# EXPERT REPORT

# OF

# ROBERT S. LAWRENCE, M.D.

**Community Association for Restoration of the Environment, Inc.**

**and Center for Food Safety, Inc.,**

**v.**

**Cow Palace, LLC**

(E.D. Wash. No. CV-13-3016-TOR)

**Prepared for:**

Law Offices of Charles M. Tebbutt, P.C.
941 Lawrence Street
Eugene, OR 97401

Public Justice
1825 K Street, NW Suite 200
Washington, D.C. 20006

Center for Food Safety, Inc.
303 Sacramento Street, 2nd Floor
San Francisco, CA 94111

*This Expert Report contains information designated by Defendant Cow Palace, LLC, as "CONFIDENTIAL" under the Stipulated Protective Order (ECF No. 82)*

**INTRODUCTION**

1. I have been retained by the Plaintiffs, Community Association for Restoration of the Environment ("CARE") and Center for Food Safety ("CFS") (collectively "Plaintiffs"), to evaluate facts and science and to render opinions on health risks associated with the Defendant Cow Palace's manure management practices in the Lower Yakima Valley. My opinions focus primarily on the health impacts and risks associated with exposure to nitrates, veterinary pharmaceuticals, hormones, pathogens, and zoonotic diseases primarily from drinking water, but also through other potential pathways, by the Defendant, Cow Palace, LLC (hereinafter "Defendant" or "Cow Palace").

2. My review of the information made available to me confirms that the environment, and the residents of the Lower Yakima Valley, are exposed to significant risks to their health and wellbeing resulting from manure loading and nitrate contamination of groundwater used as the source of drinking water. The maximum contaminant level ("MCL") for nitrate in drinking water established by the U.S. Environmental Protection Agency is 10 milligrams per liter ("mg/L"), also calculated as parts per million or "ppm", while the MCL for nitrite is 1 mg/L, owing to the greater toxicity of nitrite. Health effects in the human population have been documented at exposure levels below 10 mg/L, suggesting that the EPA MCL may need to be lowered. The Defendant's contributions to groundwater contamination, as established by the EPA, the data generated by the Dairies under the 2013 Administrative Order on Consent

("AOC"),[1] and the Plaintiffs' other experts, pose significant health threats to the human population coming in contact with the contaminated water. Other related threats to health from contaminated surface water and air exposure from the dairies also exist, but my work has not specifically evaluated them. Nonetheless, these additional exposures present additional health concerns.

3. I am a Professor of Environmental Health Sciences, Health Policy and Management, and International Health at the Johns Hopkins Bloomberg School of Public Health. I am also a Professor of Medicine at the Johns Hopkins School of Medicine. I am the founding director of the Center for a Livable Future ("CLF") at Johns Hopkins University.

4. I graduated from Harvard College with a B.A. in History, magna cum laude, while completing my premedical course requirements in chemistry, physics, biology, and mathematics. I received my M.D. from Harvard Medical School in 1964 and completed my training in internal medicine at the Massachusetts General Hospital. I am certified by the American Board of Internal Medicine and am a Master of the American College of Physicians. I served for three years as an Assistant Surgeon in the Commissioned Corps of the U.S. Public Health Service as an Epidemic Intelligence Service officer at the Centers for Disease Control and Prevention. In 1978, I was elected to the Institute of Medicine of the National Academies of Science.

5. From 1970 to 1974, I was a member of the faculty of the University of North Carolina School of Medicine where I headed the Community Medicine Divisions in the Department of Medicine and the Department of Family Medicine. From 1974 to

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[1] U.S. EPA Region 10, In the Matter of Yakima Valley Dairies, Administrative Order on Consent ("AOC"), Docket No. SDWA-10-2013-0080 (Mar. 5, 2013).

1991, I served on the faculty of the Harvard Medical School as director of the Harvard Primary Care Division. From 1980 to 1991, I also served as Chief of Medicine at the Cambridge Hospital and as the Charles Davidson Associate Professor of Medicine. In 1991, I was appointed Director of Health Sciences at the Rockefeller Foundation where I was responsible for grant-making and evaluation of health programs in Asia, Africa, and Latin America. In 1995, I became Associate Dean for Professional Programs and Practice and Professor of Health Policy and Management at the Johns Hopkins Bloomberg School of Public Health. I served as Associate Dean until June 2006. Since then I have devoted my time as Professor of Environmental Health Sciences and Director of the CLF.

6. The mission of the CLF is to "promote research and to develop and communicate information about the complex interrelationships among diet, food production, environment, and public health; to advance an ecological perspective in reducing threats to the health of the public, and to promote policies that protect health, the global environment and the ability to sustain life for future generations."

7. I have significant experience in the field of public health risks related to industrial farm animal food production methods such as those used in the Defendant's operation. Some of my experiences most salient to this matter are described below.

   a. In 1996, I founded CLF. CLF is an inter-disciplinary group of faculty and staff that focuses attention on equity, health, and stewardship of the Earth's resources. Through research, education, policy development, and advocacy, CLF examines the relationships among diet, food production systems, the environment, and human health. Through CLF, I have focused my academic work on the problems of food systems, food security, and the threats to the environment and to public health posed by industrial food animal production. CLF conducts, supervises, and funds research on such topics as the emergence of antibiotic resistant bacteria as a consequence of the use of sub-therapeutic antibiotics in animal feed or water for growth promotion and disease prevention; the contamination of air, water, and soil by bacteria, protozoan parasites, viruses, organic wastes such as ammonia and other nitrogen compounds, the composition of feed used in industrial food animal production, the adverse effects of excess nutrients such as nitrogen and phosphorus from wastes produced by animals raised in confinement operations, the contamination of the environment and food products with arsenic as a consequences of the regular use of Roxarsone and other organic arsenic containing coccidiostats, used as growth promoters, and the impact of industrial dairy production on air and water quality. I have co-authored policy papers describing the harmful effects of the industrialization of agriculture and concentrated animal feeding operations on the ecosystem, the safety and quality of the food supply, and the degradation of air, water, and soils by excess concentrations of animal waste from dairy, beef cattle, swine, and poultry concentrated feeding operations, and the human health risks from air pollution with animal dander, dried manure fomites, endotoxins, ammonia, and hydrogen sulfide generated by CAFOs.

b. In 2005, the Pew Charitable Trusts provided grant support to the Johns Hopkins Bloomberg School of Public Health to establish the Pew Commission on Industrial Farm Animal Production. I served as co-principal investigator ("PI") on the grant for the first year and as Principal Investigator for the final year and a half of the project. Several colleagues and faculty members of the CLF contributed background technical reports to the Commission. As Co-PI and PI, I was responsible for working with the Pew Charitable Trusts in recruiting the executive director of the Commission, and the members of the Commission. The final report of the Commission was released on April 29, 2008, with the summary conclusion that the current industrial food animal production system poses unacceptable risks to the health of the public, the environment, rural communities, and the welfare of animals themselves. The final report made 23 specific recommendations to curb risks to public health and the environment. These recommendations were categorized into four areas: public health, environment, animal welfare, and community impacts. Some of these recommendations pertain to the type of manure management practices performed at the Defendant's facility.[2]

c. In Fall 2013, CLF authored a follow-up analysis to the Pew Commission's 2008 investigation, "Industrial Food Animal Production in America: Examining the

[2] *See, e.g.*, Recommendations: Public Health # 4(c) (monitor farm soil and water for antimicrobial resistant organisms); Environment # 1 (improve enforcement), # 2 (implement new farm waste management systems within 10 years to protect public health and the environment), # 3 (increase and improve waste management monitoring), # 4 (increase research funding for improving waste management systems); Animal Welfare # 4 (better welfare practices will decrease threat waste management poses to public health); Community Impacts # 1 (better evaluation of site suitability for industrial animal facilities, including better evaluation of lagoon and land application suitability). Pew Charitable Trusts and Johns Hopkins School of Public Health, "Putting Meat on the Table: Industrial Farm Animal Production In the United States." (2008) (hereinafter "Pew Commission Report").

Impact of the Pew Commission's Priority Recommendations."[3] The 2013 Analysis provided specific recommendations to begin implementing the recommendations made in 2008. In 2013, CLF recommended phasing out and banning non-therapeutic antimicrobials, improving disease monitoring and tracking, improving environmental regulation, and phasing out intensive confinement, among others recommendations.

d. Johns Hopkins and CLF researchers have also studied harmful air contaminants from dairies in the Lower Yakima Valley. In 2011, D'Ann L. Williams and colleagues published a scientific study examining the impacts of large-scale dairy operations on nearby communities by assessing particulate matter, ammonia, and cow allergen inside and outside homes in the Yakima Valley.[4]

8. All opinions expressed herein are to a reasonable degree of scientific certainty, unless otherwise specifically stated. I reserve the right to modify or supplement this report based on information obtained by me or the Plaintiffs after the date of this report.

9. My qualifications, including publications I have authored in the last 10 years, may be found in Attachment A to this report. I have not testified as an expert at depositions or at trial in the last four years. My fees for working on this project are $200 per hour, including travel time, plus travel and office-related expenses. Deposition and trial time is billed at $200 per hour.

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[3] Center for a Livable Future, "Industrial Food Animal Production in America: Examining the Impact of the Pew Commission's Priority Recommendations." (Oct. 22, 2013) (hereinafter "CLF Analysis").

[4] Williams, D. et al. "Airborne cow allergen, ammonia and particulate matter at homes vary with distance to industrial scale dairy operations: an exposure assessment." Environ. Health. Vol. 10:72 (2011).

**SUMMARY OF CONCLUSIONS**

10. Based on the materials I have reviewed in connection with this matter, in my opinion it is clear that the Defendant's manure management practices not only cause, but are, and have been, causing an imminent and substantial endangerment to human health or the environment, and that to protect public health, actions must be immediately implemented to curb the amount of contaminants reaching groundwater and remediate the contamination caused by Defendant's practices. The amounts of manure generated by the Defendant, the Defendant's lack of protective measures for environmental and health concerns, and the high levels of contaminated drinking water in the aquifers below the Defendant's facility all indicate that the Defendant's contributions to groundwater contamination pose significant health threats to the human population that comes in contact with the contaminated water. Related health threats through contact with contaminated surface water and air exposure from the dairies also exist but have not been evaluated in detail as part of my work. Nonetheless, these exposures present additional health concerns.

**BASES AND METHODOLOGY**

11. I reviewed a number of discovery documents, data, samples, and studies in analyzing this case and developing my opinion. My analyses and opinions are based on my decades of experience as a medical doctor and my years of experience studying industrial food animal production facilities. I have reviewed documents relevant to all of the Cluster Defendants' facilities (Cow Palace, Bosma/Liberty, and DeRuyter/D&A) (collectively "Cluster Defendants" or "Defendant Dairies"), including those specific to Cow Palace. These documents can be summarized as

originating from the categories listed below. A specific index of the records I have consulted may be found as Attachment B to this report.

a. A wide array of publicly-available records from federal and state agencies, and their subagencies and departments, which can be summarized as including records from U.S. Environmental Protection Agency ("EPA"), U.S. Department of Health and Human Services ("HHS"), Washington State Departments of Ecology, Agriculture, and Health, and the Yakima County Department of Health.[5]

b. I reviewed studies on nitrates in groundwater in the region, including the Valley Institute for Research and Education study and the Heritage College Study.

c. Documents produced by EPA and the Defendant Dairies pursuant to the Administrative Order on Consent (Docket No. SDWA-10-2013-0080), including summaries of groundwater sampling data for monitoring wells, soil sampling, and sampling of residential wells.[6]

d. Records resulting from the implementation of the AOC, as developed by the Defendant Dairies' third-party contractor, Arcadis, and its sub-contractors.

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[5] For example, U.S. EPA, "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington" (EPA-910-R-13-004) (March 2013) (hereinafter "EPA Study"); EPA "Monitoring Well Installation & Data Summary Report Lower Yakima Valley, Yakima Co., Washington" (March 2013); EPA "Case studies on the impact of CAFOs on Ground Water Quality" (Sept. 2012); USGS "River-Aquifer Exchanges in the Yakima River Basin, Washington" (2011); EPA regulatory and policy documents regarding the MCL for nitrate; U.S. Census Bureau data; U.S. Food & Drug Administration National Antimicrobial Resistance Monitoring System reports (1998 and 1999); various U.S. Department of Health & Human Services, Centers for Disease Control and Prevention reports on nitrates, methemoglobinemia, spontaneous abortions, neural tube defects, and E. coli; Washington Department of Ecology reports on the Sumas-Blaine Aquifer (2012); Washington Department of Health reports "Well Water Quality and Infant Health Study" (2009) and "Nitrate Contamination of Drinking Water in Washington State" (2000); and Yakima County Nitrate Treatment Pilot Program and Final Report (June 30, 2011).

[6] *See* Attachments C and D.

Specifically, I have reviewed the March 2014 Provision of Water Residential Well Sampling Report,[7] and data culled from monitoring well and soil sampling events pursuant to the AOC in 2013 and 2014.[8]

e. Pleadings filed with the Court in this matter.

f. Discovery documents produced by both the Plaintiffs and the Defendant and Defendant Dairies in these cases (including data from the other surrounding facilities). Among the discovery documents, I reviewed Plaintiffs' well tests 2010-2014 (CARE025661-024673, CARE029370), Plaintiffs' sampling data from October 2013 and May 2014 (CARE029385-029690), Defendant Dairies' sampling data from August 2013 and later (*See* Summary of Arcadis records prepared by the Law Offices of Charles M. Tebbutt, P.C., Attachments C and D; SITE INSP00001-000043), Cow Palace's treatment records, notes, protocols, and explanations, and Cow Palace's feed and veterinary invoices (COWPAL010673-014464; COWPAL004291-008205).

g. Peer-reviewed scientific and policy publications related to: 1) industrial food animal manure production and management; 2) the predominance of contaminants[9] in groundwater, surface water, and soils near industrial food animal production facilities; 3) potential and actual health impacts of contaminants in groundwater, surface water, and soil; and 4) methods to curb or eliminate the

[7] DAIRIES008111-008726.
[8] *Supra* n. 7.
[9] For purposes of this Expert Report, "contaminants" include nitrates, veterinary pharmaceuticals, hormones, and pathogens as enumerated by the Plaintiffs' Notices of Intent to Sue served in this matter, and veterinary pharmaceuticals and hormones purchased or administered by the Defendant as indicated in treatment records COWPAL010673-014464, invoices COWPAL004291-008205, and deposition testimony.

presence of contaminants in groundwater, surface water, and soil so as to minimize or eliminate the risks to human health.

**BACKGROUND**

**12. CAFOS AND PUBLIC HEALTH IMPACTS, GENERALLY & BRIEFLY**

a. Animals raised in confinement produce large amounts of animal waste concentrated in a small area, contributing pathogens to air, water, and soil; and increasing the risk of infectious diseases and food-borne infection. To store CAFO manure, millions of gallons of liquid waste are commonly stored in open cesspits or "lagoons," while solid waste is often stored in piles at the facilities. In contrast with pasture-raised animals whose waste is spread over vegetation and incorporated with the organic matter in soil, CAFOs create and accumulate manure far beyond what can be absorbed and used by the crops.

b. The impacts of surface water contamination from manure escaping the confines of industrial animal farms are well documented. This contamination has caused numerous bacterial outbreaks, some of which have sickened hundreds of people and killed others.[10] Groundwater contamination from manure is increasingly well-recognized as a health and ecosystem problem. As animal waste decomposes, it creates ammnonia, nitrite, and nitrate. Nitrates and nitrites are hazardous to human health, especially to infants, the most vulnerable members of the human community. Nitrates and nitrites interact with organic material commonly found in polluted water to produce carcinogenic nitrosamines. These

[10] Pew Commission Report at 11.

kinds of water contamination spread well beyond the boundaries of a facility, putting the health of the public at risk.[11]

c. In addition to nitrates and nitrites from manure, industrial food animal facilities purchase and administer large quantities of drugs, including antibiotics, feed additives, and hormones. Many of these drugs are excreted in their active form, thus creating additional public health concerns for the presence of veterinary pharmaceuticals and hormones in manure, soil, and increasing the risks of water contamination.

d. Residential wells near the Cow Palace and Cluster Dairies were sampled for nitrate, nitrite, veterinary pharmaceuticals, and hormones. Nitrate and nitrate levels have shown sampling in excess of the MCL. Veterinary pharmaceutical and hormone sampling has shown the presence of these compounds in residential drinking water.

**NITRATES**

**13. Nitrate, nitrite, and ammonia, and how they interact with human health.**

a. Understanding the environmental fate of nitrate and nitrite can help pinpoint potential sources of exposure, and is important to assess patient exposure risk, prevention, and mitigation, and adverse health effects from exposure.[12] Nitrogen is a chemical element that can exist in different forms when linked to other elements. For purposes of this report, I considered the health impacts of nitrate ($NO_3$), nitrite ($NO_2$), and ammonia (NH3). Nitrate and nitrite exist in organic and

[11] Pew Commission Report at 11.
[12] U.S. Department of Health & Human Services, Agency for Toxic Substances and Disease Registry, "ATSDR Case Studies in Environmental Medicine Nitrate/Nitrite Toxicity," at 23 (Dec. 5, 2013) (hereinafter "ATSDR").

inorganic forms. Most organic forms of nitrate and nitrite ingested by humans are synthesized medicinal products and are usually small hydrocarbon chains attached to a nitro-oxy-radical ($-ONO_2$). Additional ingestion occurs when microbial action in soil or water decomposes wastes containing organic nitrogen into ammonia, which is then oxidized to inorganic nitrite and nitrate.[13] Nitrite is easily oxidized to nitrate, which is the compound predominantly found in groundwater and surface water.[14] Most consumption of nitrate through water is likely to occur by consuming drinking water, cooking with water, and other food and drink preparation activities. Cooking does not eliminate nitrate levels in water.[15] As water boils and converts liquid to water vapor, the concentrate of nitrate can actually increase in the remaining liquid phase of water.[16] There are other potential methods of inadvertent exposure as well, such as brushing teeth, and ingesting water while bathing, showering, or using pools and sprinklers. Nitrate is not absorbed through the skin so contaminated water can be used for bathing, but only if care is taken not to ingest any water. This is not an easy task with certain populations, such as children.

b. The MCL for nitrate is 10 mg/L (ppm), while the MCL for nitrite is 1 mg/L because of its greater toxicity through binding affinity for hemoglobin, which reduces the capacity of the blood to transport oxygen.

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[13] *See, e.g.*, ATSDR at 20, 22.
[14] Id.
[15] *See, e.g.*, CDC, Drinking Water, "Nitrate and Drinking Water from Private Wells." (Dec. 2, 2009).
[16] Id.

c. Once ingested, nitrate is converted to the more potent toxic compound nitrite and can cause adverse health effects. The conversion can occur quickly after ingestion through bacteria in saliva, the stomach, and small intestine.[17] Some studies have identified increases in inorganic nitrite levels 1 hour post-ingestion, peaking at 3 hours post-ingestion.[18]

d. Certain factors influence the conversion from nitrate to nitrite and its toxicity. *In vivo* (in the body) conversion of nitrate to nitrite can significantly enhance nitrate toxicity.[19] Also, pH levels affect the conversion. Infants typically have high pH levels (less acidity) in their gastrointestinal systems, making them more susceptible to nitrite toxicity from elevated ingestion levels.[20] Local metabolic conditions such as tissue oxygenation and inflammation can also affect the conversion.[21] With respect to duration of nitrates in the human body, some studies indicate up to 70% may be excreted within 24 hours, but about 25% may be re-absorbed.[22]

e. Ingestion of nitrates can have hematologic effects, cardiovascular effects, and reproductive and developmental effects; nitrates may increase the risk of developing diabetes mellitus, Raynaud's disease, and peripheral neuropathy, and are categorized as "probably carcinogenic to humans" under certain conditions.[23,]

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[17] ATSDR at 43.
[18] ATSDR at 42.
[19] ATSDR at 43.
[20] Id.; *see also* Bryan, N. et al. "The Role of Nitrate in Human Health." Advances in Agronomy Vol. 119 Ch. 3 at 167 (2013) (suggesting infants less than three months are even more susceptible to methemoglobinemia).
[21] ATSDR at 43.
[22] ATSDR at 44.
[23] ATSDR at 48-55.

While exposure to nitrogen-based substances can have many negative health effects, those that are most related to the ingestion of nitrates can include those listed below.[24]

i. Hematologic

1. Methemoglobinemia, also called "Blue Baby Syndrome," is probably the most well-recognized health risk of ingesting nitrates.[25] It is estimated that from 1945 – 1970, about 2,000 infants suffered from Blue Baby Syndrome worldwide and about 10% died.[26]

2. Oxygen deprivation[27]

3. Aggravation of reductase deficiency[28]

ii. Cardiovascular[29]

1. Hypertension

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[24] Note that the studies underlying the U.S. Department of Health and Human Service's Agency for Toxic Substances and Disease Registry ("ATSDR") conclusions are provided by ATSDR; the actual citations are not included in this report.

[25] *See, e.g.*, ATSDR at 15-16; Sunitha, V. "Nitrates in Groundwater: Health Hazards and Remedial Measures." Indian J. of Advances in Chemical Science. Vol. 1(3) pp. 165-170 at 166-167 (2013); Ward, M. et al. "Workgroup Report: Drinking-Water Nitrate and Health – Recent Findings and Research Needs." Environ. Health Perspect. Vol. 113, No. 11 pp. 1607- 1614 at 1608 (Nov. 2005); Knobeloch, L. et al. "Blue Babies and Nitrate-Contaminated Well Water." Environ. Health Perspect. Vol. 108, No. 7 pp. 675-678 (July 2000); Craun, G. et al. "Methemoglobinemia Levels in Young Children Consuming High Nitrate Well Water in the United States." International J. of Epidemiology. Vol. 10, No. 4 pp. 309-318 (1981).

[26] ATSDR at 49.

[27] *See, e.g.*, ATSDR at 47.

[28] *See, e.g.*, ATSDR at 48; Gupta, S.K. et al. "Adaptation of cytochrome-$b_5$ reductase activity and methaemoglobinaemia in areas with a high nitrate concentration in drinking-water." Bulletin of the World Health Organization. Vol. 77(9) pp. 749-753 (1999).

[29] *See, e.g.*, Bryan, N. § 2.2 (2013); Gupta, S.K. et al. "Recurrent Acute Respiratory Tract Infections in Areas With High Nitrate Concentrations in Drinking Water." Environ. Health Perspect. Vol. 108, No. 4 pp. 363- 366 (April 2000).

2. Cardiac dysrhythmias[30]

3. Circulatory failure[31]

4. Strokes[32]

5. Heart disease[33]

iii. Reproductive and Developmental[34]

1. Anemia[35]

2. Threatened abortion / premature labor[36]

3. Preeclampsia[37]

4. Spontaneous abortions[38]

5. Intrauterine growth restriction[39]

6. Various birth defects, neural tube defects, oral cleft defects, and central nervous system defects[40]

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[30] *See, e.g.,* ATSDR at 47.
[31] Id.
[32] *See, e.g.,*ATSDR at 53.
[33] Id.
[34] *See, e.g.,* Brender, J. et al. "Prenatal Nitrate Intake from Drinking Water and Selected Birth Defects in Offspring of Participants in the National Birth Defects Prevention Study." Environ. Health Perspect. Vol. 121, No. 9 pp. 1083- 1089 (Sept. 2013).
[35] *See, e.g.,* ATSDR at 53; Tabacova, S. et al. "Maternal Exposure to Exogenous Nitrogen Compounds and Complications of Pregnancy." Archives of Environ. Health. 52 (5) (Sept./Oct. 1997).
[36] Id.
[37] Id.
[38] *See, e.g.,* ATSDR at 53; Ward (2005); CDC "Spontaneous abortions possibly related to ingestion of nitrate-contaminated well water – LaGrange County, Indiana, 1991-1994." Morbidity and Mortality Weekly Report. 45.26 at 569 (July 5, 1996); Schmitz, J. Preliminary Report "Methemoglobinemia – A Cause of Abortions?" Obstetrics and Gynecology. Vol. 17, No. 4 (April 1961).
[39] *See, e.g.,* ATSDR at 53.
[40] *See, e.g.,* CDC Notes from the Field "Investigation of a Cluster of Neural Tube Defects – Central Washington, 2010-2013." Morbidity and Mortality Weekly Report. Vol. 62, No. 35 (Sept. 6, 2013) (hereinafter "CDC (2013) Central Washington"; ATSDR at 49, 53; Brender

7. Fetal death[41]

8. Brain tumors[42]

9. Sudden infant death syndrome[43]

iv. Cancers[44]

1. Elevate risks of non-Hodgkin's lymphoma[45]

2. Esophageal[46]

3. Nasopharynx[47]

4. Bladder[48]

5. Colon[49]

6. Prostate[50]

7. Thyroid[51]

8. Potentially stomach and gastro-intestinal cancers[52]

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(2013); Ward (2005) at 1610-1611; Arbuckle, T. et al. "Water Nitrates and CNS Birth Defects: A Population-Based Case-Control Study." Archives of Environ. Health. Vol. 43, No. 2 pp. 162-167 (March/April 1988).

41 *See, e.g.*, ATSDR at 53.

42 *See, e.g.*, Ward (2005) at 1610.

43 *See, e.g.*, George, M. et al. "Incidence and geographical distribution of sudden infant death syndrome in relation to content of nitrate in drinking water and groundwater levels." European J. of Clinical Investigation. Vol. 31 pp. 1083-1094 (2001).

44 *See, e.g.*, Ward (2005) at 1609-1610; Weyer, P. et al. "Municipal Drinking Water Nitrate Level and Cancer Risk in Older Women: The Iowa Women's Health Study." Epidemiology. Vol. 11, No. 3 (May 2001); Tsezou, A. et al. "High Nitrate Content in Drinking Water: Cytogenetic Effects in Exposed Children." Archives of Environ. Health. Vol. 51, No. 6 pp. 458-461 (Nov./Dec. 1996).

45 *See, e.g.*, ATSDR at 54.

46 Id.

47 Id.

48 *See, e.g.*, ATSDR at 54; Ward (2005) at 1609; Weyer (2001).

49 *See, e.g.*, ATSDR at 54; Ward (2005) at 1609.

50 *See, e.g.*, ATSDR at 54.

51 Id.

52 *See, e.g.*, ATSDR at 54; Sunitha (2013) at 166; Ward (2005) at 1609.

9. Tumor development[53]

10. Ovarian[54]

11. Brain[55]

v. Other Effects

1. Central nervous system effects (from circulatory failure) including dizziness, lethargy, coma, convulsions[56]

2. Diabetes mellitus[57]

3. Raynaud phenomena[58]

4. Peripheral neuropathy[59]

5. Recurrent diarrhea[60]

**14. EPA'S MAXIMUM CONTAMINANT LEVEL FOR NITRATE**

a. In 1992, EPA set the MCL for nitrate in public water sources at 10 mg/L under the Safe Drinking Water Act ("SDWA"). 42 U.S.C. § 300g *et seq*.; 40 C.F.R. § 141.5(b). The MCL is set in reliance on EPA determinations for how much of a contaminant may be present with "no known or anticipated adverse health effects on the health of persons" and which "allows an adequate margin of safety" (the

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[53] *See, e.g.*, Bryan (2013) at 155.
[54] *See, e.g.*, Weyer (2001).
[55] *See, e.g.*, Mueller, B. et al. "Household water source and the risk of childhood brain tumours: results of the SEARCH International Brain Tumor Study." International Epidemiological Assoc. Vol. 33 pp. 1209-1216 (2004).
[56] *See, e.g.*, ATSDR at 47, 68.
[57] *See, e.g.*, ATSDR at 54; Parslow, R.C. et al. "Incidence of childhood diabetes mellitus in Yorkshire, northern England, is associated with nitrate in drinking water: an ecological analysis." Diabetologia. Vol. 40 pp. 550-556 (1997).
[58] *See, e.g.*, ATSDR at 54.
[59] Id.
[60] *See, e.g.*, Gupta, S.K. et al. "Recurrent diarrhea in children living in areas with high levels of nitrate in drinking water." Archives of Environ. Health. Vol. 56, No. 4 pp. 369-373 (July/Aug. 2001).

"maximum contaminant level goal" ("MCLG")). 42 U.S.C. §300g-1(4)(A). For nitrates, the MCL and the MCLG are both 10 mg/L. For nitrites, the MCL and MCLG is 1 mg/L. 40 C.F.R. § 141.5(b). The MCL for Total Nitrate + Nitrite is 10 mg/L. 40 C.F.R. § 141.5(b). The EPA's reference dose for the 10 mg/L MCL level is based on an intake of about 7 mg nitrate ion per kilogram body weight per day.[61] In setting MCLs, the EPA recognizes that risk assessment of the toxicity of a compound is a combination of exposure dose and susceptibility of the person exposed. Given biologic variability in susceptibility, the MCL must be set to protect the most vulnerable persons exposed. There is no true threshold for safety but rather a level generally agreed upon as posing an acceptable risk given the costs to society of regulating any given toxin below that level of exposure.

b. Since 1992, peer-reviewed scientific studies suggest there may in fact be adverse health effects from nitrates below the MCL,[62] and that the MCL for nitrate may in fact be set too high to effectively protect human health from known or anticipated adverse health effects, which is the MCL requirement under the SDWA.

c. In the U.S., the mean intake of nitrate per person has been estimated at about 40-100 milligrams per day from food and water.[63] An adequate intake of water is 3 liters of total beverages for a man and 2.2 liters for a woman living in a temperate climate and having average physical activity. In warmer temperatures and with increased physical activity water intake will increase in response to water loss through sweating and respiration. If all nitrate intake were from water – an

[61] *See* Bryan (2013) at 156.
[62] *See* Paragraph 15(c) *infra*.
[63] ATSDR at 42.

unlikely scenario given the presence of nitrate in foods - the 40-100 mg intake for a man would amount to a range of 13 mg/L to 33mg/L or just above the EPA MCL. Dietary intake of nitrates, however, is mostly from vegetables,[64] which are digested and processed *in vivo* and release nitrate and nitrite more slowly than nitrate contaminated water. The nitrate concentration in vegetables is greater when higher applications of non-organic fertilizer are used.[65] These nitrates from ingested foods are bound to organic matter (carbohydrates, proteins, fats) in the food and slowly released in the process of digestion, allowing the body to utilize them gradually in the nitrate-nitrite-nitric acid pathway. In contrast, nitrates and nitrites in contaminated drinking water are absorbed rapidly to reach blood and tissue levels sufficiently high to have toxic effects. Based on this information, and the documented health effects of ingesting drinking water below the MCL, I believe that the MCL should be set below 10 mg/L to protect the health of the average individual, and particularly the health of susceptible populations of the very young, the very old, and the immunocompromised. The EPA needs to review the MCL in light of accumulating evidence of toxic effects of nitrate when present in drinking water in the 5-10 mg/L level and especially when consumed on a chronic basis as is the case in the Lower Yakima Valley.

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[64] Hassan, S. et al. "Nitrate, Ascorbic Acid, Mineral and Antioxidant Activities of *Cosmos caudatus* in Response to Organic and Mineral-Based Fertilizer Rates." Molecules. Vol. 17 pp. 7843-7853 (2012).

[65] Id.

**15. HEALTH EFFECTS ABOVE AND BELOW THE MAXIMUM CONTAMINANT LEVEL**

a. As discussed in this section, human health effects above the MCL are significant, and the nitrate levels for many residential drinking water wells on and around the Cow Palace Dairy area are in excess of the MCL, some very highly in excess.[66]

b. Health effects of nitrate consumption can be exacerbated by even a "slight" increase above the MCL in drinking water. Studies show long-term exposure to nitrate levels of 11 – 61 mg/L associated with hyperthyroidism,[67] insulin-dependent diabetes (at >15-25 mg/L),[68] increased risk for adverse reproductive outcomes at levels above 10 mg/L (including central nervous system malformations and neural tube defects),[69] and spontaneous abortions (at 19-26 mg/L).[70]

c. Nitrate intake below the MCL has been found to contribute to an increased risk of thyroid cancer and thyroid disease,[71] and insulin-dependent diabetes.[72] Again, the cumulative effect of chronic exposure at levels below the MCL increases the risk of adverse health outcomes.

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[66] *See* Paragraphs 23, 26(a), and 27 listing residential well sampling results, *infra*. The results show nitrate levels as high as 64.6 mg/L (CARE Member Steve Butler) and 72.8 mg/L (The Dolsen Companies' property at 41 Knowles Road).
[67] Burkholder, J. et al. "Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality." Environ. Health Perspect. Vol. 115, No. 2 pp. 308-312 (Feb. 2007).
[68] Burkholder (2007) at 310.
[69] Id.
[70] Id.
[71] Ward, M.H. et al. "Nitrate intake and the risk of thyroid cancer and thyroid disease." Epidemiology. Vol. 21, No. 3 pp. 389-395 (May 2010) (longer consumption of water > 5mg/L contributed to thyroid cancer and thyroid disease).
[72] Burkholder (2007) at 310.

d. Chronic exposure to nitrates in drinking water can cause substantial health problems. Significant risks exist without treatment of the contamination. Long-term exposure to nitrates has been associated with increased mortality from strokes and heart disease,[73] and hyperthyroidism (at levels of 11-61 mg/L).[74] Studies have shown a positive association between long-term exposure to nitrate in drinking water and risk of cancer and certain reproductive outcomes, while other studies have shown no association (Ward 2005).[75] Generally, though, long-term exposure to nitrates at levels > 10 mg/L are positive for cancer, specifically, cancers of the stomach, nasopharynx, prostate, uterus, and brain.[76] In fact, some cancers are associated with nitrate levels *below* the MCL, specifically non-Hodgkin lymphoma (at > 4 mg/L), colon cancer (at > 5 mg/L), ovarian cancer and bladder cancer (at > 2.5 mg/L).[77]

**16. CUMULATIVE IMPACTS OF NITRATE EXPOSURE**

a. The cumulative impacts of nitrate exposure through food preservatives, cured meats, vegetables, baby food, and the use of nitrosatable drugs such as antibiotics, anti-histamines, and aspirin can increase health risks to populations with contaminated drinking water. Nitrates and nitrites in the diet are an important part of the nitrate to nitrite to nitric acid pathway that plays an important role in vascular health. Nitric oxide dilates blood vessels,

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[73] ATSDR at 53.
[74] Burkholder (2007) at 310.
[75] EPA Study at ES-2.
[76] Burkholder (2007) at 310.
[77] Id.

increases blood flow, and lowers blood pressure. Vegetable rich diets such as the Mediterranean diet are associated with improved cardiovascular health.[78] While the effects of consuming nitrates and nitrites may be somewhat countered by the presence of antioxidants such as Vitamins C and E present in some vegetables, drinking water does not contain any such protective molecules, thus increasing cause for concern of consuming nitrate-contaminated water. Similarly, nitrite is frequently found in foods, such as cured meats, baked goods, and cereals.[79] Some studies have linked above-median meat intake and chronic exposure to drinking water exceeding 5 mg/L for nitrates with a nearly doubled rate of colon cancer.[80] Taking nitrosatable drugs and drinking higher nitrate level water during pregnancy has been associated with a significant increase in neural-tube defects such as spina bifida and anencephaly.[81] Women in that study whose drinking water nitrates measured 3.5 mg/L or greater were 1.9 times more likely to have a neural-tube defect affected pregnancy than women with lower level nitrates in their water.[82]

b. These considerations, in light of the very high nitrate levels in drinking water in the Lower Yakima Valley, give me great concern for the total nitrate intake of CARE and CFS members, and the people who live in the Lower

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[78] Lidder, S. et al. "Vascular effects of dietary nitrate (as found in green leafy vegetables and beetroot) via the nitrate-nitrite-nitric oxide pathway." British J. Clinical Pharmacology. Vol 75, No. 3 pp. 677-696 (Mar. 2012).
[79] Brender, J. et al. "Dietary nitrates and nitrites, nitrosatable drugs, and neural tube defects." Epidemiology. No. 15(3) pp. 330-336 at 335 (2004).
[80] Bryan (2013) at 170.
[81] Brender (2004).
[82] Brender (2004) at 333.

Yakima Valley and who drink water from the aquifer. This is especially true given the recent findings of high levels of neural tube defects found in the population of the Yakima Valley area.[83]

**17. POPULATION VULNERABILITY**

a. Certain populations are more vulnerable to nitrate toxicity than others. U.S. Census data for five cities in the Lower Yakima Valley (Sunnyside, Grandview, Toppenish, Wapato, and Prosser) show a solid presence of children under the age of five years of age, and adults over the age of 65.[84] The U.S. Census data also shows that as many as 20% of each city's population may be women of child-bearing age.

b. I would categorize these populations as particularly vulnerable to the adverse health effects of nitrate-contaminated of drinking water.

**18. RECENT SCIENTIFIC STUDIES HAVE DOCUMENTED CONTAMINATION IN LOWER YAKIMA VALLEY RESIDENTIAL WELLS THAT EXCEED THE MAXIMUM CONTAMINANT LEVEL FOR NITRATE AND NITRITE**

a. In 2001-2002, the Valley Institute for Research and Education ("VIRE") tested 249 private wells of low-income residents in the lower Yakima Valley. The VIRE study gathered baseline data for groundwater in the area, and informed residents of the quality of their drinking water. The VIRE study sampled for nitrate+nitrite-N, fecal coliform, E. Coli bacteria, arsenic, chloride, ammonia, pH,

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[83] CDC (2013) Central Washington.

[84] *See* U.S. Census Bureau, State & County Quick Facts Data for Grandview, Prosser, Sunnyside, Toppenish, Wapato, Washington (through June 2014).

specific conductivity, temperature, dissolved oxygen, and ferrous iron.[85] The VIRE Study focused on two regions: Region 1 included 54 wells around Buena, Toppenish, Wapato and Zillah. Region 2 included 195 wells around Grandview, Granger, Mabton, Outlook and Sunnyside.[86] While the VIRE Study found nitrate levels above the MCL in approximately 21% of the residential wells tested in Region 2, another 28% of the wells in Region 2 tested had nitrate levels between 5.0 mg/L and 9.99 mg/L.[87] Region 1 had far fewer contaminated wells.

b. In 2001-2002, Heritage College conducted a field investigation of groundwater quality in the area extending from Zillah to Sunnyside, Washington. Heritage College sampled for nitrate-nitrogen, phosphate, total dissolved solids, dissolved oxygen, and alkalinity. Of the 40-54 wells (season-dependent) sampled for nitrate-nitrogen, the primary conclusion of the Heritage College study was that nitrate-nitrogen levels were "elevated" (> 10mg/L) in three areas of the study region, all near large dairies.[88]

c. The local newspaper, the Yakima Herald-Republic, ran a three-part series of articles in 2008 called "Hidden Wells, Dirty Water", investigating the magnitude of water contamination in the Lower Yakima Valley.[89] During the same

[85] R. Sell, Valley Institute for Research and Education, "Quality of Ground Water in Private Wells in the Lower Yakima Valley, 2001-02" at 6 (Dec. 2002) (hereinafter "VIRE Study").
[86] VIRE Study at 12.
[87] VIRE Study at 14, Figure 1.
[88] Heritage College, "Sunnyside Groundwater Study Final Report" at 1, Figure 1 (Aug. 13, 2003) (hereinafter "Heritage College Study").
[89] Leah Beth Ward, "Hidden Wells, Dirty Water." Yakima Herald Republic. (Oct. 2008).

timeframe, the Washington Department of Health announced that water in an elementary school in Outlook, Washington had tested above 10 mg/L for nitrate.[90]

d. In 2011, Johns Hopkins University Bloomberg School of Public Health published a study, "Airborne cow allergen, ammonia and particulate matter at homes vary with distance to industrial scale dairy operations: an exposure assessment."[91] This study focused exclusively on the Lower Yakima Valley, and included Cow Palace amongst the study subjects. The study found that community exposures to airborne agents with known human health effects increased the closer a person lived to a CAFO. One of the air agents studied, ammonia, is caused by the breakdown of urea in cow manure.

e. EPA Region 10's 2010-2012 study, "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley Washington" ("EPA Study") sampling results for numerous compounds further confirms the presence of contaminants in Lower Yakima Valley drinking water. Of note for Plaintiffs' purposes, the EPA Study identified excessively high levels of nitrates, nitrites, and ammonia in residential drinking water wells and in other wells.

f. Additional sampling results coming from the AOC, The Dolsen Companies' sampling of drinking water on properties inhabited by Cow Palace employees and tenants, sampling performed by agencies such as the Yakima County Health District, Plaintiffs' sampling, and Defendant Dairies' August 2014 sampling

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[90] Since 2008, the Outlook Elementary School well has tested positive two more times for nitrates. The original well was 90 feet deep; a replacement well was dug to 132 feet deep and the second replacement well was dug to 243 feet deep. Nitrates in the 243-foot deep well are already at 4.4 mg/L. *See* Washington Department of Ecology, Quality Assurance Project Plan, Washington Nitrate Prioritization Project at 1 Pub. No. 14-10-005 (Jan. 2014).

[91] Williams (2011).

further confirm the seriousness of the nitrate contamination of the groundwater that residents use for drinking water.

g. Other studies continue to expose the problems related to CAFOs and nitrate contamination. In late 2013, the Centers for Disease Control and Prevention ("CDC") published a comment "Investigation of a Cluster of Neural Tube Defects – Central Washington, 2010-2013."[92] The comment identified a high level of referral patterns in Central Washington for severe neural tube defects including anencephaly, spina bifida, and encephalocele. A follow-up study confirmed the presence of neural tube defect births in the Yakima County area and described a study confirming the results that the Yakima County area has an anencephaly rate of 8.4 per 10,000 live births. This rate is significantly higher than the national average of 2.1 per 10,000 live births. One of the recommendations from the study was to monitor "private well nitrate concentrations because of their potential association with birth defects and other adverse health outcomes."[93]

h. I am also concerned that the health of the people in this region is at risk from the confirmed presence of veterinary pharmaceuticals in water, soil, and air. The EPA Study is notable in that it sampled for veterinary pharmaceuticals and hormones, many of which are heavily used at the Cow Palace Dairy.[94]

## COW PALACE DAIRY AND HIGH NITRATE DRINKING WATER

19. I have reviewed the discovery information produced in this case concerning nitrates and other contaminants (veterinary pharmaceuticals and hormones) in groundwater

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[92] CDC (2013) Central Washington.
[93] Id.
[94] *See* discussion of veterinary pharmaceutical and hormone use, Paragraphs 30-44 *infra*.

near the Cow Palace Dairy. Based on my review of the records, it is my professional opinion that the amount of nitrates in the drinking water on and near the Cow Palace Dairy poses an imminent and substantial endangerment to public health and the environment.

20. A farm with 2,500 dairy cattle is estimated to create a waste load similar to a city of 411,000 people. A key difference is the fact that human waste is treated before discharge into the environment, whereas waste from CAFOs has no such requirement, and as it is not treated, or treated minimally, before reaching the environment.[95] Based on this estimate, the Cow Palace has four times as many cows, and thus produces a similar waste load as a human population of nearly 2 million people.

21. The Cow Palace Dairy is a concentrated animal feeding operation or "CAFO" located near 1631 North Liberty Road, Granger, Washington 98932. As of 2012, Cow Palace had 7,372 milking cows, 897 dry cows, 243 springers, 3,006 calves, and 89 mature bulls housed at the facility, for a total herd size of 11,607 animals.[96] According to Cow Palace's Dairy Nutrient Management Plan ("DNMP"), much of the waste generated from these animals is directed into two settling basins, where solids are settled from the liquid, and then into a series of liquid storage lagoons.[97] Liquid manure from these lagoons is land-applied to Cow Palace's agricultural fields, 533 acres in size per the DNMP.[98] The AOC information indicates that in the vicinity of Cow Palace Dairy groundwater flows generally from the northeast and to the

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95 EPA Study at 46.
96 COWPAL002110.
97 COWPAL000009-13.
98 COWPAL000015.

southwest, with some localized variations being more north-south.[99] The direction of the flow is toward more people who reside downgradient.

22. In its analysis of the "Cluster" Dairies, which includes Cow Palace, the EPA Study sampled residential wells during Phases 2 and 3 of the study for nitrates. During Phase 2 sampling, EPA sampled 331 residential wells between February 22 and March 6, 2010.[100] EPA sampled 67 homes' water supplies; 20% of these homes had levels of nitrates that were in excess of the MCL.[101] During Phase 3, EPA obtained samples from one upgradient drinking water well (WW-06), and eight downgradient residential drinking water wells (WW-10 to WW-17).[102] The eight downgradient drinking water sources had also been sampled during Phase 2.[103] As a result of the Phase 3 sampling, EPA concluded that upgradient well WW-06 is "within background range," and found that some downgradient wells were more than four times the MCL, indicating that the Dairy Cluster, which includes Cow Palace, is a source of the increased nitrogen levels in downgradient wells.[104] Figure 15 from the EPA Study, provided below, shows the residential well sampling locations as they relate to the location of the Dairy Cluster, and to Cow Palace.

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[99] AOC Appendix A; and Figure 15 "Third Quarter 2013 Groundwater Potentiometric Contour Map" (DAIRIES009814).
[100] EPA Study, Table C1.
[101] EPA Study, Figure 10 and p. 13.
[102] EPA Study at 51. EPA also sampled two additional residential wells (WW-18 and WW-30), but these wells are not related to a specific dairy or crop field.
[103] EPA Study at ES-6.
[104] EPA Study at 53.

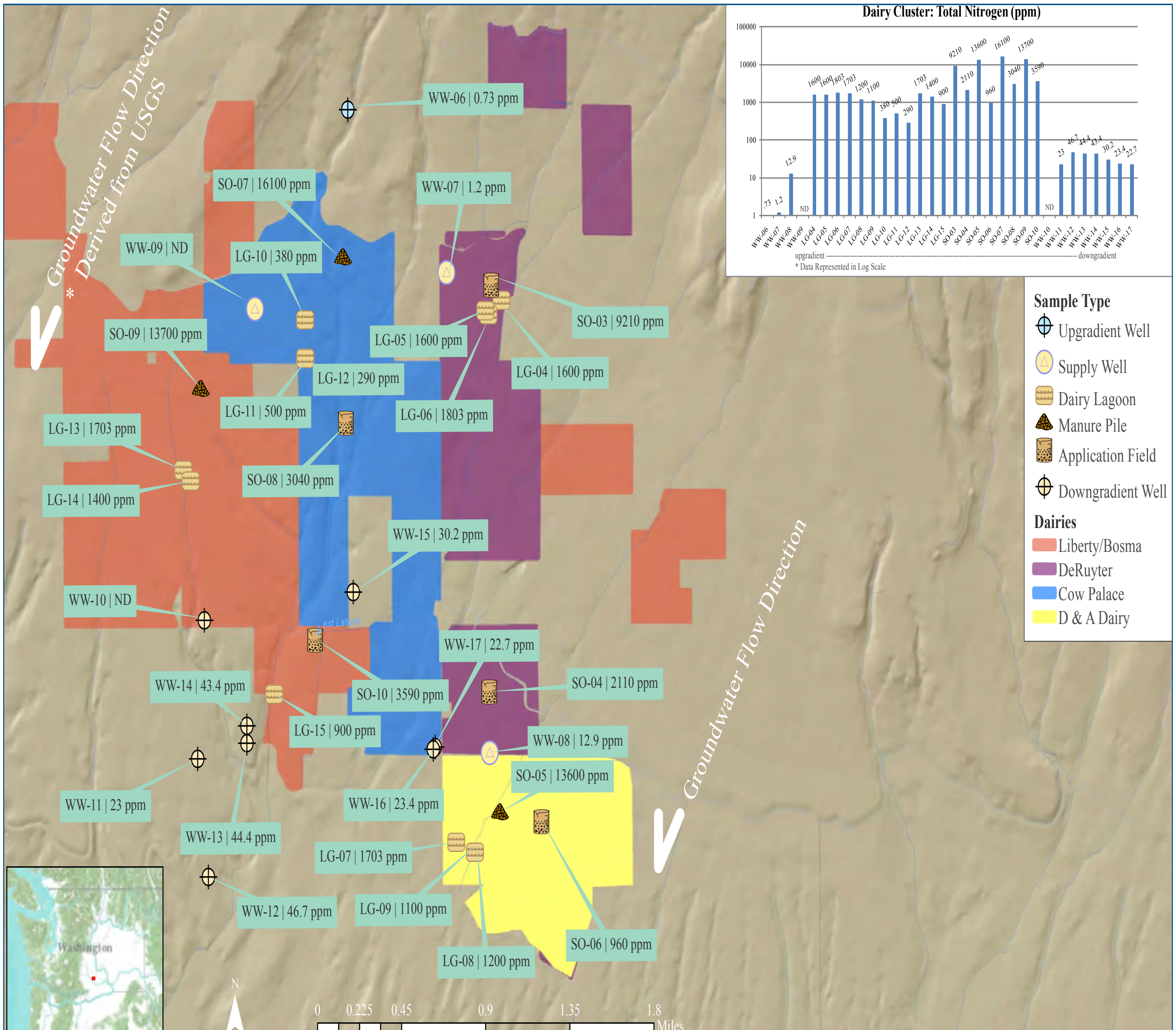


Figure 15: Dairy Cluster: Total Nitrogen Concentrations in Water Wells, Lagoons, Manure Piles, and Application Fields

23. The nine residential wells (WW-06 and WW-10 through WW-17)[105] sampled by EPA produced the following data:

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105 EPA Study at 51, Table 25 at 62-63.

| Well | Nitrate as N (ppm) | Nitrate + Nitrite as N (ppm) | Total Nitrogen (ppm) |
|---|---|---|---|
| WW-06: Upgradient Well | 0.71 | 0.73 | 0.73 |
| WW-10: Downgradient Well | Not Detected | Not Detected | Not Detected |
| WW 11: Downgradient Well[106] | 22.3 | 23 | 23 |
| WW 12: Downgradient Well | 45 | 46.7 | 46.7 |
| WW 13: Downgradient Well | 41.4 | 44 | 44 |
| WW 14: Downgradient Well | 40.9 | 43.4 | 43.4 |
| WW 15: Downgradient Well | 29.4 | 30.2 | 30.2 |
| WW 16: Downgradient Well | 22.3 | 23.4 | 23.4 |
| WW 17: Downgradient Well | 21.7 | 22.7 | 22.7 |

*Excerpts above taken from EPA Report, Table 20 at p. 52 (See Attachment E)*

24. These results show three residential drinking water wells downgradient from Cow Palace Dairy with nitrate levels four times the MCL, and four residential drinking water wells downgradient from Cow Palace Dairy with nitrate levels twice the MCL. Well WW-11, belonging to CARE member Steve Butler, was just recently tested by the Defendant Dairies and the Plaintiffs, and the Plaintiffs' August 27, 2014 split sample showed 64.6 mg/L nitrate- more than six times the MCL.[107] All of these wells are west and/or south of the Dairy, which I understand is within the path of the predominant direction of groundwater flow.[108] EPA categorized the downgradient wells as containing "substantially more" nitrate than upgradient wells;[109] I would categorize the difference as "dangerously more" nitrate in downgradient wells.

25. Following the EPA Study, in March 2013, Cow Palace and other "Cluster" Dairies entered into the Administrative Order on Consent with EPA. The AOC required the Respondents "to test each drinking water well at the residences situated within the

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[106] WW-11 Downgradient Well is on the property of CARE member Steve Butler.
[107] On August 27, 2014 the Defendants tested Mr. Butler's well for nitrate, and Plaintiffs split the samples. Plaintiffs' results show that Mr. Butler's well tested at 64.6 mg/L for nitrate (CARE029687).
[108] *See, e.g.*, AOC, App. A.
[109] EPA Study at 61.

boundary of the Dairy Facilities and those residences that are located within one mile downgradient of the Dairy Facilities."[110] In March 2014, Arcadis completed its Provision of Water Residential Well Sampling Report,[111] which I have reviewed in preparing this report. The one-time sampling event targeted 224 residences; 42 residences were on the Dairies' property and 182 residences were within the one-mile downgradient boundary.[112] Fifty of these residences already had reverse osmosis ("R.O.") systems and were eliminated from the sampling;[113] 36 residences refused sampling or residents were "not-at-home";[114] 141 residences gave permission to sample.[115] The sampling occurred in May and June 2013. The Dairies then identified 26 residences with less than 5 mg/L via Hach test strip,[116] and tested the remaining 115 residences with laboratory sampling.[117] Of these 115 residences sampled, 49 residences tested between 5.0 mg/L and 9.9 mg/L for nitrates[118] and 66 residences exceed the 10mg/L MCL for nitrates.[119] I have reviewed the Residential Well Sampling Report's Figure 6 "Nitrate Analytical Results" graphic prepared by Arcadis, which maps out the specific residences sampled for nitrates under the AOC,[120] and the sampling results in Tables 3 (less than 5 mg/L), 4 (sampling results), 6 (sampling results less than MCL), and 7 (sampling results greater than MCL).

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[110] AOC, App. B Statement of Work, Para. III.D.3.
[111] DAIRIES008111-008726.
[112] DAIRIES008132.
[113] Table 2 (DAIRIES008149-008150).
[114] Table 10 (DAIRIES008169).
[115] DAIRIES008132.
[116] Table 3 (DAIRIES008151).
[117] Tables 4-7 (DAIRIES008152-008160).
[118] Table 6 (DAIRIES008157-008158).
[119] Table 7 (DAIRIES008159-008160).
[120] Figure 3 "Nitrate Analytical Results" (DAIRIES008173).

Based on this information, the AOC sampling data test results raise significant concerns about health risks for nitrate. Of the 66 residences that exceed the 10 mg/L for nitrates, two residences had nitrates over 50 mg/L; eleven residences had nitrates between 30 and 40 mg/L, eleven residences had nitrates between 20 and 29.9 mg/L, and 42 residences had nitrates between 10 and 19.9 mg/L. These nitrate numbers are in excess of the MCL and the drinking water from these wells is of great concern for the health of the residents and anyone who drinks the water while visiting those residences.

26. It appears that The Dolsen Companies, an entity with an ownership interest in Cow Palace Dairy and in real property around Cow Palace, undertook its own independent nitrate sampling of residential wells, mostly for employees who live on Cow Palace or The Dolsen Companies' property. The nitrate sampling results of this testing, copied below, cause me great concern for the health of these families.

a. I have reviewed September 2012 laboratory sampling results produced by The Dolsen Companies in response to Plaintiffs' subpoena. The Dolsen Companies tested at least eight employee residences for nitrates.[121] Seven of the eight residences have excessively high nitrate levels and the other is very close to the MCL:

| **Address** | **Date** | **Sample Number** | **Nitrate as N** |
|---|---|---|---|
| 41 Knowles Road | 9/11/2012 | 153-91109 | 72.8 mg/L |
| 3905 Isabella Way | 9/11/2012 | 153-91114 | 59.5 mg/L |
| 461 Knowles Road | 9/11/2012 | 153-91112 | 40 mg/L |

[121] DOLSEN002078-002086.

| | | | |
|---|---|---|---|
| 510 Arms Road | 9/11/2012 | 153-91113 | 34.2 mg/L |
| 101 Knowles Road | 9/11/2012 | 153-91111 | 31.4 mg/L |
| 3770 East Zillah Drive | 9/11/2012 | 153-91115 | 30.6 mg/L |
| 51 Knowles Road | 9/11/2012 | 153-91110 | 14.5 mg/L |
| 6891 East Zillah Drive | 9/11/2012 | 153-91116 | 9.18 mg/L |

*Excerpts above taken from DOLSEN002078-002086.*

Cow Palace's former Safety Director, Vern Carson, testified during his deposition that during 2011-2012 he, Bill Dolsen, and Adam Dolsen put R.O. units in employee houses that did not already have them.[122]

b. In addition to the wells sampled above, one of Cow Palace's residential tenants shares a well with a Cow Palace employee, Fernando Romero. While Mr. Romero, who lives at 621 Arms Road and was previously told by Cow Palace employee Vern Carson not to drink out of any faucets in the house, had a R.O. system installed, Rudy Schreck, Cow Palace's other tenant who shares a well with Mr. Romero, does not. [123] Mr. Schreck resides at 731 Arms Road and cares for a special needs child living with him.[124] Mr. Schreck draws water from the same well as Mr. Romero, but does not have a R.O. system.[125] During the AOC residential well sampling, Mr. Schreck's well was sampled and had a nitrate level

[122] Tr. Vern Carson p. 31 – 33 (lines 1-13) (Jun. 4, 2014).
[123] Table 1 (DAIRIES008147); Tr. Vern Carson p. 33 (lines 6-25) – p. 34.
[124] Tr. Vern Carson, p. 41 (lines 1-12).
[125] Tr. Vern Carson, p. 43-44.

of 31.1 mg/L.[126] As of June 10, 2014, Mr. Schreck had still not received a reverse osmosis system through the AOC.[127]

27. Certain local members of CARE and CFS relatively near and downgradient of the Cluster Dairies have had their residential wells tested for nitrates, and also show results in excess of the MCL for nitrate. For example:

| **Name** | **Date** | **Nitrate** |
|---|---|---|
| Helen Reddout | 5/13/2013 | 11.8 mg/L of Nitrate-N (CARE025669) |
| Helen Reddout | 2/26/2014 | 10.5 mg/L of Nitrate-N (CARE028487)) |
| Helen Reddout | 8/27/2014 | 10.4 mg/L of Nitrate (CARE029688) |
| Steve Butler | 4/15/2010 | 23.0 mg/L of Nitrate+Nitrite (NO3+NO2) as N (CARE025661) |
| Steve Butler | 8/27/2014 | 64.6 mg/L of Nitrate (CARE029687) |

Ms. Reddout lives approximately 1.5 miles south/southwest from the Defendant Dairies' southern fields.[128] Mr. Butler lives in close proximity to the southern end of the Cluster Dairies.[129]

28. I am aware of other nitrate sampling programs in the Lower Yakima Valley, such as those organized by the Yakima Health District, the Lower Yakima Valley Groundwater Management Area, and the Washington Department of Health. All confirm the pervasive contamination problem of the groundwater. I also reviewed the final report of the Yakima County Nitrate Treatment Pilot Program, issued on June 30, 2011, which showed that 180 of 271 laboratory tests for nitrate were above the 10 mg/L MCL.[130]

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[126] Table 4 (DAIRIES008154, line 105).
[127] Table 8 (DAIRIES008164, line 61).
[128] Ms. Reddout lives approximately 4.9 miles from the front gates of Cow Palace.
[129] Mr. Butler lives approximately 1.5 miles from the front gates of Cow Palace.
[130] Yakima Co. Nitrate Treatment Pilot Program Final Report (June 30, 2011).

29. These results of consistently high nitrate levels in multiple locations in the Lower Yakima Valley raise substantial public health concerns. Like many toxins, chronic exposure to nitrates and nitrites, even at levels just above the MCL, can be as damaging or more damaging to health than an acute exposure to a higher level during a limited period of time.

## VETERINARY PHARMACEUTICALS AND HORMONES

30. Nitrates and nitrite are not the only contaminants that raise health concerns arising from large industrial facilities like Cow Palace. As shown by the EPA Study, the Lower Yakima Valley drinking water is also contaminated by veterinary pharmaceuticals and hormones. The presence of these veterinary pharmaceuticals and hormones causes me to be further concerned for public health and the environment. Veterinary pharmaceuticals such as antibiotics are designed to be quickly excreted, and are commonly found in waste and water resources affected by waste.[131] The presence of antibiotics and antibiotic residues in drinking water, as confirmed by the EPA Study, causes me concern about the development of antibiotic resistance. However, what causes me even greater concern is that while the EPA Study looked for (a) veterinary pharmaceutical compounds,[132] and (b) hormones[133] at and around the Dairy Cluster, including the Cow Palace Dairy, it selected to test for

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[131] Burkholder (2007) at 310; Love, D. et al. "Dose Imprecision and Resistance: Free-Choice Medicated Feeds in Industrial Food Animal Production in the United States." Environ. Health Perspect., Vol. 119, No. 3 pp. 279-283 at 279 (Mar. 2011).

[132] Chlortetracycline (total), erythromycin, lincomycin, monensin, oxytetracycline, ractopamine, sulfachloropyridazine, sulfadimethoxine, sulfamerazine, sulfamethazine, sulfamethoxazole, sulfathiazole, tetracycline, tiamulin, tylosin, and virginiamycin. EPA Study, Table C12.

[133] The hormone sample analyses were split between an EPA laboratory (EPA Study Table C13) and University of Nebraska Water Sciences Laboratory (EPA Study Table C14). The EPA laboratory tested for 5 hormones and the University of Nebraska tested for 20 different hormones. (*See* Attachment G).

many veterinary pharmaceuticals and hormones that the Cluster Dairies do not use, or at least in abundant or detectable quantities.[134] The EPA Study did not test for antibiotics frequently used at Cow Palace, including but not limited to penicillins, cephalasporins, fluroquinolones or phenicols. Neither did EPA Study test for hormones previously or currently used at Cow Palace, for example bovine somatotropin and oxytocin.

31. Despite the fact that approximately 80% of the antibiotics sold in the United States each year are used in animal agriculture,[135] and that hormones are widely used in the dairy industry, EPA has not issued MCLs on any veterinary pharmaceuticals or hormones.

32. Veterinary pharmaceuticals used at CAFOs generally, and specifically at Cow Palace,[136] include antibiotics that are medically important for treatment of humans, namely tetracyclines, monensin, and beta-lactams (which include penicillins, cephalosporins, and carbapenems). Virginiamycin is also medically important to treat humans, and is frequently used at CAFOs.[137] Veterinary pharmaceuticals may be administered to treat a cow, or to address herd-wide issues, or to increase feed

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[134] It appears that Cow Palace only uses one of the hormones sampled for, progesterone. (COWPAL006616-006621, COWPAL006652-006666), and only 7 of the veterinary compounds sampled for (Cow Palace records show use of chlortetracycline (total), monensin, oxytetracycline, sufadimethoxine, sufamethoxazole, tetracycline, and tylosin (*see* Paragraph 43, *infra*). But it uses many more pharmaceutical compounds.

[135] U.S. Food & Drug Administration, National Antimicrobial Resistance Monitoring System, Animal Health Institute Surveys (1998 and 1999) referenced at http://www.fda.gov/AnimalVeterinary/SafetyHealth/AntimicrobialResistance/NationalAntimicrobialResistanceMonitoringSystem/ucm095684.htm.

[136] *See* Cow Palace Treatment Records and Feed & Veterinary Invoices (2006-2014) COWPAL010673-014464, COWPAL004291-COWPAL008205; *see also* Paragraph 43 *infra*.

[137] The EPA Study found virginiamycin in dairy supply wells, downgradient wells, downgradient septics, downgradient fields, dairy lagoons, manure, and application fields. (See EPA Study, Table C12). Virginiamycin did not appear on Cow Palace treatment records or invoices.

efficiency. Cow Palace appears to use veterinary pharmaceuticals for all of these purposes. The sheer quantity of veterinary pharmaceuticals purchased and administered to the thousands of cows at Cow Palace cause me to be concerned for public health and the environment.

33. When low dose or sub-therapeutic doses of antibiotics are used in industrial food animal production, including dairy, for growth promotion or disease prevention, there is great risk of having the low dose antibiotic kill the susceptible organisms while bacteria that have spontaneous mutations of genes that confer resistance to the antibiotics continue to reproduce. Further, low-dose antibiotics can cause an increase in mutations in bacteria that are not killed by the antibiotic, which raises the frequency of resistance genes in the surviving bacteria. Sub-therapeutic doses of antibiotics in animal feed and/or drinking water may be used in the Defendant's facility to promote animal growth, and to prevent herd-wide illnesses. Such use of antibiotics provides pressure on bacterial flora to produce bacteria in which the spontaneous mutation of genes endows them with resistance to these antibiotics. When resistance genes increase in prevalence as a result of selection pressure from exposure to sub-therapeutic doses of antibiotics, these resistance genes are then exchanged or swapped among different species of bacteria capable of infecting both animals and humans, spreading the antibiotic resistance to organisms capable of causing serious disease in humans. Research has shown that this practice is promoting increased antibiotic resistance among the microbial populations present, and, potentially, increased resistance of naturally occurring pathogens in surface

waters that receive a portion of the wastes.[138] Some studies have found that antibiotics may remain in soil following land application of manure.[139] Currently, antibiotic resistant infections sicken 2 million persons and kill at least 23,000 Americans each year.[140]

34. Cow Palace's records show regular purchases and administrations of veterinary pharmaceutical products containing antibiotics including penicillins,[141] tetracyclines,[142] cephalasporins,[143] and fluroquinolones.[144] The EPA Study samples confirm the presence of some of these antibiotics in manure, application fields, and groundwater.[145] Not all compounds were selected for testing by EPA, which leaves open additional concerns about their presence in the environment and their ability to cause antibiotic resistant bacteria.

35. Hormones (including progesterones, prostaglandin-associated drugs, oxytocin, and posilac) have potential deleterious effects on endocrine systems. Hormones are or

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[138] Burkholder (2007) at 309.
[139] CLF Analysis at 6.
[140] CDC, Antibiotic / Antimicrobial Resistance "Threat Report 2013" at 11 (2013).
[141] *See, e.g.*, individual entries for drugs including penicillin, Polyflex, and Albadry on pages ranging between COWPAL010935-011065, COWPAL011495-011644, COWPAL012075-012215, COWPAL012578-012691, COWPAL013060-013189.
[142] *See, e.g.*, purchases of tetracycline powder and tetracycline SP at COWPAL006652, COWPAL066657-61, COWPAL006661-66, COWPAL006616-19, COWPAL006629.
[143] *See, e.g.*, individual entries for first and second generation cephalosporin drug ToDay (COWPAL010674-010803, COWPAL011195-011344, COWPAL011793-011933, COWPAL012350-012463, COWPAL012800-102929), and third and fourth generation cephalosporin drugs Excenel and Spectramast (COWPAL010804-010934, COWPAL011345-011494, COWPAL011934-012074, COWPAL012464-012577, COWPAL012934-013059).
[144] *See, e.g.*, individual entries for Baytril on pages COWPAL006649-006652, COWPAL006663-006664, COWPAL012692-012799, COWPAL006618-19, COWPAL006641, COWPAL006667, COWPAL006621, COWPAL006641.
[145] EPA Study Table C12.

have been used at the dairy facilities, including Cow Palace,[146] to promote optimum breeding cycles, manage reproductive issues, and to boost milk production. Cow Palace records show that it regularly purchased Posilac from 2006-2008.[147] Posilac is a bovine somatotropin, a hormone used to increase milk production also called recombinant bovine growth hormone ("rBGH") or bovine somatotropin ("BST"). Posilac increases the levels of insulin-like growth factor 1 ("IGF-1") in cows, and milk from these cows can contain IGF-1. Scientific studies have associated IGF-1 with increased risks for cancers, notably breast and prostate cancer.[148] Some studies indicate rBGH may change milk proteins thereby causing allergies in consumers.[149]

36. Endocrine-disrupting compounds are chemicals that exhibit biological hormonal activity. These compounds can mimic natural estrogens, or alter how natural hormones and their protein receptors are made.[150] The potential for human health effects such as breast and prostate cancers, thyroid abnormalities, and reproductive effects is a public health concern. Cow Palace's records show regular purchases of

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[146] *See, e.g.*, Cow Palace Feed & Veterinary Invoices regarding progesterones (COWPAL006616-21, 006652-66), prostaglandin-associated drugs (Tr. Jeff Boivin pp. 111 (lines 6-20)( Apr. 2, 2014)), oxytocin (COWPAL006654-006665, 006616-006621, 006666), Posilac (COWPAL006623, 006631-32); *see also* Paragraph 43 infra.

[147] *See, e.g.*, COWPAL005161-005213, COWPAL005451-005452; Tr. Jeff Boivin p. 111 (lines 21-25) - 112 (lines 1-11)).

[148] *See* Holmes, M. et. al. "Dietary Correlates of Plasma Insulin-like Growth Factor I and Insulin-like Growth Factor Binding Protein 3 Concentrations" Cancer Epidemiology, Biomarkers, and Prevention. Vol. 11 pp. 852-861 (Sept. 2002); Chan, J. et. al. "Plasma Insulin-like Growth Factor-I and Prostate Cancer Risk: A Prospective Study," Science. Vol. 279, No. 5350 pp. 563-566 (Jan. 23, 1998); Yu, J. et. al. "Insulin-like Growth Factors and Breast Cancer Risk in Chinese Women", Cancer Epidemiology, Biomarkers, and Prevention. Vol. 11 pp. 705-712 (Aug. 2002).

[149] *See* European Union, European Commission on Food Safety, Scientific Committee on Animal Health and Animal Welfare, "Report on Public Health Aspects of the Use of Bovine Somatotropin," pp. 17 (Mar. 10, 1999).

[150] Burkholder (2007) at 310.

veterinary pharmaceutical products containing hormones including oxytocin,[151] prostaglandins,[152] and previous purchases of bovine somatotropin.[153]

**<u>EPA STUDY SAMPLING FOR VETERINARY PHARMACEUTICALS AND HORMONES</u>**

37. In the EPA Study, two residential wells tested positive for tetracycline (WW-11, WW-17), for monensin (WW-10 and WW15), and for virginiamycin (WW-13, WW-14).[154] One residential well tested positive for tylosin (WW-11).[155] Again, CARE member Mr. Butler lives on the property where residential well WW-11 is located and that is the well he draws his drinking water from. As of approximately 2012 Mr. Butler has a reverse osmosis system.[156] The EPA Study repeatedly documents the presence of veterinary pharmaceuticals in its Cluster sampling, as detailed in Table C12 of the EPA Study.[157] The veterinary pharmaceuticals tetracycline and monensin were detected in all but one of the dairy source samples, which indicate they are used by the dairies in the Dairy Cluster.[158] Tetracycline, monensin, and tylosin are used by Cow Palace. Monensin is not used in humans. Additionally, five veterinary pharmaceuticals were detected in the water wells (chlortetracycline, monensin, tetracycline, tylosin, and virginiamycin).[159]

38. The following four drugs used at Cow Palace give especial cause to be concerned; only the first one was sampled for in EPA's study.

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151 *See, e.g.*, COWPAL006654-006666, COWPAL006616-006619.
152 *See, e.g.*, Tr. Jeff Boivin pp. 111 (lines 6-20)(Apr. 2, 2014)).
153 *See, e.g.*, COWPAL006623, 006631-32.
154 EPA Study, Table C12.
155 EPA Study, Table C12.
156 Tr. Steve Butler, p. 24 (lines 2-11) (Apr. 8, 2014).
157 Attachment F.
158 EPA Study, ES-6 and Table 21.
159 *See* EPA Study, Table C12.

a. Virginiamycin is an antibiotic drug of last resort for some serious infections in humans. Virginiamycin use in animal agriculture has been banned in the European Union because of links between its use in food-producing animals and the emergence of antibiotic resistant pathogens important to human health. Virginiamycin was found in at elevated levels Cow Palace lagoons (LG-10, LG-11, LG-12)[160] and thus may be used by Cow Palace and the Defendant Dairies.

b. Fluroquinolones have been banned for nearly a decade in the United States for use in poultry resulting from a risk assessment related to antimicrobial resistance. Fluoroquinolones are used by the Cluster Dairies, including Cow Palace.[161]

c. Penicillins and related beta lactam antibiotics are medically important antibiotics for human health, and their use in animal agriculture is part of a growing problem of antibiotic resistance, including methicillin-resistant Staphylococcus aureus ("MRSA"). Penicillin is used by the Cluster Dairies, including Cow Palace, in a variety of forms.[162]

d. Cephalosporin is a beta lactam antibiotic, and is part of a growing problem of antibiotic resistance, including MRSA. Cephalosporins are used by the Cluster Dairies, including Cow Palace.[163]

39. Cow Palace records also show regular purchases of medicated feed containing antibiotics including monensin,[164] and feeds that may contain antibiotic residues.[165]

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[160] EPA Study Table C12 at 6.
[161] *Supra* n. 148.
[162] *Supra* n. 145.
[163] *Supra* n. 147.
[164] *See, e.g.*, COWPAL004650-005160, COWPAL005267-005342, COWPAL006616-006674, COWPAL006633-006634.

These veterinary pharmaceuticals contain many drugs that are medically important to humans, and which may affect human health.

40. Cow Palace's manure sample had the highest antibiotic levels of all the samples of all the Cluster samples for two important antibiotics; SO-07 came back at 2,303 units per kilogram for chlortetracycline (total) and 2,848 units per kilogram for tetracycline.[166] Cow Palace's manure and soil samples (SO-07 and SO-08) also showed elevated levels of monensin, oxytetracycline, and tylosin.[167] Cow Palace's lagoon samples (LG-10, LG-11, LG-12) showed the presence of other veterinary pharmaceuticals.[168] Many of these veterinary pharmaceuticals are used at Cow Palace.

41. Veterinary pharmaceuticals and hormones used at Cow Palace make their way into the environment through manure excretions and manure management, improper handling of veterinary supplies, and improper storage or spillage of feed.

42. The widespread use of veterinary pharmaceuticals and hormones at Cow Palace concerns me. I reviewed the treatment records for 2009 – 2013,[169] which detail treatment events for the cows on a daily basis, identification numbers of cows, treatment events, days in milking, the date of a treatment, and any remarks or protocols. I also reviewed invoices for the 2006-2013 timeframe detailing additional drugs administered to Cow Palace cows via animal feed, and other drugs purchased by Cow Palace and presumably administered to Cow Palace cows.[170] First, the

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[165] *See, e.g.*, COWPAL004369, -004370, -004372, -004423, -004432, -004459, -004507, -004541, -004565, -004588, -004627, -004646.
[166] EPA Study Table C12 at 8.
[167] Id.
[168] Id. at 6.
[169] COWPAL010673-014464.
[170] COWPAL004291-008205.

treatment records indicate the number of cows treated by Cow Palace each year, and the number of treatment events:

| **Year** | **Number of Cows Treated** | **Number of Treatment Events** | **Bates No.** |
|---|---|---|---|
| 2009 | 10,137 | 22,523 | COWPAL011194 |
| 2010 | 10,720 | 25,591 | COWPAL011792 |
| 2011 | 13,227 | 23,826 | COWPAL012349 |
| 2012 | 12,854 | 19,283 | COWPAL012799 |
| 2013 | 14,162 | 22,010 | COWPAL013312 |

Based on the sheer number of cows being administered veterinary pharmaceuticals and hormones, I am concerned that excretions containing these veterinary pharmaceuticals and hormones pose to a threat to human health and the environment.

43. In addition to the four antibiotics of most concern referenced above (virginiamycin, fluroquinolones, penicillin, and cephalosporin), through my review of the records I identified 15 additional drug classes of antibiotics and hormones frequently used at the Cow Palace Dairy that cause me concern for public health. As outlined below, some appeared in EPA's sampling, some did not.

| **EXAMPLES OF DRUGS PURCHASED / USED AT COW PALACE** | **DRUG SAMPLED BY EPA?** |
|---|---|
| **Aminoglycosides**<br>(Adspec, *see, e.g*, entries on pages COWPAL006622, 006640, 006649-50) | No |
| **Cephalosporins, 1st & 2nd generation**<br>(ToDay, *see* n. 147 *supra*) | No |
| **Cephalosporins, 3rd & 4th generation**<br>(Excenel and Spectramast, see n. 147 supra) | No |
| **Penicillins**<br>(Penicillin, Polyflex, Albadray, see n. 145 supra) | No |

| | |
|---|---|
| **Fluoroquinolones**<br>(Baytril, *see* n. 148 *supra*) | No |
| **Lincosamines**<br>(Pirsue, *see, e.g.*, entries on pages COWPAL010673-010803, COWPAL011195-011344, COWPAL011793-011933, COWPAL012350-012463, COWPAL012800-012929) | EPA tested for one subclass, lincomycin. Lincomycin is not used by Cow Palace |
| **Macrolides**<br>(Tylan, *see, e.g.*, entries on pages COWPAL012216-012349, COWPAL013313-013477) | Yes |
| **Phenicols**<br>(Nuflor, *see, e.g.*, entries on pages COWPAL011645-011792, COWPAL012075-012215, COWPAL012216-012349, COWPAL012578-012691, COWPAL013313-013477) | No |
| **Streptogramins (virginiamycin)**<br>(Records do not indicate purchase or use at Cow Palace) | Yes |
| **Sulfas antibiotics**<br>(SMZ/TMP, *see, e.g.*, entries on pages COWPAL006653-006666, COWPAL006616-006619, 006641, 006666) | Yes, EPA tested for several sulfas |
| **Chlortetracycline**<br>(Aureo crumbles, *see, e.g.*, entries on pages COWPAL006616-006674) | Yes |
| **Oxytetracycline**<br>(Maxim and tetrasol, *see, e.g.*, entries on pages COWPAL006640-006641, 006659, COWPAL012075-012215) | Yes |
| **Tetracycline**<br>(Tetracycline power or tetracycline SP, *see* n. 146 *supra*) | Yes |
| **Ionophores**<br>(Several varieties of feed containing rumensin (monensin), *see* n. 168 *supra*) | Yes |
| **Sulfa drugs**<br>(Albon, *see, e.g.*, entries on pages COWPAL01084-010934, COWPAL011345-011494, COWPAL006616, COWPAL06619-21) | Yes, EPA tested for several sulfas |
| | |

| | |
|---|---|
| **Anti-inflammatories**<br>(Dexamethasone, *see, e.g.*, entries on pages COWPAL010935-011065, COWPAL011495-011644, COWPAL012075-012215, COWPAL012578-012691, COWPAL013060-013189) | No |
| **Oxytocin**<br>(Oxytocin, *see* n. 150 *supra*) | No |
| **Progesterone**<br>(CIDR, *see* n. 150 *supra*) | Yes |
| **Posilac**<br>(Posilac, *see* n. 150 and 151 *supra*)[171] | No |

44. The use of veterinary pharmaceuticals and hormones at these industrial dairies, including at Cow Palace, even though medical studies are sparse on this topic, causes me to have additional concerns for public health.

**PATHOGENS AND ZOONOTIC DISEASES**

45. Microbial pathogens are also of concern; some of the commonly-known pathogens associated with CAFOs include fecal coliforms (including Escherichia coli ("E. coli") O157:H7, which is a shiga toxin producing coliform, and other strains), camphylobacter, salmonella, cryptosporidium parvum, clostridium, and giardia. Pathogens are disease causing bacteria, viruses, parasites, fungi or other microorganisms.[172] Health risks of the common pathogens listed above include gastroenteritis, diarrhea, cramps, nausea, vomiting, jaundice, headaches, and fatigue. Some infections are very mild, but others can be very serious or even life-threatening. Additionally, around 5-10% of patients with shiga toxin-producing infections develop a potent life-threatening complication of hemolytic uremic syndrome, requiring

[171] Cow Palace's General Manager testified that Cow Palace no longer uses growth hormones as of approximately 2008. *See* Tr. Jeff Boivin pp. 111-112 (Apr. 2, 2014).
[172] Pew Commission Report at 23.

hospitalization and carrying a risk of kidney failure.[173] Many of these pathogens exist at CAFOs like the Defendant's facility. The EPA has set MCLs for fecal coliform and E. Coli, total coliforms, cryptosporidium, giardia, and enteric viruses at zero. Exposure to pathogens from airborne and waterborne exposure creates additional public health concerns through inhalation or ingestion of bacteria sufficient to cause respiratory or gastrointestinal disease, especially among susceptible populations such as infants, the elderly, and those with compromised immune systems. Studies have documented the ability of filth flies (*Musca domestica*) to carry antibiotic resistant bacteria up to two miles from manure piles or open cesspits.[174] Anyone living within this range of an open cesspit or a manure pile would be at risk for having pathogens deposited on food items served outdoors at picnics. Given the frequency of land application of manure to crops at Cow Palace, I am concerned about the transport of pathogens in animal waste into the environment, and their possible effects on human health.

46. Zoonotic disesases are also of concern. Zoonotic diseases transfer from animals to humans. CAFOs contribute to increasing the risk of transfer of pathogens from animals to humans. This contribution is based on (1) prolonged worker contact with large numbers of animals, and with sick or dying animals, (2) increased pathogen transmission in a herd or flock because of the hundreds or thousands of animals and the confined living conditions, (3) increased opportunities for the generation of

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[173] CDC, "General Information Escherichia coli (E. Coli)" (Aug. 3, 2012). http://www.cdc.gov/ecoli/general/index.html#what_shiga

[174] Graham, J. et al. "Antibiotic resistant enterococci and staphylococci isolated from flies collected near confined poultry feeding operations." Sci. Total Environ. (2009).

antibiotic-resistant bacteria or new strains of pathogens.[175] The stress of confinement may also increase the likelihood of infection and illness in animal populations.[176] Stress also leads to greater shedding of bacteria and other microorganisms in the manure. Given the number of animals at Cow Palace, I am concerned about the risk of zoonotic diseases.

**TREATMENT OF NITRATE-CONTAMINATED WATER**

47. The MCL for nitrate and nitrite proscribes treatment methods using the "best available technology," or BAT. The BATs for treating nitrate are ion exchange, reverse osmosis, and electrodialysis.[177] For nitrite, the BATs are ion exchange and reverse osmosis only.[178]

48. People with high nitrate drinking water have limited options to ensure safe water. They can purchase bottled water, or undertake treatment of their contaminated drinking water. From a public health standpoint, bottled water and BAT treatment methods are only temporary and partially effective solutions to address the underlying contamination problem and transfer responsibility for clean and safe drinking water on to the consumer.

49. Reverse osmosis systems are water purification systems, generally installed at the point-of-use such as the kitchen sink. Water is pushed through a membrane and the filter system, reducing or removing certain impurities. Nitrate, nitrite, and total nitrogen may be reduced or removed through reverse osmosis systems. R.O. systems do not eliminate coliform bacteria; installing a separate ultraviolet light may be one

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[175] Pew Commission Report at 13; CLF Analysis at 6.
[176] Pew Commission Report at 13.
[177] 40 C.F.R. § 141.62(c).
[178] Id.

way to inactivate coliform bacteria. Reverse osmosis system products are typically certified through the National Sanitation Foundation and the Water Quality Association.

50. Reverse osmosis systems vary in filter and membrane quality. Better membrane quality, and thus better quality water, comes at a price. The Yakima County's Nitrate Treatment Pilot Program estimates that R.O. systems cost "around $800 per unit" to install and that maintenance of the system including periodic replacement filters is $20 per month.[179]

51. It is important to maintain R.O. systems to protect the public from nitrates. R.O. systems installed at the point-of-use in home kitchens will protect residents of the home only if they use the water from the R.O. as their sole drinking source and refrain from consuming tap water in the bathroom or ingesting water while showering or bathing. The decrease in function of R.O. systems comes from clogging of the membrane filter across which contaminated water is forced, ultimately slowing the flow of water from the apparatus. There are no safeguards to prevent the impatient user from bypassing the system or drawing water from other sources in the household not connected to the R.O. system. I regard this as a major vulnerability in the risk reduction strategy of relying on point-of-use R.O. systems.

52. Installation of R.O. systems through local programs has met limited success.

a. The Yakima County program website, for example, says "If there is extra funding, this will be made available to others. Unfortunately, only limited funding is available. If you have an immediate concern about your private well,

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[179] *See* Yakima Co. Public Services Webpage "Yakima County's Nitrate Treatment Pilot Program" available at http://www.yakimacounty.us/nitrateprogram/english/FAQ_RO_2.htm.

you may want to consider purchasing bottled water for drinking and cooking."[180] It appears that the Yakima County program terminated in 2011.[181]

b. Under the AOC, for each residence where testing shows that the drinking water supply exceeds the nitrate MCL of 10 mg/L in the boundary of the Dairy Facilities or within one mile downgradient of the boundary, Respondents "shall offer to provide reverse osmosis… treatment systems, or other alternative water if mutually approved by EPA and Respondents…".[182] Within 30 days of submitting validated laboratory analytical data to EPA, if an occupant of a residence accepts alternative water, Respondents "shall supply that residence with a RO treatment system or some other form of alternative water approved by the EPA."[183] Under the AOC, this offer of testing remains open for the duration of the agreement. The AOC residential drinking water sampling and R.O. system program only resulted in installation of R.O. systems in 34 of the 66 residences with drinking water in excess of the MCL.[184] Residents have asked for household-wide systems,[185] but the AOC only provides for point-of-use systems.

53. There are also other inconveniences of using reverse osmosis systems, which may dissuade their use and thus affect public health. For example, they function at notoriously slow flow rates, so basic cooking activities such as filling a teakettle or large pot take significant amounts of time. This is true of "on demand" systems and

[180] *See* Yakima Co. Public Services Webpage "Yakima County's Nitrate Treatment Pilot Program" available at http://www.yakimacounty.us/nitrateprogram/english/FAQ_RO_2.htm.
[181] Yakima County's Nitrate Treatment Pilot Program issued its Final Report on June 30, 2011. *See* http://www.yakimacounty.us/nitrateprogram/english/default.*htm.*
[182] AOC, App. B Statement of Work, Para. III.D.1.
[183] AOC, App. B Statement of Work, Para. III.D.5.
[184] Table 8 (DAIRIES008161-008164); DAIRIES002856.
[185] *See, e.g.*, DAIRIES002663.

2-4 gallon tank systems, like what is being installed pursuant to the AOC. They are also easily clogged, decreasing flow rates even further, shortening the lifespan of filters and the system, increasing costs of maintaining the reverse osmosis system, and making regular maintenance all the more important.[186] While for individuals or small families simple solutions may exist (such as carafe filters), these are unlikely to suit the water intake needs (drinking and cooking) of a family. Lastly, reverse osmosis systems filter out a large amount of wastewater; some estimates state that 2-5 gallons of waste water are produced for every gallon of water filtered.[187] All of these effects contribute to the increased cost of reverse osmosis systems.[188]

54. Another problem is that while reverse osmosis systems treat the water to be consumed at the point-of-use, they do not treat water that is used domestically for a variety of other purposes, such as showering, brushing teeth, or providing water for domestic and farm animals, which present threats to their health as well.

55. Combined these problems increase the likelihood that even if people have R.O. systems, that they may not continue to maintain them, or use them. Thus the idea that R.O. systems alone are adequate to protect the public from nitrate contamination in their drinking water is faulty.

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[186] The system used by the Yakima County, for example, says in the second paragraph of the owners guide that "[t]he important thing to remember is to change out your filters on a regular basis. The quality of your water is only as good as the quality of your filters…". Culligan Aqua-Cleer Manual at 4.

[187] *See* Water Filter Buying Guide, Consumer Reports (May 2013) available at http://www.consumerreports.org/cro/water-filters/buying-guide.htm?pn=0; CAI Technologies, Inc. "Selecting A Reverse Osmosis Drinking Water System" (2013) available at http://www.caitechnologies.com/water-softeners/selecting-a-reverse-osmosis-drinking-water-system.htm

[188] *See, e.g.,* R. Rautenbach et al. "Nitrate Reduction of well water by reverse osmosis and electrodialysis – studies on plant performance and costs." *Proceedings of the Third World Congress on Desalination and Water Reuse*. Vol. 65 (Nov. 1987) pp. 241-258 (abstract).

**RECOMMENDATION BASED ON CONCLUSIONS**

56. My recommendation is that exposure to drinking water contaminated with nitrates, pathogens, and veterinary pharmaceuticals be avoided and that alternative water supplies be made available to the exposed population immediately.

Robert S. Lawrence, M.D.

# CURRICULUM VITAE

Robert Swan Lawrence

Highfield House 1112
4000 N. Charles Street
Baltimore MD 21218
410-235-5474

Johns Hopkins University
Bloomberg School of Public Health
615 N. Wolfe Street, Suite W-7010
Baltimore, MD 21205-2179
Tel: (410) 614-4590
Fax: (410) 502-7579
Email: **rlawrenc@jhsph.edu**

## Education

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|---|---|---|
| 1960 | A.B. | Harvard College, Cambridge, MA |
| 1964 | M.D. | Harvard Medical School, Boston, MA |

Postdoctoral Training:

Internship and Residencies:

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| 1964-1965 | Intern in Medicine, Massachusetts General Hospital (MGH), Boston, MA |
| 1965-1966 | Junior Assistant Resident in Medicine, MGH |
| 1969-1970 | Senior Assistant Resident in Medicine, MGH |

Fellowships:

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|---|---|
| 1973 | Clinical Fellow, British Medical Research Council Rheumatism Unit, Taplow, England |

Licensure and Certification:

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| 1965-96 | Massachusetts Licensure Registration (28860) |
| 1965 | National Board of Medical Examiners |
| 1970-1974 | North Carolina Board Licensure Registration |
| 1972 | American Board of Internal Medicine (37522) |

## Professional Experience

Academic Appointments:

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|---|---|
| 2013- | Adjunct Professor, Indian Institute of Health Management Research |
| 2008- | Center for a Livable Future Professor, JHSPH |
| 2007- | Professor of International Health, JHSPH (joint) |
| 2006- | Professor of Environmental Health Sciences, JHSPH (primary) |
| 2006- | Professor of Health Policy and Management, JHSPH (joint) |

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| 2000-2006 | Edyth H. Schoenrich Professor of Preventive Medicine, Bloomberg School of Public Health (JHSPH), Johns Hopkins University |
| 1999-2006 | Professor of Environmental Health Sciences, JHSPH (joint) |
| 1996- | Professor of Medicine, The Johns Hopkins School of Medicine (joint) |
| 1995-2006 | Professor of Health Policy and Management and Associate Dean for Professional Education and Programs, JHSPH |
| 1991-1995 | Adjunct Professor of Medicine, New York University |
| 1991-1996 | Lecturer in Medicine, Harvard Medical School (HMS) |
| 1982-1991 | Charles S. Davidson Associate Professor of Medicine, HMS |
| 1980-1982 | Associate Professor of Medicine, HMS |
| 1977-1980 | Assistant Professor of Medicine at the Beth Israel Hospital and Preventive and Social Medicine, HMS |
| 1975-1977 | Assistant Professor of Medicine and Preventive Medicine, HMS |
| 1974-1975 | Assistant Professor of Medicine, HMS |
| 1973-1974 | Associate Professor of Medicine, University of North Carolina School of Medicine (UNC) |
| 1970-1973 | Assistant Professor of Medicine, UNC |
| 1969-1970 | Clinical Fellow in Medicine, HMS |
| 1964-1966 | Clinical Fellow in Medicine, Harvard Medical School (HMS) |

Hospital Appointments:

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|---|---|
| 1980-1991 | Chief of Medicine, Cambridge Hospital (CH) |
| 1977-1980 | Staff Physician, Beth Israel Ambulatory Care Center and Attending Physician, Beth Israel Hospital, Boston, MA |
| 1975-1976 | Acting Chief, Department of Medicine, CH |
| 1974-1991 | Attending Physician, Cambridge, MA, CH |
| 1974-1991 | Clinical Associate in Medicine, Massachusetts General Hospital |
| 1974-1977 | Associate Chief, Department of Medicine, CH |
| 1970-1974 | Attending Physician, North Carolina Memorial Hospital, Chapel Hill |

Honors and Awards:

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|---|---|
| 2014 | REAL Food Innovator Award, U.S. Healthful Food Council |
| 2009 | Sedgwick Memorial Medal, American Public Health Association |
| 2008 | Sidney Zubrow Award, The Pennsylvania Hospital, University of Pennsylvania Health System |
| 2008 | Advising, Mentoring, and Teaching Recognition Award, Student Assembly, Bloomberg School of Public Health |
| 2006- | Who's Who in the World |
| 2005 | Chief Marshall, JHU Commencement |
| 2004 | Advising, Mentoring, and Teaching Recognition Award, Student Assembly, Bloomberg School of Public Health |
| 2002 | Albert Schweitzer Humanitarian Prize, Humboldt Foundation |
| 2002 | Advising, Mentoring, and Teaching Recognition Award, Student Assembly, Bloomberg School of Public Health |

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| 2001 | Designated lifetime National Associate of the National Academies |
| 1998 | Master, American College of Physicians |
| 1997 | Founders Award, Physicians for Human Rights |
| 1997 | Leadership and Achievement Award, Society of General Internal Medicine |
| 1997 | Delta Omega Public Health Honor Society |
| 1997 | John Atkinson Ferrell Prize, University of North Carolina |
| 1993 | Special Recognition Award and Duncan Clark Lecturer, Association of Teachers of Preventive Medicine |
| 1988-1989 | Kaiser Family Foundation Senior Fellow, Center for Advanced Study in the Behavioral Sciences |
| 1988 | Special Recognition Award, American College of Preventive Medicine |
| 1985- | Who's Who in America |
| 1978 | Institute of Medicine, National Academy of Sciences |
| 1964 | Maimonides Prize, Harvard Medical School |
| 1960 | Magna Cum Laude, Harvard College |
| 1960 | Phi Beta Kappa |
| 1957-1964 | Harvard National Scholarship |

Consultations, Other Professional Positions and Major Visiting Appointments:

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| 2014 | Invited consultant, UN Special Rapporteur on the Right to Health, Regional Consultation on Unhealthy Foods, NCDs, and the Right to Health, Mumbai, India |
| 2013 | Invited speaker, IRAS 57th annual meeting, Silver Point NY |
| 2013 | Invited speaker, U. Wisconsin School of Medicine and Public Health |
| 2013 | Invited speaker, Knight Science Journalism at M.I.T. |
| 2013 | Keynote speaker, Annual Meeting of the Association for Prevention Teaching and Research |
| 2013 | Leading Voices in Public Health speaker, East Tennessee State University School of Public Health |
| 2013 | Invited speaker, Rudd Center for Food Policy & Obesity, Yale University |
| 2012 | Invited speaker, University of Vermont Food Summit |
| 2011 | Charles Hatem Visiting Professor of Medicine, Mt. Auburn Hospital and Harvard Medical School |
| 2011 | Fraiman Lecture, Cambridge Health Alliance, Cambridge MA |
| 2011 | Visiting Scholar, School of Population Health, U. of Auckland |
| 2010 | Invited speaker, Annual Science Day, Environmental Defense Fund |
| 2010 | Keynote speaker, Environmental Grantmakers Association |
| 2010 | Rebecca Landau Social Justice Lecture, Oregon Health & Sciences University, Portland OR |
| 2009 | Invited speaker, Animal Grantmakers, Phoenix AZ |
| 2009 | Invited speaker, Alberta Heritage Foundation for Medical Research, Connects Conference, Jasper, Alberta |

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| 2008 | Keynote speaker, European Commission/WHO Euro Conference on Environment and Health, Brussels, Belgium |
| 2007 | Dennis Keeney Distinguished Lecture, Aldo Leopold Center, Iowa State University, Ames IA |
| 2006 | Invited speaker, Beijing Forum 2006 |
| 2006 | Keynote speaker, Annual Meeting of the Japan Society for Medical Education, Nara |
| 2004 | Distinguished Leaders in Medicine Visiting Professor, Dalhousie University, Halifax, Nova Scotia |
| 2002 | Centennial Keynote Speaker, St. Luke's International Hospital, Tokyo |
| 2001 | Distinguished Lecturer, Kansas Health Institute |
| 2001 | David Rogers Health Policy Colloquium, Weill Cornell Medical College |
| 2001 | Visiting Professor, Center for Bioethics and Health Law and Graduate School of Public Health, University of Pittsburgh |
| 1997 | John Atkinson Ferrell Lecture, University of North Carolina, Chapel Hill |
| 1997 | Luther Terry Lecturer, Commissioned Officers Association, USPHS |
| 1996 | Alan Seelig Memorial Lecture, Sophie Davis School of Biomedical Education, City University of New York Medical School |
| 1996 | Visiting Professor, Nippon Medical School, Tokyo, Japan |
| 1995 | Fred Soper Lecture, Johns Hopkins University School of Hygiene and Public Health |
| 1994 | AΩA Visiting Professor, SUNY Stony Brook |
| 1994 | George C. Gay Lecture in Medical Ethics, Harvard Medical School |
| 1992 | Jonathan King Lecture, Stanford University School of Medicine |
| 1992-1996 | Advisory Committee on Voluntary Foreign Assistance, USAID |
| 1991-1995 | Director, Health Sciences Division, Rockefeller Foundation |
| 1991 | Member, Board of Visitors, Department of Preventive Care, Group Health Cooperative of Puget Sound |
| 1991 | Consultant in Health Promotion/Disease Prevention, Park Nicollet Medical Foundation, Minnesota |
| 1990 | Visiting Professor, Department of Medicine, Wayne State University School of Medicine |
| 1990 | Visiting Professor, School of Medicine, University of Buenos Aires, Argentina |
| 1990 | Visiting Professor, McGaw Medical Center of Northwestern University |
| 1989 | Phineas J. Sparer Distinguished Visiting Professor, College of Medicine, University of Tennessee Center for the Health Sciences |
| 1989 | Consultant, Life Planning Center, Tokyo |
| 1988 | Visiting Professor, Department of Medicine, University of Virginia |
| 1988 | Visiting Professor, Department of Family Medicine, University of Connecticut |
| 1988 | Visiting Professor, Department of Family Medicine, Medical College of New Jersey |
| 1987 | Visiting Professor, Department of Family Medicine, Providence Hospital, University of Washington |

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| 1987 | Visiting Professor, Department of Family Medicine, University of Missouri |
| 1986-1987 | Consultant, Primary Care Initiative Project, Brown University |
| 1985-1988 | Consultant, Home Medical Service, Boston University Medical Center |
| 1985 | Visiting Professor of Medicine, Medical College of Ohio |
| 1985 | Visiting Professor of Community Medicine, Mt. Sinai School of Medicine |
| 1985 | Visiting Professor of Medicine, University of Texas Medical Branch at Galveston |
| 1984-1987 | Coordinator, Harvard-King Faisal University Project |
| 1984 | Visiting Professor of Medicine, Mayo Clinic |
| 1983-1984 | Faculty Liaison, Harvard-King Faisal University Project |
| 1982 | Consultant, Ministry of Health, Doha, Qatar |
| 1982 | Consultant, King Faisal University, Dammam, Saudi Arabia |
| 1981 | Consultant, Life Planning Center, Tokyo, Japan |
| 1980-1986 | Consultant, Primary Care Residency, Rhode Island Hospital and Brown University Program in Medicine |
| 1980 | Visiting Professor of Medicine, University of Pennsylvania |
| 1980 | Visiting Professor of Medicine, Kawasaki Medical College, Japan |
| 1980 | Visiting Professor of Medicine, University of North Carolina |
| 1979 | Visiting Professor of Medicine and Family Medicine, Case Western Reserve University School of Medicine |
| 1979 | Visiting Professor of Family Medicine, Medical University of South Carolina |
| 1978 | Consultant, World Health Organization, Conference on Strengthening of Primary Health Services, Florence, Italy |
| 1976-1991 | Director, Division of Primary Care, HMS |
| 1974-1976 | Director, Harvard Primary Care Program, HMS |
| 1973 | Consultant, Agency for International Development, U.S. Mission to El Salvador |
| 1972-1974 | Chief, Division of General Medicine, Department of Medicine, UNC |
| 1970-1974 | Chief, Division of Community Medicine, Department of Family Medicine, UNC |
| 1970-1972 | Director of Professional Services, Community Health Services Project, UNC |
| 1967-1969 | Medical Epidemiologist, Central America Malaria Research Station, Malaria Program, National Communicable Diseases Center, San Salvador, El Salvador |
| 1966-1969 | Senior Assistant Surgeon, U.S. Public Health Services, EIS Officer, Epidemic Intelligence Service, Parasitic Diseases Section, Centers for Disease Control, Atlanta, GA |

Major Committee Assignments:

National and Regional:

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| 2014 | Review Coordinator for Committee on the Recommended Social and Behavioral Domains and Measures for Electronic Health Records, Board on Population Health and Public Health Practice, IOM, NAS |
| 2013-14 | Planning Committee for IOM Interest Group 14: Environmental and Occupational Health and Toxicology, IOM, NAS |
| 2013 | Review Coordinator for Committee on Child Abuse Prevention, IOM, NAS |
| 2013 | Human Rights and Medical Ethics: An IOM Planning Meeting, Board on Health Sciences Policy, IOM, NAS |
| 2013- | Director Emeritus, Physicians for Human Rights |
| 2012 | Planning Committee on Exploring the True Cost of Food: A Workshop, Food and Nutrition Board, IOM, NAS |
| 2012 | Review Coordinator for Committee on Scientific Standards for Studies on Modified Risk Tobacco Products, IOM, NAS |
| 2011-2012 | Committee on Valuing Community-Based, Non-clinical Prevention Policies and Wellness Strategies, IOM, NAS (Chairman) |
| 2010-2013 | Advisory Board, The Glynwood Institute for Sustainable Food & Farming |
| 2009 | Review Coordinator for Committee on Smoking Cessation in Military and Veteran Populations, IOM, NAS |
| 2008-2011 | Committee on the Development of a Model for Ranking FDA Product Categories on the Basis of Health Risks, NRC, NAS (Chairman) |
| 2008- | Technical Advisory Committee, Law and Health Initiative, Open Society Foundation |
| 2008 | Review Coordinator for Committee on Gulf War and Health: Brain Injury in Veterans and Long-term Health Outcomes, IOM, NAS |
| 2007-2013 | Chair, Board of Directors, Physicians for Human Rights |
| 2006-2007 | Review Coordinator for Committee on Tobacco Use, IOM, NAS |
| 2006-2008 | Committee on Adolescent Health Care Services and Models of Care for Treatment, Prevention, and Healthy Development, IOM, NAS (Chairman; report received 2010 Hilary E.C. Millar Award for Innovative Approaches to Adolescent Health Care from the Society for Adolescent Medicine) |
| 2004- | Global Health Advisory Committee, Open Society Foundation |
| 2004-2006 | Committee to Evaluate Measures of Health Effects, IOM, NAS (Chairman) |
| 2002-2010 | Advisory Board, Soros Advocacy Fellowship, Center on Medicine as a Profession, Columbia University |
| 2001- | Board of Directors, Albert Schweitzer Fellowship Program |
| 2001-2003 | Committee on Dioxins and Dioxin-like Compounds in the Food Supply, IOM/NRC/NAS (Chairman) |
| 2001-2004 | Review Coordinator for Committee on Vaccine Safety, IOM, NAS |
| 2001 | Review Coordinator for Tuberculosis in the Workplace, IOM, NAS |
| 1999-2005 | National Advisory Committee, WK Kellogg Foundation Fellowship in Health Policy |
| 1999-2000 | Committee on Extending Medicare Coverage for Preventive and Other Services, IOM, NAS (Chairman) |
| 1999 | Review Coordinator for Pathological Gambling, IOM, NAS |

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| 1997-2003 | Advisory Board, Medicine as a Profession Program, Open Society Institute |
| 1997-1998 | Committee on Exposure of American People to I-131 from Nevada Atomic Tests: Implications for Public Health, National Research Council, NAS |
| 1997-1998 | Committee on Screening for Thyroid Cancer, IOM, NAS (Chairman) |
| 1997-2009 | Advisory Board, Mid-Atlantic Health Leadership Institute |
| 1997-2003 | Board of Directors, Physicians for Human Rights (President, 1998-2002) |
| 1996-1997 | Committee on Health Care Services in the U.S. Associated Pacific Basin, IOM, NAS (Chairman) |
| 1996-2011 | Consultant, Task Force on Community Health Services, Center for Disease Control and Prevention (CDC) |
| 1996-1998 | Committee on Scientific Freedom and Responsibility, American Association for the Advancement of Science (AAAS) |
| 1995-2008 | Health Advisory Committee, Alberta Heritage Foundation for Medical Research |
| 1995-1998 | Committee to Study Priorities for Vaccine Development, IOM, NAS (Chairman) |
| 1995-1999 | Advisory Committee, Center for the Advancement of Health, Washington, D.C. |
| 1994-1997 | Advisory Committee on Voluntary Foreign Aid, USAID |
| 1993-1998 | Medical Effectiveness Research Center for Diverse Populations, USCF, National Advisory Board |
| 1993-1995 | Member, Human Rights of Scientists Committee, New York Academy of Science |
| 1992-1998 | Board of Trustees, Teachers College, Columbia University |
| 1992-1998 | Advisory Committee, Human Rights Watch/Americas |
| 1990-1995 | Member, U.S. Preventive Services Task Force, Department of Health and Human Services |
| 1990-1991 | Health Promotion Advisory Board, Kansas Health Foundation |
| 1988-1993 | Core Group, MacArthur Foundation Network on Health and Behavior |
| 1987-1994 | Committee on Health and Human Rights, IOM, NAS (Chairman, 1990-1994) |
| 1986-1991 | Dana Awards Nomination Committee, IOM, NAS (Chairman 1987-1991) |
| 1986-1996 | Committee on Human Rights, NAS |
| 1985-1991 | Founding member, Board of Directors, Physicians for Human Rights (PHR was co-recipient of 1997 Nobel Peace Prize) |
| 1985-1988 | Steering Committee, Centers for Disease Control-Association for Teachers of Preventive Medicine Cooperative Agreement |
| 1984-1991 | Board of Overseers, Harvard Community Health Plan |
| 1984-1989 | U.S. Preventive Services Task Force, Department of Health and Human Services (Chairman) |
| 1983-1988 | Oversight Committee, Takemi Program in International Health, Harvard School of Public Health |
| 1983-1987 | Board of Trustees, Harvard Community Health Plan Foundation |

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| 1983-1985 | Residency Advisory Committee, Collaborative Project for Curriculum Development in Preventive Medicine, Association of Teachers of Preventive Medicine |
| 1982 | Subcommittee to Evaluate NASA Medical Surveillance Data Sheets, Committee on Toxicology, National Research Council, NAS |
| 1981-1989 | Mental Health Policy Working Group, Division of Health Policy, Research and Education, Harvard University |
| 1981-1986 | Board of Health Promotion and Disease Prevention, IOM, NAS (Chairman 1982-1986) |
| 1981-1985 | Board of Trustees, Boston Medical Library |
| 1980-1981 | Advisory Committee on Health Promotion and Disease Prevention, IOM, NAS |
| 1979-1980 | Committee on Patient Package Inserts, IOM, NAS |

Hospital:

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| 1990-1991 | Chairman, Steering Committee, Health of the City Project of the Pew/Rockefeller Health of the Public Program |
| 1987-1991 | Credentials Committee, Cambridge Hospital (CH) |
| 1982-1983 | Search Committee, Hospital Director, CH |
| 1981-1984 | Quality Assurance Board, CH |
| 1981-1982 | President of the Medical Staff, CH |
| 1981-1982 | Search Committee, Chief of Psychiatry, CH |
| 1981 | Search Committee, Director of Nursing, CH |
| 1980-1991 | Labor-Management Committee, CH |
| 1980-1983 | Joint Conference Committee, CH |
| 1975-1977 | Executive Committee, CH |
| 1980-1991 | Executive Committee, CH |

Memberships, Offices and Committee Assignments in Professional Societies:

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|---|---|
| 1987- | Fellow, American College of Preventive Medicine |
| 1986-1991 | Human Rights and Medical Practice Subcommittee, Health and Public Policy Committee, American College of Physicians |
| 1986-1988 | Health and Public Policy Committee (Chairman), Massachusetts Chapter of American College of Physicians |
| 1985- | American Public Health Association |
| 1984-1988 | Council, Association of Teachers of Preventive Medicine |
| 1978-1990 | American Federation of Clinical Research |
| 1978- | Association of Teachers of Preventive Medicine |
| 1970- | American College of Physicians (Fellow 1978; Master 1998) |
| 1991-1995 | American Society of Tropical Medicine and Hygiene |
| 1967-1971 | American Society of Tropical Medicine and Hygiene |
| 1963- | Boylston Medical Society |

Editorial Boards:

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|---|---|
| 1990-1992 | Editor, American Journal of Preventive Medicine |
| 1987-1992 | American Journal of Preventive Medicine |
| 1984-1987 | Journal of General Internal Medicine |
| 1983-1991 | Alumni Bulletin, Harvard Medical School |
| 1980-1991 | Massachusetts Journal of Community Health |

**Publications**

Peer-Reviewed Original Reports:

Park S, Lawrence R, Gittelsohn J. Environmental influences on youth eating habits: Insights from parents and teachers in South Korea. Ecology of Food and Nutrition (in print)

Pronk NP, Hernandez LM, Lawrence RS. An integrated framework for assessing the value of community-based prevention: A report of the Institute of Medicine. Prev Chronic Dis 2013;10:120323.

Love DC, Breaud A, Burns S, Margulies J, Romano M, Lawrence RS. Is the three-foot bicycle passing law working in Baltimore, Maryland? Accident Analysis and Prevention 2012; 48:451-456.

Rakhi S, Andrews A, Lawrence R, Ghannam J. Refugees right to employment and evolving responsibilities of host countries: the urgency of Iraqi refugees to realize economic, social, and cultural rights. J Immigrant & Refugee Studies 2012; 10(4):431-437.

Neff RA, Parker CL, Kirschenmann FL, Tinch J, Lawrence RS. Peak oil, food systems, and public health. AJPH 2011; 101(9):1587-1597.

Wang Y, Beydoun MA, Caballero B, Gary TL, Lawrence RS. Trends and correlates in meat consumption patterns in the US adult population. Public Health Nutr. 2010 Sep;13(9):1333-45.

Neff RA, Palmer AM, McKenzie SE, Lawrence RS. Food Systems and Public Health Disparities. J of Hunger & Env Nutrition 2009; 4(3):282-314.

Canela Soler J, Pallarés Fusté MR, Abós Herràndiz R, Nebot Adell C, Lawrence RS. A mortality study of the last outbreak of yellow fever in Barcelona City (Spain) in 1870. Gac Sanit 2009; 23(4):295-299.

Lawrence RS, Saundry PD. Climate change, health sciences, and education. AJPM 2008; 35(5):426-8.

Lawrence RS, Chan I, Goodman E. Poverty, Food Security, and the Right to Health. Georgetown J on Poverty Law & Policy 2008; 25(3):583-604.

Sapkota A, Sapkota AR, Kucharski M, Burke J, McKenzie S, Walker P, Lawrence RS. Aquaculture practices and potential human health risks: Current knowledge and future priorities. Environ Int 2008; doi:10.1016/j.envint.2008.04.009.

Beydoun MA, Gary TL, Caballero BH, Lawrence RS, Cheskin LJ, Wang Y. Ethnic differences in dairy and related nutrient consumption among US adults and their association with obesity, central obesity, and the metabolic syndrome. Am J Clin Nutr 2008; 87:1914-25.

Yaktine A, Harrison GG, Lawrence RS. Reducing Exposure to Dioxins and Related Compounds through Foods in the Next Generation. Nutrition Reviews 2006; 64:403-409.

König A, Bouzan C, Cohen J, Connor W, Kris-Etherton P, Gray G, Lawrence RS, Savitz DA, Teutsch S. A Quantitative Analysis of Fish Consumption and Coronary Heart Disease. Am J Prev Med 2005; 29(4):335-46.

Bouzan C, Cohen J, Connor W, Kris-Etherton P, Gray G, König A, Lawrence RS, Savitz DA, Teutsch S. A Quantitative Analysis of Fish consumption and Stroke Risk. Am J Prev Med 2005; 29(4):347-52.

Cohen J, Bellinger DC, Connor WE, Kris-Etherton PM, Lawrence RS, Savitz DA, Shaywitz BA, Teutsch SM, Gray GM. A Quantitative Risk-Benefit Analysis of Changes in Population Fish Consumption. Am J Prev Med 2005; 29(4):325-34.

Walker P, Rhubart-Berg P, McKenzie S, Kelling K, Lawrence RS. Public Health Implications of Meat Production and Consumption. J Public Health Nutrition 2005; 8(4):348-356.

O'Toole TP, Arbelaez JJ, Lawrence RS, et al. Medical debt and aggressive debt restitution practices: predatory billing among the urban poor. JGIM 2004; 19:772-778.

Boulware LE, Daumit GL, Frick KD, Minkovitz CS, Lawrence RS, Powe NR. Quality of clinical reports on behavioral interventions for hypertension. Prev Med. 2002; 34(4):463-75.

Horrigan L, Lawrence RS, Walker P. How Sustainable Agriculture Can Address the Environmental and Human Health Harms of Industrial Agriculture. Environmental Reports 2002; 110:445-456

Boulware LE, Daumit GL, Frick KD, Minkovitz CS, Lawrence RS, Powe,NR. An Evidence-Based Review of Patient-Centered Behavioral Interventions for Hypertension. Am J Prev Med 2001; 21(3):221-232.

Daumit GL, Boulware LE, Powe, NR, Frick KD, Minkovitz CS, Anderson L, Janes, G, Lawrence, RS. A Computerized Tool for Evaluating the Effectiveness of Preventive Interventions. Public Health Reports, 2001 Supplement 1, Volume 116, 244-253.

Feightner JW, Lawrence RS. Evidence-based prevention and international collaboration. Am J Prev Med 2001; 20(3 Suppl):5-6.

Zaza S, Lawrence RS, Mahan CS, et al. Scope and Organization of the Guide to Community Preventive Services. Am J Prev Med 2000; 18 (1S):27-32.

Truman BI, Smith-Akin CK, …Lawrence RS, et al. Developing the Guide to Community Preventive Services – Overview and Rationale. Am J Prev Med 2000; 18 (1S):18-26.

Woolf SH, Lawrence RS. Preserving scientific debate and patient choice: lessons from the Consensus Panel on Mammography Screening, National Institutes of Health. JAMA 1998; 278(23):2105-8.

McCally M, Haines A, Fein O, Addington W, Lawrence RS, Cassel C. Poverty and Ill Health: Physicians Can, and Should, Make a Difference. Ann Intern Med. 1998; 129:726-733.

Hannibal K, Lawrence RS. The health professional as human rights promoter: ten years of Physicians for Human Rights (USA). Health and Human Rights 1996; 2 (1): 111-127.

Lawrence RS, Woolf SH: Screening for prostate cancer: Commentary on the recommendations of the Canadian Task Force on the Periodic Health Examination. Am J Prev Med 1994; 10 (4): 187-193.

Lawrence RS: The physician's perception of health care. J Royal Soc Med 1994; 87 (S): 11-14.

Branch W, Pels RJ, Lawrence RS, Arky R: Becoming a doctor: Critical-incident reports from third year medical students. NEJM 1993; 329: 1130-32.

Sox HC, Berwick DM, Berg AO, Frame PS, Fryback DG, Grimes DA, Lawrence RS, Wallace RB. Home uterine activity monitoring for preterm labor; review article. JAMA 1993; 270(3):371-376.

Halstead SB, Lawrence RS. Reference health centres. Lancet 1993; 342(8867):372-3.

Nightingale EO, Hannibal MA, Geiger HJ, Hartmann L, Lawrence RS, Spurlock J. Apartheid medicine: health and human rights in South Africa JAMA 1990; 264: 2097-2102.

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Lawrence RS. Medical education in ambulatory settings. Arch Intern Med. 1990; 150(10):2008-9.

Woolf SH, Kamerow DB, Lawrence RS, Medalie JH, Estes EH. The periodic health examination of older adults: the recommendations of the U.S. Preventive Services Task Force, Part 1. Counseling, immunizations, and chemoprophylaxis. J Am Geriatric Soc 1990; 38: 817-23

Woolf SH, Kamerow DB, Lawrence RS, Medalie JH, Estes EH: The periodic health examination of older adults: the recommendations of the U.S. Preventive Services Task Force, Part II. Screening tests. J Am Geriatric Soc 1990;38: 933-42.

Bennett SE, Lawrence RS, Angiolillo DF, et al: Effectiveness of methods used to teach breast self-examination. Am J. Prev Med 1990; 6 (4): 208-17.

Lawrence RS, Mickalide AD, Kamerow DB, Woolf SH. Report of the US Preventive Services Task Force. JAMA 1990; 263(3):436-7.

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Wallace RB, Wiese WH, Lawrence RS, et al: Inventory of knowledge and skills relating to disease prevention and health promotion. Am J Prev Med 1990; 6 (1): 51-6.

Himmelstein DU, Woolhandler S, ...Lawrence RS, et al: A national health program for the United States: a physician's proposal. N Engl J Med 1989; 320: 120-8.

Pels RJ, Bor DH, Lawrence RS: Decision making for introducing clinical preventive services. Annual Rev Public Health, 1989; 10:363-83.

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Woolhandler S, Pels RJ, Bor DH, Himmelstein DU, Lawrence RS: Dipstick urinalysis screening of asymptomatic adults for urinary tract disorders. I. Hematuria and proteinuria. JAMA 1989; 262: 1214-19.

Pels RJ, Bor DH, Woolhandler S, Himmelstein DU, Lawrence RS: Dipstick urinalysis screening of asymptomatic adults for urinary tract disorders. II. Bacteriuria. JAMA 1989; 262: 1221-24.

Pels RJ, Bor DH, Lawrence RS. Decision making for introducing clinical preventive services. Annu Rev Public Health 1989; 10:363-83.

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Lawrence RS: Hygeia or Panacea—which is the better buy? The Internist 1986; October: 9-10.

Lawrence RS: The US Preventive Services Task Force. Perspectives on Prevention 1986; 1:8-10.

Bennett SB, Goodson J, Lawrence RS, et al: Comparing ambulatory care practices of primary care and traditional medicine residents. Med Care 1986: 23: 816-822.

Goodson J, Bennett S, Lawrence RS, et al: Multi-center evaluation of primary care internal medicine residency training: are practical goals met? Med Care 1984:22: 770-775.

Bennett SB, Lawrence RS, Fleischmann KH, Gifford CS, Slack WB: Profile of women practicing breast self-examination. JAMA 1983: 249: 488-491.

Wyshak G, Lawrence RS: Health-promoting behavior among lawyers and judges. J Comm Hlth 1983; 8:174-181.

Lawrence RS: Some humanistic dimensions of primary care. Family Medicine 1982: 14(4): 9-12.

Aronson M, Lawrence RS, Taylor W, Delbanco T: Peer review in a primary care education program. J Med Educ 1982: 57: 481-3.

Stern RS, Calkins D, Delbanco TL, Lawrence RS: Rural experience in primary care training for advanced house officers: a pilot program. J Amb Care Mgmt. 1980; 3:89-95.

Barsky AJ, Kazis LE, Freidin RB, Goroll AH, Hatem CJ, Lawrence RS, Nason FE: Evaluating the interview in primary care medicine. Soc Sci Med 1980; 14A:653-658.

Wyshak G, Lamb GA, Lawrence RS, Curran WJ: A profile of the health promoting behaviors of physicians and lawyers. N Engl J Med 1980; 303: 104-107.

Steinberg EP, Lawrence RS: Where have all the doctors gone? Physician choices between specialty and primary care practice. Ann Intern Med 1980; 93:619-623.

Lawrence RS. The role of physician education in cost containment. J Med Educ 1979; 54(11):841-7.

Lawrence RS: Harvard primary care program. In: Proceedings of first conference on primary care delivery, education and research in teaching hospitals, September 28-30, 1977. Aspens Systems Corporation. J Amb Care Mgmt 1979; 2:55-95.

Lawrence RS: Funding post-graduate health professional training. In: Conference on the status of advanced dental training programs: papers and proceedings of the conference. J Hosp Prac. 1979; X111:s43-s55.

Lawrence RS: Physician education for cost entertainment. J Med Educ. 1979; 57:841-847.

Lawrence RS, DeFriese GH, Putnam SM, Picard CG, Cyr AG, Whiteside SW: Physician receptivity to nurse practitioners: a study of correlates of the delegation of clinical responsibility. Med Care 1977; 15:289-319.

Stern RS, Jenning M, Delbanco TL, Dorsey JL, Stoeckle JD, Lawrence RS: Graduate education in primary care: an economic analysis. N Engl J Med 1977; 297:638-643.

Putnam SM, Wyse DH, Lawrence RS: A model for teaching primary care in a rural health center. J Med Educ 1975; 50:285-287.

Moore GT, Kaiser RL, Lawrence RS, Putnam SM, Kagan IG: Intradermal and serologic reactions to antigens from *Schistosoma mansoni* in schistosome dermatitis. Am J Trop Med Hyg 1968; 17: 86-91.

Chapters:

Lawrence RS. Promoting Social Justice through Education in Public Health. In: Levy B and Sidel V, eds: Social Injustice and Public Health, 2nd edition. New York: Oxford University Press 2013.

Lawrence RS, Levy BS. Creating a Vision and Inspiring Others. In: Levy BS and Gaufin JR, eds; Mastering Public Health: Essential Skills for Effective Practice. New York: Oxford University Press 2012.

Shannon K, Lawrence RS. Anthropogenic Sources of Water Pollution. In: Selendy J, ed. Water and Sanitation Related Diseases and the Environment; Challenges, Interventions and Preventive Measures. Hoboken NJ: Wiley-Blackwell 2011.

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Lawrence RS. Promoting Social Justice through Education in Public Health. In: Levy B and Sidel V, eds: Social Injustice and Public Health. New York: Oxford University Press 2006.

Walker P, Lawrence RS. Challenges of Greening a Decentralized Campus: Making the Connection to Health. In: Barlett PF and Chase GW, eds: Sustainability on Campus: Stories and Strategies for Change. Cambridge: The MIT Press 2004:259-270.

Lawrence RS. Prostate Cancer Screening. In: Branch WT, ed. The Office Practice of Medicine, 4th Edition. St. Louis: Mosby Inc. 2003:1107-11.

Lawrence RS. Cervical Cancer Screening. In: Branch WT, ed. The Office Practice of Medicine, 4th Edition. St. Louis: Mosby Inc. 2003:1104-07.

Alexander M, Lawrence RS. Periodic health assessment of asymptomatic adults. In: Branch WT, ed. The Office Practice of Medicine, 4th Edition. St. Louis: Mosby Inc. 2003:1085-92.

Mezey AP, Lawrence RS. Ambulatory Care. In: Kovner AR, ed: Health Care Delivery in the United States, 5th Edition. New York: Springer 1995:122-61.

Branch WT, Lawrence RS. Periodic health assessment of asymptomatic adults. In: Branch WT, ed: The Office Practice of Medicine, 3rd Edition. Philadelphia: WB Saunders 1994:906-914.

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Lawrence RS. Status of graduate education: internal medicine. In: Proceeding of Future Developments in Primary Care Graduate Medical Care Education, December 3-5, 1984, Bethesda, Maryland. Washington: U.S. Department of Health and Human Services, Public Health Service, Health Resources and Services Admininstration. Contractor: Boston University School of Medicine #HSRA 240-84-0048.

Lawrence RS, Jonas S. Ambulatory Care. In: Kovner AR, ed: Health Care Delivery in the United States, 4th Edition. New York: Springer 1990: 106-40.

Lawrence RS. Summary of workshop sessions of the international symposium on preventive services in primary care: issues and strategies. In: Battista RN and Lawrence RS, eds: Implementing Preventive Services. Am J Prev Med 1988; supp. 4 (4): 188-90.

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Lawrence RS: Invited testimony before the Subcommittee on Early Childhood, Elementary and Secondary Education of the Committee on Education and Labor [House of Representatives] at the hearing entitled, "Environmental Education: Teaching our Children to Preserve our Future," April 22, 2008.

Lawrence RS: Invited testimony before the Subcommittee on Environment and Hazardous Materials of the Energy and Commerce Committee, House of Representatives, at the hearing entitled "Superfund Laws and Animal Agriculture," November 16, 2005.

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CURRICULUM VITAE
Robert S. Lawrence
Part II

Teaching

Advisees

| Name | Degree | Date |
|---|---|---|
| Mark Keleman | Sc.M. (Clinical Investigation) | 1996-2000 |
| Christine Layton | Ph.D. | 1996-1999 |
| Cynthia Ronzio | Ph.D. | 1996-2000 |
| Michel Thieren | M.P.H. | 1996-1997 |
| Carlos Ince | Sc.M. (Clinical Investigation) | 1996-1999 |
| Antonia Novella | Dr.P.H. | 1997-2000 |
| Thomas Chapa | M.P.H. | 1997-1998 |
| Dominic Chow | M.P.H. | 1997-1998 |
| M. Christopher Gibbons | M.P.H. | 1997-1998 |
| David Goodfriend | M.P.H. | 1997-1998 |
| Fermin Leguen | M.P.H. | 1997-1998 |
| John Oh | M.P.H. | 1997-1998 |
| Michael Royster | M.P.H. | 1997-1998 |
| Edward Van Oeveren | M.P.H. | 1997-1998 |
| Jorge Trujillo | M.P.H. | 1997-1998 |
| Renata Arrington | M.P.H. | 1998-1999 |
| Lisa Bevilacqua | M.P.H. | 1998-1999 |
| John Patrick Co | M.P.H. | 1998-1999 |
| Edward Cox | M.P.H. | 1998-1999 |
| Elaine Cramer | M.P.H. | 1998-1999 |
| Lisa Diamond | M.P.H. | 1998-1999 |
| Denise Gray | M.P.H. | 1998-1999 |
| Jean Ling | M.P.H. | 1998-1999 |
| Paola Morello | M.P.H. | 1998-1999 |
| Angeleke Saridakis | M.P.H. | 1998-1999 |
| Hosung Shin | M.P.H. | 1998-1999 |
| Farhat Syed | M.P.H. | 1998-1999 |
| Jenifer Willmann | M.P.H | 1998-1999 |
| Susan Zieman | Ph.D. (Clinical Investigation) | 1998-2006 |
| Jean Ling | M.P.H. (Distance Education) | 1998-2002 |
| David Blodgett | M.P.H. | 2000-2001 |
| Chris Chau | M.P.H. | 2000-2001 |
| Sarah Dachman | M.P.H. | 2000-2001 |
| Amanda Folsom | M.P.H. | 2000-2001 |

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|---|---|---|
| Keith Hanley | M.P.H. | 2000-2001 |
| Virginia Huang | M.P.H. | 2000-2001 |
| Steven Landers | M.P.H. | 2000-2001 |
| Rabina Malik | M.P.H. | 2000-2001 |
| Karen Matthews | M.P.H. | 2000-2001 |
| Heidi Park | M.P.H. | 2000-2001 |
| Farah Parvez | M.P.H. | 2000-2001 |
| Bhavani Pattabiraman | M.P.H. | 2000-2001 |
| Andrew Plummer | M.P.H. | 2000-2001 |
| Karen Rigamonti | M.P.H. | 2000-2001 |
| Theresa Smith | M.P.H. | 2000-2001 |
| Wirudchada Suttayakom | M.P.H. | 2000-2001 |
| Steven Tobler | M.P.H. | 2000-2001 |
| Wakenda Tyler | M.P.H. | 2000-2001 |
| Todd Varness | M.P.H. | 2000-2001 |
| Scarlette Wilson | M.P.H. | 2000-2001 |
| Lionel Schachna | Ph.D. (Clinical Investigation) | 2000-2004 |
| Janice Eickmeier | M.P.H. (Distance Education) | 2000-2003 |
| Federico Gutierrez | M.P.H. (Distance Education) | 2000-2003 |
| Sarah Henn | M.P.H. (Distance Education) | 2001-2004 |
| Agron Ismaili | M.P.H. (Distance Education) | 2001-2004 |
| Dinesh Jain | M.P.H. (Distance Education) | 2001-2004 |
| Zulfiqar Rana | M.P.H. (Distance Education) | 2001-2004 |
| Lynda Redwood-Campbell | M.P.H. (Distance Education) | 2000-2003 |
| Robin Streeter | M.P.H. (Distance Education) | 2000-2003 |
| Janine Kossen | M.P.H. | 2001-2002 |
| Patricia Sansaricq | M.P.H. (Distance Education) | 2001-2006 |
| Susan Bartlett | M.H.S.(Clinical Investigation) | 2001-2002 |
| David Bradley | Sc.M. (Clinical Investigation) | 2001-2004 |
| Wendy Johnson | M.P.H. (Distance Education) | 2001-2004 |
| Garima Deveshwar-Bahl | M.P.H. (Distance Education) | 2001-2004 |
| Susan Zieman | Ph.D. | 2001-2005 |
| Jody Acheson | M.P.H./M.S.N. | 2003-2006 |
| Katherine Close | M.P.H. | 2003-2004 |
| Pamela Marks | M.P.H. | 2003-2004 |
| Jaime Lynn Mignano | M.P.H. | 2003-2004 |
| Brett Nelson | M.P.H. | 2003-2004 |
| Katrina Pagonis | M.P.H. | 2003-2004 |
| Nidhi Singh | M.P.H. | 2003-2004 |
| Todd Nitkin | M.P.H. | 2003-2004 |
| Dwight Chenette | M.P.H. (Distance Education) | 2003-2007 |
| Emilie Calvello | M.P.H. | 2004-2005 |
| Stephanie Calves | M.P.H. | 2004-2005 |
| William Doyle | M.P.H. | 2004-2005 |
| Jennifer Kleene | M.P.H. | 2004-2005 |
| Joshua Lozman | M.P.H. | 2004-2005 |

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|---|---|---|
| Phyra McCandless | M.P.H. | 2004-2005 |
| Kathleen Mitchell | M.P.H. | 2004-2005 |
| Lashawndra Pace | M.P.H. | 2004-2005 |
| Molly Patton | M.P.H. | 2004-2005 |
| Hayman Win | M.P.H. | 2004-2005 |
| Timothy Zeffiro | M.P.H. | 2004-2005 |
| Marlis Gonzalez-Fernandez | Ph.D. (Clinical Investigation) | 2004-2008 |
| Melissa Dawalt | M.P.H. | 2005-2006 |
| Paul Hollier | M.P.H. | 2005-2006 |
| Lydia Mann-Bondat | M.P.H. | 2005-2006 |
| James Stanbury | M.P.H. | 2005-2006 |
| David Hohuan | M.P.H. | 2005-2006 |
| Peter Gregg | M.P.H. | 2005-2006 |
| Deanna Handel | M.P.H. | 2005-2006 |
| Kayla Cunningham | Ph.D. | 2005-2008 |
| Deepali Patel | M.P.H. | 2005-2008 |
| Kayla Cunningham | M.H.S.(Clinical Investigation) | 2005-2006 |
| Pammie Crawford | Ph.D. | 2006-2012 |
| Elizabeth Dzeng | M.P.H. | 2006-2007 |
| Anita Ray | M.P.H. | 2006-2007 |
| Kerry Shannon | M.P.H. | 2006-2007 |
| Natassia Rozario | M.P.H. | 2006-2007 |
| Mary Ellen McEvoy | M.P.H. | 2006-2007 |
| Susanna Matsen Nazarian | Ph.D. (Clinical Investigation) | 2006-2009 |
| Allen Andrews | M.P.H. | 2007-2008 |
| Sana Contractor | M.P.H. | 2007-2008 |
| Jennifer Leigh | M.P.H. | 2007-2008 |
| Carlos Williams | M.P.H. | 2007-2008 |
| Ami Shah | M.H.S. | 2007-2008 |
| Thomas Stephens | M.P.H. | 2007-2011 |
| Sheryl Harris, advisor + Capstone | M.P.H. (Distance Education) | 2007-2010 |
| Jill Marie Murphy | M.P.H. (Distance Education) | 2008-2012 |
| Robert Rusher | M.H.S.(Clinical Investigation) | 2008-2009 |
| Ami Shah | M.H.S.(Clinical Investigation) | 2008-2009 |
| Gaurab Basu | M.P.H. | 2008-2009 |
| Siri Michel-Midelfort | M.P.H. | 2008-2009 |
| Roland Champagne | M.P.H. | 2008-2009 |
| Jennifer Hartle | Dr.P.H. | 2009-2013 |
| Rebecca Fielding | M.P.H. (Distance Education) | 2009-2011 |
| Ryan Westergard | Ph.D. (Clinical Investigation) | 2009-2013 |
| Allison Berry, advisor + Capstone | M.P.H. | 2010-2011 |
| Nora Rowley, Capstone advisor | M.P.H. | 2010-2011 |
| Travis Hobart, Capstone advisor | M.P.H. | 2010-2011 |
| Grace Chan | Ph.D. (Clinical Investigation) | 2010-2013 |
| Matthew Spear, advisor + Capstone | M.P.H.(Distance Education) | 2011-2013 |
| Milly Dawson, Capstone advisor | M.P.H. | 2011-2013 |

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|---|---|---|
| Brittany Davis, advisor + Capstone | M.P.H. | 2012-2013 |
| Christina Balch | M.P.H. (Distance Education) | 2012-2014 |
| J. Tyler Schwartz, advisor+Capstone | M.P.H. | 2012-2013 |
| Amanda Sorensen, Capstone advisor | M.P.H. | 2012-2013 |
| Peter Luckow | M.P.H. | 2013-2014 |

School-Wide Preliminary Oral Examination Participation

Christine Layton, Ph.D., 1996
Jiruth Srinatanaban, Ph.D., 1996
Mary Taylor, Ph.D., 1996
Cynthia Ronzio, Ph.D., 1996
Sarbani Chakraborty, Ph.D., 1997
Byron Hiebert-Crape, Ph.D., 1997
Kavita Singh, Ph.D., 1998
Jeannette Gabrielle Breugelmans, Ph.D., 1999
Isis Pluut, Dr.P.H., 2000
David Laflamme, Ph.D., 2001
Lionel Schachner, Ph.D., 2001
Jaime Eduardo Castillo, Ph.D., 2002
Nickolas Zaller, Ph.D., 2002
Kavitha Viswanathan, Ph.D., 2002
Patrick Mullen, Ph.D., 2003
Susan Zieman, Ph.D., 2003
Kristin Chossek Malecki, Ph.D., 2003
Lara Ho, Ph.D., 2004
Elena Yu, Dr.P.H., 2004
Nancy Maldeis, Ph.D., 2005
Manuel Franco, Ph.D., 2005
Arantxa Colchero, Ph.D., 2005
Ki Yeob Jeon, Ph.D., 2005
Marlis Gonzalez Fernandez, Ph.D., 2006
Rebekah Heinzen, Ph.D., 2006
Judith Douglass, Ph.D., 2006
Devaki Nambiar, Ph.D., 2006
Muge Qi, Ph.D., 2007
Helaine Rutkow, Ph.D., 2007
Sophia Carmen Ariola, Ph.D., 2008
Kristen Gibbons, Ph.D., 2008
Manjunath Shankar, Ph.D., 2008
Jessica Tuchmann Leibler, Dr.P.H., 2008
Muge Qi, Ph.D., 2008
Chidinma Ibe, Ph.D., 2008
Amelia Greiner, Ph.D., 2009
Joy Guillemot, Ph.D., 2009
Pammie Crawford, Ph.D., 2009

Julia DeBruicker, Ph.D., 2009
Beth Feingold, Ph.D., 2009
Chidinma Ibe, Ph.D., 2009
Jillian Fry, Ph.D., 2010
Seung Hee Lee, Ph.D., 2010
Ryan P. Westergaard, Ph.D., 2010
Jennifer Hartle, Dr.P.H., 2011
Grace Chan, Ph.D., 2011
Muzi Na, Ph.D., 2011
Chadd Kraus, Dr.P.H., 2012
Linnea Zimmerman, Ph.D., 2012
Hannah Tappis, Ph.D., 2012
Myra Shapiro, Ph.D., 2012
Ikwo Oboho, Ph.D., 2012
Nadine Budd, Ph.D., 2013
Bess Lewis, Ph.D., 2014

School-wide Final Oral Examination Participation and Thesis Reader

Mary Taylor, Ph.D., 1998
Christine Layton, Ph.D., 1999
Cynthia Ronzio, Ph.D., 2000
Irshad Shaikh, Ph.D., 2000
Antonia Novella, Dr.P.H., 2000
Victoria Gamino, Ph.D., 2001
Kavita Singh, Ph.D., 2001
Elisabeth Pluut, Dr.P.H., 2002
Paul Freeman, Dr.P.H., 2002
Annette Amey, Ph.D., 2002
Jessica Noel, Ph.D., 2003
David Laflamme, Ph.D., 2003
Lionel Schachna, Ph.D., 2003
Unni Karunakara, Dr.P.H., 2004
David Chang, Ph.D., 2004
Xiaoping Weng, Ph.D., 2005
Amy Chapin, Ph.D., 2005
Susan Zieman, Ph.D., 2005
Lara Ho, Ph.D., 2007
Nancy Maldeis, Ph.D., 2007
Arlyne Beeche, Ph.D., 2007
Manuel Franco, MD, Ph.D., 2007
Marlis Gonzalez Fernandez, Ph.D., 2008
Hossein Bahrami, MD, Ph.D., 2008
Susanna M Nazarian, MD, Ph.D., 2009
Gila Neta, Ph.D., 2009
Devaki Nambiar, Ph.D., 2009

Virginia Huang Richmond, Ph.D., 2010
Manjunath Shankar, Ph.D., 2010
Elizabeth Rowley, Dr.P.H., 2010
Joy Guillemot, Dr.P.H., 2011
Soawapak Hinjoy, Ph.D., 2011
Julia DeBruicker Valliant, Ph.D., 2012
Stephanie Farquhar, Ph.D., 2012
Krystal Mason, MSPH, 2012
Sohyun Park, Ph.D., 2012
Jillian Fry, Ph.D., 2012
Seung Hee Lee, Ph.D., 2012
Pammie Crawford, Ph.D., 2012
Ryan Westergaard, Ph.D., 2012
Grace Chan, Ph.D., 2013
Jennifer Hartle, Dr.P.H., 2013
William Davis, Dr.P.H., 2014

Classroom Instruction:

Johns Hopkins University:

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|---|---|
| 1996-2010 | Instructor, Case Studies in Primary Health Care (221.635) |
| 1996- | Course Head and Instructor, Problem Solving in Public Health (550.608) |
| 1996-1998 | Course Head and Instructor, Managing Your Career to Advance the Public's Health (550.601) |
| 1997- | Course Head and Instructor, Longitudinal Seminar, Health and Human Rights (180.636) |
| 1998-2002 | Tutor, Physician and Society, School of Medicine, JHU |
| 2003 | Instructor, Special Topics in Health and Human Rights: Security vs. Civil Liberties in a Time of Bio-Terrorism, Winter Institute (550.852) |
| 2004-2006 | Co-director and Instructor, Food Security: Nutritional Health, Environment and Equity, Winter Institute |
| 2004- | Instructor, Special Topics in Health and Human Rights: Public Health Implications of Health as a Human Right, Winter Institute (550.852) |
| 2004-2008 | Co-director and Instructor, Research Methods in Health and Human Rights |
| 2006- | Co-director and Instructor, Food Production, Public Health, and the Environment (180.620) |
| 2013- | Co-director and Instructor, Coursera MOOC, Food Production, Public Health and the Environment |

Harvard Medical School:

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| 1974-1991 | Attending physician, Medical Service, Cambridge Hospital |
| 1974-1991 | Clinical Associate, Massachusetts General Hospital |
| 1974-1986 | Instructor, Introduction to Clinical Medicine, Cambridge Hospital |

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| 1974-1980 | Instructor, seminar leader, lecturer, Department of Preventive and Social Medicine, Harvard Medical School |
| 1977-1980 | Attending physician, Beth Israel Hospital |
| 1980-1988 | Attending physician, Mount Auburn Hospital |
| 1980-1991 | Co-director, Primary Care Internal Medicine Course, Division of Primary Care |
| 1985-1988 | Director, curriculum planner and seminar leader, Patient-Doctor Course, New Pathway Project |
| 1985-1991 | Oliver Wendell Holmes Society (Senior Fellow) |
| 1987 | Clinical Facilities Self-Study Committee, Liaison Committee on Medical Education |
| 1987-1988 | Tutor, Pathophysiology (Human Systems Block), New Pathway Project |
| 1987-1988 | Seminar Leader, Patient-Doctor Course in Human Systems Block, New Pathway |
| 1987 | Study Group Leader (spring semester), Ethical Dilemmas in U.S. Health Policy, Institute of Politics, Kennedy School of Government, Harvard University |
| 1989-1991 | Instructor, Clinical Skills (Patient/Doctor II) |
| 1989-1991 | Member, Patient/Doctor III Policy Group |
| 1990-1991 | Tutor, Patient/Doctor III |
| 1990-1991 | Tutor, Human Systems |

University of North Carolina:

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|---|---|
| 1972-1974 | Directed and taught physical diagnosis course for second year students (class size 90-110), UNC School of Medicine |
| 1970-1074 | Designed, implemented and directed required 3 hour/week course for first year medical students, integrating basic sciences with clinical and social sciences, UNC School of Medicine |
| 1970-1974 | Co-developer and teacher of six-month nurse practitioner course, UNC School of Nursing and School of Medicine |
| 1970-1974 | Attending physician (two months/year), Medical Service, North Carolina Memorial Hospital, Chapel Hill |
| 1970-1972 | Directed honors seminar (weekly, spring semester) for sophomores in the College of Arts and Sciences, UNC |

Centers for Disease Control and Prevention:

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| 1967 | Section leader in intensive epidemiology course for Public Health Service Officers, CDC, Atlanta |

Academic Service:

Johns Hopkins University Bloomberg School of Public Health:

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| 1995-2006 | Advisory Board |
| 1995-2006 | Committee of the Whole |
| 1995- | Residency Advisory Committee |
| 1995-2005 | Convocation Speaker Selection Committee |
| 1995- | Graduate Medical Education Committee (chair, 1996-2009) |
| 1995- | Graduate Training Program in Clinical Investigation Council (chair, Admissions Committee, 1999-) |
| 1995-2001 | MPH Academic Committee |
| 1996-2003 | DrPH Academic Committee |
| 1996-2000 | Professional Education Academic Committee |
| 1996-1998 | Steering Committee |
| 1996-2002 | MPH Admissions Committee |
| 1998-2002 | Diversity Leadership Council, JHU (chair, 1999-2001) |
| 2000-2002 | Affirmative Action Committee |
| 2001-2002 | MPH Executive Board |
| 2002- | Environmental Stewardship Committee, BSPH |
| 2002-2003 | Commission on Undergraduate Education, JHU (Executive Committee) |
| 2002-2004 | Steering Committee, Middle States Accreditation of JHU |
| 2002-2003 | Search Committee, History of Public Health tenure track faculty |
| 2002-2006 | Committee on Academic Standards |
| 2003-2005 | Search Committee, Public Health Practice and Preparedness tenure track faculty |
| 2005-2006 | Steering Committee, CEPH Self-Study |
| 2005-2006 | Chair, Search Committee for Director of the Center for Alternatives to Animal Testing |
| 2006- | Energy Stewardship and Sustainability Committee, JHU |
| 2006-2007 | Search Committee, Health Systems, IH tenure track faculty |
| 2006-2009 | Conflict of Interest Committee |
| 2008-2012 | DrPH Committee, Environmental Health Sciences (EHS) |
| 2009-2013 | Research and Education Committee, EHS |
| 2010-2013 | Appointment and Promotions Committee |
| 2011-2013 | Faculty Senate |
| 2012- | Executive Committee, Environmental Health Sciences |

CARE and CFS v. Cow Palace, LLC, E.D. Washington, Nos. CV-13-3016-TOR
Attachment B to Expert Report of Robert S. Lawrence, M.D. (September 22, 2014)

| Date of Document | Document author | Document name / Description | Designated as Confidential? (as of 9/22/2014) |
|---|---|---|---|
| 9/2012 (updated 3/2013) | EPA Region 10 | Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington | No |
| Mar-13 | EPA | Monitoring Well Installation & Data Summary Report Lower Yakima Valley, Yakima Co., Washington | No |
| Sep-12 | EPA | Case Studies on the Impact of CAFOs on Ground Water Quality | No |
| 11/4/08 | EPA | EPA letter to Yakima Herald Republc re SDWA and nitrate contamination of groundwater | No |
| 5/22/89 | EPA | 54 Fed Reg 22062 (May 22, 1989) SDWA Amendments | No |
| 1/30/91 | EPA | 56 Fed Reg 3526 (Jan. 30, 1991) Final Rule | No |
| 2014 | EPA | 40 CFR s. 141.62 (MCL and BAT for Nitrate, nitrite, total nitrogen) | No |
| 1990 | EPA | EPA Drinking Water Criteria Document on Nitrate / Nitrite | No |
| 3/5/13 | EPA & Dairies | Administrative Order on Consent ("AOC") | No |
| 2011 | USGS | River-Aquifer Exchanges in the Yakima River Basin, Washington | No |
| Accessed 9/2014 | U.S. Census | Census data for Yakima area | No |
| 9/6/13 | U.S. Health & Human Services | Amy Pereson, et al. CDC, Morbidity & Mortality Weekly. Notes from the Field - Investigation of a Cluster of Neural Tube Defects - Central Washington, 2010 - 2013 | No |
| Retrieved 2014 | U.S. Health & Human Services | Ceners for Disease Control & Prevention - Nitrate and Drinking Water from Private Wells | No |
| Retrieved 2014 | U.S. Health & Human Services | Centers for Disease Control & Prevention - E. coli | No |
| 2001 | U.S. Agency for Toxic Substances & Diseases Registry | "Case Studies in Environmental Medicine: Nitrate/Nitrite Toxicity." | No |

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|---|---|---|---|
| 1993 | CDC | Methemoglobinemmia in an infant - Wisconsin, 1992. Morbidity & Mortality Weekly Report 42(12) 217-219 | No |
| 1996 | CDC | Spontaneous Abortions Possibly Related to Ingestion of Nitrate-Contaminated Well Water - La Grange Co., Indiana, 1991. Morbidity & Mortality Weekly Report 45(26) 569. | No |
| 1998-1999 | U.S. FDA | FDA National Antimicrobial Resistance Monitoring System | No |
| 1978 | U.S. FDA | S. Feinman et al, "Draft Environmental impact statement: subtherapeutic antibacterial agents in animal feeds." | No |
| 1986 | U.S. Senate | Senate Conference Report on SDWA Amendments, 132 Cong. Rec. S. 6287 | No |
| 1999 | European Union Scientific Committee on Animal Health & Animal Welfare | Report on Animal Welfare Aspects of the Use of Bovine Somatotrophin | No |
| 1987 | Science Advisory Board Drinking Water Committee | SAB review of EPA's Drinking Water Criteria Document for Nitrate and Nitrite | No |
| 1991 | Science Advisory Board Drinking Water Committee | SAB Drinking Water Committee critique of EPA's nitrate / nitrite standards | No |
| May-12 | WA Dep't of Ecology | Report summarizes 30 years of nitrate studies in the Sumas-Blaine Aquifer | No |
| 6/2012 (revised 2/2013) | WA Dep't of Ecology | Sumas-Blaine Aquifer Nitrate Contamination Summary | No |
| 1/4/09 | James VanDerslice, DOH | Well Water Quality and Infant Health Study | No |
| 1/18/02 | Melanie Kimsey, Hydrogeologist, WA Dep't of Ecology | Construction of Dairy Lagoons Below the Seasonal High Ground Water Table | No |
| 4/1/12 | DOH (Kitty Weisman) | Comments to ECY re: NRCS Standard 590 | No |
| 4/11/12 | DOH staff | DOH Comments to Dep't of Ecology and Dep't of Ag re: 590 Nutrient Management Matrix- DOH Drinking Water Information | No |
| 5/7/12 | DOH staff | DOH Comments to Dep't of Ecology re: draft CAFO Permit | No |

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| Dec-08 | DOH staff | Nitrate Prioritzation Project (not implemented?) (drafted 2008; requested 11/15/2012) [Note - Implemented 1/2014] | No |
| 4/28/00 | DOH | Nitrate Contamination of Drinking Water in Washington State, Background Paper, Risk Communication Case Study | No |
| 11/14/02 | DOH staff | Various emails re: nitrate monitoring by DOH vs. by Dep't of Ecology, noting that DOH's number of wells required is "more stringent" | No |
| 1996 | Washington Dept of Health | An Examination of Methemoglobinemia in Washington State | No |
| Jan-14 | ECY | Nitrate Prioritization Project QAPP | No |
| Undated | Yakima Co. | Critical Aquifer Recharge Area (Lower Valley) and (East of Moxee) | No |
| Retrieved 9/2014 | Yakima County | Yakima County's Nitrate Treatment Pilot Program and Final Report (June 30, 2011) | No |
| 12/1/02 | Ron Sell & L. Knutson | Valley Institute for Research & Education ("VIRE") Quality of Ground Water in Private Wells in the Lower Yakima Valley 2001-02 (Part 1 and Part 2) | No |
| 8/13/03 | Heritage College | Heritage College Sunnyside Groundwater Study Final Report | No |
| 3/6/2014 (first page has typo re date) | Arcadis | Residential well sampling results (summer 2013)(DAIRIES008111-008726) | No |
| 4/29/14 | Arcadis | Cow Palace Post-Harvest Soil Sampling (DAIRIES008727-008827), and post-harvest soil sampling for Bosma/Liberty (DAIRIES08988-009135) and DeRutyer/D&A (DAIRIES008828-008987) | No |
| 4/29-4/30/2014 | Arcadis | 1st Q (2014), 3rd & 4th Q (2013) Groundwater Usability Reports (all sets of wells) (DAIRIES010640-010798, 009724-010116, 010117-010540) | No |
| 9/4/13 | Arcadis | DAIRIES002663 (request for whole house R.O. system) | No |
| 3rdQ 2013 | Arcadis | AOC sampling results (DAIRIES001185-001395) | No |
| 2012 | Defendants | The Dolsen Co. sampling data & reverse osmosis installs (DOLSEN002078-002987) | No |
| 2012 | Defendants | Cow Palace Dairy Nutrient Management Plan | Yes |
| Approx. 2006 - 5/2014 | Defendants | Cow Palace and Bosma Rx Treatment Records (COWPAL010673-014464 and BOSMA013567-014504, BOSMA014767) | Yes |

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| Various | Defendants | GDR/D&A (DeRuyter) Rx Treatment Records (GEOMAR003163-003325, -003340) | Yes |
| 2006-2013 | Defendants | Cow Palace Rx Invoices (2006-2013) (COWPAL004291-COWPAL008205) | No |
| 2007-2010 | Defendants | Bosma Rx Invoices (2007-2010) (BOSMA002125-008035, BOSMA008042-011235) | No |
| 2011-2014 | Defendants | Bosma Rx Invoices (2011-2014) (See Bates Nos. in # 85) | No |
| 2012-2013 | Defendants | GDR/D&A (DeRuyter) Rx Invoices (2012-2013) (DADAIRY001737-002596 and GEOMAR001712-001715, 001717-002572) | No |
| 2/18/14 | Defendants | Answer (on 2nd Amd Complaint) | No |
| 2012 | Defendants | COWPAL002110 (Numbers of Cows, 2012) | Yes |
| 8/27/14 | Defendants | SITE INSP00001-000043 | No |
| Sep-14 | Plaintiffs' counsel | Tebbutt Law Summary of Arcadis soil data (Bates Nos. cited in summary document) | Underlying data, yes |
| Sep-14 | Plaintiffs' counsel | Tebbutt Law Summary of Arcadis dairy well sampling data (Bates Nos. cited in summary document) | Underlying data, yes |
| 4/2/14 | Discovery | Deposition of Jeff Boivin | No |
| 6/4/14 | Discovery | Deposition of Vern Carson | No |
| 4/8/14 | Discovery | Deposition of Steve Butler | No |
| 8/27/14 | Plaintiffs | Butler and Reddout well sampling results (CARE025669, -029687) | No |
| 2/14/14 | Plaintiffs | Complaint (Second Amended) | No |
| October 2013 and May 2014 | Plaintiffs | Plaintiffs Rule 34 data | No |
| 2010-2014 | Plaintiffs | CARE sampling data 2010-2014 (CARE025661-025673, -029370, -029385-029690) | No |
| 6/21/13 | Judge Rice | Order on Motion to Dismiss | No |
| 2008 | Pew Charitable Trusts and Johns Hopkins Bloomberg School of Public Health | Putting Meat On The Table: Industrial Farm Animal Production In the United States | No |
| 2013 | Johns Hopkins Center For A Livable Future | Industrial Food Animal Production in America: Examining the Impact of the Pew Commission's Priority Recommendations | No |

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|---|---|---|---|
| 2013 | CAI Technologies, Inc. | General summary fact sheet on choosing reverse osmosis products | No |
| 2013 | Consumer Reports | Consumer Reports Water Filter Buying Guide | No |
| Retrieved 9/2014 | Culligan | Culligan Aqua-Cleer Advanced Drinking Water Systems Owners Guide | No |
| 1948 | Annals of Medicine | "The Case of Eleven Blue Men." The New Yorker | No |
| 1/30/13 | J. Fry et al. | "Investigating the Role of State & Local Health Departments in Addressing Public Health Concerns Related to Industrial Animal Food Production Sites." PLOS One (no volume identifcation yet) | No |
| Sep-13 | J. Brender et al. | "Prenatal Nitrate Intake from Drinking Water and Selected Birth Defects in Offspring of Participants in the National Birth Defects Prevention Study." Environ. Health Perspect. Vol. 121, No. 9 pp. 1083- 1089 | No |
| 2013 | Bryan et al. | "The Role of Nitrate in Human Health." Advances in Agronomy Vol. 119 | No |
| 2013 | Sunitha | "Nitrates in Groundwater: Health Hazards and Remedial Measures." Indian J. of Advances in Chemical Science. Vol. 1(3) pp. 165-170 | No |
| 2011 | Balazs et al | "Social Disparities in Nitrate-Contaminated Drinking Water in California's San Joaquin Valley." Environ. Health Perspect. Vol. 119, No. 9 pp. 1272-1278 | No |
| 2008 | Arnon et al. | "Transport of Testosterone & Estrogen from Dairy-Farm Waste Lagoons to Groundwater." Environ. Sci. Technol. 42 (5521-5526) | No |
| 2007 | J. Burkholder et al. | "Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality." Environ. Health Perspect. Vol. 115, No. 2 pp. 308-312 | No |
| 2007 | Sapkota et al. | "Antibiotic-Resistant Enterococci and Fecal Indicators in Surface Water and Groundwater Impacted by a Concentrated Swine Feeding Operation." Environ. Health Perspect. Vol. 115 No. 7 pp. 1040-1045. | No |
| 2005 | Ward et al. | "Workgroup Report: Drinking-Water Nitrate and Health – Recent Findings and Research Needs." Environ. Health Perspect. Vol. 113, No. 11 pp. 1607- 1614 | No |
| 2003 | Townsend et al | "Human health effects of a changing global nitrogen cycle." Frontiers in Ecology.org pp. 240-246 | No |
| 2003 | Gessel | "Persistence of zoonotic pathogens in surface soil treated with different rates of liquid pig manure." Applied Soil Ecology. 25 pp. 237-243. | No |

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|---|---|---|---|
| 2002 | Krapac | "Impacts of Swine Manure Pits on groundwater quality." Environmental Pollution Vol. 120 pp. 475-492 | No |
| 2001 | Weyer et al. | "Municipal Drinking Water Nitrate Level & Cancer Risk in Older Women: The Iowa Women's Health Study." Epidemiology. Vol. 11, No. 3 | No |
| 2002 | Mugel | "Ground-Water Quality & Effects of Poultry Confined Animal Feeding Operations on Shallow Ground Water, Upper Shoal Creek Basin, Southwest Missouri, 2000" (abstract) (available through USGS Water Resources Investigations Reports) | No |
| 1991 | Kleinjans et al. | "Nitrate Contamination of Drinking Water: Evaluation of Genotoxic Risk in Human Populations." Environ. Health Perspect. Vol. 94, pp. 189-193 | No |
| 1998 | Arbuckle, T.E. et al. | "Water Nitrates and CNS birth defects: a population based case control study." Arch. Environ. Health 43(2):162-167. | No |
| 2004 | Brender, et al. | "Dietary nitrites and nitrates, nitrosatable drugs, and neural tube defects." Epidemiology 15(3):330-336 | No |
| 1993 | Bruning-Fann, C.S. et al | "The effects of nitrte, nitrite, and N nitroso compounds on human health: a review." Vet Hum Toxicol (1993) 35:521-538. | No |
| 1981 | Craun, G.F. et al. | "Methaemoglobin levels in young children consuming high nitrate well water in the United States." Int. J. Epidemiol. 10(4):309-317. | No |
| 2001 | Croen, L.A. et al. | "Maternal exposure to nitrate from drinking water and diet and risk for neural tube defects." Am. J. Epidemiol. 153(4):325-331. | No |
| 2001 | George, M. et al | "Incidence and geographical distribution of sudden infant death syndrome in relation to content of nitrate in drinking water and groundwater levels." Eur. J. Clin. Invest. 31(12):1083-1094. | No |
| 1999 | Gupta, S.K. et al | "Adaptation of cytochrome b5 reductase activity and methaemoglobinaemia in areas with a high nitrate concentration in drinking water." Bull. World Health Organ. 77(9):749-753. | No |
| 2000 | Gupta, S.K. et al | "Recurrent acute respiratory tract infections in areas with high nitrate concentrations in drinking water." Environ. Health Persp. 108(4):363-366 | No |
| 2001 | Gupta, S.K. et al | "Recurrent diarrhea in children living in areas with high levels of nitrate in drinking water." Arch. Of Environ. Health 56(4):369-373 | No |

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| 2004 | Inoue, T. et al | "Increases in serum nitrite and nitrate of a few fold adversely affect the outcome of pregnancy in rats." J. Pharmacol. Sci. 95(2):228-233. | No |
| 2000 | Knobeloch, L. et al | "Blue Babies and nitrate contaminated well water." Environ. Helath Perspect. 108(7):675-678. | No |
| 2001 | Knobeloch, L. & M. Proctor | "Eight Blue Babies." WMJ 100(8): 43-47. | No |
| 2006 | Manassaram, D.M. et al | "A Review of Nitrates in Drinking water: Maternal Exposure & Adverse Reproductive and Developmental Outcomes." Environ. Health Perspect. 114(3):320-327. | No |
| 2001 | Mueller, B.A. et al | "Residential water source and the risk of childhood brain tumors." Environ. Health Perspect. 109(6):551-556. | No |
| 2004 | Mueller, B.A. et al | "Household water source and the risk of childhood brain tumours: results of the SEARCH International Brain Tumor Study." Int.J. Epidemiol. 33(6):1209-1216 | No |
| 2002 | Nolan, B.T. et al | "Probability of nitrate contamination of recently recharged ground waters in the conterminous United States." Environ. Sci. Technol. 36(10):2138-45. | No |
| 1997 | Parslow, R.C. et al | "Incidence of childhood diabetes mellitus in Yorkshire, northern England, is associated with nitrate in drinking water: an ecological analysis." Diabetologia 40(5):550-6. | No |
| 1982 | Preston-Martin, S. et al | "N Nitroso compounds and childhood brain tumors: a case-control study." Cancer Res. 42(12):5240-5245 | No |
| 2001 | Sanchez-Echaniz, J. et al | "Methemoglobinemia and consumption of vegetables in infants." Pediatrics 107(5):1024-1028 | No |
| 2006 | Savino, F. et al | "Methemoglobinemia caused by the ingestion of courgette soup given in order to resolve constipation in two formula fed infants." Ann. Nutr. Metab. 50(4):368-371. | No |
| 1961 | Schmitz, J.T. | "Methemoglobinemia - cause of abortions?" Preliminary Report. Obstet. Gynecol. 17:413-415. | No |
| 1972 | Shearer, L.A. et al | "Methemoglobin levels in infants in an area with high nitrate water supply." Am. J. Public Health 62(9):1174-80 | No |
| 1992 | Shuval, H.I. et al | "Epidemiological and toxicological aspects of nitrates and nitrites in the environment." Am. J. Public Health 62(8):1045-52 | No |

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|---|---|---|---|
| 1997 | Tabacova, S. et al | "Maternal exposure to exogenous nitrogen compounds and complications of pregnancy." Arch. Environ. Health 52:341-347 | No |
| 1996 | Tsezou, A. et al | "High nitrate content in drinking water: cytogenetic effects in exposed children." Arch. Environ. Health 51(6):458-461. | No |
| 2005 | Volkmer et al | "Influence of nitrate levels in drinking water on urological malignancies: a community-based cohort study." BJU Int. 95(7):972-096 | No |
| 2005 | Ward, M. et al | "Workgroup Report: Drinking-Water Nitrate and Health - Recent Findings and Research Needs." Environ. Health Perspect. 113(11) 1607-1614 | No |
| 2008 | Ward, M. et al | "Hidden Wells, Dirty Water" (Three part article series) Yakima Herald Republic, October 2008 | No |
| 2002 | Zeman, C.L. et al | "Exposure methodology and findings for dietary nitrate exposures in children of Transylvania, Romania." J. Expo. Anal. Environ. Epidemiol., 12(1):54-63. | No |
| 1951 | Walton | Survey of Literature Relating to Infant Methemoglobinemia Due to Nitrate-Contaminated Water. American Journal of Public Health. Vol. 41 pp. 986-996 | No |
| 1950 | Bosch | Methemoglobinemia and Minnesota Well Supplies, American Water Works Association (Feb. 1950) | No |
| 1945 | Comly | "Cyanosis in infancts caused by nitrates in well water." JAMA 129:112-116 | No |
| 1997 | Kapoor, A. et al. | "Nitrate removal from drinking water - review" Journal of Environmental Engineering p. 371-380. | No |
| 1987 | Fan, A. Et al. | "Evaluation of the Nitrate Drinking Water Standard with Reference to Infant Methemoglobinemia and Potential Reproductive Toxicity." Regulatory Toxicology & Pharmacology 7, 135-148 (1987) | No |
| 2012 | Lidder, S. et al. | "Vascular effects of dietary nitrate (as found in green leafy vegetables and beetroot) via the nitrate-nitrite-nitric oxide pathway" British Journal of Clinical Pharmacology 1365-2125 (2012) | No |
| 2011 | Williams et al | "Airborne cow allergen, ammonia and particulate matter at homes vary with distance to industrial scale dairy operations: an exposure assessment." Env. Health 10:72 (2011) | No |
| 2011 | D. Love et al | "Dose Imprecision and Resistance: Free-Choice Medicated Feeds in Industrial Food Animal Production in the United States." Environmental Health Perspectives Vol. 119, No. 3 at 279-283. | No |

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|---|---|---|---|
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| 2009 | Graham, J. | "Antibiotic resistant enterococci and staphylococci isolated from flies collected near confined poultry feeding operations." Sci. Total Environ. (2009). | No |
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| 6/1/13 | J. Mendoza | Email to EPA with article re: pre-term deliveries and congenital malformations in Yakima | No |
| Nov-13 | J. Mendoza & D. Effler | Emails re methemoglobinemia | No |

# AOC groundwater sampling results at and near Cow Palace Dairies

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-02 | 35 | 1264.8 ft. | Background | 09/24/13 | 25.09 | 3.85 | 20.4 | 0.41 | 0.124 J | 8.56 | 5.77 | 5.89 |
| | | | | 03/16/14 | unavailable | 3.93 | 90.8 | 5.3 U | 0.06 | 88.6 | 66.9 | 71.7 |
| | | | | 06/02/14 | unavailable | 2.75 | 62.7 | <0.200 U | 3.80 J | 23.0 | 3.12 | 48.7 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-03 | 200.1 | 931 | AOC - upgradient | 09/16/13 | 198.88 | 14 | 57.5 | 4.75 | 0.890 | 43.000 | 70.7 | 24.3 |
| | | | | 12/10/13 | 190.42 | 14.3 | 48.7 | 5.96 | 1.020 | 40.2 | 54.8 J | 20.4 |
| | | | | 03/17/14 | unavailable | 13.3 | 51.2 | 4.75 | 0.23 | 37.6 | 38 | 18.2 |
| | | | | 06/02/14 | unavailable | 10.7 | 46.40 | 3.9 | 0.300 J | 36.8 | 36.0 | 16.8 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-04 | 245.2 | 894.9 | AOC - upgradient | 09/16/13 | 220.55 | 14.9 | 37.4 | 4.45 | 0.100 U | 49.2 | 39.1 | 11.2 |
| | | | | 12/10/13 | 223.5 | 15.0 | 38.2 | 4.64 | 0.112 | 49.9 | 42.2 J | 11.7 |
| | | | | 03/17/14 | unavailable | 15.1 | 37.7 | 4.03 | 0.078 | 47.8 | 35.2 | 11.6 |
| | | | | 06/02/14 | unavailable | 14.3 | 36.8 | 3.78 | 0.053 J | 50.5 | 36.2 | 11.5 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-05 | 182.2 | 884.3 | AOC - downgradient | 09/17/13 | 167.41 | 10.2 | 66 | 4.9 | 1.62 | 46.2 | 76.8 | 31 |
| | | | | 12/11/13 | 166.39 | 10.0 | 41.5 | 4.36 | 0.462 | 45.5 | 68.4 J | 17.0 |
| | | | | 03/17/14 | unavailable | 8.40 | 33.7 | 3.3 | 0.14 | 43.1 | 52.7 | 13.5 |
| | | | | 06/01/14 | unavailable | 8.40 | 30.8 | 3.00 | 0.150 J | 43.9 | 50.5 | 13.2 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC-01 | 160 | 1048.7 | AOC - upgradient | 01/04/13 | 150.5 | | | 9.8 | | | | |
| | | | | 09/24/13 | 15.47* | 44 | 88.9 | 11.1 | 0.123 J | 43 | 223 | 32.5 |
| | | | | 12/11/13 | 150.49 | 47.8 | 91.4 | 11.5 | 0.186 | 41.9 | 280 J | 32.6 |
| | | | | 03/17/14 | unavailable | 48.2 | 90.5 | 11.2 | 0.079 | 40.2 | 250 | 31.4 |
| *appears to be a transposition error | | | | 06/02/14 | unavailable | 41.4 | <1.00 J | 10 | <0.050 J | <0.500 J | 224 | 31.9 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-06 | 169 | 942.8 | Background | 09/17/13 | 110.67 | 3.13 | 46 | 0.51 | 0.410 | 17.600 | 8.140 | 12.8 |
| | | | | 12/09/13 | 108.21 | 2.73 | 31.2 J | 0.49 J | 0.0600 U | 13.0 J | 8.53 | 5.27 J |
| | | | | 3/16/2014* | unavailable | 3.470 | 40.1 | 0.61 | 0.13 | 16.20 | 8.33 | 7.59 |
| | | | | 06/01/14 | unavailable | 2.88 | 37.8 | 0.51 | 0.057 J | 16.7 | 7.59 | 6.50 |
| *labled as "field blank;" duplicate labeled YVD-D1 | | | | | | | | | | | | |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-09 | 122.3 | 856.8 | AOC - downgradient | 09/19/13 | 110.00 | 96.3 J | 107 | 74.7 | 0.232 J | 189 | 236 | 39.3 |
| | | | | 12/12/13 | 109.93 | 87.2 | 109 | 64.4 | 0.647 | 176 | 193 | 42 |
| | | | | 03/19/14 | unavailable | 104.00 J | 109.00 | 62.40 | 0.53 | 173.00 | 214.00 J | 40.80 |
| | | | | 06/03/14 | unavailable | 89.80 | 113.0 | 57.1 | 0.720 | 193 | 214 | 44.5 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-10 | 103.1 | 867.6 | AOC - downgradient | 09/17/13 | 90.23 | 95.4 | 216 | 95 | 0.148 | 104 | 199 | 51.8 |
| | | | | 12/12/13 | 89.2 | 91.4 | 202 | 86.9 | 1.4 | 102 | 174 | 55.6 |
| | | | | 03/19/14 | unavailable | 86.80 J | 218.00 | 77.60 | 0.77 | 96.80 | 163.00 | 54.00 |
| | | | | 06/03/14 | unavailable | 94.3 | 232 J | 86.1 | 0.800 J | 103 J | 188 | 58.6 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-14 | 91 | 843 | AOC - downgradient | 09/18/13 | 77.31 | 118 | 260 | 112 | 0.100 U | 110 | 213 | 65.4 |
| | | | | 12/12/13 | 76.97 | 104 | 249 | 105 | 0.060 U | 108 | 186 | 85.6 |
| | | | | 03/19/14 | unavailable | 108.00 J | 248.00 | 101.00 | 0.05 U | 102.00 | 190.00 J | 64.50 |
| | | | | 06/04/14 | unavailable | 109 | 240 J | 102 | 0.078 J | 112 J | 191 | 63.2 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| YVD-15 | 105.1 | 849.2 | AOC - downgradient | 09/17/13 | 90.16 | 62.8 | 125 | 72.5 | 0.100 U | 127 | 51.5 | 51.6 |
| | | | | 12/12/13 | 90.49 | 120 | 131 | 71.2 | 0.238 | 114 | 114 | 59.4 |
| | | | | 03/19/14 | unavailable | 54.90 J | 124.00 | 47.40 | 0.22 | 93.50 | 44.70 | 57.90 |
| | | | | 06/03/14 | unavailable | 82.5 | 138 | 88.1 | 0.310 | 110 | 39.0 | 64.7 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC-14 | 151 | 906.6 | AOC - downgradient | 01/03/13 | 130.61 | | | 26 | | | | |
| | | | | 09/17/13 | 131.21 | 80.2 | 121 | 12 | 0.199 | 94.9 | 34.2 | 32.3 |
| | | | | 12/11/13 | 131.1 | 64.4 | 91.2 | 5.8 | 0.167 | 94 | 33.9 J | 23.9 |
| | | | | 03/18/14 | unavailable | 71.8 | 107 | 10.6 | 0.26 | 87 | 35.7 | 28.4 |
| | | | | 06/02/14 | unavailable | 56.1 | <0.100 J | 6.46 | <0.050 J | <0.500 J | 24.2 | 26.3 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC-03 | 85 | 838.2 | AOC - downgradient | 01/02/13 | 72.4 | | | 190 | | | | |
| | | | | 09/18/13 | 72.2 | 176 J | 284 | 166 | 0.100 UJ | 173 | 176 | 73.7 |
| | | | | 12/12/13 | 72.55 | 172 | 280 | 174 | 0.244 | 172 | 176 | 75 |
| | | | | 03/19/14 | unavailable | 159.00 J | 261.00 | 195.00 | 0.06 | 165.00 | 189.00 J | 66.80 |
| | | | | 06/04/14 | unavailable | 201 | 259 J | 234 | 0.120 J | 177 J | 214 | 67.7 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC-03D | 116.1 | 838.3 | AOC - downgradient | 09/18/13 | 72.87 | 56 J | 198 | 46.4 | 0.100 UJ | 62.1 | 101 | 44 |
| | | | | 12/12/13 | 73.16 | 67.9 J | 194 | 38.9 | 0.0600 U | 59.7 | 99.1 | 43.3 |
| | | | | 03/19/14 | unavailable | 65.90 J | 200.00 | 42.50 | 0.05 U | 57.50 | 106.00 J | 43.90 |
| | | | | 06/03/14 | unavailable | 65.5 | <1.00 J | 42.0 | <0.050 J | <0.500 J | 103 | 40.9 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC-04 | 51 | 844.6 | AOC - downgradient | 01/03/13 | 32.68 | | | 26 | | | | |
| | | | | 09/20/13 | 32.21 | 39.4 | 141 | NA | 0.100 U | 32.1 | 93.6 | 25.5 |
| | | | | 09/24/13 | NL | NA | NA | 31.7 | NA | NA | NA | NA |
| | | | | 12/12/13 | 32.6 | 41.1 | 148 J | 36.7 | 0.104 | 31.7 | 110 | 28.4 |
| | | | | 03/18/14 | unavailable | 42.00 J | 153.00 | 37.30 | 0.13 | 30.40 | 107.00 J | 28.00 |
| | | | | 06/03/14 | unavailable | 36.2 | <1.00 J | 36.4 | <0.050 J | <0.500 J | 104 | 28.9 |

| Well | Well Depth (ft bgs) | Water Table Elevation (ft AMSL) (reported once in well installation rpt) | AOC-upgradient/ AOC-downgradient/ Background | Date | DTW (ft bTOC) | Chloride (mg/l) | Calcium (mg/l) | Nitrate (mg/l) | Phosphorus (mg/l) | Sodium (mg/l) | Sulfate (mg/l) | Magnesium (mg/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC-07 | 61 | 845.2 | AOC - downgradient | 01/03/13 | 44.11 | | | 2.8 | | | | |
| | | | | 09/18/13 | 44.7 | 30.5 | 122 | 4.3 | 0.100 U | 45.7 | 168 | 18.4 |
| | | | | 12/10/13 | 44.15 | 31.0 | 27.5 J | 4.7 J | 0.0648 | 38.4 J | 117 | 11.5 J |
| | | | | 03/16/14 | unavailable | 26.5 | 88.4 | 4.72 | 0.11 | 33.5 | 78.9 | 15.4 |
| | | | | 06/02/14 | unavailable | 28.2 | 93.70 | <0.800 U | 0.120 | 36.3 | 105.000 | 16.500 |

| Cow Palace Dairies -- soil sampling data, Field 1 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| | 10/14/98 | 1 ft | 36 | 16 | #/ac | 21 | 115 | ppm | N/L | N/A |
| | 10/14/98 | 1 ft | 40 | 18 | #/ac | 25 | 221 | ppm | N/L | N/A |
| South | 8/16/01 | 1 ft | 132 | 18 | #/ac | 212 | 796 | ppm | N/L | N/A |
| North | 8/16/01 | 1 ft | 202 | 11 | #/ac | 311 | 866 | ppm | N/L | N/A |
| | 3/6/02 | 1 ft | 260 | 12 | #/ac | 190 | 1010 | ppm | N/L | N/A |
| | 10/21/03 | 2 ft | 94 | 14 | #/ac | 203 | 1300 | ppm | N/L | N/A |
| | 9/25/03 | 1 ft | 150 | 13 | #/ac | 223 | 1135 | ppm | N/L | N/A |
| | 3/2/05 | 1 ft | 320 | 14 | #/ac | 204 | 1,392 | ppm | 3.0 | % |
| | 3/31/04 | 1 ft | 150 | 17 | #/ac | 201 | 1152 | ppm | N/L | N/A |
| | 3/31/04 | 2 ft | 198 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 6/23/05 | 0-12" | 300 | 3 @ 24" | #/ac | 141 | 2,478 | mg/kg | 2.5 | % |
| | 6/23/05 | 13-24" | 248 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/27/06 | 1 ft | 96 | 18 | #/ac | 266 | 1,298 | ppm | 4.1 | % |
| | 9/27/06 | 2 ft | 122 | 14 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 5/15/06 | 1 ft | 90 | 31 | #/ac | 208 | 1,174 | ppm | 2.8 | % |
| | 5/15/06 | 2 ft | 77 | 27 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 2/27/07 | 0-12" | 214 | 42 | #/ac | 216 | 956 | ppm | 3.42 | % |
| | 2/27/07 | 12-24" | 190 | 34 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 10/17/07 | 0-12" | 188 | 20 | #/ac | 158 | 1,022 | ppm | 2.70 | % |
| | 10/17/07 | 12-24" | 200 | 16 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/8/08 | 0-12" | 238 | 21 | #/ac | 156 | 1384 | ppm | 3.09 | % |
| | 9/8/08 | 12-24" | 12 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/3/09 | 1 ft | 159 | 25 | #/ac | 134 | 1,295 | ppm | 2.75 | % |
| | 9/3/09 | 2 ft | 152 | 16 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 10/14/10 | 1 ft | 118 | 29 | #/ac | 116 | 1,050 | ppm | 3.55 | % |
| | 10/14/10 | 2ft | 121 | 22 | #/ac | N/L | N/L | ppm | N/L | N/A |
| | 9/30/11 | 0-12" | 83 | 29 | #/ac | 131 | 1,207 | ppm | 2.42 | % |
| | 9/30/11 | 12-24" | 89 | 14 | #/ac | 108 | 1,090 | ppm | 1.23 | % |
| | 9/27/12 | 0-12" | 280 | 32 | #/ac | 190 | 1,521 | ppm | 3.09 | % |
| | 9/27/12 | 12-24" | 245 | 9 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/24/13 | 1 ft | 304 | 2 | #/ac | 290 | 1474 | ppm | 3.0 | % |
| | 9/24/13 | 2 ft | 221 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/24/13 | 3 ft | 229 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 5/13/14 | 1 ft | 103 | 4 | #/ac | 264 | 1456 | ppm | 2.7 | % |
| | 5/13/14 | 1 ft DUP | 106 | 4 | #/ac | 261 | 1490 | ppm | 2.8 | % |
| | 5/13/14 | 2 ft | 124 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |

N/L = Not listed

Cow Palace Dairies -- soil sampling data, Field 2

| | **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10/14/98 | 1 ft | 22 | 17 | #/ac | 36 | 263 | ppm | N/L | N/A |
| | 10/14/98 | 1 ft | 26 | 16 | #/ac | 10 | 254 | ppm | N/L | N/A |
| South | 8/16/01 | 1 ft | 73 | 18 | #/ac | 132 | 394 | ppm | N/L | N/A |
| North | 8/16/01 | 1 ft | 121 | 16 | #/ac | 203 | 557 | ppm | N/L | N/A |
| | 3/8/02 | 1 ft | 71 | 9 | #/ac | 97 | 403 | ppm | N/L | N/A |
| | 10/21/03 | 2 ft | 115 | 7 | #/ac | 46 | 489 | ppm | N/L | N/A |
| | 9/25/03 | 1 ft | 234 | 14 | #/ac | 140 | 514 | ppm | N/L | N/A |
| | 3/2/05 | 1 ft | 96 | 19 | #/ac | 79 | 687 | ppm | 2.1 | % |
| | 3/31/04 | 1 ft | 141 | 14 | #/ac | 106 | 609 | ppm | N/L | N/A |
| | 3/31/04 | 2 ft | 177 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 6/23/05 | 0-12" | 60 | 1 @ 24" | #/ac | 210 | 1,317 | mg/kg | 1.9 | % |
| | 6/23/05 | 13-24" | 24 | N/L | N/L | N/L | N/L | | N/L | N/A |
| | 9/27/06 | 1 ft | 45 | 17 | #/ac | 138 | 833 | ppm | 2.2 | % |
| | 9/27/06 | 2 ft | 32 | 7 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 5/15/06 | 1 ft | 125 | 23 | #/ac | 136 | 922 | ppm | 2.4 | % |
| | 5/15/06 | 2 ft | 109 | 15 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 2/27/07 | 0-12" | 70 | 28 | #/ac | 96 | 645 | ppm | 1.63 | % |
| | 2/27/07 | 12-24" | 64 | 21 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 10/17/07 | 0-12" | 66 | 33 | #/ac | 92 | 456 | ppm | 1.71 | % |
| | 10/17/07 | 12-24" | 48 | 9 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/8/08 | 0-12" | 232 | 28 | #/ac | 140 | 1,282 | ppm | 2.38 | % |
| | 9/8/08 | 12-24" | 10 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/3/09 | 1 ft | 94 | 19 | #/ac | 55 | 609 | ppm | 1.64 | % |
| | 9/3/09 | 2 ft | 132 | 20 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/9/10 | 1 ft | 149 | 25 | #/ac | 99 | 729 | ppm | 2.74 | % |
| | 9/9/10 | 2 ft | 192 | 15 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/30/11 | 0-12" | 94 | 38 | #/ac | 136 | 970 | ppm | 2.30 | % |
| | 9/30/11 | 12-24" | 112 | 13 | #/ac | 65 | 460 | ppm | 1.14 | % |
| | 9/27/12 | 0-12" | 235 | 20 | #/ac | 164 | 1,201 | ppm | 2.68 | % |
| | 9/27/12 | 12-24" | 212 | 10 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/27/13 | 1 ft | 226 | 4 | #/ac | 27 | 886 | ppm | 2.5 | % |
| | 9/27/13 | 2 ft | 179 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/27/13 | 3 ft | 196 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 5/14/14 | 1 ft | 102 | 2 | #/ac | 138 | 1062 | ppm | 2.2 | % |
| | 5/14/14 | 2 ft | 113 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 5/14/14 | 3 ft | 115 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 3 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| South | 8/16/01 | 1 ft | 49 | 12 | #/ac | 175 | 449 | ppm | N/L | N/A |
| North | 8/16/01 | 1 ft | 64 | 9 | #/ac | 169 | 375 | ppm | N/L | N/A |
| | 3/8/02 | 1 ft | 34 | 9 | #/ac | 105 | 339 | ppm | N/L | N/A |
| | 10/21/03 | 2 ft | 13 | 7 | #/ac | 29 | 283 | ppm | N/L | N/A |
| | 9/25/03 | 1 ft | 30 | 14 | #/ac | 128 | 444 | ppm | N/L | N/A |
| | 3/7/05 | 1 ft | 275 | 16 | #/ac | 102 | 600 | ppm | 2.2 | % |
| | 3/31/04 | 1 ft | 109 | 11 | #/ac | 107 | 464 | ppm | N/L | N/A |
| | 3/31/04 | 2 ft | 99 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 6/23/05 | 0-12" | 348 | 2 @ 24" | #/ac | 90 | 550 | mg/kg | 2.1 | % |
| | 6/23/05 | 13-24" | 188 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/27/06 | 1 ft | 70 | 11 | #/ac | 75 | 888 | ppm | 3.0 | % |
| | 9/27/06 | 2 ft | 141 | 9 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 5/9/06 | 1 ft | 93 | 43 | #/ac | 209 | 1,210 | ppm | 2.9 | % |
| | 5/9/06 | 2 ft | 160 | 26 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 2/27/07 | 0-12" | 175 | 44 | #/ac | 184 | 817 | ppm | 2.63 | % |
| | 2/27/07 | 12-24" | 195 | 25 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 10/17/07 | 0-12" | 226 | 22 | #/ac | 138 | 658 | ppm | 3.21 | % |
| | 10/17/07 | 12-24" | 236 | 17 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 10/6/08 | 0-12" | 171 | 26 | #/ac | 125 | 1,033 | ppm | 3.03 | % |
| | 10/6/08 | 12-24" | 173 | 8 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 12/2/09 | 1 ft | 178 | 27 | #/ac | 174 | 869 | ppm | 3.74 | % |
| | 10/13/10 | 1 ft | 64 | 25 | #/ac | 102 | 633 | ppm | 3.47 | % |
| | 10/13/10 | 2 ft | 158 | 19 | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/30/11 | 0-12" | 127 | 26 | #/ac | 135 | 650 | ppm | 2.73 | % |
| | 9/30/11 | 12-24" | 103 | 15 | #/ac | 97 | 445 | ppm | 1.37 | % |
| | 9/14/12 | 0-12" | 146 | 18 | #/ac | 162 | 919 | ppm | 2.78 | % |
| | 9/14/12 | 12-24" | 141 | 5 | #/ac | 99 | 424 | ppm | 1.50 | % |
| | 9/27/13 | 1 ft | 168 | 5 | #/ac | 134 | 803 | ppm | 2.5 | % |
| | 9/27/13 | 2 ft | 152 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/27/13 | 2 ft (DUP) | 160 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 9/27/13 | 3 ft | 215 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| | 5/6/14 | 1 ft | 111 | 2 | #/ac | 134 | 678 | ppm | 2.40 | % |
| | 5/6/14 | 2 ft | 117 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 4 (through 2007) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 10/19/98 | N/L | 174 | 18 | #/ac | 130 | 273 | ppm | N/L | N/A |
| 3/8/02 | 1 ft | 27 | 11 | #/ac | 120 | 377 | ppm | N/L | N/A |
| 10/21/03 | 2 ft | 82 | 7 | #/ac | 58 | 650 | ppm | N/L | N/A |
| 9/25/03 | 1 ft | 41 | 13 | #/ac | 188 | 369 | ppm | N/L | N/A |
| 3/2/05 | 1 ft | 45 | 26 | #/ac | 118 | 428 | ppm | 2.4 | % |
| 3/31/04 | 1 ft | 59 | 10 | #/ac | 137 | 441 | ppm | N/L | N/A |
| 3/31/04 | 2 ft | 56 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 6/23/05 | 0-12" | 48 | 1 @ 24" | #/ac | 112 | 440 | mg/kg | 2.1 | % |
| 6/23/05 | 13-24" | 24 | N/L | N/L | N/L | N/L | N/A | N/L | N/A |
| 9/27/06 | 1 ft | 51 | 9 | #/ac | 207 | 353 | ppm | 2.7 | % |
| 9/27/06 | 2 ft | 38 | 9 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 5/9/06 | 1 ft | 61 | 24 | #/ac | 121 | 375 | ppm | 2.2 | % |
| 5/9/06 | 2 ft | 90 | 30 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 2/27/07 | 0-12" | 68 | 30 | #/ac | 118 | 406 | ppm | 1.86 | % |
| 2/27/07 | 12-24" | 94 | 18 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 10/17/07 | 0-12" | 179 | 43 | #/ac | 108 | 470 | ppm | 2.33 | % |
| 10/17/07 | 12-24" | 161 | 9 | #/ac | N/L | N/L | N/A | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 4N | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 8/16/01 | 1 ft | 66 | 11 | #/ac | 253 | 607 | ppm | N/L | N/A |
| 9/19/08 | 0-12" | 189 | 26 | #/ac | 105 | 409 | ppm | 2.76 | % |
| 9/19/08 | 12-24" | 144 | 24 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/16/09 | 1 ft | 178 | 28 | #/ac | 182 | 663 | ppm | 3.04 | % |
| 9/16/09 | 2 ft | 124 | 18 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/30/10 | 1 ft | 198 | 40 | #/ac | 122 | 505 | ppm | 4.10 | % |
| 9/30/10 | 2 ft | 179 | 20 | #/ac | N/L | N/L | ppm | N/L | N/A |
| 9/28/11 | 0-12" | 118 | 24 | #/ac | 139 | 489 | ppm | 2.11 | % |
| 9/28/01 | 12-24" | 103 | 12 | #/ac | 84 | 345 | ppm | 0.89 | % |
| 10/10/12 | 0-12" | 136 | 24 | #/ac | 148 | 748 | ppm | 3.42 | % |
| 10/12/12 | 12-24" | 86 | 12 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/17/13 | 1 ft | 68 | 7 | #/ac | 162 | 450 | ppm | 2.9 | % |
| 9/17/13 | 2 ft | 52 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/17/13 | 3 ft | 63 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 5/23/14 | 1 ft | 61 | 9 | #/ac | 144 | 640 | ppm | 3.4 | % |
| 5/23/14 | 2 ft | 46 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 4S | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 8/16/01 | 1 ft | 53 | 19 | #/ac | 184 | 322 | ppm | N/L | N/A |
| 10/6/08 | 0-12" | 149 | 27 | #/ac | 94 | 495 | ppm | 2.63 | % |
| 10/6/08 | 12-24" | 106 | 8 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 10/28/09 | 1 ft | 60 | 53 | #/ac | 116 | 401 | ppm | 2.3 | % |
| 10/14/10 | 1 ft | 56 | 45 | #/ac | 80 | 420 | ppm | 2.76 | % |
| 10/14/10 | 2 ft | 39 | 18 | #/ac | N/L | N/L | ppm | N/L | N/A |
| 10/5/11 | 0-12" | 42 | 37 | #/ac | 79 | 236 | ppm | 2.41 | % |
| 10/5/11 | 12-24" | 20 | 32 | #/ac | 49 | 192 | ppm | 1.18 | % |
| 9/14/12 | 0-12" | 212 | 14 | #/ac | 120 | 694 | ppm | 1.9 | % |
| 9/14/12 | 12-24" | 183 | 9 | #/ac | 90 | 354 | ppm | 1.74 | % |
| 9/17/13 | 1 ft | 52 | 10 | #/ac | 116 | 860 | ppm | 1.9 | % |
| 9/17/13 | 2 ft | 135 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/17/13 | 3 ft | 224 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 5/23/14 | 1 ft | 50 | 2 | #/ac | 211 | 703 | ppm | 2.4 | % |
| 5/23/14 | 1 ft | 51 | 2 | #/ac | 223 | 791 | ppm | 2.3 | % |
| 5/23/14 | 2 ft | 86 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |

N/L = Not listed

Cow Palace Dairies -- soil sampling data, Field 5

| Date | Depth | NO3-N | NH4-N | Unit | P | K | Unit | OM | Unit |
|---|---|---|---|---|---|---|---|---|---|
| 3/8/02 | 1 ft | 44 | 13 | #/ac | 189 | 254 | ppm | N/L | N/A |
| 10/21/03 | 2 ft | 24 | 8 | #/ac | 63 | 499 | ppm | N/L | N/A |
| 9/25/03 | 1 ft | 25 | 14 | #/ac | 177 | 461 | ppm | N/L | N/A |
| 3/2/05 | 1 ft | 29 | 21 | #/ac | 89 | 414 | ppm | 2.0 | % |
| 3/31/04 | 1 ft | 34 | 9 | #/ac | 86 | 212 | ppm | N/L | N/A |
| 3/31/04 | 2 ft | 40 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 6/23/05 | 0-12" | 24 | 1 @ 24" | #/ac | 159 | 498 | mg/kg | 1.5 | % |
| 6/23/05 | 13-24" | 16 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/27/06 | 1 ft | 35 | 13 | #/ac | 123 | 215 | ppm | 2.3 | % |
| 9/27/06 | 2 ft | 32 | 10 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 5/15/06 | 1 ft | 64 | 18 | #/ac | 80 | 287 | ppm | 1.8 | % |
| 5/15/06 | 2 ft | 58 | 14 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 2/27/07 | 0-12" | 40 | 29 | #/ac | 86 | 200 | ppm | 1.95 | % |
| 2/27/07 | 12-24" | 40 | 18 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 10/17/07 | 0-12" | 42 | 18 | #/ac | 62 | 127 | ppm | 1.97 | % |
| 10/17/07 | 12-24" | 31 | 11 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 10/6/08 | 0-12" | 132 | 25 | #/ac | 78 | 595 | ppm | 2.59 | % |
| 10/6/08 | 12-24" | 47 | 9 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/16/09 | 1 ft | 184 | 28 | #/ac | 146 | 645 | ppm | 2.14 | % |
| 9/16/09 | 2 ft | 176 | 11 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 10/14/10 | 1 ft | 28 | 43 | #/ac | 102 | 17 | ppm | 2.67 | % |
| 10/14/10 | 2 ft | 43 | 8 | #/ac | N/L | N/L | ppm | N/L | N/A |
| 9/30/11 | 0-12" | 45 | 21 | #/ac | 119 | 798 | ppm | 2.10 | % |
| 9/30/11 | 12-24" | 34 | 11 | #/ac | 65 | 317 | ppm | 1.29 | % |
| 10/5/12 | 0-12" | 39 | 28 | #/ac | 111 | 1243 | ppm | 1.88 | % |
| 10/5/12 | 12-24" | 7 | 11 | #/ac | N/L | N/L | ppm | N/L | N/A |
| 9/17/13 | 1 ft | 39 | 11 | #/ac | 133 | 735 | ppm | 2.3 | % |
| 9/17/13 | 2 ft | 17 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/17/13 | 3 ft | 17 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 5/23/14 | 1 ft | 98 | 7 | #/ac | 140 | 984 | ppm | 2.2 | % |
| 5/23/14 | 2 ft | 73 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 5/23/14 | 2 ft | 69 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| N/L = Not listed | | | | | | | | | |

| Cow Palace Dairies -- soil sampling data, Field 5N (2001) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 8/16/01 | 1 ft | 100 | 15 | #/ac | 296 | 530 | ppm | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 5S (2001) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 8/16/01 | 1 ft | 61 | 12 | #/ac | 234 | 718 | ppm | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 6 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 10/19/99 | N/L | 231 | 17 | #/ac | 81 | 411 | ppm | N/L | N/A |
| 3/8/02 | 1 ft | 50 | 10 | #/ac | 114 | 280 | ppm | N/L | N/A |
| 10/21/03 | 2 ft | 207 | 5 | #/ac | 24 | 117 | ppm | N/L | N/A |
| 9/25/03 | 1 ft | 72 | 11 | #/ac | 86 | 325 | ppm | N/L | N/A |
| 9/16/09 | 1 ft | 198 | 40 | #/ac | 246 | 1037 | ppm | 3.44 | % |
| 9/16/09 | 2 ft | 202 | 18 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/30/10 | 1 ft | 158 | 17 | #/ac | 74 | 357 | ppm | 2.61 | % |
| 9/30/10 | 2 ft | 178 | 18 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 10/01/1013 | 1 ft | 227 | 5 | #/ac | 105 | 934 | ppm | 1.9 | % |
| 10/01/1013 | 2 ft | 183 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 10/01/1013 | 3 ft | 115 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |
| 5/13/14 | 1 ft | 123 | 7 | #/ac | 140 | 725 | ppm | 2.5 | % |
| 5/13/14 | 2 ft | 171 | N/L | #/ac | N/L | N/L | N/A | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 6N | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 10/11/12 | 0-12" | 183 | 21 | #/ac | 100 | 625 | ppm | 2.00 | % |
| 10/11/12 | 12-24" | 175 | 16 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/28/11 | 0-12" | 180 | 18 | #/ac | 86 | 541 | ppm | 1.36 | % |
| 9/28/11 | 12-24" | 206 | 10 | #/ac | 35 | 234 | ppm | 0.74 | % |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Field 6S | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 10/11/12 | 0-12" | 120 | 23 | #/ac | 123 | 652 | ppm | 2.4 | % |
| 10/11/12 | 12-24" | 171 | 9 | #/ac | N/L | N/L | N/A | N/L | N/A |
| 9/28/11 | 0-12" | 128 | 18 | #/ac | 134 | 643 | ppm | 1.67 | % |
| 9/28/11 | 12-24" | 186 | 13 | #/ac | 69 | 306 | ppm | 1.02 | % |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Pen 9 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 1/31/02 | 1 ft | 360 | N/L | #/ac | 14 | N/L | ppm | N/L | N/A |
| 1/31/02 | 3 ft | 190 | N/L | #/ac | 5 | N/L | ppm | N/L | N/A |

N/L = Not listed

| Cow Palace Dairies -- soil sampling data, Pen 18 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Date** | **Depth** | **NO3-N** | **NH4-N** | **Unit** | **P** | **K** | **Unit** | **OM** | **Unit** |
| 1/31/02 | 1 ft | 310 | N/L | #/ac | 8 | N/L | ppm | N/L | N/A |
| 1/31/02 | 3 ft | 96 | N/L | #/ac | 3 | N/L | ppm | N/L | N/A |

N/L = Not listed

**Table 20: Dairy Cluster – Distribution of Total Nitrogen in Wells, Dairy Lagoons, Manure Piles, and Application Fields**

| Location | Nitrate as N (ppm) | Nitrate + Nitrite as N (ppm) | Ammonia as N (ppm) | TKN as N (ppm) | Calculated Total Nitrogen (ppm) |
|---|---|---|---|---|---|
| **Water Wells and Lagoons** | | | | | |
| WW-06: Upgradient Well | 0.71 | 0.73 | ND | ND | 0.73 |
| WW-07: Supply Well | 1.02 | 1.19 | ND | ND | 1.19 |
| WW-08: Supply Well | 11.7 | 12.9 | ND | ND | 12.9 |
| WW-09: Supply Well | ND | ND | ND | ND | ND |
| LG-04: Lagoon | NA | ND | 920 (J) | 1600 (J) | 1600 |
| LG-05: Lagoon | NA | ND | 1200 (J) | 1600 (J) | 1600 |
| LG-06: Lagoon | NA | ND | 1200 (J) | 1800 (J) | 1800 |
| LG-07: Lagoon | NA | 3.1 (J) | 950 (J) | 1700 (J) | 1703 |
| LG-08: Lagoon | NA | ND | 730 (J) | 1200 (J) | 1200 |
| LG-09: Lagoon | NA | ND | 760 (J) | 1100 (J) | 1100 |
| LG-10: Lagoon | NA | ND | 190 (J) | 380 (J) | 380 |
| LG-11: Lagoon | NA | ND | 240 (J) | 500 (J) | 500 |
| LG-12: Lagoon | NA | ND | 240 (J) | 290 (J) | 290 |
| LG-13: Lagoon | NA | 2.5 (J) | 970 (J) | 1700 (J) | 1703 |
| LG-14: Lagoon | NA | ND | 860 (J) | 1400 (J) | 1400 |
| LG-15: Lagoon | NA | ND | 560 (J) | 900 (J) | 900 |
| WW-10: Downgradient Well | ND | ND | ND | ND | ND |
| WW-11: Downgradient Well | 22.3 | 23 | ND | ND | 23 |
| WW-12: Downgradient Well | 45 | 46.7 | ND | ND | 46.7 |
| WW-13: Downgradient Well | 41.4 | 44 | ND | ND | 44 |
| WW-14: Downgradient Well | 40.9 | 43.4 | ND | ND | 43.4 |
| WW-15: Downgradient Well | 29.4 | 30.2 | ND | ND | 30.2 |
| WW-16: Downgradient Well | 22.3 | 23.4 | ND | ND | 23.4 |
| WW-17: Downgradient Well | 21.7 | 22.7 | ND | ND | 22.7 |

**Dairy Manure Piles**

| Location | Ammonia-N Solid (ppm) | Nitrate-N solid (ppm) | Total Nitrogen Solid (ppm) | Total Nitrogen (ppm) |
|---|---|---|---|---|
| SO-03: Manure | 1470 | 32.8 | 9210 | 9210 |
| SO-05: Manure | 1060 | 43.1 | 13600 | 13600 |
| SO-07: Manure | 3600 | 18.9 | 16100 | 16100 |
| SO-09: Manure | 1700 | 5.69 | 13700 | 13700 |

**Dairy Application Fields**

| Location | Ammonium as N (ppm) | Nitrate + Nitrite as N (ppm) | Total Nitrogen Solid (ppm) | Total Nitrogen (ppm) |
|---|---|---|---|---|
| SO-04: Application field | 7.3 | 247 | 2110 | 2110 |
| SO-06: Application field | 6.8 | 45.6 | 960 | 960 |
| SO-08: Application field | 2.9 | 84.3 | 3040 | 3040 |
| SO-10: Application field | 7.1 | 139 | 3590 | 3590 |

J – the analyte was positively identified, but the associated numerical value is an estimate.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | WW-01 | WW-02 | WW-03 | WW-04 | WW-05 | WW-06 | WW-07 |
|---|---|---|---|---|---|---|---|
| Sample ID | 10154201 | 10154202 | 10154203 | 10154204 | 10154205 | 10154206 | 10154207 |
| Sample Type | Upgradient Well | Dairy Supply Well | Downgradient Well | Downgradient Well | Downgradient Well | Upgradient Well | Dairy Supply Well |
| Sample Matrix | Water | Water | Water | Water | Water | Water | Water |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| Chlortetracycline(total) | 0.02 U | 0.02 U | 0.02 U | 0.049 | 0.02 U | 0.02 U | 0.02 U |
| Erythromycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Lincomycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.04 U |
| Monensin | 0.027 | 0.02 U | 0.028 | 0.023 | 0.022 | 0.02 U | 0.109 |
| Oxytetracycline | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Ractopamine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfachloropyridazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfadimethoxine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamerazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethoxazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfathiazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Tetracyline | 0.02 U | 0.02 U | 0.041 J | 0.075 J | 0.02 U | 0.051 J | 0.041 J |
| Tiamulin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Tylosin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Virginiamycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.023 J |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | WW-08 | WW-09 | WW-10 | WW-11 | WW-12 | WW-13 | WW-14 |
|---|---|---|---|---|---|---|---|
| **Sample ID** | 10154208 | 10164209 | 10164210 | 10154211 | 10154212 | 10154213 | 10154214 |
| **Sample Type** | Dairy Supply Well | Dairy Supply Well | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well |
| **Sample Matrix** | Water | Water | Water | Water | Water | Water | Water |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| Chlortetracycline(total) | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Erythromycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Lincomycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.085 U | 0.073 U |
| Monensin | 0.02 U | 0.023 | 0.499 | 0.02 U | 0.02 U | 0.02 U | 0.033 |
| Oxytetracycline | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Ractopamine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfachloropyridazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfadimethoxine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamerazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethoxazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfathiazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Tetracyline | 5.17 | 0.02 U | 0.02 U | 0.038 | 0.02 U | 0.02 U | 0.02 U |
| Tiamulin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Tylosin | 0.02 U | 0.02 U | 0.02 U | 0.029 | 0.02 U | 0.02 U | 0.02 U |
| Virginiamycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.041 | 0.024 |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | WW-15 | WW-16 | WW-17 | WW-18 | WW-19 | WW-20 | WW-21 |
|---|---|---|---|---|---|---|---|
| **Sample ID** | 10154215 | 10154216 | 10154217 | 10154218 | 10154219 | 10154220 | 10154221 |
| **Sample Type** | Downgradient Well | Downgradient Well | Downgradient Well | Residential Well | Downgradient - Septic | Downgradient - Septic | Downgradient - Septic |
| **Sample Matrix** | Water | Water | Water | Water | Water | Water | Water |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| Chlortetracycline(total) | 0.119 | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Erythromycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.11 |
| Lincomycin | 0.02 U | 0.02 U | 0.02 U | 0.03 U | 0.02 U | 0.02 U | 0.371 |
| Monensin | 0.393 U | 0.02 U | 0.02 U | 0.02 U | 1.62 | 0.02 U | 0.194 |
| Oxytetracycline | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Ractopamine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.079 |
| Sulfachloropyridazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfadimethoxine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamerazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.053 |
| Sulfamethazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethoxazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.04 |
| Sulfathiazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.051 |
| Tetracyline | 0.02 U | 0.02 U | 0.049 | 0.02 U | 0.02 U | 0.04 J | 0.02 U |
| Tiamulin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.05 |
| Tylosin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Virginiamycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.162 |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | WW-22 | WW-23 | WW-24 | WW-25 | WW-26 | WW-27 |
|---|---|---|---|---|---|---|
| Sample ID | 10164222 | 10154223 | 10154224 | 10154225 | 10154226 | 10154227 |
| Sample Type | Downgradient - Septic | Downgradient - Mint | Downgradient - Mint | Downgradient - Corn | Downgradient - Hops | Downgradient - Hops |
| Sample Matrix | Water | Water | Water | Water | Water | Water |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| Chlortetracycline(total) | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Erythromycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.185 | 0.02 U |
| Lincomycin | 0.038 U | 0.02 U | 0.02 U | 0.02 U | 0.376 | 0.02 U |
| Monensin | 0.02 U | 0.02 U | 0.02 U | 0.023 U | 0.319 | 0.02 U |
| Oxytetracycline | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.2 | 0.02 U |
| Ractopamine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.061 | 0.02 U |
| Sulfachloropyridazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfadimethoxine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamerazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethazine | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.055 | 0.02 U |
| Sulfamethazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Sulfamethoxazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.041 U | 0.02 U |
| Sulfathiazole | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.037 | 0.02 U |
| Tetracyline | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Tiamulin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.029 | 0.02 U |
| Tylosin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.02 U |
| Virginiamycin | 0.02 U | 0.02 U | 0.02 U | 0.02 U | 0.084 | 0.02 U |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | WW-28 | WW-29 | WW-30 | LG-01 | LG-02 | LG-03 | LG-04 | LG-05 |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | 10154228 | 10154229 | 10164230 | 10154251 | 10154252 | 10154253 | 10154254 | 10154255 |
| **Sample Type** | Downgradient - Corn | Field Blank | Residential Well | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon |
| **Sample Matrix** | Water | Water | | Liquid | Liquid | Liquid | Liquid | Liquid |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| Chlortetracycline(total) | 0.02 U | 0.02 U | NA | 0.02 R | 0.067 J | 0.02 R | 0.02 UJ | 0.075 J |
| Erythromycin | 0.02 U | 0.02 U | NA | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.916 J |
| Lincomycin | 0.02 U | 0.059 | NA | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 UJ | 3.55 J |
| Monensin | 0.02 U | 0.02 U | NA | 44.97 J | 1086 J | 420 J | 0.02 UJ | 430.2 J |
| Oxytetracycline | 0.02 U | 0.02 U | NA | 0.02 R | 0.02 R | 0.02 R | 0.02 UJ | 1.24 J |
| Ractopamine | 0.02 U | 0.02 U | NA | 0.081 J | 0.085 J | 0.078 J | 0.02 UJ | 0.04 J |
| Sulfachloropyridazine | 0.02 U | 0.02 U | NA | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 UJ | 1.21 J |
| Sulfadimethoxine | 0.02 U | 0.02 U | NA | 0.38 J | 4.68 J | 2.18 J | 0.02 UJ | 0.322 J |
| Sulfamerazine | 0.02 U | 0.02 U | NA | 0.02 UJ | 0.117 J | 0.02 UJ | 0.02 UJ | 0.068 J |
| Sulfamethazine | 0.02 U | 0.02 U | NA | 0.071 J | 0.109 J | 0.02 UJ | 0.02 UJ | 1.5 J |
| Sulfamethazole | 0.02 U | 0.02 U | NA | 0.06 J | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 R |
| Sulfamethoxazole | 0.02 U | 0.02 U | NA | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 R |
| Sulfathiazole | 0.02 U | 0.02 U | NA | 0.305 J | 0.312 J | 0.216 J | 0.02 UJ | 0.137 J |
| Tetracyline | 0.02 U | 0.02 U | NA | 1.96 J | 5.83 J | 2.88 J | 0.02 UJ | 4.48 J |
| Tiamulin | 0.02 U | 0.02 U | NA | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 R |
| Tylosin | 0.02 U | 0.02 U | NA | 0.381 J | 1.85 J | 1.12 J | 0.02 UJ | 1.7 J |
| Virginiamycin | 0.02 U | 0.02 U | NA | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.02 UJ | 0.334 J |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | LG-06 | LG-07 | LG-08 | LG-09 | LG-10 | LG-11 | LG-12 | LG-13 | LG-14 |
|---|---|---|---|---|---|---|---|---|---|
| Sample ID | 10154256 | 10154257 | 10154258 | 10154259 | 10164260 | 10164261 | 10164262 | 10164263 | 10164264 |
| Sample Type | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon |
| Sample Matrix | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| Chlortetracycline(total) | 0.02 UJ | 0.02 R | 0.02 R | 0.02 R | 0.079 J | 0.02 R | 0.02 R | 0.02 R | 0.02 R |
| Erythromycin | 0.02 UJ | 0.02 R | 0.02 R | 1.87 J | 0.02 R | 2 J | 1.11 J | 1.3 J | 0.02 R |
| Lincomycin | 8.5 J | 0.02 R | 0.02 R | 0.02 R | 1.7 J | 2.64 J | 1.54 J | 3.37 J | 2.04 J |
| Monensin | 463.8 J | 0.02 R | 449.6 J | 337.7 J | 2.24 J | 85 J | 135 J | 662 J | 498 J |
| Oxytetracycline | 4.49 J | 0.02 R | 0.929 J | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R |
| Ractopamine | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.048 J | 0.066 J | 0.046 J | 0.081 J | 0.056 J |
| Sulfachloropyridazine | 0.157 J | 0.095 J | 0.254 J | 0.02 R | 0.043 J | 0.156 J | 0.172 J | 0.32 J | 0.16 J |
| Sulfadimethoxine | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.065 J | 0.841 J | 0.875 J | 4.13 J | 3.65 J |
| Sulfamerazine | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R |
| Sulfamethazine | 0.17 J | 0.02 R | 0.39 J | 2.07 J | 0.077 J | 0.064 J | 0.07 J | 0.108 J | 0.139 J |
| Sulfamethazole | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.114 J | 0.02 R | 0.02 R | 0.148 J | 0.02 R |
| Sulfamethoxazole | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.133 J | 0.269 J | 0.264 J | 0.02 R | 0.031 J |
| Sulfathiazole | 0.829 J | 0.02 R | 0.872 J | 0.02 R | 0.038 J | 0.089 J | 0.065 J | 0.24 J | 0.061 J |
| Tetracyline | 5.41 J | 0.442 J | 6.07 J | 3.6 J | 6.55 J | 1.76 J | 1.91 J | 10.3 J | 8.6 J |
| Tiamulin | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.079 J | 0.02 R |
| Tylosin | 10.22 J | 0.184 J | 0.02 R | 1.07 J | 0.02 R | 0.02 R | 0.02 R | 0.139 J | 0.02 R |
| Virginiamycin | 0.02 R | 0.02 R | 0.02 R | 0.02 R | 0.816 J | 0.413 J | 0.314 J | 0.184 J | 0.02 R |

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**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | LG-15 | SP-01 | SP-02 | SP-03 | SP-04 | SO-01 | SO-02 | SO-03 |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | 10164265 | 10154271 | 10154272 | 1E+07 | 10154274 | 10154231 | 10154232 | 10154233 |
| **Sample Type** | Dairy Lagoon | WWTP | WTTP | WWTP | WWTP | Manure | Soil – Dairy Application Field | Manure |
| **Sample Matrix** | Liquid | Liquid | Liquid | Liquid | Liquid | Solid | Solid | Solid |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/Kg | ug/Kg | ug/Kg |
| Chlortetracycline(total) | 0.02 R | 0.02 R | 0.02 UJ | 0.02 U | NA | 0.5 U | 45.6 | 0.7 |
| Erythromycin | 4.35 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 2.1 |
| Lincomycin | 1.71 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 17.1 | 0.5 U | 1.5 |
| Monensin | 426 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 441 | 2.9 | 109 |
| Oxytetracycline | 0.02 R | 0.02 R | 0.02 UJ | 0.02 U | NA | 4.5 | 2.4 | 251 |
| Ractopamine | 0.06 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 0.5 U |
| Sulfachloropyridazine | 0.658 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 0.5 U |
| Sulfadimethoxine | 2.98 J | 0.021 J | 0.02 R | 0.02 U | NA | 0.5 U | 1 | 0.5 U |
| Sulfamerazine | 0.028 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethazine | 0.601 J | 0.02 UJ | 0.02 R | 0.086 | NA | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethazole | 1.27 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethoxazole | 0.037 J | 0.02 UJ | 0.106 J | 0.662 | NA | 0.5 U | 0.5 U | 0.5 U |
| Sulfathiazole | 0.135 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 0.5 U |
| Tetracyline | 7.55 J | 0.55 J | 0.02 UJ | 0.02 U | NA | 178 | 26.9 | 954 |
| Tiamulin | 0.132 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 0.5 U |
| Tylosin | 0.02 R | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 14.8 |
| Virginiamycin | 1 J | 0.02 UJ | 0.02 R | 0.02 U | NA | 0.5 U | 0.5 U | 0.5 U |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | SO-04 | SO-05 | SO-06 | SO-07 | SO-08 | SO-09 | SO-10 |
|---|---|---|---|---|---|---|---|
| Sample ID | 10154234 | 10154235 | 10154236 | 10164237 | 10164238 | 10164239 | 10164240 |
| Sample Type | Soil – Dairy Application Field | Manure | Soil – Dairy Application Field | Manure | Soil – Dairy Application Field | Manure | Soil – Dairy Application Field |
| Sample Matrix | Solid | Solid | Solid | Solid | Solid | Solid | Solid |
| Compound Units | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg |
| Chlortetracycline(total) | 0.6 | 17.7 | 3 | 2303 | 13.5 | 0.5 U | 0.5 U |
| Erythromycin | 0.5 U | 3.1 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Lincomycin | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 6.9 | 0.5 U |
| Monensin | 5.1 | 1329 | 5.1 | 283 | 7.9 | 437 | 7 |
| Oxytetracycline | 3.2 | 0.5 U | 3.3 | 134 | 2.4 | 2.1 | 2.4 |
| Ractopamine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfachloropyridazine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfadimethoxine | 0.5 U | 0.5 U | 0.5 U | 6.8 | 0.5 U | 0.5 U | 0.6 |
| Sulfamerazine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.7 |
| Sulfamethazine | 0.9 | 7.7 | 0.5 U | 2 | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethazole | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethoxazole | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfathiazole | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tetracyline | 27.4 | 17.9 | 16.5 | 2484 | 104 | 309 | 53 |
| Tiamulin | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tylosin | 2.1 | 0.5 U | 0.5 U | 21.1 | 0.5 U | 0.5 U | 0.5 U |
| Virginiamycin | 0.5 U | 0.5 U | 0.5 U | 0.5 | 0.5 U | 0.5 U | 0.5 U |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | SO-11 | SO-12 | SO-13 | SO-14 | SO-15 | SO-16 |
|---|---|---|---|---|---|---|
| **Sample ID** | 10154241 | 10154242 | 10154243 | 10154244 | 10154245 | 10154246 |
| **Sample Type** | Soil – Mint Field | Soil – Mint Field | Soil – Corn Field | Soil – Corn Field | Soil – Hops Field | Soil – Hops Field |
| **Sample Matrix** | Solid | Solid | Solid | Solid | Solid | Solid |
| **Compound** **Units** | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg |
| Chlortetracycline(total) | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Erythromycin | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Lincomycin | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Monensin | 0.5 U | 4.3 | 0.5 U | 0.5 U | 4.5 | 0.7 |
| Oxytetracycline | 1.3 | 1.4 | 0.5 U | 1.3 | 10.5 | 5.3 |
| Ractopamine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfachloropyridazine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfadimethoxine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfamerazine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethazine | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethazole | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfamethoxazole | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Sulfathiazole | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tetracyline | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 20.7 | 10.5 |
| Tiamulin | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |
| Tylosin | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 |
| Virginiamycin | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U |

See Table C12 notes on page 10 of 10.

**Table C12: Phase 3 Analytical Results for Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

Veterinary pharmaceutical analyses were conducted by the University of Nebraska Water Sciences Laboratory in Lincoln, Nebraska (UNL).

**Abbreviations**

LG - dairy waste lagoon

NA - not analyzed

SO - solid

SOP- Standard Operating Procedure

SP - wastewater treatment plant influent

WW - water well

WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

ug/Kg = micrograms per kilogram

**Analytical Method**

Liquids: UNL SOP "*Analysis of veterinary pharmaceuticals in water samples using a Spark Holland symbiosis on-line C18 cartridge solid phase extraction (SPE) and high pressure liquid chromatography/tandem mass spectrometry (HPLC/MS/MS)"; Document File number: LCMS_VET_PHARM_WATER_001".*

Solids: UNL SOP "*Analysis of Steroids in solid samples (i.e. soils, manure, etc) by microwave-assisted solvent extraction (MASE) and liquid chromatography-tandem mass spectrometry (LC/MS/MS)" (SOP-VetPharmSED-001)"* .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.

R = The data are unusable for all purposes.

U = The analyte was not detected at or above the reported value.

UJ = The analyte was not detected at or above the reported estimated result. The associated numerical value is an estimate of the quantitation limit of the analyte in this sample.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| | **Location ID** | WW-01 | WW-02 | WW-03 | WW-04 | WW-05 | WW-06 |
|---|---|---|---|---|---|---|---|
| | **Sample ID** | 10154201 | 10154202 | 10154203 | 10154204 | 10154205 | 10154206 |
| | **Sample Type** | Upgradient Well | Dairy Supply Well | Downgradient Well | Downgradient Well | Downgradient Well | Upgradient Well |
| | **Sample Matrix** | Water | Water | Water | Water | Water | Water |
| **Compound** | **Units** | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |
| 17-α-ethynyl-estradiol | | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| 17-β-estradiol | | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U |
| Estriol | | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U |
| Estrone | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| | Location ID | WW-07 | WW-08 | WW-09 | WW-10 | WW-11 | WW-12 |
|---|---|---|---|---|---|---|---|
| | **Sample ID** | 10154207 | 10154208 | 10164209 | 10164210 | 10154211 | 10154212 |
| | **Sample Type** | Dairy Supply Well | Dairy Supply Well | Dairy Supply Well | Downgradient Well | Downgradient Well | Downgradient Well |
| | **Sample Matrix** | Water | Water | Water | Water | Water | Water |
| **Compound** | **Units** | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |
| 17-α-ethynyl-estradiol | | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| 17-β-estradiol | | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U |
| Estriol | | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U |
| Estrone | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| Location ID | WW-13 | WW-14 | WW-15 | WW-16 | WW-17 | WW-18 |
|---|---|---|---|---|---|---|
| Sample ID | 10154213 | 10154214 | 10154215 | 10154216 | 10154217 | 10154218 |
| Sample Type | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well | Residential Well |
| Sample Matrix | Water | Water | Water | Water | Water | Water |
| **Compound** / **Units** | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |
| 17-α-ethynyl-estradiol | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| 17-β-estradiol | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U |
| Estriol | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U |
| Estrone | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| | **Location ID** | WW-19 | WW-20 | WW-21 | WW-22 | WW-23 |
|---|---|---|---|---|---|---|
| | **Sample ID** | 10154219 | 10154220 | 10154221 | 10164222 | 10154223 |
| | **Sample Type** | Downgradient - Septic | Downgradient - Septic | Downgradient - Septic | Downgradient - Septic | Downgradient - Mint |
| | **Sample Matrix** | Water | Water | Water | Water | Water |
| **Compound** | **Units** | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |
| 17-α-ethynyl-estradiol | | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| 17-β-estradiol | | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U |
| Estriol | | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U |
| Estrone | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| | Location ID | WW-24 | WW-25 | WW-26 | WW-27 | WW-28 |
|---|---|---|---|---|---|---|
| | Sample ID | 10154224 | 10154225 | 10154226 | 10154227 | 10154228 |
| | Sample Type | Downgradient - Mint | Downgradient - Corn | Downgradient - Hops | Downgradient - Hops | Downgradient - Corn |
| | Sample Matrix | Water | Water | Water | Water | Water |
| **Compound** | **Units** | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |
| 17-α-ethynyl-estradiol | | 0.16 U | 0.16 U | 0.16 U | 0.16 U | 0.16 U |
| 17-β-estradiol | | 0.14 U | 0.14 U | 0.14 U | 0.14 U | 0.14 U |
| Estriol | | 0.22 U | 0.22 U | 0.22 U | 0.22 U | 0.22 U |
| Estrone | | 0.21 U | 0.21 U | 0.21 U | 0.21 U | 0.21 U |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| | **Location ID** | WW-29 | WW-30 | LG-01 | LG-02 | LG-03 | LG-04 | LG-05 |
|---|---|---|---|---|---|---|---|---|
| | **Sample ID** | 10154229 | 10164230 | 10154251 | 10154252 | 10154253 | 10154254 | 10154255 |
| | **Sample Type** | Field Blank | Residential Well | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon |
| | **Sample Matrix** | Water | Water | Liquid | Liquid | Liquid | Liquid | Liquid |
| **Compound** | **Units** | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | | 0.21 U | 0.21 U | 10320 | 1610 | 1590 | 3430 | 1100 |
| 17-α-ethynyl-estradiol | | 0.16 U | 0.16 U | 38.3 U | 20 U | 20 U | 20 U | 20 U |
| 17-β-estradiol | | 0.14 U | 0.14 U | 86.8 | 18 J | 21.3 | 555 | 44 |
| Estriol | | 0.22 U | 0.22 U | 8.8 U | 8.8 U | 8.8 U | 8.8 U | 8.8 U |
| Estrone | | 0.21 U | 0.21 U | 2660 | 1920 | 1950 | 1100 | 3180 |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| | Location ID | LG-06 | LG-07 | LG-08 | LG-09 | LG-10 | LG-11 | LG-12 |
|---|---|---|---|---|---|---|---|---|
| | **Sample ID** | 10154256 | 10154257 | 10154258 | 10154259 | 10164260 | 10164261 | 10164262 |
| | **Sample Type** | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon |
| | **Sample Matrix** | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid |
| **Compound** | **Units** | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | | 1190 | 1730 | 1200 | 1270 | 292 | 570 | 559 |
| 17-α-ethynyl-estradiol | | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| 17-β-estradiol | | 38.5 | 38.2 | 25.4 | 22.3 | 16 J | 12 J | 11 J |
| Estriol | | 8.8 U | 8.8 U | 8.8 U | 8.8 U | 8.8 U | 8.8 U | 8.8 U |
| Estrone | | 3300 | 592 | 1020 | 1050 | 73 | 453 | 451 |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C13: Phase 3 Analytical Results for Hormones in Well, Lagoons, Manure Piles, Application Field, Wastewater Treatment Influents, and Crop Soils**

| | Location ID | LG-13 | LG-14 | LG-15 | SP-01 | SP-02 | SP-03 | SP-04 |
|---|---|---|---|---|---|---|---|---|
| | **Sample ID** | 10164263 | 10164264 | 10164265 | 10154271 | 10154272 | 10154273 | 10154274 |
| | **Sample Type** | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | WWTP | WTTP | WWTP | WWTP |
| | **Sample Matrix** | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid |
| **Compound** | **Units** | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L | ng/L |
| 17-α-estradiol | | 1220 | 1050 | 792 | 7.6 U | 7.6 U | 7.6 U | NA |
| 17-α-ethynyl-estradiol | | 20 U | 20 U | 20 U | 6.4 U | 6.4 U | 6.4 U | NA |
| 17-β-estradiol | | 179 | 41 | 25.3 | 21.1 | 35.4 | 34.1 | NA |
| Estriol | | 8.8 U | 8.8 U | 8.8 U | 1030 | 863 | 640 | NA |
| Estrone | | 390 | 419 | 830 | 77.1 | 96.4 | 72.7 | NA |

Samples were analyzed by the EPA Robert S. Kerr Environmental Research Center.

**Abbreviations**

LG - Dairy waste Dairy Lagoon
SOP- Standard Operating Procedure
SP - wastewater treatment plant influent
WW - water well
WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

**Analytical Method**

EPA SOP "*Quantitation of Estrogens in Groundwater and Animal Waste Lagoon Water Using Solid Phase Extraction, Pentafluorobenzyl and Trimethylsilyl Derivatization and Gas Chromatography Negative Ion Chemical Ionization/Mass Spectrometry/Mass Spectrometry, RSKSOP-253, Revision 2, October 2010*" .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.
U = The analyte was not detected at or above the reported value.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | WW-01 | WW-02 | WW-03 | WW-04 | WW-05 | WW-06 | WW-07 | WW-08 |
|---|---|---|---|---|---|---|---|---|
| Sample ID | 10154201 | 10154202 | 10154203 | 10154204 | 10154205 | 10154206 | 10154207 | 10154208 |
| Sample Type | Upgradient Well | Dairy Supply Well | Downgradient Well | Downgradient Well | Downgradient Well | Upgradient Well | Dairy Supply Well | Dairy Supply Well |
| Sample Matrix | Water | Water | Water | Water | Water | Water | Water | Water |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| 11-Keto Testosterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-α-Hydroxyprogesterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.005 U |
| 17-α-trenbolone | 0.003 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.004 U |
| 17-β-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-β-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.003 |
| 4-Androstenedione | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.003 U | 0.002 U | 0.004 U |
| 17-α-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.003 | 0.002 U | 0.003 |
| Androstadienedione | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.003 U | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 J |
| Androsterone | 0.006 U | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ |
| α-Zearalanol | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.005 J | 0.009 J |
| α-Zearalenol | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 J |
| β-Zearalanol | 0.002 U | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ |
| β-Zearalenol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Epitestosterone | 0.002 U | 0.002 U | 0.002 U | 0.003 | 0.002 U | 0.002 U | 0.002 | 0.003 |
| Estriol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Estrone | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ |
| 17-α-ethynyl-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Melengesterol Acetate | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.004 U |
| Progesterone | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.004 U | 0.004 U | 0.007 U |
| Testosterone | 0.021 | 0.016 | 0.009 | 0.012 | 0.007 | 0.005 | 0.002 U | 0.003 |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | WW-09 | WW-10 | WW-11 | WW-12 | WW-13 | WW-14 | WW-15 | WW-16 |
|---|---|---|---|---|---|---|---|---|
| Sample ID | 10164209 | 10164210 | 10154211 | 10154212 | 10154213 | 10154214 | 10154215 | 10154216 |
| Sample Type | Dairy Supply Well | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well | Downgradient Well |
| Sample Matrix | Water | Water | Water | Water | Water | Water | Water | Water |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| 11-Keto Testosterone | 0.003 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-α-Hydroxyprogesterone | 0.003 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-α-trenbolone | 0.003 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-β-estradiol | 0.006 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-β-trenbolone | 0.004 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 4-Androstenedione | 0.003 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-α-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Androstadienedione | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.004 J | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| Androsterone | 0.005 J | 0.002 UJ | 0.002 UJ | 0.018 J | 0.002 U | 0.002 U | 0.019 J | 0.004 UJ |
| α-Zearalanol | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| α-Zearalenol | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| β-Zearalanol | 0.002 J | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| β-Zearalenol | 0.003 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Epitestosterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Estriol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Estrone | 0.002 J | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| 17-α-ethynyl-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Melengesterol Acetate | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Progesterone | 0.005 U | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| Testosterone | 0.008 | 0.002 U | 0.004 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | WW-17 | WW-18 | WW-19 | WW-20 | WW-21 | WW-22 | WW-23 |
|---|---|---|---|---|---|---|---|
| **Sample ID** | 10154217 | 10154218 | 10154219 | 10154220 | 10154221 | 10164222 | 10154223 |
| **Sample Type** | Downgradient Well | Residential Well | Downgradient - Septic | Downgradient - Septic | Downgradient - Septic | Downgradient - Septic | Downgradient - Mint |
| **Sample Matrix** | Water | Water | Water | Water | Water | Water | Water |
| **Compound Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| 11-Keto Testosterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.005 | 0.002 U |
| 17-α-Hydroxyprogesterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.006 U | 0.002 U |
| 17-α-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.007 U | 0.002 U |
| 17-β-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.006 | 0.002 U |
| 17-β-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 4-Androstenedione | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.006 U | 0.002 U |
| 17-α-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.005 | 0.002 U |
| Androstadienedione | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 UJ | 0.002 U | 0.003 | 0.002 UJ |
| Androsterone | 0.008 J | 0.002 U | 0.002 UJ | 0.004 J | 0.002 U | 0.002 U | 0.002 UJ |
| α-Zearalanol | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 UJ |
| α-Zearalenol | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 UJ |
| β-Zearalanol | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 UJ | 0.002 U | 0.003 | 0.002 UJ |
| β-Zearalenol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Epitestosterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.004 | 0.002 U |
| Estriol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Estrone | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 UJ | 0.002 U | 0.004 | 0.002 UJ |
| 17-α-ethynyl-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Melengesterol Acetate | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.005 U | 0.002 U |
| Progesterone | 0.002 UJ | 0.003 U | 0.002 UJ | 0.002 UJ | 0.002 U | 0.008 U | 0.002 UJ |
| Testosterone | 0.002 U | 0.003 | 0.002 U | 0.002 U | 0.002 U | 0.01 | 0.002 U |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | WW-24 | WW-25 | WW-26 | WW-27 | WW-28 | WW-29 | WW-30 |
|---|---|---|---|---|---|---|---|
| **Sample ID** | 10154224 | 10154225 | 10154226 | 10154227 | 10154228 | 10154229 | 10164230 |
| **Sample Type** | Downgradient - Mint | Downgradient - Corn | Downgradient - Hops | Downgradient - Hops | Downgradient - Corn | Field Blank | Residential Well |
| **Sample Matrix** | Water | Water | Water | Water | Water | Water | |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| 11-Keto Testosterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 | NA |
| 17-α-Hydroxyprogesterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.003 | NA |
| 17-α-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 | NA |
| 17-β-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | NA |
| 17-β-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.005 | 0.002 U | 0.002 U | NA |
| 4-Androstenedione | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.003 | NA |
| 17-α-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 | 0.002 U | 0.002 U | NA |
| Androstadienedione | 0.002 UJ | 0.002 UJ | 0.002 U | 0.003 J | 0.002 U | 0.002 U | NA |
| Androsterone | 0.002 UJ | 0.002 UJ | 0.002 U | 0.022 J | 0.002 U | 0.002 U | NA |
| α-Zearalanol | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 U | 0.002 U | NA |
| α-Zearalenol | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 U | 0.002 U | NA |
| β-Zearalanol | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 U | 0.004 J | NA |
| β-Zearalenol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | NA |
| Epitestosterone | 0.002 U | 0.002 U | 0.002 U | 0.005 | 0.002 U | 0.002 U | NA |
| Estriol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | NA |
| Estrone | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 UJ | 0.002 U | 0.002 U | NA |
| 17-α-ethynyl-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | NA |
| Melengesterol Acetate | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.003 | NA |
| Progesterone | 0.002 UJ | 0.002 UJ | 0.003 U | 0.002 UJ | 0.002 U | 0.005 | NA |
| Testosterone | 0.002 U | 0.002 U | 0.002 U | 0.004 | 0.002 U | 0.002 U | NA |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | LG-01 | LG-02 | LG-03 | LG-04 | LG-05 | LG-06 | LG-07 | LG-08 | LG-09 |
|---|---|---|---|---|---|---|---|---|---|
| Sample ID | 10154251 | 10154252 | 10154253 | 10154254 | 10154255 | 10154256 | 10154257 | 10154258 | 10154259 |
| Sample Type | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon |
| Sample Matrix | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid |
| **Compound** **Units** | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| 11-Keto Testosterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.857 | 0.765 | 0.549 | 0.444 |
| 17-α-Hydroxyprogesterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.131 | 0.038 | 0.002 U | 0.002 U | 0.002 U |
| 17-α-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-β-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-β-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 4-Androstenedione | 0.196 | 0.35 | 0.171 | 0.002 U | 0.5 | 0.101 | 0.107 | 0.16 | 0.204 |
| 17-α-estradiol | 7.401 | 0.374 | 1.043 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.383 | 0.844 |
| Androstadienedione | 0.002 UJ | 0.074 J | 0.002 UJ | 0.002 U | 3.504 | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Androsterone | 1.48 J | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| α-Zearalanol | 1.643 J | 1.181 J | 2.889 J | 13.9 | 11.9 | 12.6 | 11.3 | 4.819 | 6.969 |
| α-Zearalenol | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| β-Zearalanol | 0.002 UJ | 0.002 UJ | 0.002 UJ | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| β-Zearalenol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Epitestosterone | 0.002 U | 0.002 U | 0.002 U | 0.181 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Estriol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Estrone | 0.994 J | 0.002 UJ | 0.002 UJ | 0.002 U | 1.945 | 1.666 | 0.002 U | 0.002 U | 0.002 U |
| 17-α-ethynyl-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Melengesterol Acetate | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Progesterone | 0.806 J | 0.532 J | 0.333 J | 0.002 U | 0.912 | 0.185 | 0.757 | 0.184 | 0.328 |
| Testosterone | 0.032 | 0.002 U | 0.002 U | 0.002 U | 0.193 | 0.195 | 0.016 | 0.09 | 0.007 |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| Location ID | LG-10 | LG-11 | LG-12 | LG-13 | LG-14 | LG-15 | SP-01 | SP-02 |
|---|---|---|---|---|---|---|---|---|
| Sample ID | 10164260 | 10164261 | 10164262 | 10164263 | 10164264 | 10164265 | 10154271 | 10154272 |
| Sample Type | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | Dairy Lagoon | WWTP | WTTP |
| Sample Matrix | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid | Liquid |
| Compound / Units | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| 11-Keto Testosterone | 0.002 U | 0.002 U | 0.002 U | 0.758 | 0.002 U | 0.002 U | 0.1 | 0.043 |
| 17-α-Hydroxyprogesterone | 0.002 U | 0.085 | 0.107 | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-α-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 1.562 | 1.014 |
| 17-β-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| 17-β-trenbolone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 1.059 |
| 4-Androstenedione | 0.033 | 0.411 | 0.23 | 0.314 | 0.31 | 0.002 U | 0.28 | 0.269 |
| 17-α-estradiol | 0.459 | 2.92 | 3.268 | 0.002 U | 0.002 U | 0.002 U | 0.263 | 0.002 U |
| Androstadienedione | 0.002 U | 0.166 | 0.2 | 0.002 U | 0.002 U | 0.002 U | 0.255 J | 0.614 J |
| Androsterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 5.049 J | 2.137 J |
| α-Zearalanol | 1.434 | 1.664 | 2.576 | 9.851 | 8.83 | 4.977 | 0.176 J | 0.22 J |
| α-Zearalenol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| β-Zearalanol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| β-Zearalenol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Epitestosterone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.06 |
| Estriol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.632 | 0.002 U |
| Estrone | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 UJ | 0.002 UJ |
| 17-α-ethynyl-estradiol | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U | 0.002 U |
| Melengesterol Acetate | 0.002 U | 0.043 | 0.002 U | 0.002 U | 0.039 | 0.002 U | 0.002 U | 0.002 U |
| Progesterone | 0.002 U | 0.251 | 0.248 | 0.926 | 0.682 | 0.002 U | 0.002 UJ | 0.002 UJ |
| Testosterone | 0.028 | 0.002 U | 0.024 | 0.262 | 0.17 | 0.002 U | 0.053 | 0.059 |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | SP-03 | SP-04 | SO-01 | SO-02 | SO-03 | SO-04 | SO-05 | SO-06 |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | 10154273 | 10154274 | 10154231 | 10154232 | 10154233 | 10154234 | 10154235 | 10154236 |
| **Sample Type** | WWTP | WWTP | Manure | Soil – Dairy Application Field | Manure | Soil – Dairy Application Field | Manure | Soil – Dairy Application Field |
| **Sample Matrix** | Liquid | Liquid | Solid | Solid | Solid | Solid | Solid | Solid |
| **Compound Units** | ug/L | ug/L | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg |
| 11-Keto Testosterone | 0.002 U | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-α-Hydroxyprogesterone | 0.002 U | NA | 0.1 U | 0.1 U | 1.94 | 0.1 U | 0.1 U | 0.1 U |
| 17-α-trenbolone | 1.521 | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-β-estradiol | 0.002 U | NA | 0.1 U | 0.1 U | 12.4 | 0.1 U | 1.48 | 0.1 U |
| 17-β-trenbolone | 0.439 | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 4-Androstenedione | 1.352 | NA | 2.08 | 0.16 | 33.2 | 0.1 U | 5.63 | 0.12 |
| 17-α-estradiol | 0.002 U | NA | 2.39 | 0.24 | 34.7 | 0.1 U | 0.1 U | 0.11 |
| Androstadienedione | 14.1 J | NA | 0.1 U | 0.1 U | 29.4 | 0.1 U | 15.4 | 0.1 U |
| Androsterone | 3.187 J | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| α-Zearalanol | 0.011 J | NA | 17.4 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| α-Zearalenol | 0.002 UJ | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| β-Zearalanol | 0.002 UJ | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| β-Zearalenol | 8.015 | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Epitestosterone | 0.002 U | NA | 0.1 U | 0.1 U | 8.47 | 0.1 U | 0.1 U | 0.1 U |
| Estriol | 0.55 | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Estrone | 0.002 UJ | NA | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-α-ethynyl-estradiol | 0.002 U | NA | 6.3 | 0.1 U | 4.22 | 0.1 U | 10.5 | 0.1 U |
| Melengesterol Acetate | 0.002 U | NA | 0.44 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Progesterone | 0.002 UJ | NA | 2.83 | 0.1 U | 70.4 | 0.25 | 33.1 | 0.17 |
| Testosterone | 0.045 | NA | 0.1 U | 0.1 U | 2.95 | 0.1 U | 0.1 U | 0.1 U |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | SO-07 | SO-08 | SO-09 | SO-10 | SO-11 | SO-12 | SO-13 | SO-14 |
|---|---|---|---|---|---|---|---|---|
| **Sample ID** | 10164237 | 10164238 | 10164239 | 10164240 | 10154241 | 10154242 | 10154243 | 10154244 |
| **Sample Type** | Manure | Soil – Dairy Application Field | Manure | Soil – Dairy Application Field | Soil – Mint Field | Soil – Mint Field | Soil – Corn Field | Soil – Corn Field |
| **Sample Matrix** | Solid | Solid | Solid | Solid | Solid | Solid | Solid | Solid |
| **Compound Units** | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg | ug/Kg |
| 11-Keto Testosterone | 8.8 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-α-Hydroxyprogesterone | 3.64 | 0.1 U | 3.42 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-α-trenbolone | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-β-estradiol | 8.35 | 0.1 U | 4.37 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-β-trenbolone | 0.1 U | 0.29 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 4-Androstenedione | 10.2 | 0.1 U | 12.4 | 0.12 | 0.1 U | 0.12 | 0.1 U | 0.1 U |
| 17-α-estradiol | 18.7 | 0.1 U | 16.9 | 0.1 U | 0.1 U | 0.11 | 0.1 U | 0.1 U |
| Androstadienedione | 13.5 | 0.1 U | 19.3 | 0.1 U | 0.18 | 0.1 U | 0.1 U | 0.1 U |
| Androsterone | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| α-Zearalanol | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| α-Zearalenol | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| β-Zearalanol | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| β-Zearalenol | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Epitestosterone | 2.78 | 0.1 U | 4.43 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Estriol | 0.1 U | 0.48 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Estrone | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| 17-α-ethynyl-estradiol | 8.52 | 0.1 U | 4.06 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |
| Melengesterol Acetate | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.13 | 0.1 U |
| Progesterone | 39 | 0.1 U | 48 | 0.23 | 0.14 | 0.17 | 0.1 U | 0.1 U |
| Testosterone | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

| **Location ID** | SO-15 | SO-16 |
|---|---|---|
| **Sample ID** | 10154245 | 10154246 |
| **Sample Type** | Soil – Hops Field | Soil – Hops Field |
| **Sample Matrix** | Solid | Solid |
| **Compound** **Units** | ug/Kg | ug/Kg |
| 11-Keto Testosterone | 0.1 U | 0.1 U |
| 17-α-Hydroxyprogesterone | 0.1 U | 0.1 U |
| 17-α-trenbolone | 0.1 U | 0.1 U |
| 17-β-estradiol | 0.1 U | 0.1 U |
| 17-β-trenbolone | 0.1 U | 0.1 U |
| 4-Androstenedione | 0.16 | 0.13 |
| 17-α-estradiol | 0.1 U | 0.1 U |
| Androstadienedione | 0.15 | 0.1 U |
| Androsterone | 0.1 U | 0.1 U |
| α-Zearalanol | 0.1 U | 0.1 U |
| α-Zearalenol | 0.1 U | 0.1 U |
| β-Zearalanol | 0.1 U | 0.1 U |
| β-Zearalenol | 0.1 U | 0.1 U |
| Epitestosterone | 0.1 U | 0.1 U |
| Estriol | 0.1 U | 0.1 U |
| Estrone | 0.1 U | 0.1 U |
| 17-α-ethynyl-estradiol | 0.1 U | 0.1 U |
| Melengesterol Acetate | 0.1 U | 0.1 U |
| Progesterone | 0.13 | 0.1 |
| Testosterone | 0.1 U | 0.1 U |

See Table C14 notes on page 10 of 10.

**Table C14: Phase 3 Analytical Results for Hormones in Wells, Lagoons, Manure Piles, Application Fields, Wastewater Treatment Plant Influents, and Crop Soils**

Samples were analyzed by the U. of Nebraska Water Sciences Laboratory

**Abbreviations**

LG - dairy waste lagoon

NA - not analyzed

SO - solid

SOP - Standard Operating Procedure

SP - wastewater treatment plant influent

WW - water well

WWTP - wastewater treatment plant

**Units**

ug/L = micrograms per liter

ug/Kg = micrograms per kilogram

**Analytical Methods**

Liquids: UNL SOP LCMS-APPI-STEROIDS- WATER-001 *"Analysis of steroids in water samples using a Spark Holland symbiosis on-line C18 cartridge solid phase extraction (SPE) and high pressure liquid chromatography/tandem mass spectrometry (HPLC/MS/MS)"* .
Solids: UNL SOP Analyte-Steroids-Solids-001 *"Analysis of Steroids in solid samples (i.e. soils, manure, etc) by microwave-assisted solvent extraction (MASE) and liquid chromatography-tandem mass spectrometry (LC/MS/MS)"* .

**Data Qualifiers**

J = The analyte was positively identified. The associated numerical value is an estimate.

R = The data are unusable for all purposes.

U = The analyte was not detected at or above the reported value.

UJ = The analyte was not detected at or above the reported estimated result. The associated numerical value is an estimate of the quantitation limit of the analyte in this sample.