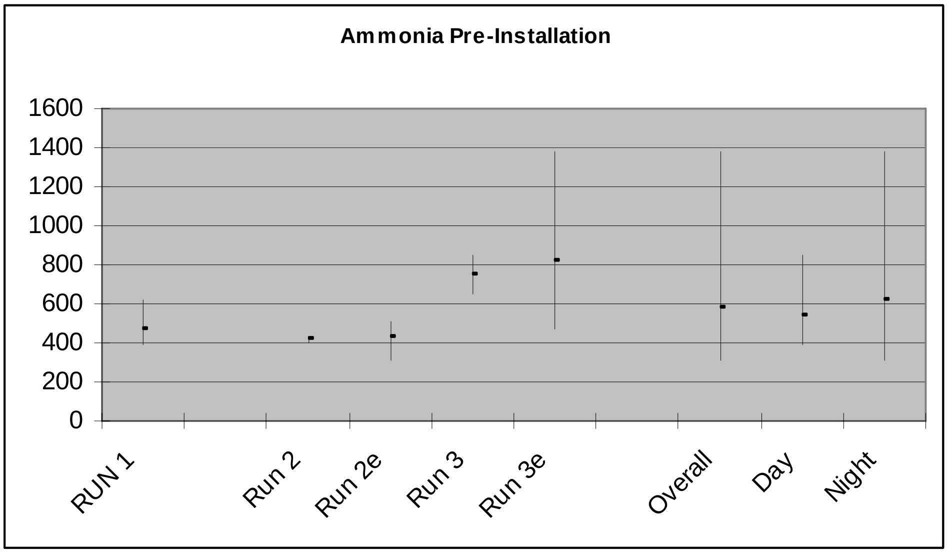

Figure 3.2
Ammonia Pre-Installation (Kewaunee County)

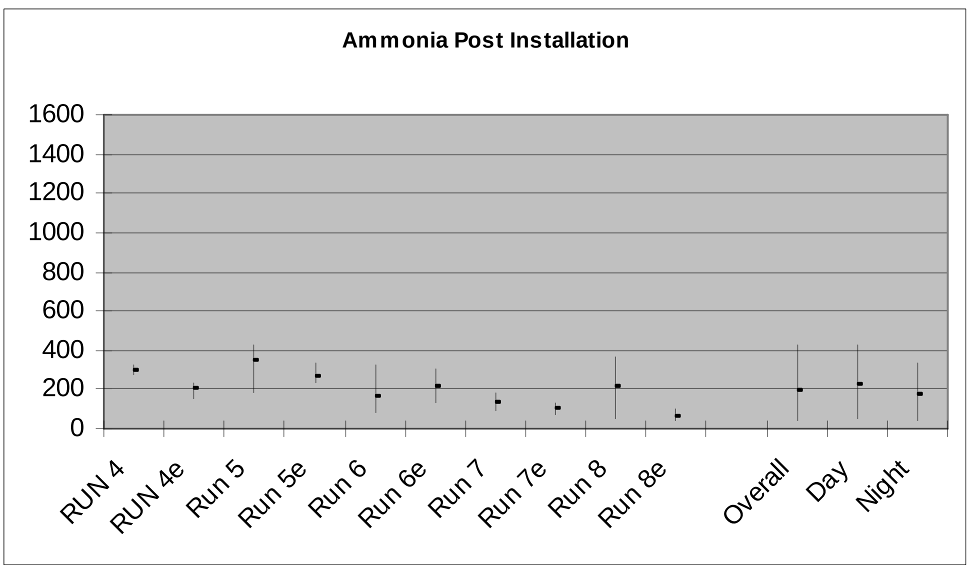

Figure 3.3
Ammonia Post-Installation (Kewaunee County)

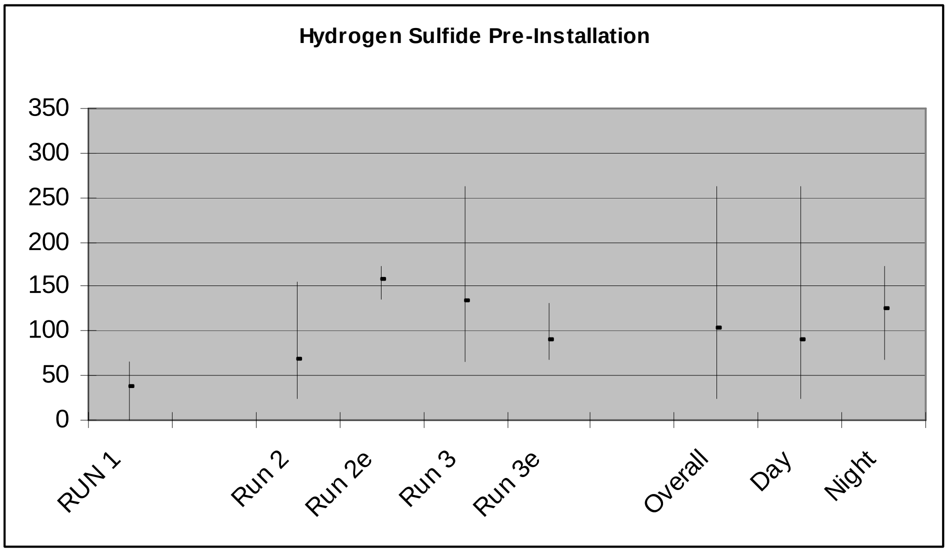

Figure 3.4
Hydrogen Sulfide Pre-Installation (Kewaunee County)

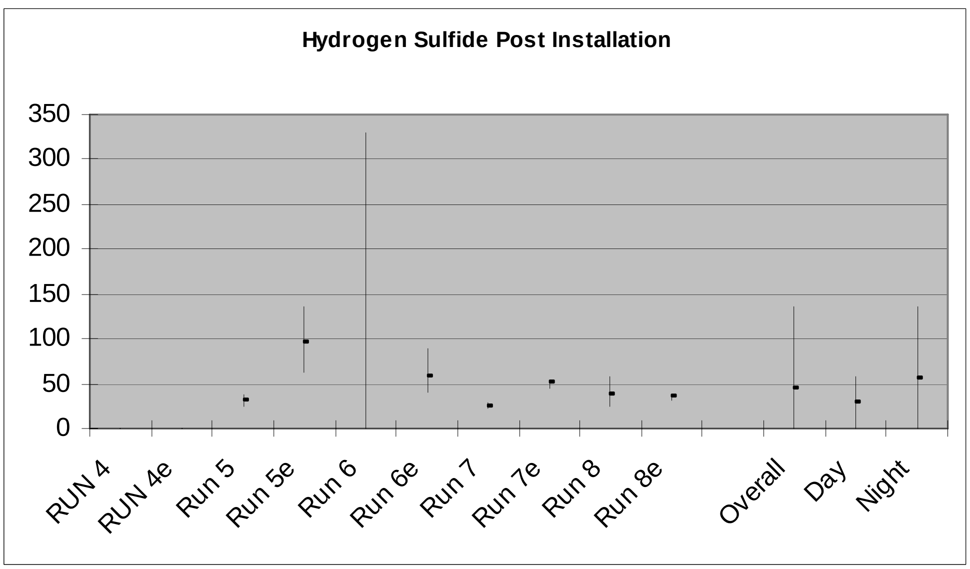

Figure 3.5
Hydrogen Sulfide Post-Installation (Kewaunee County)

While the lagoon perimeter results appear to support the efficacy of the semi-permeable cover in reducing local concentrations of ammonia and hydrogen sulfide, the samples collected on the berm between the primary and secondary lagoons tell a slightly different story.

Prior to the installation of the cover, the outfall between the two pits was an open spillway. This was adopted as a sampling location following the first test (location 32 in the figures), largely because of the significant hydrogen sulfide concentrations observed using the Jerome Meter. Following installation of the cover, the spillway was replaced with a buried pipe leading under the cover, thereby significantly reducing the agitation to the manure during its transfer from the primary to the secondary lagoon. In addition to continuing to sample at this point, a second point on the berm was added for additional coverage (location 33).

Prior to installation, both parameters were consistently detected at the outfall spillway. Interestingly, the maximum daytime hydrogen sulfide value is significantly less than the minimum nighttime value, thus apparently showing the nighttime increases observed also at Manitowoc and around the undigested manure pit at Waupaca. This pattern was not apparent from the other samples collected around this lagoon. Following installation of the cover, however, results observed on the berm changed significantly.

Ammonia results appear to increase somewhat, from an average of about 100 $\mu g/m^3$ to about 250 $\mu g/m^3$ at the outfall. Hydrogen sulfide results are even more variable, with none detected half of the time, but the other half returning an average value (675 $\mu g/m^3$) greater than the maximum value before installation (405 $\mu g/m^3$), as well as the highest lagoon associated H_2S concentration observed at this facility. It should be noted that the nighttime increases continue to manifest for samples where there is a detectable quantity of H_2S. Samples collected during the second year following installation yielded uniformly lower results for both parameters.

At this point it is indeterminable whether the trend in our data is a sampling artifact resulting from the relatively few trips made to the facility, or whether the increases observed along the interior berm of the lagoons is an unexpected result attributable somehow to the cover. The general consistency of the observed increases does suggest a real pattern, however. The increases are even more remarkable given the replacement of the open spillway with an enclosed pipe.

The following table presents the results from the spillway and berm samples before and after the installation of the cover. In addition to each individual result, averages and relative standard deviations are provided.

Spillway, Pre	**Run 2**	**Run 2e**	**Run 3**	**Run 3e**			**Avg**	**RSD**
H2S	45	405	118	169			184	84.3%
NH3	56	56	176	118			102	56.6%
Spillway Post	**RUN 4**	**RUN 4e**	**Run 5**	**Run 5e**	**Run 6**	**Run 6e**	**Avg**	**RSD**
H2S	ND	ND	108	1643	ND	273	337	192.2%
NH3	246	129	258	372	245	297	258	30.8%
Spillway Post	**RUN 7**	**RUN 7e**	**Run 8**	**Run 8e**	**Avg Yr 2**	**RSD**	**Avg All**	**RSD**
H2S	**ND**	**ND**	**69**	**54**	**31**	**117.1%**	**215**	**237.1%**
NH3			**69**	**30**	**49**	**56.1%**	**206**	**57.3%**
Berm Post	**RUN 4**	**RUN 4e**	**Run 5**	**Run 5e**	**Run 6**	**Run 6e**	**Avg**	**RSD**
H2S	ND	ND	68	205	ND	42	53	152.3%
NH3	218	133	334	244	169	125	204	38.7%

Table 3.5
Ammonia and Hydrogen Sulfide Concentrations Between the Lagoons

The spillway results are shown graphically in the following figure. Concentration values are in micrograms per cubic meter.

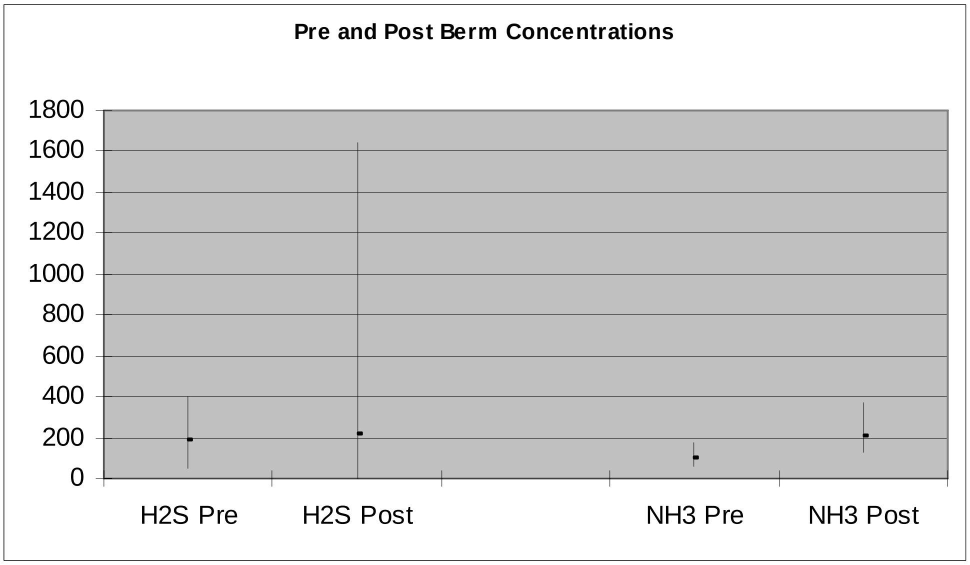

Figure 3.6
Pre- and Post-Berm Concentrations (Kewaunee County)

Manure Surface Sampling
Sampling at the manure surface using the flux chamber was conducted solely on the larger, second manure pit. The graphs below show the maximum, minimum and average values from flux samples collected from the manure surface before and after the installation of the permeable cover. Samples to the left and right represent those collected before and after installation of the cover, respectively.

It should be noted that following installation of the cover, there were significant challenges in maintaining a seal between the flux chamber and the surface sufficient to allow collection of samples. In addition to these difficulties, there was a general interest in sampling from different portions of the cover, so during one sample run the flux chamber might be in a puddle, while during the next it is on a dry patch. These differences contribute to the wide range seen in the results. It should also be noted that due to operator error, surface samples were not collected during the 7th sample run.

Note that a logarithmic scale is used for the value axis, which is in micrograms per cubic meter. Note that the H_2S results following installation were non-detects, so that the graph shows the maximum possible values. These values are somewhat higher than desirable, and any future sampling at this location should use an increased sampling rate to reduce the detection limit.

All NH_3 samples showed detectable quantities both with and without the cover. It is interesting to note that the permeable cover has significantly reduced the H_2S concentrations observed at the lagoon surface, while not significantly affecting the NH_3 concentrations.

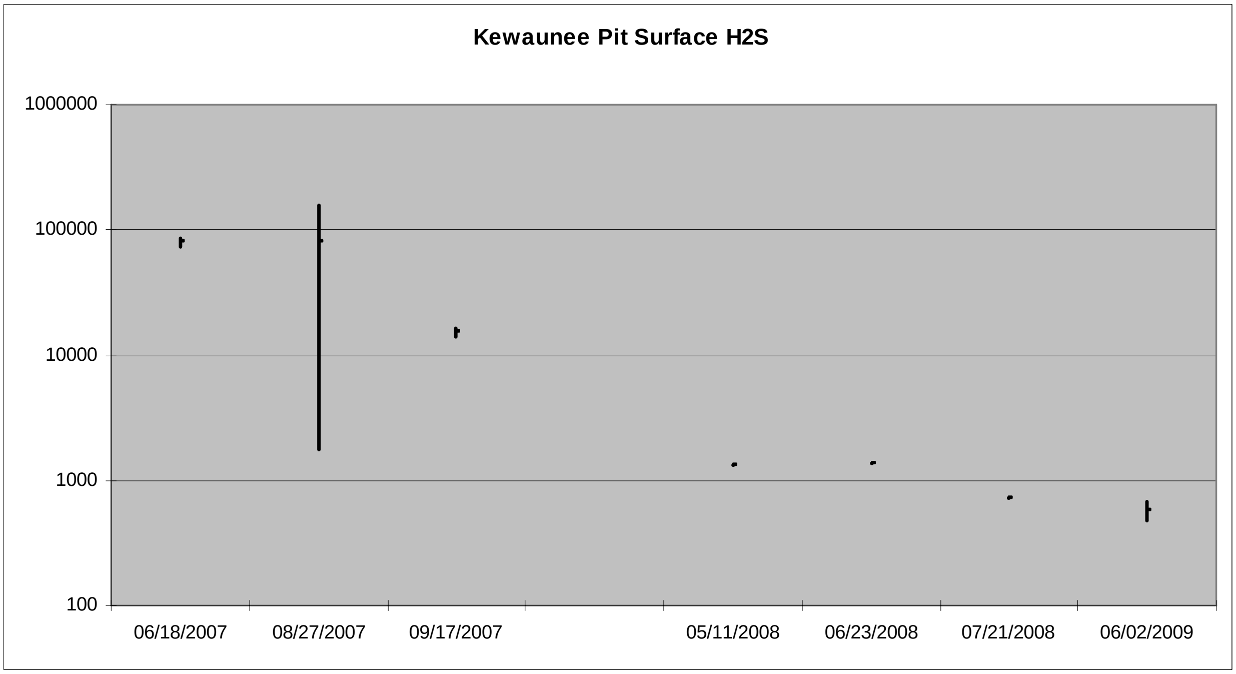

Figure 3.7
Lagoon Surface H_2S (Kewaunee County)

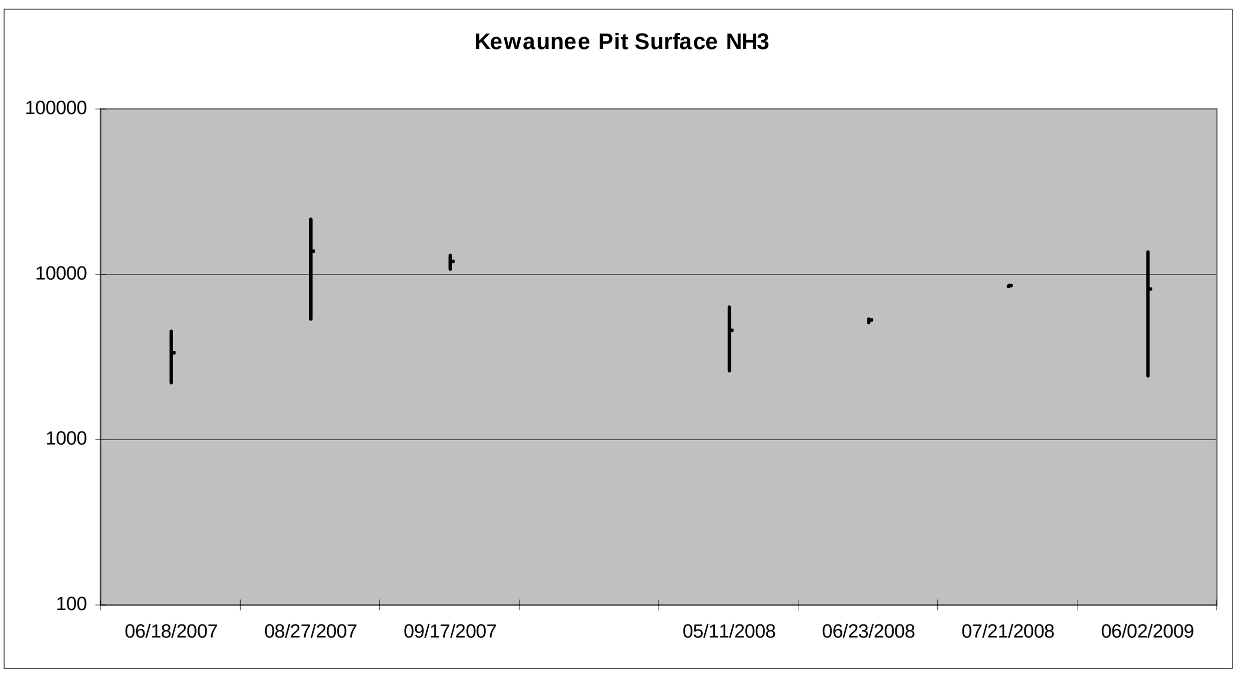

Figure 3.8
Lagoon Surface NH_3 (Kewaunee County)

Case Study 3 Key Findings Summary Statements

Installation of the semi-permeable cover appears to have led to reductions in lagoon perimeter ambient concentrations of both ammonia and hydrogen sulfide, although there is some ambiguity in this conclusion.

Ambient concentrations of both parameters observed near the spillway between the primary and secondary lagoons appear to increase following installation of the cover, in spite of the reduction of exposed surface area and turbulence afforded by replacing the open spillway with a submerged pipe.

Lagoon surface concentrations of hydrogen sulfide have been significantly reduced by installation of the cover, which reduced them to levels below the detection limit. The effect of the cover in reducing surface concentrations of ammonia was slight, if present at all.

Project Focus Key Comparison ~ Case Study 3: Permeable Cover (Kewaunee County) – Before Cover vs. After Permeable Cover

The outcome of the odor transects conducted on the three initial trips to the Kewaunee County farm are depicted in the data supplement. These represent the odors being generated by a typical earthen lagoon without a cover. The outcome of the odor transects conducted on the three follow-up trips to the same farm are depicted in the data supplement. These represent the odors being generated by the same lagoon with a permeable (Geotextile) cover installed.

Comparing these two sets of figures it appears that the cover was quite effective at controlling odors. This is not unexpected since the cover is acting like an artificial crust, which has been shown to reduce odors from lagoons on other farms.

Graphing the odor readings from this lagoon, both before and after the installation of the cover, it becomes clear how effectively the cover controlled odors (see Figure 3.9). By averaging the results from each set of trips, the overall reduction in odor is about 80% (+/-10%) for the first year, and about 60% (+/- 10%) for the second year. However, note that the vertical lines representing the range of values observed at each location display some overlap in the data.

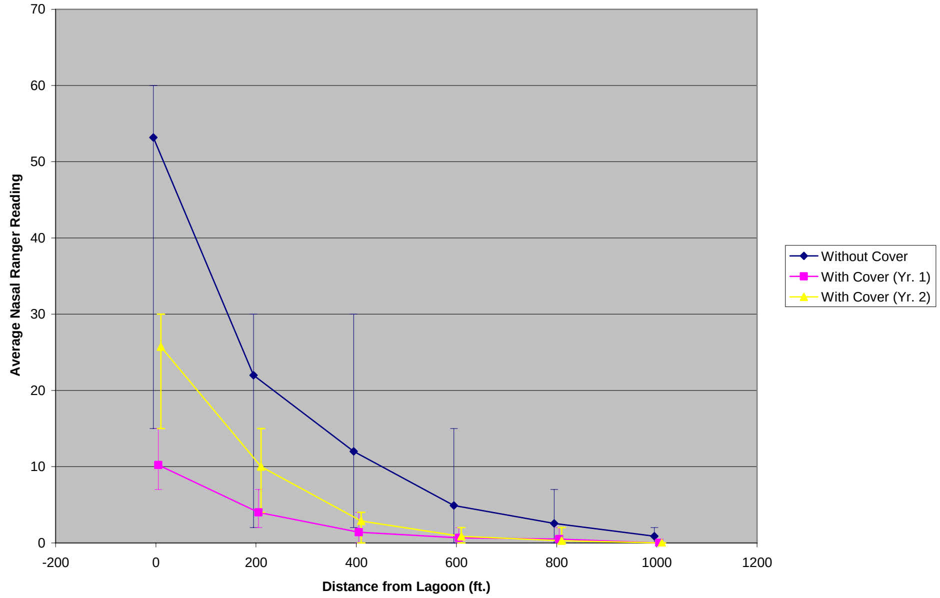

Figure 3.9
Average Nasal Ranger™ Reading at 200 ft Intervals
Before Cover vs. After Permeable Cover (Kewaunee County)

The flux chamber testing from this lagoon, with and without the cover, mirrored our Nasal Ranger™ readings. Figure 3.10 below is a bar graph depicting the laboratory-determined odor intensities of our flux chamber samples. The first three bars are for samples taken from the lagoon surface before the cover was installed, and the last four bars are for samples taken directly off the geotextile cover.

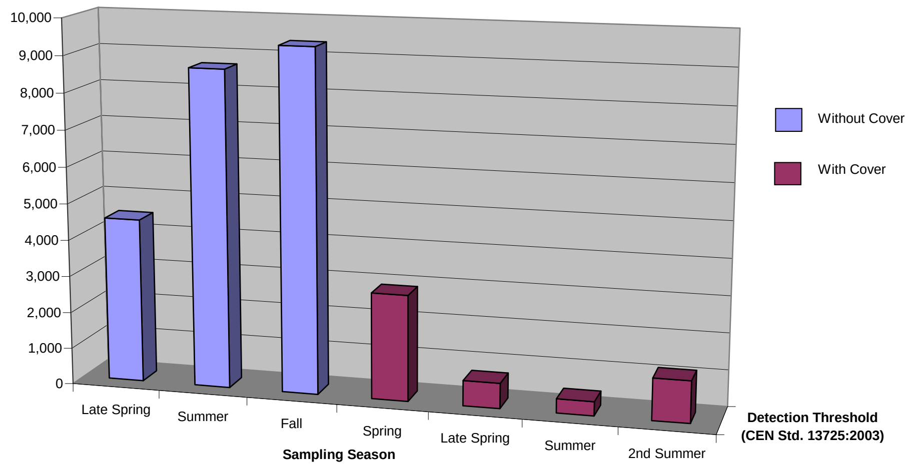

Figure 3.10
Flux Chamber Seasonal Average Detection Threshold
Before Cover vs. After Permeable Cover (Kewaunee County)

These data support the Nasal Ranger^{TM} findings that a permeable cover can provide a high level of odor control. The follow-up data from the second year seem to indicate that the level of control dropped off over time, however, the overall performance was still very good. We hope to continue to monitor this installation to determine the long term performance of this control technology.

Figure 3.11 below shows the comparison of Nasal Ranger^{TM} readings taken in the field at our Kewaunee County farm, to the calculated odor scores for the waste storage lagoon on that farm. The odor score was calculated for the lagoon assuming the nearest neighbor was located at various distances downwind. These scores were plotted against separation distance to create an odor score curve. The Nasal Ranger^{TM} odor results were then plotted against distance on the same graph. This allowed us to determine the measured average odor level at the distance that corresponds to a passing odor score of 500.

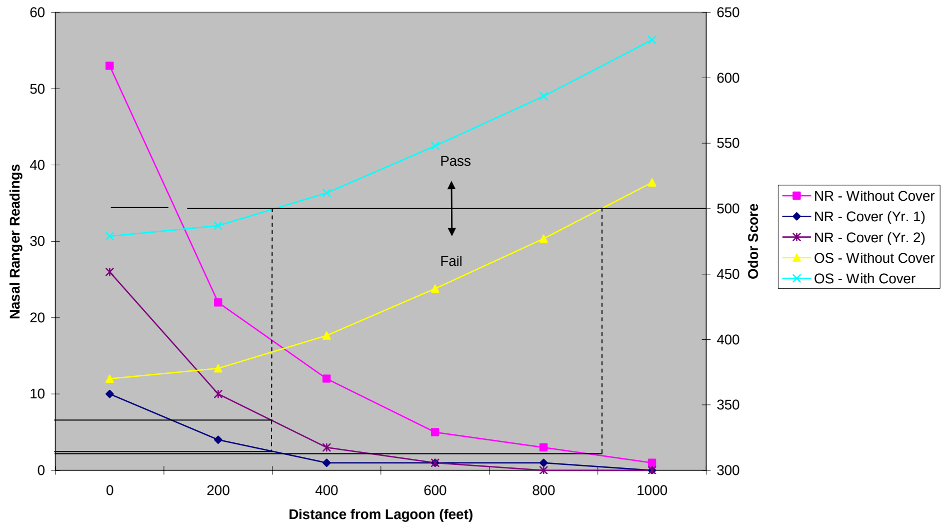

Figure 3.11
Comparison of Nasal Ranger™ Field Readings to the Odor Score Before Cover vs. After Permeable Cover (Kewaunee County)

Looking at these results, we see a very good correlation between the field readings and the predicted odor score. The yellow line with triangles is the odor score curve before a cover was installed, and the red line with squares is the “before” field readings curve. Drawing a horizontal line at a passing odor score of 500, and then dropping down from where that line intersects the odor score curve, we see that the point corresponds with a separation distance of just over 900 feet. At this distance the Nasal Ranger™ field readings averaged around 2, the lowest measureable reading. This indicates that for medium sized waste storage lagoons (3.8 acres) the odor standard was collaborated by our field odor measurements.

Following the same exercise with the permeable cover installed, the horizontal passing score line intersects the blue curve with X’s at a separation distance of 300 feet. This in turn corresponds with an average “after” Nasal Ranger™ reading the first year (black curve with diamonds) of just over 2 and an average reading the second year (yellow line with triangles) of about 6, both acceptable levels. This indicates that the odor control credit given for permeable covers in the odor standard was collaborated by our field odor measurements.

Case Study 4: Solids Separation and Aeration (Monroe County)

Background

Our Monroe County farm was the smallest of our farms in the study, as well as being the newest. This was a green field site where a state-of-the-art dairy was built from the ground up in about two year's time (see Figure 4.0). The freestalls house 357 milking cows, 30 freshening heifers, and 50 calves. The cows are bedded on sand; however, the plan is to eventually bed them on separated manure solids, once the system is fully functional. Flushing the alleys with recirculated waste from the secondary basin cleans the single freestall barn multiple times daily.

Figure 4.0
Monroe County Farm Layout

The practice being evaluated for our study was solids separation and basin aeration (see Figures 4.1 & 4.2). This is a proprietary system developed by *Integrity Co.*, Chambersburg, PA. Flushed wastes coming from the freestall barn are passed through a screen press separator, which removes most of the liquids from the manure. These liquids are piped to a 1 million gallon primary waste storage lagoon, which then overflows to a 4 million gallon secondary lagoon. Manure solids (containing about 80% moisture) are stockpiled on a concrete pad. The recovered solids are currently being used as a soil amendment, however as mentioned earlier, they eventually will be used as bedding material in the freestall barn.

Figure 4.1
***Integrity Co.*, Solids Separators**

Figure 4.2
Floating Aerator on Secondary Basin

The small primary waste storage lagoon is equipped with a single floating aerator and the large secondary lagoon is equipped with two. The following explanation provided by the system developer describes the theory behind how the system functions:

> "Two *Integrity* Roller Press Separators are utilized to remove the coarse solids matter to allow for proper operation of the aeration system and to allow for irrigation and flushing of the separated effluent. All of the flushed manure, bedding, and parlor inputs are processed through these units. They are controlled via automatic level controls for operation throughout the day.
>
> Separated liquids flow via gravity into a dual stage lagoon system. The first stage is approximately 948,000 gallons with the secondary basin being 4.1 million gallons. The first basin is designed as a primary treatment basin allowing for increased detention of the liquid flow for additional treatment. One 5 HP aspirating style aerator will be used on this basin using a facultative treatment approach. The basin is maintained at a full liquid level throughout the year, with the exception of periodic sludge removal events.
>
> The secondary aerated treatment basin performs a treatment role primarily through induced settling and a storage function for wastewater inputs. It is also the location from which primary recycled flushwater and land applied liquids will be withdrawn. This basin will also use a facultative style treatment approach in which two 5 HP floating aspirating style aerators will be used to induce oxygen into the upper three feet of the basin. This facultative style treatment, rather than full aerobic treatment,

helps minimize horsepower and operating inputs. A dissolved oxygen level equal to or greater than 0.1 mg/L will be the target maintenance level. These aerators work by using a directly connected motor to spin a hollow shaft fitted with a propeller at the far end. This creates a venturi effect that draws air down through the main aerator tube where it is injected below the surface and is forced forward by the propeller. A minimum depth will be maintained in the treatment basins so as to not force settled solids off the bottom.

The aeration is not designed to fully treat the BOD load, rather it is meant to improve the overall quality of the recycled water in relation to odor level and mucous content. The lower aeration level also helps to minimize sludge production from aerobic treatment processes. Aerated liquids from the upper levels of the secondary basin will be drawn off and used for flushing the freestall barn. When it is necessary to lower the basin level, some of these liquids will occasionally be drawn off for land application." (Source: Provided by *Integrity Co.* <http://www.integrityagsystems.com/>)

During our first visits to this farm the solids separation equipment had been installed and tested, but was not running, therefore unseparated wastes were being sent directly to the first basin. Also, the floating aerators were on site, but had yet to be installed. This provided an opportunity for us to do some "before" sampling. On our subsequent visits the following year, the two separators and three aerators were all operational, giving us an "after" picture.

Case Study 4 Results Discussion

General Sampling Overview

A total of six sampling runs were made to this facility, with two performed before the aerator was turned on, and two during each of the next two years following. Solids separation was functioning for all runs. During the first sampling run, the second manure pit was nearly empty. A total of 278 samples for NH_3 and 278 for H_2S have been collected, of which 258 NH_3 and 263 H_2S have been submitted to the laboratory for analysis. Void samples are evenly distributed and no single run experienced sufficient sample loss to invalidate it.

A summary of the test dates and general conditions is shown in the following table. Parameters include the testing start date and the vector mean wind speed (in meters/sec.), wind direction (in degrees from north) and temperature (in degrees Celsius) for both the daytime (AM) and nighttime (PM) sampling runs. Note that the test continued to the day following the test date.

Date	AM			PM		
	VMWS	VMWD	T(C)	VMWS	VMWD	T(C)
06/11/2007	7.7	170	26.8	1.1	60	16.4
10/29/2007	4.9	200	14.0	2.3	180	7.7
06/09/2008	8.1	250	22.8	1.2	140	15.9
07/07/2008	4.5	170	24.4	4.7	210	20.6
05/19/2009	10.9	195	26.4	10.4	180	24.3
06/16/2009	13.2	100	22.4	3.9	80	15.6

Table 4.0
Monroe County Test Dates and Basic Meteorology

Standard sampling protocols have been followed for all tests conducted at this site. Additional sampling was conducted in several locations, including inside the second manure pit near the outfall pipe during the first sampling run when the pit was nearly empty, near the separator building, and multiple barn oriented samples.

A significant fraction of all successful duplicate samples were collected at Monroe (17 of both H_2S and NH_3 pairs) Of these, four H_2S and six NH_3 sampling pairs failed quality criteria. The average RPD of all H_2S duplicate samples is 17.3%, and the average RPD of the NH_3 samples is 42.3%. Removing the two worst NH_3 duplicates from consideration provides an RPD of 26.2%.

Four H_2S blanks collected showed detectable quantities, with an average of 5.9 μg/sample. The blank levels were subtracted from the results reported by the lab. All other blanks contained non-detectable levels of the parameters.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

This facility is relatively unique among the farms we have chosen to sample. It is by far the smallest operation in terms of animals on site. It is the newest operation, although some of the facilities added on during the course of our study and therefore have newer portions. The initial manure storage lagoon has the smallest surface area of any of the manure lagoons sampled. The size of this lagoon allowed for us to deploy a greater coverage of samplers than anywhere else in our study, thereby providing much a much tighter spatial distribution of results. Especially during some of the later sample sets, distances between samplers could be as low as 25 feet or less.

Interpretation of results obtained from sampling around the lagoons at this facility is complicated by the fact that the farm was new from the ground up, and during the initial sampling run (in June, 2007) the secondary storage lagoon was almost empty. The following sampling trip occurred at the end of October 2007, in significantly cooler weather than the post-practice installation sampling runs. The comparison between the different trips is radically impacted because of these conditions.

For example, during the first sampling run, conducted on June 11 and 12, 2007, ambient concentrations observed around the second manure lagoon (locations 11 – 21) are generally lower than those around the smaller lagoon. This is undoubtedly related to the smaller lagoon being full, and the second being nearly empty.

While this situation was rectified by the time of the second sampling trip in October 2007, and concentrations around the lagoons are similar, the overall magnitude of the concentrations is significantly less than the maximum samples observed during all other testing runs. The cause of this is likely related to the cooler weather, but fully evaluating the impact of this based on our results is not really feasible.

The combination of these factors, plus the very limited sampling conducted around this facility (2 tests pre-installation, and 2 tests post), leads to a situation wherein there are apparently significant increases in nearby ammonia and hydrogen sulfide concentrations following installation of the aerators, especially during the first year following installation. Discerning the validity of this observation is the challenge in evaluating this dataset.

Summaries of the downwind samples for each parameter are tabulated in the following tables. Values documented in the tables are the averages, maxima and minima of the three highest downwind results, as well as the relative standard deviation (RSD), which is a measure of the variability of the results. Note that "ND" indicates that no samples showed detectable quantities of the parameter of interest. In determining the overall average, tests with no detects are averaged in at zero.

UPPER	**Run 1**	**Run 1e**	**Run 2**	**Run 2e**	**Overall**	**Day**	**Night**
Avg	743	450	232	272	424	488	361
Max	817	586	282	345	817	817	586
Min	611	375	186	219	186	186	219
RSD	15.5%	26.1%	20.7%	24.2%	52.9%	59.6%	36.0%
LOWER							
Avg	105	121	241	154	155	173	138
Max	125	207	312	169	312	312	207
Min	92	51	152	130	51	92	51
RSD	16.0%	65.8%	33.7%	13.6%	47.6%	52.4%	40.1%

Table 4.1
Downwind Ammonia Concentrations
Near Upper & Lower Manure Lagoons, Pre-Installation

UPPER	**Run 3**	**Run 3e**	**Run 4**	**Run 4e**	**Overall**	**Day**	**Night**
Avg	725	1068	843	600	809	784	834
Max	1036	1211	871	837	1211	1036	1211
Min	542	855	798	373	373	542	373
RSD	37.4%	17.6%	4.6%	38.7%	30.9%	23.6%	38.2%
LOWER							
Avg	1364	487	802	664	829	1083	576
Max	1890	699	945	775	1890	1890	775
Min	897	292	624	576	292	624	292
RSD	36.6%	41.9%	20.4%	15.2%	50.7%	41.8%	30.2%

Table 4.2
Downwind Ammonia Concentrations
Near Upper & Lower Manure Lagoons, Post-Installation

UPPER	Run 5	Run 5e	Run 6	Run 6e	Overall	Day	Night	All Post
Avg	600	431	755	545	596	677	499	707
Max	1082	476	951	657	1082	1082	657	1211
Min	307	386	431	438	307	307	386	307
RSD	70.0%	14.7%	37.5%	20.1%	43.7%	48.9%	20.9%	38.4%
LOWER								
Avg	439	402	365	297	377	410	349	613
Max	923	670	702	373	923	923	670	1890
Min	170	83	29	230	29	29	83	29
RSD	95.6%	73.9%	130.4%	24.2%	75.0%	93.5%	57.7%	68.9%

Table 4.2a
Downwind Ammonia Concentrations
Near Upper & Lower Manure Lagoons, 2nd Year Post-Installation

UPPER	Run 1	Run 1e	Run 2	Run 2e	Overall	Day	Night
Avg	90	47	27	52	54	59	49
Max	122	63	31	76	122	122	76
Min	55	37	23	34	23	23	34
RSD	37.5%	30.1%	14.9%	41.6%	55.6%	69.3%	33.5%
LOWER							
Avg			19		45		
Max	122	ND	22	ND	122		
Min			15		15		
RSD			19.3%		114.9%		

Table 4.3
Downwind Hydrogen Sulfide Concentrations
Near Upper & Lower Manure Lagoons, Pre-Installation

UPPER	Run 3	Run 3e	Run 4	Run 4e	Overall	Day	Night
Avg	454	253	306	452	358	365	352
Max	495	454	527	685	685	527	685
Min	413	109	149	69	69	149	69
RSD	12.8%	70.7%	64.5%	74.0%	59.5%	44.9%	74.7%
LOWER							
Avg	78	76	55	37	61	66	57
Max	146	126	65	54	146	146	126
Min	36	49	46	14	14	36	14
RSD	76.6%	57.1%	18.2%	56.7%	60.6%	60.7%	65.7%

Table 4.4
Downwind Hydrogen Sulfide Concentrations
Near Upper & Lower Manure Lagoons, Post-Installation

UPPER	Run 5	Run 5e	Run 6	Run 6e	Overall	Day	Night	All Post
Avg	357	373	261	240	302	309	293	330
Max	697	569	549	356	697	697	569	697
Min	186	178	86	178	86	86	178	69
RSD	82.6%	74.1%	96.3%	41.8%	68.9%	81.1%	58.5%	62.9%
LOWER								
Avg	140	159	45	61	101	93	110	81
Max	231	182	89	88	231	231	182	231
Min	36	128	18	40	18	18	40	14
RSD	70.1%	17.6%	83.4%	40.2%	68.8%	90.9%	53.2%	71.7%

Table 4.4a
Downwind Hydrogen Sulfide Concentrations
Near Upper & Lower Manure Lagoons, 2nd year Post-Installation

The figures below and on the following pages represent this data in max/min charts. The values on the (Y) axis are in micrograms per cubic meter.

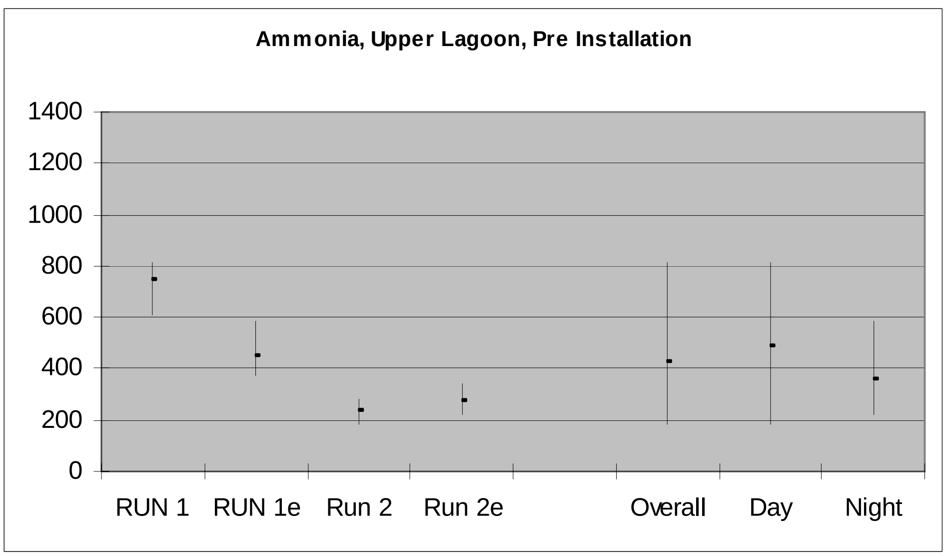

Figure 4.3
Ammonia, Upper Lagoon, Pre-Installation (Monroe County)

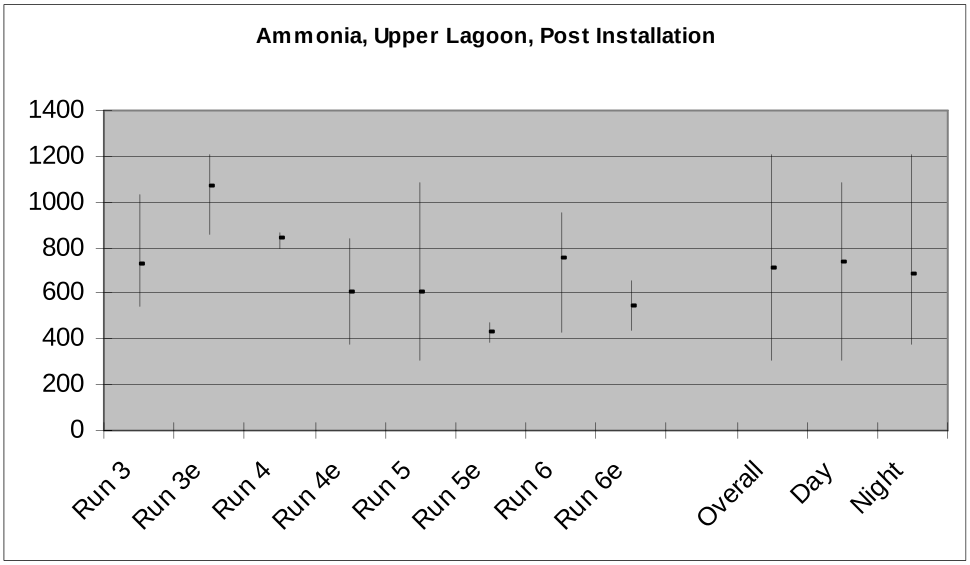

Figure 4.4
Ammonia, Upper Lagoon, Post-Installation (Monroe County)

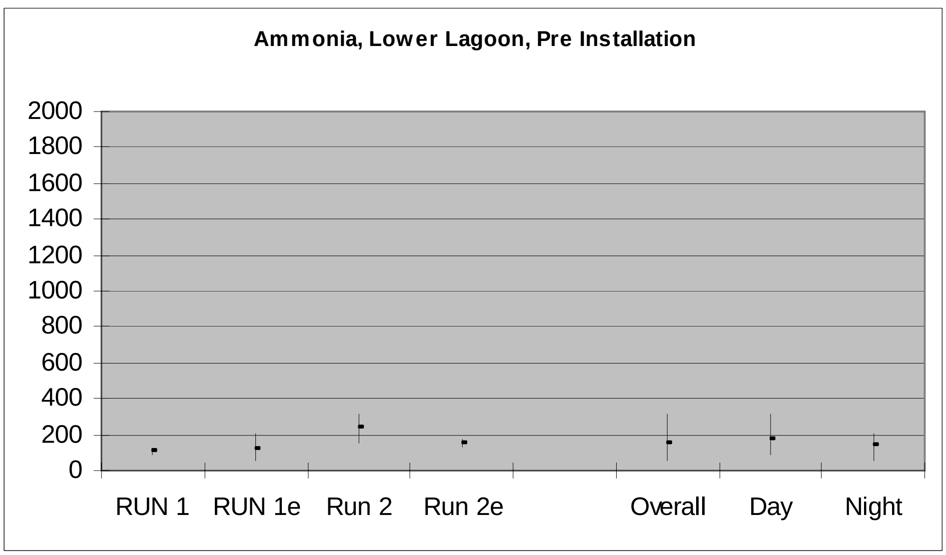

Figure 4.5
Ammonia, Lower Lagoon, Pre-Installation (Monroe County)

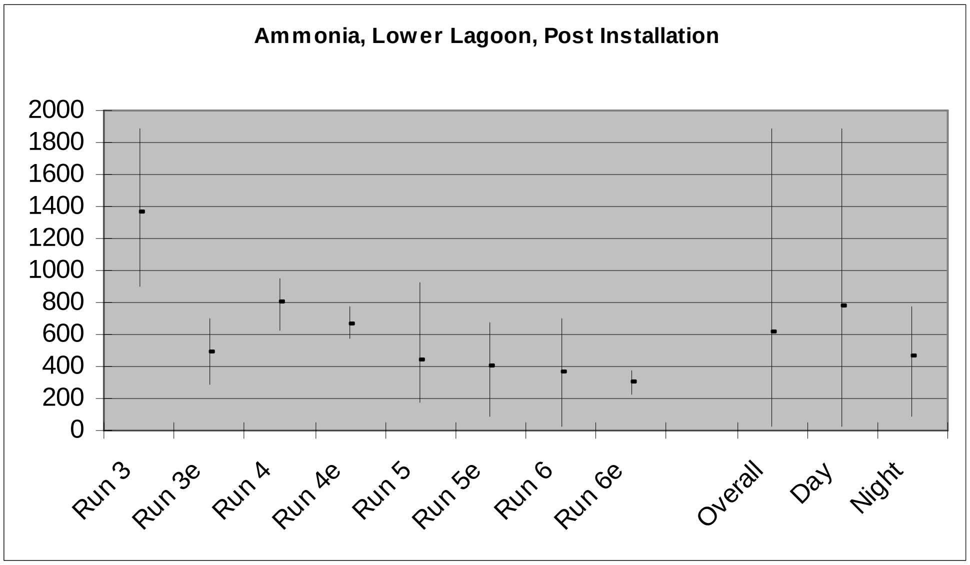

Figure 4.6
Ammonia, Lower Lagoon, Post-Installation (Monroe County)

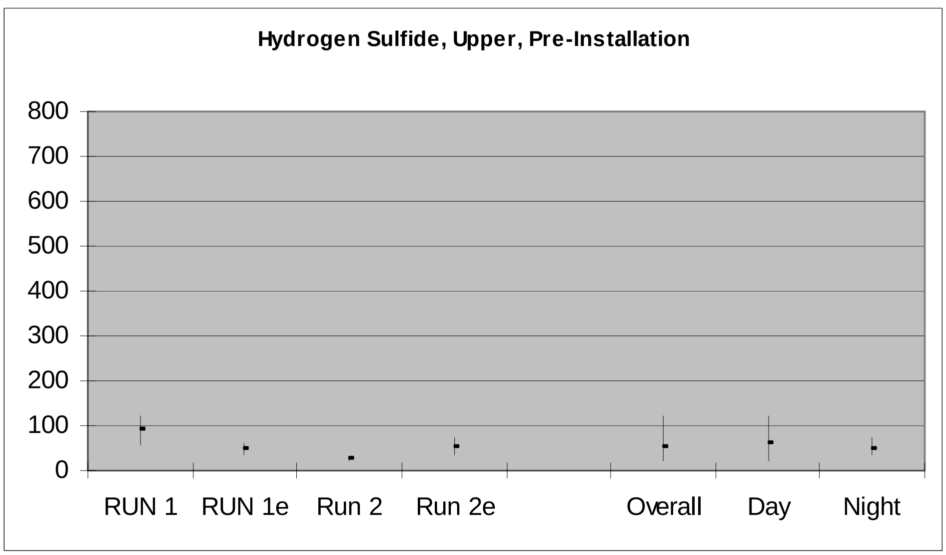

Figure 4.7
Hydrogen Sulfide, Upper Lagoon, Pre-Installation (Monroe County)

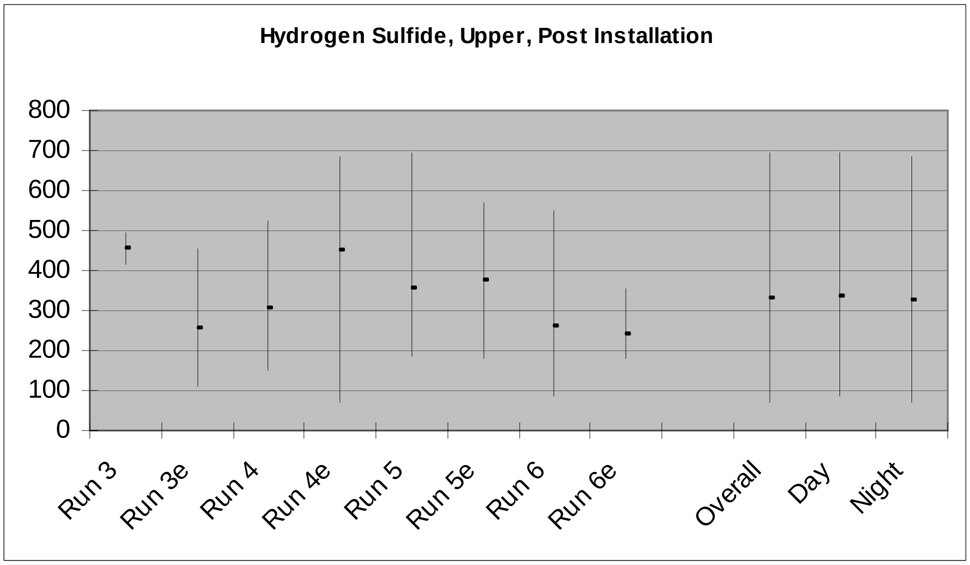

Figure 4.8
Hydrogen Sulfide, Upper Lagoon, Post-Installation (Monroe County)

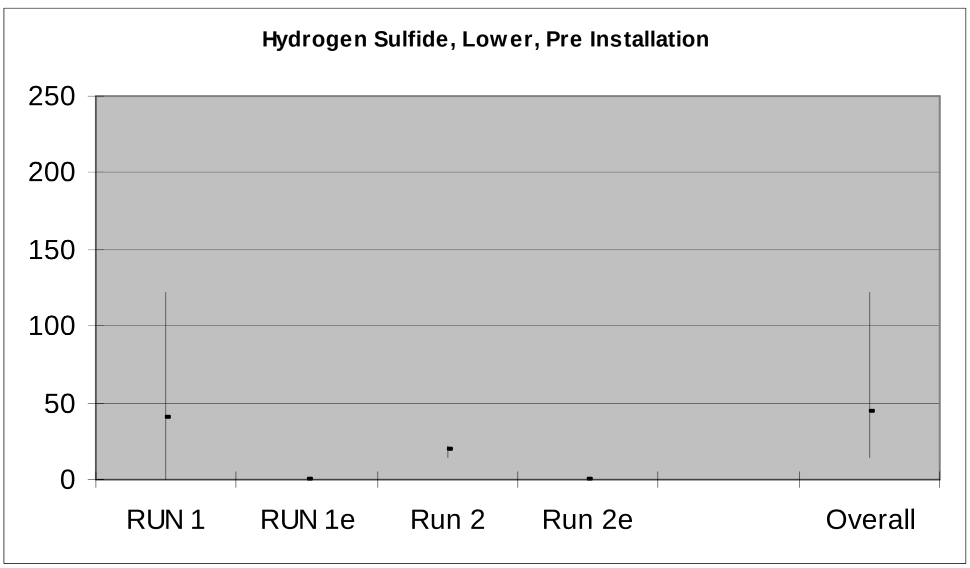

Figure 4.9
Hydrogen Sulfide, Lower Lagoon, Pre-Installation (Monroe County)

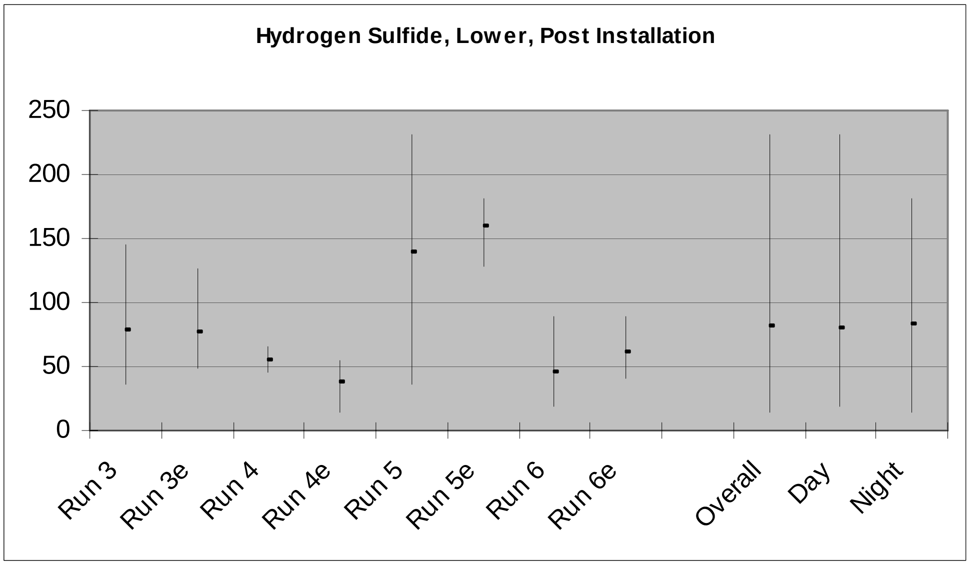

Figure 4.10
Hydrogen Sulfide, Lower Lagoon, Post-Installation (Monroe County)

Data in the tables appears to support the contention that ambient concentrations of both parameters increased following installation of the aeration system, especially hydrogen sulfide concentrations around the upper lagoon. It is important to note, however, that the impacted area appears to be quite small, with adjacent samples returning radically divergent results, even though as little as 25 feet or less may be between them.

The probable cause of this is likely related directly to the aeration units themselves. When a sampler just happens to be directly downwind of one of the aeration units, significantly elevated concentrations are likely to be observed. This situation probably pertains to the large lagoon as well, although results don't necessarily illustrate this point, perhaps because none of our samplers were located directly downwind, or because a greater minimum separation distance was present between the berm and the aeration units, or possibly because the surface of the manure in the larger lagoon was lower relative to the surrounding berm than it was for the smaller lagoon. It should be noted that it is also possible that less hydrogen sulfide is present around the larger lagoon because, in fact, the amount of this compound available in the manure may be reduced.

While none of our sampling sets truly has enough depth for statistically significant conclusions to be drawn from them, and all of the facilities altered on-farm conditions during the study, the data from this farm is the weakest overall. While individual sampling runs are as solid as any of the others, the situational differences between the sampling runs are huge, thereby rendering our sample set inadequate, especially in terms of the pre-installation samples.

In addition to the lagoon oriented ambient sampling, several barn oriented samples were collected during the course of the visits to this facility. These samples include several from downwind of the freestalls, and two pair collected at either end of the eastern freestall.

The locations downwind from the freestalls were about 35 – 50 meters north of the structures during the first sampling run. Two samplers were deployed, one directly to the north of each freestall. During the second sampling trip, the easternmost of these locations was retained, while a second location was established in the corn field about 30 – 40 meters to the east of the freestall, about halfway along its length. During the final sampling run, two extra samplers were available and were deployed just inside the eastern freestall.

Samples collected downwind of the freestalls showed no detectable hydrogen sulfide (with detection limits ranging from 12 – 18 μg/m^3). Ammonia results from these samples are shown in the table below, along with both ammonia and hydrogen sulfide results from the samples collected inside the barns. Note that the "upwind" barn samples were not only still inside the barn, they were downwind of the upper manure lagoon.

	Ammonia	Ammonia In		Hydrogen Sulfide In	
	Downwind	Upwind	Downwind	Upwind	Downwind
Average	87	191	1963	24	32
Max	139	223	2453	32	37
Min	38	160	1473	15	26
RSD	40.6%	23.2%	35.3%	50.9%	23.1%

Table 4.5
Barn Related Ammonia and Hydrogen Sulfide Results

Manure Surface Sampling

During the first run it was only possible to sample on the surface of the small upper manure lagoon because the second lagoon did not hold sufficient material. Following this run, both pits were sampled. Results are shown in the following figures, with the upper pit results to the left and the lower to the right. Note that sampling in 2007 was conducted prior to aeration, while 2008 sampling runs occurred after the system was operating. Sample units are micrograms per cubic meter, presented on a logarithmic scale. Note that while initial H_2S values obtained at the surface of the manure appear to decrease following aeration, second year results are not as clear in this respect. The ammonia values show a general increase during the first year, and a possible increase the second year.

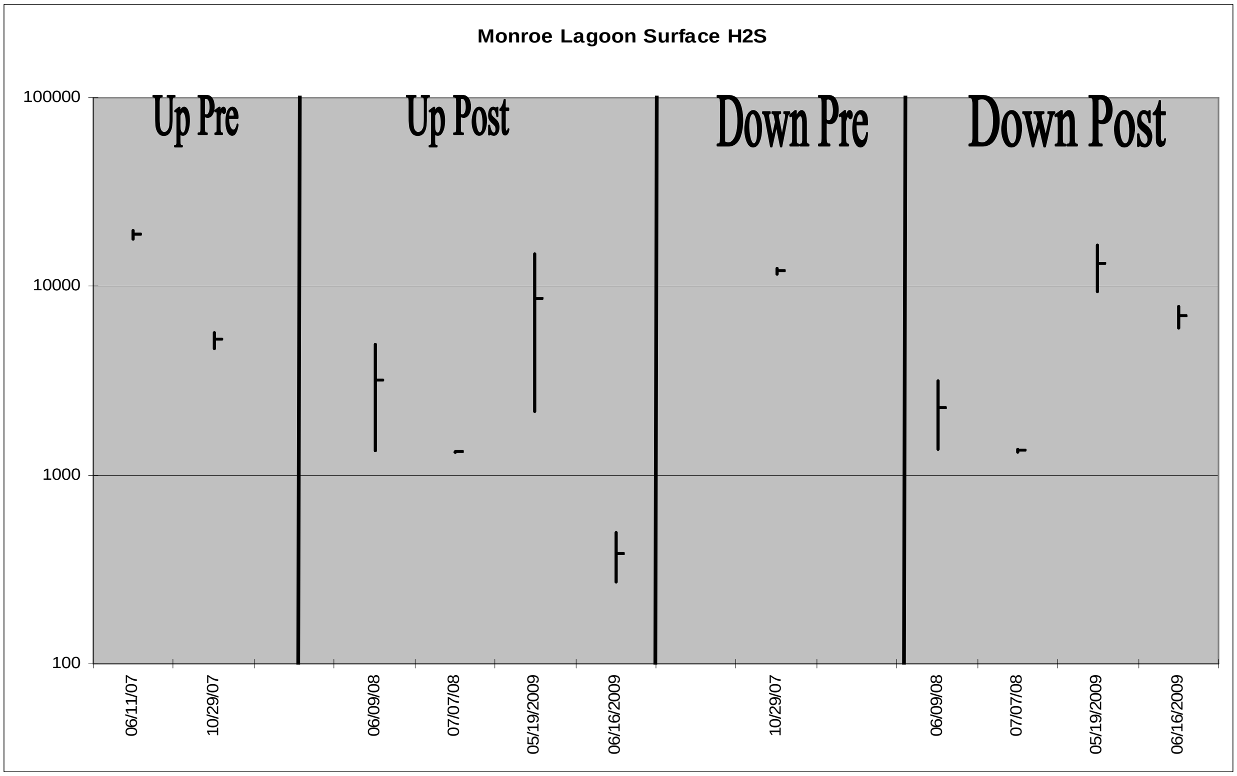

Figure 4.11
Lagoon Surface H_2S (Monroe County)

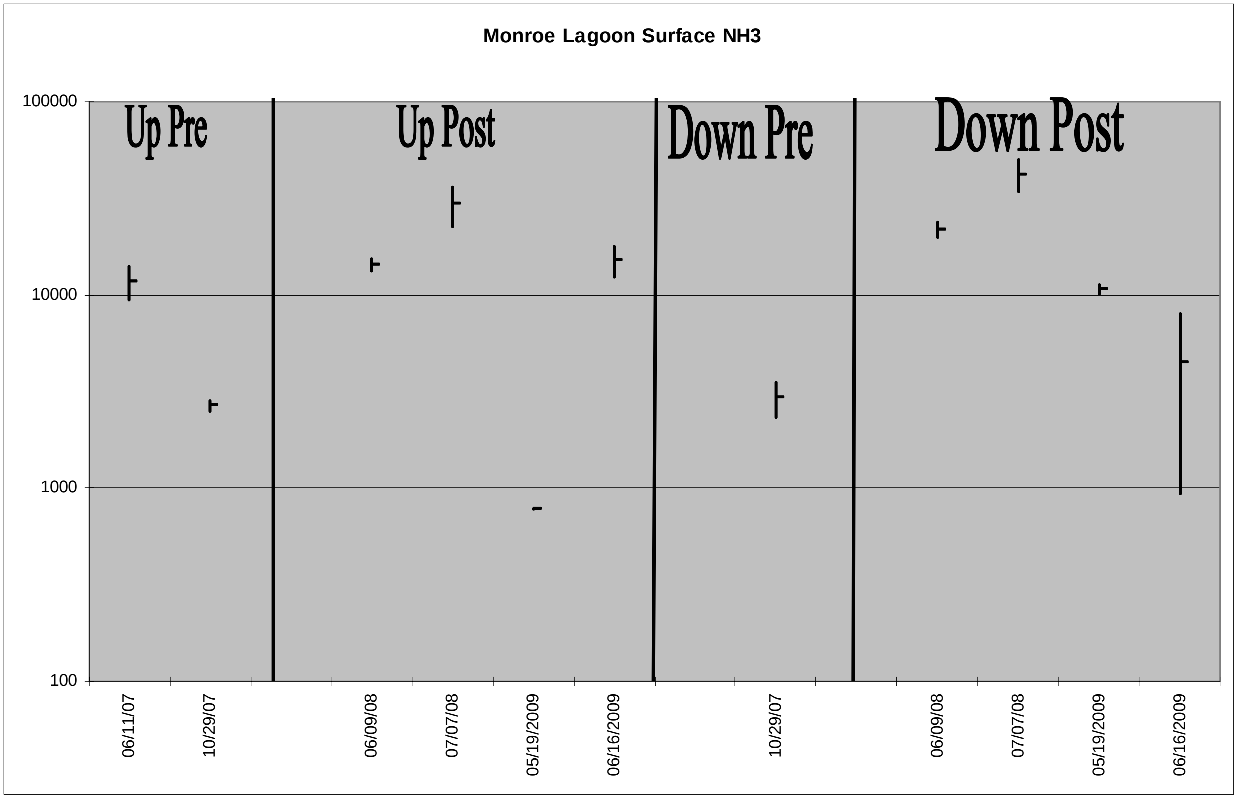

Figure 4.12
Lagoon Surface NH_3 (Monroe County)

Case Study 4 Key Findings Summary Statements

Changes on this farm during the sampling process, combined with the fewest sampling trips before and after installation of a practice, render this data set our most tenuous.

Aeration appears to induce ambiguous and potentially contradictory changes to the parameters we measured during this project. Local concentrations of hydrogen sulfide appear to be significantly elevated after installation, but on a very limited spatial scale. Meanwhile, surface concentrations of this parameter appear to be significantly reduced following aeration. A possible explanation of this combination of factors is that the aeration process is simply aspirating the hydrogen sulfide out of the surface layers of the lagoon, thus reducing surface concentrations while raising ambient concentrations directly downwind.

The effect of aeration on ammonia generation by the lagoons is less clear. Local ambient concentrations may be increased, but insufficient pre-installation data was obtained for this to be a firm conclusion. Surface concentrations of this parameter appear to be significantly elevated following aeration, but potential causes of this possible outcome are entirely unknown at this time.

Project Focus Key Comparison ~ Case Study 4: Solids Separation and Aeration (Monroe County) – Before Practice vs. After Solids Separation and Aeration

The outcome of the odor transects conducted on the two initial trips to the Monroe County farm are depicted in the data supplement. These represent the odors being generated by a typical two-stage earthen lagoon without treatment. The outcome of the odor transects conducted on the four follow-up trips to the same farm are depicted in the data supplement. These represent the odors being generated by the same lagoons after a solids separation and aeration system was installed.

Comparing these two sets of figures it appears that this proprietary system was only slightly effective at controlling odors. Although odors were somewhat reduced overall, the agitation of the lagoon surface caused by the aerators created localized areas of high odor levels.

Graphing the odor readings from these lagoons, both before and after the installation of the system, some reduction in odor appears to be provided by solids separation and aeration, especially beyond 100 feet from the lagoons (see Figure 4.13). By averaging the results from each set of trips, this difference is about a 20% (+/-10%) reduction in odors the first year, and about a 25% (+/-10%) reduction the second year. Note that the vertical lines representing the range of values observed at each data point display considerable overlap. The apparent spike in odor levels adjacent to the lagoons after the system was installed could be attributed to the localized areas of high odor caused by the aerators agitating the lagoon surface. This localized effect quickly dissipates at distances of 100 feet and more from the lagoons.

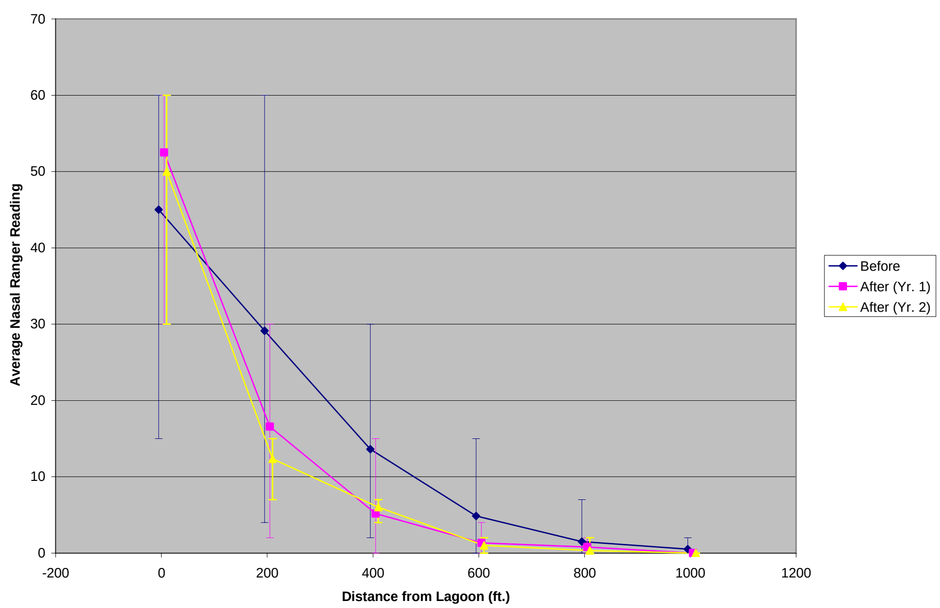

Figure 4.13
Average Nasal Ranger™ Reading at 200 ft Intervals
Before Practice vs. After Solids Separation and Aeration (Monroe County)

The flux chamber testing from these lagoons, before and after the practice was installed, indicated somewhat better odor control than did our Nasal Ranger™ readings. Figure 4.14 below is a bar graph depicting the laboratory-determined odor intensities of our flux chamber samples. The blue bars are for samples taken from the lagoons before the system was installed, and the magenta bars are for samples taken after the system was in place and operational.

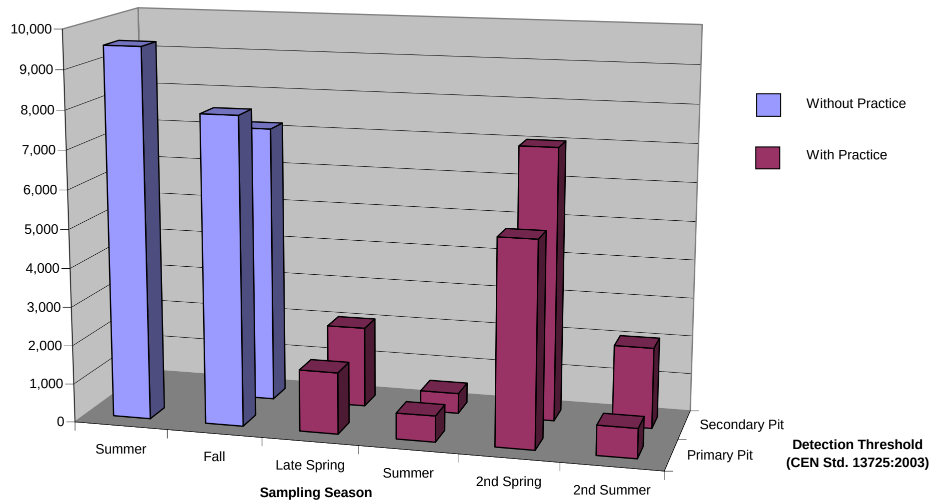

Figure 4.14
Flux Chamber Seasonal Average Detection Threshold
Before Practice vs. After Solids Separation and Aeration (Monroe County)

These data are more encouraging than our Nasal Ranger™ findings, however they may be biased due to the fact that we could not sample the surface near the aerators, because of turbulence. Again, getting a representative sample with the flux chamber was quite challenging. Also of note are the high readings in the spring of the second year. This may be attributable to the fact that these samples were taken earlier in the year, and it had been a cool spring, therefore the biological system may not have had a chance to become fully operational.

Comparing the volatile fatty acid levels in the lagoons before and after the installation of this system seems to indicate that it could lead to increased odors (see Figure 4.15 below).

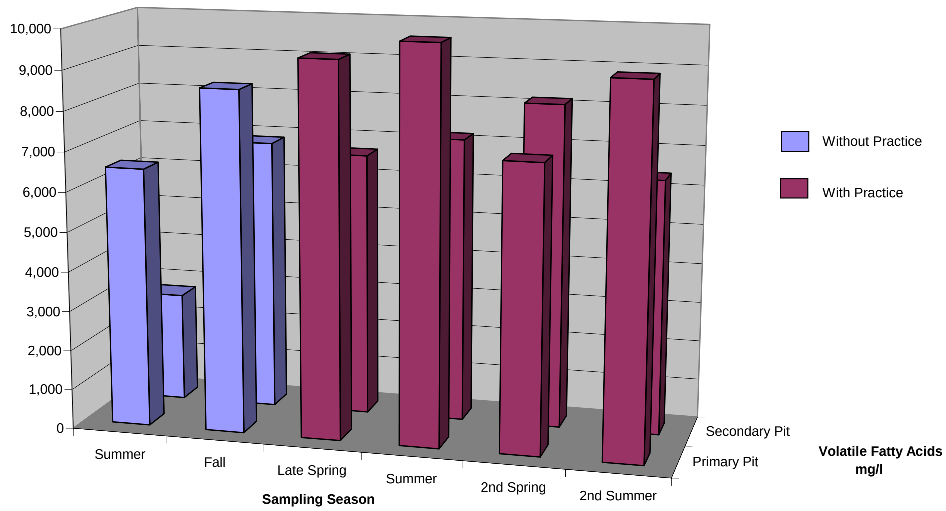

Figure 4.15
Volatile Fatty Acids, mg/l
Before Practice vs. After Solids Separation and Aeration (Monroe County)

The blue bars are the volatile fatty acid levels prior to the system being installed, and the magenta bars are the levels following installation. These results run counter to our field observations of reduced odor after the system was installed. This further supports conventional thinking that no one parameter can be used to accurately predict odor emissions from manure pits. Rather, odors are a result of many components operating in synergy.

Anecdotally, the landowner indicated that he was very pleased with this system. When he land applied manure from these pits in early spring he noticed far less solids accumulation than before. And he said that his neighbors actually commented to him about how fewer odors there were coming from his fields compared to years past.

Figure 4.16 below shows the comparison of Nasal Ranger™ readings taken in the field at our Monroe County farm, to the calculated odor scores for the small waste storage lagoon, using the odor model in ATCP 51. The odor score was calculated for the primary lagoon assuming the nearest neighbor was located at various distances downwind. These scores were plotted against separation distance to create an odor score curve. The Nasal Ranger™ odor results were then plotted against distance on the same graph. This allowed us to determine the measured average odor level at the distance that corresponds to a passing odor score of 500.

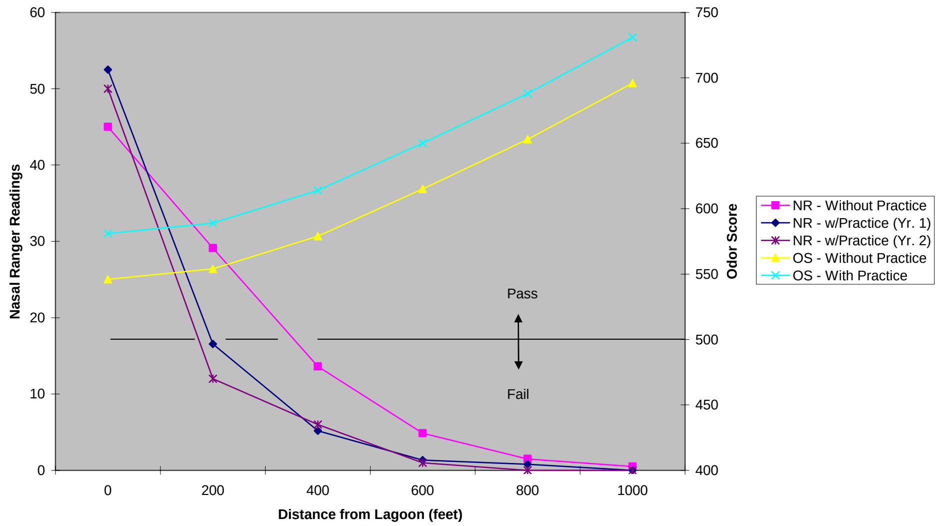

Figure 4.16
Comparison of Nasal Ranger™ Field Readings to the Odor Score
Before Practice vs. After Solids Separation and Aeration (Monroe County)

Looking at these results, we see a poor correlation between the field readings and the predicted odor score. The yellow line with triangles is the odor score curve before the solid separation and aeration system was installed, and the red line with squares is the "before" field readings curve. Drawing a horizontal line at a passing odor score of 500, nowhere does the odor score drop below it, indicating that a passing score can be achieved at any separation distance. However, the average Nasal Ranger™ field readings indicate unacceptable odors as far away as 750 feet from the lagoon. This indicates that the odor standard may under predict odors from small waste storage lagoons (0.38 acre in this case) and may have to be adjusted when the Livestock Siting rule is revised.

Following the same exercise with the solid separation and aeration system installed, the blue odor score curve with X's never point drops below the horizontal passing score line. However, the average "after" Nasal Ranger™ field readings for the first year (black curve with diamonds), and for the second year (magenta line with triangles) both indicate unacceptable odors as far away as 550 feet from the lagoon. This says that the odor control credit given for solid separation and aeration in the odor standard is too generous and may have to be lowered when the Livestock Siting rule is revised.

Case Study 5: Animal Feedlot (Clark County)

Background

Our Clark County farm was the site where an existing outside feedlot configuration was to be monitored and later upgraded. Due to management changes, however, this site was removed from the monitoring program prior to the feedlot improvements being made. The terrain around this farm is characterized by gently rolling farmland with large open areas broken up by trees at fencelines (see Figure 5.0). This farm was a satellite heifer raising site for a large dairy farm several miles away. Cows of all ages, from weaning through bred heifers just prior to calving, are housed at this site in open bedded sheds with constant access to large earthen exercise lots.

Figure 5.0
Clark County Farm Layout

At the time of our study, the farm housed approximately 500 cows, 180 heifers, and 300 calves in a combination of bedded pack loose housing and outside lots of either dirt or concrete. The feed alleys located inside the barns were regularly scraped with a skid steer every few days. The outside concrete lot was scraped as required when manure accumulated to a couple of inches in depth. This concrete lot was seldom used due to the poor performance of the runoff buffering system leading to contaminated discharge onto the neighbor's property. The outside earthen lots were not regularly scraped, and were only maintained occasionally to repair soft spots, etc. Manure scraped from the barn feed alleys was hauled to either the on-site earthen manure storage basin, or immediately field spread on nearby cropland. The bedded pack was periodically hauled directly to cropland.

The landowners planned to install additional open housing bedded pack barns, as well as additional manure storage, and abandon the concrete lot nearest the road. Their proposed plan also included reducing the size of the earthen lots and creating grazing paddocks. The paddocks were to also serve as vegetated buffers around the production facility to improve runoff quality. As part of the planned outside lots, fence line feeding systems and a runoff containment basin were to be installed to reduce overall building costs and simplify scraping of the lots and feed lanes. The proposed improvements to the manure handling system and increased manure storage capacity would have improved labor efficiency and facilitated manure application to cropland during appropriate times of the year. The intent of the modifications was to improve air quality by allowing a larger percentage of manure to be collected and field applied. Another goal was to reduce the amount of bare soil exercise lots and replace them with vegetated paddock areas. This was intended to control dust from the bare earthen lots, and thus possibly reduce odor emissions.

Ultimately, the landowner decided not to make these improvements in lieu of relocating about half of the animals to new housing facilities constructed at the main farm. The reduction in animals at the satellite farm effectively addressed the dust and runoff issues, making the installation of control practices unnecessary.

Case Study 5 Results Discussion

General Sampling Overview

The Clark County site was in some ways the most difficult to sample for this project. In the first place, a much wider area was involved in the study, which surrounded the entire feedlot area with samplers on the fenceline. In addition to the extra effort involved in setting up, monitoring and collecting the samplers over such a wide area, the low concentrations encountered at this distance from relatively diffuse sources required altering the sampling protocol.

A summary of the test dates and general conditions is shown in the following table. Parameters include the testing start date and the vector mean wind speed, wind direction and temperature (in degrees Celsius) for both the daytime (AM) and nighttime (PM) sampling runs. Note that the test continued to the day following the test date.

Date	AM			PM		
	VMWS	VMWD	T(C)	VMWS	VMWD	T(C)
05/21/2007	7.9	170	22.7	6.4	130	15.2
07/17/2007	4.2	190	26.2	0.7	140	20.1
09/10/2007	2.1	160	10.9	8.3	230	9.4

Table 5.0
Clark County Test Dates and Basic Meteorology

The first test was run using the standard setup and flow rates. Efforts to improve the detection limit for the samples were made following this, with subsequent tests employing flow rates up to about 1.5 liters per minute for some samples, allowing for the collection of up to 3 times the volume collected by the regular sampling protocol. Sampling at this flow rate required removing the sample splitters, so that only single samples were collected with each pump. Minimum theoretical detection limits for the higher volume samples were about 4 micrograms per cubic meter for hydrogen sulfide and about 7 $\mu g/m^3$ for ammonia.

A small number of samples were collected around the more concentrated sources, including the small manure pit and immediately next to two of the barns. The purpose of these samples was to provide a sense of the source magnitude to both demonstrate how quickly concentrations may disperse from area sources and provide some basis of comparison with other farms tested.

A total of 86 H_2S and 96 NH_3 samples were collected during the three tests at this facility, of which 78 H_2S and 89 NH_3 samples were submitted to the laboratory for analysis.

There were six successful H_2S duplicate sampling pairs submitted to the laboratory, all of which showed qualitative agreement (both samples were non-detects). A total of 7 NH_3 sample pairs were submitted of which two show qualitative disagreement (one sample a detect, the other a non-detect). Of the remaining 5 NH_3 pairs, one failed at 64.9% RPD, while the other four passed with RPDs below 30%. The average RPD for these samples is 16.9%.

A total of 6 H_2S and 6 NH_3 blanks were submitted from sampling efforts at this facility. Of these, 2 of the H_2S blanks showed detectible quantities, with an average detection level of 6.8 micrograms per sample. The single NH_3 blank detect was obtained from this site, with a level of 8.3 μg/sample, while the remaining five blanks showed no trace of ammonia.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

Sampling points along the north, south and east of the facility were generally located along the property line, in an attempt to measure the overall concentrations of ammonia and hydrogen sulfide leaving the feedlot. The western edge was sampled along a transect located in the neighboring corn field, as the property line was too distant to be practical.

In addition to these points, several others were sampled one or more times, including the loading chute gate located near the old barn which was sampled on all site visits (sampling point #4), next to the small manure storage pit (#21) and next to the barns (#'s 22 and 23). The final three sampling points were only sampled during the second site visit.

In general, most concentrations encountered around this facility were quite low, with a high rate of non-detects, especially for the hydrogen sulfide samples, for which there were only two detects throughout the study, both of which were between the limit of detection and the limit of quantitation, and thus of relatively low analytical reliability. After the first sample run, hydrogen sulfide was sampled only at more limited locations to conserve sampling budget and resources.

The first hydrogen sulfide detect on the evening of the first sampling trip was at location 9, which was actually upwind of the facility. While an upwind detect can represent the effect of a neighboring operation, in this case it is more likely to represent random background contamination in the sampling tube.

The second H_2S detect occurred during the evening of the second trip. While it was downwind of the facility, and relatively close to the barns, it is a suspect result because there was no detectable H_2S closer to the barns. The low concentration observed increases the possibility that the sampling tube contained more than the average amount of sulfur, thus generating a false positive result.

This low level of hydrogen sulfide was supported by the Jerome Hydrogen Sulfide meter results, which only rarely showed any H_2S above the instrument detection limit of 3 parts per billion. This concentration is equivalent to about 4.5 micrograms per cubic meter, and represents a lower concentration than can be reliably detected by the charcoal tube sampling method under even the modified conditions employed after the first trip to this facility.

While the hydrogen sulfide sample results from this location were generally unfruitful, the ammonia results were quite revealing. Though this compound was frequently detected, concentrations observed in most locations were relatively low. Most often, the highest concentrations were observed at the gate of the loading chute. Typically there would be a significant fraction of the herd congregating nearby this location.

Of special interest is the sampling run on the evening of July 16 – 17, 2007. During this run, samples close to the most concentrated source (the barns) were collected. These samples revealed high concentrations (between 672 and 1,966 $\mu g/m^3$), and yet downwind samples collected 100 – 300 meters away yielded results of less than 100 $\mu g/m^3$. This hints at the dispersion even short distances can cause.

In this particular case, our results are more comparable to NR445 than the remaining tests. This is because our sampling was conducted along the property line, and thus our locations are equivalent to the area of regulatory concern. While our sampling was not designed to capture 24 hour average values, and our three visits over the course of 4 months are not truly representative of typical conditions at the farm, our results can give a hint of whether or not this type of operation is likely to exceed levels of concern.

The table following summarize the top three observed ammonia concentrations on the downwind side of the property. Note that no table for hydrogen sulfide results is included, as there was little to none detected. Reported parameters include the average, maximum and minimum values, as well as the relative standard deviation (RSD), a measure of the variability of our results. In addition to a summary for each sampling period, the table shows an overall summary of results, as well as a day and night sample comparison.

	Run 1	Run 1e	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Average	84	120	53	97	57	33	74	65	84
Max	143	209	96	115	74	49	209	143	209
Min	50	54	26	83	36	17	17	26	17
RSD	62.0%	66.2%	70.6%	17.0%	34.3%	48.5%	63.9%	56.4%	68.1%

Table 5.1
Downwind Ammonia Concentrations Near the Property Line

The figure on the following page represents this data in a max/min charts. The value (Y) axis is in micrograms per cubic meter. Note that the variation between the test runs is significant enough that no statistically significant patterns are clear.

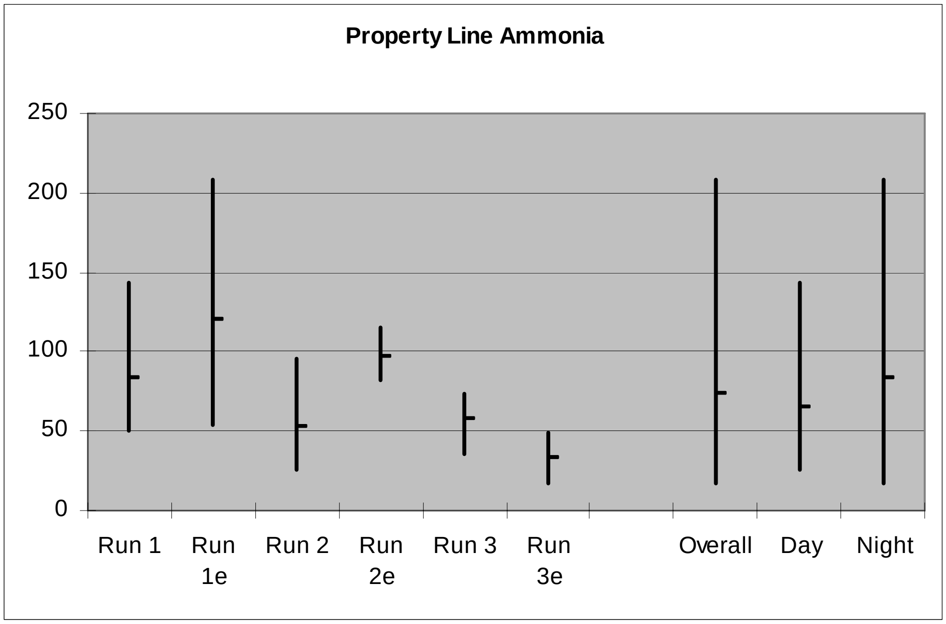

Figure 5.1
Property Line Ammonia (Clark County)

The NR445 ambient action concentration for ammonia is 418 μg/m^3 on a 24 hour average basis. At no point along the property line did observed concentrations exceed 100 μg/m^3 during this study. The NR445 ambient action concentration for hydrogen sulfide is 336 μg/m^3 on a 24 hour average basis. This value is well above detection limits, and was not approached within an order of magnitude anywhere sampled on this facility during this test.

Case Study 5 Key Findings Summary Statements

Essentially no hydrogen sulfide was observed on this facility during any of the sampling visits. The open nature of the lot and relatively low population density of the animals, combined with minimal collection and dry handling of manure probably lead to this relatively pristine condition. Observations made around this feedlot should not be extrapolated to higher density lots where the ground does not have the opportunity to dry out.

While ammonia concentrations were observed throughout the sampling, fenceline concentrations were generally low. The few "source" area samples obtained show much higher values, but dispersion over the relatively short distances to the property line was sufficient to reduce concentrations significantly during the testing periods.

Project Focus Key Baseline ~ Case Study 5: Baseline Animal Feedlot (Clark County)

The outcome of the odor transects conducted on the three trips to the Clark County farm are depicted in the data supplement. These represent the odors being generated by a large earthen feedlot. Because the decision was made to not install odor control practices on this farm no "after" sampling took place. Despite this fact, the data gathered during the initial visits are still useful as baseline information.

Graphing the odor readings from this farm, it can be seen that large low density feedlots of this type do not appear to be a significant source of odors (see Figure 5.2).

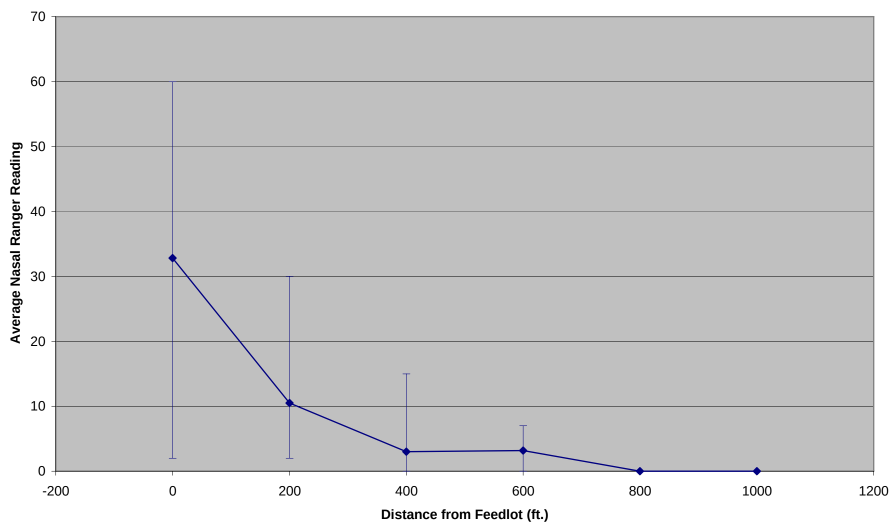

Figure 5.2
Average Nasal Ranger^{TM} Reading at 200 ft Intervals
Baseline Animal Feedlot (Clark County)

Although a reading over 30 could be described as very noticeable, at a distance of only 200 feet the average reading was around 10, which is noticeable, but not evident. And at 400 feet and beyond the average reading was 4 and below, which is barely detectable. Caution should be used when applying these results to other animal feedlot operations. Size, stocking densities, and overall management can all influence odor generation rates.

Figure 5.3 below shows the comparison of Nasal Ranger^{TM} readings taken in the field at our Clark County farm to the calculated odor scores for that animal feedlot, using the odor model in ATCP 51. The odor score was calculated for the feedlot assuming the nearest neighbor was located at various distances downwind. These scores were plotted against separation distance to create an odor score curve. The Nasal Ranger^{TM} odor results were then plotted against distance on the same graph. This allowed us to determine the measured average odor level at the distance that corresponds to a passing odor score of 500.

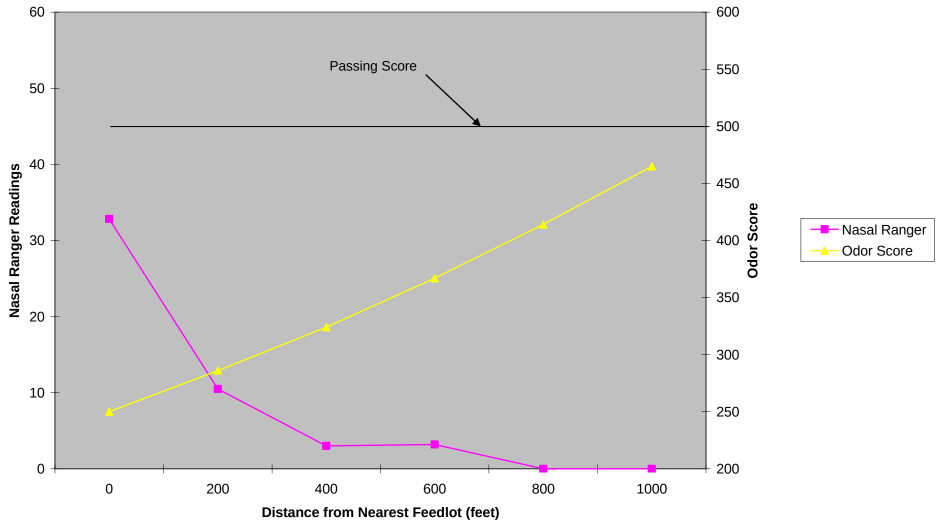

Figure 5.3
Comparison of Nasal RangerTM Field Readings to the Odor Score
Baseline Animal Feedlot (Clark County)

Looking at these results, we see a very poor correlation between the field readings and the predicted odor score. The yellow line with triangles is the odor score curve, and the red line with squares is the Nasal Ranger™ field readings curve. Drawing a horizontal line at a passing odor score of 500, we see that at all points the odor score curve is below passing, meaning that the feedlot fails at all separation distances up to and including 1,000 feet. However, looking at the Nasal RangerTM curve (red line with squares) we can see that as close as 650 feet the measured average odors were acceptable, and even as close as 400 feet they were not excessive. This result indicates that for large animal feedlots with low stocking rates (12.5 A.U./acre) the odor standard may not apply. The standard was developed using concrete feedlots with higher stocking rates, whereas the Clark County feedlot is more akin to a heavily used pasture.

Case Study 6: Manure Storage Lagoon (Manitowoc County)

Background

The Manitowoc farm was our baseline operation. It represents a fairly typical large freestall dairy operation in Wisconsin. It is situated on a high spot of the local landscape, but the terrain surrounding it is open and flat, making it a good candidate for air concentration studies (see Figure 6.0).

Figure 6.0
Manitowoc County Farm Layout

At the start of our study, the operation housed 2,700 head of milking and dry cows on sand bedding. Manure is continuously removed from the alleys using automated scrapers, which dump the wastes into a very long cross channel. This channel is flushed using recycled manure, which is routed through a sand separation channel and then returned to the 21 million gallon primary lagoon. After the wastes flow to the far end of the primary lagoon, they are pumped up to the 20 million gallon secondary lagoon. At the opposite end of this lagoon is the pump that recirculates the wastes back to the freestall barns for flushing the cross channel. Sand that is captured in the separation channel is stockpiled and allowed to drain out and dry before being reused as bedding in the freestalls.

At the end of our study, two new freestall barns had been built, adding 500 more cows, for a total of 3,200 head. We had originally selected this farm for comparison with the Waupaca County digester farm. It was opportune that this farm expanded during the course of our study, because the Waupaca farm underwent a size increase as well. This allowed for data from the two farms to be compared over the length of the study.

Case Study 6 Results Discussion

General Sampling Overview

A total of three sampling runs have been conducted at the Manitowoc County site. A total of 143 samples for NH_3 and 143 for H_2S have been collected, with 18 of each being invalid for reasons in the field. The invalid samples are evenly distributed between the sampling trips, and no single run experienced sufficient sample loss to invalidate it.

A summary of the test dates and general conditions is shown in the following table. Parameters include the testing start date and the vector mean wind speed, wind direction and temperature (in degrees Celsius) for both the daytime (AM) and nighttime (PM) sampling runs. Note that the test continued to the day following the test date.

Date	AM			PM		
	VMWS	VMWD	T(C)	VMWS	VMWD	T(C)
07/02/2007	8.0	160	20.7	3.3	180	16.9
10/15/2007	10.1	70	12.2	8.3	100	12.7
05/05/2008	4.4	120	12.4	0.8	140	7.9

Table 6.1
Manitowoc County Test Dates and Basic Meteorology

Standard sampling protocols have been followed for all tests conducted at this site. Additional sampling was conducted around the sand channel on the second and third sampling runs, with results included separately in Section 6.1 following. One additional upwind sample was collected on the first trip, with no ammonia or hydrogen sulfide detected. No additional sampling was practical at this facility.

Only four successful duplicate pairs were collected at Manitowoc (two of both H_2S and NH_3 pairs). All sampling pairs passed quality criteria. The average RPD of the H_2S duplicate samples is 4.0%, while the average RPD of the NH_3 samples is 12.1%, both well within quality criteria.

Three blanks collected show detectable quantities of H_2S, with an average of 7.3 μg/sample. The blank levels were subtracted from the results reported by the lab. All other blanks contained non-detectable levels of the parameters.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

Concentrations of H_2S around the pits during our sampling visits were generally the highest of ambient samples we observed at any of the farms. On two out of the three trips, a significant number of samples yielded results in excess of 1,000 micrograms per cubic meter for both ammonia and hydrogen sulfide. More ambient samples that exceeded this level were collected at this facility than any of the others.

Whether this observation represents a true difference between the manure at this facility and that of the others, or is the result of management practices is unknowable based on our data set. The large surface area of the manure pits exposed to the air as well could also explain our results. The limited nature of our sampling (a mere three to six trips to each facility over the course of more than a year) does not provide enough information to be able to quantitatively compare results with the other farms tested in a manner that conclusively determines what leads to the differences observed.

Results from this facility also demonstrate clearly the extremely variable nature of concentrations observed around manure pits. Not only do the ranges of concentrations vary significantly between sampling trips, but also between adjacent sampling locations, even though some of these are as little as a hundred feet apart of so. Not only does the magnitude of the concentrations vary, but the ratios of H_2S and NH_3 can diverge radically within a short area as well.

For example, the results from the sampling trip conducted on July 2-3, 2007, demonstrate this clearly. Samples were collected at the north end of both pits (locations 8, 9, 21 and 22). During the daytime run, ammonia exceeded hydrogen sulfide at all locations. Ammonia at location 8 was nearly twice that of location 9. The hydrogen sulfide dropped by a factor of nearly 7 over the same distance. Similarly, results obtained during the daytime from location 21 are significantly greater than those at 22, although the differences aren't quite so great.

These differences can be ascribed to the local influence of the circulation of flush water. Location 21 was positioned above the outfall of flush water from the sand channel, and location 8 was positioned near the pump outlet on the upper pit. During the test on July 2nd, both of these sources were open to the air, greatly increasing the potential emission from them. When this was pointed out to the farmer, the simple solution of extending the pipes to beneath the manure surface was employed, and remained the case for both future sampling visits.

That sites nearby are apparently far less impacted than those directly next to the outfalls can be explained by the predominant wind direction, which was such as to move outfall emissions away from the adjacent sampling sites 9 and 22. It is interesting to note, however, that the ammonia concentrations at location 22 are significantly elevated above background (as represented by locations 15, 24 and 26), even though the winds were mostly from open field, with only a small corner of the manure pit between the sampler and the wind.

What proximity to these localized sources does not reveal, however, is what caused the differences observed between day and night on the July 2-3 trip. Nighttime results from the same locations show a significant shift in the ratios of H_2S and NH_3 concentrations. The daytime samples reveal uniformly higher ammonia than hydrogen sulfide concentrations, while at night, those samples collected closest to the outfalls (locations 8 and 21) show significantly more H_2S than ammonia.

The cause of this is unknown, but similar observations can be made for the remainder of the sampling trips at this facility. An extreme case of this is the nighttime run on May 5-6, 2008, during which almost entirely calm wind conditions prevailed. During this sampling run, almost all sampling locations show significantly elevated concentrations of both parameters, but especially hydrogen sulfide. In general, qualitatively more hydrogen sulfide is observed at night than during the day. Sampling at the other facilities does not demonstrate this phenomena so clearly, so it is unknown whether this is a characteristic of the type of manure handling practices employed here, whether it is a location specific phenomenon, or whether it was a chance occurrence based on the timing of our visits.

As can be seen from the examples above, overall hydrogen sulfide concentration trends observed around these lagoons tend to be strongly driven by the samples impacted by the outfalls. For this reason, the following summaries are prepared with this data removed and considered separately. The purpose of this is to better compare results collected around the different lagoons. Outfall impacted results obtained at other farms are treated separately as well.

Summaries of the downwind data are show in the following tables and figures. Note that each manure lagoon is treated separately. The top three non-outfall impacted concentrations observed downwind of each lagoon for both ammonia and hydrogen sulfide are summarized in the following tables. Values shown are the average, maximum and minimum concentrations observed among the three most concentrated downwind samples, as well as the relative standard deviation (RSD), which is a measure of the variability of the data. Concentration values are expressed in micrograms per cubic meter.

Note that the ammonia results typically have a much lower RSD than the hydrogen sulfide results. This is a reflection of the much wider variation seen among the hydrogen sulfide data, which tended to be significantly higher at one site than the others included in this evaluation. The only sampling period this was not true for was the nighttime sampling on May 5-6, 2008, where most locations showed significant elevation.

LOWER	**Run 1**	**Run 1e**	**Run 2**	**Run 2e**	**Run 3**	**Run 3e**	**Overall**	**Day**	**Night**
Avg	852	642	562	512	1655	816	840	1023	657
Max	918	1131	806	756	1751	1116	1751	1751	1131
Min	737	293	126	183	1581	404	126	126	183
RSD	11.8%	67.8%	67.4%	57.7%	5.2%	45.2%	56.4%	51.8%	52.9%
UPPER	**Run 1**	**Run 1e**	**Run 2**	**Run 2e**	**Run 3**	**Run 3e**	**Overall**	**Day**	**Night**
Avg	575	652	497	316	1208	863	685	760	610
Max	738	1092	567	408	1379	934	1379	1379	1092
Min	314	259	453	242	964	766	242	314	242
RSD	39.8%	64.2%	12.4%	26.8%	18.0%	10.0%	50.8%	49.2%	53.0%

Table 6.2
Downwind Ammonia Concentrations Near Upper & Lower Lagoons

LOWER	Run 1	Run 1e	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Avg	54	145	88	227	106	724	224	83	365
Max	74	254	145	312	140	849	849	145	849
Min	32	81	45	132	77	526	32	32	81
RSD	38.6%	65.0%	57.9%	39.8%	30.1%	23.9%	111.0%	47.3%	79.9%
UPPER	Run 1	Run 1e	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Avg	54	54	95	289	40	400	155	63	248
Max	80	88	143	323	59	574	574	143	574
Min	29	29	67	237	28	235	28	28	29
RSD	47.3%	56.6%	43.7%	15.7%	41.8%	42.4%	100.5%	56.8%	71.4%

Table 6.3
Downwind Hydrogen Sulfide Concentrations Near Upper & Lower Lagoons

The figures on the following pages represent this data in max/min charts. Note that the variation between the test runs is significant enough that no statistically significant patterns are clear, even though qualitatively it appears that daytime ammonia concentrations may be higher than those observed during the night, while the reverse may be true for hydrogen sulfide. The upper and lower lagoons are not readily distinguished in this manner, either.

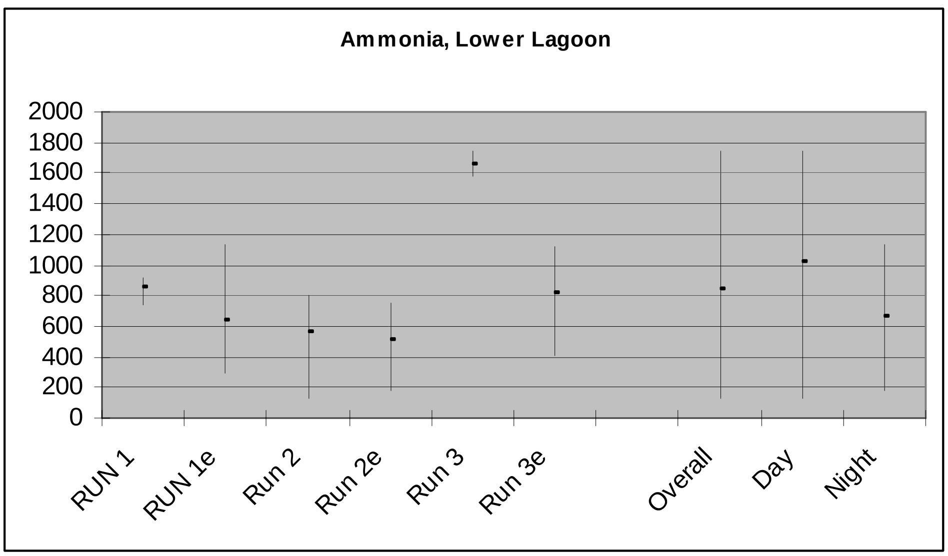

Figure 6.1
Ammonia, Lower Lagoon (Manitowoc County)

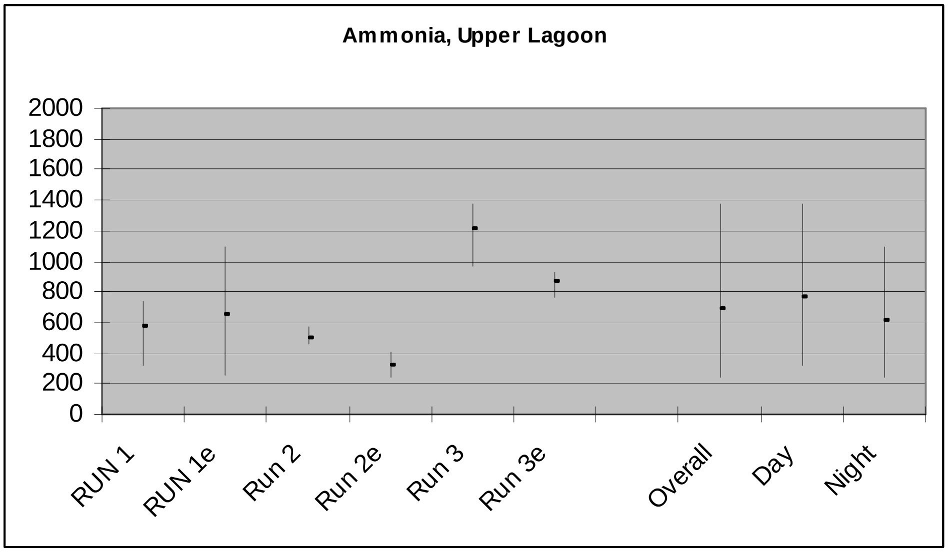

Figure 6.2
Ammonia, Upper Lagoon (Manitowoc County)

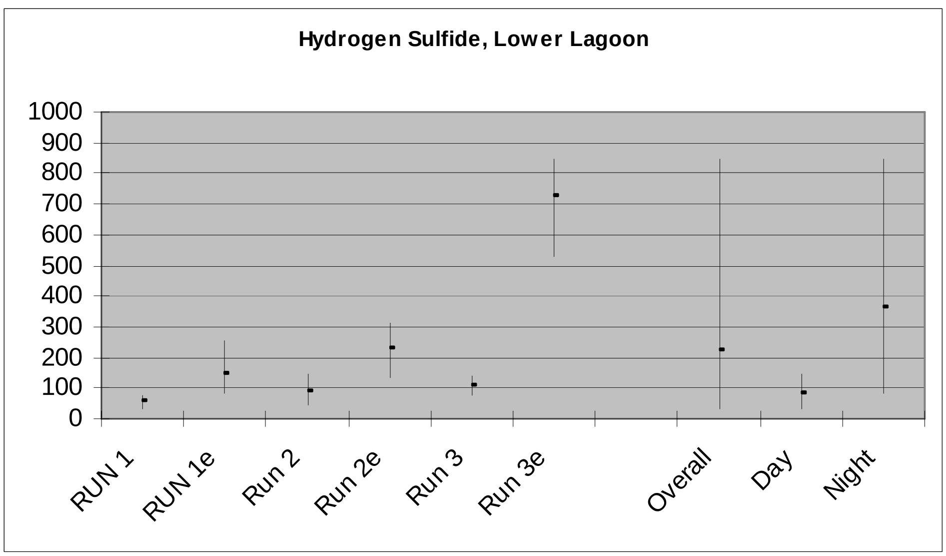

Figure 6.3
Hydrogen Sulfide, Lower Lagoon (Manitowoc County)

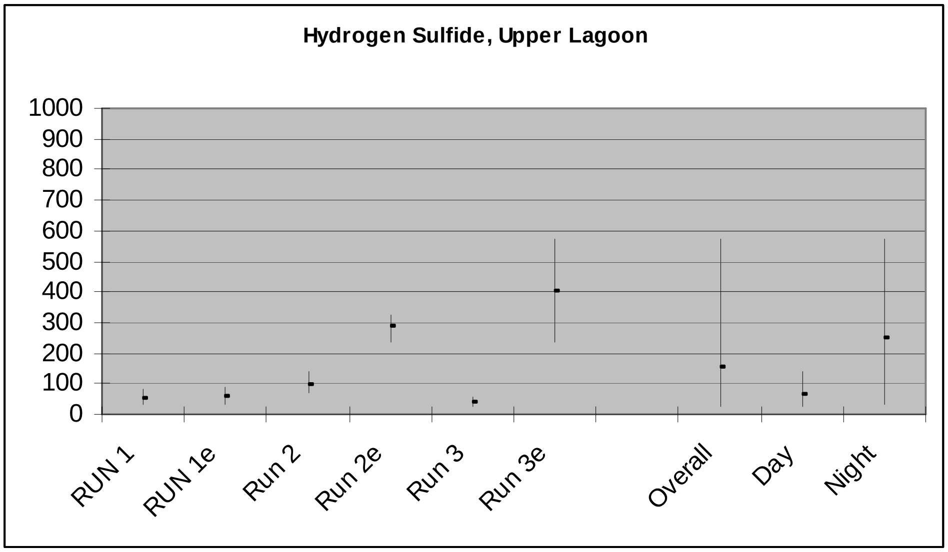

Figure 6.4
Hydrogen Sulfide, Upper Lagoon (Manitowoc County)

Results obtained from the outfall influenced samples on both lagoons are combined and presented in the following graph which compares general results obtained near the upper and lower lagoons with those impacted by the outfalls. Note that this graph presents the overall average plus or minus the 90% confidence interval of the dataset, rather than the max/min/average presented in the graphs above. Hydrogen sulfide results are on the left, while ammonia results are on the right. Note that while the outfall hydrogen sulfide concentrations are obviously and significantly different from the remaining samples, there is no such distinction with the ammonia samples.

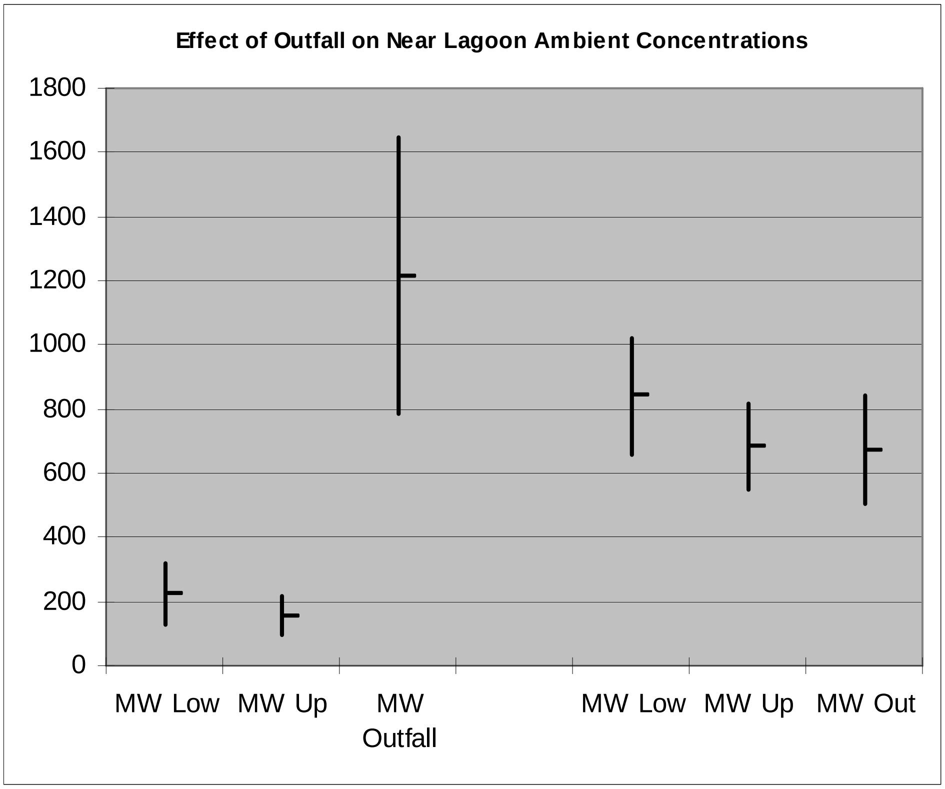

Figure 6.5
Outfall vs. General Results, H_2S (left) and NH_3 (right) (Manitowoc County)

Manure Surface Sampling
Sampling was conducted on the surfaces of both manure lagoons. The figures below display the results obtained from these tests, with the lower lagoon (first to receive the waste) on the left and the upper on the right. Concentration units are micrograms per cubic meter, presented on a logarithmic scale. Note that H_2S results from the different lagoons track well between visits, with the upper lagoon showing consistently higher H_2S concentrations at the surface. NH_3 results are more variable and do not show a specific pattern such as this.

While the data do show this pattern, it should be noted that concentrations on both lagoons vary between site visits by well over an order of magnitude for each parameter. This type of variability impedes our ability to base firm conclusions on our data. A point of interest that will be discussed further in the comparison with other farms is that while the highest H_2S values were observed at this facility, the lowest maximum NH_3 value was recorded here.

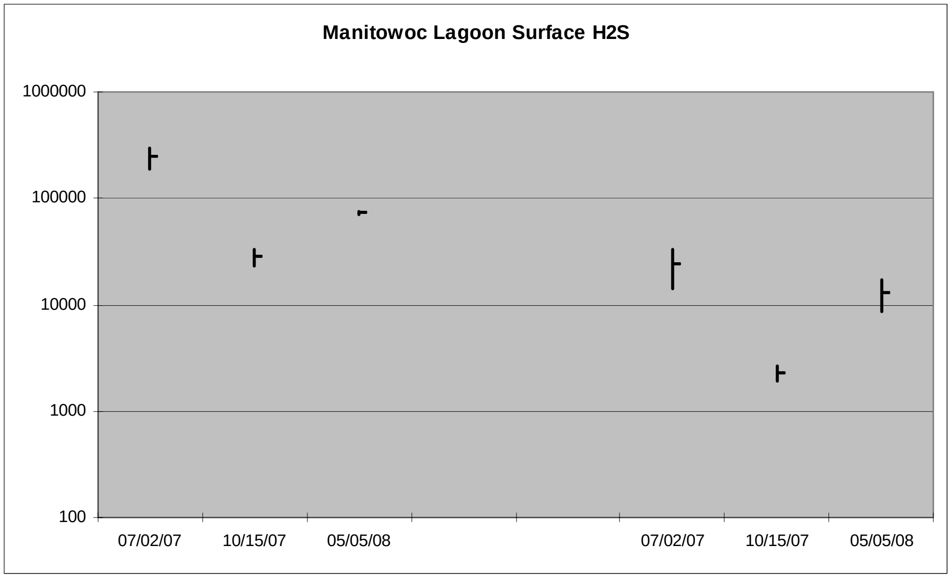

Figure 6.6
Lagoon Surface H_2S (Manitowoc County)

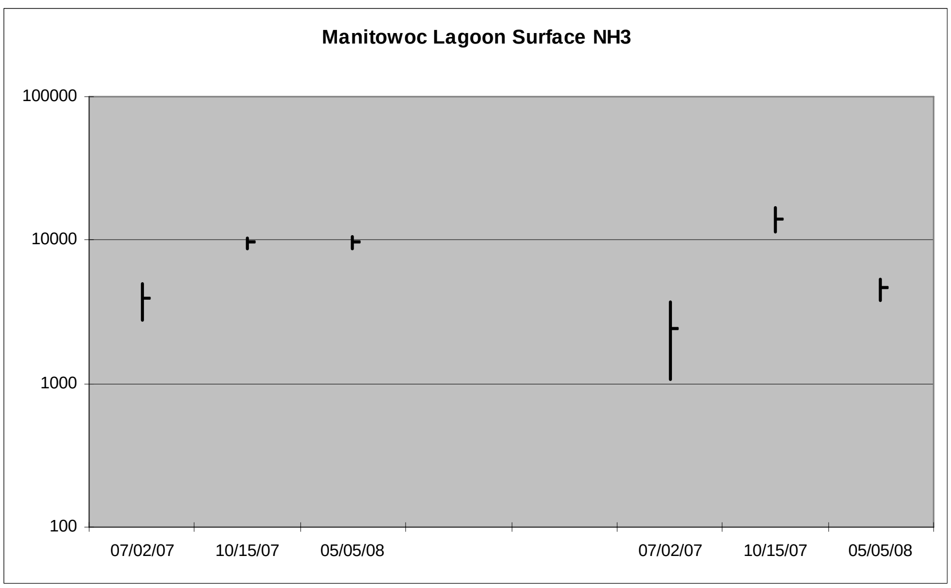

Figure 6.7
Lagoon Surface NH_3 (Manitowoc County)

Case Study 6 Key Findings Summary Statements

Significantly elevated concentrations of both hydrogen sulfide and ammonia were observed around this facility during this study. In general, elevated ammonia concentrations were more widespread than H_2S, but the maximum H_2S concentrations observed exceed the maximum NH_3 significantly.

The highest lagoon oriented hydrogen sulfide concentration observed during this study was collected at this facility. Maximum concentrations were observed either next to or immediately downwind of the outfalls, where manure is being introduced into the lagoons, either from the sand channel (in the case of the lower pit), or pumped up from the lower pit.

In addition to demonstrating the effect surface agitation introduced through an outfall has on hydrogen sulfide concentrations, one sampling event managed to capture an almost calm overnight period, probably representative of an inversion. High concentrations of both H_2S and NH_3 were observed in a majority of the samples collected during this period.

The most concentrated lagoon surface hydrogen sulfide levels were observed at this facility, but concentrations varied widely between sampling trips. An apparent difference between the upper and lower lagoons exists, with the lower lagoon showing higher concentrations than the upper on a consistent basis.

Ammonia results from the surface are significantly lower than the H_2S observations, and do not show the apparent differences between the lagoons. The lowest observed maximum lagoon surface ammonia concentration of the farms in our study was observed at this facility.

Project Focus Key Baseline ~ Case Study 6: Baseline Manure Storage Lagoon (Manitowoc County)

The outcome of the odor transects conducted on the three trips to the Manitowoc County farm are depicted in the data supplement. These represent the odors being generated by a typical large manure storage lagoon. This farm was selected to provide us with baseline data to be used for comparison with the two digester farms. No practices were planned to be installed on this farm. This data is being provided here for baseline purposes only.

Graphing the odor readings from this farm, it can be seen that large manure storage lagoons appear to be a significant source of odors (see Figure 6.8).

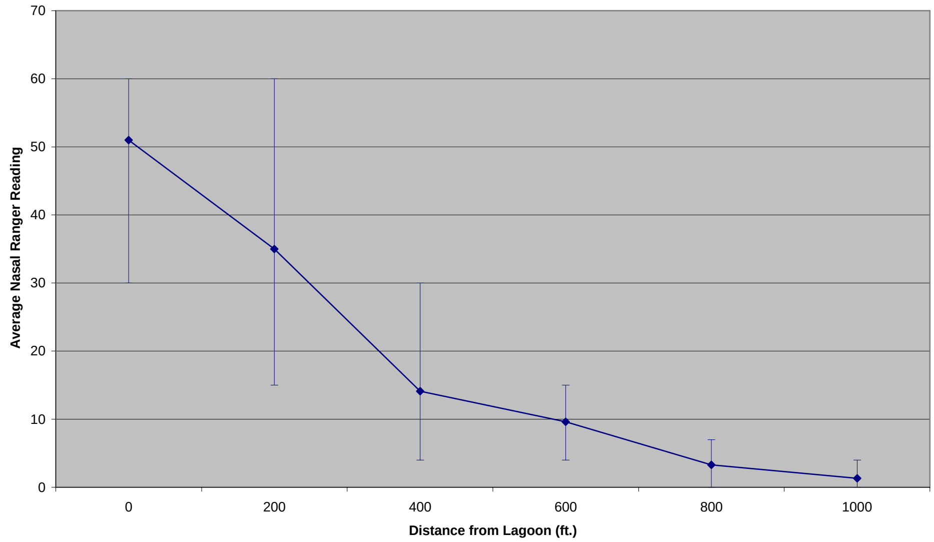

Figure 6.8
Average Nasal Ranger™ Reading at 200 ft Intervals
Baseline Manure Storage Lagoon (Manitowoc County)

Immediately adjacent to the lagoon the average reading was over 50, which would be considered a very strong odor. And, even at a distance of 400 feet downwind of the lagoon average readings are in excess of 10, a noticeable level. It isn't until a separation distance of 900 feet that average readings are 2 or less, which would generally be considered acceptable. Again, this represents a very limited number of samples taken under variable conditions. Caution should be used in applying these results to other manure storage lagoons.

Figure 6.9 below shows the comparison of Nasal Ranger™ readings taken in the field at our Manitowoc County farm to the calculated odor scores for that waste storage lagoon, using the odor standard in ATCP 51. The odor score was calculated for the lagoon assuming the nearest neighbor was located at various distances downwind. These scores were plotted against separation distance to create an odor score curve. The Nasal Ranger™ odor results were then plotted against distance on the same graph. This allowed us to determine the measured average odor level at the distance that corresponds to a passing odor score of 500.

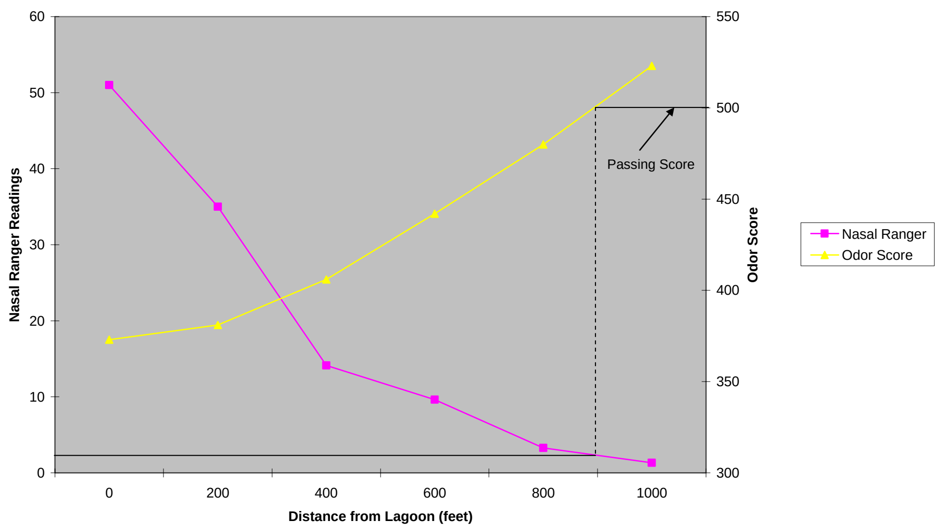

Figure 6.9
Comparison of Nasal RangerTM Field Readings to the Odor Score
Baseline Manure Storage Lagoon (Manitowoc County)

Looking at these results, we see a very good correlation between the field readings and the predicted odor score. The yellow line with triangles is the odor score curve, and the red line with squares is the Nasal Ranger™ field readings curve. Drawing a horizontal line at a passing odor score of 500, and then dropping down from where that line intersects the odor score curve, we see that the point corresponds with a separation distance of just under 900 feet. At this distance the Nasal Ranger™ field readings averaged about 2, the lowest measureable reading. This result indicates that for medium sized waste storage lagoons (4.2 acres) the odor standard was collaborated by our field odor measurements.

PROJECT FOCUS SUPPLEMENT: TWO CASE STUDIES OF SAND SEPARATION CHANNEL IMPACTS ON ODOR CONTROL STUDIES AND MEASURES

Case Study 3.1: Sand Channel (Kewaunee County)

Case Study 3.1 Results Discussion

General Sampling Overview

Key aspects, protocols and results of the testing program conducted on this farm are previously presented in the section titled, "Project Focus: Six Case Studies of Lagoon/Pit Odor Control Measures, Case Study 3.0" The material that follows is focused on sampling around the sand channel, which was conducted on 5 of the 6 sampling visits to this facility. Of the 361 total samples for each of ammonia and hydrogen sulfide collected during all sampling at the Kewaunee farm, 112 of each were collected around the sand channel. Of these, three NH_3 and two H_2S samples were considered void, although not all samples collected during 2009 were submitted to the laboratory.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

The physical layout of the sand channel at this facility allowed for good sampler coverage. Three of the sampling locations (numbers 1 – 3) were located on the edge of the channel itself (location 3 was not available after the August 27-28, 2007 sampling trip because an additional sand drying pad was made in that area), while two of them (4 and 5) were located at either end of the pump area directly to the south of the sand channel.

Of the remaining locations, 6 and 7 were situated on the edge of the sand drying area, while 8 and 9 were located between the sand channel and the road to the south. Under the wind conditions experienced during most of the sampling trips (generally southerly winds), concentrations observed at these locations represent the probable influence of the lagoons, about 100 meters to the south.

Results from around the sand channel at this facility tend to show a greater rate of positive detections than those collected around the pits. There is less generally less upwind/downwind variation, and there these results have been treated somewhat differently than those from the main study.

In the main case studies, the three most concentrated downwind samples were extracted from the entire dataset and evaluated for comparing the different trips. For most of the sampling trips to this facility, the rate of detection is generally so high (2/3rds of the sampling locations returned a detection rate of greater than 75% for ammonia), that somewhat realistic comparisons of overall results are possible.

As such, results obtained from the samplers alongside the sand channel (locations 1 though 5) have been evaluated and are presented below. Results shown are in $\mu g/m^3$, with average, maximum and minimum values for each sampling event, as well as the relative standard deviation (RSD). Note that only a single detect for hydrogen sulfide was obtained from these locations during run 2, and that none of this parameter was detected during runs 4 and 4e.

	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Average	490	382	325	317	385	417	353
Max	769	644	728	580	769	769	644
Min	317	239	159	141	141	159	141
RSD	34.2%	41.1%	84.0%	59.7%	50.0%	53.4%	46.4%

Table 3.1.1
Ammonia Concentrations Near the Sand Channel, Pre-Cover

	Run 4	Run 4e	Run 5	Run 5e	Run 6	Run 6e	Overall	Day	Night
Average	188	359	274	292	287	180	270	262	277
Max	324	687	589	427	414	270	687	589	687
Min	52	43	86	178	126	108	43	52	43
RSD	102.5%	82.2%	83.3%	40.4%	46.8%	38.1%	64.9%	65.1%	67.4%

Table 3.1.2
Ammonia Concentrations Near the Sand Channel, Post-Cover

	Run 7	Run 7e	Run 8	Run 8e	Overall	Day	Night	All Post
Average	227	134	222	211	205	229	178	288
Max	489	246	349	316	489	489	316	769
Min	97	75	166	100	75	97	75	43
RSD	78.1%	73.2%	34.7%	50.0%	56.7%	56.5%	57.5%	61.9%

Table 3.1.2a
Ammonia Concentrations Near the Sand Channel, 2nd Year Post-Cover

	Run 2	Run 2e	Run 3	Run 3e	Overall	Day	Night
Average	ND	309	106	128	192	127	229
Max	208	607	151	184	607	208	607
Min		20	41	49	20	41	20
RSD		82.4%	48.6%	45.6%	90.4%	50.3%	90.6%

Table 3.1.3
Hydrogen Sulfide Concentrations Near the Sand Channel, Pre-Cover

	Run 4	Run 4e	Run 5	Run 5e	Run 6	Run 6e	Overall	Day	Night
Average			789	8181	411	433	2454	600	4307
Max	ND	ND	2411	16750	1014	809	16750	2411	16750
Min			189	1792	127	95	95	127	95
RSD			137.4%	88.6%	99.4%	72.1%	193.3%	130.8%	146.3%

Table 3.1.4
Hydrogen Sulfide Concentrations Near the Sand Channel, Post-Cover

	Run 7	Run 7e	Run 8	Run 8e	Overall	Day	Night	All Post
Average	75	67	272	168	153	188	119	983
Max	158	109	501	350	501	501	350	16750
Min	28	17	82	62	17	28	17	17
RSD	95.0%	69.4%	64.5%	77.8%	93.0%	89.4%	96.3%	303.6%

Table 3.1.4a
Hydrogen Sulfide Concentrations Near the Sand Channel, 2nd Year Post-Cover

The figures on the following pages represent this data in max/min charts. The value (Y) axis is in micrograms per cubic meter. The scales for the results have been equalized for the pre and post cover sampling; note, however, that the hydrogen sulfide value scales are logarithmic.

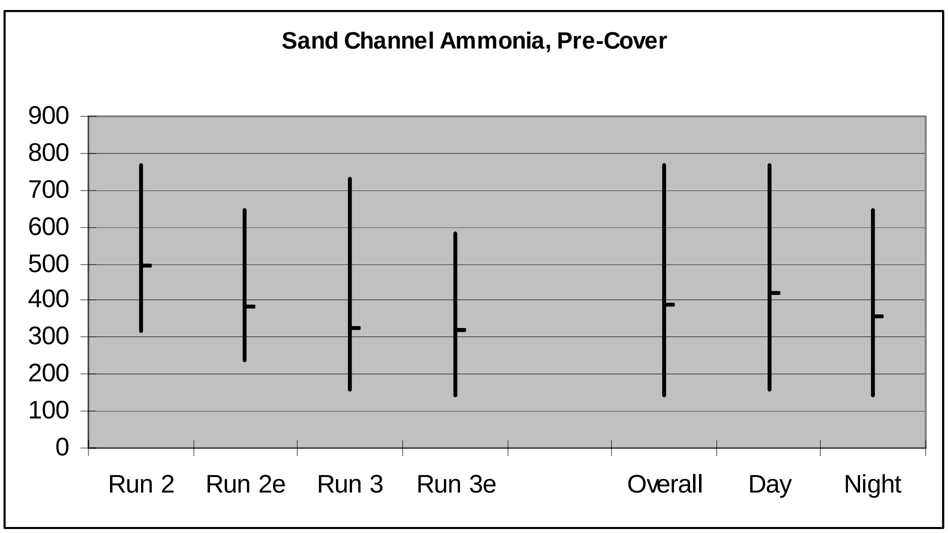

Figure 3.1.1
Sand Channel Ammonia, Pre-Cover (Kewaunee County)

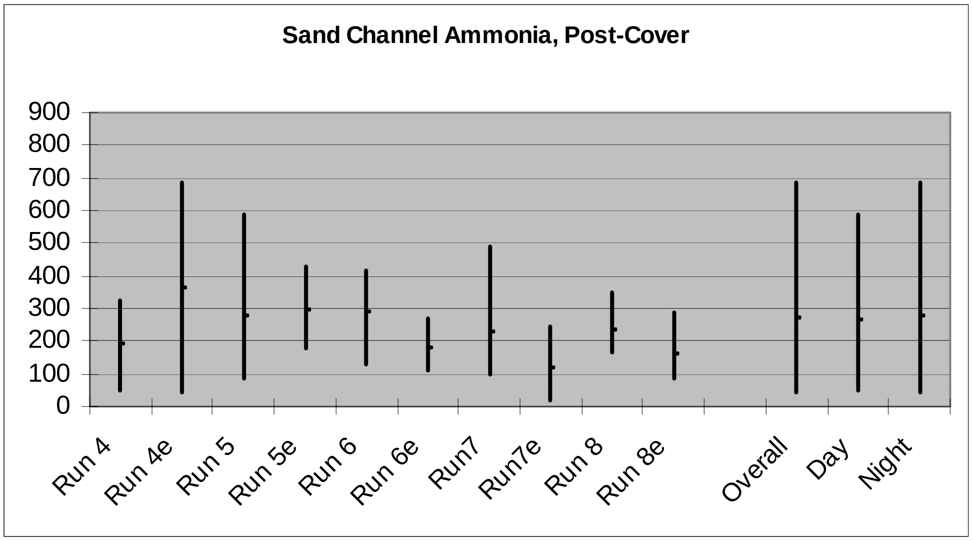

Figure 3.1.2
Sand Channel Ammonia, Post-Cover (Kewaunee County)

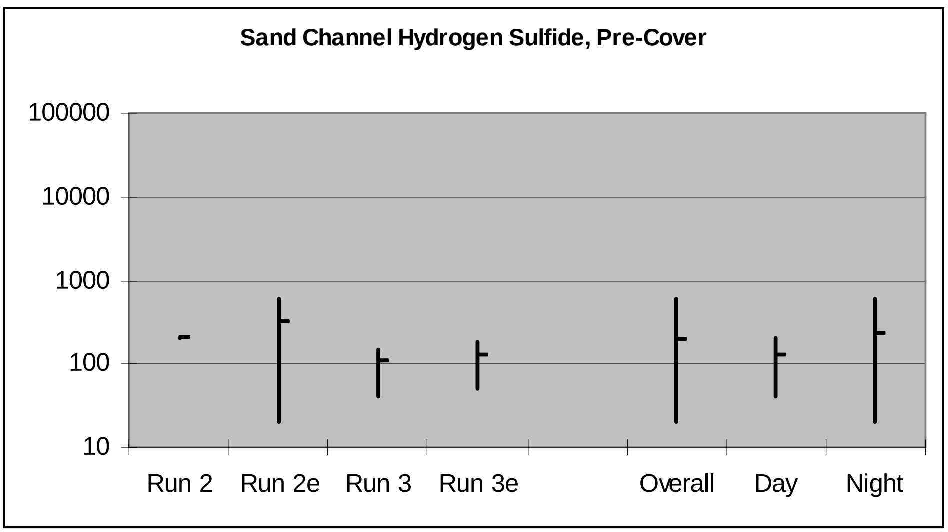

Figure 3.1.3
Sand Channel Hydrogen Sulfide, Pre-Cover (Kewaunee County)

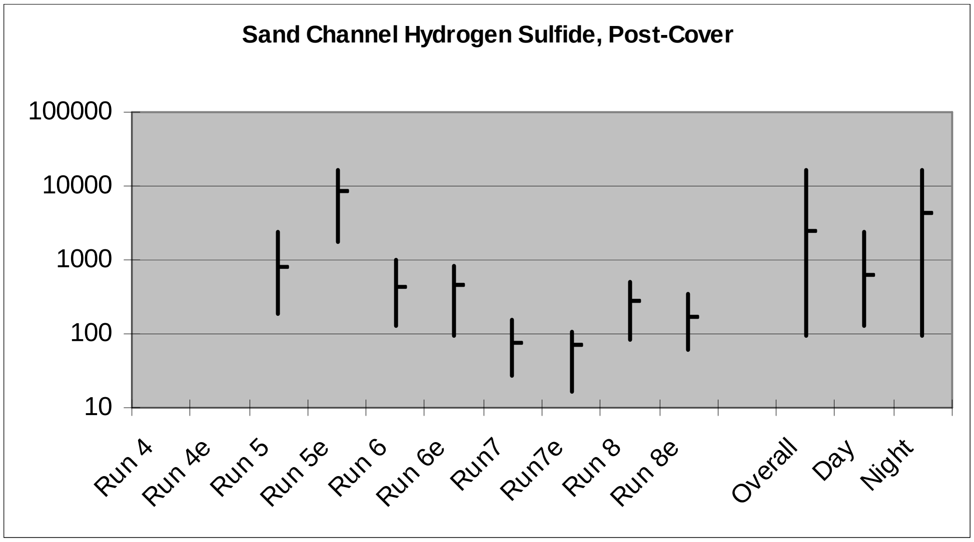

Figure 3.1.3a
Sand Channel Hydrogen Sulfide, Post-Cover (Kewaunee County)

Case Study 3.1 Key Findings Summary Statements

Ammonia concentrations observed around the sand channel at this facility are similar to those observed around the lagoons. Addition of the cover had no significant effect on these concentrations.

Hydrogen sulfide, however, was observed at higher concentrations around the sand channel than next to the lagoon. During the first year following installation of the cover, hydrogen sulfide was an order of magnitude or more concentrated around the sand channel than prior to the cover during most sampling runs. However, during the initial testing period following installation (Run 4 and 4e), no hydrogen sulfide was detected anywhere around the sand channel, and during the second year, results were similar to those obtained prior to installation of the cover. Whether the results of the first year following installation represent a seasonal impact unobserved during the earlier and later testing is unknown.

Odor Sampling

Although not part of the original study plan, we decided to conduct odor transects on the sand separation channel during the follow-up sampling visits to our Kewaunee County farm. This was a result of observations made during our earlier sampling visits, where we noticed that the sand channel produced strong, localized odors.

The proximity of the channel to the animal housing made it difficult to run odor transects under all wind conditions. Transects could only be run when the wind direction was parallel to the freestall barns. A total of three odor transects were run, the results of which can be found in the data supplement to this report.

Looking at the results, it can be seen that the odors were quite strong immediately adjacent to the sand channel, but that they diminished fairly quickly downwind, as compared to odors from the manure storage lagoon. This would indicate that sand channels are a significant source of odor, however their overall impact on neighbors may be less than that of manure storage lagoons due to their smaller footprint.

Case Study 6.1: Sand Channel (Manitowoc County)

Case Study 6.1 Results Discussion

General Sampling Overview

Key aspects, protocols and results of the testing program conducted on this farm are previously presented in the section titled, "Project Focus: Six Case Studies of Lagoon/Pit Odor Control Measures, Case Study 6.0" The material that follows is focused on sampling around the sand channel, which was conducted on 2 of the 3 sampling visits to this facility. Of the 143 total samples for each of ammonia and hydrogen sulfide collected during all sampling at the Manitowoc farm, 9 of each were collected around the sand channel.

Ambient Sampling

Figures showing the results described herein are located in the Project Data Supplement in chronological sequence.

The physical layout of the sand channel at this facility was less conducive for comprehensive sampling than that at the Kewaunee facility. The actual sand channel was surrounded on either side by a significant drying pad for the recovered sand, so that samplers could only be deployed next to the actual channel at the head and foot of the channel (locations 28 and 29). Additional locations were added at about the mid-point of the channel on either side of the drying pad during the final sampling runs (locations 30 and 31).

The very few samples collected at these locations make any numerical summarization somewhat meaningless, so no tables or graphics beyond the results figures have been prepared. It should be noted that the highest hydrogen sulfide concentrations observed throughout the study (> 18,000 $\mu g/m^3$) were collected next to this sand channel, and that the majority of samples observed at concentrations greater than 2,000 $\mu g/m^3$ were obtained in this vicinity.

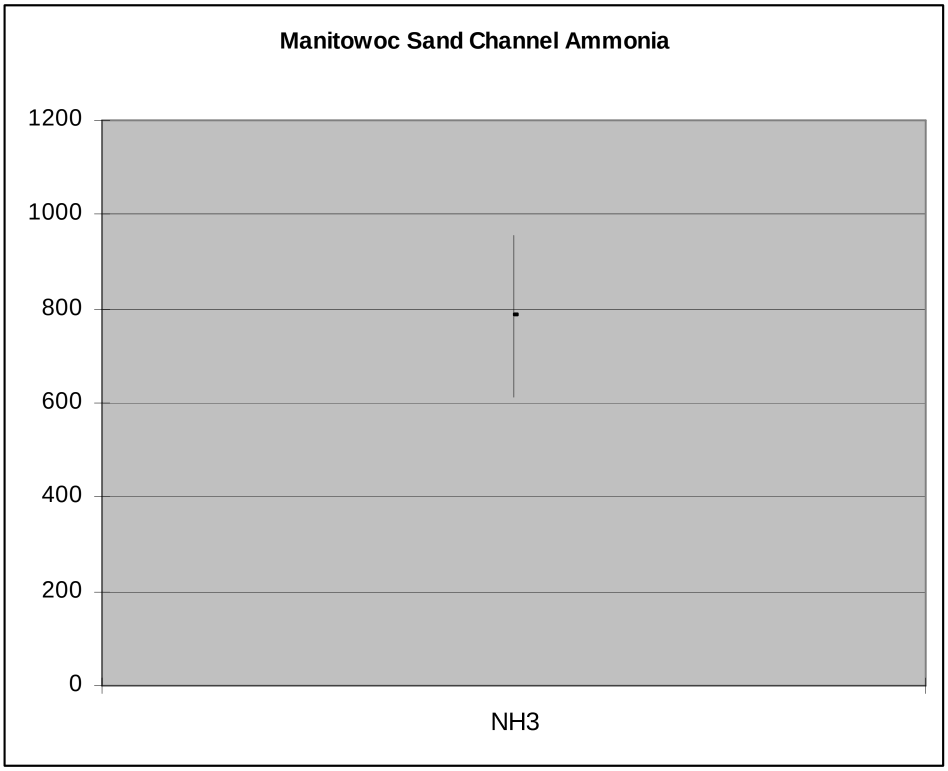

Figure 6.1.1
Sand Channel Ammonia (Manitowoc County)

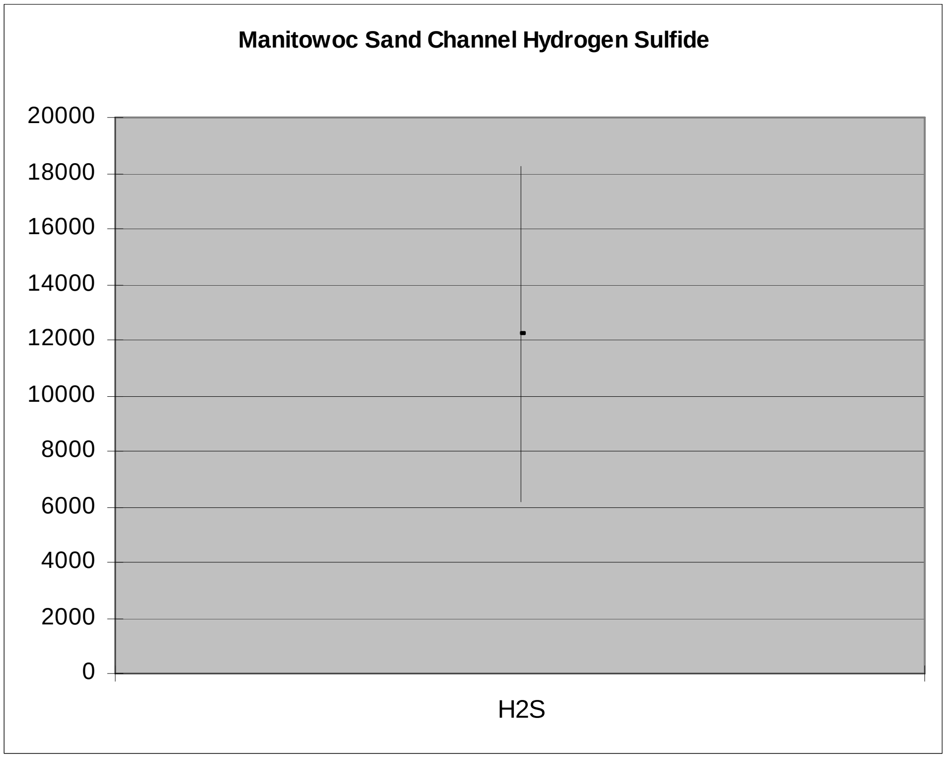

Figure 6.1.2
Sand Channel Hydrogen Sulfide (Manitowoc County)

Case Study 6.1 Key Findings Summary Statements

Ammonia concentrations observed around the sand channel at this facility are similar to those obtained around the lagoons.

Hydrogen sulfide concentrations observed near the sand channel are significantly higher than those observed around the lagoons, and especially higher than concentrations observed away from the outfalls.

SAND CHANNEL OCCUPATIONAL HAZARD IMPLICATIONS

A surprise finding associated with the sand separation channel is the observation of elevated levels of hydrogen sulfide at concentrations at or above recommended occupational exposure levels. Occupational exposure standards, established by OSHA, for hydrogen sulfide are 20 ppm averaged over a typical 8-hour day (also not to exceed 50 ppm over any 10 minute period) which is significantly higher than those established by the Wisconsin Department of Natural Resources for general ambient air (0.24 ppm). Occupational standards are higher because it is assumed that these exposures will be to healthy individuals working typical work days (40 hours per week) in workplaces, while general ambient air concentrations can represent year round exposure levels.

Typically, workers are not near the sand separation channels for significant periods of time. Usually, exposure is limited to the amount of time required to clear the channels of sand for drying and recovery, or to remove the dried sand for re-use as bedding.

In confined spaces associated with manure systems, such as enclosed reception tanks and pits, hydrogen sulfide should always be considered an extreme hazard. Sand separation channels, with open circulation, are not confined spaces and do not warrant confined entry precautions. Nonetheless, this study suggests that the potential exists for hazardous conditions to be present around these structures, and farms with sand separation channels should consider adopting the following safety precautions:

1. Provide fencing, warning signs and other means to exclude unauthorized or accidental entry
2. Avoid worker entry at times when winds are calm (typically early morning and late evening)
3. Avoid prolonged exposure

It should be noted that hydrogen sulfide is an extremely toxic gas. Hydrogen sulfide levels may increase a thousand-fold during the agitation of manure. It is colorless, heavier than air, and may cause death within minutes at high concentrations. At lower concentrations it can irritate and damage the eyes and respiratory tract. While hydrogen sulfide is commonly known for its rotten egg odor, the odor is not detectable by the human sense of smell at higher concentrations. As such, there may be very little warning when a relatively benign situation has changed into a potentially hazardous one.

In addition, several occupational and health agencies are considering changes to the acceptable level of hydrogen sulfide in the air for workers. For example the ACGIH, which is an independent non-governmental organization, is currently proposing to recommend an 8-hour Time Weighted Average (TWA) of 5 ppm (about 7 mg/m^3). By convention, the maximum allowed 30-minute exposure would then be set at 15 ppm, and the maximum allowed peak concentration would be 25 ppm. These guidelines would represent the latest advice of this scientific body as to what levels of exposure would be advisable to protect worker health.

SIGNIFICANT FINDINGS

Several points are important to keep in mind when reviewing the data collected during this project. First and foremost of these is that no matter what the quality of individual measurements and sampling trips may be, we did not make enough trips to any particular facility to determine whether we were sampling during “best-case”, “typical” or “worst-case” conditions with respect to odors or ammonia and hydrogen sulfide.

This reality, combined with the generally large variability observed between trips to the same farm, reduces our overall ability to make firm, general conclusions based on our observations. At the same time, however, for those few cases where our data does suggest an observable difference related to a management practice, the paucity of data strengthens the likelihood that the difference is real.

In general, care must be observed when evaluating our results, and in applying any conclusions drawn from them. The wording used to express the conclusions and evaluations are very specific. The phrase "tended to" or "tendency" means that many of the results observed conformed to whatever point is being made; it does not mean that all results did.

The qualifier "significantly" is used here in the general sense of showing a substantial or considerable difference, as opposed to use of the word in a statistical sense of being quantifiably different. As this project was a demonstration project with limited sampling, instead of a research project wherein a statistically relevant population of samples was collected, statistical tools to evaluate the data beyond simple averages and standard deviations have not been applied.

The descriptor "elevated" is in no way meant to imply magnitude. A downwind concentration of 25 $\mu g/m^3$ is elevated with respect to an upwind observation of 18 $\mu g/m^3$, as is a downwind concentration of 2,500 $\mu g/m^3$.

The descriptor "indistinguishable" indicates that there was considerable overlap in the range of results from the compared observations. Again, statistical tools to quantify the level of overlap between the samples were not applied.

Beyond these qualifiers, it is also important to remember that the BMPs studied here are not the only ones available, nor are they necessarily the most effective. They are merely the ones that were part of this study.

While comparisons between farms are not made on a quantitative basis, the following graphs illustrating the findings are included for reference. Specific conclusions based on these results are listed following.

Figures F and G present a compilation of the lagoon surface sampling, with results presented on a logarithmic scale with units of micrograms per cubic meter. Figure H and I present a comparison of the near lagoon sampling, with results in units of micrograms per cubic meter.

Note that the red line separates the digested manures on the left, from the undigested manures on the right, while the blue lines separate the different practices being studied at each location. The different study locations are abbreviated along the X-axis, with WC for Waupaca County, DC for Dunn County, MW for Manitowoc County, MC for Monroe County and KC for Kewaunee County. Results from Clark County are not presented for comparison in these graphs.

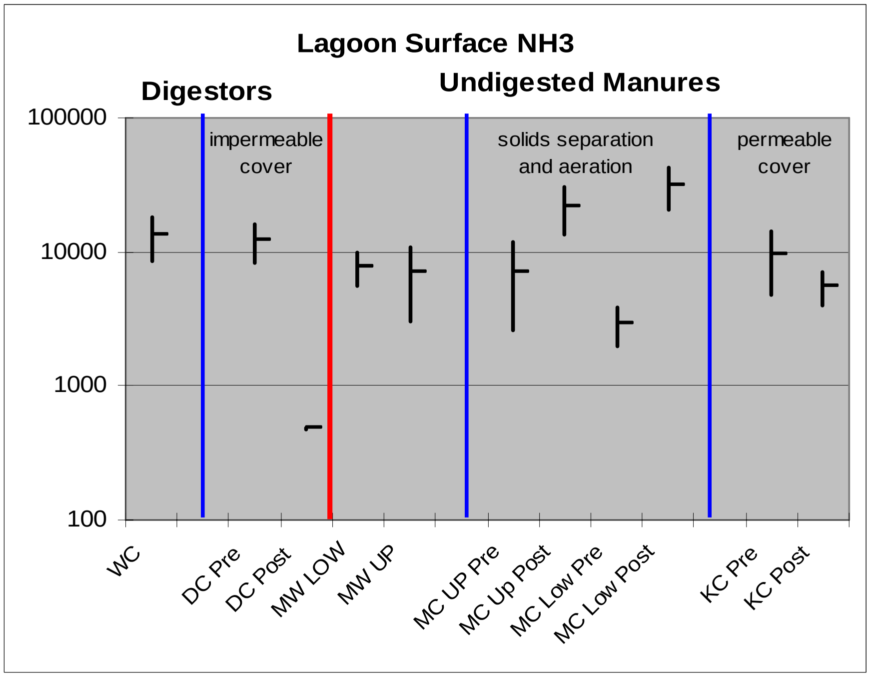

Figure F
Lagoon Surface Ammonia Concentrations

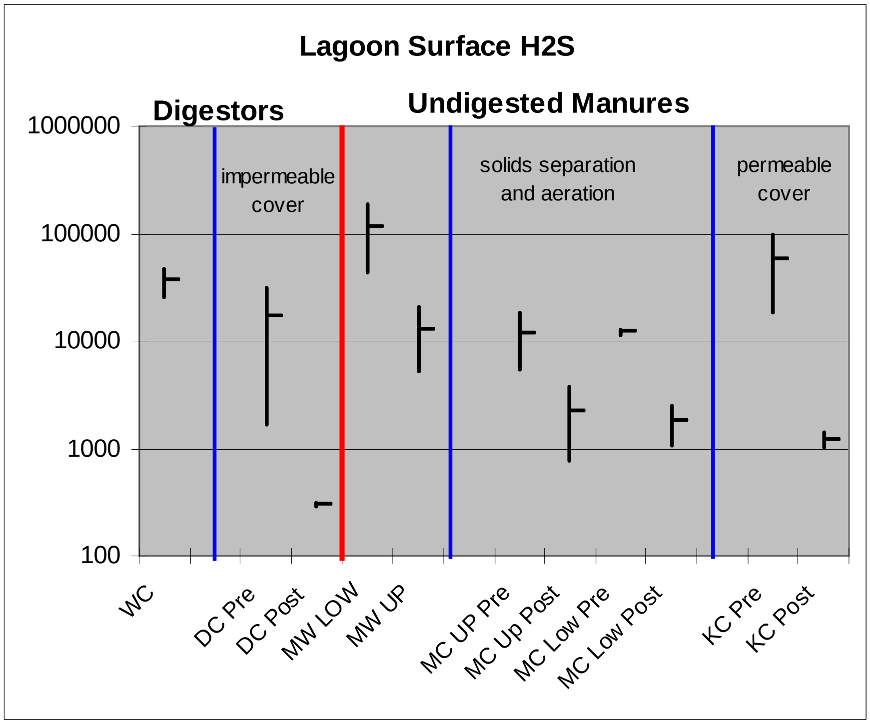

Figure G
Lagoon Surface Hydrogen Sulfide Concentrations

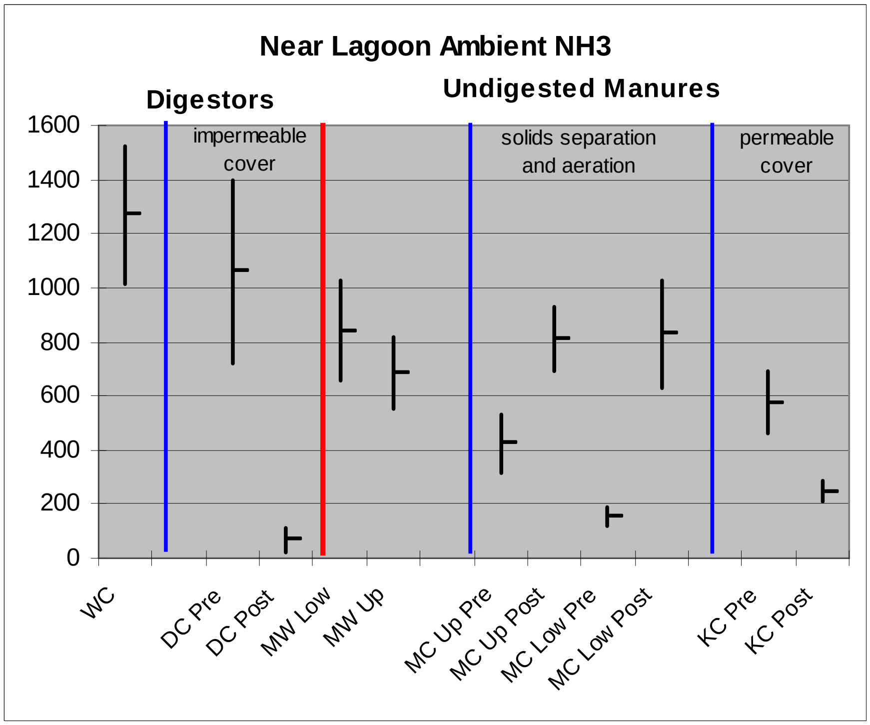

Figure H
Near Lagoon Ammonia Concentrations

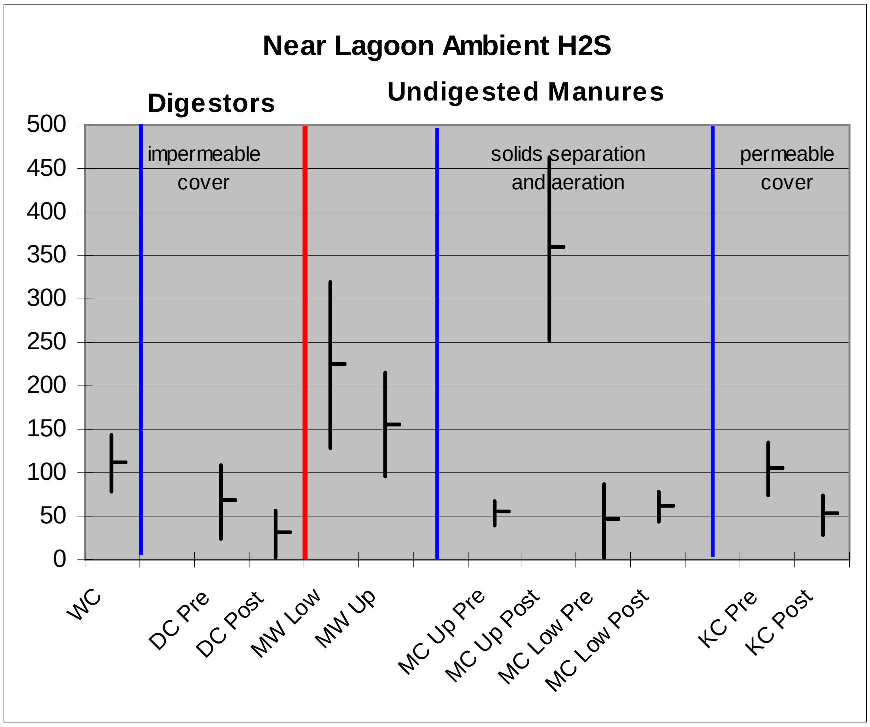

Figure I
Near Lagoon Hydrogen Sulfide Concentrations

The case studies in Waupaca and Dunn counties were intended to collect data on farms where anaerobic digestion is employed, to be compared with the undigested manure farms, especially the Manitowoc and Kewaunee County facilities. Results of these comparisons lead to the following points:

- Lagoon surface concentrations of hydrogen sulfide are indistinguishable between digested and undigested manures.
- Conversely, lagoon surface ammonia concentrations on digested manure tend to be higher than those observed on undigested manure, in the absence of other practices.
- Near lagoon downwind concentrations of hydrogen sulfide tend to be indistinguishable between digested and undigested manures, however, slightly higher rates of detection for this compound are observed around the undigested manures.
- Near lagoon downwind concentrations of ammonia tend to be higher around digested manure lagoons.
- The mesophilic (Waupaca County) and thermophilic (Dunn County) digesters are indistinguishable using our dataset.
- Lagoons that receive digested wastes do not predictably produce less odor than do lagoons receiving undigested wastes. Mesophilic digestion resulted in slightly lower odors, however thermophilic digestion resulted in slightly higher odors.

In addition to employing a digester, the Dunn County facility elected to install an impermeable cover for further odor and gaseous emission control as part of this study. Our results indicate:

- Installation of an impermeable cover significantly reduced surface concentrations of both ammonia and hydrogen sulfide. All lagoon surface samples collected off the surface of the lagoon cover collected undetectable quantities of both analytes. Note that sampling limitations render lagoon surface sample detection limits far higher than those possible around the lagoons.
- An impermeable cover will likewise significantly reduce nearby concentrations of both gases, although not necessarily to below detectable limits.
- Impermeable covers are highly effective at controlling odors from waste storage lagoons.
- No data in this study was collected around land spreading, so no statements can be made regarding effects of the cover on this stage of manure management.

The Kewaunee facility installed a permeable cover during the course of this study. In addition to employing this practice, the farm went through a significant expansion, including the construction of an additional manure storage lagoon adjacent to the lagoon sampled for the project. A cover was installed on new lagoon as well, and there was no noticeable impact from its installation during our sampling.

- Installation of a permeable cover significantly reduced concentrations of hydrogen sulfide observed on the surface. None of this compound was detected in surface samples following installation.

- The permeable cover did not likewise reduce the on-surface ammonia concentrations. Post-installation results were indistinguishable from pre-installation samples.
- Downwind near lagoon hydrogen sulfide results from samples collected following installation appear to be somewhat lower, however there was a significant increase in concentrations observed near areas of turbulence (the sand channel and lagoon outfall).
- Downwind near lagoon ammonia results from samples collected following installation are significantly lower, while those around the sand channel and outfall are indistinguishable than those collected beforehand.
- Permeable covers are very effective at controlling odors from waste storage lagoons, however, not as effective as impermeable covers.

The Monroe County facility installed solids separation and aeration as their best management practice. This installation was planned as part of the original farm construction, and solids separation was employed throughout the project. There were limited opportunities for sampling before aeration was begun. As such, our before and after sampling are less comparable from this facility than from the others.

- Aeration appears to reduce lagoon surface hydrogen sulfide concentrations, however, the surface ammonia concentrations appear to be increased.
- Downwind near lagoon ammonia concentrations appear to be increase following aeration of the lagoon, however this may be an artifact of insufficient pre-installation sampling.
- Downwind near lagoon hydrogen sulfide concentrations show locally significant increases following installation of the aeration units, however the plumes associated with the equipment appear to be quite discrete.
- Solids separation and aeration appears to reduce odors from waste storage lagoons, however further sampling is needed to determine the full potential of this technology to control odors.

ADDITIONAL LESSONS LEARNED

In addition to observations relating directly to the practices being studied, there were a handful of characteristics observed almost universally among our study sites, which may have manure management implications.

Lessons Related to Ammonia and Hydrogen Sulfide:

- On most farms, on-lagoon concentrations of hydrogen sulfide tended to be significantly higher than ammonia concentrations observed at the same time
- Conversely, near-lagoon concentrations of ammonia tended to be significantly higher than the hydrogen sulfide concentrations collected at the same locations
- Elevated near lagoon ammonia concentrations tended to be somewhat evenly distributed across the downwind edge, implying a general surface/air exchange

- Near lagoon hydrogen sulfide concentrations were strongly driven by areas of turbulence (such as outfalls) which would behave somewhat like point sources. While some general elevation in hydrogen sulfide concentrations was usually observed downwind of the lagoon, very discrete plumes associated with turbulence were frequently captured.
- Near lagoon ammonia concentrations tended to be of generally the same magnitude during the day and night time sampling periods during individual sampling trips, with perhaps a slightly higher daytime concentration. This was true whether wind conditions remained consistent between the sampling periods, or if there were nighttime inversions.
- Near lagoon hydrogen sulfide concentrations, on the other hand, were frequently elevated during the night time sampling with respect to the daytime samples collected on the same trip, especially around undigested manures when the wind dropped during the night.
- The highest ambient hydrogen sulfide concentrations observed during this study were in samples collected around the sand channels and outfalls.
- The highest ambient ammonia concentrations observed were in samples obtained around manure lagoons containing digested manures.

Lessons Related to Odor:

- Agitation of wastes greatly increases the odors generated from waste storage lagoons. Whenever possible, submerged inlets should be used to help minimize surface disturbances, and thus reduce odors.
- Although digesters reduce the organic content of the wastes passing through them, some organics remain undigested. The longer the retention time, the more thorough the digestion, however, the larger the digester also needs to be. Most digesters are sized to optimize pay-back, which means they are smaller than what would be needed for complete digestion. If odor control is a goal, retention time should be maintained at 29 days or longer. Future farm expansions should be considered when sizing a digester. A 20% expansion in herd size will result in a 20% reduction in retention time (i.e. 23 days versus 29 days) and a probable increase in odors.
- Most digesters employ a flare to burn off excess gas not used in the generator set. If the flare malfunctions, unburned gasses are released directly to the atmosphere. To avoid this, it is important that the flare has a reliable igniter that is maintained in good working condition. Also, an oversized baffle can help to avoid the flare from being extinguished in high winds. The Waupaca farm actually replaced its original flare with one having these design features to improve reliability.
- The discharge point from anaerobic digesters can be a significant source of odors. The owner of the Waupaca county farm devised and installed an innovative system to control these odors. This system consists of a blower, air ducting, and a gas-entrapment tank.

  The 2 HP regenerative blower is connected to 3” PVC piping such that it pulls air from around three separate odor sources. These three areas are the digester extraction tank, the solids separator room, and a 4,500 gallon separated liquids holding tank. The emissions from these three sources are then sent by the blower through additional piping to a 600 gallon air sparging tank. In this tank the gasses are bubbled up through 20” of water via small holes drilled in the piping. As the gasses pass through the water, hydrogen sulfide is converted to sulfuric acid. This acid then flows from the tank to the waste storage lagoon. A trickle of fresh water into tank constantly replenishes the supply.

Since the installation of this system, the owner has noticed significantly lower odor levels, and has not noticed any detrimental effects to his waste storage lagoon. The concentration of sulfuric acid is so low that it is easily buffered by the large volume of waste in the lagoon. The system continues to perform well, and has required very little maintenance.

- Permeable covers are very effective at controlling odors from manure storage lagoons, however they can interfere with traditional methods of agitation and pumping. With a cover in place, an above-surface gun can not be used to break up floating solids. Also, the added friction caused by a cover can reduce the effective distance of a below-surface mixer. A number of openings should be designed into the cover to allow for complete agitation of the wastes. A manure pump should be stationed at each opening to circulate the entire contents of the lagoon at once. This will re-suspend settled solids and break up floating solids prior to emptying and land application. The availability of pumps, or the cost to rent additional pumps, should be factored into the decision to install a permeable cover.

- The Kewaunee farm experienced difficulties with removing solids from one of their covered lagoons in the fall. This was from the second of three lagoons, all connected in series. This lagoon receives overflow from a small primary lagoon. The third lagoon, which in turn receives overflow from the second lagoon, experienced no difficulties. The solution to their problem was to use multiple pumps as described above, however they plan to make modifications to avoid that in the future. Their plan is to connect lagoons one and two using a submerged pipe rather than a surface channel. This should retain floating solids in lagoon one, which is not covered, where they can be more easily removed. The contents of lagoon two should then be mostly liquid, as it currently is in lagoon three, thus aiding agitation and pumping. Lagoon one is also where residual sand bedding accumulates if it escapes the sand separation channel. Any farmer who uses sand bedding, and wishes to install a cover on their waste storage lagoon, would be well advised to have a small uncovered primary lagoon preceding their larger covered lagoon.

  Impermeable covers do not provide for agitation of the wastes in a lagoon. For that reason, they should be used only on lagoons that are preceded by a solids separation system. Also, if the farm uses sand bedding, an effective sand separation system must precede the lagoon.

  Experience with a covered lagoon at another Wisconsin farm indicates that solids accumulation may not be a concern. Even after a number of years, few solids remain after the liquids are pumped out twice each year. The theory is that the anaerobic conditions which exist in the sealed lagoon serve to liquefy the solids over time, much as what happens in a home septic tank. The plan at this farm is to wait until the cover needs replacing before completely emptying the lagoon of any accumulated solids.

- During the course of this study, it was noted that feed storage often generated significant odors. At times, depending on wind direction and other factors, it became difficult to determine which was more noticeable, the odors from the waste storage lagoon or the ones from the feed bunker. These conditions seemed to occur at farms where feed was stored at higher moisture content. Feed that was put up dry, and kept well protected from precipitation, did not generate as much odor as did feed that was leaching due to wet conditions. A farmer wishing to control odors should maintain stored feed in as dry a condition as possible.
- The sampling on our baseline animal feedlot indicated that this type of facility is not a concern for odors or concentrations of ammonia and hydrogen sulfide. However, this must be qualified with the fact that the stocking rate at this facility was fairly low (999 animals on 80 acres of land). The sampling also indicated that areas where the animals were concentrated, such as around feed bunks, tended to have higher levels than did other areas, as would be expected. Open feedlots with very high stocking rates, such as is common in the western U.S., would logically produce more odors, and higher concentrations of ammonia and hydrogen sulfide, than our study farm.

  If control of odors and emissions from open feedlots is a concern, it stands to reason that stocking rates should be kept low. Lower animal densities will also help to maintain vegetation and reduce erosion. A good land base will bring nutrients into balance, reducing inputs as well as the need to haul manure.

ADDITIONAL RESEARCH NEEDS IDENTIFIED BY THIS PROJECT

It became apparent quite early in the study that our study design was stretched too thin to accomplish our goals to a statistically relevant and significant extent. As such, more sampling in general would be desirable around most of these facilities. Beyond this, the following specific recommendations for facilities involved in this study are included below.

Case Study 1, Anaerobic Digester (Waupaca County): Although no additional practices were installed at this farm, further sampling would be of use because of the existence of separate digested and undigested manure lagoons. If we had realized early enough in the study that this was the case at this facility, sampling on and around both lagoons would have been conducted as a matter of course. Although not the highest priority at this point, re-sampling this facility for a series of three sampling runs encompassing both lagoons would be of interest.

Case Study 2, Impermeable Cover (Dunn County): Addition of the impermeable cover renders this facility somewhat less interesting for further sampling. Although it would be of use to check on the condition of the cover and general odors around the facility on a perhaps annual basis, no further sampling is recommended.

Case Study 3, Permeable Cover (Kewaunee County): Further sampling at this facility is something of a priority. Initial post-cover results obtained in May 2008 showed no hydrogen sulfide, while follow up visits revealed significant concentrations, especially around the sand channels and outfall. Determining whether this was a random occurrence, or whether there truly is a reduction in local hydrogen sulfide to almost zero on a seasonal basis is of importance in evaluating the impact of this practice. Follow up visits in Spring, 2009 did not capture both hydrogen sulfide conditions. An on-going program of periodic long term sampling would be of interest to observe the behavior of the cover over time.

Case Study 4, Solids Separation and Aeration (Monroe County): in the ideal world, more pre-practice sampling would be conducted around this facility, to make our pre- and post- practice results more comparable. However, this is not possible, so the best we can do is conduct more sampling runs with the system in operation, to see if there are reductions as the system reaches a more complete equilibrium. An on-going program of periodic long-term sampling would be of interest to observe the aeration system over time..

Case Study 5, Animal Feed Lot: Further sampling at this facility is not of significant interest.

Case Study 6, Manure Storage Lagoon (Manitowoc County): although no practices were installed at this facility, its significant concentrations render it an interesting site for further background studies. However, with limited resources, no immediate further sampling is recommended.

In addition to the recommendations above, significant further research would be useful. It must be recognized that the practices studied here are by no means the only possible BMPs related to odor and air emissions control. Finding examples of different practices and conducting before and after studies on them would be of great value in determining which of the practices accomplish goals of reducing air impacts in a cost effective manner.

Of special interest would be investigating practices surrounding the use of sand channels, which our study identified as significant areas of elevated concentrations. In addition, the little sampling we did around barns have identified that they are sources of ammonia, and thus could be the subject of altered management practices intended to reduce air impacts.

TECHNICAL COST BENEFITS REALIZED

Operating Costs	Dunn County Site *		Waupaca County Site *	
	Cash (Out of Pocket Costs)	In-kind	Cash (Out of Pocket Costs)	In-kind
Digester Maintenance	$27,300		0	
Substrate Transportation	$255,970		NA	
Separator Repair/Maintenance	$32,200		$17,500	
Pumps Repair/Maintenance	$38,951		$3,000	
Other Costs (Repairs, Maintenance, Labor, Fuel, Insurance, etc.)	$84,108		$70,100	$9,500
Total Operating Costs for Reporting Period	$538,529		$90,600	$9,500

Benefits/Income	Dunn County Site *	Waupaca County Site *
Income from Energy Produced	$359,134	$248,756
Selling Compost	$6,000	$27,300
Savings on Bedding Materials	$42,000	$117,250
Other Benefits/Income	(Substrate Income) $125,017	$35,000
Other Benefits/Income	(Offset Credits) $80,948	
Total Benefits/Income for Reporting Period	$613,099	$428,306

* Costs and Income from both sites are for the 3rd and 4th quarter of 2006, all of 2007, and the 1st quarter of 2008

Table E
Costs and Income for Participating Manure Digester Systems

APPENDIX A: SAMPLE NASAL RANGER™ ODOR SENSITIVITY TEST DATA SHEET SAMPLE

St. Croix Sensory, Inc.

Odor Sensitivity Test Data Sheet B

Name : Steve Struss Date : 5/19/08 Time : 11:00 AM

The Red Pen presention order is designated by the shaded box.
Record Responses as G for guess and D for detect.

Warm Up presentations alternate every-other dilution

Round 1 Starting Point is 3 levels back from the first of two consecutive correct Warm Up Detects

Round 2 Starting Point is 2 levels back from the first of two consecutive correct Round 1 Detects

Level	Warm Up 1	Warm Up 2	Warm Up 3	Round 1 1	Round 1 2	Round 1 3	Round 2 1	Round 2 2	Round 2 3
15			G						
14									
13	G								
12									
11	G								
10					G				
9	G			G				G	
8						G		D	
7		D		D			D		
6					D				
5			D						
4									
3									
2									

The Score is the first level of two consecutive correct D responses.

SCORE: 7 SCORE: 8

Individual's Odor Sensitivity (average of the SCORES): 7.5

Test Administrator : Mike Murray

Odor Pen Kit Serial Number : S/N 50361

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St. Croix Sensory, Inc. 3549 Lake Elmo Ave. N. P.O. Box 313 Lake Elmo, MN 55042 U.S.A. Tel:800-879-9231 Fax:651-439-1065
Email:stcroix@fivesenses.com Web:www.fivesenses.com and www.nasalranger.com

APPENDIX B: PRE- AND POST-BMP SURVEY RESULTS

<Farm Name> Survey Results					**Comments**
1. Length of residency in Kewaunee Co.					
1-5 yrs	5-10 yrs	10-25 yrs	25+ yrs	NR	2/3 over 10 yrs
1	3	3	7	1	
6.66%	20%	20%	46.60%	6.66%	
2. Odor impact outdoor plans					about
Never	Almost never	Occasionally	Frequently	NR	1/2 no impact
5	2	4	3- 1 windows open	1	and 1/2 impact
			1- 57 days identified		
33.30%	13.30%	26.60%	20%	6.66%	
3. Season of odor issues					
Never	Spring fall	Summer	Pit emptying and agitating	NR	Summer and pit
1	5	8	4	1	agitation
5.20%	26.30%	42.10%	21%	5.20%	19 responses- multiple months
					Multiple responses on some surveys
4. Increase of odor nuisance					
Yes	No	No response			over 1/2 had not
5	9	1			reported increase
33.30%	60%	6.66%			
5. Are you satisfied with <Farm Name> efforts to control odors					
Very satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied	NR	
4	6	2	2	1	2/3 satisfied
26.60%	40%	13.30%	13.30%	6.66%	1/3 not
6. Move to another home in area-location of <Farm Name> impact decision					
Yes	No				Overwhelming response
13	2				on location
86.60%	13.30%				
					normal farm odors
7. Farm odors make you move from rural area					do not appear to force
yes	no	NR			people to move
3	9	3			
1 if CAFO					
8. Air emissions/odors impact human health					
not concerned at all	somewhat concerned	very concerned	NR		40% is either somewhat
8	3	3	1		or very concerned about
53.30%	20%	20%	6.60%		health impacts
9.Live on a farm					
yes	no				
10	5				
66.60%	33.30%				

Additional comments- concerned about lagoon seepage, small farm odors do not bother respondent but CAFO's do, more concern about hog than dairy cattle odors; type of odor, hauling and spreading was also mentioned.

NR- no response

<Farm Name> SURVEY 2 RESPONSES

1. How long have you lived in the Town of <>, Kewaunee Co? Average 30.1 years
Range from 0 to 74 years

1-5 years	5-10 years	10-25 yrs	25+ yrs	NA
0	3	2	4	1

2.Have you noticed reduced odor instances or intensity since the cover was installed in late 2007?

Yes	No	No difference
4	4	2

3. How frequently have odors from <Farm Name> affected your outdoor plans, such as eating outdoors, taking a walk, gardening, etc. since the manure storage cover was installed in late 2007?

Never	Almost Never	Occasionally	Frequently
4	1	3	2

4. Are you satisfied with the efforts <Farm Name> to control its odor?

Very Satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied	NR
4	2	1	2	1

5. Has the efforts of <Farm Name> made it more likely that you want to continue to live in the neighborhood?

Yes	No	NR
5	3	2

6. Are you still concerned about the effect of air emission/odors from livestock to your health?

Not concerned at all	Somewhat concerned	Very concerned
2	4	4

7. Do you currently live on a farm?

Yes	No
5	5

Concentrated Animal Feeding Operations and Proximate Property Values

by John A. Kilpatrick

abstract

Property located near a concentrated animal feeding operation (CAFO) will be negatively impacted by this externality. The degree of impairment depends on proximity and property type and use. Properties with higher unimpaired values are probably impacted more than otherwise lower-valued properties.

Concentrated animal feeding operations (CAFOs) are often called "feedlots." They may include facilities where animals are raised or where animals are brought for slaughter. The common denominator is a large, perpetual inventory and density of animals.[1]

Currently, the USDA and the EPA estimate that livestock in the United States produces 130 times the amount of manure produced by the entire human population of this country. Spills from CAFOs have killed fish in several states; phosphorus in land and water has been correlated with livestock density; and manure has caused eutrophication and degradation of U.S. waterways.[2]

The trend toward CAFOs has been rapid and pronounced in the U.S., but federal and state laws generally are considered to have some gaps. In addition to water quality issues resulting from manure and waste run-off, these facilities attract flies and other insects and pests that parasitize the insects.[3]

Professor John Ikert, an agricultural economist with the University of Missouri at Columbia, sums up the problems quite succinctly in a recent working paper when he says, "Piling up too much 'stuff' in one place causes problems." Writing specifically about swine CAFOs, he goes on to comment, "If you spread out the hogs and let hog manure lay where it falls in a pasture, it doesn't bother anyone very much. But if you start collecting it, flushing it, spreading and spraying it around—all normal practices in confinement hog operations—it becomes air pollution."[4]

Because of the noxious and obvious problems associated with CAFOs, many states have enacted severe restrictions on permits. For example, in 1997 the

1. Numerous documents were reviewed to develop this section, see subsequent footnotes for details. Much of the nomenclature comes from Drew L. Kershen, JD, and Chuck Barlow, JD, "Concentrated Animal Feeding Operations and Water, Air, Land, and Welfare." A report of the American Bar Association Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, (September 23, 1999).
2. Stephen Jann, "Recent Developments in Water Pollution Control Strategies and Regulations." Presented at the American Bar Association Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, Minneapolis, MN, (May 12, 1999).
3. Smith-Comeskey Ground Water Sciences, "Concentrated Animal Feeding Operations – Resources for Environmental Responsibility." Working paper (April 1, 2000). See <http://www.groundwatersystems.com/agwaste.html> for more details.
4. John Ikerd,"Social, Economic, and Cultural Impacts of Large-Scale, Confinement Animal Feeding Operations." Working paper, University of Missouri (March 2, 2001).

legislature of typically livestock-friendly Oklahoma mandated setbacks and other pollution controls, and in 1998 that legislature enacted a moratorium on new livestock permits.[5] Kansas is another typically agriculture-friendly state that recently has enacted a moratorium on CAFOs, and it is considering legislation to end CAFOs.[6] In 1998, the North Carolina legislature, faced with unregulated establishment of CAFOs, enacted House Bill 1480, which mandated the registration of growers for integrators, extended a moratorium, and mandated substantial elimination of both atmospheric emission of ammonia and odor beyond the boundary of existing CAFOs.[7] Minnesota enacted similar odor control legislation in 1997 and established both a complaint control protocol and an enforcement response protocol specific to CAFOs.[8]

CAFOs and the Value of Nearby Real Estate

A CAFO impacts the value of proximate properties to the extent that the CAFO is viewed, in the market, as a negative externality.[9] As an externality, it is typically not considered to be economically "curable" under generally accepted appraisal theory and practice.[10–12] Some of this loss in value may be attributable to stigma, when there are unknowns and risks associated with ownership of the property.

Impairment and Value—An Overview

From an economic perspective, the rights enjoyed by a fee-simple owner fall into three categories:

1. Right of use and enjoyment
2. Right of exclusion
3. Right of transfer[13]

It is important to note that in the U.S. property itself is not "owned," but rather the rights of the property are owned.[14] The ability to delineate these rights, and the ability of owners to transfer some or all of these rights voluntarily is a necessary condition for property valuation.

Use and Enjoyment

The first of these rights, that of use and enjoyment, is generally interpreted to mean that the owner may determine how property will be used, or if it is to be used at all. The right of use traditionally is limited in western culture by both public restrictions (e.g., eminent domain, police power) and private restrictions (e.g., liens, mortgages). Private restrictions are generally voluntary, and property owners willingly submit to the disutility of such restrictions in trade for some other economic benefit. For example, a property owner will issue a mortgage to a lender in trade for leverage in the purchase. Also, a homeowner will purchase in a subdivision with covenants and restrictions in trade for the assurance of uniform property use within the neighborhood. It is noteworthy that the voluntary acceptance of private restrictions is always in trade for some economic compensation. For example, a property owner may grant a scenic easement, which restricts the use and enjoyment of his or her property, but will expect to be compensated for that easement.

An impairment often places a restriction on the right of use without some economic compensation. This is illustrated in potential restrictions that may be placed on the use of real estate due to a physical impairment and can thus limit the property to something less than its highest and best use. For example, odor or flies from a nearby CAFO will restrict the use and enjoyment of impaired property without compensation.

5. Michelle Stephens, "NGO and Grassroots Perspectives and Action." Presented at the American Bar Association Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations, Minneapolis, MN, (May 12, 1999).
6. Roger Myers, "Graves May Lift Licensing Ban on Large-Scale Hog Farming," *The Topeka Kansas Journal* (24, 1998).
7. Michael C. Williams, "CAFO Odor Control Options." Working paper, North Carolina State University, presented at the American Bar Association Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations (September 23, 1999).
8. Michael Sullivan, "Minnesota's Program Regarding Hydrogen Sulfide Emissions from CAFOs." Working paper, Minnesota Pollution Control Agency, presented at the American Bar Association Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations (September 23,1999).
9. For a thorough discussion in this context, see Appraisal Institute, *The Appraisal of Real Estate,* 11th Ed. (Chicago: Appraisal Institute, 1996): 46–48, 336–337, 398.
10. Ibid., 336–337.
11. For a discussion of the incurability of external obsolescence, see Hal Smith and John Corgel, *Real Estate Perspectives,* 2nd Ed. (Boston: Irwin, 1992): 524.
12. Under some circumstances, such as a class-action suit, the externality may be curable. However, when considering one impacted parcel alone, the externality probably is not economically curable.
13. While owners' rights are delineated in many texts, this specific characterization is derived from Austin J. Jaffee and Demetrios Louziotis Jr., "Property Rights and Economic Efficiency," *Journal of Real Estate Literature* (4, 1996): 137–162.
14. Armen A. Alchian and Harold Demsetz, "The Property Rights Paradigm," *Journal of Economic History* (53, March 1973): 16–27. See also, Harold Demsetz, "Toward a Theory of Property Rights," *American Economic Review* (57, 1967): 347–373.

Right of Exclusion

The right of exclusion—often called the right of exclusive use or right of exclusive enjoyment—provides that those who have no claim on property should not gain economic benefit from enjoyment of the property. In other words, the right of use is exclusive to the property owner, and any violation of the right of exclusive use typically carries either payment of compensation to the rightful owner or assessment of a penalty. For example, if "A" trespasses on land owned by "B," then "A" will be guilty of a crime and a possible criminal penalty may be in order, as well as civil damages. Physical impairment, such as the odor or flies, in effect is a trespass on property rights and violates the right of exclusion.

Society places a high value on the right of exclusion, for justifiable reasons. Exclusion provides that both the current benefits of ownership as well as future benefits accrue only to the rightful owner, and his/her successors and assigns. In the absence of exclusion, the right of use is under constant threat of nullification without just compensation. In an economy without the right of exclusion, property owners would adopt short-term strategies for use, rather than long-term strategies. In an economic sense, this would lead to widespread inefficiency in the allocation of resources. Hence, the right of exclusion carries with it a significant societal good,[15] and thus a significant, societally recognized value.[16]

Right of Transfer

Finally, the right of transfer provides the owner with the ability to swap one resource for another. An impairment restricts the right of transfer, and may destroy the right of transfer altogether.

Effects of Negative Externalities on Property Values

Real estate economics and appraisal practice uniformly recognize that many externalities such as contamination may have a negative impact on property values. For example, appraisers are required by the Uniform Standards of Professional Appraisal Practice (USPAP) to consider the impacts of such contamination in the value estimation process.[17]

"Real estate economics and appraisal practice uniformly recognize that many externalities such as contamination may have a negative impact on property values."

Fitchen[18] was one of the first to look at the value of the rights of a property owner in the face of impairment—in that case, a toxic chemical pollution. As an anthropologist and a professor of anthropology, she looks principally at residential values and considers not only the real aspects of "violation of the home" by contamination (e.g., carcinogenic effects of polluting chemicals) but also the symbolic interference of what she calls "…a threat to the assumptions people have about themselves and the way life is supposed to be."[19] She notes, "Toxic contamination also attacks the valued institution of homeowner-ship, violating many of the rights that are assumed to flow from the ownership of ones home, including the assumed right to control entry to it….Chemical contamination may affect homeowners more seriously than renters, not only in terms of potential financial loss, but also in terms of devaluation of the achieved status of homeowners."

Edelstein also deals with this "home" theme, and calls impairment to or near a residence an "…inversion of home…" when "…the previous locus of family security and identity becomes instead a place of danger and defilement."[20] He builds on previous works, such as Perin[21] and Altman and Chemers,[22] that show the very special place the home has in American society, culture, and economics. Perin states, "Not being a nation of shopkeepers, America

15. See for example, Frank Snare, "The Concept of Property," *American Philosophical Quarterly* (9, April 1992).
16. George Stigler, "Law or Economics?" *Journal of Law and Economics* (35, October 1992): 455–469.
17. This is specifically covered under USPAP Rule 1-2(e). This is one of the rules from which departure specifically is not permitted. For a thorough discussion of the appraiser's responsibility see also, J.D. Eaton, *Real Estate Valuation in Litigation* (Chicago: Appraisal Institute, 1995): 128–129, 149–54, 235–37.
18. Janet M. Fitchen, "When Toxic Chemicals Pollute Residential Environments: The Cultural Meanings of Home and Homeownership," *Human Organization* (48, Winter 1989): 313–324.
19. Ibid., 320.
20. Michael R. Edelstein, "Toxic Exposure and the Inversion of the Home," *Journal of Architecture Planning and Research* (3, 1986): 237–251.
21. Constance Perin, *Everything in its Place: Social Order and Land Use in America* (Princeton, NJ: Princeton University Press, 1977).
22. I. Altman and M. Chemers, *Culture and Environment* (Monterey, CA: Brooks/Cole Publishing, 1980).

is one of homeowners, busily investing in plant maintenance and expansion with both money and time, keeping the product attractive for both use and sale."[23]

Edelstein specifically stresses the investment diminution aspect of the inversion of home principle. In citing case studies of experiences following neighborhood-wide impairment in the Legler section of Jackson Township in southern New Jersey, he shows that residents could not separate the psychological pride in home ownership from the question of economic value. Surveys of the population found uniformity of opinion that property values had diminished as a result of the problem. While previous studies had focused on the diminution of value from existing homes, Edelstein was one of the first to focus on the opportunity costs stemming from the inability to move. In short, homeowners were stuck holding unsellable homes with stagnant prices, while homes in other neighborhoods were soaring in value. Thus, the owners were harmed not only by the diminution of value in the existing residences, but by the opportunity costs inherent in lost gains from alternative home investments.

Value Loss: Stigma Issues

Edelstein refers, in a general sense, to the issue of stigma as a mechanism for manifestation of value diminution in residential property. Stigma is an increasingly common term in appraisal and real estate economics literature, and refers to a very specific quantitative mechanism by which value is impacted by proximate contamination or negative externalities.

The earliest references to stigma as a quantitative concept in real estate economics appear to be in the writings of Patchin[24] and Mundy.[25] The latter study differentiated between the cost to cure and the cost of stigma. The former is an out-of-pocket expense born either by the property owner or some other responsible party, while the latter manifests in property value diminution even in the absence of a cost to cure. For example, a property that is completely cured may continue to suffer a diminution in value, and hence damages, because of stigma.

Kilpatrick outlines the quantitative model by which the value of income producing property is reduced by the effects of stigma manifested via increases in market driven capitalization rates.[26] He outlines four components of income producing property value impacts: net operating income, actual cost-to-cure, ongoing increases in maintenance, and stigma. In his model, the stigma losses actually overwhelm the other three factors as a component of value diminution. He concludes that under many circumstances the stigma impacts are actually the greater portion of value losses to property owners.

Other Proximate Contamination Issues

The issue of value loss for proximate contamination or other impacts has been considered in a number of studies, and includes how the citing of an externality, such as a CAFO, can impact nearby values. Some of the earliest researchers, such as Blomquist, looked at the impact of locating a power generating plant,[27] while Guntermann showed that landfills have a negative impact on the value of surrounding industrial property, and that this value loss has a spatial component.[28] Kinnard and Geckler had similar findings for nuclear facilities,[29] as did Kinnard[30] and Kiel[31] for hazardous waste sites.

In a similar vein, Colwell analyzes the property value diminution associated with proximity to power lines,[32] and Kirshner and Moore show that water quality can impact nearby residential property values.[33] Simons's study of pipeline ruptures shows that diminution in value occurs on properties up to two miles from the site of a petroleum spill.[34]

23. Perin, 120.

24. Peter Patchin, "Contaminated Properties–Stigma Revisited," *The Appraisal Journal* (April, 1991): 162–172.

25. William Mundy, "Stigma and Values," *The Appraisal Journal* (January, 1992): 7–13.

26. John Kilpatrick, "Appraisal of Contaminated Property," *Career News* (University of South Carolina, Darla Moore School of Business, August 1998).

27. Glenn Blomquist, "The Effect of Electric Utility Power Plant Location on Area Property Values," *Land Economics* (50:1, 1974): 97–100.

28. Karl Guntermann, "Sanitary Landfills, Stigma and Industrial Land Values," *Journal of Real Estate Research* (10:5, 1995): 531-542.

29. William Kinnard and Mary Beth Geckler, "The Effects on Residential Real Estate from Proximity to Properties Contaminated with Radioactive Materials," *Real Estate Issues* (Fall/Winter, 1995): 25–36.

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Case Studies

The following cases illustrate the effects of CAFOs and the impact of CAFOs on property value.

Minnesota Case Study[35]

A homeowner in Minnesota lives about two miles from one swine CAFO and about three-quarters of a mile from a second CAFO. When these CAFOs were first opened in the early 1990s, she was initially a supporter. However, she and her family immediately began suffering illnesses, which they attributed to the proximate CAFOs. She contacted the Minnesota poison control center and for the first time learned about the dangers of hydrogen sulfide emissions. She kept track of her illnesses and weather conditions (e.g., wind and direction) and concluded that her illnesses were caused by the emissions from the CAFOs. Testing was warranted, and on at least one occasion the reading was above 1,000 ppb hydrogen sulfide, well above danger levels.

North Carolina Study[36]

Palmquist, et. al, were the first to quantitatively determine that the distance from a residence to a CAFO has an impact on residential values. However, their study looked only at residences already near CAFOs and measured the impacts of additional CAFO capacity (either new CAFOs or additional livestock at existing CAFOs) located at 0.5-, 1.0-, and 2.0-mile distances from the residence. Nonetheless, they established a methodological model for spatial impacts of CAFOs.

University of Minnesota Study[37]

In 1996, the Minnesota Department of Agriculture commissioned a study by researchers at the University of Minnesota on the topic of value diminution resulting from proximate CAFOs. In addition to substantial secondary research in the area, the study authors also conducted primary research into value impacts in that state. Specifically, they conducted a hedonic price analysis on 292 rural residences that were sold during 1993–1994 in two Minnesota counties. They found a statistically significant pricing impact related both to the existence of a CAFO as well as the distance from the CAFO. In other words, not only does a CAFO have a significant impact on property value, but the nearer the CAFO, the greater the impact. The researchers also found that CAFOs tend to be located near older or lower valued homes. Hence, the pricing impacts in a simple empirical study may be muted by other negative impacts to value, and high-valued residences may be impacted to a greater degree by CAFOs than would be suggested by their findings.

University of Missouri Study[38]

Following the methodology of the Minnesota study, researchers at the University of Missouri were able to quantify both the average value impact of a CAFO and the impact by distance. An average vacant parcel within 3 miles of a CAFO experienced a value loss of about 6.6%. However, if that parcel was located within one-tenth of a mile from the CAFO (the minimum unit of measure in the study) and had a residence on it, then the loss in value was estimated at about 88.3%.

Pasco, Washington Case Study[39]

A 309-acre family farm that had been operated for many years produced alfalfa, asparagus, corn, apples, peaches, nectarines, cherries, melons, and a range of garden produce. A CAFO was adjacent to the residence (about ¼ mile away), and consequently the farm product was impacted by dust, flies, fly fecal matter, and odor. The farm was appraised for litigation purposes and a value diminution of over 50% was determined, using traditional farm appraisal methods. The CAFO settled the lawsuit by purchasing the plaintiff's farm and relocating the residents to a nearby farm that was not impacted by the CAFO externalities.

Michigan Horse Farm Case Study[40]

A horse-breeding operation (owner-occupied farm) is located approximately 1,000 feet from a recently

35. Presentation at the American Bar Association Special Committee on Agricultural Management Roundtable II on Environmental Challenges in Animal Feeding Operations (September 23,1999). Results of the study not independently validated by the author.
36. R. Palmquist, F. Roka, and T. Vukina, "Hog Operations, Environmental Impacts, and Residential Property Values," *Land Economics* (73:1, 1997): 114–124. Results of the study not independently validated by the author.
37. Steven J. Taff, Douglas Tiffany, and Sanford Weisberg, "Measured Effects of Feedlots on Residential Property Values in Minnesota: A Report to the Legislature," University of Minnesota Staff Paper Series (July, 1996). Results of the study not independently validated by the author.
38. Mubarek Hamed, Thomas Johnson, and Kathleen Miller, "The Impacts of Animal Feeding Operations on Rural Land Values," University of Missouri-Columbia Community Policy Analysis Center Report R-99-02 (May, 1999). Results of the study not independently validated by the author.
39. Mundy Associates, LLC files. Details of case confirmed by property owners.
40. Mundy Associates, LLC files. Details of the case confirmed by property owner and attorneys for both sides.

constructed large scale, pork processing facility. The use and enjoyment of the home has been diminished by airborne externalities, and the ability to use the site as a farm may be compromised as a result of flies carrying animal blood and feces that contain antibiotics and other nuisances. In 2000, the property owner appealed for a property tax reassessment representing a devaluation of over 50% from fair market value, and the county attorney concurred with that appeal.

Michigan Residence Case Study[41]

A family purchased a "fixer upper" residence in rural Vicksburg, Michigan in 1995. In 1997, a large-scale pork processing facility was located about 700 feet from the home. The reduction in air quality was so severe as to force the residents to abandon their home and move elsewhere. To date, they have not been able to sell the home. The owner of the processing facility offered to compensate them for 60% of the fair market value of the home (i.e., a 60% diminution in value). As of this writing, litigation is pending.

Summary and Conclusions

The above suggests that the establishment of a CAFO may result in value diminution to other nearby properties. The amount of the value loss is typically an inverse function of distance (closer properties diminish more), a function of property type (newer, nicer residences lose more), and a function of property use (farm will lose value due to diminished productivity and comparative marketability to other farm lands). While the appraisal profession has only begun to quantify the loss attributable to CAFOs, it is clear from the above case studies that diminished marketability, loss of use and enjoyment, and loss of exclusivity can result in a diminishment ranging from 50% to nearly 90% of otherwise unimpaired value.

When appraising a property located proximate to a CAFO, the appraiser needs to consider seven specific issues, each of which will have an impact on the value conclusions:

1. Type of subject property,
2. Distance to the CAFO,
3. Physical manifestations (e.g., air quality, insects),
4. Engineering/scientific testing performed (e.g., air quality),
5. Impacts on property use (e.g., habitability, rental income or vacancy),
6. Marketability evidence (e.g., time on market of comparable properties), and
7. Impact on highest and best use.

While there is little disagreement that a CAFO has an impact on surrounding property values, the degree of impact is clearly a function of the interplay of these factors.

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Table 1 Summary of CAFO Impacts

Case Study	Value Loss	Remarks
Minnesota	N/A	Significant diminution in air quality
North Carolina	N/A	Established distance component to value
University of Minnesota	N/A	CAFO sited near older, less-expensive homes
University of Missouri	Residential 3 miles: 6.6% Residential 0.1 mile: 83%	Quantified average value impact by distance
Washington	Family farm adjacent: 50%	Impact included flies and loss of farm income
Michigan farm	Farm adjacent: 50%	Impact included loss of use as a farm
Michigan residence	Residence adjacent: 60–100%	Residence abandoned, could not be sold

41. Mundy Associates, LLC files. Details of the case confirmed by property owner and neighbors.

Odor From Feedlot Setback Estimation Tool (OFFSET) Version 2.0

OFFSET Ver 2.0
University of Minnesota
1/21/2017

This spreadsheet was developed by the Department of Bioproducts and Biosystems Engineering through grant funds provided by the Minnesota Department of Agriculture via the Minnesota State Legislature.

OFFSET is intended to provide farmers, consultants, regulators, and concerned citizens in Minnesota a simple and quick means of assessing the air quality impacts from animal feeding operations. The model is based on the original OFFSET (Odor From Feedlot Setback Estimation Tool) model , also developed at the University of Minnesota but has been reformatted to make it more user friendly. Other upgrades include provisions for adding odor control technologies and some graphical representations of odor setbacks.

Additionally, OFFSET Version 2.0 uses the average emission flux values to estimate the loading of hydrogen sulfide (H_2S) and ammonia (NH_3) from the site (daily and annual). Note that this is not a minimum or maximum value but an average value and reported as tons per year or pounds per day. An estimation of the daily maximum H_2S and NH_3 emissions is also reported and calculated as twice the average (2 x) daily value. This maximum value of twice the average daily loading and is based on best professional judgement using a review of published daily emission values on several different studies.

Note that OFFSET does not include any predictions for property line hydrogen sulfide concentrations as was originally intended and proposed as the MNSET model (Minnesota Setback Estimation Tool). The generalized predictions from this model had too many uncertainities for the specific regulatory limits in Minnesota due to the inability of a simple model to capture the variability in site specific layout of the farms and the variability of emissions from the buildings and manure sources.

More information regarding the development of this model is found in a final project report submitted to the Minnesota Department of Agriculture on August 15, 2007.

Published reports to support the development of the OFFSET model.

Guo H., Jacobson, L.D., D. R. Schmidt, R. E. Nicolai, J. Zhu, K. A. Janni. 2005. Development of the OFFSET model for determination of odor-annoyance-free setback distances from animal production sites: Part II. Model Development and Evaluations. Transactions of the ASAE. Vol. 48(6): 2269-2276.

Jacobson, L.D., H. Guo, D. R. Schmidt, R. E. Nicolai, J. Zhu, K. A. Janni. 2005. Development of the OFFSET model for determination of odor-annoyance-free setback distances from animal production sites: Part I. Review and Experiment. Transactions of the ASAE. Vol. 48(6): 2259-2268.

Nimmermark, S.A., L.D. Jacobson, S.W. Gay, and D.R. Schmidt. Prediction by the Odor From Feedlot, Setback Estimation Tool (OFFSET) Compared to Observations by Neighborhood Monitors. 2005. J Air & Waste Manage Assoc 55:1306-1314.

Guo, H., L.D. Jacobson, D.R. Schmidt, R.E. Nicolai. 2001. Calibrating INPUFF-2 Model by Resident-Receptors for Long-Distance Odor Dispersion from Animal Feedlots. Applied Engineering in Agriculture 17(6):859-868.

Zhu, L.D. Jacobson, D.R. Schmidt, R. Nicolai. 2000. Evaluation of INPUFF-2 Model for predicting downwind odors from animal production facilities. Applied Engineering in Agriculture 16(2):159-164.

Input Worksheet

Recordkeeping Information Only	
Farm Name	The name of the farm
Address or County	The county or address of the farm
Evaluator	The person conducting the model evaluation
Date	The date of the model evaluation

Inputs critical to the model predictions	
Source Edge to Nearest Neighbor (ft)	The closest distance (feet) from the nearest neighbor to an emission source on the farm.
Source Edge to Property Line (ft)	The closest distance (feet) from the edge of the odor source to the property line.
Source Description	Source Descriptions are divided into "Building" sources and "Area" sources. Buildling include all types of buildings. Area sources typically include feedlots and manure storages A source is a building or area that emits odors and gasses.
# Similar sources	Numeric indication of the number of sources of a similar type and similar dimensions.
Source Width (feet)	The width of the indicated source, in feet. Note that if the source is round, input the source area
Source Length (feet)	The length of the indicated source, in feet. If the source is round put a '1' in this cell.
Control Technology	A drop down menu indicating optional technologies that have been shown to reduce emissions Note that there are several spaces for adding future technologies built into the spreadsheet. In addition, at the bottom of the spreadsheet there is an option to add other emission control technology options and their effectiveness that may not be validated by UMN.
% of Air through Treatment	Note the percentage of building air being treated by the technology. For instance, if only some of the building fans have a biofilter this fraction of air should be recorded in this cell.

Optional Inputs	
Additional Building or Area Source	There may be some types of facilities that are not listed in the drop down menus. Typically, these types of sources are not listed because there has been no emission data collected at these types of sources. For these cases, a best professional judgement can be used to estimate the flux rates. These can be based on similar facilities or current literature.
Name of Source	The name of the building type or area
Odor Flux (ou/ s/ m2)	The flux of odor from the source. Note that this is different than the Odor Emission Rate used in OFFSET. Most literature reports in odor units per second per square meter.
H2S Flux (ug/ s/ m2)	The hydrogen sulfide flux from the source in units of micrograms per second per square meter.
Ammonia Flux (ug/ s/ m2)	The ammnonia flux from the source in units of micrograms per second per square meter.

Control Technology	Often there are technologies proposed to reduce source emissions that are not included in the standard table values provided by this model. If the evaluators have evidence to suggest that some technologies may be valid they can enter these technologies here. If listed here they will show up in the "Control Technolgy" drop down menus.Note that there are options to add either building technologies or area source technologies.
Name of Technology	The name of the emission control technology
Odor Reduction (%)	The percent reduction in odor emissions expected from the technology
H2S Reduction (%)	The percent reduction in hydrogen sulfide emissions expected from the technology
Ammonia Reduction (%)	The percent reduction in ammonia emissions expected from the technology

Results Worksheetsheet

Site Information Summary	
Farm Name	Verification of Input
Address or County	Verification of Input
Evaluator	Verification of Input
Date	Verification of Input

Source Characteristics Summary	
Source Type	Verification of Input
Similar Sources	Verification of Input
Area	Calculation of total area of this source type in square feet
Control Technology	Verification of Input
Percent Treated	Verification of Input
Odor (ou/ s/ m2)	Odor flux from the source in units of odor units per second per square meter, including reductions
OER	Odor Emission Rate that is used by OFFSET and includes and control technology reductions
H2S (ug/ s/ m2)	Hydrogen sulfide flux from the source in units of micrograms/ second per square meter
Ammonia (ug/ s/ m2)	Ammonia flux from the source in units of micrograms per second per square meter

Site Emissions Summary	
Total Site Area (ft2)	The combined emission area from all sources
Total Odor Emission Factor (TOEF)	The total odor emission factor (with scaling factors included)
Total Site H2S Emissions (mg/ s)	The total site emissions of hydrogen sulfide in milligrams per second
Total Site H2S Emissions (lb/ day)	The total site emissions of hydrogen sulfide in pounds per day
Total Site H2S Emissions (tons/ yr)	The total site emissions of hydrogen sulfide in tons per year
Total Site Ammonia Emissions (mg/ s)	The total site emissions of ammonia in milligrams per second
Total Site Ammonia Emissions (lbs/ day)	The total site emissions of ammonia in pounds per day
Total Site Ammonia Emissions (tons/ yr)	The total site emissions of ammonia in tons per year

Site Setbacks	
Source Edge to Nearest Neighbor (ft)	Verification of Input
Odor Impact	The odor annoyance-free frequency predicted at the indicated distance to nearest neighbor

Manure Management and Environmental Quality

OFFSET odor from feedlots setback estimation tool

Larry Jacobson, David Schmidt, and Susan Wood

OFFSET TOOL

Introduction

When discussing odor problems related to animal agriculture, the following questions often arise:

- How far does odor travel?
- Are animal numbers or animal species accurate predictors of nuisance odors?
- How much odor control is needed to solve an odor problem from an existing facility?
- Can the odor impact from a new facility be predicted?

Answers to these questions are as varied as the people having the discussion. Until now, scientific methods to predict odor impacts did not exist. This publication discusses a new tool that has been developed at the University of Minnesota to answer some of these questions.

- Odor From Feedlots Setback Estimation Tool (OFFSET) (196 K XLS)
- Or, use the metric version of OFFSET (207 K XLS)

Figure 1. Prediction of odor problems is important
as rural and non-rural areas converge.

The tool is the result of four years of extensive data collection and field testing. It is a simple tool designed to help answer the most basic questions about odor impacts from livestock and poultry facilities.

OFFSET is designed to estimate average odor impacts from a variety of animal facilities and manure storages. These estimations are useful for rural land use planners, farmers, or citizens concerned about the odor impact of existing, expanding, or new animal production sites. OFFSET is based on odor measurements from Minnesota farms and Minnesota climatic conditions. As such, the use of OFFSET for estimating odor impacts in other geographic areas should be done with caution and through consultation with the authors of this publication.

Getting started

The amount of odor emitted from a particular farm is a function of animal species, housing types, manure storage and handling methods, the size of the odor sources, and the implementation of odor control technologies. However, the impact of these odors on the surrounding neighborhood or community is a function of both the amount of odor emitted and the weather conditions. Weather conditions strongly influence the movement and dilution of odors. Odor impact includes the strength of the odors and the frequency and duration of the odor events. OFFSET combines odor emission measurements with the average weather conditions to estimate the strength and frequency of odor events at various distances from a given farm.

The worksheet on the next page (Table 1) outlines a step-by-step process for determining the total odor emissions for a specific animal production site. This Total Odor Emissions Factor (TOEF) is the sum of odor emissions from all odor sources (e.g. barns, manure storages) on the site. The procedure accounts for species, housing types and sizes, manure storage types and sizes, and odor control technologies used at the site.

Determining the total odor emissions factor (TOEF)

The following five steps and accompanying tables can be used to estimate the odor emissions from the farm site.

Step 1.	List all the odor sources on the farm site in Column A of Table 1 (e.g. buildings, manure storage areas, lots, etc.).
Step 2.	Use Tables 2 and 3 to determine the odor emission number for each odor source. Enter these values in Column B, Table 1.
Step 3.	List the area of each odor source in Column C of Table 1 (in square feet).
Step 4.	Enter any odor control factors from Table 4 in Column D of Table 1.
Step 5.	Fill in Column E of Table 1 by multiplying the values in Columns B, C, and D and dividing by 10,000. (Dividing by 10,000 is done to make the numbers easier to work with.) Sum all the numbers in Column E to determine the Total Odor Emission Factor (TOEF) for the farm site.

Table 1. Worksheet for calculating the Total Odor Emission Factor.

Column A Odor source	**Column B Odor Emission Number/ft.2**	**Column C Area (sq. ft.)**	**Column D Odor Control Factor**	**Column E Odor Emission Factor (B x C x D/10,000)**
1.				
2.				
3.				
4.				
Total Odor Emission Factor (TOEF) sum of Column E):				

Table 2. Odor emission numbers for animal housing with average management level.*

Species	**Animal**	**Housing Type**	**Odor**

	Type		Emission Number/ft.2
Cattle	Beef	Dirt/concrete lot; Free stall, scrape	4
	Dairy	Free stall, deep pit; Loose housing, scrape Tie stall, scrape	6 2
Swine	Gestation	Deep pit, natural or mechanical Pull plug, natural or mechanical	50 30
	Farrowing	Pull plug, natural or mechanical	14
	Nursery	Deep pit, natural or mechanical; Pull plug, natural or mechanical	42
	Finishing	Deep pit, natural or mechanical Pull plug, natural or mechanical Hoop bar, deep bedded, scrape; Cargill (open front), scrape Loose housing, scrape; Open concrete lot, scrape	34 20 4 11
Poultry	Broiler	Litter	1
	Turkey	Litter	2

Table 3. Odor emission reference rate for manure storage.

Storage Type	Odor Emission Number/ft.2
*Earthen basin, single or multiple cells	13
Steel or concrete tank, above or below ground	28
Crusted stockpile	2

**Earthen basins are designed for manure storage without any treatment. Properly designed lagoons may have far less odor.*

Table 4. Odor control factors.

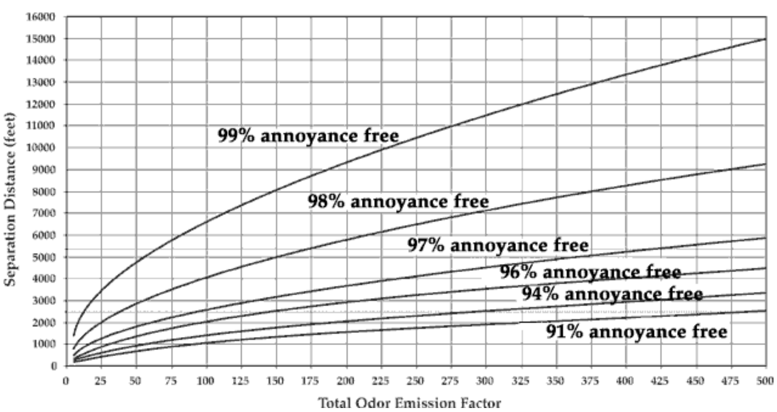
Odor Control Technology	Odor Control Factor
No odor control technology	1
Biofilter on 100% of building exhaust fans	0.1
Geotextile cover (≥2.4 mm)	0.5
Straw or natural crust on manure	0.5

4" 8"	0.3
Impermeable cover	0.1
Oil sprinkling	0.8

Predicting odor events

Once the TOEF is calculated, the frequency of odor occurrences at various distances from the farm site can be estimated using Chart 1. The horizontal axis in Figure 4 is the TOEF as calculated in Table 1. The vertical axis is the distance from the farm site. The curves represent different frequencies of time when odors will not be at levels considered "annoying." **These odor annoyance-free frequency curves in Chart 1 represent the percent of time where odors are possibly detected, but at a level that is NOT typically considered annoying.** To find the separation distance for a specific frequency curve and TOEF, simply find the TOEF on the horizontal axis, then move vertically to the desired annoyance-free frequency curve, then move horizontally to the vertical axis. The number on the vertical axis is the separation distance (in feet) needed to achieve the desired frequency of odors.

Chart 1. Estimated setback distances (in feet) from farms at different odor annoyance-free frequency requirements, leeward of the prevailing wind from animal operations. (Note: 1 mile = 5280 feet)



Different odor annoyance-free frequencies result in different setback distances for the same TOEF. For example, to achieve an odor annoyance-free frequency of 99% for a facility with a TOEF of 150 requires a separation distance of 1.5 miles. (This separation distance is measured from the edge of the nearest odor source.) During the rest of the time (1% or 7 hours per month), annoying odors will be detected at this distance. Reducing the frequency of annoyance-free odors to 96% would require a separation distance of less than 0.5 miles. At this distance, annoying odors would be experienced 4% of the time or 29 hours per month. Odor annoyance-free frequencies of 99%, 98%, 97%, 96%, 94%, and 91% correspond to 7, 15, 22, 29, 44, and 66 hours/month of annoying odors during the months of April through October. During the winter months less frequent odor events can be expected due to the reduced odor emissions during cold weather. Since these predicted frequencies are based on "average" weather conditions, actual frequencies of odor events may be significantly different.

Emission numbers

OFFSET bases the odor emission numbers on measured odor emission rates. The odor emission numbers (Tables 2 and 3) are the average of 200 odor emission measurements made on 79 different farms. The values reported are average values for a series of measurements from each odor source type. Unfortunately, there is a wide variation in odor emissions from similar sources and even from the same source. This variation is related to farm management, animal diet, or such things as ambient temperature, humidity, and wind speed. Note that the emission factors are based on odor emission measurements on Minnesota farms. Therefore, these emission factors may or may not be valid in other geographic areas.

Figure 3. Wind direction and wind speed play an important role in odor movement and dispersion.

Odor control factors

Several technologies are currently available to control odor, although little testing and research has been done to document their effectiveness. Technologies listed in Table 3 are the only technologies where sufficient information is available to determine likely reductions in odor emissions for field conditions. Changes and additions to Table 3 will be made as more research is conducted and more technologies are developed. Currently, there is no standard procedure for getting control technologies listed on Table 3, nor is it required by OFFSET to allow only odor control technologies listed in Table 3. However, estimated reductions in odor emissions should be based on sound scientific research.

Figure 2. Odor control is a critical part of reducing the frequency of annoying odor events.

Annoyance odors

The frequency curves in Figure 2 are based on "annoyance-free" odors. For purposes of OFFSET, annoyance-free odors are defined as those odors with an intensity less than 2 on a 0 to 5 scale. Odors with an intensity of less than 2 are weak or mild odors that are not likely to be annoying. A small percentage of the population is highly sensitive to odors. These individuals may detect odors at very low levels and be annoyed at intensities less than 2.

Meteorological data

Weather is one of the most important factors that affect the movement and dispersion of odors. The frequency curves used in OFFSET combine the average wind speeds and atmospheric stability conditions in Minnesota from six weather stations over a nine-year period. The curves represent different weather stability classes and wind speeds. Since there is considerable variability in weather conditions, OFFSET will likely both overpredict or underpredict odor events in any given month.

The lowest annoyance-free frequency in Figure 2 is 91%. Annoyance-free curves of lower frequencies are not shown on the graph. These lower curves (e.g. 60, 70, or 80% annoyance-free) would show setbacks less than the typical minimum setbacks of 1000 feet. These minimum setbacks consider other factors besides odor impacts (e.g. noise, dust).

Prevailing wind direction

OFFSET assumes that the receptor (the resident or person smelling the odor) is always located downwind of the odor source in the prevailing wind direction. Therefore, receptors in other directions from the odor source will likely experience annoying odors less frequently than what is predicted in Figure 2. OFFSET can be modified to predict these frequencies in non-prevailing wind directions, but this would need to be done on a site specific basis.

Topography

Topography (hills, valleys, trees, buildings, etc.) also affects odor dispersion. During very stable meteorological conditions with cooling temperatures, odorous air may travel long distances along low lying areas. Wind breaks may increase the dilution of odorous air thus reducing the travel distance of annoying odors. The "odor annoyance-free" curves given in Figure 2 were obtained assuming flat terrain with no obstructions. Significantly more effort is required to conduct a site specific odor evaluation which would include topographic features.

Cumulative impact

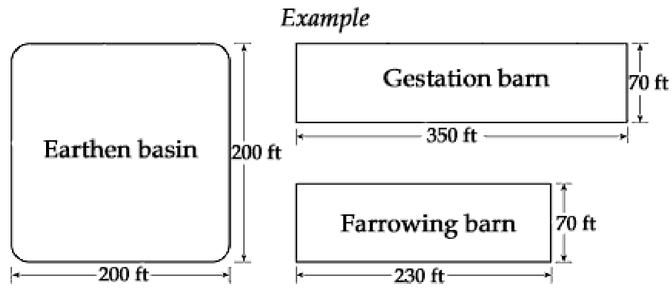
OFFSET may have the ability to consider the cumulative odor impact of multiple farm sites. However, to do this accurately would require site specific information. A general idea of cumulative impact on a specific location could be demonstrated by adding the annoyance-free frequencies from the surrounding farm sites.

Example

A farmer has a 1200-head sow gestation and farrowing operation with mechanical ventilation and pull plug gutters and a single stage earthen basin (Figure 3). The county suggests setbacks equal to the 97% annoyance-free curve at the nearest community. Currently, the nearest community is 0.5 miles (2640 feet) from the farm. Does this farm meet the county guidelines?

Step 1	There are three odor sources at the site, i.e. two buildings and one basin. The three source names are listed in Column A of Table 5 along with the odor emission numbers for each source from Table 2.
Step 2	The dimensions of the gestation building and farrowing building are 70 x 350 ft. and 70 x 230 ft., respectively. The areas are 24,500 ft.2 and 16,100 ft.2, respectively for these two buildings (Area = Width x Length). The dimensions of the basin are 200 x 200 ft (40,000 ft.2). These areas are entered in Column C of Table 5.
Step 3	There is no odor control technology for this site, so 1 is entered in Column D of Table 5 for each source.
Step 4	The odor emission factor (Column E) for each source is found by multiplying the above three numbers and dividing by 10,000.
Step 5	The three odor emission factors in Column E are summed to determine the TOEF for the site. In this case the TOEF is 148.
Step 6	In Figure 2, locate 148 on the x-axis. Then move vertically to the 97% "odor annoyance-free" curve. Moving horizontally to the vertical axis shows the minimum setback distance to achieve 97% annoyance-free is approximately 2900 ft. or 0.56 miles. Therefore, this farm does not comply with the county guidelines because the community will experience annoying odors greater than the allowable 3% per month (22 hours per month).

Figure 3. Example farm sketch.



To comply with county regulations, the farmer must reduce odor emissions from his animal production site. The question then becomes how much odor emission reduction is necessary to meet the 97% annoyance-free standard. The farmer contemplates the addition of a biofilter on the two buildings (odor control factor of 0.1) and a geotextile cover on the manure storage (odor control factor of 0.5). Table 6 indicates the changes in odor emissions with these two modifications. Note that Columns A, B, and C did not change between Table 5 and Table 6.

With a new TOEF, go to Figure 2 and find 30.5 on the horizontal scale. For this TOEF only the 99% annoyance-free curve is not reached by a 0.5 mile setback. The odor control technologies used in this example are presently available. Although not common, they can be seen on demonstration farms. Additional cost to the producer to implement these odor control measures should be weighed against the expenses incurred in trying to find an alternative site.

Table 5. Summary of the information in example 1.

Column A **Odor source**	**Column B** **Odor Emission Number/ft.2**	**Column C** **Area (sq. ft.)**	**Column D** **Odor Control Factor**	**Column E** **Odor Emission Factor (B x C X D/10000)**
1. Gestation barn	**30**	**24,500**	**1**	**73.5**
2. Farrowing barn	**14**	**16,100**	**1**	**22.5**
3. Basin	**13**	**40,000**	**1**	**52.0**
Total Odor Emission Factor (sum of Column E)				**148.0**

Table 6. Summary of the information of MODIFIED example.

Column A **Odor source**	**Column B** **Odor Emission Number/ft.2**	**Column C** **Area (sq. ft.)**	**Column D** **Odor Control Factor**	**Column E** **Odor Emission Factor (B x C X D/10000)**
1. Gestation barn	**30**	**24,500**	**0.1**	**7.4**
2. Farrowing barn	**14**	**16,100**	**0.1**	**2.2**
3. Basin	**13**	**40,000**	**0.5**	**26**

Total Odor Emission Factor (sum of Column E)	**35.7**

Safety Alerts

Manure agitation and pumping in progress door tag

Revised 2017

UNIVERSITY OF MINNESOTA
EXTENSION

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Purdue Setl

Send questions and comments

Step 1: Find the smallest rectangle that encompasses all of the emitting sources on the livestock production site
Step 2: Mark the SW corner of this rectangle as the site reference point. Individual emission source x-y origins a
Step 3: Input X-Y coordinates (distance in feet from source origin to east and north of site reference point) for eac
Step 4: Choose the orientation and input the dimensions of each emission source.

PLO

SITE REFERENCE POINT (SRP)			GE Lat/Long Locator
Latitude (decimal)	45	Longitude (decimal)	-86

SOURCE L

SOURCE	SHAPE	LOCATION OF SOURCE (x-y origin) N DISTANCE (ft)	E DISTANCE (ft)

SOURCE CHARA

SOURCE	ODOR EMISSIONS PER SOURCE SPECIES	EMISSION SOURCE	NUMBER or AU

ODOR ABATEMENT			
SOURCE	**TECHNIQUE 1**	**TECHNIQUE 2**	**TECHNIQUE 3**
TERRAIN AROUND SITE		**EXPOSURE AROUND SITE**	
SAME ALL DIRECTIONS?	**UNIFORM TERRAIN**	**SAME ALL DIRECTIONS?**	**UNIFORM EXPOSURE**
Yes	Treeline / shelterbelt	Yes	96% odor free
			DI
			ENTER BELOW IF TERR
NORTH	**NORTHEAST**	**EAST**	**SOUTHEAST**
No trees, relatively flat	No trees, relatively flat	No trees, relatively flat	Hillside/valley up-flow
		USED IN SETBACK CALCULATIONS (De	
Treeline / shelterbelt	Treeline / shelterbelt	Treeline / shelterbelt	Treeline / shelterbelt
			DIR
			ENTER BELOW IF LAND USE OR
NORTH	**NORTHEAST**	**EAST**	**SOUTHEAST**
91% odor free	99% odor free	99% odor free	99% odor free
		USED IN SETBACK CALCULATIONS (De	
96% odor free	96% odor free	96% odor free	96% odor free
			DIRECTIONAL W
			FROM DATABASE FOR
NORTH	**NORTHEAST**	**EAST**	**SOUTHEAST**
8.1	7.9	11.6	6.5
			FROM USER ENT
11.8	11.8	11.8	11.8

USED IN SETBACK CALCULATIONS (Dep			
8.1	7.9	11.6	6.5

USER ENTRY OF WIND FREQUENCIES

WIND FREQUENCY (BLOWING FROM)	
DIRECTION	**Frequency, %**
N	5.90
NNE	5.90
NE	5.90
ENE	5.90
E	5.90
ESE	5.90
SE	5.90
SSE	5.90
S	5.90
SSW	5.90
SW	5.90
WSW	5.90
W	5.90
WNW	5.90
NW	5.90
NNW	5.90
Calms	5.60

back Model (2015)

to purdueodor@gmail.com or heber@purdue.edu

re SW corners of rectangular sources and centers of circular sources.
ch emission source (GoogleEarth or similar tool can be used).

OTTING INFORMATION

REFERENCE CIRCLE (OPTIONAL)			
Circle radius, ft	2640	**Plot circle?**	Yes

OCATIONS AND DIMENSIONS

ORIENTATION	DIMENSIONS OF EMISSION SOURCES		
	LENGTH (ft)	WIDTH (ft)	RADIUS (ft)

CTERISTICS

MANURE MANAGEMENT		PLOT SETBACK?
REMOVAL FREQUENCY	DILUTION/DRYING/COLLECTION	

OTHER (%)	EXPOSURE RECOMMENDATIONS: LAND USE	EXPOSURE
	Agricultural, Few Residences	91% odor free
	Rural Residential	94% odor free
	Small Residential (< 50 homes)	96% odor free
	Large Residential (50+ homes)	97% odor free
	Town (< 5000 people)	98% odor free
	City (5000+ people)	99% odor free

HISTORICAL WIND DIRECTIONS FROM DATABASE

SELECT WEATHER STATION?	STATE	STATION	DISTANCE (miles)
Yes	Indiana	West Lafayette	320.5

RECTIONAL TERRAIN

AIN IS NOT THE SAME IN ALL DIRECTIONS

SOUTH	SOUTHWEST	WEST	NORTHWEST
Treeline / shelterbelt	No trees, relatively flat	No trees, relatively flat	Treeline / shelterbelt
pends on answer to "Same All Directions?" question above)			
Treeline / shelterbelt	Treeline / shelterbelt	Treeline / shelterbelt	Treeline / shelterbelt

ECTIONAL EXPOSURE

EXPOSURE IS NOT THE SAME IN ALL DIRECTIONS

SOUTH	SOUTHWEST	WEST	NORTHWEST
96% odor free	96% odor free	96% odor free	94% odor free
pends on answer to "Same All Directions?" question above)			
96% odor free	96% odor free	96% odor free	96% odor free

IND FREQUENCIES (Blowing From)

R WEATHER STATION SELECTED ABOVE

SOUTH	SOUTHWEST	WEST	NORTHWEST
11.6	14.8	18.3	8.5
RY OF WIND FREQUENCIES BELOW			
11.8	11.8	11.8	11.8

ends on answer to "Select Weather Station" question above)			
11.6	14.8	18.3	8.5

PURDUE UNIVERSITY

PAAQL

Purdue Agricultural Air Quality Laboratory

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Livestock Odor Setback Model – Purdue University

Disclaimer

Purdue University does not accept any responsibility for any errors in, or for any errors that may result from using the setback guideline. We expressly disclaim any responsibility for any damage arising from the application or reliance on the recommendations and information contained herein.

Purdue Setback Model – June 2015 (NOTE: This may be updated periodically).

Purdue Setback Model Instruction Manual

Odor nuisance is a concern of livestock producers and their neighbors. The use of atmospheric air to dilute odors from livestock production facilities through appropriate setback distances is a cost-effective odor control strategy. However, the determination of such setbacks is difficult and complex.

A simple-to-use, site-specific odor setback model was developed by Purdue University. This guideline considers facility size, orientation and shape, wind frequency, land use, topography, building design and management, manure handling characteristics, and odor abatement. Odor emission factors were based on actual measurements and literature reported odor emission measurements at commercial livestock farms and manure production rates. Atmospheric dispersion models and downwind odor measurements have been utilized to enhance and validate the setback guideline. The Purdue Setback Model (PSM) combines features of Austrian and British setback guidelines (Schauberger and Piringer, 1997; Williams and Thompson, 1985) and incorporates new features developed through our research. The PSM is as follows:

Setback distance in feet = $20\ F\ L\ T\ V\ (A_E E + A_S S)^{0.5}$

where:

- F = wind frequency factor
  - L = land use factor
  - T = topography factor
- V = orientation and shape factor
- E = building odor emission, N x P x B, OU/s
  - N = number of animals or birds
  - P = odor emission factor, OU/s-hd
  - B = building design and management factor, M-D
    - M = manure removal frequency
    - D = manure dilution (swine), drying (poultry) or residue (dairy) factor
- S = odor emission from outdoor storage, C x G, OU/s
  - C = odor emission factor for outside liquid manure storage, 50 OU/s-AU
    - G = animal unit, AU=1100 lb of animal weight
- A_E = odor abatement factor for buildings
- A_S = odor abatement factor for outside liquid manure storage

References

Schauberger, G. and M. Piringer. 1997. Guideline to assess the protection distance to avoid annoyance by odour sensation caused by livestock husbandry. Proc. Fifth International Livestock Environment Symposium. May 29-31, pp. 170-178.

Williams, M.L. and N. Thompson. 1985. The effects of weather on odour dispersion from livestock buildings and from fields. In: Odor Prevention and Control or Organic Sludge and Livestock Farming. Ed: V.C. Nielsen, J.H. Voorburg, and P.L'Hermite. Elsevier, New York, pp. 227-233.

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Research
Articles

Symptomatic Effects of Exposure to Diluted Air Sampled from a Swine Confinement Atmosphere on Healthy Human Subjects

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Abstract Go to:

Aerial emissions from a swine house at North Carolina State University's field laboratory were diluted to a level that could occur at varying distances downwind from a confined animal feeding operation (CAFO) both within and beyond the property line, and these emissions were delivered to an environmental exposure chamber. The study design consisted of two 1-hr sessions, one in which 48 healthy human adult volunteers were exposed to diluted swine air and another in which they were exposed to clean air (control). Objective measures of blood pressure, temperature, heart rate, respiratory rate, lung function, nasal inflammation, secretory immunity, mood, attention, and memory were correlated with objective measures of air quality. Ratings of perceived (self-reported) health symptoms were also obtained. The mean levels of airborne constituents in the swine air condition were hydrogen sulfide (24 ppb), ammonia (817 ppb), total suspended particulates (0.0241 mg/m^3), endotoxin (7.40 endotoxin units/m^3), and odor (57 times above odor threshold). No statistical differences on objective measures of physical symptoms, mood, or attention resulted from the 1-hr exposure to swine emissions in the environmental chamber when compared with clean air for healthy human volunteers. However, subjects were 4.1 (p = 0.001) times more likely to report headaches, 6.1 (p = 0.004) times more likely to report eye irritation, and 7.8 (p = 0.014) times more likely to report nausea in the swine air (experimental) condition than in the control condition. These results indicate

that short-term exposure in an environmental chamber to malodorous emissions from a swine house at levels expected downwind can induce clinically important symptoms in healthy human volunteers.

Keywords: airborne emissions, attention, environmental chamber, memory, mood, nasal inflammation, pulmonary function, secretory immunity, spirometry, swine

The rapid proliferation of confined animal feeding operations (CAFOs) that house thousands of animals at a single facility has raised public health concerns for workers as well as neighbors who live in adjacent communities (Schiffman et al. 1995; Thu et al. 1997; Wing and Wolf 2000). One focus of this concern has been potential human health effects from airborne agents that emanate from livestock houses, waste storage systems, and manure application sites. Aerial emissions from CAFOs are composed of a mixture of hydrogen sulfide (H_2S), ammonia, volatile organic compounds (VOCs), and particulates including bioaerosols that arise during biodegradation of manure (Sweeten 1988). VOCs, ammonia, and H_2S in the emissions are found in the gas phase as well as adsorbed to particulates (Schiffman 1998; Schiffman et al. 2001a).

Occupational studies of workers at CAFOs have documented a variety of health complaints as well as objective health effects including respiratory inflammation and dysfunction. Common health complaints among workers at animal production facilities include sinusitis, chronic bronchitis, nasal mucous membrane inflammation, nasal and throat irritation, headaches, and muscle aches and pains (University of Iowa Study Group 2002). Objective measures of lung function using spirometry have shown both acute cross-shift decline in lung function as well as chronic respiratory impairment in workers at confined swine and poultry feeding operations (Donham 1993; Donham et al. 1977; Schwartz et al. 1992, 1995). Progressive decline in lung function among CAFO workers occurs over a period of years. Furthermore, acute exposures to high levels of H_2S from agitated manure can lead to reactive airway distress syndrome, permanent neurologic damage, and even death (Centers for Disease Control and Prevention 1993; Schiffman et al. 2001a).

Studies of potential health risks to community residents living in the proximity of CAFOs have been more limited than investigations of occupational risks. Several controlled studies in North Carolina and Iowa, however, have found that self-reported health symptoms are elevated in communities adjacent to intensive swine facilities. A field study in Iowa found that persons residing within a 2-mile radius of a 4,000-head swine operation reported higher frequencies of 14 out of 18 physical health symptoms, especially respiratory symptoms, than did a control group in an area with no intensive livestock operations (Thu et al. 1997). Residents of a rural North Carolina community with a 6,000-head hog operation reported increased symptoms of headache, runny nose, sore throat, excessive coughing, diarrhea, burning eyes, and reduced quality of life compared with residents in rural communities with intensive cattle operations or without livestock facilities (Wing and Wolf 2000). Furthermore, residents near swine facilities in North Carolina reported more tension, more depression, more anger, more fatigue, and more confusion at the time when the odors were strongest than did a control group of unexposed persons (Schiffman et al. 1995). No objective medical tests of physical health symptoms, however, were obtained in these community studies near CAFOs.

The purpose of the present investigation was to build upon previous occupational health and epidemiologic studies that have reported health symptoms associated with exposure to swine emissions. In this study, we used an exposure chamber to systematically investigate the physiologic and psychological responses in human volunteers that result from an exposure to a known level of emissions of swine confinement air in a controlled environment. The environmental chamber was built next to a swine facility, and air from a swine house was diluted to a level that could occur downwind from a confined swine operation both within and beyond the property line. This method of exposure was novel in that it enabled an assessment of the symptomatic effects of an environmentally relevant mixture of well-characterized pollutants in a group of self-selected healthy volunteers. The objective was to determine whether healthy human subjects voluntarily exposed to diluted air from a swine confinement house in a controlled environment (e.g., environmental chamber) experienced altered lung function, nasal inflammation, psychological changes, or other health symptoms related to such an exposure. Use of the human chamber allowed direct dose–response assessment of potential acute health effects from a specified level of airborne emissions.

Materials and Methods

Go to:

Overview The study design consisted of two 1-hr sessions, one in which human subjects were exposed to diluted swine air (experimental condition) and another in which they were exposed to cleaned air (control condition). Objective measures of lung function, nasal inflammation, secretory immunity, mood, respiratory symptoms, attention, and memory were correlated with objective measures of air quality. The concentration of odor, particulates, H_2S, ammonia, VOCs, and endotoxin in exposure chamber air were monitored throughout the study. The maximum exposure duration of 1 hr was requested by the Duke Institutional Review Board because health complaints have been reported to North Carolina agencies from ≤ 1 hr of exposure.

Subjects Forty-eight healthy adults, ranging in age from 19 to 49 years (mean age = 26.0 ± 9.46 years), participated in this study. Half of the subjects were males and half were females. The group consisted of 33 Caucasians, 11 African Americans, 2 Hispanics, and 2 Asian Americans. The subjects were volunteers recruited by advertisements that were posted in workplaces throughout the Research Triangle community of North Carolina (Durham, Chapel Hill, and Raleigh). Potential subjects were prescreened by telephone to determine their eligibility for study participation. Those who met the inclusion criteria were enrolled sequentially in the order that they called. Enrollment stopped when 24 males and 24 females who met the inclusion criteria were enrolled.

To meet the criteria for the study, subjects were required to be healthy adults. Exclusion criteria were history of asthma (present or past), allergies for which they took prescription medications, smoking (not current smokers and never smoked > 10 packs of cigarettes in their lifetime), use of chronic prescription medications (except birth control pills), history of heart or lung disease, significant occupational exposure, and pregnancy. The mean height of the group was 67.4 ± 3.97 inches; the mean weight of the group was 171.4 ± 38.5 lbs. Subjects were paid $500.00 for their participation. All subjects signed a consent form approved by the Duke University Institutional Review Board that indicated their willingness to participate in “an experiment on exposure to air from swine operations.” All 48 subjects completed the study, and none experienced a serious adverse event.

Exposure Facility An exposure facility was constructed at the Swine Unit of North Carolina State University’s field laboratory. The exposure chamber (12 × 16 ft) was adjoined by a medical examination room 8 × 12 ft (Figure 1). The exposure chamber accommodated eight subjects who were seated at a table with dividers so that they could not speak to or observe each other (Bottcher et al. 2002). The ventilation system was custom designed so that it could deliver either totally cleaned air drawn from outside through an air cleaning unit (control condition) or emissions drawn from the exhaust fans of an adjacent swine building diluted with cleaned air (experimental condition). The cleaned air was generated from outside air processed by a packaged air-cleaning unit (model 6500; Allerair Industries, Laval, Québec, Canada) that consisted of an in-series arrangement of a prefilter and HEPA filter for particulate matter removal and two cartridges containing activated charcoal granules specially formulated for removal of gaseous pollutants expected from swine facilities. Particulates were not directly filtered or removed from the swine building air stream so that they would be incorporated into the exposure room airflow. The indoor airflow pattern within the exposure chamber was symmetrical in order to eliminate variability in air quality in the microenvironments of each of the eight subjects. The walls of the facility were insulated and paneled with waterproof materials that did not absorb odors and could be completely cleaned between trials to eliminate residual odorant compounds and particulates from surfaces. The air conditioning system was sufficient to maintain the chamber at a constant temperature (70°F) with eight subjects in the room.

Figure 1

Exposure facility. Reprinted from Bottcher et al. 2002 with permission.

Exposure Conditions and Monitoring of Airborne Constituents Subjects participated in two 1-hr exposures, one in which they were exposed to diluted swine air (experimental condition) and another in which they were exposed to cleaned air (control condition). The levels of gases, VOCs, particulates, endotoxin (a cell wall component of gram-negative bacteria), and odor in the experimental condition simulated concentrations that could occur downwind of swine production facilities both within and beyond the property line. Although higher concentrations than those tested here can potentially occur intermittently during sporadic spraying of fields with aerosolized liquid from the lagoons that hold decomposing waste, the levels used in this study are representative of air emissions both within and beyond the property line in the absence of spraying. Simulation of downwind exposure was achieved by the custom-designed air flow system that provided a variable method of mixing clean air with swine building air to allow a range of dilution ratios. The mean levels of the H_2S, ammonia, particulates, endotoxin, and odor in the two exposure conditions are given in Table 1. All means in the experimental condition were significantly different from those in the control condition as determined by *t*-tests.

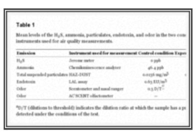


Table 1

Mean levels of the H_2S, ammonia, particulates, endotoxin, and odor in the two conditions along with the instruments used for air quality measurements.

Techniques to Quantify Airborne Emissions H_2S was measured continuously with a Jerome 631-X H_2S analyzer (Arizona Instrument, Tempe, AZ) that uses a gold film sensor selective for H_2S without interference from sulfur dioxide, carbon dioxide, carbon monoxide, and water vapors. Ammonia was measured continuously with the model 17C chemiluminescence ammonia analyzer (Thermo Environmental Instruments, Franklin, MS). Total suspended particulate concentrations were measured in real time by the HAZ-DUST EPAM-5000 environmental particulate air monitor (Environmental Devices Corporation, Haverhill, MA) that uses aerodynamic particle sizing and an in-line filter cassette for gravimetric sampling. Endotoxin was collected on fiberglass filters placed in a 47-mm in-line filter holder (model 2220; Gelman Sciences, Pall Corporation, East Hills, NY) connected to a piston pump that was calibrated at 46 L/min (Rietschle Thomas, Sheboygan, WI). The endotoxin was eluted from the filters with 15 mL deionized water. Endotoxin on the filters was quantified using a *Limulus* amebocyte lysate (LAL) assay (Bio-Whittaker, Walkersville, MD), and the concentration in endotoxin units (EU) was calculated (EU per milliliter). The concentration was multiplied by the elution volume to get the total EUs in the sample (total per filter). The concentration of endotoxin in the air was then calculated using the pump speed (46 L/min) and collection period (60 min). Odor levels in the chamber were measured in two ways. Real-time monitoring of odor levels was performed with the Scentometer (Barnebey-Sutcliffe, Columbus, OH) and the Nasal Ranger (St. Croix Sensory, Lake Elmo, MN). The Scentometer and Nasal Ranger are portable devices that can determine the number of dilutions necessary to reach threshold (i.e., odor dilution-to-threshhold; D/T). In addition, air samples from the exposure chamber were obtained in Tedlar bags during each trial, and odor thresholds were determined in the laboratory by a trained panel using an AC'SCENT olfactometer

(St. Croix Sensory). The mean value for each of the above variables in a given condition was maintained within 8% of the overall mean in Table 1 for each test session. Variability within a session was also limited to 8% using a plenum in the inlet with data integrated over 5-min intervals.

VOCs were measured in two ways. First, real-time monitoring of VOCs at ppb levels was performed with the ppbRAE VOC monitor PGM-7240 (RAE Systems, Sunnyvale, CA) that uses a photoionization detector that can detect VOC concentrations down to a few parts per billion. Second, air samples were obtained in canisters and analyzed by gas chromatography and mass spectrometry (GC/MS) and gas chromatography/flame ionization detection (GC/FID) at the U.S. Environmental Protection Agency (EPA; Research Triangle Park, NC). Mean total VOCs were numerically elevated in the experimental condition compared with the control condition using both the ppbRAE and GC techniques, but this did not reach statistical significance. The mean exposure in the experimental condition as determined by GC/FID was 344.2 ± 27.6 ppbC (parts per billion carbon) and in the control condition, 322.7 ± 21.3 ppbC.

Study Design Each subject participated in two separate sessions that were at least 10 days apart. In one session, subjects were exposed to filtered air pumped into the exposure chamber for 1 hr (control session); in the other session, subjects were exposed for 1 hr to air from the swine house that had been diluted with uncontaminated air (experimental session). Eight subjects were tested at a time, resulting in 12 total sessions for all 48 subjects. Half the subjects participated in the experimental session first, and the other half participated in the control session first.

A series of physiologic and psychological measurements were obtained at four time points on each of the two exposure days: just before exposure, during the 1 hr exposure (at 30 min into the exposure), directly after exposure (at 1 hr), and 2 hr after the end of exposure (3 hr after beginning the exposure). The measurements assessed vital signs (blood pressure, temperature, heart rate, respiratory rate), pulmonary function (spirometry), nasal inflammation (using nasal lavage), total salivary IgA, mood [Profile of Mood States (POMS) scale (McNair et al. 1992)], attention, memory, and other symptoms. The timeline for these measurement types is given in Table 2.

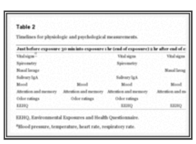


Table 2

Timelines for physiologic and psychological measurements.

Just before exposure	30 min into exposure	1 hr (end of exposure)	2 hr after end of e
Vital signs[a]		Vital signs	Vital signs
Spirometry		Spirometry	
Nasal lavage			Nasal lavag
Salivary IgA		Salivary IgA	
Mood	Mood	Mood	Mood
Attention and memory	Attention and memory	Attention and memory	Attention and me
Odor ratings	Odor ratings	Odor ratings	
EEHQ		EEHQ	EEHQ

EEHQ, Environmental Exposures and Health Questionnaire.

[a]Blood pressure, temperature, heart rate, respiratory rate.

Table 2

Timelines for physiologic and psychological measurements.

Vital signs. Blood pressure and heart rate were measured using a Dinamap Pro 100 monitor (GE Healthcare—Critikon Division, Jupiter, FL). A Welch Allyn SureTemp thermometer (model 679; Welch Allyn Medical Products, Skaneateles Falls, NY) with an oral probe and a disposable Welch-Allyn probe cover were used to measure temperature. Respiratory rate was determined by counting the number of breaths each subject took in a 30-sec time interval and then multiplying that number by 2.

Spirometry. Forced vital capacity (FVC), forced expiratory volume at 1 sec (FEV_1), and averaged forced expiratory flow between the full expiration of 25 and 75% of the total FVC (FEF 25–75%) were assessed in triplicate using a KoKo Portable Spirometer and KoKo Pulmonary Function Testing Software (PDS Instrumentation, Louisville, CO). FVC is the maximal volume of air (in liters) released during the forced maximal expiration. FEV_1 is the volume of air that was expired in the first second of the forced maximal expiration. FEF 25–75%, measured in liters per second, gives an indication of the condition of the subject's smaller airways. The pulmonary function testing software indicated which of the three trials was the best for each subject. The best trial from the preexposure testing was compared with the best trial from the postexposure testing to determine if there were any changes in the subjects' pulmonary functioning. Subjects' height and weight were measured and recorded at the first visit because this information was necessary to analyze the pulmonary function data.

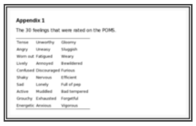
Nasal lavage. The nasal passages of study subjects were lavaged with 10 mL saline (0.9% sodium chloride; Abbott Laboratories, Chicago, IL), before and 3 hr after initiation of exposure (2 hr after completion of exposure) to swine facility air and to cleaned air. Subjects sat in a chair with their heads tilted back. They were given a plastic straw and instructed to blow into the straw while blocking the other end of the straw with a finger to close the passageway between the nose and the throat. Five milliliters of saline solution (warmed to body temperature) were introduced into each naris using a needleless 10-cc syringe and were held in the nares for 10 sec. The contents of the nares were then expelled into a 120-mL sterile specimen container. The sample was then transferred from the specimen container to a 15-mL centrifuge tube. The samples were put immediately on ice and transferred to the laboratory for analysis. Lavage fluids were treated with *N*-acetyl cysteine to disrupt mucus, and the cells were pelleted by centrifugation. Total cell counts were also determined by enumeration using a hemacytometer. Cytospin preparations of cells were stained for differential analysis. The nasal lavage supernatants were frozen at −70°C for cytokine analysis. The levels of the proinflammatory cytokines interleukin (IL)-1β and IL-8 were quantified because of their recognized importance in lipopolysaccharide-induced airway responsiveness (Jagielo et al. 1996; Wang et al. 1998). Both polymorphonuclear cells (PMN) and IL-8 are also known to increase dramatically in the lungs of persons who spend several hours inside of swine buildings (Larsson et al. 1997; Senthilselvan et al. 1997). Undiluted specimens of nasal lavage fluid were analyzed using Quantikine enzyme-linked immunosorbent assay (ELISA) kits (R&D Systems, Minneapolis, MN) for the proinflammatory cytokines IL-8 and IL-1β.

Salivary IgA. Unstimulated saliva samples were collected using a sterile 2.0-mL vial and one-third of a plastic straw. Subjects uncapped the vial, placed the straw into the vial, and passively drooled down the straw for 90 sec. The samples were then collected and immediately placed in a freezer. They were later sent to Salimetrics LLC (State College, PA) on dry ice, where they were analyzed for salivary IgA. These measurements were obtained because Avery et al. (In press) found that persons exposed to strong swine odors had reduced levels of salivary IgA. All samples were assayed for salivary IgA in duplicate using a highly sensitive enzyme immunoassay (EIA) developed by Salimetrics. The test used 25 µL saliva, has a lower limit of sensitivity of 2.5 µg/mL, a range of sensitivity from 2.5 to 540 µg/mL, and average intra- and interassay coefficients of variation 5.6 and 8.79%, respectively. Method accuracy, determined by spike recovery, and linearity, determined by serial dilution, are 108 and 101%. Intermethod correlations for salivary IgA levels from saliva samples ($n = 21$) assayed using the Salimetrics EIA protocol and a radial diffusion assay, and the Salimetrics EIA protocol and a commercially available salivary IgA ELISA, were $r(19)$-values = 0.94 and 0.91 (p-values < 0.0001), respectively. The salivary IgA levels returned by the Salimetrics EIA protocol (mean ± SD = 379.39 ± 261.47 µg/mL) and the comparison ELISA (mean ± SD = 365.81 ± 311.53 µg/mL) were not statistically distinct. Salivary IgA levels returned by radial immunodiffusion were significantly higher (mean ± SD = 675.21 ± 467.94) than levels from both immunoassay protocols.

Mood. The POMS questionnaire was used to assess mood. The POMS is a highly sensitive standardized scale that, based on subjects' responses, measures six different aspects of transient mood: anger–hostility, confusion–bewilderment, depression–dejection, fatigue–inertia, tension–anxiety, and vigor–activity. The POMS has been used previously to evaluate mood changes in response to odors by neighbors of swine operations (Schiffman et al. 1995). The POMS questionnaire has been extensively tested and validated; it has been widely used to evaluate the degree to which behavioral and treatment interventions as well as environmental factors affect mood. The form of the scale used here consists of 30 different feelings (Appendix 1) on which subjects rated "how they are feeling at the present time" on scales coded from 0 (not at all) to 4 (extremely).

Appendix 1

The 30 feelings that were rated on the POMS.



Appendix 1

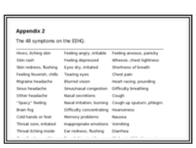
The 30 feelings that were rated on the POMS.

Tense	Unworthy	Gloomy
Angry	Uneasy	Sluggish
Worn out	Fatigued	Weary
Lively	Annoyed	Bewildered
Confused	Discouraged	Furious
Shaky	Nervous	Efficient
Sad	Lonely	Full of pep
Active	Muddled	Bad tempered
Grouchy	Exhausted	Forgetful
Energetic	Anxious	Vigorous

Attention and memory. We used a digit span test to measure levels of attention and memory. The test was a modified version of the digit span test used on the Weschler Adult Intelligence Scale, in which a researcher reads strings of simple numbers to a subject, and the subject repeats the numbers back to the researcher in the correct order. The test was presented visually in the present study rather than orally so that the results were not affected by the qualitatively different voices of several researchers who administered the test. Each subject was presented with strings of simple numbers (from 1 to 9) using flashcards, beginning with a string of two digits and presenting one digit per second. After each string of numbers, the subject was shown a flashcard that read, "recall numbers." The subject then recalled the digits in the order in which they were presented by writing them down. Each subject was given 10 sec between the time that they saw the "recall numbers" flashcard and the time that they were presented the next string of numbers to recall and write down the string of digits. After each recall, a new string of digits was presented, with each successive string increased by one digit until the subject recalled the last string consisting of 9 digits. Because the digit span test was administered to the subjects four times at each visit, four different sets of cards were made using random number generation. The same four sets were used at the subjects' second visit, but the sets were presented to the subjects at different time points at the second visit. The subject's score was the length of the last string of numbers accurately recalled.

Odor ratings. The perceived odor was rated on three global 9-point line scales numbered from 0 to 8. These included odor intensity, irritation intensity, and hedonic ratings. For odor and irritation intensity, the scale was labeled as follows: 0, none at all; 1, very weak; 2, weak; 3, moderate weak; 4, moderate; 5, moderate strong; 6, strong; 7, very strong; and 8, maximal. The descriptors for pleasantness/unpleasantness were 0, extremely pleasant; 1, very pleasant; 2, moderately pleasant; 3, slightly pleasant; 4, neither pleasant nor unpleasant; 5, slightly unpleasant; 6, moderately unpleasant; 7, very unpleasant; and 8, extremely unpleasant. Subjects also rated an additional five scales to characterize the odor using the intensity scale above: "musty, earthy, moldy," "fecal," "like urine," "sewer odor," and "sweaty."

Environmental Exposures and Health Questionnaire. Subjects indicated how much, if at all, they were affected by 48 different symptoms on this questionnaire (Appendix 2). The Environmental Exposures and Health Questionnaire (EEHQ) was developed by the U.S. EPA Health Effects Research Laboratory and has been used previously to assess health symptoms from odors (Schiffman 1998). Subjects made their ratings on four different categories: don't have symptom at all (0), mildly affected (1), moderately affected (2), severely affected (3).



Appendix 2

The 48 symptoms on the EEHQ.

Hives, itching skin	Feeling angry, irritable	Feeling anxious, panicky
Skin rash	Feeling depressed	Wheeze, chest tightness
Skin redness, flushing	Eyes dry, irritated	Shortness of breath
Feeling feverish, chills	Tearing eyes	Chest pain
Migraine headache	Blurred vision	Heart racing, pounding
Sinus headache	Sinus/nasal congestion	Difficulty breathing
Other headache	Nasal secretions	Cough
"Spacy" feeling	Nasal irritation, burning	Cough up sputum, phlegm
Brain fog	Difficulty concentrating	Hoarseness
Cold hands or feet	Memory problems	Nausea
Throat sore, irritated	Inappropriate emotions	Vomiting
Throat itching inside	Ear redness, flushing	Diarrhea

Appendix 2

The 48 symptoms on the EEHQ.

Description of statistical methods. For all but one outcome, we estimated two equations of the general form:

$$y_2 = \tau_1 \text{ exposure} + \tau_2 \text{ period} + \tau_3 \, y_1 + e \qquad [1]$$

$$y_2 = \tau_1 \text{ exposure} + \tau_2 \text{ period} + \tau_3 \, y_1 + \tau_4 \text{ exposure} \times \text{period} + e, \qquad [2]$$

where y_1 and y_2 are the pre- and postexposure scores on an outcome, "exposure" is a dummy variable coded 1 for swine air and 0 otherwise, and "period" is a dummy variable coded 0 for those who received clean air first, and 1 for those who received swine air first. In Equation 1, the coefficient for exposure (τ_1) estimates its effect on y_2 with preexposure score and period-related differences controlled. As shown by Kessler and Greenberg (1981), this coefficient is equivalent to the effect of exposure on (time 2 – time 1) change in the dependent variable controlling for other independent variables in the equation. Our significance tests for the effect of exposure on each dependent variable are based on this coefficient from Equation 1. The (exposure × period) product term in Equation 2 was used to test whether the effect of exposure differed according to whether swine air was administered first or second. On all but one dependent variable (discussed below), this testfor the presence of a carryover effect was negative.

The analysis focused on potential effects of exposure on seven general classes of outcome variables: vital signs, pulmonary function (spirometry), nasal inflammation (cytokines and cell counts), saliva measures (salivary IgA), mood (POMS), memory/attention (digit span), and self-reported symptoms. Several of these classes, including vital signs, self-reported symptoms, mood, and digit span, contained multiple measures after exposure commenced. Because we did not hypothesize delayed effects of exposure on these specific outcomes, we tested whether exposure-related differences were present at multiple time points after exposure only if a significant effect was present for the first measurement after exposure. Given the exploratory nature of the study, we did not correct for multiple tests. However, given the *p*-values and magnitudes of most significant effects, the positive findings are not the result of chance. We return to this issue in the discussion of the findings.

All outcomes other than respiratory symptoms were analyzed as continuous dependent variables. We used SAS PROC MIXED (SAS Institute, Cary, NC) to obtain generalized least squares estimates of the coefficients (τ) in Equations 1 and 2, with between-subject variance treated as a random effect and removed from the error term in significance testing. As discussed by Verbeke and Molenberghs (1997), generalized least squares estimators are more "efficient" (have smaller variance) compared with corresponding ordinary least squares estimators.

On self-reported symptom measures, nearly all respondents had scores of 0 or 1. Therefore, each self-reported symptom measure was coded as a (0/1) variable scored 1 for the presence of any symptoms, and SAS PROC GENMOD was used to estimate Equations 1 and 2 as logistic generalized estimating equations. Between-subject variance was again treated as a random effect, making these models the logistic equivalent of those estimated in PROC MIXED for the continuous outcomes. To examine potential non-proportionality (nonequivalence) of effects between those with and those without self-reported symptoms at baseline, we performed two analyses for self-reported symptoms.

Results

Go to:

Results of significance testing for effects of exposure on change in an outcome. First, Equations 1 and 2 were estimated for all respondents. Then respondents reporting any preexposure symptoms were dropped, and our models were re-estimated excluding preexposure score (y_1) as a control. [An average of four respondents was excluded across self-reported symptom outcomes (maximum = 12) in the second set of analyses]. Results were essentially the same for both logistic analyses. In Table 3 we report those based on the full sample of respondents. For each dependent variable, we present *p*-values for whether change in an outcome is significantly different in the exposure group compared with the control group. When significant differences are present, we give regression coefficients estimating the effect of exposure (vs. control) on change in a dependent variable. Unlike the raw group differences in the descriptive tables, these coefficients are estimated controlling for initial (preexposure) status and for period of exposure.

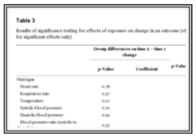


Table 3

Results of significance testing for effects of exposure on change in an outcome (effect coefficients are given for significant effects only).

None of the measures of vital signs, pulmonary function (spirometry), nasal lavage, salivary IgA, mood, or digit span score was significantly related to exposure. Two nasal lavage measures were related to exposure. Compared with controls, the (time 1–time 2) decrease in percentage of epithelial cells was greater among those exposed to swine air. The exposure group also had a larger increase in percentage of lymphocytes but not in absolute numbers of lymphocytes. Three (of 11) measures of the self-reported symptoms were significantly related to exposure. Based on the logistic odds ratio, when subjects were exposed to swine air, they were 4.1 ($p = 0.001$) times more likely to report headaches, 6.1 ($p = 0.004$) times more likely to report eye irritation, and 7.8 ($p = 0.014$) times more likely to report nausea than in the control condition. Significant exposure-related differences on headache were still present at time 3. None of the pulmonary or mood measures was related to exposure.

Descriptive statistics. The means ± SDs for physical measures (vital signs, nasal lavage, salivary measures, and pulmonary function) over time are given in Table 4. Results of pulmonary function studies are presented as percentage of predicted values based upon population norms. It is customary to report the magnitude of change as percent change from baseline. Means ± SDs for scores on POMS at four time points are shown in Table 5. Means ± SDs for scores on digit span at four time points are shown in Table 6. Table 7 gives the number of persons who self-reported specific symptoms.

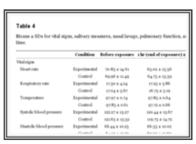


Table 4

Means ± SDs for vital signs, salivary measures, nasal lavage, pulmonary function, and the digit span test over time.

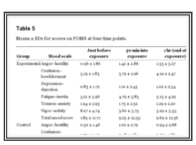


Table 5

Means ± SDs for scores on POMS at four time points.

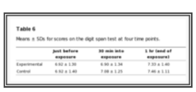


Table 6

Means ± SDs for scores on the digit span test at four time points.

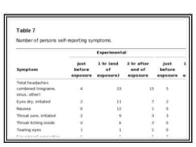


Table 7

Number of persons self-reporting symptoms.

Odor perception. All subjects perceived an odor in the experimental condition and very little odor in the control condition, with no overlap of ratings in the two conditions by any subject. The mean odor intensity during the experimental exposure was 5.29 (moderate strong to strong) compared with 1.46 (very weak to weak) in the control condition. The mean irritation intensity during the experimental exposure was 3.77 (moderate weak to moderate) compared with 0.73 (very weak) in the control condition. The mean unpleasantness during the experimental exposure was 6.21 (moderately unpleasant to very unpleasant) compared with 4.12 (neither pleasant nor unpleasant to slightly unpleasant) in the control condition. The rank order of the mean intensities on the odor adjectives in the experimental condition was fecal > sewer odor > musty, earthy, moldy > like urine > sweaty.

Discussion

Go to:

The results of this study indicate that a 1-hr exposure to odorous swine air in an environmental chamber (at levels that could occur downwind from a swine facility both within and beyond the property line) has no significant acute effects on vital signs, lung function, nasal inflammation, salivary IgA, mood, attention, or memory in healthy volunteers. That is, there were no statistical differences on objective measures of physical symptoms, mood, or attention that resulted from a 1-hr exposure to air emissions from a swine facility when compared with clean air in persons who self-selected to participate in the exposure study. However, self-reported symptoms of headaches, eye irritation, and nausea were significantly more prevalent in these healthy volunteers exposed to swine air for 1 hr compared with clean air. The rapid onset of exposure-related avoidance symptoms reported by our subjects in response to diluted swine air is consistent with epidemiologic studies (Thu et al. 1997; Wing and Wolf 2000) in which persons “downwind” from swine facilities report similar symptoms.

The underlying mechanism responsible for the headaches, eye irritation, and nausea is not known, but it is unlikely that a single constituent of the emissions induces these effects. As explained below, no single component in the airborne emissions was present at a high enough concentration to be wholly responsible for these symptoms. However, additivity or synergy among the combined components may be the cause of these physical symptoms (Schiffman et al. 2000). That is, the symptoms may be caused by the combined load of some or all of the components in the air (H_2S, ammonia, VOCs, particulates, and endotoxin). Another possibility is that these self-reported symptoms are innate or learned warning signals of potential health effects at higher concentrations or with prolonged exposure.

Endotoxin. Headache, eye irritation, and nausea have been reported in previous studies by persons exposed to endotoxin (Crook et al. 1991; Melbostad and Eduard 2001; Poulsen et al. 1995a, 1995b; Thorn and Kerekes 2001). Endotoxin is also known to contribute to airway inflammation and airflow obstruction (Kline et al. 1999). However, it is unlikely that the endotoxin levels experienced by the subjects in this study are wholly responsible for these self-reported symptoms. The levels of endotoxin to which the subjects were exposed in the chamber were orders of magnitude lower than levels inside swine buildings (e.g., 3,984 EU/m^3 reported by Zhang et al. 1998). Furthermore, the levels used in the experimental condition are far lower than ambient air endotoxin in office buildings (0.25–0.4 μg/m^3) that have been associated with health complaints (Teeuw et al. 1994). (If one assumes that the biologic activity per mass unit of endotoxin is 10 EU/ng in this study, the exposure is approximately 0.06 ng/m^3 in the clean air condition and 0.74 ng/m^3 in the experimental condition.)

The cumulative exposure to endotoxin over 1 hr in the experimental condition of this study is also far below the level expected to cause physiologic symptoms. Assuming a tidal volume of 0.5 L (a single breath in normal quiet breathing) and 15 breaths/min, this translates to 450 L in 1 hr. Because there are 1,000 L in 1 m^3, the cumulative dose in this study is 0.332 ng. This dosage is far below the 15–20 μg dose at which airway responsiveness is altered in sensitive populations (Michel et al. 1989) and the 40 μg dose at which airway resistance is altered in healthy, nonatopic, nonasthmatic controls (Kline et al. 1999).

Ammonia. The mean concentration of ammonia in the experimental arm of this study was 817 ppb, a concentration that is below the published eye irritation threshold (irritation just barely noticeable) for ammonia of 4 ppm (World Health Organization 1986). It is also far below the short-term (15 min) exposure limit of for ammonia of 35 ppm set by the Occupational Safety and Health Administration

(OSHA 2003). Average concentrations of ammonia in swine housing have been reported to range from 5 to 18 ppm; maximum concentrations in sow buildings are 43.7 ppm and in finishing barns are 59.8 ppm (Koerkamp et al. 1998), but these levels decrease rapidly downwind as they are diluted in ambient air.

H_2S and VOCs. H_2S is a colorless, flammable gas that smells like "rotten eggs" at low concentrations. The mean concentration of H_2S during the 1-hr exposure in this study was 24 ppb. This level is above the odor detection threshold (0.5 ppt to 8 ppb) but far below the irritant threshold, which ranges from 2.5 to 20 ppm (Amoore 1985; Collins and Lewis 2000). Thus, the H_2S level in this study was 3–4 orders of magnitude (i.e., 10^3 and 10^4 times) below the level that causes classical irritant symptoms. The scientific literature on H_2S, however, suggests that health symptoms can occur at H_2S concentrations far below the levels at which irritation or toxicity occur. For example, community investigations near paper mills, refineries, geothermal sources, and meat-packing plants indicate that sustained exposure to low levels of H_2S or other reduced sulfur compounds (below the irritant threshold) can cause health symptoms (Campagna et al. 2000; Jaakkola et al. 1990, 1991; Kilburn and Warshaw 1995; Legator et al. 2001). In two of these community studies, health symptoms were found from an average daily exposure to 10–11 ppb H_2S (Jaakkola et al. 1990; Kilburn and Warshaw 1995).

GC/MS was performed on air samples from both the experimental and control conditions in our study, and many diverse compounds were identified in both the control and experimental conditions. The vast majority of these compounds were present at concentrations far below published odor thresholds; furthermore, all of the compounds for which irritation thresholds were available in the literature were below these levels (Schiffman et al. 2001b). Yet human assessments indicated that odors as well as irritant sensations were perceived in the exposure condition of this study. Comparison of the findings from chemical and human assessments in this study with previous studies (Cometto-Muñiz et al. 1997; Schiffman et al. 2001b) points to the importance of the cumulative effects of hundreds of compounds in producing odor and irritant sensations.

Self-reported headaches, eye irritation, and nausea. The underlying cause of the significant increase in self-reported headaches, eye irritation, and nausea in the experimental condition of this study is not known. As described above, no single component in the airborne emissions was present at a high enough concentration to be wholly responsible for these symptoms. It is possible, however, that synergy among the combined components may induce these physical symptoms. That is, the symptoms may be caused by the combined load of all or some of the components in the air (H_2S, ammonia, VOCs, particulates, and endotoxin). Donham and Cumro (1999) have previously found that ammonia and particulates are synergistic with one another in their impact on human health. Furthermore, low concentrations (even sub-threshold levels) of individual VOCs can add together when delivered in a mixture to produce noticeable sensory irritation (Cometto-Muñiz et al. 1997, 1999; Korpi et al. 1999). Another possibility is that these self-reported symptoms are innate or learned warning signals of potential health effects at higher concentrations or with more prolonged exposure. The symptoms may carry more significance for health effects in studies of vulnerable populations, such as children and elderly, and patients with cardiovascular or respiratory diseases.

Vital signs. The finding that no significant changes in respiratory rate, blood pressure, or pulmonary function were found here suggests that a single 1-hr exposure to unpleasant swine odor typical of downwind concentrations does not impair these health parameters in healthy volunteers tested in an environmental chamber. Previous studies have shown that exposure to unpleasant odors can in some cases lead to an inhibited breathing pattern (Schiffman et al. 2000). Stress, independent of unpleasant odors, also produces sustained inhibited breathing patterns that in turn can elevate blood pressure (Anderson 1998; Anderson and Chesney 2002). The mediating mechanism for elevated blood pressure from sustained inhibition of respiration is acidification of the plasma with subsequent increases in sodium/hydrogen exchange in kidneys and blood vessels. If inhibited breathing did occur during the 1-hr exposure in this study, it was not sustained after exposure, nor was the breathing frequency sufficiently altered to affect blood pressure. Future studies may employ additional measures of cardiovascular function such as alteration in heart rate variability, a finding that is associated with adverse effects in relationship to air pollution. More sensitive markers of airway inflammation, such as increased exhaled nitric oxide or increased epithelial permeability, may yield clues to long-term health effects of swine air exposure.

Mood (POMS scales). The finding that a 1-hr exposure to odorous swine air had no significant effects on mood scores on the POMS scale of healthy volunteers tested in an environmental chamber contrasts with a previous community study in which neighbors were frequently exposed to swine odor (Schiffman et al. 1995). In that study, neighbors of swine facilities in North Carolina experienced significantly more tension, depression, anger, fatigue, and confusion and less vigor on POMS scales when odors were present than when odors were absent (Schiffman et al. 1995). The difference in these findings can be explained by the differences in the exposure situations and the persons exposed. In the present study using a chamber, subjects were healthy volunteers who knew that the exposure would be time-limited and that the exposure levels were controlled by the investigators and approved for human subjects by the Duke University Medical Center Institutional Review Board. Furthermore, they were financially compensated and could withdraw at any time. Neighbors of swine operations, however, have no advanced warning about the timing, magnitude, or duration of the exposure. The intermittent presence of unavoidable, and unpredictable malodors can engender feelings of lack of control and negative affect when neighbors cannot use their home and property as they want. Unpleasant odors in the home can affect overall quality of life. Unconscious odor conditioning may also play a role in impaired mood of neighbors. When odors are associated with stressful or unpleasant situations, this odor can elicit subsequently alter mood, attitudes, and behavior (Kirk-Smith et al. 1983).

Salivary IgA. The finding of no changes in salivary IgA concentrations in this study is probably due to the short duration of the exposure period as well as the fact that the subjects were healthy volunteers who were financially compensated. Participants in this experimental trial as volunteers had more control over the odor exposure than do persons actually living downwind of a swine facility. Previous studies have shown that unavoidable stress and passive coping can produce decrements in salivary IgA within 10–15 min, whereas active coping and controllable stressors can increase salivary IgA (Bosch et al. 2001; Ring et al. 2002; Willemsen et al. 2002). Real-life stressful events and negative emotions can also decrease salivary IgA (Carins and Booth 2002; Yang et al. 2002). A recent study in North Carolina of neighbors of swine facilities found that their salivary IgA decreases significantly upon exposure to moderately strong swine odors (Avery et al., in press). This indicates that unavoidable and unpredictable odors from swine facilities that are not time-limited can have psychophysical impacts. The long-term health significance of alterations in salivary IgA levels is not well understood at present.

Odor ratings. The mean intensity ratings of 5.29 for odor (moderate strong to strong) and 3.77 for irritation (moderately weak to moderate) given by naive subjects in the experimental condition (for an odor 56 times above threshold) are higher than those given for the same level of swine odor by trained panelists who have extensive experience rating swine odor both on and off of farms in a natural environment. Trained panelists rate an odor 56 times above threshold at a mean odor intensity of 4.21 (moderate to moderately strong) with an irritation intensity of 3.01 (moderately weak) (Schiffman and Graham 2004). The mean unpleasantness ratings given by naive subjects during the experimental condition to an odor of 56 odor units was 6.21 (moderately unpleasant to very unpleasant). Trained panels give this odor a mean rating of 5.76 (moderately unpleasant). The probable reason why trained panelists give lower numbers is context specific. Trained panelists are exposed to very intense odors at odor sources next to the barns and lagoons as well as odors downwind. That is, scores of trained panelists are based on a wider range of intensities.

Conclusion

Go to:

In this study that evaluated healthy volunteers, no statistical differences on objective physical measures, mood, or attention were found from a 1-hr exposure in an environmental chamber to air emissions from a swine house when compared with clean air. However, self-reported symptoms of headaches, eye irritation, and nausea were significantly higher in the swine air (experimental) condition than the clean air (control) condition. The underlying cause of self-reported headaches, nausea, and eye irritation in the experimental condition is not known but may be due to the combined load of some or all of the components in the air (H_2S, ammonia, VOCs, particulates, and endotoxin). Another possibility is that these self-reported symptoms are innate or learned warning signals of potential health effects at higher concentrations or with prolonged exposure.

The self-reported headaches, nausea, and eye irritation in this controlled study using healthy volunteer subjects without occupational exposure are a subset of a larger number of symptoms reported in community studies by individuals exposed to environmental odors (Shusterman 1992; Thu et al. 1997; Wing and Wolf 2000). The greater number of health symptoms reported by neighbors of swine operations compared with our healthy volunteers may be due to inclusion of vulnerable populations (e.g., persons with asthma), previous exposure history, higher levels of exposure in certain communities (both swine and non-swine sources), involuntary and prolonged exposure, and quality of life issues. In addition, persons living downwind are exposed to emissions from lagoons and spray fields as well as swine houses, although the former two sources tend to contain similar but less varied compounds than those emitted from the houses (Schiffman et al. 2000).

More research is necessary to determine the mechanism responsible for self-reported symptoms and their elevated number in neighbor exposures relative to this experimental exposure. First, controlled studies in the environmental chamber should be expanded in the future to include volunteers from vulnerable populations (e.g., persons with asthma). Most scientific literature (Nieto et al. 2003; Nolte and Berger 1983; Sant'Ambrogio 1987; Shusterman 2002), but not all (Levi et al. 1990; Opiekun et al. 2003), suggests that persons with asthma have sensory hyper-responsiveness to irritants. These conflicting findings may be due to medical status at the time of testing; activation of afferent neurons in the airways is not a static property but rather appears to change rapidly in response to inflammation (Carr and Undem 2001). Asthmatic subjects with active symptoms may not volunteer for an exposure experiment.

Second, the contribution of stress must be incorporated in controlled experimental paradigms because stress responses can sensitize various neuronal, hormonal, and behavioral responses that could potentially affect the parameters tested in the present controlled exposure study (Johnson et al. 2004). Neighbors who are involuntarily exposed to unpredictable swine emissions report significantly more tension, depression, anger, fatigue, and confusion and less vigor on POMS scales (Schiffman et al. 1995) than did the subjects in the present experiment, whose exposure was voluntary. Although it is not possible to design a study that precisely replicates the involuntary and unpredictable exposure to malodorous swine emissions (potential stressor) in a natural setting, symptoms can be studied during a prolonged intermittent (and thus unpredictable) but time-limited exposure under controlled experimental paradigms. In addition, symptoms during exposure to swine air while performing a stressful activity (e.g., mental arithmetic) versus symptoms while performing a nonstressful activity (control) can be compared.

Controlled exposure studies as well as further epidemiologic studies should include subjects with a broad range of exposure history to swine emissions to determine the prevalence of sensitization as well as tolerance for (or adaptation to) odorous emissions. Several experimental studies suggest that increased sensitivity to an odor can develop with repeated exposure (Wysocki et al. 1989), and that the effect is pronounced in women (Dalton et al. 2002). Yet tolerance to swine confinement air (with fewer symptoms) has been reported to occur in some chronically exposed workers (Von Essen and Romberger 2003), although it is not known whether tolerance to aerial emissions develops in an analogous manner at lower concentrations that occur at neighbors downwind of swine facilities. Both controlled and epidemiologic research studies will help clarify the impact of sporadic exposure to swine emissions on health symptoms of persons who are involuntarily exposed intermittently to malodors.

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Go to:

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Community Health and Socioeconomic Issues Surrounding Concentrated Animal Feeding Operations

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Abstract

Go to:

A consensus of the Workgroup on Community and Socioeconomic Issues was that improving and sustaining healthy rural communities depends on integrating socioeconomic development and environmental protection. The workgroup agreed that the World Health Organization’s definition of health, “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity,” applies to rural communities. These principles are embodied in the following main points agreed upon by this workgroup. Healthy rural communities ensure *a*) the physical and mental health of individuals, *b*) financial security for individuals and the greater community, *c*) social well-being, *d*) social and environmental justice, and *e*) political equity and access. This workgroup evaluated impacts of the proliferation of concentrated animal feeding operations (CAFOs) on sustaining the health of rural communities. Recommended policy changes include a more stringent process for issuing permits for CAFOs, considering bonding for manure storage basins, limiting animal density per watershed, enhancing local control, and mandating environmental impact statements.

Keywords: animal confinements, environmental impact, livestock, mental health, odor, poultry, right-to-farm legislation, swine

Background and Recent Developments

Go to:

The agricultural community in areas of large-scale livestock production

The rural and agricultural community has changed dramatically over the past half century. The trends include an overall reduction in the number of farms, an increase in size of the farms, and economic concentration in the industries that supply inputs and purchase commodities from farms. The structure of the pork industry has also changed dramatically during the past three decades. The number of hog producers in the United States was more than 1 million in the 1960s but fell to about 67,000 by 2005 [U.S. Department of Agriculture (USDA) 2005]. Although the total inventory of hogs has changed little over the years, the structural shift toward concentration has been dramatic with the 110 largest hog operations in the country, each of which has over 50,000 hogs, now constituting 55% of the total national inventory (USDA 2005). The swine industry includes the following types of producers: small independent "niche" operators who often market organic pork to local markets, traditional independent operators, and large family or unaffiliated corporations. Former independent operators are increasingly raising livestock on contract for larger corporations. According to the U.S. Government Accountability Office, in 1999 contract production constituted more than 60% of total hog output and 35% of the cattle market (U.S. Government Accountability Office 2005), while poultry is produced almost entirely via contracts. Corporate producers or incorporated family-based operations employ from a few individuals to several hundred. Most often upper management and many of the workers in such operations do not come from or live in the vicinity of concentrated animal feeding operations (CAFOs).

The community of people living in the region of large-scale livestock production consists of residents of small family farms (that may or may not produce pork), workers at the production facilities, rural nonfarm residents, and the residents of neighboring towns. The challenges CAFOs place on neighbors were extensively reviewed in 1996 (Thu 1996) and again in a 2002 report accompanied by a number of consensus recommendations for the future of the hog industry in Iowa (Iowa State University and University of Iowa 2002). A number of additional scientific reviews and symposia summaries have been issued (Centers for Disease Control and Prevention 1998; Cole et al. 2000; Donham 2000; National Academy of Sciences 2002; Schiffman et al. 2000; Thu 2002).

Economic health Economic concentration of agricultural operations tends to remove a higher percentage of money from rural communities than when the industry is dominated by smaller farm operations, which tend to circulate money within the community. Goldschmidt (1978) documented this as early as 1946 in California, one of the first states where industrialized agriculture developed. Specifically, he compared two agricultural communities, one dominated by larger industrialized farms with absentee ownership and a high percentage of hired farm labor, and the other community was dominated by smaller owner-operated farms. The latter community was found to have a richer civic and social fabric with more retail purchases made locally and with income more equitably distributed. A similar study by MacCannell (1988) of comparable types of communities found that the concentration and industrialization of agriculture were associated with economic and community decline locally and regionally. Studies in Illinois (Gomez and Zhang 2000), Iowa (Durrenberger and Thu 1996), Michigan (Abeles-Allison and Conner 1990), and Wisconsin (Foltz et al. 2002) demonstrated decreased tax receipts and declining local purchases with larger operations. A Minnesota study (Chism and Levins 1994) found that the local spending decline was related to enlargement in scale of individual livestock operations rather than crop production. These findings consistently show that the social and economic well-being of local rural communities benefits from increasing the number of farmers, not simply increasing the volume of commodity produced (Osterberg and Wallinga 2004).

Physical health There have been more than 70 papers published on the adverse health effects of the confinement environment on swine producers by authors in the United States, Canada, most European countries, and Australia (Cormier et al. 1997; Donham 2000; Donham et al. 1977, 1982, 1986, 1990, 2002; Kirkhorn and Schenker 2002; Kline et al. 2004; Preller et al. 1995; Reynolds et al. 1996; Rylander et al. 1989; Schiffman et al. 1995; Schwartz et al. 1992; Thu et al. 1997; Wing and Wolf 2000). It is clear that at least 25% of confinement workers suffer from respiratory diseases including bronchitis, mucus membrane irritation, asthmalike syndrome, and acute respiratory distress syndrome. Recent findings substantiate anecdotal observations that a small proportion of workers experience acute respiratory symptoms early in their work history that may be sufficiently severe to cause immediate withdrawal from the work place (Dosman et. al. 2004). An additional acute respiratory condition, organic dust toxic syndrome, related to high concentrations of bioaerosols in livestock buildings occurs episodically in more than 30% of swine workers.

Environmental assessments of air quality inside livestock buildings reveal unhealthful concentrations of hydrogen sulfide, ammonia, inhalable particulate matter, and endotoxin (Iowa State University and University of Iowa 2002; Schenker et al. 1998). While there is less information on adverse effects among residents living in the vicinity of swine operations, that body of literature has been growing in recent years (Avery et al. 2004; Bullers 2005; Centers for Disease Control and Prevention 1998; Kilburn 1997; Merchant et al. 2005; Mirabelli et al. 2006a; Reynolds et al. 1997; Schiffman et al. 1995, 2000; Thu 2002; Thu et al. 1997; Wing and Wolf 2000).

Thu et al. (1997) documented excessive respiratory symptoms in neighbors of large-scale CAFOs, relative to comparison populations in low-density livestock-producing areas. The pattern of these symptoms was similar to those experienced by CAFO workers. Wing and Wolf (2000) and Bullers (2005) found similar differences in North Carolina. A case report associated with hydrogen sulfide exposure from a livestock processing facility in South Sioux City, Nebraska, revealed excessive diagnoses of respiratory and digestive disturbances in people living nearby (Campagna et al. 2004). Schiffman and colleagues reported that neighbors of confinement facilities experienced increased levels of mood disorders including anxiety, depression, and sleep disturbances attributable to exposures to malodorous compounds (Schiffman et al. 1995, 2000). Avery et al. (2004) found lower concentration and secretion of salivary immunoglobulin A among swine CAFO neighbors during times of moderate to high odor compared with times of low or no odor, suggesting a stress-mediated physiologic response to malodor (Shusterman 1992).

Community environmental air quality assessments have shown concentrations of hydrogen sulfide and ammonia that exceed U.S. Environmental Protection Agency (U.S. EPA) and Agency for Toxic Substances and Disease Registry recommendations (Reynolds et al. 1997). A recent study revealed that children living on farms raising swine have an increased risk for asthma, with increasing prevalence of asthma outcomes associated with the increased size of the swine operation (Merchant et. al. 2005). Children in North Carolina attending middle schools within 3 miles of one or more swine CAFOs and children attending schools where school staff report CAFO odors in school buildings were found to have a higher prevalence of wheezing compared with other middle school children (Mirabelli et al. 2006a, 2006b). It should be noted that these studies (although controlled) lack contemporaneous exposure assessment and health outcomes ascertainment. Additional research to include environmental exposure data related to biomarkers of response is needed.

Mental health Living in proximity to large-scale CAFOs has been linked to symptoms of impaired mental health, as assessed by epidemiologic measures. Greater self-reported depression and anxiety were found among North Carolina residents living near CAFOs (Bullers 2005; Schiffman et al. 1995). This finding was not corroborated in a small study by Thu et al. (1997) of depression among people living near to or far from CAFOs. However, it should be noted that the study of Thu et al. differed in that residents were not asked to report on their mental state during an actual odor episode as was the case in the study by Schiffman et al. (1995).

Greater CAFO-related posttraumatic stress disorder (PTSD) cognitions have been reported among Iowans living in an area of CAFO concentration compared with Iowans living in an area of a low concentration of livestock production (Hodne CJ, unpublished data). PTSD cognitions were consistent with interviewees' multiple concerns about the decline in the quality of life and socioeconomic vitality caused by CAFOs, in areas of CAFO concentration with declining traditional family farm production.

Social health One of the most significant social impacts of CAFOs is the disruption of quality of life for neighboring residents. More than an unpleasant odor, the smell can have dramatic consequences for rural communities where lives are rooted in enjoying the outdoors (Thu 2002). The encroachment of a large-scale livestock facility near homes is significantly disruptive of rural living. The highly cherished values of freedom and independence associated with life oriented toward the outdoors gives way to feelings of violation and infringement. Social gatherings when family and friends come together are affected either in practice or through disruption of routines that normally provide a sense of belonging and identity—backyard barbecues and visits by friends and family. Homes are no longer an extension of or a means for enjoying the outdoors. Rather, homes become a barrier against the outdoors that must be escaped.

Studies evaluating the impacts of CAFOs on communities suggest that CAFOs generally attract controversy and often threaten community social capital (Kleiner AM, Rikoon JS, Seipel M, unpublished data; 2000; Ryan VD, Terry Al, Besser TL, unpublished data; Thu 1996). The rifts that develop among community members can be deep and long-standing (DeLind 1998). Wright et al. (2001), in an in-depth six-county study in southern Minnesota, identified three patterns that reflect the decline of social capital that resulted from the siting of CAFOs in all six rural communities they studied: *a*) widening gaps between CAFO and non-CAFO producers; *b*) harassment of vocal opponents of CAFOs; and *c*) perceptions by both CAFO supporters and CAFO opponents of hostility, neglect, or inattention by public institutions that resulted in perpetuation of an adversarial and inequitable community climate. Threats to CAFO neighbors have also been reported in North Carolina (Wing 2002). Clearly, community conflict often follows the siting of a CAFO in a community. What is not known is if community conflict resulting from the siting or presence of CAFOs has an impact on the ability of communities to act on other issues.

Environmental injustice Disproportionate location of CAFOs in areas populated by people of color or people with low incomes is a form of environmental injustice that can have negative impacts on community health (Wing et al. 2000). Several studies have shown that a disproportionate number of swine CAFOs are located in low-income and nonwhite areas (Ladd and Edwards 2002; Wilson et al. 2002; Wing et al. 2000) and near low-income and nonwhite schools (Mirabelli et al. 2006a, 2006b). These facilities and the hazardous agents associated with them are generally unwanted in local communities and are often thrust upon those sectors with the lowest levels of political influence. CAFOs are locally unwanted because of their emissions of malodor, nutrients, and toxicants that negatively affect community health and quality of life. Low-income communities and populations that experience institutional discrimination based on race have higher susceptibilities to CAFO impacts due to poor housing, low income, poor health status, and lack of access to medical care.

Failure of the political process In 2005 the U.S. Government Accountability Office issued a report on the effectiveness of U.S. EPA efforts in meeting its obligations to regulate concentrated animal feeding operations (U.S. Government Accountability Office 2005). The report identified two major flaws: *a*) allowing an estimated 60% of animal feeding operations in the United States to go unregulated, and *b*) lack of federal oversight of state governments to ensure they are adequately implementing required federal regulations for CAFOs. Additionally, many states have not taken a proactive stance to comply with the U.S. EPA regulations. Therefore, the concentration of livestock production, most noted by CAFO-style production, has continued to expand in most states. This has resulted in many rural communities and individuals taking action on their own, through local ordinances or litigation, as they have not been able to find access through usual governmental channels.

Several studies have found that property values decrease when CAFOs move into a community (Abeles-Allison and Conner 1990; Hamed et. al. 1999; Herriges et al. 2003; Palmquist et al. 1997). Neighbors of CAFOs are interested in preventing loss of property value, loss of their homes and land, forced changes in their life style, adverse changes in their communities, and threats to their health (Thu and Durrenberger 1998). The democratic process offers citizens access to lawmakers, to the courts, and to direct action to redress their grievances. However, the legislative process in many states has often been unresponsive to citizen wishes concerning CAFOs (Cantrell et al. 1996). For example, 13 states have enacted laws that inhibit citizens from speaking freely about agriculture if it is disparaging. A representative example can be seen in a South Dakota law that defines disparagement as

> *dissemination in any manner to the public of any information that the disseminator knows to be false and that states or implies that an agricultural food product is not safe for consumption by the public or that generally accepted agricultural and management practices make agricultural food products unsafe for consumption by the public. (South Dakota Codified Laws 2006)*

All 50 states have some form of right-to-farm legislation. This legislation serves to protect farming operations from zoning laws or lawsuits that would overly restrict the ability of farmers to do business (Chapin et al. 1998; Hamilton 1998). Right-to-farm legislation varies from state to state but may include laws that prevent zoning from limiting farm practices that have substantial detrimental effects on neighbors, such as CAFO production. Right-to-farm laws may also include preemption of other actions of local government that normally could limit what businesses are allowed to do, known as home rule. For example, the Iowa Supreme Court has ruled that county governments cannot use home rule powers or protection of public health to promulgate laws that are more restrictive than state laws currently in force (Worth County Friends of Agriculture v. Worth County, Iowa, 2004). Although local governmental action has been limited by the bias toward agricultural producers, individual actions have not. Courts in several states have ruled that right-to-farm laws give only limited protection from nuisance action. The Iowa Supreme Court in June 2004 found that CAFO immunity provisions written in Iowa statutes were unconstitutional (Gacke v. Pork XTRA 2004). A district court in Illinois granted a temporary injunction stopping the construction of a nearby CAFO based on an anticipatory nuisance premise (Nickels et al. vs. Burnett 2002) that such a facility would constitute reasonable interference with neighbors' quality of life.

Most states have enacted some forms of environmental laws aimed at protecting the environment from agricultural discharges or emissions. One form of these laws requires establishment of manure management plans. Typically, these laws call for certain sizes of operations to apply for permits. These permits may include the filing of a manure management plan, which calls for a plan for CAFO operators to manage their manure in a manner to prevent water and soil pollution. However, there is little if any performance inspection or enforcement of these plans (Jackson et al. 2000). Nonenforcement is primarily due to the lack of personnel and technical resources at state environmental agencies. For example, some states may have 2,000 or more such operations but not enough staff to efficiently process permit applications, much less get out into the field to inspect performance of these operations.

Workshop Recommendations

Go to:

Priority research needs

Community health studies Although sufficient research supports actions to protect rural residents from the negative impacts of CAFOs on community health, additional research could be conducted to further delineate mechanisms of effects and impacts on susceptible subgroups. These areas include psychophysiologic impacts of malodor; impacts of malodor on mental health and quality of life; and respiratory impacts of bioaerosol mixtures, especially among asthmatics, children, and the elderly.

Wider and more effective application of community-based participatory research will be important to advance research in these areas.

Sustainability of livestock production Federal funding for agricultural research should be reoriented to promote innovation in sustainable livestock production.

Translation of science to policy Requirements for issuing permits for CAFOs should include increased protections for health and the environment including the following:

- CAFOs should be sited and issued permits on the basis of total animal density allowed in a given watershed as determined by the carrying capacity.
- Environmental impact statements should be mandated for all new CAFOs. These should include environmental health, social justice, and socioeconomic issues.
- Decisions to issue permits for CAFOs should be considered in public meetings and decided at the local level.
- CAFOs should be regulated using standards applied to general industry based on the level of emissions and type of waste handling.
- Permits for manure storage basins should require bonding for performance and remediation.
- The current state of knowledge of community impacts of CAFOs warrants support for the American Public Health Association recommendation for a moratorium on all new CAFO construction.

Footnotes

Go to:

This article is part of the mini-monograph "Environmental Health Impacts of Concentrated Animal Feeding Operations: Anticipating Hazards—Searching for Solutions."

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STAFF PAPER SERIES

Measured Effects of Feedlots on Residential Property Values in Minnesota: A Report to the Legislature

by

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COLLEGE OF AGRICULTURAL, FOOD, AND ENVIRONMENTAL SCIENCES

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BRIEF

We were asked by the Legislature to conduct "research into the effects feedlots have on the value of nearby property." To do so, we carried out a statistical examination of the interrelationships among residential property sales prices and nearby feedlots in a southwestern Minnesota study area. Structure and location data for 292 residential property sales in Redwood and Renville Counties, excluding the cities of Olivia and Redwood Falls, were linked to the location and physical characteristics of every larger feedlot within three miles of each sale.

The basic approach was to ask, "Does the addition of information about feedlot proximity help us explain observed house prices beyond the explanatory power of statistical models that use only the house's structure and other location characteristics?" We examined this overall question with respect to a series of constructed proximity indicators that capture the effects of feedlot size, direction, distance, and types of animals, among others.

We found statistically significant evidence of a link between feedlot location and house prices in the study area. That relationship was positive in sign, not negative as initially expected. Houses closer to feedlots appear to have sold for more than expected from knowledge of the characteristics of the houses alone. The effect was most pronounced for houses that are older, relatively lower in price, or located in small towns.

Are these results generalizable to elsewhere in Minnesota? Not necessarily. Negative links between house prices and feedlots might well actually exist, but statistical "noise" could have masked them. Or it is possible that our sample data is not representative of the total housing market in the area, in which case our findings are not representative. Or there might be a negative relationship, but it won't show up in observed property sales prices for a number of years yet. But it just might be the case that feedlots do indeed positively influence nearby property values.

Introduction

Feedlot location has become one of the more contentious issues facing Minnesota's local governments. While the state's Pollution Control Agency has broad permitting authority over most new facilities, this authority extends only to questions of design and operation -- not of location. Whether or not new facilities can be built at a particular site is a decision usually left to county or to city or township officials.

In the public hearings that precede location decisions in those jurisdictions that choose to exercise oversight, many opinions for and against the proposed facility -- or feedlots in general -- are proffered. Among these are assertions that the new facility will result in lower nearby property values. The evidence that can be brought to bear on this assertion is the subject of the present study. We do not address the policy implications of a positive or negative finding; we simply address the basic question of fact.

Nearby feedlots might affect property values in two broad ways: they might increase or diminish the current owner's willingness to sell, or they might increase or diminish potential buyers' willingness to purchase. The actual price at which a property sells, the only property value we can actually observe, necessarily lies somewhere between the seller's lowest acceptable price and the buyer's highest potential offer. The observed sales price is the net outcome of all the conflicting influences on buyers' and sellers' preferences.

For example, a seller might be willing to settle for less, just to get away from perceived negative effects from the feedlot. Or a buyer might be willing to pay less, to compensate for anticipated negative effects. Either or both would lead to a pattern of observed sales prices that are lower for houses near feedlots. Conversely, feedlots might provide sufficient positive benefits to nearby residents that sellers can hold out for a higher price. Or buyers might be willing to pay more, for the same reason. If this is the case, we would expect to observe sales prices that, on average, exceed those of houses that lie farther away.

Whichever the situation, if we observe different average prices when feedlots are nearby, then we have evidence linking feedlots to property values -- all other property characteristics held constant. We cannot, however, use this evidence to decide which combination of buyer and seller influences was the root cause of the observed prices.

Evidence of a link

Three major sources of evidence might be brought to bear on the proximity question. The first is anecdote -- the accumulation of personal observation, news accounts, public hearing statements, or appraisal reports. These "stories" have the advantage of being personalized and particular, because they can capture the subtleties and nuances of individual situations. They have the decided disadvantage of not being "scientific," in the legal or academic sense, because it is very difficult to generalize from a few instances to new occurrences.

A second data source is the collective judgments of local property tax assessors. These officials are charged with annually assigning a market value, defined as an expected sales price, to every property in their jurisdictions. Assessors' value estimates have proved fairly reliable on average, although their estimates on individual properties of course are more prone to deviation. The disadvantage of using assessor values is that any observed differences in value associated with feedlots is by definition simply a discovery of the assessors' own judgments on the question.

The final source for data bearing on the question is the set of residential properties that actually sold in the study area during the study period. This approach limits the number of properties subject to analysis, but it has several advantages that recommend it. The principal reason economists prefer actual sales prices, rather than assessed values, is that sales prices capture more information from the market; after all, the final price tells us that both buyer and seller agreed that that was a "fair" price for the property. For this reason, we have chosen to examine only actual property sales in this study.

Previous studies

Abeles-Allison and Connor (1990), in a broader study of the local costs and benefits of the hog industry in Michigan, examined housing sales prices in the context of property, neighborhood, and environmental characteristics. Eight feedlots were selected from a list of those receiving numerous odor complaints. Each house in the data set was associated with one and only one of the study feedlots. The authors reported a negative relationship between housing values and nearby feedlots.

Palmquist et al. (1997) is the only other published study that directly examines the feedlot proximity question. They linked sales data from 237 rural residential properties in nine North Carolina counties to swine feedlots within two miles of each sale. Because feedlot data is considered confidential in North Carolina, the researchers did not have direct access to location or size attributes. They were able to arrange with the State Veterinarian's Office, that state's feedlot data repository, to report the aggregate number and size of swine feedlots within 1/2, 1, and 2 miles of each sale. From this sorting, the authors constructed a manure index which weighted the aggregate number of hogs by distance.

After substantial data manipulation, the researchers calculated a range of effects for different sizes of feedlots locating at various distances from a mid-range priced house. They found a small but statistically significant negative effect on house values. For example, if a new 2,400 head finishing floor were to be built within 0.5 miles of a house that already had some feedlots nearby, the authors calculate that the average house value would drop by 4.75% ($2,889 from $60,816), If the same feedlot were instead to be built two miles away, the value of that house would drop only 0.56%.

The present study

The present study builds from these findings, expanding particularly upon the North Carolina study. Our approach, sometimes termed "hedonic price analysis," links observed property sales prices to those properties' structure, location, and feedlot characteristics. The underlying data are 292 rural residential property sales in 1993-94 for two Minnesota counties for which complete data is available, plus all larger nearby feedlots. Because we know the geographic location of each property and of each feedlot, we are able to measure the direction and distance of each feedlot from each house. This permits us to explore aspects of the proximity question that were not possible in the other studies.

We examine the data in two steps. First, ignoring any feedlot characteristics, we model sale price solely as a function of characteristics of the house such as its size and its location. Assessors call this method "mass appraisal," whereby housing characteristics are used to "explain the variability" in sale prices. If we could explain 100% of the variability, then we could insert the housing characteristics into an equation and calculate a predicted price. That predicted price would exactly equal the eventual observed sales price. Of course such a 100% accurate prediction is not possible: two houses with identical characteristics, according to the information from the assessors records, might sell for very different prices due to the condition of the property, to the proximity of feedlots, or to other unmeasured factors unrelated to feedlots.

As a second step in the analysis, we compute the prediction errors, which are the differences between the observed sale price and the sale price predicted from this basic property model. Some of the prediction errors are positive, and some are negative. If proximity to feedlots is an important determinant of sales price, then we would expect that the prediction errors would be "explained by" proximity to feedlots. If the addition of the feedlot data does not improve the basic model by decreasing prediction errors, these variables can be classified non-important.

We ask a series of interrelated questions about property values and feedlot proximity: Does distance matter? Does direction matter? Does type of animal matter? Does manure handling method matter? Does the size of the operation matter? Each of these can be addressed in our framework.

We choose to report our results essentially as “yes/no” answers to these broad questions of fact, rather than as what we would consider to be overly precise estimates of feedlot effects on property values. The method of analysis we used is outlined in Cook and Weisberg (1994). The software included with this book, called the R-code, was used for the bulk of the data analysis.

Study Area

Economic theory requires that all examined properties lie within the same "housing market," a geographic area in which it is plausible that potential buyers might choose from among all properties. On that count, we could not lump all Minnesota sales or even all sales in southern Minnesota. We required a more compact, more homogeneous market area.

The present study examines the rural residential property market in Redwood and Renville Counties, Minnesota. The two counties lie approximately 100 miles west of the Twin Cities and jointly cover 1,868 square miles. Each contains about 17,000 people, down slightly from a peak just after World War II. . The major city in the area is Redwood Falls, with a population of just over 5,000. Residents in each county have similar off-farm employment opportunities and average income levels.

The study area is almost entirely agricultural and largely flat with few wooded areas, except along the Minnesota River. Principal crops are corn, soybeans, and sugar beets. The area is known for extensive swine and poultry operations which have grown substantially within the past decade. The two counties have shown somewhat different approaches to regulating feedlots. Renville County has generally approved only lagoons for manure storage, while Redwood County has only approved pits and above ground tanks for this function.

Proximity

Given the large number of both property sales and livestock facilities, we need to measure the distances among a complex of feedlots and residential properties. Unlike those in the Michigan study noted above, houses in our study area might have several feedlots "nearby." Unlike that used in the North Carolina study, our data set tells us a great deal more about which feedlots lie in what direction and distances from each house. What we require is a set of measures that captures and notions such as "many," "near," "large," etc.

Two approaches suggest themselves. The first would be to draw circles of stated radius around each <u>feedlot</u> and examine the relative prices of houses inside and outside each circle. This approach would help us answer such questions as "Do houses nearer to feedlots have lower values on average?" Unfortunately, however, it can't help us with other questions that we have, such as "Does the total number of nearby feedlots reduce values?"

The second approach preferred by economists for both practical and theoretical reasons is to draw a circle around each <u>property</u> and count all feedlots within the circle as "nearby." This is the approach adopted for this study. We classify all feedlots within three miles of each property as "nearby" and, hence, subject to further analysis. For each property in our data set, we have, in addition to its structure and location features, a list of all nearby feedlots, including their direction and distance. For each feedlot, we know the animal type, its size, and its manure handling facilities. From these data we are able to create the several feedlot proximity indicators that become the principal variables of interest.

Feedlot Data

In Minnesota, all new and upgraded feedlots over 50 animal units (AU) in size require a state permit, issued by the Minnesota Pollution Control Agency. An animal unit is a standardized measure of feedlot size: the necessary conversions are shown in Table 1.

Table 1: Conversion to standardized animal units

animal	animal units
Horse	1.0
Dairy Cow	1.4
Dairy Youngstock	0.5
Finishing Pigs (>55 lb.)	.40
Breeder Swine	.40
Boars	.40
Farrowing Sows	.40
Gestating Sows	.40
Feeder Pigs (<55 lb.)	.05
Turkeys	.018
Chicken Layers	.01
Chicken Broilers	.01
Chicken Pullets	.005
Beef Feeders	1.0
Beef Cow w/Calf	1.0

We chose to consider only those feedlots with more than 500 AU. This had the effect of excluding many traditional dairy farms and a few older swine facilities; consequently, it more closely approximates, in our judgment, the image that most people form in their minds when they hear the word "feedlot." Virtually all new facilities built in the study area in recent years exceed 500 AU in size..

There has been a flurry of feedlot permit issuance in recent years in Minnesota, partly linked to a 1995 relaxation of the state's corporate farming laws. Many new operations have been set up, and scores of new MPCA permits have been issued -- but in some cases no physical facility is yet on-line. It seems unlikely that the prospective issuance of a permit, not to mention actual construction, would greatly influence those sales. For our analysis, therefore, we excluded from our nearby-feedlot count any permit that was dated after the sale. Feedlot permits contain the following data, of which we use the first six items in this study:

1) date of the application
2) number and type of animals to be housed in the facility
3) location of the proposed facility, usually to the quarter-quarter section
4) the name and address of the applicant
5) the type of animal confinement
6) the manure storage structure
7) the soil type around the facility
8) the land application method for the manure as well as acres available
9) the usage of the well on the property (humans, livestock, or irrigation)
10) data on the existence of special conditions

For each feedlot, we identified the dominant animal type (swine, bovine, poultry) and associated major manure process (solid-pack, liquid-lagoon, liquid-tank, liquid-pit). The number of animal units for the entire facility was that number attached to the dominant animal type. This assignment was rarely a problem, because nearly all the permits were for a single animal type or for a type that accounted for over 90% of the total facility's manure production.

Housing Data

The housing data in this study came from county assessor records and state Department of Revenue sales reports. Periodically each parcel is classified according to use, inspected, and measured. The number of bedrooms and bathrooms are noted, as well as the year a property was built, recent improvements, and additions. Assessors make a plat drawing, describe the lot size, and separately value the land and building components. The assessors in the study area rely on "multipliers" to be applied against foundation area for homes of known condition and construction style. For example, assessors assign particular classes to homes depending upon whether or not they are two-story, ramblers, split levels, Cape Cods, domes, and so forth.

Sales data came from official Certificates of Real Estate Value filed with the Minnesota Department of Revenue and from each county assessor's field cards, which detail the attributes of each property. Sales were included if the property is located in any city or township with population 2,500 or less. This restriction excluded from our analysis the City of Redwood Falls in Redwood County and the City of Olivia in Renville County. We counted a property as "residential" if the sale was so classified by the Department of Revenue: farmsteads are generally <u>not</u> included in this category.

Our final data set of 292 sales consists of all reported 1993-94 sales for which complete data was available. Most of the sales used in this study were for less than $50,000, and over a third were for less than $20,000 (Figure 1). Table 2 lists various descriptive statistics for the housing data.

Somewhat less than half of the sales were for properties that had no feedlot of size over 500 AU within three miles, including feedlots located in adjoining counties. The majority of sales were associated with two or fewer nearby feedlots, although one cluster of sales, all in a single community, was surrounded by eleven feedlots within three miles.

Figure 1: Distribution of sales prices (n=292)

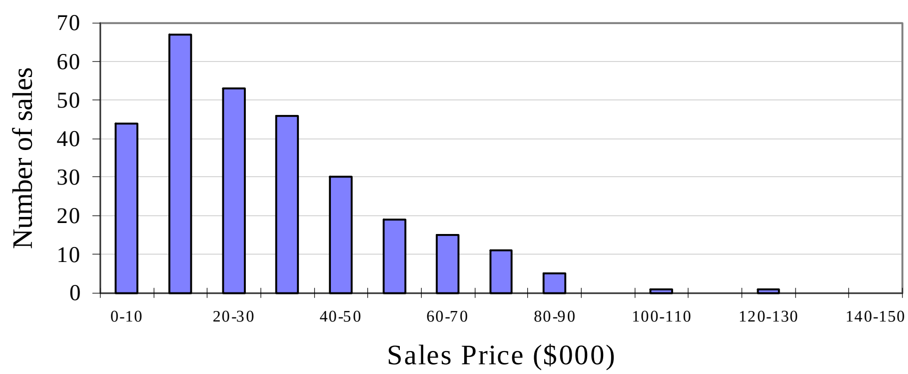

Table 2: House structure variables

variable	description	min.	mean	median	max.	std. dev.
FOOTPRINT	Number of square feet in foundation	320	979	927	2,096	284.2
BUILT	Year of initial construction	1885	1936	1936	1988	28.2
BEDROOMS	Number	1	2.9	3	6	0.8
BATHROOMS	Number	1	1.4	1	3.5	0.5
RATIO	Ratio of assessor's estimates of house value to total property value	0.36	0.84	.88	0.99	0.2
PRICE	Reported sales price adjusted for time and terms	5,000	31,434	26,500	120,500	21,213

Basic property model

The first task is to explain as much of the observed variation in house prices as we can, using only available structural and location characteristics. As is common in this type of study, we used multiple regression analysis to obtain an equation relating price to several characteristics at once. Following Cook and Weisberg (1994) we first transformed the independent variables (also called the predictors) so that they are as linearly related as possible. Special software included in the R-code makes finding the needed transformations straightforward. We used this method and then rounded the selected transformations to the nearest whole number or simple root:

variable	transformation
BATHROOMS	inverse
FOOTPRINT	cube root
RATIO	arcsine square root
BUILT	logarithm

The arcsine square root transformation is often used to make more nearly symmetrical the distribution of a quantity bounded between zero and one. Similarly, we transformed the scale of the dependent (or "response") variable to improve the applicability of a model: we used the Box-Cox method to transform PRICE to the cube root scale.

Table 3 gives the full basic property model and estimated coefficients. The COUNTY variable is 0 if the property is in Redwood County and 1 if in Renville County. TOWNSHIP is 0 if the property is in a city and 1 if in a township. The joint distribution of these two variables is shown in Table 4.

Statisticians generally agree that a t-value of 2.0 or more in absolute value, which corresponds to a significance level of about one in twenty, means that the associated coefficient estimate can be considered "important" or "statistically significant." These higher values make us pretty confident that the "true" values of the coefficients (which we can never observe) are not really zero. The 2.0 threshold for t-values was our criterion of statistical significance in this study.

Table 3: Basic property model (cube root of price)

variable name	estimated coefficient	standard error	t-value
CONSTANT	-1156	152	-7.6
COUNTY (0/1)	2.2	0.5	4.4
TOWNSHIP (0/1)	7.5	0.9	8.7
BEDROOMS	0.8	0.3	2.5
RATIO (arcsine square root)	9.4	2.2	4.3
BATHROOMS (inverse)	-4.4	1.1	-3.9
FOOTPRINT (cube root)	2.3	0.3	7.0
BUILT (log)	133.1	20.1	6.6
N= 292			
R2 = .66			
sigma-hat = 4.0			
F = 78.9			

Table 4: Distribution of 0/1 variables in basic property model

COUNTY / TOWNSHIP	(0) Redwood County	(1) Renville County	total
city (0)	117	142	259
township (1)	10	23	33
total	127	165	292

Adding in the feedlot variables

We can now assess the implications of adding various feedlot variables to this basic property model. If the model is "improved" by an addition, then that variable accounts for a part of the price that is not attributable to house characteristics alone. We demonstrate the effects of adding feedlot variables to the basic model through use of *proximity indicators*, each of which encapsulates one of the basic research questions. These indicators, described in Table 5, are categorical, not continuous variables. Their interpretation will become apparent as we discuss each in the results section. Briefly, a statistically significant coefficient estimate (t-value greater than 2.0) on a proximity indicator suggests that the feedlot characteristic underlying that indicator does indeed "matter."

In each case, the parameters of the basic property model portion of the new model shift, but only slightly. We therefore report the statistical properties of only the independently added proximity indicators.

Table 5: Definition and distribution of feedlot proximity indicators

indicator	category levels	associated value	number of sales	meaning
NEARBY	0	no	138	Is there any feedlot within three miles?
	1	yes	154	
SWINE	0	no	160	Are there any swine feedlots within three miles?
	1	yes	132	
LAGOON	0	no	194	Are there any feedlots that use lagoons within three miles?
	1	yes	98	
DISTANCE	0	0 - 1	7	Miles to nearest feedlot of any type or size.
	1	1 - 2	97	
	2	2 - 3	50	
	3	3 +	138	
SIZE	0	0	138	Total number of animal units on all feedlots within three miles combined.
	1	1 - 1,000	34	
	2	1,000 - 10,000	102	
	3	10,000 +	18	
NUMBER	0	0	138	Total number of feedlots of any type or size within three miles.
	1	1 - 10	147	
	2	10 +	7	
NORTHWEST	0	no	250	Are there any feedlots of any type or size located northwest of the property within three miles?
	1	yes	42	

Results

Table 6 summarizes the results from adding each of the proximity indicators independently to the basic model. All proximity indicators "mattered," in that their associated t-value was greater than the critical value. The conclusion is striking: for this study area, nearby feedlots do influence property values -- positively. On average, nearby feedlots are associated with higher property values. This is true over the whole range of indicators, not just in isolated instances.

Table 6: Estimated coefficients for proximity indicators, added individually

indicator	estimated coefficient	standard error	t-value
NEARBY	1.9	0.5	3.8
SWINE	1.9	0.5	3.6
LAGOON	1.8	0.5	3.3
DISTANCE	-1.3	0.3	-4.8
SIZE	0.9	0.2	3.4
NUMBER	1.7	0.5	3.7
NORTHWEST	2.2	0.7	3.2

Discussion

Table 7 lists the parameter estimates that permit a judgment about whether the statistically significant estimates listed in Table 6 are economically significant. This we accomplish by comparing the estimate with its proportional (and marginal) effect on property values. For example, the estimate for the NEARBY indicator's coefficient is 1.9. This can be interpreted as the amount the estimated (transformed) price would change if a particular house that has no nearby feedlots were to instead have a feedlot (of any sort, of any size, in any direction, etc.) within three miles. At the mean transformed value for PRICE (29.0), the proportional price effect of the new feedlot would therefore be 1.9 divided by 29.0, or 6.6%. This is equivalent to a $1,750 change in the $26,500 median house price.

The table lists the proportional effects for each indicator. Because the response variable price has been transformed, the calculated effect will vary with the price of the house. To suggest the range of such effects, we report value-effects estimates for houses at the 25% and 75% quartiles of the distribution of the untransformed price variable, equivalent to $14,000 and $44,000 houses.

.

Table 7: Change in property prices due to incremental change in proximity indicator

indicator	categories	estimated coefficient	percent change (at 25% / 75%)	price change (at 25% / 75%)
NEARBY	no, yes	1.9	8.2 / 5.6	1,150 / 2,450
SWINE	no, yes	1.9	8.2 / 5.6	1,150 / 2,450
LAGOON	no, yes	1.8	7.7 / 5.3	1,100 / 2,300
DISTANCE	0-1, 1-2, 2-3, 3+	-1.3	-5.6 / -3.8	-800 / -1,650
SIZE	0, 1-1000, 1000-10000, 10000+	0.9	3.9 / 2.6	550 / 1,150
NUMBER	0, 0-10, 10+	1.7	7.3 / 5.0	1,000 / 2,200
NORTHWEST	no, yes	2.2	9.4 / 6.5	1,300 / 2,850

The estimated coefficients for the proximity indicators that have other than 0/1 values are interpreted like continuous variables in regression models. For example, the -1.3 estimated coefficient for the DISTANCE indicator is the decrement to the transformed price variable associated with a change in the property's status from having the closest feedlot located within a mile to having it located between one and two miles, or from 1-2 to 2-3 mile status. Similarly, the coefficients for the SIZE and NUMBER indicators are interpreted as the change in property value associated with a change to the next higher category for that indicator. Downward movement among categories calls for use of the opposite sign, of course.

In our judgment, these property value effects are not "small." Simply adding a feedlot to the northwest of a house, for example, adds 9.4 % on average to a lower-price house's value. Or adding a feedlot a mile closer than an existing feedlot results in a $1,650 increase for a higher-price house. We cannot dismiss these influences as insubstantial. Their sources must be examined further.

The NEARBY indicator, which reflects whether or not there is any feedlot of any type or size within three miles of the house, itself captures all of our findings, so we use it next to identify those properties that most strongly influence the revealed feedlot-value relationship. We do this by fitting models separately for each value of three 0/1 indicators: age of the house, price of the property, and location of the property. Specifically, we create two new variables and re-use one from before:

OLDER:	1, if built before 1945
	0, if built after 1945
LOWPRICE:	1, if under $26,500 (the median of the sample price distribution)
	0, if over $26,500
TOWNSHIP:	1, if located in township
	0, if located in city

We refit the basic property model plus the NEARBY indicator using in sequence, only the older houses, only the newer houses, only the lower priced houses, and so forth. The estimated coefficient on the NEARBY indicator plus its standard error then help us isolate any notable drivers of our results. Table 8 shows the results of these "segmented" models. They are separated into two groups: those models that show a strong relationship between the NEARBY variable and the sales price, and those that do not.

Table 8: Estimated coefficients for NEARBY indicator in segmented models

model using only houses that are:	number of sales	estimated coefficient	standard error	t-value
older	173	2.9	0.7	4.4
lower priced	147	1.8	0.5	3.6
city	259	1.9	0.5	3.6
lower/older	115	1.5	0.6	2.5
lower/older/city	112	1.4	0.6	2.4
newer	119	0.4	0.7	0.5
higher priced	145	0.5	0.5	0.9
township	33	2.2	1.7	1.3
newer/higher	87	-.8	0.6	-1.3
newer/higher/township	16	-2.0	3.4	-0.6

The residential properties that most clearly are affected by nearby feedlots (indicated by t-values greater than 2.0 or so) tend to be older, lower priced, or located in the small cities that account for most of the sales in the study area. Focusing on the variables jointly reaffirms that older, lower priced houses tend to be the ones that are most affected by feedlot proximity. (Almost without exception, these houses are located in the small cities, as examination of the tabulation in Table 9 indicates. Half of the township houses in the data set are newer and higher priced.) Newer, non-city, or higher priced houses do not appear to be affected by feedlot proximity in the two-level housing market that characterizes the study area. The sign on the “newer/higher” combination is suggestive of a negative effect of feedlot proximity on this type of house, but the t-value is too small for us to classify this effect as “significant” under the criterion used in this study.

Table 9: Cross tabulation of segmentation variables (number of houses)

	older/lower price	**newer/higher price**	**other**	**total**
city	131	94	34	259
township	6	17	10	33
total	137	111	44	292

Is the relationship real?

While many causal factors could plausibly be put forward to explain the positive proximity effect, our simply observing that effect can't tell us which factor or factors actually did cause it. Why might houses nearer feedlots sell for more, on average? It might be that feedlot owners are buying nearby residences, either to provide housing for their own workers or to remove from use those properties whose new owners might complain about the feedlot's operations. Or it might be that feedlot workers are buying nearby houses in order to live nearer to their jobs. In either case, if these purchases tend to be at higher than typical prices, and if there are a substantial number of them, then the observed pattern of prices might result.

It could be, however, that there really is a negative (or neutral) effect, but our analysis caused us to miss it. In particular, suppose that houses near feedlots are more difficult to sell because of odors or some other negative effect. Had these houses sold, the price would have been less than the owners desired, so they might be withdrawn from the housing market more often than houses farther away from feedlots. Under these conditions, the set of observed sales would incorrectly give the appearance that proximity to a feedlot increases sales price.

Conclusion

Even with our "simpler" presentation of the statistical results, we have clearly answered the central question posed at the outset. The results do surprise us. Most anecdotal evidence and some appraisal studies seemed to point in the opposite direction. So did the two other property sales studies discussed earlier. We'd expected to find either negative or at least non-positive influences in the present study as well. It is of some interest, in light of these findings, that the Michigan study noted a similar result in passing, but quickly explained it away as an artifact of the analysis procedure. We cannot so casually put this evidence aside. Additional investigations may prove instructive. For that purpose, the authors have assembled similar data sets for Blue Earth County. These could be used for a second phase of this study, should additional funding permit.

Until or unless other geographic areas are examined, we are left with the fairly strong suggestion that nearby feedlots positively influence property values in Minnesota.

Sources

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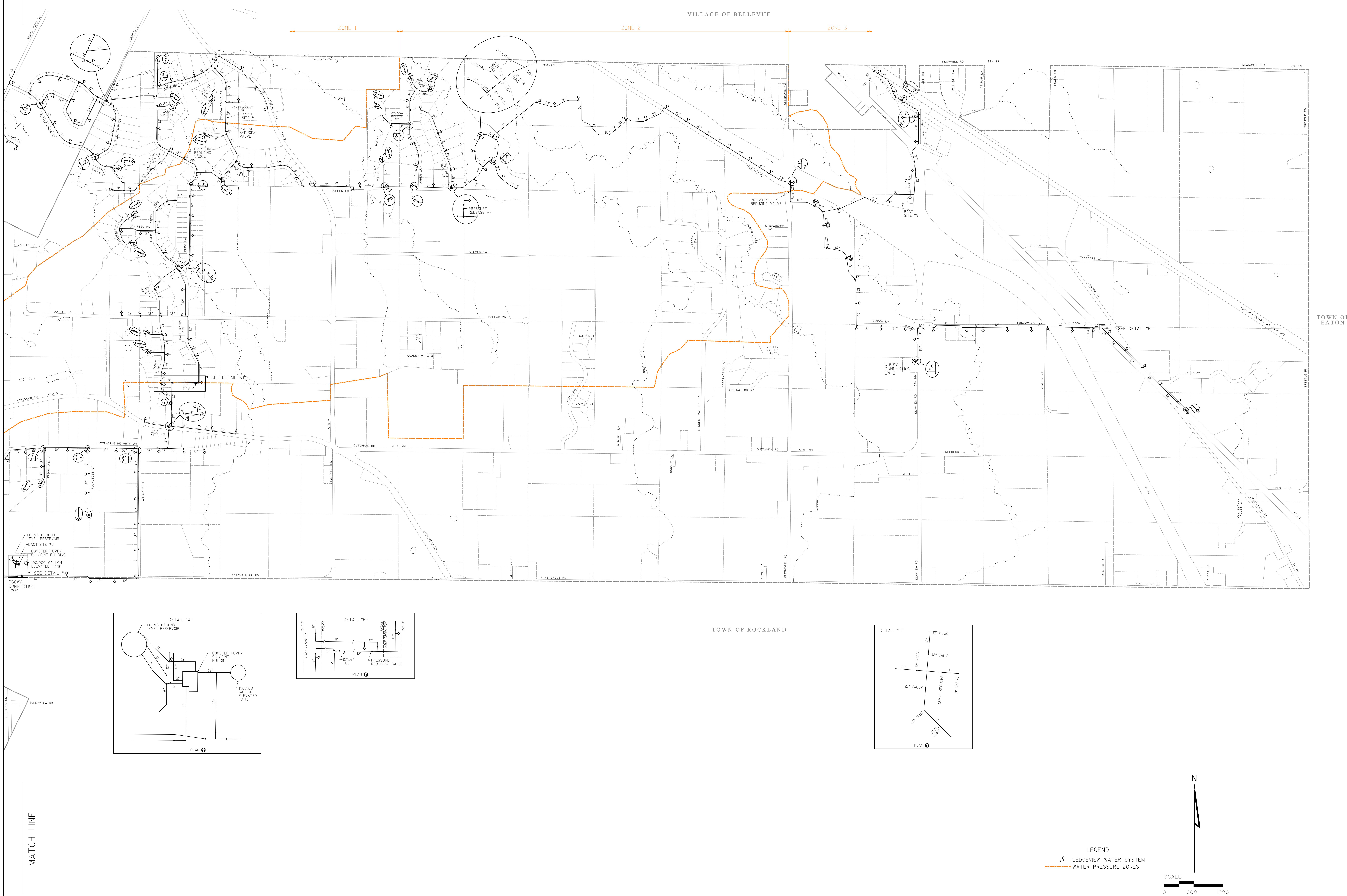
TOWN OF LEDGEVIEW
MASTER WATER SYSTEM MAP



memorandum

To: Ledgeview Town Board
From: Dustin Wolff, AICP, Town Planner
Cc: Corey Kimps, Attorney
Scott Brosteau, PE, Town Engineer
Date: August 3, 2017

RE: CAFO Approval Processes and Livestock Facility Siting Law

The following is a summary from various sources of the key components to the evaluation and approval for expanding and siting livestock operations and facilities. Please note that this is only a brief primer on the issues, touching on a number of the "high points" as they may apply. This issue is quite complex and there are tomes of information available.

OVERVIEW OF WDNR CONCENTRATED ANIMAL FEEDING OPERATION (CAFO) EVALUATION

A Wisconsin animal feeding operation with 1,000 animal units or more is a CAFO. The WDNR may designate a smaller-scale animal feeding operation (fewer than 1,000 animal units) as a CAFO if it has pollutant discharges to navigable waters or contaminates a well.

The US EPA delegates implementation of the Clean Water Act and Federal Non-Point Discharge Elimination System (NPDES) CAFO permit program to the WDNR. Wisconsin implements the water quality protection permit program by requiring that CAFOs have a WDNR approved Wisconsin Pollutant Discharge Elimination System (WPDES) permit in place when they to operate. CAFO WPDES permits ensure farms use proper planning, nutrient management, and structure/system construction to protect Wisconsin waters. These permits apply only to water quality protection. They do not give the WDNR authority to address air, odor, traffic, lighting, land use nor any of the social concerns people may have about large farms. [SEE ATCP 51]

In summary:

- If an operation is or plans to become a CAFO, it must have a WPDES permit. Twelve months before an operation becomes a CAFO, it must begin the WPDES permit application process.
- There is a "zero" discharge standard for runoff to navigable waters from CAFO animal production areas (areas where animals are housed or otherwise confined, manure is stored and feed is stored).
- WDNR reviews and approves plans and specifications for reviewable facilities (e.g. manure and process wastewater storage and handling systems).
- CAFOs must be prepared for manure and non-manure spills by developing a response plan and must properly dispose of animal carcasses.
- CAFOs, as part of the permit process, must develop and implement a nutrient management plan.
- Six months of liquid manure storage is required.

- Visual inspection, monitoring and reporting requirements by the farm operator are included in the WDNR CAFO Compliance Calendar for development of the annual report to the WDNR. Enforcement is under WDNR jurisdiction, and the local municipality has not authority.

  Daily Inspections

  - Inspect water lines that could potentially come into contact with pollutants or drain to storage, containment structures or runoff control structures for leakage. Examples of these water lines include cattle waterers or sprinklers.

  Weekly Inspections

  - Stormwater controls to ensure proper operation of all stormwater diversion devices.
  - Runoff controls to ensure proper operation of all devices channeling contaminated runoff to storage or containment structures.
  - Storage/containment inspections of liquid storage and containment structures for: leakage, seepage, erosion, cracks and corrosion, rodent damage, excessive vegetation and other signs of structural weakness.
  - Read depth marker and record the level of material in all liquid storage and containment facilities. Record in feet or inches above or below the margin of safety level.

  Quarterly Inspections

  - Production area inspections including outdoor animal pens, barnyards, raw material storage areas and CAFO outdoor vegetated areas.
  - A quarterly summary of inspections is required to be submitted with the annual report. A copy of the calendar properly completed can be included as part of the annual report. The WDNR may request additional information if needed.

An Environmental Assessment (EA) is required when you are developing a new site or you are significantly increasing the number of animal units at your site and WDNR action is required (e.g., plan review for a proposed manure storage structure). Applicants prepare an Environmental Analysis Questionnaire and submit it to the WDNR regional agricultural runoff specialist contact as part of the final application. WDNR staff use the questionnaire and the other portions of the WPDES permit application to prepare the EA. Operations that qualify for coverage under the Large Dairy CAFO WPDES General Permit may not need an EA and your regional agricultural runoff specialist makes that determination.

OVERVIEW OF WISCONSIN'S LIVESTOCK FACILITY SITING LAW (ATCP 51, WIS. ADMIN. CODE)

The statute itself was enacted in 2004 by the Department of Agriculture, Trade, and Consumer Protection (DATCP). It must be noted that the Siting Law is heavily biased in favor of the rapid expansion of CAFOs, and significantly restricts the ability of local governments to direct the location of new livestock facilities through zoning or protective ordinances. The Siting Law does not provide communities any additional authority to manage the growth of livestock operations than they may have had prior to the law's passage.

A municipality <u>must enact a siting ordinance</u> to even gain access to the uniform state standards of the Siting Law; the Law is does not automatically apply. “The livestock facility siting law does not require local approval. But if local approval is required, the political subdivision must grant or deny approval based on [the siting law].” <u>If there is no local siting ordinance, the standards found in the Siting Law are meaningless and offer no opportunity for communities to use the regulations</u>. This was confirmed in a conversation with Christopher Clayton at DATCP. Note that an operation must have at least 500 animal units for the Siting Law to apply. Also, for the Law to apply to an expanding operation, the expansion must be at least 20-percent; for example, an increase from 500 AU to 600 AU (about 70 cows).

Setback Requirements

The setback requirements address the location of livestock structures—buildings housing animals and waste storage facilities—with respect to property lines, road right-of-ways, and for the protection of surface and ground water resources. There are not state-mandated setback requirements. <u>The Law establishes a state maximum which local governments may not exceed</u>.

<u>Property line setbacks</u>

- Up to 100 feet from a property line for facilities <1000 AU
- Local setbacks, up to 200 feet from a property line for facilities >1000 AU
- At least 350 feet from a property line for a new waste storage structure

<u>Road right-of-way setbacks</u>

- Up to 100 feet from public road right-of-way for facilities of <1000 AU
- Up to 150 feet from public road right-of-way for facilities with >1000 AU
- At least 350 feet from a public road right-of-way for a new waste storage structure

<u>Other required setbacks</u>

- 250 feet from a private well.
- 1,000 feet from a municipal well.
- 300 feet upslope or 100 feet downslope of a karst feature.

Odor and Air Emissions

Certain facilities covered by the Siting Law must comply with an odor standard that uses a predictive model to determine acceptable odor levels from the farm structures. The odor standard does not apply if all structures are at least 2,500 feet from the nearest neighbor, or for an expanding facility until it reaches 1,000 AU. DATCP is responsible for evaluating and enforcing odor emission standards and practices. Local municipalities do not have the authority in this area.

A maximum calculated “odor score” is required using the DATCP developed model. The score is based primarily on:

- Predicted odor from livestock structures.
- Separation distance from those structures to the nearest affected neighbor.
- Management practices used to control odor.

Note that the Siting Law does not provide authority to monitor and regulate air emissions. In the future, livestock farms may be required to meet air emission standards for hydrogen sulfide and ammonia under the DNR air toxics rule NR 445, Wis. Admin. Code.

Nutrient Management

Manure is required to be managed and land-applied consistent with technical guidelines established by the USDA. These guidelines dictate how, when, and where manure may be spread on land. The goal of these standards is to “minimize nutrient entry into surface water, groundwater, and atmospheric resources while maintaining and improving the physical, chemical, and biological condition of the soil.” Brown County, in conjunction with the WNDR, enforce their ordinances and statutes, respectively.

County ordinances require a permit for new or modified manure storage structures, ensuring design and construction according to NRCS technical standards. A nutrient management plan must be developed to ensure that stored manure is properly land applied. County Land & Water Conservation Departments help farmers identify special design considerations for sensitive sites, as well as explain other County requirements such as winter manure spreading plans. [SEE WDNR REQUIREMENTS] Through a siting permit (conditional use permit) a municipality can reinforce compliance with local codes and regulations.

More Restrictive Standards

Bayfield County is trying to enact its own, more stringent siting standards in relation to water quality standards, but the WDNR rejected the proposed ordinance. Standards more stringent than the state standards must “be based on reasonable and scientifically defensible findings of fact,” and “clearly show that the standards are needed to protect public health or safety.” The DNR filed a response through their attorneys, and Bayfield County submitted a response to the Courts in May countering the WDNR’s reasoning behind denial of the ordinance. At this time, Bayfield County and the WDNR have begun formal settlement talks over the ordinance. This is an outcome the Town should watch, but Brown County should be the entity to adopted stricter standards if permissible.