Appendix B - ***Animal Housing***

Established Practices – pages 2 - 18
Demonstration Practices – pages 19 - 28

Biofilter

Description: A biofilter is a system receiving exhaust air from animal housing, head space air from enclosed manure storage, or any other mechanically-ventilated structure, and passes it through some type of moistened porous media, so microorganisms can biologically treat the airstream.

Rationale: Biofilter media treats contaminated air both physically and biologically. Physical treatment occurs when contaminants (such as gases, aerosols and small particles) are trapped on the media surface and/or absorbed into the moist biofilm. Biological treatment occurs when microbes in the biofilm degrade contaminants into carbon dioxide (CO2), water (H2O), mineral salts, volatile organic compounds (VOCs) and microbial biomass. The microbial action is what differentiates a biofilter from a simple filter or scrubber.

Conventional Baseline Practice: The baseline practice for comparison is untreated air from mechanically-ventilated systems.

☒ Established ☐ Demonstration

Farm Component:

- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☒ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes: Applicable to mechanically ventilated or targeted to pit fans

Animal Type:

- ☒ Bovine
- ☒ Swine
- ☒ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

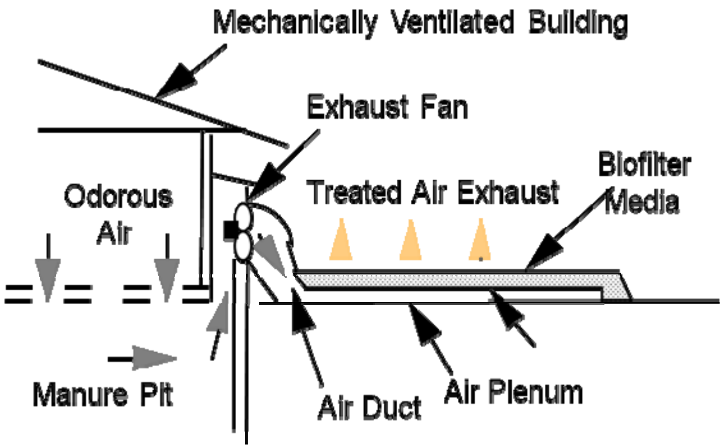
- ☒ Ammonia 60 % Notes: of air treated by the biofilter
- ☒ Hydrogen Sulfide 90 % Notes: of air treated by the biofilter

Other Air Quality Considerations Potential reductions in particulare matter, VOCs, and odors

Engineering, O&M requirements: The percent control must be prorated according to the volume of air treated. Applicable to mechanically ventilated buildings or other facilities including animal housing, manure handling (such as solids separation), head space above impermeable storage basins, pit fans. See design information published by University of Minnesota Extension referenced below.

In general, the air should be in contact with this porous media from 3 to 5 seconds (defined as empty bed contact time) and the media should be maintained between 30 to 50% moisture by weight. Biofilters used to treat air from livestock barns include moist biofilm, covered support media, ductwork, distribution plenum, and fans. The below figure shows a flat-bed biofilter treating air from a livestock barn with a below ground manure pit. The moist, biologically-active biofilm is where gases in the air are absorbed and broken down before the air leaves the biofilter. Ductwork connects the fan to the air source and a plenum where the air is distributed evenly to the media. Fans are required to draw air from the barn and push it through the ductwork and media.

Develop and implement an operation and maintenance plan that is consistent with the purposes of this practice, its intended life, safety requirements, and the criteria used for its design. Operate and maintain the device or system in accordance with the manufacturer's recommendation if applicable. Biofilters need to have required maintenance, especially moisture added in warm weather plus weed control periodically. Prevent rodents and burrowing wild animals from digging holes which can short circuit airflow from source directly to outside without being treated.



Confirmation that BMP is working:

☒ Record Keeping — Notes:

- ☒ O&M — Frequency:
- ☒ Design/construction documents
- ☐ Other specify — Frequency:
- ☒ Visual Inspection — Frequency: Quarterly for verification and performance

☒ Monitoring — Notes:

Parameter: pressure drop per manufactuers specification — Frequency:semi-annually

Parameter: ammonia and/or hydrogen sulfide — Frequency:as needed

Additional Considerations, references: NRCS Conservation Practice Standard 371 - Air Filtration and Scrubbing

Composting Manure with Proper C:N ratio

Description: Composting manure can reduce emissions of both hydrogen sulfide and odor, if done correctly. Properly managed compost piles will maintain aerobic conditions, which will be unfavorable for the production of hydrogen sulfide. (Composting increases ammonia emissions relative to a stacked manure pile.)

Rationale: A higher carbon to nitrogen (C:N) ratio creates bulking, which allows air to be incorporated into the compost. This, in turn, creates aerobic conditions, reducing the formation of hydrogen sulfide and not increasing the formation of ammonia, relative to other composting methods.

Conventional Baseline Practice: The baseline practice for comparison is solid manure stacked outdoors and not turned or actively managed for composting. Liquid manure slurry is a baseline for comparison as well.

☒ Established ☐ Demonstration

Farm Component:

☐ Nutrition and/or Feed Management
☒ Housing
☒ Storage & Treatment
☐ Open Lots/Corrals
☐ Land Application

Notes: Could apply to compost barns or other housing with combined manure storage

Animal Type:

☒ Bovine
☒ Swine
☒ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

☐	Ammonia		%	Notes:	
☒	Hydrogen Sulfide	30	%	Notes:	Keeps manure aerobic and hence H2S reduced

Other Air Quality Considerations Composting, even with proper C:N ratio compost, has substantial nitrogen loss; especially ammonia. In general, composting, when compared to a static heap or pile, may increase ammonia emissions, particularly if carbon to nitrogen ratios are not adjusted as described above. The greater the C:N ratio, the less ammonia will be emitted.

Engineering, O&M requirements: This practice must be prorated based on the percent of the manure waste stream composted, on a dry matter basis.

Composting manure at the proper carbon-nitrogen ratio requires laboratory testing of manure, recipe formulation, compost monitoring, management of the composting process, and proper record keeping to track the composting process. Because manure nitrogen, carbon, and moisture contents vary dramatically from one farm to another, manure samples should be collected and submitted to a Wisconsin-certified laboratory for analysis at least annually. The manure sample submitted for lab analysis should be a composite of multiple samples. Manure should be thoroughly mixed prior to collection of subsamples. When possible, collect manure samples from hauling equipment rather than from in the barn. If samples are not immediately shipped, they should be frozen or refrigerated to minimize losses or changes in nutrient content. For more information on manure sampling see publication A3769 Recommended Methods for Manure Analysis.

Manure test results can be used to determine compost recipes using computer spreadsheets, such as the Spartan Compost Optomizer, or by using compost recipe formulas like those described in the On-Farm Composting Handbook (NRAES-54). Regardless of recipe formulation method, the final mixture prior to composting should have the following characteristics: carbon to nitrogen ratio 25:1 to 40:1, moisture content 40 to 65%, pH 5.5 to 9, and bulk density <40 pounds per cubic foot.

After recipes are determined, materials mixed, and composting operations begun, the temperature of the compost should be monitored and recorded weekly. During active composting, internal compost pile temperatures should range from 130 to 150 degrees Fahrenheit. Lower temperatures indicate either that the composting process is complete, or there are problems with the composting process, such as excess moisture. Active composting can be complete in a matter of days for rotating drums, or two years for passive composting. Detailed guidance on manure composting methods is described in On-Farm Composting Handbook (NRAES-54) and The Art and Science of Composting.

<u>Confirmation that BMP is working:</u>

☒ Record Keeping — Notes: See monitoring note below
- ☐ O&M — Frequency:
- ☐ Design/construction documents
- ☐ Other specify — Frequency:
- ☒ Visual Inspection — Frequency: Monthly

☒ Monitoring — Notes:
- Parameter: C:N ratio — Frequency: Direct measurement on a monthly basis
- Parameter: — Frequency:

<u>Additional Considerations, references:</u> NRCS Conservation Practice Standard 317 - Composting Facility, and s. NR502 Wisconsin Administrative Code.

Vegetative Environmental Buffer (VEB)

Description: This practice is a shelterbelt or windbreak of vegetation (trees and shrubs) that deflects and/or adsorbs air contaminates that are emitted from either an animal building or a manure storage basin or pad.

The following are design and maintence considerations for a vegetative environmental buffer.

- A three row vegetative environmental buffer (shelterbelt) incorporating three different tree species is best. Using a row of shrubs (e.g., chokecherry and elderberry), a row of tall growing conifers (e.g., eastern white pine and northern white cedar), and a row of fast growing deciduous trees (e.g., hybrid poplar) is recommended..
- Trees and shrubs should be vigorous and well-suited for the site.
- Locate the vegetative shelterbelt 75 to 100 feet both upwind and downwind from the source (no more than 200 feet away). Ideally the VEB should extend around the entire perimeter of the source of emissions i.e., housing, manure storage or open lot/corral.
- Plants should have 40% to 60% porosity. Porosity expresses how dense the foliage is and is quantified by the simple ratio of plant surface area to the total area.
- Irrigation and weed control are essential to insure plant survivability and maximize early growth
- Trees and shrubs, used as a VEB, must be replanted after 10-15% total plant mortality occurs.
- A long-term plan shall be in place for maintaining the vegetative shelter belt

Rationale: Vegetative environmental buffers can filter, trap, and disperse air pollutants.

Conventional Baseline Practice: The baseline practice for comparison is the absence of any vegetative environmental buffer (trees or shrubs) near the emission source

☒ Established ☐ Demonstration

Farm Component:

☐ Nutrition and/or Feed Management
☒ Housing
☒ Storage & Treatment
☒ Open Lots/Corrals
☐ Land Application
Notes:

Animal Type:

☒ Bovine
☒ Swine
☒ Poultry
Notes:

Air Toxic Emission Reductions - specific to farm component

☒ Ammonia 10 % Notes:
☒ Hydrogen Sulfide 10 % Notes:

Other Air Quality Considerations May reduce particulate matter, volatile organic compounds and odor

Engineering, O&M requirements: In addition to newly planted VEBs, existing, appropriately-designed, VEBs may be considered for emission reductions.

Confirmation that BMP is working:

☒ Record Keeping Notes:

- ☒ O&M Frequency:
- ☐ Design/construction documents
- ☐ Other specify Frequency:
- ☒ Visual Inspection Frequency:

☐ Monitoring Notes:

Parameter: Frequency:

Parameter: Frequency:

Additional Considerations, references: See NRCS Conservation Practice Standard for Wisconsin 380 - Windbreak/Shelterbelt Establishment, and Practice Standard 650 -Windbreak/Shelterbelt Renovation.

The design of the VEB should consider adverse impacts including snow deposition and restriction of natural air flow.

Mechanical Scraping

Description: The practice is mechanical scraping, with no more frequency than is necessary, of accumulated manure from dairy freestall housing.

Rationale: Greater mixing of feces and urine by frequent scraping increases urease activity (and also increases the emitting surface area) and therefore ammonia formation and loss. Flushing with slurry releases more ammonia and hydrogen sulfide than operations using mechanical scraping.

Conventional Baseline Practice: The baseline practice for comparison is a flush freestall barn, using recycled water from the manure storage facility.

☒ Established ☐ Demonstration

Farm Component:

- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☐ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:

- ☒ Bovine
- ☐ Swine
- ☐ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

☒	Ammonia	20	%	Notes:
☒	Hydrogen Sulfide	20	%	Notes:

Other Air Quality Considerations More frequent scraping of freestall housing, than the minimum that is necessary, increases ammonia emissions within the housing component.

Engineering, O&M requirements:

Confirmation that BMP is working:

☒ Record Keeping Notes:

- ☐ O&M Frequency:
- ☐ Design/construction documents
- ☐ Other specify Frequency:
- ☒ Visual Inspection Frequency:

☐ Monitoring Notes:

Parameter: Frequency:

Parameter: Frequency:

Additional Considerations, references: See NRCS Conservation Practice Standard 634 - Waste Transfer.
Until studies prove that emission reductions are also achieved with vacuuming of manure, vacuuming is not be included in this practice.

Vegetable oil sprinkling (for swine only)

Description: This practice entails sprinkling vegetable oil in the barn on manure and other housing surfaces. Vegetable oil sprinkling systems consist of a pump, supply line, nozzles and timer that sprinkles vegetable oil in a barn each day. Initial application rate of 40 mL/m2/day for first 1 to 2 days and then a maintenance rate of 5 mL/m2/day. This application rate will generally be accomplished by activating the system for only 30 to 60 seconds per day depending on the pump's flowrate. Oils that may be used include soybean, canola, corn, sunflower, etc.

Rationale: This practice suppresses gases and dust, thereby reducing emissions.

Conventional Baseline Practice: The baseline practice for comparison would be no oil sprinkling within swine housing.

☒ Established ☐ Demonstration

Farm Component:

- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☐ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:

- ☐ Bovine
- ☒ Swine
- ☐ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

- ☒ Ammonia 20 % Notes:
- ☒ Hydrogen Sulfide 20 % Notes:

Other Air Quality Considerations

Engineering, O&M requirements: Nozzles must be inspected and cleaned weekly to ensure they are not plugged.

Confirmation that BMP is working:

- ☒ Record Keeping Notes:Weekly documentation of oil nozzle inspection and cleaning.
  - ☒ O&M Frequency:
  - ☒ Design/construction documents
  - ☐ Other specify Frequency:
  - ☒ Visual Inspection Frequency:

- ☐ Monitoring Notes:
  Parameter: Frequency:

Parameter: Frequency:

Additional Considerations, references:

Swine Housing - Wall or Ceiling Ventilated

Description: This practice entails the transfer of the air exchange provided by pit exhaust fans to exhaust fans located in the walls or ceiling of the barn. This means either physically moving all pit fans to the walls or ceiling of the barn (exhaust from the animal space and NOT the manure pit space) or rendering the pit fans inoperable, so they neither will exhaust air or allow air to backdraft through their shutters (sealed). This practice applies to both fully mechanically ventilated and "curtain sided" pig barns.

Rationale: Elimination of pit fan exhaust air reduces ammonia and hydrogen sulfide emissions.

Conventional Baseline Practice: The conventional baseline practices for swine housing are: Sow farrowing housing or Nursery housing - well-maintained, pull-plug or shallow gutter system; Gestation - well-maintained, full-slatted deep pit, pull-plug or shallow gutter system; Grow-finishing housing - well-maintained, fully-slatted deep pit

☒ Established ☐ Demonstration

Farm Component:
- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☐ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:
- ☐ Bovine
- ☒ Swine
- ☐ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component
- ☒ Ammonia 20 % Notes:
- ☒ Hydrogen Sulfide 20 % Notes:

Other Air Quality Considerations: This practice may also reduce particulate matter and odors.

Engineering, O&M requirements: With the elimination of pit fans, adequate ventilation air flow must be maintained in the animal housing space through wall, ceiling, or other ventilation methods.

Confirmation that BMP is working:
- ☒ Record Keeping Notes:
  - ☐ O&M Frequency:
  - ☐ Design/construction documents
  - ☐ Other specify Frequency:
  - ☒ Visual Inspection Frequency:

☐ Monitoring Notes:

Parameter: Frequency:

Parameter: Frequency:

Additional Considerations, references: Other management practices, such as biofilters and bioscrubbers, may be used on pit and housing ventilation systems, providing substantially greater emission reductions than elimination of pit fans.

Binding Ammonium - Alum Treatment of Poultry Litter

Description: This practice includes the liquid or dry application of alum to broiler or turkey floor litter. Alum treatment is accomplished by either spraying directly or sprinkling alum amendments with an automated system, generally once a day, to poultry floor litter. Alum must be applied in accordance with manufacturer's recommended application rate and frequency.

Rationale: Alum reduces the litter pH and inhibits transformation of ammonium into ammonia.

Conventional Baseline Practice: The baseline practice for comparison is manure and litter without alum treatment.

☒ Established ☐ Demonstration

Farm Component:
- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☐ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:
- ☐ Bovine
- ☐ Swine
- ☒ Poultry

Notes: Broilers, turkeys, not layers

Air Toxic Emission Reductions - specific to farm component

☒	Ammonia	40	% Notes:	for amended litter
☐	Hydrogen Sulfide		% Notes:	potential increase

Other Air Quality Considerations With the reduction of pH, hydrogen sulfide emissions may increase

Engineering, O&M requirements: Emissions reduction will be prorated based on the percentage of floor space and numbers of animal housing treated. Use alum at manufacturer's recommended application rate and frequency. (Rate of application is generally in the range of 0.025 to 0.05 kg alum/kg bird.)

Confirmation that BMP is working:

☒ Record Keeping Notes:
- ☒ O&M Frequency: Product description, Application rates & timing and who performs treatment per manufacturer's recommendation
- ☐ Design/construction documents
- ☐ Other specify Frequency:
- ☒ Visual Inspection Frequency:

☐ Monitoring Notes:

Parameter: Frequency:
Parameter: Frequency:

<u>Additional Considerations, references:</u> NRCS Conservation Practice Standard 591 - Amendments for Treatment of Agricultural Waste.

Also, see Chemical and Biologitcal Manure Additives Recommended Practice. Binding ammonium in manure can also be accomplished with products such as zeolite or by treating litter/manure with additives such as enzymes .

Frequent Cleaning (Removal) of Poultry Litter or Manure

Description: For layers, remove manure, mortality, or other organic matter (litter) from the structure housing the animals on a timely basis (weekly minimum) and land applied or stored temporarily (less than a week) under cover. This only applies to housing where manure is not directly deposited into long-term storage, separate from the housing.

For broilers and turkeys, use new litter for each flock .

Rationale: Wet and accumulated poultry manure creates high ammonia emissions. Regular removal will reduce ammonia emissions.

Conventional Baseline Practice: The baseline practice for comparison for layers is well-maintained, high rise housing. The baseline practice for comparison for broilers and turkeys is well-maintained, built-up litter, where litter is stacked outside of barns temporarily.

☒ Established ☐ Demonstration

Farm Component:
- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☐ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:
- ☐ Bovine
- ☐ Swine
- ☒ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component
- ☒ Ammonia 30 % Notes:
- ☐ Hydrogen Sulfide % Notes:

Other Air Quality Considerations

Engineering, O&M requirements: Appropriate cleaning frequencies could vary based on design of barns and species. This practice will be prorated based on the number of houses managed in this manner. Ensure manure and litter is removed and stored in accordance with covered solid manure storage practice.

Confirmation that BMP is working:
- ☒ Record Keeping Notes: Time & date manure or litter removed from housing.
  - ☒ O&M Frequency:
  - ☐ Design/construction documents
  - ☐ Other specify Frequency:
  - ☒ Visual Inspection Frequency:

☐ Monitoring Notes:
Parameter: Frequency:
Parameter: Frequency:

Additional Considerations, references: The Wisconsin Poultry Producers' Odor/Air Emissions Reduction Best Management Practices (BMPs) document from 2001 was reviewed by the Swine & Poultry Subgroup and relevant practices were incorporated into the recommendations.

Wet Scrubber/Bio Scrubber

Description: This practice treats the exhaust air from an animal building (or head space air from enclosed manure storage) and passes through a liquid (water or acid). A minimum contact time of the airstream is necessary to achieve the stated reduction, along with collection, storage and eventual treatment of the liquid (water or acid) used in the scrubber design. The air flowing through the scrubber may have either a counterflow or crossflow design.

Rationale: Wet scrubbers clean air by physically absorbing gases and trapping particulate matter in the liquid. In some cases, the gases react with chemicals in the liquid. Small liquid droplets are more effective per unit volume of scrubber liquid because they have more surface area than fewer, larger droplets. Very small liquid droplets, however, are difficult to remove from the airstream.

Conventional Baseline Practice: The baseline practice for comparison is untreated air from mechanically-ventilated systems.

☐ Established ☒ Demonstration

Farm Component:

☐ Nutrition and/or Feed Management
☒ Housing
☒ Storage & Treatment
☐ Open Lots/Corrals
☐ Land Application

Notes:

Animal Type:

☒ Bovine
☒ Swine
☒ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

☒ Ammonia % Notes: Up to 90% but requires further demonstration
☒ Hydrogen Sulfide % Notes: Up to 90% but requires further demonstration

Other Air Quality Considerations Particulate matter, VOCs and odor.

Engineering, O&M requirements: Gases are removed by absorbing the gases into the liquid, typically water. Gas solubility, which describes how easily a gas is absorbed in the scrubbing liquid, depends on concentration gradients, chemical compatibility, reactivity between gas and liquid phases, liquid temperature, pH, and contact time. Many problematic gases such as carbon dioxide, methane, and other volatile organic compounds are not readily captured by water alone due to low solubility at ambient conditions. Ammonia, an 'acid soluble' gas, is more easily absorbed in water at low (acidic) pH. Hydrogen sulfide is a 'base soluble' gas. To remove hydrogen sulfide, a base like hypochlorite, is added to raise water pH, increase hydrogen sulfide absorption, and react with (oxidize) the hydrogen sulfide in solution. The oxidation reaction is an important part of absorbing hydrogen sulfide. If both acid soluble and base soluble chemicals need to be removed from the air, two wet scrubbing stages may be required. The main drawbacks of adding an acid or base to the scrubbing water are chemical costs, increased corrosion potential and difficulties in handling chemicals safely. Plain water and a very long contact time could be used but this requires building a larger scrubber.

Verify that system is designed to match mist delivery to ventilation airflow rate, and that system is maintained to avoid clogging, corrosion, microbial growth. Scrubber needs to have required maintenance, especially if other than water (acid or base) is used.

<u>Confirmation that BMP is working:</u>

- ☐ Record Keeping   Notes:
  - ☐ O&M   Frequency:
  - ☐ Design/construction documents
  - ☐ Other specify   Frequency:
  - ☐ Visual Inspection   Frequency:

- ☐ Monitoring   Notes:
  - Parameter: Frequency:
  - Parameter: Frequency:

<u>Additional Considerations, references:</u> NRCS Conservation Practice Standard 371 - Air Filtration and Scrubbing;
While adoption of this technology is limited currently in agricuture, the technology is well-established in other industries.

Urine-feces Segregation

Description: This practice is accomplished by a specific floor design in the animal building that results in the immediate separation of feces and urine. Typically this is done by designing a low angle sloping floor under a slatted floor, so that urine will drain off quickly to a center or outside channels, while the feces are physically removed to a separate storage area by a scraper or other physical method.

Rationale: Separating urine (containing urea) from feces immediately eliminates mixing of urine with feces, which contain the enzyme urease. Urease quickly converts urinary nitrogen into ammonia.

Conventional Baseline Practice: The baseline practice for comparison is solid floor animal housing.

☐ Established ☒ Demonstration

Farm Component:

- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☐ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:

- ☒ Bovine
- ☒ Swine
- ☐ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

- ☐ Ammonia % Notes: Requires further investigation
- ☐ Hydrogen Sulfide % Notes: Requires further investigation

Other Air Quality Considerations

Engineering, O&M requirements: This practice requires separate storage and management for the liquid (urine) and solid (feces) fractions of the manure

Confirmation that BMP is working:

- ☒ Record Keeping Notes:
  - ☒ O&M Frequency:
  - ☒ Design/construction documents
  - ☐ Other specify Frequency:
  - ☒ Visual Inspection Frequency:

- ☐ Monitoring Notes:

Parameter: Frequency:
Parameter: Frequency:

<u>Additional Considerations, references:</u> If properly designed, ammonia and hydrogen sulfide prevention may be significant (i.e., 40-60 % and 20-40%, respectively).

The sub-floor systems should be designed with consideration of safe handling and transport of manure and manure gases.

See Manure Gas Safety Review of Practices and Recommendations for Wisconsin Livestock Farms, November, 2008.

Chemical or Biological Manure Additives

Description: This practice includes the application or incorporation of chemically or biologically active products to accumulated or stored manure solids or liquids to reduce ammonia and/or hydrogen sulfide emissions. Typical modes of action are urease inhibitors, enzymes, pH regulators, oxidizers, and precipitation enhancers.

For poultry, controlling ammonia release from litter is commonly practiced for bird health. Binding ammonium in manure can also be accomplished with products, such as zeolite, or by treating litter/manure with additives such as enzymes. The method to apply and quantity used would depend on the product and would need to follow the manufacturer's recommendation. In this category are litter amendments which can include microbial products that may be applied to litter or incorporated in animal feed.

Alum addition to poultry litter is described separately as an established practice.

Rationale: Broadly, the application of chemical or biological manure additives may reduce ammonia or hydrogen sulfide emissions.

Conventional Baseline Practice: The baseline practice for comparison is no addition of chemical or biological additives to manure.

☐ Established ☒ Demonstration

Farm Component:

- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☒ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:

- ☒ Bovine
- ☒ Swine
- ☒ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

- ☐ Ammonia % Notes: Requires further investigation
- ☐ Hydrogen Sulfide % Notes: Requires further investigation

Other Air Quality Considerations

Engineering, O&M requirements: Independent, third party scientific documentation, for the specific biological or chemical additive, must be provided.

Confirmation that BMP is working:

☐ Record Keeping Notes:
- ☐ O&M Frequency:
- ☐ Design/construction documents
- ☐ Other specify Frequency:
- ☐ Visual Inspection Frequency:

☐ Monitoring Notes:

Parameter: Frequency:
Parameter: Frequency:

Additional Considerations, references: See NRCS Conservation Practice Standard 591 - Amendments for Treatment of Agricultural Waste.

The use of strong acids by producers may require an additional safe handling certification. Sulfuric acid also increases the sulfur content of farm wastes.

pH reduction of liquid manure (acidification) could either involve a batch treatment (adding acid to the liquid manure storage) or a metering method (metering preferred, since this provides better mixing of the acid to manure) that adds a given rate as manure is transported to the manure storage. Application rate varies but final manure pH should be in the range of 4 to 5. Acidification is not a stand-alone practice for swine and bovine. This practice would likely require solids separation. The liquid portion would be treated with acid. Controlling ammonia by acidification will result in greater hydrogen sulfide emissions, especially for swine.

Some products bind ammonium or inhibit generation of hydrogen sulfide. Lower pH (goal of some chemical additions) leads to a lower proportion of aqueous ammonia and therefore, a lower potential of ammonia volatilization. Acidification does not reduce nutrients, but it does drive the formation of ammonium to ammonia ($NH_3 + H^+$ to NH_4^+) . Ammonium remains in aqueous solution.

Alum addition to bedded manure pack (for cattle) may also reduce ammonia emissions, but increase hydrogen sulfide emissions.

Chimney Exhaust/Air Impaction Methods

Description: This practice entails constructing an effective vertical chimney through which animal housing air is exhausted. The impaction of particles in the chimney may cause some particulates to drop out of the air. This practice would be specific to mechanically-ventilated animal housing and must be prorated based on the percentage of air volume treated by the system.

Rationale: Impaction of particulates within a chimney may reduce concentrations of ammonia bound on particulates from animal housing.

Conventional Baseline Practice: The baseline practice for comparison is housing without vertically-exhausting chimneys.

☐ Established ☒ Demonstration

Farm Component:

- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☐ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:

- ☒ Bovine
- ☒ Swine
- ☒ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

- ☐ Ammonia % Notes: Requires further investigation
- ☐ Hydrogen Sulfide % Notes: Requires further investigation

Other Air Quality Considerations May reduce odor and particulate matter

Engineering, O&M requirements: When designing this system, animal housing air particle size distribution, ambient air handling velocities, vertical chimney velocities, chimney height and chimney diameter must be considered.

Confirmation that BMP is working:

- ☐ Record Keeping Notes:
  - ☐ O&M Frequency:
  - ☐ Design/construction documents
  - ☐ Other specify Frequency:
  - ☐ Visual Inspection Frequency:

- ☐ Monitoring Notes:
  Parameter: Frequency:

Parameter: Frequency:

Additional Considerations, references:

Poultry Manure Drying

Description: This practice produces dry manure for egg laying operations. It requires the producer to install and properly operate equipment that is designed to produce dry chicken manure by capturing the manure on belts, or manure scraper boards, and moving the air, used to ventilate the building, over the manure surface to further dry the manure. As the manure dries, it is then conveyed or scraped into manure storage facilities or land applied.

Rationale: Increasing the Dry Matter (reducing moisture content) in poultry manure reduces ammonia emissions.

Conventional Baseline Practice: The baseline practice for comparison is a high-rise egg laying operation without scraper boards, belts, and manure drying practices.

☐ Established ☒ Demonstration

Farm Component:

- ☐ Nutrition and/or Feed Management
- ☒ Housing
- ☒ Storage & Treatment
- ☐ Open Lots/Corrals
- ☐ Land Application

Notes:

Animal Type:

- ☐ Bovine
- ☐ Swine
- ☒ Poultry

Notes:

Air Toxic Emission Reductions - specific to farm component

- ☒ Ammonia % Notes:
- ☐ Hydrogen Sulfide % Notes:

Other Air Quality Considerations

Engineering, O&M requirements: This practice could result in an ammonia reduction of up to 70% depending on the system used and the length of time the manure is stored. The ammonia emission reduction will be prorated based on the system type and proportion of manure dried.

Confirmation that BMP is working:

- ☐ Record Keeping Notes:
  - ☐ O&M Frequency:
  - ☐ Design/construction documents
  - ☐ Other specify Frequency:
  - ☐ Visual Inspection Frequency:

- ☐ Monitoring Notes:

  Parameter: Frequency:

Parameter: Frequency:

Additional Considerations, references: