Hog Confinements and Human Health: the intersection of science, morals, and law.

A Handbook for Regulating Hog Confinements.
2nd Edition
e-book www.civandinc.com

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Hog Confinements and Human Health: the intersection of science, morals, and law.

A Handbook for Regulating Hog Confinements.

Introduction:

This handbook is a request, and a how to, for help in a grassroots campaign to regulate hog confinements in Iowa. Chapter 3 will give you legislative language that, if adopted, will regulate the discharge of manure pollution from the air avenue of hog confinements. State law now says all manure must be retained in the hog confinement between disposal events. But, the courts have said that is only for the water pollution avenue of confinements. This campaign is about including the other pollution avenue, the air avenue, in that law.

It is our hope that you will use this language to help in a grassroots campaign to convince sitting legislators to adopt and introduce this air avenue language, and/or, to elect legislators who would be in favor of this language. This language, if adopted, will help protect the health of Iowans who live, work, and study in proximity to hog confinements.

Chapter 1 is our powerpoint presentation: "Unintended Health and Environmental Consequences of CAFO Agriculture." Chapter 2 contains the documents of our recent lawsuit against the Iowa DNR.

Between the powerpoint and the DNR lawsuit documents, you can get a pretty good understanding of what hog confinements are, why they produce the human health problems they do, what those health problems are, and why we have had such a hard time getting anything done to protect humans from hog confinement pollutants and toxins.

The powerpoint explains hog confinement technology, what that technology is, how that technology affects the hog's waste as it breaks down in an anaerobic (sewer) environment, and explains the human health harming constituent parts that waste produces as it breaks down in this sewer environment. Those human health harming constituent parts of manure are vented or blown out into the surrounding neighborhood and larger environment 24/7/365.

When reading the DNR lawsuit documents, start by reading the media guide pdf. The media guide document has notes in the margin that will help you understand what we are doing and why we put together the lawsuit the way we did. The last page of the media guide is the template we had to follow in order to make our request of the DNR for a declaratory order. That template will explain what we are about in the document when it says "this addresses template number such and such."

We changed the lawsuit, but not in any real way. We simply left out the original step of trying to get the DNR to agree with us and issue a declaratory order using our wording to protect the public's health. Instead, we skipped that step and asked the DNR in our lawsuit to "retain" all excreta/waste/manure, and the constituent parts of that manure, that the code/law says it is supposed to do. As it is written today, the code/law regulations leave out the pollution coming out of the air avenue of hog confinements. It only regulates the water pollution avenue. The existing

code/law language led to the dismissal of our DNR lawsuit, and, led to this grassroots campaign to get language in the regulations which includes the air avenue and would regulate the human health harming pollution coming out of the air avenue

The lawsuit documents, along with the Jillian Fry 2014 Johns Hopkins study used in the main lawsuit document, will also help you understand why opponents of hog confinements have had such a hard time making any headway in protecting the public's health. It shows that the regulatory scheme leaves out humans, hence there are no laws pertaining to the effects hog confinement waste has on people.

This legislative language effort is a particular effort using hog confinements to fight against the larger general problem of pollution from this industrial model of agriculture. It is what we can do today to lessen the inherent pollution problems coming from the use of this industrial model of agriculture that is dominant in the US today.

The epilogue in this booklet is a "transition to a clean agriculture" document. This document shows where we can, and should, go in the future in terms of having a clean and healthy agriculture in Iowa. The legislative language grassroots campaign is a particular effort. The transition document is a general effort toward a future clean and healthy agriculture.

This transition to a clean agriculture document is also being proposed as a symposium for the Iowa Academy of Science 2020 Annual Conference. Because all the agricultural crops and cropping systems discussed in the transition document exist today, the symposium will stipulate that the transition to a clean agriculture has already been completed. The presenters will then be asked to tell how that transition was accomplished from their research perspective, and/or, what Iowa is like now that we have transitioned to a clean and soil rejuvenating agriculture. It is important to let people know that this future can exist today, show them what it can be like, and let them know that we do not need to continue with this inherently polluting industrial model of agriculture to feed ourselves.

The printed booklet will have links to the full version e-book at the appropriate places. All of the documents in the book, our lawsuit documents, and the 867 peer-reviewed journal studies we cite to justify our positions will be in the full e-version book.

We hope you find this book/e-book informative. We also hope that you will use this information to help with this grassroots campaign to regulate Iowa hog confinements. If you invite us to visit your group, we will discuss how best to use this information locally, and answer any questions you may have about any of the information we have given you.

Since this book is, and contains, the ask of your help with this grassroots effort, we will not be charging for the printed version. We will ask for a freewill donation if you want to help with the printing costs. The e-version is free and printable from the website: www.civandinc.com and click on the book title.

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Unintended Health and Environmental Consequences of CAFO Agriculture

Bob Watson and Larry Stone

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This presentation will present the perspective that **CAFOs - confinements and feedlots - are wastewater technology** which has been inappropriately transferred to agriculture.

Using this perspective, we will provide a context that will give you a different way to view this CAFO model of agriculture.

3

Unintended consequences have occurred:

- because the unregulated sector of agriculture adopted technologies designed for use in **industrial/municipal wastewater treatment**;
- but the training, regulations, public safety, and engineering used in the **wastewater industry** have not been carried over to industrial agriculture.

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We discuss:

- the technology,
- its inherent industrial poisons,
- its effects on people's health, and
- how people can be protected.

We avoid:

- emotional arguments about animals,
- the treatment of animals,
- private property, and
- models of agriculture.

We simply address the **interface** between **industrial poisons** and the **public**.

5

This manure collection technology has produced **unintended consequences**. Some include:

- creation of an environment suitable for MRSA and other antibiotic-resistant organisms.
- the release of air-borne toxins
  - **hydrogen sulfide (H_2S)**,
  - **methane (CH_4)**,
  - **ammonia (NH_3)**,
  - **particulates**, and
  - **drug-resistant organisms;**
- explosive conditions inside the confinements; and
- nitric acid rain.

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This is not a blame game.

No one originally understood the human health costs, environmental degradation, and pollution that would result from using these technologies in agriculture.

As such, we should all bear the costs of transitioning to a biologically benign agriculture.

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Please keep in mind during this presentation that the focus of most individuals, corporations, and government entities is

"you can't regulate poisons coming from agriculture,"

rather than focusing on the uncomfortable fact that

"people - especially children - are breathing poisons from agriculture."

This presentation will include:

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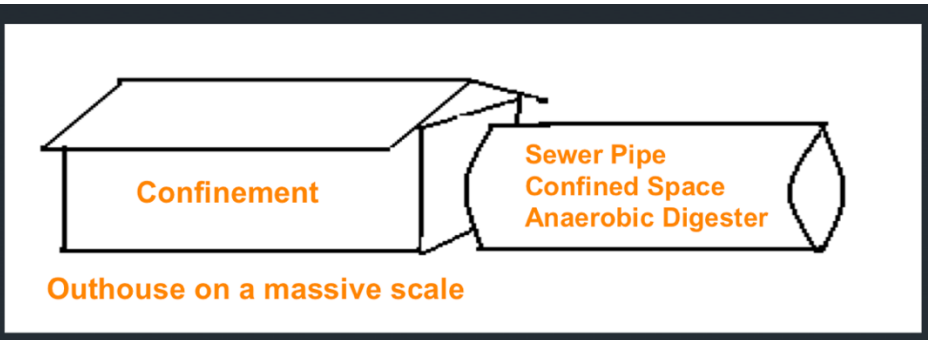
An explanation of the **technology** that **creates the same sewer environments** in both **CAFOs** and the **wastewater industry**.

A discussion of the regulations and design that have matured with this technology, but that have not been transferred to agriculture with that technology.

We will proceed to specific examples of unintended consequences:

- Increase of deaths and fires in confinements from foaming problems.
- The new acid rain - **nitric acid rain** - much of which can be traced to agriculture.
- Health impacts on people.

Then we will dispel some common myths.



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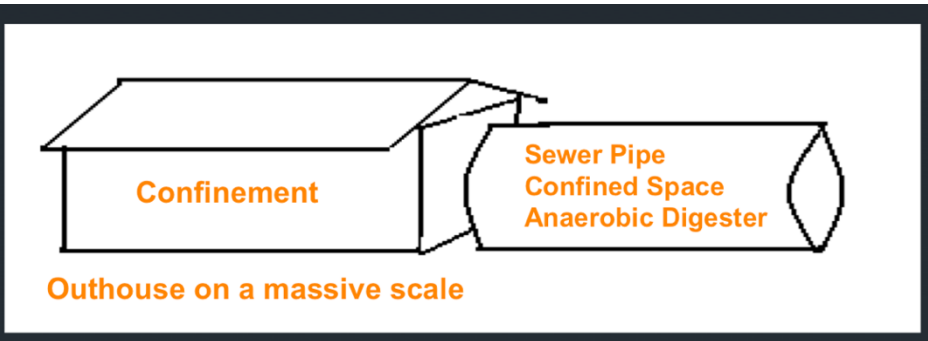
Similarities Between CAFOs and Waste Water Treatment:

- Both are closed spaces.
- Both have untreated fecal waste in them.
- That waste constantly generates antibiotic-resistant organisms, particulates, and poison sewer gases: hydrogen sulfide, ammonia, the explosive and green-house gas methane.
- Inherent in the technology: If you use this technology, these things must happen.
- Causes of diseases and death from those gases are the same.
- Constant ventilation is needed to survive in either.



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Differences Between CAFOs and Waste Water Treatment:

- Sewers are designed to contain the poison gases, while confinements are designed to blow poison gases into the surrounding neighborhood.
- The waste in sewers is ultimately treated; confinement waste is not treated. Problems are prior to treatment, and would exist even if waste was treated.
- There are no regulations for confinements that provide for educating and training about, and protections from, a hazardous work place.
- There are no regulations protecting the public from the poisons created in confinements. There ARE such regulations for sewage treatment, and for everywhere else in which there is fecal waste producing hydrogen sulfide, ammonia, and methane gases in a closed structure.

Summary of toxicology for

Hydrogen Sulfide

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High Concentrations

- respiratory paralysis…may cause coma after a single breath and may be rapidly fatal.
- convulsions.
- acute conjunctivitis with pain, lacrimation, and photophobia.
- keratoconjunctivitis and vesiculation of the corneal epithelium.
- pulmonary edema.
- rhinitis, pharyngitis, bronchitis, and pneumonitis.
- rapid olfactory fatigue.

Low Concentrations

- irritates the eyes and respiratory tract.
- headache, fatigue, irritability, insomnia, and gastrointestinal disturbances.
- dizziness.

Summary of toxicology for

Ammonia

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- Ammonia vapor is a severe irritant of the eyes, especially the cornea, the respiratory tract, and skin.
- Dyspnea, bronchospasm, chest pain and pulmonary edema which may be fatal.
- Bronchitis and pneumonia.
- Asthma.
- Ironically, a 1969 study to set human limits for ammonia was done on pigs.

Stombaugh DP, Teague HS, & Roller WH (1969 June). Effects of atmospheric ammonia on the pig. *Journal of Animal Science, 28*(6): 844-847.

Health Impacts on People

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- **Asthma and Farm Exposures in a Cohort of Rural Iowa Children (2005)**
  - ***Environmental Health Perspectives*, *113*(3): 350-356.**
  - James A. Merchant, Allison L. Naleway, Erik R. Svendsen, Kevin M. Kelly, Leon F. Burmeister, Ann M. Stromquist, Craig D. Taylor, Peter S. Thorne, Stephen J. Reynolds, Wayne T. Sanderson, and Elizabeth A. Chrischilles
- **School Proximity to Concentrated Animal Feeding Operations and Prevalence of Asthma in Students (2006)**
  - ***CHEST*,* *129*(6): 1486-1491.**
  - Sigurdur T. Sigurdarson and Joel N. Kline

*** = Journal of the American College of Chest Physicians**

The Two Studies in Brief

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Iowa's overall rate of asthma is about **6.7%.**

- To generalize the studies, it has been found that if a rural school has a confinement within 10 miles, **11.7%** of the children exhibit **asthma** health outcomes – nearly **twice the state rate**.
- If a confinement is within ½ mile of a school, **24.6%** of children exhibit **asthma** health outcomes – **four times the state rate**.
- And if you are a kid unlucky enough to live on a farm with a confinement that adds antibiotics to feed, there is a **55.8%** chance you will experience **asthma** health outcomes – **nine times the state rate**.

Research Packets Available for Boards of Health

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- **192 CAFO Research Studies**
  - Impact of CAFOs on Workers and Farmers (29)
  - Impact of CAFOs on Neighbors & the Environment (62)
  - Impact of Hydrogen Sulfide on Health (32)
  - Problems with CAFO Operations (6)
  - Toxic & Greenhouse Gas Emissions from Agriculture, i.e., CAFOs et al (61)

Research Packets Available for Boards of Health, cont.

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- **296 MRSA Research Studies**
  - Detection of MRSA in Livestock (34)
  - Links Between Human Exposure to Pigs and Human MRSA Colonization / Infection (96) (IC VA Study)
  - MRSA in Meat Products (12)
  - Impact of Pig Fecal Slurry Applications to Ag Fields on Microbial Soil Organisms, on Soil, & on Groundwater (53)
  - Spread of Swine MRSA to Wildlife (11)
  - Spread of Swine MRSA via Field Applications of Swine Slurry (13)
  - Other Antibiotic-resistant Pathogens Resulting from Ag Use of Antibiotics (50)
  - Risks to Human Health Posed by MRSA Colonization (27)

Measures and Precautions You Can Take to Protect Yourselves

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1. Put correct bio-filters in your HVAC system that will filter out hydrogen sulfide and ammonia gases. At least you will be safe in your own home.
2. Cancel, or do not renew, any hog waste application contracts you have signed.
3. Ask neighbors to cancel or to not renew any hog waste application contracts they have signed.
4. Restrictive covenants.

Measures and Precautions You Can Take to Protect Yourselves

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4. If you wish to file a nuisance law suit, start keeping a log of times and dates, both inside and outside of your house, when odor is present. Nuisance suits have not shut down confinements, but might get you a fair market buyout if you want to move. Include baseline well testing in your log.
5. Keep your children away from confinements and fields where confinement waste has been applied.

Measures and Precautions You Can Take to Protect Yourselves

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6. **If hospitalized, make sure you tell your doctor you may be colonized with MRSA due to living in proximity to confinements and/or fields where confinement waste is applied. If you are already colonized with MRSA, your chances of getting a MRSA infection increase.**
7. **Move.**

Op Ed: Fundamental Problems

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Sept. 2010, by Bob Watson

- Based on conversations with producers at the World Pork Expo, this op-ed concerned the problem of foaming in pits beneath hog confinements, exacerbating the already **serious problem of dead pigs and flash fires** caused by hydrogen-sulfide and methane
- "I wish we had the answer," said Angela Rieck-Hinz of ISU, writing in August on the Iowa Manure Management Action Group website, "but at this point in time **we still have no answers** as to what is causing the foaming or how best to control or manage the foam. If you have information regarding foaming pits you would like to share please contact me. In the meantime, I urge caution when pumping from manure pits. Be aware of safety concerns regarding manure gases, pit fires and explosions. Not all pit fires and explosions have happened in barns with foaming pits."

Op Ed: Fundamental Problems

Sept. 2010, by Bob Watson

David Pressler, Exec. Director, Minnesota Pork Producers Association

Op Ed Continued…

There may be many causes for the upswing in foaming problems.

- The wastewater industry understands these causes:
  1. Old fecal seed stock
  2. Volume of waste being deposited into the pit over time versus the total volume that the pit can hold. When the volume of waste increases as a percentage of the total volume of the pit, foaming increases.
  3. The water-manure ratio also impacts foaming.
  4. The amount & kind of ventilation exerts an impact.

5. Increased feeding of DDGs (Dried Distiller Grain) from ethanol plants has two impacts on increased foaming:
   - Undigestible roughage increases the volume of waste;
   - Undigestible roughage increases the organic loading of the waste being deposited by animals;
   - Addition of uncounted antibiotics to pigs and waste.
6. Barn-cleaning chemicals; and
7. Consumption of genetically modified corn or soybeans leads to significant organ disruptions, particularly in liver and kidneys, which affects the quality of the waste.

There is no ability for confinement operators to control the foaming problem because they can't mix the pit.

Op Ed Continued…

- A 2009 ISU report reviewed literature that cited CAFO fires from as long ago as 1969.
- Thus, it's disturbing that no research questioned the confinement technology that may lead to these explosions.
- Causes of foaming are best understood when you realize that **CAFOs are wastewater technology**.

Op Ed Continued…

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Consequences of foaming:

Normally, gases tend to stay in suspension in a liquid; to get out they must break the surface tension

1. Foaming increases surface area.
2. Foaming provides a direct path to the pigs. The gas does not have to disperse and travel through air to get to the pigs.
3. The pigs bite/eat the foam, or the foam breaks, and the pigs die from hydrogen-sulfide.
4. The methane also has a direct path to the confinement area, resulting in higher incidence of methane flash fires.

Op Ed Continued…

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The crux of the problem is that confinement advocates have inappropriately transferred wastewater technology from the highly regulated sector of municipal and industrial wastewater to the unregulated – in terms of wastewater – sector of industrial agriculture.

In the wastewater industry, we learned long ago – after workers became ill or died - that we could not put normal workspaces in proximity to areas where fecal waste is decomposing.

Op Ed Continued…

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The constant production of the **poisonous** and **explosive gases** –

- **hydrogen sulfide (H_2S),**
- **ammonia (NH_3)**, and
- **methane (CH_4)**

– was finally taken into account in designing wastewater facilities and technology that would protect both the workers and the surrounding public.

Those protections have been codified in the regulations and design standards that control municipal/industrial wastewater technology. But **industrial agriculture remains exempt.**

Op Ed Continued…

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To date, the following entities **deny** that **CAFOs** are a form of **wastewater technology**:

- The **Iowa Legislature**,
- the **Iowa Department of Natural Resources**, and
- **corporate industrial agricultural** officials.

Although seeming illogical, in fact a DNR construction permit requires this type of building, resulting in these problems.

Nitric acid rain: September 2010 Scientific American article "Sour Showers" by Michael Tennesen

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- "Acid rain is back – this time triggered by nitrogen emissions. The acid rain scourge of the 1970s and 1980s that killed trees and fish and even dissolved statues on Washington, D.C.'s National Mall has returned with a twist. Rather than being sulfuric acid derived from industrial sulfur emissions, the corrosive liquid is nitric acid, which has resulted not just from smokestacks but also from farming."
- National Problem

Sour Showers

Sept. 2010 Scientific American, By Michael Tennesen

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- People or organizations mentioned include:
  - **Viney P. Aneja**, professor of air quality and environmental technology at North Carolina State University;
  - the Hubbard Brook Experimental Forest in New Hampshire's White Mountain National Forest;
  - **William H. Schlesinger**, president of the Cary Institute for Ecosystems Studies in Millbrook, NY;
  - the 1999 Gothenburg Protocol; and a
  - 2009 paper in Environmental Science & Technology.

Sour Showers

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Sept. 2010 Scientific American, By Michael Tennesen

- The Integrated Nitrogen Committee of the EPA's Science Advisory Board generated a draft report in 2009 followed by a final report in 2011 that lays out the details, including management options for nitric acid rain.

  Reactive nitrogen in the United States: An analysis of inputs, flows, consequences, and management options: A report of the EPA Science Advisory Board.

- The report also discusses ways to monitor atmospheric emissions, currently the weak link in the nitrogen-control picture. The report may be accessed at:

http://permanent.access.gpo.gov/gpo21530/EPA-SAB-11-013-unsigned.pdf

Ag ammonia causes nitric acid rain

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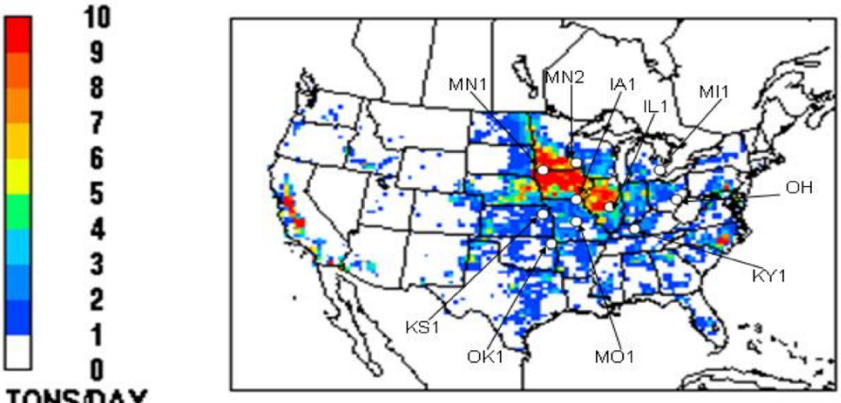


MIDWEST WIDE AMMONIA CLOUD

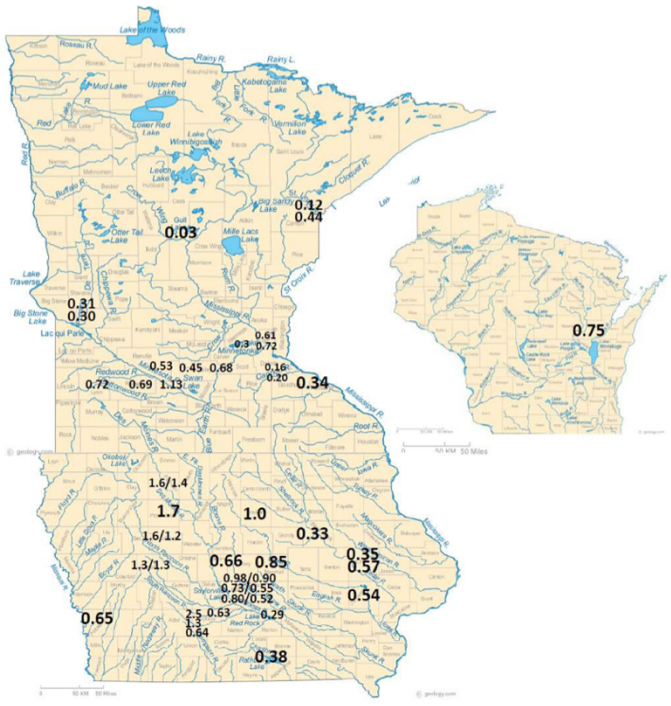
COURTESY OF DONNA KENSKI, Phd.

LAKE MICHIGAN AIR DIRECTORS CONSORTIUM, DES PLANES, IL

•Ammonia from confinements, open feedlots, and volatilization of anhydrous ammonia applications drifts east and falls to earth

Ammonia-N in Melted Snow, mg/L

0.07: Ear Falls, ONT



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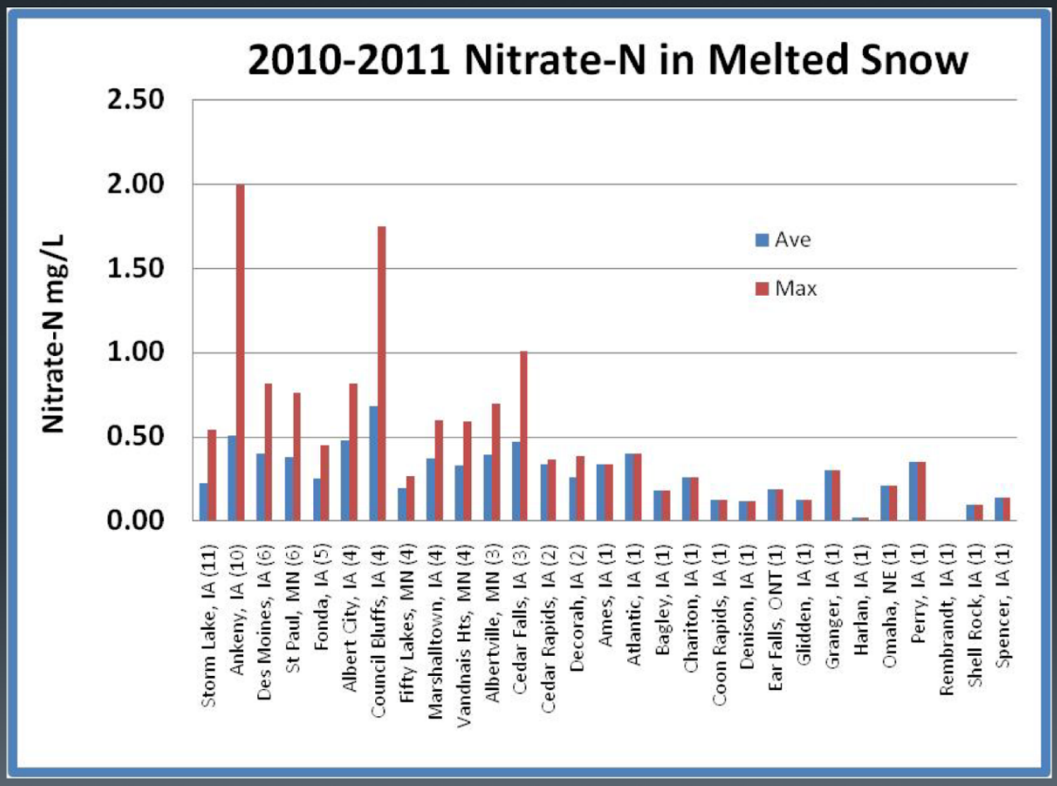

Co-authored Research Papers

by Bill Schlesinger, Cary Institute for Ecosystem Studies.

- "Effects of Agriculture upon the Air Quality and Climate: Research, Policy, and Regulations" (2009). *Environmental Science & Technology*, *43*(12): 4234-4240. Co-authored with VP Aneja & JW Erisman.
- "Farming pollution" (2008). *Nature Geoscience*, *I*: 409-411. Co-authored with VP Aneja & JW Erisman.
- "Ammonia assessment from agriculture: U.S. status and needs" (2008). *Journal of Environmental Quality*, *37*: 515-520.

Authored Research Papers
by Bill Schlesinger, Cary Institute for Ecosystem Studies.

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- "On fertilizer-induced soil carbon sequestration in China's croplands" (2010). *Global Biology Change, 16*: 849-850.
- "On the fate of anthropogenic nitrogen" (2009). In *Proceedings of the National Academy of Sciences of the United States of America, 106*(1): 203-208.

Thoughts of Bill Schlesinger:

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- Schlesinger thinks that national arguments over climate change have allowed the U.S. to ignore the nitrogen problem, which he predicts will be the next big environmental issue.
- "It's another example of humans upsetting global bio-geochemical cycles with unintended consequences," he says.

Common Myths

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1. **"This is a valuable manure." It is not!**
   - Today waste sits and "cooks" (anaerobic digestion) for months in pits, tanks, or lagoons, constantly generating and sending toxic and poison sewer gases, drug-resistant organisms, and particulates into the surrounding neighborhood and larger environment. And it becomes toxic before being applied to fields.
   - For thousands of years, manure used to be deposited directly to the land by animals, or frequently spread by farmers. It broke down into its constituent parts within a few days.
   - Relative pollution numbers:

	Treated Human Waste	Raw Human Waste	Confinement Waste
CBOD	25	200	1000
TSS	30	200	1000+
Ammonia/Nitrogen	1-5	15-20	300-400

   - **Because** hog manure is five times more polluting than human waste, and **because** we have ~20 million hogs at any one time being raised in the state, **it is like having 100 million people** in Iowa having their waste collected but not treated and spread directly onto the land, and calling it valuable manure.

Common Myths continued…

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2. **"The odor is merely a nuisance, with no health problems."** **There ARE health problems.** Studies have shown significant increases in respiratory ailments in neighbors of confinements, including asthma from ammonia exposure, in central nervous and digestive system ailments from hydrogen sulfide exposure, and the drug-resistant organisms problem.

3. **"Separation distances protect the public." They do not.**
   - Required separation distances – usually 1250 & 1875 – but SAFOs have no distance separation. The state recently discovered 5,000 of these SAFOs.
   - The Iowa City VA Study showed veterans living within 1 mile of a hog confinement had a 3 times greater chance of being colonized with MRSA versus those who lived outside the 1-mile limit.
   - The Joel Kline North Winn Study found that students in rural schools within a half-mile of a hog confinement had a 24% rate of asthma. That is 4 times the state asthma rate of 6%.
   - The Nitric Acid Rain Study shows ammonia travels hundreds of miles.

Common Myths continued…

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4. **"Technology can fix any problem."** **No, it can't.**
   - Any time there is fecal waste decomposing in a pit, there must be poison gases being produced. If you use this technology, this will happen.
   - These problems are prior to and separate from any treatment.
   - Because people and animals are in proximity to the pit, there is no technological fix.

5. **"Confinements and feedlots are regulated."** **Not really.**
   - The only rules are about where waste may be spread.
   - There are no wastewater regulations.

Common Myths continued…

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6. **"Opponents are urban activists."** **They are not.**
   - In our 20 years going to many counties in Iowa, we've learned that most opponents are farmers, farm wives, children and farm widows.
   - Rural neighbors of CAFOs are most affected. Many CAFOs are built close to neighbors.
   - Most CAFOS are not associated with what we would consider a farmstead.

7. **"We must keep this model because it gives us cheap food."** **It does not.**
   - Government subsidies and the externalization of soil loss, pollution and human health costs make this model cheap.
   - A model that poisons and pollutes poses moral/ethical questions, which cannot be reduced to monetary figures.

In this presentation we have discussed:

- myths,
- the technology,
- inherent industrial poisons,
- explosive conditions in confinements,
- effects on people's health, and
- how people can be protected from this wastewater technology's harmful effects.

We have avoided:

- emotional arguments about animals,
- the treatment of animals,
- private property, and
- models of agriculture.

We have simply addressed the **interface** between **industrial poisons** and the **public**.

•This is a local problem.
•This is a national problem.
•There is no technological fix.
•To clean up air, water, and soil, put animals back on the land.

Thank you

Questions?

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Chapter 2 – Iowa DNR lawsuit documents – To download click below link

https://drive.google.com/drive/folders/16JSVu2yMOKrVjajcmTudqT5eurkbkbDC

Start by reading the media guide. "ch 2 media guide (1).pdf". When complete reading/downloading documents from google drive click the Back Arrow ← on your browser to return to the eBook.

Chapter 3: Legislative language

In this chapter we give you legislative language based on our DNR lawsuit. Please use this language in a grassroots campaign to try to convince sitting legislators to adopt and introduce this language, and/or, to elect legislators who would be in favor of this language. This language, if adopted, will help protect the health of Iowans who live, work, and study in proximity to hog confinements.

The language would propose that all excreta and its constituent parts be retained in the confinement building between disposal events. This is currently the case in Iowa law for the water pollution avenue for excreta (the State's name for manure), but is not the case for the air pollution avenue.

The proposed language would be about regulating excreta that escapes confinements through the air avenue. The State says they regulate the water avenue (this is pretty weak), but they say the air avenue can't be regulated; this was the reason our DNR lawsuit was dismissed. The air avenue is the more dangerous pollution avenue. If it is read correctly, the State's definition of excreta ends up saying that everything in a hog confinement except the pigs is excreta; we explain this in the DNR lawsuit document. That means that all of the lethal and toxic gasses, particulates, and antibiotic-resistant organisms that are constituent parts of the excreta as it collects and breaks down and leaves the confinement through the air avenue are excreta, too.

In the water avenue, the state says that all excreta must be retained in the confinement between disposal events. The disposal event would be the pumping out and land applying the excreta every six months to a year. This is why the State is able to call these hog confinements "no discharge buildings" and therefore say they don't need NDPES permits (national permits which have limits on the discharged pollution).

There is no regulation of excreta and its constituent parts coming through the air avenue. The State says that their separation distances, normally some 2000 feet more or less, protect the public's health. This is demonstrably false which our studies and our powerpoint show. The hog confinement air avenue pollution which consists of the constituent parts of excreta that include gasses, particulates, and antibiotic-resistant organisms, can travel up to hundreds of miles.

Our proposed legislative language: "All hog confinement excreta and its constituent parts must be retained in the confinement between disposal events. No excreta, or its constituent parts, may leave the hog confinement either through the water pollution avenue, or the air pollution avenue, between disposal events."

Again, please use this language to help in a grassroots campaign to convince sitting legislators to adopt and introduce this air avenue language, and/or, to elect legislators who

would be in favor of this language. This language, if adopted, will help protect the health of Iowans who live, work, and study in proximity to hog confinements.

2nd Edition Epilogue.

This epilogue is the outline of a symposium Bob Watson put together with Matt Liebman, Laura Jackson, and Chris Jones, for the Iowa Academy of Science Annual Conference. It talks about an agricultural future for Iowa that can start being a reality today.

Iowa Can Be: a water cleansing, soil building, flood mitigating sponge, habitat enhancing, human recreating state with a healthy agriculture growing crops and animals in sustainable and non-polluting ways for both people food and manufacturing goods.

2022 IAS Symposium title: Iowa can transition to a healthy agriculture now.

Abstract: Historically Iowa was a water cleansing sponge and soil building land. Because all the agricultural crops and cropping systems discussed in this transition symposium exist today, the symposium will stipulate that the transition to a healthy agriculture has already been completed. The presenters will then be asked to tell how that transition was accomplished from their perspective, and/or, what Iowa is like now that we have transitioned to a healthy and soil rejuvenating agriculture. It is important to let people know that this future can exist today, show them what it would be like, and let them know that we do not need to continue with this inherently polluting industrial model of agriculture to feed ourselves.

Symposium:

Industrial agriculture's inherent pollution is existential for humans in terms of climate change, water – air – and soil – pollution, soil loss, ecosystem pollution, and human health-harming pollution.

It has been reported that it will take decades to attain just a 45% reduction of this industrial agriculture pollution based on the pace that is actually being done by farmers through the voluntary Iowa Nutrient Reduction Strategy. Do we have that long to wait? Why wait when we can start this transition to a healthy agriculture today?

What follows is "what we can do." The "how we can do it" is the discussion that will be difficult because of entrenched forces, and entrenched visions of the future. This transition assumes that mindsets must change, that the Farm Bill must change, and that the government must be involved to achieve the changes envisioned to attain this transition to a "healthy agriculture" and a "livable world" going forward.

Housekeeping before we go to the future: We have been cautioned on two items that have been central to many of us working on these issues, carbon sequestration and STRIPS. We will discuss those cautions here in the present before we go to the future. (Cautions are at the end of this outline.)

Transition to a healthy agriculture:

1. Long crop rotations discussion – Matt Liebman, Professor Emeritus of Agronomy ISU.

Enhancing Biodiversity to Improve Environmental Quality and Crop Production:

Recent meta-analyses of experiments conducted around the world indicate that enhancing biodiversity in cropping systems can promote multiple ecosystem services and environmental benefits without compromising yield. Over the past two decades the effects of different rotation systems comprising different levels of crop diversity have been investigated in a 9-hectare (22-acre) field experiment at Iowa State University's Marsden Farm in Boone Co., IA. Results indicate that adding oat, red clover, and alfalfa to a conventionally managed 2-year corn-soybean rotation to form 3-year and 4-year rotations had positive effects on a wide range of environmental indicators and crop performance. Compared with the simpler rotation system, the more diverse rotations had higher corn and soybean yields, enhanced soil quality, equivalent profitability, and lower herbicide-related aquatic toxicity, fossil energy consumption, greenhouse gas emissions, and damage to human health due to fine particulate matter. Crop diversification also reduced discharge of soil sediment, nitrogen, and phosphorus. Transitions to more diverse, more sustainable cropping systems can be promoted by at least four factors: state and national policies, including regulations and incentive payments; new marketing opportunities due to changes in consumer preferences and the activities of food processors and distributors; farmer-to-farmer education and outreach; and technical innovations, including those derived from plant breeding. Substantial improvements in the environmental sustainability of Iowa's agriculture are achievable now, without sacrificing food security or farmer livelihoods.

2. Laura Jackson – Director and Professor of Biology, Tallgrass Prairie Center, UNI.

How we used Prairie as a model and benchmark for designing our agroecosystems, including features such as perennial grain crops, long crop rotations with ruminant herbivores, rotational grazing, and prairie plantings for biomass energy – thermal heat.

3. Chris Jones – IIHR Research Engineer, IIHR-Hydroscience & Engineering, U of Iowa.
Making choices: Designing a production system around human nutrition, environmental outcomes, and farmer prosperity.

Nearly all of Iowa's landscape is highly disturbed, but some areas are much more disturbed than others. Going forward, it makes little sense to continue shoehorning the corn-soybean-ethanol-CAFO model into every possible acre while at the same time wasting taxpayer resources trying to overcome its fundamental flaws. How can we design a production system focused on human nutrition, environmental outcomes, and prosperity? This presentation will look at the varied Iowa landscapes and what they might look like in a transformed system.

4. Bob Watson – Prairie as part of the farm bill allows us to move towards being a non-polluting biologically benign and beneficial, soil building, sponge-like agriculture.

Historically Iowa was covered by deep-rooted forests, prairies, savannahs, and wetlands. This flora/hydrological system created a vast sponge ranging some 15 to 30 feet in depth both below and above the surface. This sponge allowed rainwater to infiltrate at 7 to 14 inches per hour, while purifying and slowly releasing the stored water for plant uptake and recharging groundwater and aquifers. Prairie provides habitat for pollinators and other insects and animals necessary to our food raising systems. As a model of how prairie might fit into the farm bill, see Laura Jackson's presentation above.

5. Bob Watson – Hemp as part of the farm bill.

The US is one of the world's largest importers of hemp products. Hemp is similar to prairie in that it is a cover crop with deep roots. Hemp can be used for thousands of products, both food and manufacturing. Hemp can replace many petro-chemical products. As a bulk commodity, hemp can help revitalize rural Iowa's small communities since it would be best to process hemp locally. We have had hemp factories in Iowa in the past.

Conclusion:

The world now produces enough food through grains to feed double our current population. By encouraging eating lower on the food chain and raising meat animals on the land, we would no longer need the confinements and feedlots that are polluting Iowa's air, water, and soils, and negatively affecting human health. Iowan's health, with a healthy agriculture, would have a better chance at positive outcomes.

This is Iowa's choice. Will we continue to be an existential threat to human life on earth through the industrial model of agriculture now prevalent in Iowa, or will we be part of the solution to that threat?

Thank you.

Questions and comments.

Cautions:

STRIPS – Bob Watson – Matt Liebman – Chris Jones.

STRIPS – because tile lines and groundwater both allow nitrogen ladened water to bypass STRIPS and enter streams and rivers, we caution the expected nitrogen removal from the use of STRIPS where tile lines and groundwater flow exist.

Carbon Sequestration in Iowa soils – Matt Liebman:

Sequestering atmospheric carbon in agricultural soils is being discussed a lot by both farmers and scientists. Most of the people I interact with believe that the potential to draw carbon dioxide out of the air and store large quantities of it in farm soils is being oversold in the northern Corn Belt.

The carbon capture potential of soils is a function of their minerology, organic matter content, and management history. In the SE US, like in Georgia, older highly weathered soils (e.g., Ultisols) can hold quite a bit of carbon if tillage intensity is reduced, and organic matter additions increase. Well managed grazing systems there have demonstrably beneficial effects on soil C levels.

In the north central states, on much younger Mollisols, it is MUCH more difficult to put large amounts of carbon in soils. See, for example: https://www.agupdate.com/agriview/news/business/soil-carbon-tells-grim-story/article_020700ad-7d18-5690-9827-ed4028e4833e.html, https://mosesorganic.org/publications/broadcaster-newspaper/farms-as-carbon-sinks/?eType=EmailBlastContent&eId=5d9f6a33-7387-42d3-8744-4241346c07fe for summaries of long-term soil assessments in the University of Wisconsin's Integrated Cropping Systems Trial results. I can share technical results from Iowa that show the same pattern.

Where cropland is placed under continuous cover, e.g. CRP, soil C levels can increase but recovery may be slow. See, for example: "Soil health recovery after grassland reestablishment on cropland: The effects of time and topographic position."
https://acsess.onlinelibrary.wiley.com/doi/full/10.1002/saj2.20007
"Native grasslands had superior soil health compared with cropland and most CRP soils, and even 40 yr since grassland reestablishment was not adequate for full soil health recovery. Patience is needed to observe changes in soil health, even in response to a drastic management change like conversion of cropland to CRP grassland."

In the croplands of north central Iowa and much of the tile drained areas of the Corn Belt, increased oxygenation of soil that had originally been seasonal wetlands has changed soil C dynamics. Where there is more oxygen in the soil, organic matter decomposes more readily, releasing CO2. Conversely, recreating wetlands can be an important way to increase soil C. You can consider the likelihood of doing that in north central Iowa cropland.

Sampling depth of soil can strongly influence conclusions about soil organic C levels. No-tillers often report dramatic increases in soil C after cessation of tillage, but typically the measurement s are made only on surface soil (e.g. 10-15 cm, 4-6"). Accurate assessment of soil C stocks must include deep soil layers, not just the surface layer. In an experiment conducted in the Central Valley of California, Tautges and colleagues ("Deep soil inventories reveal that impacts of cover crops and compost on soil carbon sequestration differ in surface and subsurface soils,".
doi:10.1111/gcb.14762) compared soil organic C stocks to a depth of 200 cm over a 19-year period for corn and tomato grown in rotation with and without winter cover crops. For the full

200-cm profile, no net change in SOC was seen for the corn-tomato system without cover crops, whereas soil C stocks decreased by 13.42 metric tons C ha^{-1} (-0.67 metric tons C ha^{-1} $year^{-1}$) when cover crops were included in the rotation. Importantly, focusing only on the surface layer of soil could have resulted in "grossly overestimating" SOC gains. In the corn-tomato rotation with cover crops, constraining soil C measurements to the top 30 cm would have shown gains of 1.44 metric tons C ha^{-1}, compared to cumulative losses of 14.86 metric tons C ha^{-1} in the 30□200 cm layer. Inclusion of deep soiil layers in the assessment of SOC stocks was necessary to prevent drawing false conclusions in this experiment.

At least in the north central states, I think it would be much more worthwhile to concentrate on farming techniques that reduce the use of fossil fuels and minimize emissions greenhouse gases (CO2, N2O, CH4) than focus on capturing and storing large amounts of carbon. Our Marsden Farm plots show a 64% reduction in fossil C use and a 64% reduction in GHG emissions in the 4-year rotation (corn-soybean-oat/alfalfa-alfalfa) rotation compared to the 2-year rotation (corn-soybean) ("Fossil Energy Use, Climate Change Impacts, and Air Quality-Related Human Health Damages of Conventional and Diversified Cropping Systems in Iowa, USA," https://dx.doi.org/10.1021/acs.est.9b06929). There has been no difference in soil carbon levels in those plots ("Whole-profile soil organic matter content, composition, and stability under cropping systems that differ in belowground inputs," https://doi.org/10.1016/j.agee.2019.106810).

My recommendation is to support increased conservation and enhancement of soil, water, and wildlife through reducing tillage intensity, diversifying rotations with perennial crops like alfalfa and clover, and introducing high-level grazing management. Soil carbon won't be diminished by those practices but we shouldn't expect that they will have dramatically positive effects on soil C in many cropland sites Iowa. Where farming practices do have a beneficial effect on whole-profile soil C stocks, changes may be on the order of decades.

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