STATE OF INDIANA) IN THE HENDRICKS SUPERIOR COURT
) SS:
COUNTY OF HENDRICKS) CAUSE NO. 32D04-1510-PL-000150

MARTIN RICHARD HIMSEL, JANET L. HIMSEL, ROBERT J. LANNON and SUSAN M. LANNON,

Plaintiffs,

vs.

SAMUEL T. HIMSEL, CORY M. HIMSEL, CLINTON S. HIMSEL, 4/9 LIVESTOCK, LLC, and CO-ALLIANCE, LLP,

Defendants.

AFFIDAVIT OF MARK CHERNAIK, PH.D

I, MARK CHERNAIK, declare under penalty of perjury as follows:

Kim Ferraro, attorney with the Hoosier Environmental Council, a non-profit environmental organization representing Plaintiffs in this case, asked me to address the following questions regarding the above-referenced matter:

1) whether the complaints of Martin Richard and Janet L. Himsel (Himsels) and Robert and Susan Lannon (Lannons) about noxious odors on their properties located at 3581 West 350 North, in Danville, Indiana, and 3868 West 350 North in Danville, Indiana, are due to the operation of a concentrated animal feeding operation (the CAFO) located at 3042 North 425 West, in Danville, Indiana; and

2) whether chemicals with noxious odors emitted by the CAFO have traveled onto the Himsels' and Lannons' properties; and, if so, whether this is an expected result considering the nature of operations at the CAFO in proximity to the Himsels' and Lannons' properties.

I. Professional Qualifications

I am qualified to answer these questions. In 1990, I earned a Ph.D. in biochemistry from Johns Hopkins University School of Public Health, in Baltimore, Maryland. My doctoral studies and research focused on the intersection of molecular biology and environmental toxicology. In 1993, I earned a degree in law from the University of Oregon School of Law, Eugene, Oregon, with a focus on environmental law. Since 1993, I have served as Staff Scientist for the U.S. Office of the Environmental Law

Alliance Worldwide. In this capacity, I provide scientific information and analysis to public interest attorneys in more than 60 countries.

In June 2005, and again in February 2011, the European Court of Human Rights relied extensively on my work to reach landmark decisions (*Fadeyeva v. Russia; Dubetska v. Ukraine*) regarding the rights of individuals exposed to toxic substances. [Citation: Fadeyeva v. Russia 55723/00 [2005] ECHR 376 (9 June 2005); *Dubetska v. Ukraine* 30499/03 [2011] ECHR (10 February 2011)]. My opinions on environmental matters have been cited favorably in judgments of the Supreme Court of India, the Supreme Court of Pakistan, and the Supreme Court of Belize. [Citation: *M.C. Mehta v. Union of India*, 1999-(003)-CLJ 0361–SC; *Shehla Zia v. WAPDA*, PLD 1994 (SC) 693; *Belize Institute for Environmental Law (BELPO) v. Department of Environment (DOE)*, Supreme Court of Belize (30 June 2008) (Claim No. 302 OF 2007)].

In 2011, the United States District Court for the Northern District of Indiana accepted my expert opinions in support of a motion for class certification on the cause and effects of exposure on the surround community to air pollution from an industrial waste processing facility. The court granted class certification in that case relying on my testimony and awarded damages of more than $50 million to the plaintiff class based in part on my expert testimony about the health effects caused by defendants' releases of toxic substances. In 2011 and 2012, the Superior Court of California, Alameda County accepted my expert written testimony, and in court, on the impacts to air quality of industrial pollution (principally manganese) from Pacific Steel Casting in the City of Berkeley. A jury awarded a verdict for plaintiffs with award of nominal damages.

A major focus of my work is the protection of air quality through community-based air quality monitoring projects. I have worked on the design of air quality monitoring projects, and interpretation of air quality data in dozens of projects throughout the United States and additional projects throughout the world.

Please see my attached C.V. for further details.

II. Documents and Information Reviewed

In preparing this report, I examined the following documents:

- American Society of Agricultural and Biological Engineers (April 2012) Management of Manure Odors, Standard EP379.5
- Hendricks County Area Plan Commission (March 12, 2013) Partial Transcript, Zoning Amendment Application Hearing, ZA 418/13
- 4/9 Livestock LLC (April 16, 2013) Confined Feeding Approval Application

- Indiana Department of Environmental Management (May 31, 2013) Approval Decision

- Indiana Department of Environmental Management (December 15, 2014) CFO Inspection Report

- Sure-Tech Lab (April 14, 2016) Lab Analysis of Liquid Manure, 4/9 Livestock LLC

- Ag-Odor Control (Undated) MOC-7 Manure Pit Treatment

- 4/9 Livestock LLC (Various dates) Confined Feeding Operation (CFO) Manure Application Record

- Daily Observation Reports of the Himsels and Lannons

III. Scientific Studies Reviewed

In preparing this report, I examined the following scientific studies

- Schiffman, S. S., Miller, E. A. S., Suggs, M. S., & Graham, B. G. (1995). The effect of environmental odors emanating from commercial swine operations on the mood of nearby residents. *Brain research bulletin*, 37(4), 369-375;

- Zahn, J. A., DiSpirito, A. A., Do, Y. S., Brooks, B. E., Cooper, E. E., & Hatfield, J. L. (2001). Correlation of human olfactory responses to airborne concentrations of malodorous volatile organic compounds emitted from swine effluent. *Journal of Environmental Quality*, 30(2), 624-634;

- Schiffman, S. S., Bennett, J. L., & Raymer, J. H. (2001). Quantification of odors and odorants from swine operations in *North Carolina. Agricultural and Forest Meteorology*, 108(3), 213-240;

- Miller, G. Y., Maghirang, R. G., Riskowski, G. L., Heber, A. J., Robert, M. J., & Muyot, M. E. (2004). Influences on air quality and odor from mechanically ventilated swine finishing buildings in *Illinois Journal of Food and Agriculture and Environment* 2, 353-360;

- Bunton, B., O'Shaughnessy, P., Fitzsimmons, S., Gering, J., Hoff, S., Lyngbye, M., ... & Werner, M. (2007). Monitoring and modeling of emissions from concentrated animal feeding operations: overview of methods. *Environmental health perspectives,* 303-307;

- Wing, S., Horton, R. A., Marshall, S. W., Thu, K., Tajik, M., Schinasi, L., & Schiffman, S. S. (2008). Air pollution and odor in communities near industrial swine operations. *Environmental health perspectives*, 116(10), 1362.

IV. Air Study Design

To determine whether noxious levels of odorants emitted by swine feedlots are on the properties of the Himsels and Lannons, I designed a project to measure levels of odorous chemicals on their properties. I began by reviewing the scientific literature identified above about noxious odors from swine operations to identify: 1) which chemicals contribute most to noxious odors from these facilities; and 2) which are the most reliable methods that on a practical basis could be employed to quantify the levels of these chemicals on the Himsels' and Lannons' properties.
Industrial swine operations generate several classes of gases, as illustrated in Table 1 below, from a standard developed by the American Society of Agricultural and Biological Engineers.[1]

Table 1 – Typical compounds resulting from the anaerobic decomposition of animal manure

Volatile Fatty Acids	Sulfides
Acetic	Hydrogen sulfide
Propionic	Dimethysulfide
Butyric	Diethylsulfide
Isobutyric	Disulfides
Isovaleric	Ammonia and Amines
Alcohols	Ammonia
Aldehydes	Methylamine
Esters	Ethylamine
Phenols and Cresols	Dimethylamine
Phenol	Trimethylamine
p-Ethyl-phenol	Diethylamine
p-Cresol	Nitrogen Heterocycles
Mercaptans	Indole
Methymercaptan	Skatole
Ethylmercaptan	Odorless Gases
Propylmercaptan	Carbon Dioxide
	Methane

[1] American Society of Agricultural and Biological Engineers (April 2012) Management of Manure Odors, Standard EP379.5

Although gases emitted by concentrated swine operations are heterogeneous, the scientific literature indicates that a relatively small number of individual chemicals contribute to the overall noxiousness of air in the vicinity of these facilities. The major odorants are primarily volatile *fatty acids, phenols and cresols, sulfides and mercaptans, ammonia, amines, and nitrogen heterocycles*.

Of the chemicals in the chart above, I designed testing methods for: 1) volatile fatty acids; 2) ammonia; 3) sulfides and mercaptans; and 4) amines.

Measuring levels of *volatile fatty acids* on the Himsels' and Lannons' properties consisted of passing 100 liters of air (at a rate of 1 liter/minute by use a portable pump) on a commercially available sorbent tube with a high-affinity for volatile fatty acids. The sorbent tubes were shipped to a commercial laboratory (ALS in Simi Valley, California) where volatile fatty acids were desorbed and quantified by combined gas chromatography/mass spectrometry (GC/MS).

Measuring levels of *ammonia* consisted of setting out for a measured period of time commercially available passive samplers containing a sorbent with a high-affinity for ammonia,[2] and then shipping the samplers to a commercial laboratory (Gradko Environmental, Winchester, United Kingdom) where ammonia was desorbed from the samplers and quantified by ion chromatography.

Measuring levels of *sulfides and mercaptans* on the Himsels' and Lannons' properties consisted of collecting 1 liter of air in an evacuated stainless steel canister (Summa canister). The filled canisters where shipped to a commercial laboratory (ALS, Simi Valley, California) where mercaptans and sulfides in the canister were quantified by a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD).

Measuring levels of *amines* consisted of passing 100 liters of air (at a rate of 1 liter/minute by use a portable pump) on a commercially available sorbent tube with a high-affinity for amines. The sorbent tubes were shipped to a commercial laboratory (ALS, Simi Valley, California) where amines were desorbed and quantified by combined gas chromatography/mass spectrometry (GC/MS).

I was not able to include all possible classes of chemicals with noxious odors that might be occurring on the Himsels' and Lannons' properties within the project design. For example, there are no commercially-available methods for measuring *nitrogen heterocycles*, including <u>indole and skatole</u>, so my design did not include these even though indole and skatole, which are present in feces, are known to contribute a substantial portion to the noxiousness of odors from concentrated swine feedlot operations. Also, there are also no commercially-available methods for measuring *phenols and cresols*, so my design did not include these even though certain phenols and cresols, such as 4-methyl phenol, are known to contribute a

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[2] The DIFRAM-400 – Rapid Air Monitor for Ammonia sold by Ormantine, USA Ltd. Inc. http://www.ormantineusa.com/ammonia-ram

significant portion to the noxiousness of odors from concentrated swine feedlot operations. I chose not to include testing for *alcohols and esters* in the design of the project because these two classes of compounds have odors that are not potently offensive except for very high concentrations. I chose not to include testing for *aldehydes* because there is a lack of strong evidence in the scientific literature that this class of compounds contributes a substantial portion to the noxiousness of odors from concentrated swine feedlot operations.

I trained the Himsels and the Lannons to collect air samples from their properties. The training took place on Saturday, June 11th, from approximately 9:00 a.m. to 6:00 p.m. and focused on the use of a pump[3] and an air flow calibrator[4] for the purpose of passing a measured volume of air through sorbent tubes for the capture of volatile fatty acids and amines. The training also included how to open and close Summa canisters for collecting air samples that were analyzed for levels and sulfides and mercaptans, and how to set out passive samplers for collecting air samples that were analyzed for levels of ammonia.

The training also focused on how to properly fill out Chain-of-Custody forms that accompany samples when shipped to analytical laboratories and include contemporaneous observations of field conditions. The training was 'hands-on' in that the Himsels and Lannons received instruction until they could demonstrate, on their own, consistently successful use of the equipment and supplies for the collection of mock samples.

The sample collection methods the Himsels and Lannons used to collect air samples from their properties have been verified in the scientific literature to be reliable methods as follows:

- The commercially available pump and air flow calibrator used by the Himsels and Lannons for passing a measured volume of air through sorbent tubes have been relied upon for air sample collection in peer-reviewed studies on air quality in agricultural and occupational settings.[5]

- The commercially available sorbent tubes used by the Himsels and Lannons for capturing volatile fatty acids and amines in pumped air

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[3] The AirChek ® XR5000 Sample Pump rented from SKC Inc. http://www.skcinc.com/catalog/pdf/instructions/38047.pdf

[4] The 4146 Calibrator Kit rented from SKC Inc. http://www.skcinc.com/catalog/product_info.php?products_id=2360

[5] Jerez, S. B., Cheng, Y., & Bray, J. (2014). Exposure of workers to dust and bioaerosol on a poultry farm. *The Journal of Applied Poultry Research*, 23(1), 7-14; Kim, B., Yoon, J. H., Choi, B. S., & Shin, Y. C. (2013). Exposure assessment suggests exposure to lung cancer carcinogens in a painter working in an automobile bumper shop. *Safety and health at work*, *4*(4), 216-220.

samples have been relied on by peer-reviewed studies on air quality in agricultural settings.[6]

- The commercially available passive samplers containing a sorbent with a high-affinity for ammonia used by the Himsels and Lannons have been relied upon for air sample collection in peer-reviewed air quality studies in agricultural settings.[7]

- The commercially-available Summa canisters used by the Himsels and Lannons for collecting samples analyzed for sulfides and mercaptans have been relied on in hundreds of peer-reviewed air quality studies over the last 30 years.[8]

- Combined gas chromatography/mass spectrometry (GC/MS) used for the measurement of volatile fatty acids and amines in pumped air samples is the basis of numerous standard methods of the U.S. Environmental Protection Agency.[9] GC/MS is considered to the 'gold standard' of all analytical methods.[10]

- Ion chromatography used for the measurement of ammonia in passive air samples is the standard method for determining ammonia in the Manual of Analytical Methods of the National Institute of Occupation Safety and Health.[11]

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[6] Parker, D. B., Buser, Z., Caraway, E., Rhoades, M., Olsen, M., Casey, K., ... & Green, G. (2007, September). VOC concentrations downwind of beef feedlots during intense odour events. In Proceedings of the 14th IUAPPA World Congress (pp. 9-13). Koziel, Jacek A., Jarett P. Spinhirne, Jenny D. Lloyd, David B. Parker, Donald W. Wright, and Fred W. Kuhrt. "Evaluation of sample recovery of malodorous livestock gases from air sampling bags, solid-phase microextraction fibers, Tenax TA sorbent tubes, and sampling canisters." Journal of the Air & Waste Management Association 55, no. 8 (2005):

[7] D'Ann, L. W., Breysse, P. N., McCormack, M. C., Diette, G. B., McKenzie, S., & Geyh, A. S. (2011). Airborne cow allergen, ammonia and particulate matter at homes vary with distance to industrial scale dairy operations: an exposure assessment. *Environmental Health*, 10(1), 1.; Wilson, S. M., & Serre, M. L. (2007). Use of passive samplers to measure atmospheric ammonia levels in a high-density industrial hog farm area of eastern North Carolina. *Atmospheric Environment*, 41(28), 6074-6086.

[8] Oliver, K. D., Pleil, J. D., & McClenny, W. A. (1986). Sample integrity of trace level volatile organic compounds in ambient air stored in SUMMA® polished canisters. Atmospheric Environment (1967), 20(7), 1403-1411; Brymer, D. A., Ogle, L. D., Jones, C. J., & Lewis, D. L. (1995). Viability of using SUMMA polished canisters for the collection and storage of parts per billion by volume level volatile organics. Environmental science & technology, 30(1), 188-195.

[9] U.S. EPA method 8260C: Volatile organic compounds by gas chromatography/mass spectrometry (GC/MS). https://www.epa.gov/sites/production/files/2015-12/documents/8260c.pdf

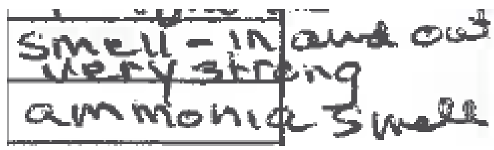
[10] Krone, N., Hughes, B. A., Lavery, G. G., Stewart, P. M., Arlt, W., & Shackleton, C. H. (2010). Gas chromatography/mass spectrometry (GC/MS) remains a pre-eminent discovery tool in clinical steroid investigations even in the era of fast liquid chromatography tandem mass spectrometry (LC/MS/MS). *The Journal of steroid biochemistry and molecular biology*, *121*(3), 496-504.

[11] Method 6016: Ammonia by IC https://www.cdc.gov/niosh/docs/2003-154/pdfs/6016.pdf

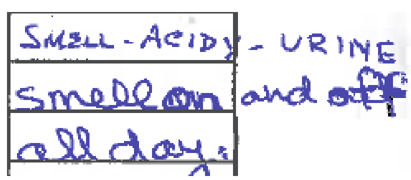
- A gas chromatograph equipped with a sulfur chemiluminescence detector used for the measurement of sulfides and mercaptans in air samples collected in Summa canisters is the method relied up by regulatory agencies. [12]

V. RESULTS: VOLATILE FATTY ACIDS

On June 20th, 2016, from 10:10 a.m. to 11:50 a.m., an air sample was collected on the Himsels' property on the patio to the south side of the home, approximately 510 meters (555 yards) east-northeast (ENE) of the eastern sides of barns of the CAFO. During the collection of the sample, winds were recorded to be from the south-southwest (SSW) direction at a speed of 10-15 miles per hour (mph) and weather was recorded to be partly sunny with a temperature between 79° F and 82° F. Susan Lannon, who collected the sample, recorded the following observation:


Smell - in and out
very strong
ammonia smell

On June 30th, 2016, from 5:55 p.m. to 7:35 p.m., an air sample was collected on the property of Robert and Susan Lannon, in the front yard of the home, approximately 1010 meters (1100 yards) northeast (NE) of the eastern sides of barns of the CAFO operated by 4/9 Livestock, LLC. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 3-8 mph and weather was recorded to be sunny with a temperature of 80° F. Susan Lannon, who collected the sample, recorded the following observation:


SMELL - ACIDY - URINE
smell on and off
all day.

On August 13th and 14th, 2016, Field Blanks were collected at identical locations at both properties. The Field Blank collected on the property of Robert and Susan Lannon was collected at 9:15 a.m. on August 13th, 2016. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 3 mph and weather was recorded to be raining with 93% humidity. Susan Lannon, who collected the sample, recorded the following observation:

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[12] Bay Area Air Quality Management District Method 44A: Determination of reduced sulfur gases and sulfur dioxide in a gaseous matrix using the sulfur chemiluminescence detector. http://www.baaqmd.gov/~/media/files/records/mop/vol-3/mop-44a.pdf?la=en

wet fecal smell

The Field Blank collected on the property of Martin Richard and Janet L. Himsel was collected at 7:15 a.m. on August 14th, 2016. During the collection of the sample, winds were recorded to be calm and weather was recorded to be mostly cloudy with 94% humidity and rain in the forecast. Susan Lannon, who collected the sample, recorded the following observation:

strong manure smell

For the air sample collected on the Himsels' property on June 20th, 2016, the following levels of volatile fatty acids were detected: **acetic acid, 24 parts per billion (ppb); propionic acid, 4.7 ppb; butanoic acid, 1.3 ppb; pentanoic acid, 2.4 ppb; hexanoic acid, 15 ppb; heptanoic acid, 1.2 ppb; octanoic acid, 2.6 ppb; and nonanoic acid, 1.3 ppb.**

For the air sample collected on the Lannons' property on June 30th, 2016, the following levels of volatile fatty acids were detected: **acetic acid, 37 ppb; propionic acid, 2.5 ppb butanoic acid, 1.0 ppb; pentanoic acid, 1.3 ppb; hexanoic acid, 7.2 ppb; heptanoic acid, 2.9 ppb; octanoic acid, 9.1 ppb; and nonanoic acid, 1.8 ppb.**

All levels of volatile fatty acids in the Field Blanks collected on August 13th and 14th, 2016, were below method detection limits.

A. Comparison to levels of volatile fatty acids typically found in outdoor air

Levels of volatile fatty acids typically found in outdoor air are orders of magnitude lower compared to the levels of volatile fatty acids found on Himsels' and Lannons' properties.

For example, for hexanoic acid, according to the National Library of Medicine's TOXNET toxicology data network.[13]

> "Atmospheric Concentrations:
> "URBAN/SUBURBAN: Mean atmospheric concns of 0.006-0.063 ppb hexanoic acid were detected in ambient air samples collected in Los Angeles, CA in Jul and Sep 1984(1). Hexanoic acid was detected in the indoor air of manufactured homes at levels of 0.3-5.5 ppb (geometric mean = 1.2 ppb) and newly constructed homes at levels of 0.5-2.0 ppb (geometric mean = 1.0

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13 https://toxnet.nlm.nih.gov/cgi-bin/sis/search/a?dbs+hsdb:@term+@DOCNO+6813

ppb)(2). Hexanoic acid was detected in the air of Southern California in October 1984 at levels of 0.004-0.027 ppb(3). The average concn of hexanoic acid in the air of Long Beach, Los Angeles, Azusa, and Claremont, CA was 0.32, 0.48, 0.52, and 0.27 ug/cu m, respectively during a photochemical smog event in the summer of 1993(4). [(1) Kawamura K et al; Environ Sci Technol 19: 1082-6 (1985) (2) Hodgson AT et al; Indoor Air 10: 178-192 (2000) (3) Kawamura K et al; Atmos Environ 34: 4175-4191 (2000) (4) Nolte CG et al; Environ Sci Technol 35: 540-545 (1999)] **PEER REVIEWED**

"RURAL/REMOTE: The concentration at a background remote location (San Nicolas Island, off the southwest coast of California) was measured as 0.02 ug/cu m(1). [(1) Nolte CG et al; Environ Sci Technol 35: 540-545 (1999)] **PEER REVIEWED**

Similarly, for octanoic acid, according to the National Library of Medicine's TOXNET toxicology data network.[14]

"URBAN/SUBURBAN: Octanoic acid was identified in air samples collected along the Niagara River in Sept 1982 at an unreported concn(1). Air samples collected in Los Angeles between July and Sept 1984 contained 0.002 to 0.021 ppb octanoic acid(2). Octanoic acid was detected at 0.08, 0.10, 0.12 and 0.08 ug/cu m in Long Beach, Los Angeles, Azusa and Claremont, CA, respectively, Sept 8-9, 1993(3). Octanoic acid was found at 0.002-0.012, 0.002-0.007, 0.011-0.015, and 0.009-0.025 ppbv at UCLA campus, Newberry Park, Monterey Park, and La Habra, CA in Oct 1984(4). Octanoic acid had an average concentration of 2.4 ng/cu m in 4 urban sites from southern CA from samples taken Sept 8-9, 1993(5).
[(1) Hoff RM, Chan K; Environ Sci Technol 21: 556-61 (1987) (2) Kawamura K et al; Environ Sci Technol 19: 1082-6 (1985) (3) Nolte CG et al; Environ Sci Technol 33: 540-5 (1999) (4) Kawamura K et al; Atmos Environ 34: 4175-91 (2000) (5) Fraser MP et al; Environ Sci Technol 37: 446-53 (2003)] **PEER REVIEWED**

"RURAL/REMOTE: Octanoic acid was found in 20% of samples taken near a lighthouse in Fajardo and was also detected in the open ocean off the south coast of Puerto Rico(1). Octanoic acid was not detected on San Nicolas Island, CA Sept 8-9, 1993(2). Remote aerosol samples collected from the North Pacific Ocean and heavily vegetated areas of American Samoa contained an octanoic acid concn of 0.018 ng/cu m and 2.1 ng/cu m, respectively(3).
[(1) Mayol-Bracero OL et al; Atmos Environ 35: 1735-45 (2001) (2) Nolte CG et al; Environ Sci Technol 33: 540-5 (1999) (3) Kawamura K, Gagosian RB; Nature 325: 330-1 (1987)] **PEER REVIEWED**"

[14] https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~AHC6B6:1

B. Significance of the levels of volatile fatty acids found on the Himsels' and Lannons' properties

In 2010, scientists with the UCSD and University College London, published a study on how humans perceive volatile fatty acids in ambient air.[15] The scientists noted: "From an environmental perspective, carboxylic acids play an important role in the generation of odor pollution in a variety of environments." Using an air dilution olfactometer the scientists measured the responsiveness of 33 young, healthy, non-smoking subjects to varying concentrations of volatile fatty acids, alone or in combination and found the following odor thresholds (ODTs) for volatile fatty acids that were found of the Himsels' and Lannons' properties.

Table 2 Quantification of the parameters from the group psychometric function for each acid, considering all subjects (upper part) and only the common subjects tested with all five odorants (lower part)

	n	ODT (ppb)	C (log ppb)	SE (C)	D	SE (D)	R^2
All subjects							
Formic acid	18	514	2.711	0.062	0.30	0.06	0.954
Acetic acid	16	5.2	0.716	0.021	0.25	0.02	0.994
Butyric acid	14	0.26	−0.584	0.019	0.16	0.02	0.994
Hexanoic acid	18	1.0	0.008	0.023	0.22	0.02	0.993
Octanoic acid	14	0.86	−0.066	0.026	0.20	0.02	0.990
Common subjects							
Formic acid	3	485	2.686	0.072	0.16	0.06	0.909
Acetic acid	3	5.7	0.759	0.045	0.18	0.04	0.970
Butyric acid	3	0.23	−0.630	0.035	0.09	0.02	0.976
Hexanoic acid	3	1.1	0.024	0.036	0.17	0.03	0.979
Octanoic acid	3	1.1	0.042	0.038	0.20	0.03	0.981

Columns show number of subjects (*n*), ODT (in ppb), parameters C (log of ODT) and D (function steepness) with their respective standard error (SE), and goodness of fit (R^2)

Earlier, in 2007, scientists with the Monell Chemical Senses Center, the Flavor System & Technology Laboratory, and the University of Pennsylvania School of Medicine examined human responsiveness to mixtures of individual volatile fatty

[15] Cometto-Muñiz, J., & Abraham, M. (2010). Structure–activity relationships on the odor detectability of homologous carboxylic acids by humans. *Experimental brain research*, 207(1-2), 75-84.

acids to determine whether mixtures elicit an additive response.[16] These scientists found:

> "Additivity of detectability was assessed with respect to response addition (independent processing of mixture components). For C2 [acetic acid]+ C6 [hexanoic acid], for which the mixture components differed by 4 methylene units, and C2 [acetic acid] + C8 [octanoic acid], which differed by 6 methylene units, *response addition provided a reasonably good description of detection at all levels of performance*. In contrast, for C2 [acetic acid] + C4 [butyric acid], which differed by only 2 methylene units, detection showed a tendency to exceed additivity at low concentrations but fell below additivity at higher concentrations."

Therefore, responsiveness to the mixtures of volatile fatty acids found on the Himsels' and Lannons' properties should be assumed to elicit an additive response to humans on the properties. Applying this assumption to levels of volatile fatty acids found on the Himsels' and Lannons' properties shows the mixtures of C2, C4, C6 and C8 volatile fatty acids found on those properties exceed human odor thresholds for these substances by roughly 28-fold on both properties.

Volatile Fatty Acid levels at Clients Property, parts per billion (ppb)

	Acetic Acid (C2)	Butyric Acid (C4)	Hexanoic Acid (C6)	Octanoic Acid (C8)	
Himsel Property, 20 June	24.0	1.3	15.0	2.6	
Lannon Property, 30 June	37.0	1.0	7.2	9.1	
Odor Threshold[FN1]	5.2	0.26	1	0.86	Cumulative exceedance of odor threshold assuming additivity [FN2]
Multiple of odor threshold, %					
	Acetic Acid (C2)	Butyric Acid (C4)	Hexanoic Acid (C6)	Octanoic Acid (C8)	
Himsel Property, 20 June	462%	500%	1500%	302%	2764%
Lannon Property, 30 June	712%	385%	720%	1058%	2874%

Odor Threshold = reliable detection of odor by 50% of healthy, non-smoking subjects, 5-second controlled exposure

FN1: Cometto-Muñiz, J. E., & Abraham, M. H. (2010). Structure–activity relationships on the odor detectability of homologous carboxylic acids by humans. Experimental brain research, 207(1-2), 75-84.
FN2: Wise, P. M., Miyazawa, T., Gallagher, M., & Preti, G. (2007). Human odor detection of homologous carboxylic acids and their binary mixtures. Chemical senses, 32(5), 475-482

The odors associated with exposure to of C2, C4, C6 and C8 volatile fatty acids have been described as 'sour,' 'pungent,' 'fecal,' 'stench,' and 'rancid.'[17] There is an evolutionary basis for how volatile fatty acids are perceived. Since rotting organic matter, including vomit, is the source of volatile fatty acids, the olfactory systems have evolved to be repulsed by volatile fatty acids as an avoidance mechanism against pathogens in rotting material.

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[16] Wise, P. M., Miyazawa, T., Gallagher, M., & Preti, G. (2007). Human odor detection of homologous carboxylic acids and their binary mixtures. *Chemical senses*, *32*(5), 475-482.
[17] Goldstein, N. (2002). Getting to know the odor compounds. *Biocycle*, 43(7), 42-44.

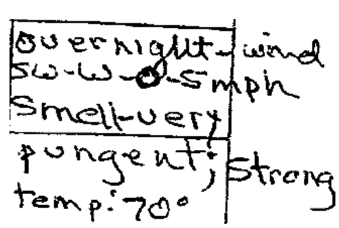
The presence on the Himsels' and Lannons' properties of C2, C4, C6 and C8 volatile fatty acids at roughly 28-times their odor threshold on an additive basis, combined with contemporaneously recorded observations of odor intensity, demonstrates that the Himsels and Lannons are exposed to noxious levels of volatile fatty acids.

The presence of C3 (propionic acid), C5 (pentanoic acid) and C7 (heptanoic acid) at levels above 1 ppb on the Himsels' and Lannons' properties would further add to the intensity of noxiousness associated with exposure to of C2, C4, C6 and C8 volatile fatty acids discussed above.

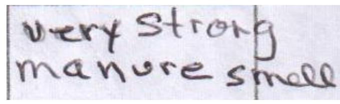
Because samples were collected over a 100-minute period, levels of volatile fatty acids measured in the samples are *average levels* over the 100-minute period. Because levels of gases in ambient air emitted by fugitive sources fluctuate over time (for example, due to variable winds), then the Himsels' and Lannons' properties would have experienced peak levels of volatile fatty acids higher than the average levels that are reported.
Field blanks were collected by cutting open and immediately capping sorbent tubes from the Himsels' and Lannons' properties. No ambient air was pumped through the tubes. The absence of detectable levels of volatile fatty acids in the Field Blanks rules out the possibility that volatile fatty acids detected in the pumped air samples are spurious results associated with a defect in the sorbent tubes or how they were handled.

<u>VI. RESULTS: AMMONIA</u>

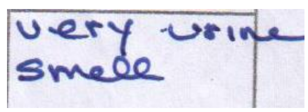
On June 11th-12th, 2016, from 9:30 a.m. to 9:30 a.m., an air sample was collected on the Himsels' property, on the patio to the south side of the home. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 10-15 miles per hour (mph) and weather was recorded to be partly sunny with a temperature between 70° F and 92° F. Susan Lannon, who collected the sample, recorded the following observation:



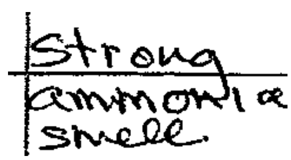
On June 20th, 2016, from 9:50 a.m. to 9:50 p.m., a second air sample was collected on the Himsels' property, on the patio to the south side of the home. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 10-15 miles per hour (mph) and weather was recorded to be partly sunny with a temperature between 79° F and 91° F. Susan Lannon, who collected the sample, recorded the following observation:



On June 26th, 2016, from 9:45 a.m. to 7:15 p.m., an air sample was collected on the Lannons' property, in the front yard of the home. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 8-15 miles per hour (mph), calming around 7:00 p.m. and changing to the north as a storm was approaching. Susan Lannon, who collected the sample, recorded the following observation:



On July 7th-8th, 2016, from 9:00 a.m. to 9:00 p.m., an air sample was collected on the Lannons' property, in the front yard of the home. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 5-10 miles per hour (mph), then changing to the west. Susan Lannon, who collected the sample, recorded the following observation:



For the air sample collected on the Himsels' property on June 11th-12th, 2016, the following level of ammonia was found: **70.6 parts per billion (ppb)**.

For the air sample collected on the Himsels' property on June 20th, 2016, the following level of ammonia was found: **93.4 ppb**.

For the air sample collected on the Lannons' property on June 26th, 2016, the following level of ammonia was found: **118.2 ppb**.

For the air sample collected on the Lannons' property on July 7th-8th, 2016, the following level of ammonia was found: **25.5 ppb**.

A. Comparison to levels of ammonia typically found in outdoor air

Levels of ammonia typically found in outdoor air are at least an order of magnitude lower compared to the levels of ammonia found on the Himsels' and Lannons' properties. According to the National Library of Medicine's TOXNET toxicology data network[18]:

> "Atmospheric Concentrations:
> In fall 1979, the concentration of gaseous ammonia in air samples taken at ground-level at urban Hampton and rural Langley, VA, ranged from 0.2-4.0 and from 1.5-4.0 ppb, respectively(1). Ammonia concentrations obtained in December 1979 on Long Island, NY, ranged from 80-200 nmol/cu m(1). [(1) ATSDR; Toxicological Profile for Ammonia. Atlanta, GA: Agency for Toxic Substances and Disease Registry, US Public Health Service (2004)] **PEER REVIEWED**"

B. Significance of the levels of ammonia found on the Himsels' and Lannons' properties

The odor of ammonia is distinctly pungent and irritating and odor thresholds for ammonia cover a wide range, with some persons detecting ammonia only above 2500 ppb and some persons detecting ammonia at 40 ppb.[19] Levels of ammonia on the Himsels' property averaged 82 ppb, while levels of ammonia on the Lannons' property averaged 71.9 ppb, which are levels above the level at which some persons detect ammonia.

Air sampling for ammonia at the Himsels' property took place over a cumulative period of *32 hours*, while air sampling for ammonia at the Lannons' property took place over a cumulative period of *45.5 hours*. Because levels of gases in ambient air emitted by fugitive sources fluctuate over time, and because the cumulative periods for collecting samples analyzed for ammonia were of such long duration, then the Himsels' and Lannons' properties would have experienced peak levels of ammonia substantially higher than the average levels that are reported.

VII. RESULTS: SULFIDES AND MERCAPTANS

On July 4th at 7:15 p.m. a 1-L sample of air was collected from the Himsels' property in a Summa canister. During the collection of the sample, winds were recorded calm and the weather was recorded to be overcast with a temperature of 80^{o} F. Susan Lannon, who collected the sample, recorded the following observation:

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18 https://toxnet.nlm.nih.gov/cgi-bin/sis/search2/f?./temp/~yj1BZG:1

19 Michaels, R. A. (1999). Emergency planning and the acute toxic potency of inhaled ammonia. *Environmental health perspectives*, 107(8), 617: van Thriel, C., Schäper, M., Kiesswetter, E., Kleinbeck, S., Juran, S., Blaszkewicz, M., ... & Brüning, T. (2006). From chemosensory thresholds to whole body exposures—experimental approaches evaluating chemosensory effects of chemicals. *International archives of occupational and environmental health,* 79(4), 308-321.

Smells like hog shit. & skunky smell

On July 5th at 6:30 p.m. a 1-L sample of air was collected from the Lannons' property in a Summa canister. During the collection of the sample, winds were recorded as coming from the southwest direction (SW) at a speed of 5 mph, with a temperature of 89^{o} F. Susan Lannon, who collected the sample, recorded the following observation:

PUNGENT

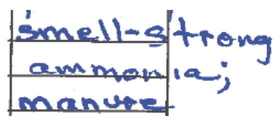
No detectable levels of sulfides and mercaptans were found in either sample.
In concentrated swine operations, carbon-based material in liquid manure is raw material for generation of volatile fatty acids; nitrogen-based material in liquid manure is the raw material for generation of ammonia; and sulfur-based material in liquid manure is the raw material for the generation of sulfides and mercaptans. In liquid manure, carbon-based material predominates, with smaller amounts of nitrogen and sulfur. Elemental analysis of liquid manure at the CAFO in question shows a sulfur content of 0.06% compared to a nitrogen content of 0.53%, which is a possible explanation for why ammonia, but not sulfides and mercaptans were detected on the Himsels' and Lannons' properties.

ANALYSIS	PERCENT(%)	LBS PER 1000 GAL	LBS/TON
TOTAL NITROGEN	0.53	44.22	10.60
NITROGEN FROM AMMONIA	0.36	30.03	7.20
PLANT AVAILABLE NITROGEN	0.44	36.71	8.80
PHOSPHORUS (P2O5)	0.22	18.81	4.50
POTASSIUM (K2O)	0.38	31.93	7.65
CALCIUM	0.12	10.83	2.59
MAGNESIUM	0.07	6.43	1.54
SODIUM	0.11	9.34	2.23
SULFUR	0.06	5.70	1.36

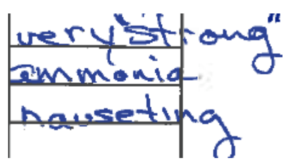
VIII. RESULTS: AMINES

On July 13th, 2016, from 12:00 p.m. to 1:40 p.m., an air sample was collected on the Lannons' property, in the front yard of the home. During the collection of the sample, winds were recorded to be from the south-southwest (SSW) direction at a speed of 1-5 miles per hour (mph). Susan Lannon, who collected the sample, recorded the following observation:

On July 20th, 2016, from 6:30 p.m. to 8:10 p.m., a second air sample was collected on the Lannons' property, in the front yard of the home. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 1-5 mph and weather was recorded to be partly cloudy with a temperature of 84° F. Susan Lannon, who collected the sample, recorded the following observation:



On July 28th, from 6:20 p.m. to 8:00 p.m, an air sample was collected on the Himsels' property, on the patio to the south side of the home. During the collection of the sample, winds were recorded to be from the southwest (SW) direction at a speed of 3-7 mph and weather was recorded to be sunny with a temperature of 86° F. Susan Lannon, who collected the sample, recorded the following observation:



No detectable levels of amines were found in the three samples.

Trimethylamine is a major odorant emitted by concentrated swine operations. It is the chemical I targeted in deciding to test for levels of amines on the Himsels' and Lannons' properties. The reported odor threshold for trimethylamine is between 0.2 and 0.87 ppb.[20] The method reporting limit (MRL) for trimethylamine of the method used for measuring levels of amines on Himsels' and Lannons' properties is 4.2 ppb, significantly above the odor threshold for trimethylamine.

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[20] https://hazmap.nlm.nih.gov/category-details?table=copytblagents&id=219

CAS #	Compound	Result µg/Tube	Result µg/m³	MRL µg/m³	Result ppbV	MRL ppbV
124-40-3	Dimethylamine	< 1.1	ND	11	ND	5.7
75-04-7	Ethylamine	< 1.1	ND	11	ND	5.8
75-50-3	Trimethylamine	< 1.0	ND	10	ND	4.2

Therefore, although no detectable levels of amines were found, the method cannot rule out the presence of odorous levels of trimethylamine on Himsels' and Lannons' properties.

IX. OCULAR AND OLFACTORY INSPECTION

On the day I trained the Himsels and Lannons to collect air samples (June 11th, 2016), I conducted an ocular and olfactory inspection of the *immediate vicinity* of Himsels' and Lannons' properties, and the *general surrounding* area of their properties.

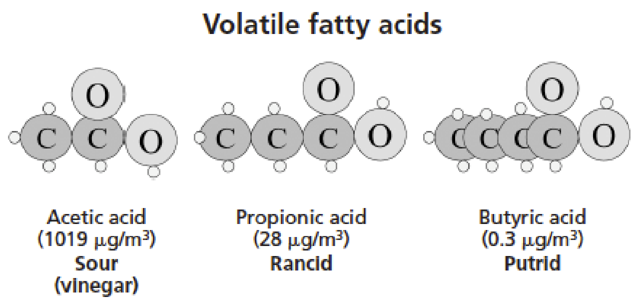
With respect to the immediate vicinity of Himsels' and Lannons' properties, I began walking from the Himsels' property in a south-by-southwesterly direction trough a soybean field towards the at-issue CAFO, stopping 60 yards from the eastern edge of the CAFO on North County Road 425 W. Throughout my inspection, winds were blowing from the southwest – that is from the CAFO and towards the Himsels' property. The intensity of the malodor I experienced in the immediate vicinity of the Himsels' and Lannons' properties consistently increased as I grew closer to the CAFO.

With respect to the general area surrounding the Himsels' and Lannons' properties, I rode slowly with the window down as a passenger in a vehicle over an area with a 3-mile radius surrounding the Himsels' and Lannons' properties. I requested that the vehicle stop at any area of significant interest, including lagoons and animal barns and sheds. At no other location during this inspection of the general surrounding area did I detect the malodor that I detected during my inspection of the immediate vicinity of Himsels' and Lannons' properties.

X. CONCLUSIONS

The evidence I gathered demonstrates that Himsels' and Lannons' complaints of noxious odors on their properties are proximately caused by the operation of the CAFO. Studies have characterized the identity of chemicals emitted by swine CAFOs that cause noxious odors. Two classes of chemicals with noxious odors – volatile fatty acids and ammonia – were found on the Himsels' and Lannons' properties at levels that can cause a noxious response at the same time the Himsels and Lannons observed experiencing noxious odors. The noxious odors that they observed were that same odors I observed over a gradient that continually increased when walking closer and closer to the CAFO.

The evidence I gathered demonstrates that chemicals with noxious odors emitted by the CAFO have traveled onto the Himsels' and Lannons' properties. Although gaseous and therefore invisible to the naked eye, as diagrammed below[21], volatile fatty acids and ammonia found on the Himsels' and Lannons' properties at levels above their odor detection thresholds are *space-filling* compounds that were occupying a discrete portion of the Himsels' and Lannons' properties (see figure below).



My examination of 34 Daily Observation Reports containing contemporaneous observations by the plaintiffs over the period of June 11th to November 2nd of 2016 of odors they experienced lead me to conclude that the entry onto plaintiffs properties of noxious chemicals emitted by defendants' CAFO is ongoing. The plaintiffs' observations are consistent with what I personally experienced when I visited the site on June 11th, 2016; these observations are consistent with continuing, unchanged operations at the CAFO.

In my professional opinion, the foregoing findings are expected given the nature of emissions that swine CAFOs are well-known to generate and the short distance upwind from the Himsels' and Lannons' properties where the Defendants chose to locate the CAFO.

I affirm, under the penalties for perjury, that the foregoing representation(s) are true.

Date: 14 December 2016

Mark Chernaik, Ph.D.

[21] Goldstein, N. (2002). Getting to know the odor compounds. *Biocycle*, 43(7), 42-44.