EXPERT REPORT

OF

BYRON H. SHAW, Ph.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, Byron Shaw, have been retained by Plaintiffs in the above-captioned matter to provide expert testimony about the manure management, storage, and application practices of Defendant Cow Palace Dairy, LLC ("Cow Palace" or "Defendant"), including how these activities have caused or contributed to the contamination of soils, surface water, and groundwater.

2. I am a licensed professional soil scientist and hydrologist in the State of Wisconsin. I have a Ph.D. in soil science from University of Wisconsin (UW) Madison and a minor in water chemistry. I taught, conducted research, ran an environmental research lab, and conducted educational programs for the University of Wisconsin Stevens Point ("UWSP") and UW Extension for 32 years prior to retiring in 2000. I have done part-time soil and water consulting for the past 14 years. My research and publications cover a wide range of soil and water issues, with many dealing with surface and groundwater contamination from agricultural activities. I have received a number of awards for my work. I have also lived on and worked a 110-acre farm for the past 45 years.

3. As part of my research, I was principal advisor to 50 Master of Science graduate research projects. As part of these studies I designed, and supervised the installation of, several hundred monitoring wells, many evaluating various agricultural practices. I also initiated a water quality testing program at UWSP that, among other findings, identified the first occurrence of pesticides in Wisconsin groundwater. This testing program presently employs 10 to 25 people and is both State and United States Geological Survey (USGS) certified.

4. As part of my UW extension position, I managed and conducted over 50 groundwater testing programs for citizens throughout Wisconsin, including the designing and implementation of an educational program to explain testing results to homeowners. These programs involved the sampling and testing of private wells on a township-sized area, and included the mapping of results. This program continues to date and has resulted in an extensive database of private well water quality conditions in Wisconsin.

5. My curriculum vitae is attached hereto as Exhibit 1. It contains a list of my past publications and other prior work history.

6. I have previously provided expert testimony, in deposition and/or in trial, in the following matters over the previous four years: *CARE v. Nelson Faria Dairy*, LLC, case number 2:04-cv-03060-LRS (E.D. Wash.). I also provided expert testimony in a contested case hearing in an administrative forum in Wisconsin in February 2014 relative to an expansion of a dairy CAFO.

7. My hourly rate for the time I have spent working on this case is $200/hour. This rate is doubled for depositions and trial testimony.

8. I have reviewed numerous documents about Cow Palace and the other Cluster Dairies, the Yakima Valley, and resource information for Yakima County. This information includes:

a. The Dairy Nutrient Management Plan ("DNMP") for Cow Palace, and the other Cluster Dairies, along with all appendices and attached information; citations herein are to the DNMP provided at COWPAL000001-70 – I have compared it to the other DNMP produced by Cow Palace and find them to be identical in all material aspects.

b. Inspection reports from the Washington Department of Agriculture about Cow Palace and the other Cluster Dairies;

c. Cow Palace's, and the other Cluster Dairies', soil sampling information provided to Plaintiffs during discovery, dating from 1998 to the present, including information obtained pursuant to the Administrative Order on Consent ("AOC") with EPA;

d. Cow Palace's, and the other Cluster Dairies', lagoon and manure sampling information provided to Plaintiffs during discovery, including information obtained pursuant to the AOC;

e. Cow Palace's, and the other Cluster Dairies', field application summary logs;

f. Cow Palace's hand-written field application logs;

g. Cow Palace's, and the other Cluster Dairies', crop yield information, where available;

h. Cow Palace's statements about the Dairy's herd size;

i. Well sampling information for wells sampled by the United States Environmental Protection Agency, including the wells described in the publication titled "Relation Between Nitrate in Water Wells and Potential Sources in the Lower Yakima Valley, Washington" EPA-910-R-13-004 (the "EPA Report");

j. Well installation and sampling information obtained by Cow Palace, and the other Cluster Dairies, pursuant to the AOC, including but not limited to Cow Palace's, and the other Cluster Dairies', quarterly monitoring reports, the groundwater monitoring well installation report, and well logs from well installation;

k. Residential well sampling information obtained by Cow Palace, and the other Cluster Dairies, pursuant to the AOC;

l. Documents generated by Cow Palace pursuant to the AOC;

m. Documents, records, sampling data, my own personal observations, and other information obtained during Plaintiffs' October 2013 Rule 34 inspection of Cow Palace Dairy and the other Cluster Dairies;

n. Documents, records, sampling data, and other information obtained during Plaintiffs' May 2014 Rule 34 inspection of Cow Palace Dairy and the other Cluster Dairies and Haak Dairy;

o. Natural Resource Conservation Service Soil Survey Report for Yakima County, Washington;

p. Several studies and reports from the Washington State Department of Ecology, including: Carey, Barbara, *Effects of Land Application of Manure on Groundwater at Two Dairies over the Sumas-Blaine Surficial Aquifer*, 2002, Washington State Dept. of Ecology Publication No. 02-03-007; Carey, Barbara & Harrison, Joseph, *Nitrogen Dynamics at a Manured Grass Field Overlying the Sumas-Blaine Aquifer in Whatcom County*, 2014, Washington State Dept. of Ecology Publication No. 14-03-001; Erickson, Denis R., *Effects of Leakage from four Dairy Waste Storage Ponds on Groundwater Quality*, Final Report, 1994, Washington State Dept. of Ecology Publication No. 94-109; E.S. Marx, J. Hart, and R.G. Stevens, *Soil Test Interpretation Guide*,1996, Oregon State Extension

Service, EC-1478, and its July, 2011 update by D.A. Horneck, D.M. Sullivan, J.S. Owen, and J.M. Hart; Vaccaro, J.J., Jones, M.A., Ely, D.M., Key, M.E., Olsen, T.D., Welch, W.B., and Cox, S.E., 2009, *Hydrogeologic Framework of the Yakima River Basin Aquifer System, Washington*: U.S. Geological Survey Scientific Investigations Report, 2009-5152.

q. The deposition testimony of Jeff Boivin, Cow Palace employee and manager, Dirk Porter, Cow Palace employee, and Daniel McCarty, a dairy inspector for the Washington State Department of Agriculture, along with other deposition testimony;

r. Residential well sampling data taken by Cow Palace/Dolsen Companies of residences owned by the Dairies;

s. Many scholarly articles, publications, and recommendations, some as referenced and cited specifically herein;

t. The report by McFarland, M., Devlin, D., Koenig, R., Osmond, D., entitled "Comparison of Land Grant University Soil Test Recommendations for Nitrogen, Phosphorus and Potassium," (undated).

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

10. Generally, I have been requested by Plaintiffs to render an opinion about whether Cow Palace's manure management, storage, and application practices have resulted in nitrogen, phosphorus, and other plant nutrients found in cow manure being leached through the ground and into groundwater and other potential environmental impacts from manure overapplication. For instance, overloading of phosphorus, along with nitrogen, is likely to lead to surface water runoff that causes eutrophication of surface waters, or the addition of excess nutrients into bodies of water that typically cause excessive algae growth. Based on my review of the available information, I conclude that Cow Palace's manure management, storage, and application practices are one of the primary contributing sources of the nitrogen (in the form of nitrate) contamination observed in the groundwater downgradient of Cow Palace's facility and application fields. In some specific situations, Cow Palace is the primary source.

11. I have also been asked by Plaintiffs to render an opinion as to what measures Cow Palace could reasonably take that would reduce nitrogen loading from the Dairy and would remediate the nitrate contamination of groundwater. I discuss these options at the end of this report.

SCIENTIFIC AND FACTUAL BACKGROUND

12. The Cow Palace Dairy is a concentrated animal feeding operation or "CAFO" located near 1631 North Liberty Road, Granger, WA, 98932. As of 2012, Cow Palace had 7,372 milking cows, 897 dry cows, 243 springers, and 3095 calves housed at the facility, for a total herd size of 11,607 animals.[1] According to Cow Palace's 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.[2] Liquid manure from these lagoons is land-applied to Cow Palace's agricultural fields, which total 533 acres in size per the DNMP.[3]

13. A facility with 2500 dairy cattle is estimated to create a similar waste load as a city of 411,000 people.[4] A key difference is the fact that human waste is treated before discharge into the environment, whereas waste from CAFOs has no such requirement as it is not treated, or treated minimally, before reaching the environment.[5] Based on this estimate, Cow Palace's milking cows produce a similar waste load as a human population of more than 1,211,957 people (411,000/2500*7372).

14. Cow Palace is located in the northern end of the Lower Yakima

[1] COWPAL002097.
[2] COWPAL000010.
[3] COWPAL000005.
[4] EPA Report at 46.
[5] *Id.*

Valley, and is bounded to the north by basalt hills known as the "Rattlesnake Hills."[6] There are only a handful of agricultural fields located north of Cow Palace Dairy, as is readily apparent by looking at any internet mapping service, such as Google Maps.[7]

15. There are two main aquifer types in the area. The first is a surficial unconfined to semi-confined alluvial aquifer. The second is an extensive basalt aquifer of great thickness underlying the sedimentary deposits. The deep portion of the basalt aquifer is believed by the USGS to be semi-isolated from the surficial aquifer and local stream systems and eventually discharges to the Columbia River.[8] Natural groundwater flow within the shallower, surficial aquifer generally follows topography, but may be influenced by irrigation practices, drains, ditches, and canals.[9] This shallower aquifer feeds the Yakima River,[10] which is one way how contamination introduced by Cow Palace to groundwater can later cause or contribute to surface water impacts.

16. Precipitation is the main source of groundwater recharge in this area, and as a result, most natural groundwater recharge occurs in the winter and early spring months when evapotranspiration is low and precipitation is

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[6] EPA Report at p. 127, Figure 7.
[7] *See also* EPA Report at p. 46.
[8] EPA Report at p. 7, *see also* Vaccaro et al., (USGS 2009).
[9] EPA Report at p. 7.
[10] *Id.*

high. Groundwater recharge is also influenced, however, by irrigation water and liquid manure that applied to agricultural fields. Irrigation and manure applications thus impact the natural groundwater recharge occurring whenever precipitation plus irrigation/application exceed the water holding capacity of the soil.

17. The Lower Yakima Valley is filled with sediments shed by the basalt ridges at the borders of the Valley, such as the Rattlesnake Hills, and those deposited in the valley bottom by the Yakima River. The sediments' internal structure strongly controls groundwater movement, meaning that water movement through the sediments tends to follow preferential flow paths composed of coarse sediments. There can be sizeable ranges in groundwater velocities among aquifer materials of varying grain size, such as the sediments found in the Valley. As a result, a well that is located along a preferential flow path may draw a substantial portion of its water from a particular source, whereas a neighboring well located along a different preferential flow path may have different water chemistry.[11]

18. Shallower wells located in the Lower Yakima Valley are more likely to be contaminated with nitrates than deeper wells, because the sources of the nitrogen loading to the groundwater are anthropogenic, or man-made,

[11] *Id*. at 7-8.

and occur on the land's surface. These activities include land-application of fertilizer and pesticides, including liquid and solid manure, and from storage of manure in unpaved confinement pens and unlined, earthen lagoons. The EPA Report, along with other earlier studies, documented more contaminated wells screened within the shallower aquifer than the deeper, basalt aquifer; in fact, the highest levels of nitrate generally occur in the shallow alluvial aquifer.[12]

19. Anthropogenic nitrogen sources above the aquifer can cause excess nitrogen to move through soils and into groundwater. Nitrogen is a highly mobile element, and the "nitrogen cycle" is well documented and understood, as shown in the figure below:

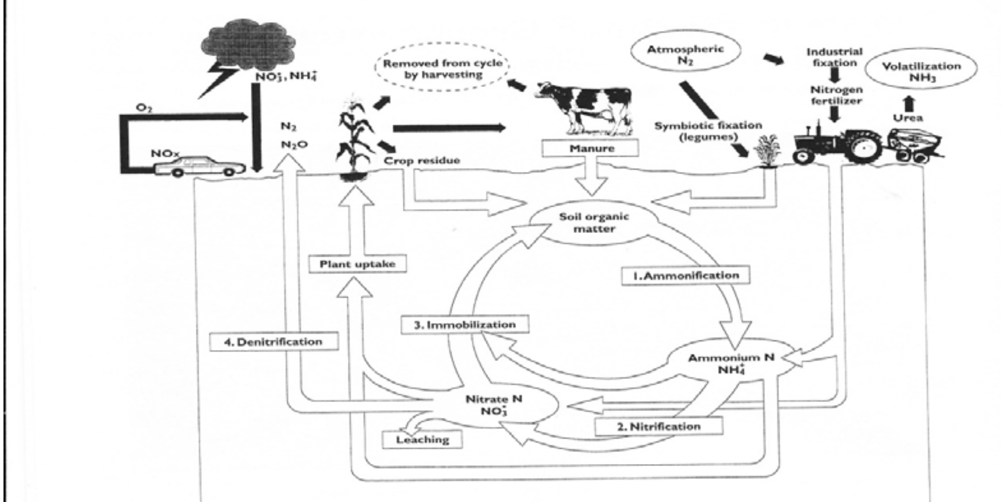

Figure 1. The nitrogen cycle.

20. Nitrogen contained in manure starts primarily in the organic nitrogen

[12] *Id*. at 8.

and ammonium form. Ammonium is then rapidly converted to nitrate if soil temperatures are above four degrees centigrade and aerobic conditions are present. Both nitrate and ammonium are available to plants and are important plant nutrients when properly applied. Nitrate, which is more mobile in soils than is ammonium, readily leaches through the unsaturated (vadose) zone of soil; in both the unsaturated and saturated zone, it can move at nearly the speed of migrating water. As a result of this high mobility, it is important that nitrates be applied only when plants have the ability to use it and only in amounts that a crop can completely utilize. Any residual nitrate present at the end of the growing season is susceptible to leaching from irrigation, precipitation, snowmelt, and further application. Fall rain, winter snowmelt, and early spring rain convey excess nitrate further into the soil before any plant growth can utilize it. Excess nitrogen present during the growing season is also susceptible to leaching from over irrigation, rainfall, and additional manure application.

21. Once nitrate leaches below the root zone of crops it is destined to reach groundwater, unless conditions suitable to denitrification exist in the soils. Denitrification is the conversion of nitrate to harmless nitrogen gas by bacteria or nitrogen oxides, a green house gas issue. It can only occur in poorly drained or organic soils where oxygen is depleted in the root zone. In the absence of denitrification, nitrate moves with the groundwater until the groundwater is discharged to surface water, or extracted from a well.

22. Denitrification is unlikely to occur in the soils underlying Cow Palace's agricultural fields. Within the approximate property boundary of the Cow Palace, six soil units have been mapped by the NRCS. All six soil units have a silt loam texture with a "well-drained" classification. Three of the soil units (Esquatzel, Shano, and Warden) represent approximately 81 percent of the surface area. These units have a saturated hydraulic conductivity in the range of 1.1 to 4.0 feet per day, which is characterized as "moderately high to high" in their capacity to transmit water. Two of the soil units (Burke and Scoon) represent approximately 19 percent of the surface area and have a saturated hydraulic conductivity in the range of 0.0 to 0.12 feet per day which is characterized as "very low to moderately low." One of the soil units (Finlay) represents less than 1 percent of the surface area and has a saturated hydraulic conductivity of 4 to 11.9 feet per day, which is characterized as "high."[13] The predominant soils present little potential for any loss of nitrate through denitrification.[14] The lack of any denitrification was verified by the EPA through nitrogen and argon gas

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[13] EPA Report, Appendix B at B-3.
[14] EPA Report, Appendix B at B-4.

analysis, which showed no evidence of denitrification.[15] In addition, the AOC monitoring data shows oxygen to be present in all monitoring wells which means nitrate is stable and little chance of denitrification in the aquifer.

23. The soils present in Cow Palace's application fields are all developed in alluvial deposits from erosion of the nearby "Rattle Snake Mountains" and all have a loess silt cap of varying thickness. The Warden soil dominates the soils, with Scoon in lower topographic positions and Finley along waterways. All the soils are well drained with Warden soil having a potential rooting depth in excess of 5 feet while the scoon has a rooting depth of less than 2 feet due to the development of a caliche layer. All soils have moderate to high permeability. Warden soil is identified as having a high hazard for soil runoff and erosion. The soil maps and area topography maps show a strong drainage pattern running from north east to south west through the application fields with several intermittent streams present.[16] The moderate slopes draining to the intermittent streams means there is a significant potential for runoff and pollution of downstream surface waters. The extremely high phosphorus concentrations found in all application fields along with winter spreading of manure make this potential very likely.

[15] EPA Report at p. 30.
[16] DAIRIES0016903.

24. Because denitrification is extremely unlikely in the soils underlying Cow Palace Dairy, any excess nitrogen or nitrate that moves past a crop's root zone – and therefore not used by the crop as fertilizer – will continue to migrate downward with water movement, eventually reaching groundwater.

25. Manure contains two primary forms of nitrogen: ammonium and organic nitrogen. The organic form of nitrogen is nearly immobile. It becomes mobile, and available to crops as fertilizer, through mineralization. Mineralization is the process by which soil microbes decompose organic nitrogen and release ammonium, which is then available as fertilizer for crops. The rate of mineralization varies with soil temperature, soil moisture, and the amount of oxygen in the soil. Cow Palace's DNMP recognizes this fact, noting that mineralization is "temperature, pH and moisture dependent" and that stating that "[a]lthough some nutrients are available immediately, a lag time between the time that organic material such as manure is applied to the soil and when its nutrients become available for crop use should be expected." It is for this reason why obtaining soil samples showing the level of plant-available nutrients *prior* to a manure application is required by the DNMP. [17] The total organic nitrogen is important because it will mineralize over time and become ammonium and then nitrate.

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[17] COWPAL000015.

26. After mineralization, microorganisms within the soil convert ammonium into nitrate. This process, called nitrification, occurs most rapidly when the soil is warm, moist, and well-aerated. Nitrates are a plant-available form of nitrogen for fertilization purposes, but as described above, are highly mobile and susceptible to leaching loss to groundwater. During winter months when soil temperatures drop below 50 degrees Fahrenheit, mineralization and nitrification slows until soil temperatures warm in the spring.

27. Some nitrogen contained in manure may be lost through volatilization, which is the loss of nitrogen through the conversion of ammonium to ammonia gas. After conversion, ammonia gas can be released into the atmosphere. Volatilization losses increase at higher soil pH and when weather conditions are hot and windy. Organic nitrogen is not lost through this process.

28. Facets of the nitrogen cycle are discussed in Cow Palace's DNMP. The DNMP's primary purpose is to "provide the dairy manager with Best Management Practices (BMP's) for the production, collection, storage, transfer, treatment, and agronomic utilization of the solid and liquid components of dairy nutrients in such a manner that will prevent the pollution or degradation of state ground waters and surface waters."

Adherence to the DNMP is intended to, among other things, "[p]revent the chance of contaminate migration from the dairy facility to the underlying aquifer," and to "agronomically recycle the nutrients produced through soil and crops."[18]

29. To accomplish these goals, the DNMP lays out the general "equation" that Cow Palace is required to follow to ensure that applications of manure wastes are "agronomic," or are calculated to provide the right amount of manure nutrients to fertilize a crop. The DNMP instructs Cow Palace to use the following information in determining an agronomic rate of application: (1) the nutrient value of the manure that is being applied to a field, including levels of organic nitrogen, ammonium, and phosphorus;[19] (2) post-harvest soil samples and, where double-cropping, both a spring post-harvest and a fall post-harvest sample;[20] (3) the infiltration rates of the soils to which manure is applied;[21] the soil moisture content of the soil, to evaluate the amount of liquid manure that be applied based on the water holding capacity of the soil;[22] (4) the nutrient needs of the crop planned to be grown, based on an average of crop yields for the last 3-5 years for each field;[23] and (5) the

[18] COWPAL000005.
[19] COWPAL000016.
[20] *Id.*
[21] COWPAL000018.
[22] COWPAL000018-19.
[23] COWPAL000015.

weather conditions 24-hours prior to and at the time of application, which can impact when, whether, and how manure is applied, as well as the amount of manure to apply.[24] Additionally, Cow Palace is required to keep track of how much irrigation water is applied to fields and to properly calibrate its manure application equipment.[25] Finally, it is important to recognize that the DNMP instructs Cow Palace to take soil samples *before* applying manure, so that the dairy manager knows what the residual nutrient levels in the field are before adding additional nutrients that the crop might not need or be able to use.[26]

30. The DNMP does not, however, require calculating a nutrient budget. A nutrient budget accounts for the residual nitrate of the soil, organic nitrogen mineralization rates, the amount of nitrogen applied through past applications, and any nutrient credits from past cropping systems. This also includes taking into account any alfalfa nitrogen credits that should be applied to a field. Recommendations for the Pacific Northwest state that nitrogen application rates should be reduced between 60-100 lbs./ac after an alfalfa crop is converted to corn, as the alfalfa roots decompose over time,

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[24] COWPAL000016; *see also* COWPAL000020-21; COWPAL000024.
[25] COWPAL000025 (weather records); COWPAL000020 (calibration).
[26] COWPAL000015.

causing additional nitrogen to be released into the soil.[27]

31. In my experience, such a nutrient budget is required by most nutrient management plans. Cow Palace's DNMP simply uses an estimated maximum crop yield to determine the amount of nutrients, including nitrogen, to apply for a given crop, without including any of the other sources of nutrients that are already present in the soil.

32. To demonstrate compliance with these requirements, the DNMP requires Cow Palace to "[m]aintain a record for each field showing the crop sequence, crop, soil test data, any tissue testing data, kind and amount of nutrients applied, special application practice, crop yields, and water applied." The records are to be maintained for the past five years.[28]

DISCUSSION AND OPINIONS:

COW PALACE HAS CONSISTENTLY APPLIED MANURE IN QUANTITIES THAT EXCEED AGRONOMIC RATES

33. I have reviewed the discovery information produced by Cow Palace concerning the Dairy's manure application records, including soil sampling data, application summary sheets, manure nutrient analyses, crop yield sheets, and application field logbooks. Based on my review of Cow Palace's records, which span over a decade, it is my professional opinion that Cow

[27] PNW 615, "Nutrient Management for Field Corn Silage and Grain in the Inland Pacific Northwest," February 2010.
[28] COWPAL000020.

Palace has consistently applied manure to its agricultural fields in amounts that exceed agronomic rates; that is, in amounts beyond that which crops could effectively utilize as fertilizer. As a result, nitrates have moved below crop root zones. Because conditions suitable for denitrification do not exist in the vast majority of Cow Palace's agricultural soils, these excess nitrates are destined to reach groundwater.

General Observations of Cow Palace Manure Application Practices

34. I have reviewed all field application, manure sampling, soil sampling, field application handbooks, and field summary spreadsheets provided by Cow Palace to Plaintiffs in this litigation. In my opinion, these records demonstrate that Cow Palace has not calculated whether the applications of manure to its fields are agronomic.

35. First, the vast majority of Cow Palace's records do not indicate the weather conditions at the time of application, a specific requirement of the DNMP and a necessary component of determining agronomic rates.[29] The specific weather conditions at the time of application impacts the amount of volatilization that occurs, the rate of absorption of applications into the soil, and the chances that an application causes manure liquid to runoff the field. Without this information, Cow Palace could not have accurately calculated

[29] COWPAL000020; COWPAL000024.

the amount of nitrogen and other manure nutrients its applications were placing onto fields for crop uptake as fertilizer.

36. Second, Cow Palace's records show the Dairy did not take post-harvest samples in the spring when double-cropping its fields, a requirement of the DNMP.[30] Failure to obtain post-harvest samples means that Cow Palace did not know the residual nutrient content of its soil after a crop had been removed; that is, it lacked information about how much nitrogen, phosphorus, and other manure nutrients the crop had actually used as fertilizer. This information is critically important for calculating agronomic rates, because the amount of extra plant-available nitrogen in the soil dictates how much manure the Dairy should apply to adequately fertilize the next crop. While the main focus of over application is nitrogen, phosphorus has also been regularly over-applied.

37. Along these lines, Cow Palace's manure application summary spreadsheets, which Cow Palace used to show compliance with its DNMP's requirement for agronomic manure applications, failed to take into account the fall, post-harvest residual nutrient levels in the soil when calculating the next year's application rates. Jeff Boivin, the manager at Cow Palace Dairy,

[30] COWPAL000016.

testified to this fact;[31] it is also apparent from the spreadsheets themselves that no prior soil sampling data was considered when determining a field's "N crop balance."[32] By failing to take into account the residual nutrient levels in soils, Cow Palace's nitrogen balance was never actually in balance, but instead resulted in excess nitrogen, nitrate, phosphorus, and other manure nutrients being applied to fields at rates greater than crops could use as fertilizer.

38. Fourth, Cow Palace also failed to vary its manure application rates based on realistic crop yields. The DNMP contains some general guidance on how much nitrogen, phosphorus, and potassium the crops planted by Cow Palace could use as fertilizer.[33] It cautions, however, that these amounts should be varied based upon the average crop yields from the past three to five years.[34] Crop yield and fertilization needs are closely related. A crop that has a high yield may indicate an unusually good growing season or presence of excessive nutrients, which can lead to environmental degradation. Extensive literature indicates that attempting to achieve maximum crop yields through fertilization often results in excessive nutrient

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[31] Mr. Boivin's deposition transcript admits this throughout. *See, e.g.*, Trans. at 352:6-8; 353:9-11.

[32] COWPAL000270-76 (2010 summaries); COWPAL000277-83 (2011 summaries); COWPAL000284-91 (2012 summaries); COWPAL00292-99 (2013 summaries); COWPAL015790-96 (2014 summaries).

[33] COWPAL000015.

[34] *Id.*

carryover, leaching, and runoff to surface waters. This is largely because nutrient use efficiency decreases with increasing yield. A lower crop yield often is a result of a poor growing season, which can be caused by a variety of environmental factors such as temperature, rainfall, wind, etc. In these years, there is the highest risk of excessive nutrient carryover, as crops do not remove all of the plant nutrients that were applied even if they were applied at the correct amounts. This is another reason to use long-term average yields when setting yield goals and not fertilizing for the maximum possible yield each year, as it appears Cow Palace has done.

39. Per the DNMP, when calculating agronomic rates, Cow Palace should have looked to its past crop yields to determine whether to increase or decrease the amount of manure to be applied to a field. Cow Palace's records contain no documentation that the Dairy ever varied its applications based on prior crop yields; instead, it appears that the Dairy always used the maximum capacity numbers found in the DNMP.[35] As a consequence, Cow Palace applied manure not based on actual crop needs but rather to maximize manure application, thereby placing more manure nutrients into the soil than the crops could effectively use as fertilizer.

40. Fifth, my review of Cow Palace's records shows that the Dairy never

[35] *See, e.g.*, COWPAL00292-99 (Cow Palace's 2013 field summary spreadsheets, which begin each year with the maximum nitrogen uptake capacity for each crop).

took manure nutrient sampling for all sources of manure applied to its fields, and grossly underestimated the nitrogen content of the manure that it did apply. The DNMP requires the Dairy to obtain nutrient sampling for all sources of manure *before* applications occur.[36] Cow Palace's field application logbooks frequently do not identify the source of the manure applied, and never identify the nutrient content of the manure. The field summary spreadsheets also do not state the source of the manure applied or its actual nutrient content. Instead, Cow Palace applied a generic, 1.5 lbs./1000 gallon nitrogen number for at least four years (from 2010-2013) without variation, to determine application rates – a number that, in my experience and based upon other nitrogen numbers I have seen at nearby dairies and nationwide, is very low for cow manure. In fact, when Cow Palace did take manure nutrient samples, it was usually from only one lagoon, and the sample was taken in the fall of each year, after the vast majority of manure applications had concluded. Manure nutrient concentrations can vary widely from lagoon to lagoon and throughout the year in any one lagoon.[37] Without knowing the actual nitrogen, phosphorus, and potassium content of each source of manure, Cow Palace lacked critical information necessary to calculate agronomic rates; one must know the

[36] COWPAL000015-16.
[37] *Compare, e.g.*, COWPAL009262 with COWPAL009270.

nutrient content of manure in order to determine how much manure to apply for fertilization purposes.

41. Along these lines, it appears that Cow Palace also overestimated volatilization rates. Cow Palace's manure manager testified that he used a generic, 50% volatilization rate in determining agronomic rates.[38] This 50% figure does not reflect reality. The following table illustrates how climatic conditions and the duration of time between application and incorporation into the soil are critical to estimating the amount of ammonia that is volatized. This is the type of information that should be used for nutrient management. Maximum utilization of manure nutrients occurs when manure is incorporated upon or soon after application. Moreover, the volatilization rates only apply to ammonia, not the entire nitrogen content of the manure. In some cases ammonia is only a small percent of the total nitrogen applied, such as the sample obtained from Cow Palace Lagoon 4 on September 11, 2013, where the recorded total nitrogen was 5.38 lbs./1000 gallons, while the ammonia content was only .5 lbs./1000 gallons.[39] In this example, even applying an exaggerated 50% volatilization rate would still provide 2.69 lbs./1000 gallons, or nearly 80% more nitrogen than calculated by Cow Palace using the generic 1.5 lbs./1000 gallons number.

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[38] *See* Boivin Trans., 256:19-257:9.
[39] COWPAL009247.

Estimated loss (%) of the ammonium-nitrogen fraction due to weather and soil conditions

Day after application	Average	Cool (<10°C)		Warm (>25°C)	
		Wet	Dry	Wet	Dry
Spring					
Incorporated within 1 day	25	10	15	25	50
Incorporated within 2 days	30	13	19	31	57
Incorporated within 3 days	35	15	22	38	65
Incorporated within 4 days	40	17	26	44	73
Incorporated within 5 days	45	20	30	50	80
Not incorporated	66	40	50	75	100
Injected	0	0	0	0	0
Fall					
Early fall applied	66	40	50	75	100
Late fall applied	25	25	25	N/A	N/A
Cover crop	35	25	25	40	40

Source: Ontario Ministry of Agriculture, Food and Rural Affairs, Agdex 538-3
Atta Atia, PhD.
Livestock Air Quality Specialist
Agriculture Stewardship Division
Alberta Agriculture and Food

42. Sixth, I have not seen any records documenting the irrigation water Cow Palace applies to its fields, thus making it difficult to determine impacts on leaching from irrigation practices. The DNMP requires the Dairy to keep "Irrigation Water Management Records" identifying the fields to which irrigation water was applied and the total quantity of water applied.[40] This is important information, because the timing and quantity of irrigation water that is applied to a field can have an effect on the transportation of nitrate through the soil. It is common practice to over apply irrigation water to

[40] COWPAL000025.

leach out soluble salts and prevent soil from becoming saline in dry areas like the Yakima Valley. Along with the removal of soluble salts, the process will also carry excess nitrate to groundwater. In fact, USGS has found that as a result of over irrigation in the irrigated parts of the Yakima Valley that groundwater recharge has exceeded groundwater pumpage by over 20 feet between 1960 and 2001.[41] The lack of irrigation records for Cow Palace makes it impossible to know what their irrigation practices have been, although the soil samples and other information discussed *supra* leave no doubt that nitrate leaching has occurred and will continue to occur. Cow Palace also appears to have used rill irrigation in the past, which is less efficient than sprinkler irrigation.

43. Seventh, the crop yield goals and removal rates contained within Cow Palace's DMNP are set at very high levels without any documentation that they have ever been achieved by the Dairy. While the DNMP instructs Cow Palace to set realistic and achievable crop yield goals, the removal rates identified in the DNMP appear to be for the highest yields ever achieved in the state of Washington and are not reasonable goals to use in an environmentally sound nutrient management plan.

44. Most of the yield numbers contained in Cow Palace's DNMP appear

[41] Vaccaro, et al. (USGS 2009).

to be based on nitrogen removal by crops on a dry matter basis. In my experience, all forage crops are allowed to dry down a day or so in the field before they are removed from the field, but are not delivered to the farm on a dry weight basis. That is, there is still sufficient moisture within the crop for a wet-ton basis to be used. In fact, for use as silage, a higher moisture content is needed for the effective silage decomposition to take place.

45. The very limited amount of crop yield data presented by Cow Palace is for weights of silage material as delivered to the farm directly from fields. Using these fresh yield numbers for silage and the United States Department of Agriculture ("USDA") Crop Nutrient tool for crops grown gives a much more accurate prediction of the number of pounds of nitrogen and phosphorus removed by the crops harvested by Cow Palace. Using the Crop Nutrient tool from the USDA shows the following values, which are far more realistic than those contained in the DNMP:

- Corn Silage 7.75 lbs./ac nitrogen and 2.26 lbs./ac phosphorus, at 77% moisture, per ton. These values are close to what is contained within the DNMP;
- Alfalfa for silage 15.5-18 lbs./ac. nitrogen and 1.7 lbs./ac phosphorus, at 77% moisture, per ton;
- Sorghum/sudan grass silage 7.2 lbs./ac nitrogen and 1.53

lbs./ac phosphorus, at 74.5 percent moisture, per ton;

- Triticale-*Wheat- green chop 10.2-12.2 lbs./ac nitrogen and 1.64 lbs./ac phosphorus at 73.5 % moisture, per ton.

46. While there is no data specific for triticale, the literature I have reviewed indicates that nutrient content of forage from all cereal grains, i.e., wheat, oats, triticale, rye, etc., are all very similar in nutrient removal per ton.

47. Using the numbers above and yield data from Cow Palace indicates that the Dairy is greatly overestimating the nutrient removal from most of their crops, with the possible exception of corn silage, and even this was based on only one year's data from one field.

48. In sum, my general opinion after reviewing Cow Palace's records is that the Dairy has failed to comply with its DNMP's requirements for calculating agronomic rates. Cow Palace has not recorded or obtained the correct information and has failed to properly use the information at its disposal to determine application rates that could provide the proper amount of manure nutrients necessary to adequately fertilize a crop. Because of these shortcomings, Cow Palace has not agronomically applied manure to its fields, as demonstrated by consistently high soil sample results for nitrate, phosphorus, and potassium. In my opinion, these high results show that

Cow Palace's crops have not used the manure nutrients being supplied as fertilizer. The conclusions of the laboratories and consultants used by Cow Palace and the Plaintiffs to analyze samples also confirm my opinions.[42] Consequently, excess manure nutrients, especially nitrate, migrate beyond crop root zones with precipitation, further applications, and irrigation, where they will eventually discharge to groundwater.

49. Before 1997, Cow Palace did not take soil samples, manure nutrient samples, or other analytical data for its manure. Applications were made based upon a field man's judgment only.[43]

50. In the following sections, I explain how Cow Palace has over-applied manure for each of Cow Palace's agricultural fields, in chronological order by field. A summary of Cow Palace's agricultural fields' soil sampling results I have reviewed is attached hereto as Exhibit 2.

Cow Palace Field 1

51. Cow Palace Field 1 is located south of Cow Palace Dairy, just beneath a series of three lagoons, and is bordered to the south by Cow Palace Field 2

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[42] *See, e.g.*, COWPAL009292-94, COWPAL009296, and COWPAL009298 (reports on September 2013 samples from Cow Palace application fields noting that "residual nitrates are high"); CARE029385-91, CARE029428-30, CARE029435-59 (reports on May 2014 samples from Cow Palace application fields noting nitrate levels in "excess" or "above optimum.").

[43] *See* Porter Trans., 20:8-22:18.

and to the east by Cow Palace Field 3.[44] The field is between 69 and 75 acres in size, depending upon which document one examines.[45] The soil underlying the field is "warden silt loam,"[46] which is a well-drained soil.[47]

52. Cow Palace does not possess records of crop yields, crop types, application amounts, irrigated water applied, or other data for Field 1 from 1998 to 2004. The only records in existence for this time period are annual and, sometimes, semi-annual soil sampling results.

53. On August 15, 2001, Cow Palace had the soils tested in the 0-12 inch soil column depth in Field 1 "South" and Field 1 "North." It appears, but it is unclear, given the time of year, that these were post-harvest samples. For purposes of opinions about year 2001 applications, I assume the sampling was post-harvest. At that time, Field 1 South had residual nitrate levels, or NO3-N, of 132 lbs./ac, and residual ammonium levels, or NH4-N, of 16 lbs./ac. In total, this means that there were 148 lbs./ac NO3-N + NH4-N available in the first foot for plant use. Field 1 North had residual nitrate levels, or NO3-N, of 202 lbs./ac, and residual ammonium levels, or NH4-N, of 11 lbs./ac. In total, this means that there were 213 lbs./ac NO3-N + NH4-

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[44] DAIRIES0002524 (Figure 3 to Cow Palace Application Field Management Plan); *see also* COWPAL000031.

[45] *Compare* DAIRES002516 (Application Field Management Plan, 69 acres) to COWPAL000031 (DNMP, 75 acres).

[46] *See, e.g.*, DAIRIES008805; COWPAL000043.

[47] COWPAL000018.

N immediately available in the first foot for plant use.[48] In my opinion, these are high residual nitrogen levels for a post-harvest field. They strongly indicate that more manure and, consequently, more nitrogen, was applied to the field than what the crop could utilize as fertilizer.

54. In addition to these forms of nitrogen, the total organic matter available on the field will release additional plant-available nitrogen over time. Total organic matter releases additional nitrogen fertilizer over time through biological processes. Organic matter is composed primarily of rather stable material called humus that has collected over a long period of time. Easily decomposed portions of organic material disappear relatively quickly, leaving behind residues more resistant to decay. Soils contain approximately 2,000 pounds of nitrogen in organic form for each percent of organic matter. Decomposition of this portion of organic matter proceeds at a rather slow rate and releases about 20 lbs./acre/year nitrogen for each percent of organic matter present in the soil.[49] Cow Palace should be using a credit for the amount of nitrogen released by organic matter in its soils, but the records I have seen indicate this is not the case for any of Cow Palace's fields.

[48] COWPAL010640.
[49] Mike O' Leary, George Rehm and Michael Schmitt, "Understanding nitrogen in soils," University of Minnesota Extension Service, 2014.

55. Considering that Cow Palace's DNMP indicates that double-cropping on Field 1 only began in 2013,[50] there would have been no winter crop planted to make use of this excess nitrogen in the fall-winter of 2001, meaning excess nitrates, due to their high mobility, would have migrated downward into the soil with further applications, irrigation, snowmelt, and precipitation. Once they moved passed the crop root zone, they were destined to reach groundwater. If a winter crop was planted in Fall 2001, then it failed to utilize the available nitrogen in the soils as evidenced by the high Spring 2002 nitrogen levels, as discussed below in Para. 59.

56. The Washington State Department of Agriculture ("WSDA") has informed dairies east of the Cascades that they should be targeting post-harvest soil nitrate results of less than 120 lbs./ac in the top foot of the soil column in order to minimize nitrate leaching.[51] The AOC discusses Cow Palace "achieving" a residual nitrate level of 45 mg/l at the two-foot soil depth level.[52] Forty-five mg/l of NO3-N at the two-foot depth is the equivalent of 157 lbs./ac, and does not consider the amount in the surface foot or deeper soil layers. 157 lbs./ac nitrogen is more nitrogen than is needed for fertilization by some of Cow Palace's crops.

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[50] COWPAL000010.
[51] McCarty Trans. at 59:19-60:14.
[52] AOC at App. B, "Statement of Work," ¶ F.1.d.

57. In my opinion, both of these numbers are too high and are not protective of the environment or of groundwater. Instead of using "target" figures, a nitrogen budget approach should be used, with a ban on applications if there is more than 175 lbs./ac or an average of 25 mg/l nitrate present in the top two feet of the soil column. This method allows additional nitrogen application only when the amount already present in the top two feet (as documented in soil samples), plus the amount of nitrogen that should be credited from previous manure applications, crops and soil mineralization, do not meet actual crop needs. This approach has been recommended by Marx, et. al and Sullivan and Cogger of Oregon State.[53]

58. The 2001 results from Field 1 indicate that residual nitrate levels (132 and 232 lbs./ac) are higher than both the target levels established by the EPA and the WSDA. These concentrations, if expressed as mg/l in soil solution using a modest 25 percent soil moisture content,[54] would translate into 151mg/l Nitrate N in the soil water in the surface foot and 265 mg/l in the second foot. These are obviously well above the nitrate standard of 10 mg/l. It should only take a small portion of this amount of nitrate loading to result

[53] Marx, E.S., J. Hart and G. Stephens, Soil Test Interpretation Guide, Oregon State University Extension Service, E.C. 1478 (1999); Sullivan, D.M. and C.G. Cogger, Post-harvest Soil Nitrate Testing for Manured Cropping Systems West of the Cascades, Oregon State University Extension Service, EM8832-E (2003).

[54] The soil nitrate concentration in parts per million (ppm) expressed on a dry weight basis divided by the decimal % water = ppm nitrate in soil water. Soil Quality Indicators – Available Water Capacity, NRCS 2008.

in groundwater contamination above the MCL standard of 10 mg/l.

59. On March 6, 2002, Field 1 was sampled again; the soil test report does not identify whether the sampling occurred on the north or south of the field, so I assume the entire field was sampled. At that time, Field 1 had residual nitrate levels, or NO3-N, of 260 lbs./ac, and residual ammonium levels, or NH4-N, of 12 lbs./ac. In total, this means that there were 272 lbs./ac NO3-N + NH4-N available for plant use, in the 0-12 inch soil column depth.[55] I do not know if a winter crop was planted on Field 1 at this time, but it is obvious that the increase in soil nutrient levels resulted from additional nitrogen input above and beyond any crop removal rate. The increase in soil nitrate levels is also more than I would expect to see from soil organic matter mineralization over winter. If Cow Palace did apply manure, then the application(s) subsequent to the August 2001 sample were not agronomic, as there were already excessive nitrogen levels in the soil to fertilize a crop, considering that the winter crop post-harvest sample still had 260 lbs./ac of nitrate available in the surface foot alone.

60. Cow Palace did not take any fall, post-harvest samples from Field 1 in 2002. This is a violation of Cow Palace's DNMP, which requires the Dairy

[55] COWPAL010642.

to take annual, post-harvest soil samples,[56] so the manure manager can plan future manure applications based upon the residual soil nitrate levels are in the fields.

61. There were also no Spring 2003 soil samples taken from Field 1.

62. In my expert opinion, if Cow Palace applied manure between Fall 2002 and Fall 2003, then it was doing so without having the requisite information to know whether its manure applications were agronomic. Without soil samples, a manure manager would not know whether the fields already have sufficient nutrient levels to fertilize a crop. As such, any applications that occurred during this time were non-agronomic. Indeed, that the Fall 2003 soil sample (discussed in Para. 63, *infra*) came back high suggests that manure applications during this time frame exceeded agronomic rates, because more nitrates were placed onto the field than what the crop utilized as fertilizer.

63. Field 1 was sampled twice in the fall of 2003, once on September 25 and again on October 21. On September 25, Field 1 had residual nitrate level of 150 lbs./ac, and residual ammonium level of 13 lbs./ac. In total, this means that there was 163 lbs./ac NO3-N + NH4-N available for plant use, in

[56] COWPAL000016.

the 0-12 inch soil column depth.[57] In my opinion, this is a high residual soil nitrate result heading into the fall months. Again, I do not have information about whether Cow Palace planted a winter crop on Field 1 at that time. If no winter crop were planted, then the excess nitrates in Field 1 would have migrated downward into the soil with further application, irrigation, snowmelt, and precipitation. Once they moved passed the crop root zone, they were destined to reach groundwater. If a winter crop was planted, then it failed to utilize the available nitrogen in the soils, as discussed below in Para. 65.

64. On October 21, 2003, Field 1 was sampled again. This time, Field 1 had residual nitrate level of 94 lbs./ac, and residual ammonium level of 14 lbs./ac. In total, this means that there was 108 lbs./ac NO3-N + NH4-N available for plant use. This sample, however, was taken at the 12-24 inch soil column depth, which is one foot lower than the September sample.[58] In my expert opinion, any winter crop planted on this field (if there was one) would have been able to use little, if any, of the nitrates found at this soil column depth. This is because it takes time, weeks to months, for a new crop to develop roots that reach down below the one-foot level. This is especially true for winter forage crops such as triticale. In fact, most of the

[57] COWPAL010645.
[58] COWPAL010644.

crops grown at Cow Palace, such as corn and triticale, do not have root systems that effectively extend beyond two-feet into the soil column at any time.[59] As a result, it is likely that the nitrates found in the 12-24 inch soil column depth in October 2003 were not used, or were not capable of being used, by any crop as fertilizer, but instead migrated deeper into the soil with further applications, irrigation, snowmelt, and precipitation, eventually discharging to groundwater. That this level of nitrates was observed at the two-foot level also indicates that manure applications in 2003 were not agronomic, for they resulted in more nitrogen and nitrates being applied to the field than what the crop used as fertilizer.

65. On March 31, 2004, Field 1 was sampled at both the 1-foot and 2-foot soil column depths. At the 0-12 inch soil column depth, Field 1 had residual nitrate levels, or NO3-N, of 150 lbs./ac, and residual ammonium levels, or NH4-N, of 17 lbs./ac. In total, this means that there was 167 lbs./ac NO3-N + NH4-N available for plant use. At the 12-24 inch depth, Field 1 had a residual soil nitrate level of 198 lbs./ac. No ammonium sample was taken at this depth.[60] While I do not have information concerning whether a winter crop was planted on Field 1 between 2003-2004, the fact that the overall

[59] *See. e.g.*, DAIRIES016901 (Arcadis conceptual site model, identifying root zone as 0-24 inches).
[60] COWPAL010647.

residual nitrate levels went up from what was observed in September and October 2003 (150 and 94 lbs./ac nitrate, at the 1 and 2 foot level, respectively) indicate that Cow Palace made additional manure applications between October 2003 and March 2004, the timeframe in which the DNMP cautions the Dairy to avoid manure applications in order to protect against discharges to ground or surface waters.[61] These data also indicate that such applications exceeded agronomic rates, because nutrient levels were higher after the winter season at both the one- and two-foot soil column depths, indicating that even if a winter crop had been planted, and there is no information to determine whether one was planted, any crop did not utilize much of the nitrogen as fertilizer. Moreover, the 198 lbs./ac nitrate results from the two-foot level are further evidence of the over-application of manure, because it is unlikely that a crop planted in Spring 2004 would be able to grow roots fast enough to make use of all that nitrate as fertilizer prior to the nitrate moving deeper into the soil profile; plants tend to use the nutrients in the surface foot of the soil column, where the root density is much greater. Consequently, it is likely that these excess nitrates migrated deeper into the soil column, eventually making their way to groundwater.

66. No post-harvest soil samples were taken by Cow Palace in Fall 2004.

[61] COWPAL000017.

This is a violation of Cow Palace's DNMP.[62] Any manure applications that took place subsequent to the spring/summer crop being removed were therefore conducted without having the requisite information to make a determination of agronomic rates.

67. Cow Palace sampled Field 1 on March 2, 2005. The sample was taken at the 0-12 inch soil column depth, and revealed a residual nitrate value of 320 lbs./ac and a residual ammonium value of 14 lbs./ac, for a total of 334 lbs./ac available nitrogen for fertilization.[63] In my expert opinion, this is a very high residual nitrate level coming out of the winter months. Based on the fact that Cow Palace did not take any soil samples post-harvest in 2004, it is likely that the Dairy did not know how much manure to apply to provide the winter crop (if any – again no documentation that one was planted) with its fertilization needs. As a result, considering how high the residual nitrate value is for this sample, Cow Palace's manure applications on Field 1 in 2004 were non-agronomic, because they provided more nitrate than any planned crop could reasonably be expected to utilize as fertilizer. Moreover, 320 lbs./ac of nitrate should be more than sufficient to fertilize Cow Palace's planned spring/summer crop for 2005.

68. Cow Palace's documents state that the Dairy may have begun planting

[62] COWPAL000016.
[63] COWPAL010646.

alfalfa on Field 1 in May of 2005.[64] According to the Dairy's DNMP, an alfalfa crop has the capacity to utilize up to 480 lbs./ac of nitrogen. The DNMP instructs the Dairy to apply this nitrogen in three equal amounts in early spring, the beginning of June, and mid-August.[65] In my expert opinion, the reason for this requirement is to minimize the potential for nitrogen and nitrate leaching, as an alfalfa crop is unlikely to be able to effectively use an entire, one-time application of 480 lbs./ac of nitrogen as fertilizer, meaning excess nitrates will move deeper into soils and eventually groundwater. This amount would only be used if the maximum yield of 30 ton per acre were achieved. The limited yield data does not suggest the Dairy is achieving this yield. This also assumes that the crop is not using any mineralized nitrogen from the soil, carry over nitrogen, or nitrogen fixed from the atmosphere, which alfalfa does very well. I also believe that, based on my experience and on the literature and crop removal estimates I have seen, 480 lbs./ac is an excessive estimate for the amount of nitrogen removed by alfalfa.

69. Cow Palace's hand-written field application logs state that the Dairy applied liquid manure to Field 1 between May 8, 2005 and May 13, 2005 from a wheel line at a rate of either 800 or 900 gallons per minute

[64] COWPAL010655. This document identifies "alfalfa" as the crop, and then contains soil sample results for Fields 1, 2, and 5. *See also* COWPAL000345.
[65] COWPAL000015.

("GPM").[66] Nowhere on this document is there an indication of whether or how Cow Palace determined the nutrient needs of Field 1's alfalfa crop based on the average of the last three to five years' crop yield, as instructed by the DNMP.[67] Additionally, I have not seen any records from Cow Palace stating the nutrient content of the manure that was applied to Field 1 at this time, or for any time during 2005. I have seen a June 23, 2004 manure nutrient sampling document from Cow Palace, which states that the Total Nitrogen content of manure sampled from the "lagoon" was 9 lbs./ton, or 33.7 lbs./1000 gallons.[68] The application log book does not state the time at which application began on May 8, 2005, the specific lagoon from which the manure was sourced, or the manure nutrient content. Assuming, however, that: (1) the wheel lines continuously applied manure for five days (there is no indication that they were shut off); (2) 50% of the nitrogen content of the manure volatilized during application; (3) Field 1 is 75 acres; and (4) the nitrogen content of the manure was *half* that as reported one year prior from Cow Palace's lagoons, these applications placed down nearly 647 lbs./ac of nitrogen, far in excess of what the alfalfa crop could effectively utilize.[69] In

[66] COWPAL000345.
[67] COWPAL000017.
[68] COWPAL009722.
[69] 5 days X 24 hours X 60 minutes X 800 GPM / 75 acres = 76,800 gallons/ac. 76,800 gallons X 33.7 lbs. of nitrogen / 1000 gallons = 2,588.16 lbs./ac total. Divide this number by two (one-half of 2004 manure nitrogen estimate) and two again (50%

my opinion, and based on the soil sample that followed, these applications were not agronomic, applying more nitrogen and nitrate on the ground than the crop could effectively utilize as fertilizer.

70. On June 23, 2005, Cow Palace received a soil sample result for Field 1. That sample indicated that, at the 0-12 inch soil column, Field 1 had 300 lbs./acre of nitrate. At the 12-24 inch soil column depth, the Field had 248 lbs./ac nitrate. In total, Field 1 had 548 lbs./ac nitrate, and 648 lbs./ac of plant available nitrogen for fertilization in the top two feet, according to the sampling report.[70] This soil sample result indicates that the May 8-13 applications to Field 1 were not agronomic. As described above, Cow Palace's DNMP states that an alfalfa crop has the *capacity* to use 480 lbs./ac of nitrogen, but only if applied in three equal amounts spaced throughout the growing season. This soil sample indicates that, as of the middle of the growing season, Field 1 had 648 lbs./ac of available nitrogen, or 168 lbs./ac *more* than what the alfalfa crop could use during the *entire* growing season. As Cow Palace's records state, the Dairy did not evenly space out its applications to this field in either quantity or time. Such a high soil

volatilization estimate) presents an estimate of 647.04 lbs./ac total nitrogen. I have calculated strongly on the conservative side. For instance, I expect to see far less than 50% volatilization, and I suspect, given the high residual nitrate numbers, that the manure nutrient content of Cow Palace's manure was comparable to the 33.7 lbs. of nitrogen/1000 gallon reported one-year prior.

[70] COWPAL010648.

nitrate/nitrogen test means the manure applications made by Cow Palace preceding this soil test were not calculated to be agronomic nor even in timing or amount, as the DNMP instructs for alfalfa crops. Consequently, it is highly likely that the alfalfa crop did not make use of all the available nitrogen and nitrate contained in Field 1 at this time, meaning that excess nitrate not used by the crop as fertilizer migrated further down into the soil, eventually making its way to groundwater.

71. Cow Palace did not take a fall, post-harvest sample on Field 1 at the end of the 2005 growing season. Cow Palace therefore lacked the necessary information to determine if its alfalfa crop had utilized all of the nitrogen and nitrate applied to the field during the year. Despite not having this information, Cow Palace's hand-written manure application records state that Field 1 had manure applied to it between November 14-15, 2005; January 5, 2006; and January 19-20, 2006.[71] In the absence of soil sampling information or manure nutrient sampling information from Cow Palace's lagoons, the Dairy lacked the necessary information to determine whether these applications were providing nutrients to the alfalfa crop that it could actually utilize as fertilizer. Additionally, Cow Palace's DNMP cautions that the Dairy should avoid manure applications from November through

[71] COWPAL000345.

March, for there is an increased chance of discharge to ground or surface waters. Winter applications should only occur when soil moisture conditions are suitable, and "agronomic needs as reflected in annual soil testing" show a need for additional nutrients.[72] Furthermore, crop growth is very slow during the winter months, increasing the likelihood that nutrient applications will not be used by the crop, which in turn will cause manure nutrients to leach through soil and into groundwater.

72. The hand-written application records discussed above do not state whether or how Cow Palace varied the amount of nutrients applied based on the average of the previous three to five years' crop yield from Field 1, the specific lagoon from which the manure was sourced, the manure nutrient content of that manure, or the weather conditions at the time of application. This is the type of information that is necessary to calculate what rate of application is agronomic, and is required by the DNMP.[73]

73. On May 15, 2006, Cow Palace took a soil sample of Field 1. That sample indicted that there were 90 lbs./ac nitrate and 31 lbs./ac ammonium in the top one foot, and 77 lbs./ac nitrate and 27 lbs./ac ammonium in the second foot. In total, Field 1 had 225 lbs./ac available plant nitrogen in the top two feet of the soil column for the alfalfa crop. In addition to the high

[72] COWPAL000017.
[73] COWPAL000024.

nitrate levels, the extremely high phosphorus and potassium levels further verify that manure overapplication was taking place.[74] Agronomically, this means that Field 1 only required a *maximum* of 255 lbs./ac of plant available nitrogen to fertilize the alfalfa crop for this growing season, spread evenly between three applications. If this occurred, then I would expect Cow Palace's fall, post-harvest sample from 2006 to have low residual nitrate levels (which it did not).

74. Cow Palace applied manure on Field 1 between August 14-23, 2006, according to the Dairy's manure application records. These records do not state whether or how Cow Palace varied the amount of nutrients applied based on the average of the previous three to five years' crop yield from Field 1, the rate at which manure was applied, the nutrient content of the manure that was applied, or the weather conditions at the time of application.[75] This is the type of critical information needed to calculate agronomic rates of manure application, and is required by the DNMP.[76]

75. Cow Palace took a post-harvest sample on Field 1 on September 27, 2006. The results of that sampling were that Field 1 had 96 lbs./ac nitrate and 18 lbs./ac ammonium in the top foot of the soil column, and 122 lbs./ac

[74] COWPAL010655.
[75] COWPAL000345.
[76] COWPAL000024.

nitrate and 14 lbs./ac ammonium in the second foot. This means that Field 1 had a total residual nitrate level of 218 lbs./ac, and a total residual nitrogen level of 250 lbs./ac. Phosphorus and potassium levels both increased from the spring 2006 test as well. Based on these results, Cow Palace did not agronomically apply manure during the 2006 growing season to Field 1. As explained above, Field 1 already had a total of 255 lbs./ac available for fertilization as of May 2006. If manure had been applied at a rate in which the alfalfa crop would utilize the available nitrogen as fertilizer, then I would expect the fall sample to be much lower than a combined total of 250 lbs./ac. I would also expect that the residual nitrate levels in the second foot (122 lbs./ac) would be less. Based on this high, post-harvest result, it is likely that the excess nitrate, especially that found in the second foot, was not used as fertilizer, but instead migrated further into the soil with further application, irrigation, snowmelt, and precipitation, eventually discharging to groundwater.

76. Cow Palace sampled Field 1 again on February 27, 2007. That report found that there were 214 lbs./ac nitrate and 42 lbs./ac ammonium in the 0-12 inch soil column depth, and 190 lbs./ac nitrate and 34 lbs./ac ammonium at the 12-24 inch depth. Residual phosphorus and potassium were also high, at 216 ppm and 959 ppm, respectively. In total, Field 1 had 404 lbs./ac of nitrate available in the top two feet, and a total of 480 lbs./ac total nitrogen available in the top two feet.[77] While Cow Palace's manure application records show no recorded manure applications to Field 1 between August 2006 and May 2007,[78] it is likely that additional applications were made over the winter of 2006-2007, considering that the residual nitrate and nitrogen levels *increased* from the September 27, 2006, fall post-harvest soil sample. These applications were not agronomic, given that (1) they occurred during the winter months, when crops are unlikely to fully utilize manure nutrients, and (2) the alfalfa crop had been more than adequately fertilized the preceding year. In fact, the top two feet of the soil in Field 1 already had the maximum amount of nitrogen that an alfalfa crop could be expected to use for an entire season under optimal circumstances, making any further manure applications during the 2007 crop year excessive.

77. Despite having adequate nitrogen to fertilize the alfalfa crop (per the DNMP nitrogen removal estimate), Cow Palace applied manure in 2007 to Field 1 on May 15-26; June 19; June 27; and November 5. The application record does not state whether or how Cow Palace varied the amount of nutrients applied based on the average of the previous three to five years' crop yield from Field 1, the rate at which manure was applied, the specific

[77] COWPAL010657.
[78] COWPAL000345, 344.

source of the manure, the nutrient content of that manure, or the weather conditions at the time of application.[79] This is the type of information necessary for calculating agronomic rates, and is required by the DNMP.[80] The only manure nutrient sampling Cow Palace possessed for these applications was from October 9, 2006, which indicated that this manure had a total nitrogen content of 7.8 lbs./1000 gal.[81] There is no identified manure source on this document as well. Considering the already high nutrient levels in Field 1's soils based on the February 2007 soil sample, these applications were not agronomic. They applied more manure nutrients to a field that did not require additional nitrogen or phosphorus for crop fertilization.

78. As a result, Field 1 had, again, a high residual nitrate level documented by the 2007 post-harvest soil sample. That sample, taken on October 17, 2007, indicates that Field 1 had 188 lbs./ac nitrate and 20 lbs./ac ammonium in the top foot of the soil column, and 200 lbs./ac nitrate and 16 lbs./ac ammonium in the second foot. This means there were 388 lbs./ac residual nitrate and a total of 424 lbs./ac nitrogen in the top two feet heading

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[79] COWPAL000344.
[80] COWPAL000024.
[81] COWPAL009270.

into winter.[82] The results also showed 158 ppm phosphorus and 1022 ppm potassium. These are very high residual numbers for a post-harvest field, indicating that the applications of manure to this field in 2007 provided far more nutrients than what the crop could effectively utilize as fertilizer. Some portion of these excess nitrates likely migrated down into the soil with further application, irrigation, snowmelt, and precipitation, eventually discharging to groundwater.

79. In the winter of 2007, Cow Palace began planting Field 1 in a triticale/corn double-crop rotation.[83] According to Cow Palace's DNMP, a triticale crop has the capacity to use up to 250 lbs./ac nitrogen for fertilization purposes.[84] Based on Cow Palace's post-harvest 2007 soil sample, there was more nitrogen available for the triticale crop than it had the capacity to use (250 lbs./ac vs. 424 lbs./ac total).

80. Cow Palace's DNMP requires the Dairy to take a post-harvest sample after a winter crop is harvested if double-cropping a field.[85] This way, the manager at Cow Palace knows how much manure nutrients the winter crop used, and how much residual nutrients are available for the next crop to be planted. I have not seen any records from Cow Palace for a Spring 2008

[82] COWPAL010662.
[83] COWPAL003172.
[84] COWPAL000015.
[85] COWPAL000016.

post-harvest soil sample after the triticale crop was harvested.

81. Because Cow Palace did not take a post-harvest sample after the triticale was harvested, the Dairy did not know what the residual nutrient levels were in Field 1. It therefore lacked one of the primary pieces of information necessary to calculate an agronomic application of manure. Nonetheless, Cow Palace applied manure to Field 1 over June 16-22 and July 1-10, 2008.[86] At this time, Cow Palace had planted sudan grass on Field 1.[87] These hand-written application records do not state whether or how Cow Palace varied the amount of nutrients applied based on the average of the previous three to five years' crop yield from Field 1, the specific lagoon from which the manure was sourced, the nutrient content of that manure, or the weather conditions at the time of application. This is the critical information that is necessary to calculate what rate of application is agronomic, and is required by the DNMP.[88]

82. Cow Palace did not take a post-harvest soil sample after it harvested its sudan grass in 2008, according to its records. The Dairy instead planted triticale around August 25, 2008, and proceeded to apply manure – again without knowing the residual nutrient content of the soil – from August 25

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[86] COWPAL000343-344.
[87] *Id.*
[88] COWPAL000024.

through September 2.[89]

83. The Dairy then took a soil sample from Field 1 on September 5, 2008. At that time, Field 1 had 238 lbs./ac nitrate and 31 lbs./ac ammonium in the top 0-12 inches of the soil column, along with an additional 12 lbs./ac nitrate in the 12-24 inch depth.[90] In the top foot, there was a total of 269 lbs./ac available nitrogen for fertilization. The results also showed 156 ppm phosphorus and 1384 ppm potassium, which are also very high residual nutrient amounts following a crop harvest. The triticale crop therefore had more than enough nitrogen available in the top foot for fertilization purposes before application, considering that triticale, according to the DNMP, has the capacity to use a maximum of 250 lbs./ac nitrogen. Based on the literature I have reviewed and on Cow Palace's own harvest data, I believe this number is excessively high. There is no data to substantiate these high estimates for any of the crops they grow. The US Department of Agriculture ("USDA") has a website on crop nutrient removal for most crops and shows that 6 ton of wheat green chopped would remove 74 pounds of nitrogen.[91] This is about the yield average for Cow Palace. Similar calculations for crops grown show much lower crop removal values than they used from their

[89] COWPAL000342.
[90] COWPAL010667.
[91] *See* https://plants.usda.gov/npk/main.

DNMP.

84. Cow Palace did not stop applying manure after receiving this soil sample. Instead, the Dairy applied manure every day between September 17 and September 26, 2008, with the exception of September 21.[92] The application field logs, once again, do not state the weather conditions at the time of application, soil moisture conditions the nutrient content of the manure that was applied, or whether or how Cow Palace varied manure applications based on prior crop yields. Without this information, Cow Palace could not have calculated an agronomic rate of application. Based on the already sufficient nitrogen levels documented in the soils in September 2008, these subsequent applications were not agronomic, and instead placed further excess nitrate and nitrogen into the soil that could not be used for fertilization purposes by the triticale crop. Similar to what I have explained above, it is highly likely that excess nitrates thereafter leached further into the soil with further application, irrigation, snowmelt, and precipitation, eventually passing beyond the crop root zone. At that point, the nitrates are destined to discharge to groundwater.

85. According to the records I have reviewed, Cow Palace did not take a post-harvest sample after the triticale was harvested from Field 1 in 2009.

[92] COWPAL000341.

As a result, the Dairy did not know what the residual nutrient levels were in Field 1, and it therefore lacked one of the primary pieces of information necessary to calculate an agronomic application of manure.

86. Cow Palace applied substantial amounts of manure to Field 1 without knowing how much nutrients, including nitrogen, were already contained within the soils. Four wheel-lines were used on Field 1 every day between June 4 and June 12, 2009, in four-hour sets; two sets were run each day.[93] The application records again do not state the weather at the time of application, whether or how the application was varied based on previous crop yields, or the nutrient content of the manure being applied. In fact, Cow Palace did not take any manure nutrient sampling of the manure it applied before this application; instead, it sampled the manure months later, on September 25, 2009. Those results do not state the source of the manure that was sampled, but report a nitrogen content of 1.47 lbs./1000 gallons of liquid manure.[94] This is a low number; liquid cow manure typically has a higher nitrogen content. These applications were not agronomic, because Cow Palace did not know what the residual nutrient content of the soil was, and therefore did not know how much more nitrogen the sudan grass crop needed for adequate fertilization. The above-referenced USDA website lists

[93] COWPAL000340.
[94] COWPAL009251.

a value of 6 to 7 pounds of nitrogen removed per ton of harvested sudan grass for silage. Cow Palace's records indicate that the 2009 sudan grass harvest from Field 1 yielded 8.3 tons/acre, which according to the USDA means that the crop only removed around 60 lbs./acre of nitrogen, nowhere near the 275 lbs./acre value identified in the DNMP.

87. Cow Palace continued to apply manure to Field 1 from July 30, 2009 through August 9, 2009, with the exception of August 2.[95] Again, the application records do not state the weather conditions at the time of application, the manure nutrient content of the manure, or the application rate or whether any of this was incorporated into the soil. After this multi-day application, which again used four wheel lines in four hour sets, with two sets occurring per day, the Dairy applied irrigation water to Field 1 for an unspecified amount of time beginning on August 10. Without knowing the residual nutrient content of the soil or the nutrient content of the manure being applied, Cow Palace did not have the information necessary to determine an agronomic rate for the applications discussed in Para. 86. As a result, it is likely that these applications placed more nutrients into the soil than the crop could effectively uptake as fertilizer.

88. My opinion that Cow Palace's summer 2009 applications were non-

[95] COWPAL000338-339.

agronomic is supported by the high residual nitrogen levels documented in the soils of Field 1 on September 3, 2009. That soil test shows that there was 159 lbs./ac nitrate and 25 lbs./ac ammonium in the top foot, and 152 lbs./ac nitrate and 16 lbs./ac ammonium in the second foot of the soil column depth, for a total of 311 lbs./ac residual nitrate and 352 lbs./ac total nitrogen remaining after the sudan grass crop had been harvested.[96] The results also showed 134 ppm phosphorus and 1295 ppm potassium, which are also very high residual nutrient amounts following a crop harvest. In sum, Cow Palace over-applied manure nutrients, including nitrate, nitrogen, phosphorus, and potassium to Field 1 during the summer of 2009, causing more nutrient to be placed into the soil than the sudan crop could effectively uptake as fertilizer.

89. Cow Palace's "Farm Plan" indicates that there was a double crop of triticale in 2009.[97] But Cow Palace's application field log does not mention the planting of triticale.[98] If there was no winter crop planted on Field 1 for the winter of 2009-2010, then in my opinion it is very likely that the high residual nitrates observed in September 2009 migrated deeper into the soil with further application, irrigation, snowmelt, and precipitation, moving past

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[96] COWPAL000654; COWPAL000341 (noting that triticale winter crop was seeded on August 20, 2008).
[97] COWPAL003172.
[98] *Compare* COWPAL000338-339

the crop root zone and eventually discharging to groundwater. Even if a triticale crop was planted, however, there was more nitrogen fertilizer present in the soils than the crop could effectively use, meaning that excess nitrates would also move through soils and into groundwater with further application, irrigation, snowmelt. and precipitation.

90. Cow Palace did not take a post-harvest sample following the triticale harvest in Spring 2010. It is unclear, however, whether Cow Palace planted a triticale crop in the winter of 2009-2010. In any event, the Dairy did not know what the residual nutrient levels were in Field 1 moving into the 2010 crop season, and it therefore lacked one of the primary pieces of information necessary to calculate an agronomic application of manure.

91. Cow Palace returned to planting alfalfa on Field 1 for the 2010 season. Without having any idea of the residual soil nutrient levels, Cow Palace proceeded to apply large amounts of liquid manure to Field 1 during 2010. Cow Palace's records indicate that the Dairy applied liquid manure to Field 1 every day over the following dates in 2010: March 9-March 17 (no manure source identified); April 5-April 10 (no manure source identified); May 24-May 28; August 30-September 7; and November 3-November 7.[99] According to the records, these applications applied a combined total of

[99] COWPAL000333-337.

12,960,000 gallons of liquid manure onto Field 1 in 2010, or 172,800 gallons per acre (assuming 75 acres). Similar to every application described above, Cow Palace did not have a current manure nutrient sample of the manure it was applying to this field, and therefore did not have the information necessary to calculate an agronomic rate of application. In fact, the November applications were stopped only when the lagoon was "empty," which Jeff Boivin, the manager at Cow Palace Dairy, stated was an agronomic rate.[100] Considering the large amount of manure applied, the fact that Cow Palace had no prior soil sample showing residual nitrate levels, and that the application records do not contain the critical information needed to determine an agronomic rate (no weather conditions, manure nutrient sampling, or previous crop yields), these applications were not and could not be agronomic. In addition, a new crop of alfalfa would not have developed a significant root system for nutrient uptake until late in the growing season.

92. Cow Palace's Fall 2010 soil test provides additional support for my opinions in Para. 91. The soil in Field 1 was sampled on October 14, 2010, and had a nitrate content of 118 lbs./ac and ammonium content of 29 lbs./ac in the top foot, and 121 lbs./ac nitrate and 22 lbs./ac ammonium in the second foot, for a total of 239 lbs./ac nitrate and 290 lbs./ac available

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[100] COWPAL000333; Boivin Trans. at 399:17-25; 400:12-15.

nitrogen.[101] These are very high residual nutrient amounts heading into winter, and demonstrate to me that the applications made during 2010 were not calculated properly, let alone to provide the amount of nutrients necessary to fertilize the crop. Cow Palace should not have made the manure applications it did from November 3-November 7, 2010, after receiving these results. Those applications, which continued only until the lagoon was "empty," were not agronomic. There was already excess nitrogen fertilizer available for the alfalfa crop heading into the winter months, when alfalfa is not likely to use any nitrogen until the next spring and summer. The excess nitrate observed in the soil in October, 2010, likely leached deeper into the soil with some of it moving past the crop root zone, and eventually to groundwater. This would be aided by further liquid manure application, irrigation, snowmelt and precipitation,

93. Beginning in 2010, Cow Palace kept track of its application records using a new spreadsheet.[102] I have reviewed the spreadsheet for Field 1 for 2010, and compared it against Cow Palace's field application records.[103] The spreadsheet for 2010 – and as will be seen, for each year that Cow Palace has maintained these spreadsheets – does not contain the information

[101] COWPAL000646.
[102] Boivin Trans. at 404:2-13.
[103] COWPAL000270 (spreadsheet); COWPAL000333-37 (field application records).

necessary to calculate agronomic rates. First, the sheet purports to have an "N Crop Balance" column, which begins with the number "480," the amount of nitrogen that Cow Palace's DNMP says an alfalfa crop has the capacity to use.[104] With each application, that number decreases. Cow Palace failed to take into account, however, the residual nitrate and nitrogen in Field 1's soil, as documented in the Fall 2009 post-harvest soil sample. It does not credit any soil mineralization or carryover of manure nitrogen from past year applications. Cow Palace also used a generic "1.5 lbs. of N/1000 gal" number to determine the amount of nitrogen placed onto Field 1.[105] This number does not correspond to any manure nutrient sampling I have seen for 2010. Consequently, the "N Crop Balance" that Cow Palace calculated for Field 1 is inaccurate; if it *were* correct, there would have been a 240 lbs./ac nitrogen deficit at the end of the year, which was not the case, as observed in the October 14, 2010 soil sample. There is also no yield data to substantiate the amount of nitrogen removed by the harvested crop. The USDA Nutrient Removal table indicates that alfalfa will remove 12 lbs./ton Nitrogen at 82 percent moisture content. If similar yields as were reported for Fields 3 and 4B were obtained from Field 1, at a similar moisture content, then there

[104] COWPAL000015.

[105] Cow Palace took a sample from a "lagoon" on September 30, 2010, near the conclusion of the application season; that sample had a result of 1.67 lbs./1000 gallons of total nitrogen. COWPAL009250. I find this number to be low for cow manure.

would only be about 60 to 78 lbs./ac of nitrogen removed by the alfalfa crop – a stark contrast compared to Cow Palace's estimate of 480 lbs./acre.

94. Cow Palace's spreadsheet also does not include any existing available nitrogen in the soil profile, nitrogen that is mineralized from soil organic matter, nitrogen fixated by the alfalfa crop, or credits from past years of manure application. Overall, the spreadsheets are a very poor accounting of nutrient application and removal, and are not in accord with modern nutrient management practices. Following appropriate nutrient budgeting practices is one of the most important ways that Cow Palace can ensure that its future manure applications do not result in excessive nutrient loading and leaching problems to groundwater.

95. No spring soil sample was taken by Cow Palace in 2011.

96. Cow Palace applied at least 17,280,000 gallons of liquid manure to Field 1 in 2011, according to its records.[106] The field application records maintained by Cow Palace again do not indicate the source of the manure applied to the field, the nutrient content of that manure, the weather conditions at the time of application, or the prior years' crop yields and how or whether those yields were used to vary application rates. Furthermore, Cow Palace's summary spreadsheet also does not identify the source of the

[106] COWPAL000277; COWPAL000328-32 (field application records).

manure that was applied to the field or the actual manure nutrient content of that manure; the document again uses a generic, 1.5 lbs./1000 gallon figure to calculate application rates. Thus, Cow Palace lacked the information necessary to calculate agronomic rates of manure application.

97. The summary spreadsheet for 2011 calculated that there would be a 134.4 lbs./ac nitrogen deficit at the end of the 2011 season.[107] If this were true, I would expect there to be little, if any, nitrogen left in the soil at the time of the fall soil sample. That was not the case. Cow Palace's September 30, 2011 soil sample states that there was 83 lbs./ac nitrate and 29 lbs./ac ammonium in the top foot, and 89 lbs./ac nitrate and 14 lbs./ac ammonium in the second foot of the soil column, for a total of 172 lbs./ac residual nitrate and 215 lbs./ac total available nitrogen.[108] Soil phosphorus and potassium were also high, with 131 ppm phosphorus recorded in the first foot and 108 ppm in the second; potassium was present at 1207 ppm and 1090 ppm in the first and second foot of the soil column, respectively. These residual nutrient numbers at the end of the growing season demonstrate that Cow Palace over-applied manure to Field 1 during the 2011 and preceding crop years, because more manure nutrients were placed into the soil than the alfalfa crop used as fertilizer. The residual nitrate found in

[107] COWPAL000277.
[108] COWPAL000637.

the soil sample likely leached down through the soil with further application, irrigation, snowmelt, and precipitation, moving beyond the crop root zone and eventually to groundwater.

98. Cow Palace did not take a Spring 2012 soil sample for Field 1.

99. Cow Palace applied at least 7,680,000 gallons of liquid manure to Field 1 in 2012, according to its records.[109] The field application records maintained by Cow Palace again do not indicate the source of the manure applied to the field, the nutrient content of that manure, the weather conditions at the time of application, or the prior years' crop yields and how or whether those yields were used to vary application rates. Furthermore, Cow Palace's summary spreadsheet also does not identify the source of the manure that was applied to the field or the actual manure nutrient content of that manure; the document again uses a generic, 1.5 lbs./1000 gallon figure to calculate application rates. Thus, Cow Palace lacked the information necessary to calculate agronomic rates of manure application.

100. The summary spreadsheet for 2012 calculated that there would be a 326.4 lbs./ac nitrogen deficit at the end of the 2012 season.[110] If this were true, I would expect there to be little, if any, nitrogen left in the soil at the time of the fall soil sample. That was not the case. Cow Palace's September

[109] COWPAL000284; COWPAL000325-27 (field application records).
[110] COWPAL000284.

27, 2012 soil sample found there to be 280 lbs./ac nitrate and 32 lbs./ac ammonium in the top foot, and 245 lbs./ac nitrate and 9 lbs./ac ammonium in the second foot of the soil column, for a combined total of 525 lbs./ac residual nitrate and 566 lbs./ac total available nitrogen. These available nitrogen values do not include the amount of nitrogen that would be contributed from soil organic matter mineralization or past year manure applications. Some of the soil test reports do add available nitrogen from soil organic matter for the upper foot of soil. These are usually in the range of 20 to 35 pounds of nitrogen per percent organic matter. For soil test farm consultants, Field 1 soil organic matter values run between 2.5 and 3 percent, which would contribute an additional, unaccounted for 50 to 105 pounds per year of available nitrogen. The residual phosphorus (190 ppm) and potassium (1521 ppm) documented in the top foot were also excessively high; no sample for these analytes was taken at the second foot.[111] These high residual nutrient numbers at the end of the growing season demonstrate that Cow Palace over-applied manure to Field 1 during the 2012 crop year, because more manure nutrients were placed into the soil than the alfalfa crop used as fertilizer. The excessive residual nitrate found in the soil sample likely leached down through the soil with further application, irrigation,

[111] COWPAL000261.

snowmelt, and precipitation, moving beyond the crop root zone and eventually to groundwater.

101. Cow Palace planted a corn/triticale rotation on Field 1 beginning the winter of 2012. According to its records, triticale was planted sometime in October 2012.[112] Even though Field 1 had a residual nitrate content of over 566 lbs./ac in the fall of 2012, Cow Palace applied manure to Field 1 between October 15-19 and November 5-9, 2012. These applications were not agronomic. According to the DNMP, triticale has the capacity to use 250 lbs./ac nitrogen; as of the date of Cow Palace's 2012 soil sample, there were already 312 lbs./ac total nitrogen in the top foot alone and over double what it could use if one took into account the levels found in the second foot. This mean that the triticale crop already had more nitrogen available to it than it could possibly uptake as fertilizer especially at the actual yield and nutrient removal values they achieve. Any further manure applications were therefore unwarranted from an agronomy standpoint, and likely caused the residual nitrate to be pushed further down into the soil column, pass the crop root zone and eventually to groundwater.

102. Cow Palace's records indicate that the triticale crop from Field 1

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[112] COWPAL000324.

yielded 6.2 tons/ac.[113] According to the USDA crop removal site, a triticale crop is expected to use about 10.5-12.5 lbs./ac nitrogen per ton harvested. Using this number, Cow Palace's triticale crop likely used between 65.1 and 77.5 lbs./ac nitrogen as fertilizer, meaning the rest of the nitrogen and nitrate in the soil was beyond that which the triticale could uptake. Field 1's triticale crop would need to yield at least 10 tons/ac dry matter in order to justify applying 250 lbs./ac nitrogen for fertilizer.[114]

103. Cow Palace did not take a Spring 2013 soil sample from Field 1.

104. Cow Palace applied at least 11,400,000 gallons of liquid manure to Field 1 in 2013, according to its records.[115] The field application records maintained by Cow Palace again do not indicate the source of the manure applied to the field, the nutrient content of that manure, the weather conditions at the time of application, or the prior years' crop yields and how or whether those yields were used to vary application rates. They also do not indicate any credit for the nitrogen released from the previous alfalfa crop, which should be at least 60 pounds per acre. Furthermore, Cow Palace's summary spreadsheet also does not identify the source of the manure that was applied to the field or the actual manure nutrient content of

[113] COWPAL009398; *see also* COWPAL004140.
[114] COWPAL000035.
[115] COWPAL009284; COWPAL000322-24 (field application records).

that manure; the document again uses a generic, 1.5 lbs./1000 gallon figure to calculate application rates. Thus, Cow Palace lacked the information necessary to calculate agronomic rates of manure application.

105. The summary spreadsheet for 2013 calculated that there would be a 272 lbs./ac nitrogen deficit at the end of the 2013 season.[116] If this were true, I would expect there to be little, if any, nitrogen left in the soil at the time of the fall soil sample. This was, again, not the case. Cow Palace's September 24, 2013 soil sample was the first to be taken by Agrimanagement, its subcontractor under the AOC. That sample found there to be 304 lbs./ac nitrate and 2 lbs./ac ammonium in the top foot of the soil column. In the second foot, there were 221 lbs./ac residual nitrate. In the third foot, there were 229 lbs./ac residual nitrate.[117] In total, Field 1 had 754 lbs./ac residual nitrate at the end of the 2013 growing season, a number that I would classify as extremely high (Agrimanagement characterized it only as "high"). In the top foot, the soil sample also had 290 ppm phosphorus, 1474 ppm potassium, and 6.4 ppm zinc. Taken together, the high residual nitrate, phosphorus, potassium, and zinc results indicate to me that Cow Palace greatly over-applied manure in 2013. The high 2- and 3-foot results for nitrate are indicative of a long history of manure applications that were not

[116] COWPAL009284.
[117] DAIRES008805.

agronomic, given the amount of nitrogen (in nitrate form) that has moved into the 3-foot soil column depth, deeper than most of the crops' effective root depth for nitrogen uptake. The excessive residual nitrate found in the soil sample, especially at the second and third-foot depths, are very likely to leach further down through the soil with further application, irrigation, snowmelt, and precipitation, and will eventually, and probably already, reach groundwater.

106. Cow Palace's corn crop yield for Field 1 was 24.6 tons/ac.[118] Corn is expected to use up to 250 lbs./ac nitrogen if it yields 30 tons/ac, according to Cow Palace's DNMP.[119] That the yield on this field was below 30 tons/ac means that the corn crop did not uptake 250 lbs./ac nitrogen, but more likely used closer to 200 lbs. Thus, the excess nutrients applied by Cow Palace were not used by the crop as fertilizer, as demonstrated by Cow Palace's post-harvest soil sampling for Field 1, which revealed excessive nitrogen and nitrate levels in all three feet of the soil column.

107. Despite having this excessively high soil sample in hand, Cow Palace proceeded to apply 612,000 gallons of manure to Field 1 on October 4 and 9, 2013. There was no agronomic reason for making this application; the field already had significantly more nitrogen in it than the winter triticale crop

[118] COWPAL009398; COWPAL004138-39.
[119] COWPAL000035.

could use as fertilizer. As such, this application, along with winter and spring precipitation and snowmelt, likely caused these nitrates to leach further into the soil column, moving past crop root depths and toward groundwater.

108. Cow Palace's sampling of Field 1 in May, 2014, showed that the Field still had very high nitrate values. In the top three feet of the soil column, there was 333 lbs./ac nitrate available for fertilization. I believe that the drop in residual nitrate between fall, 2013 and spring, 2014 is primarily due to leaching losses. Cow Palace's triticale crop, which yielded 6.53 tons/ac,[120] almost certainly did not make use of all of the available nitrate that was present in the soils at the time of the fall, 2013 sample. Based on the USDA Nutrient Removal tool, actual crop removal was likely in the range of 68.5 to 81.6 lbs./ac nitrogen. Thus, the triticale crop alone cannot account for the drop in nitrate; the only other plausible explanation is leaching loss. Plaintiffs' own sampling, discussed *infra*, further confirms my opinion.

109. Even though Field 1 had more than enough nitrogen available as fertilizer for Cow Palace's summer corn crop, the Dairy proceeded to apply 2,562,000 gallons of manure to the Field on May 24, June 12-13, June 17,

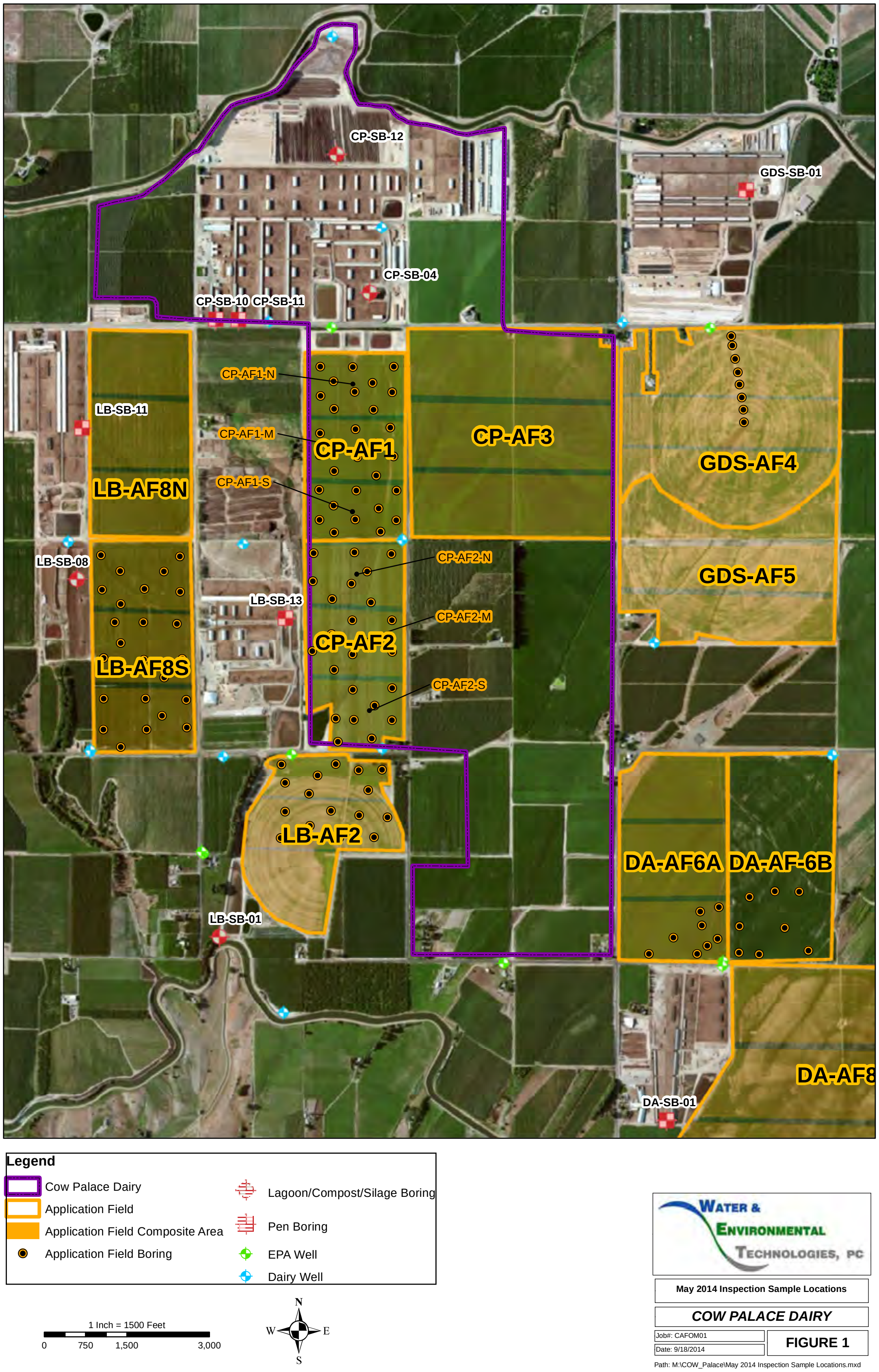
[120] COWPAL015671.

and July 21-22, 2014.[121] These were not agronomic applications because the corn crop already had sufficient nitrogen fertilizer in the soil. As a result, these applications, along with additional irrigation and precipitation, likely caused excess nitrate to migrate deeper into the soil, past crop root zones and toward groundwater.

110. In sum, after reviewing Cow Palace's records for Field 1, Cow Palace consistently over-applied manure to this field in quantities that exceeded agronomic rates. Even after receiving soil samples that had high residual nutrient amounts, Cow Palace continued to apply manure to Field 1.

111. Plaintiffs in this action conducted their own deep soil sampling on Field 1 on May 19-20, 2014. Plaintiffs' team took composite samples at the 28 locations depicted in the map below (hereafter, "Figure 1"); the sample results below are broken down into Field 1 North, Field 1 Middle, and Field 1 South in the table that follows. For the Nitrate-N column, the first number represents the amount of nitrate in terms of parts per million (ppm); the second number represents the amount of nitrate in lbs./ac.

[121] COWPAL015790.



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Sample ID	Sample Date	Depth (ft)	pH, SU	Phosphorus, ppm	Nitrate-N, ppm/pounds per acre*	Ammonium-N, ppm/ Pounds per acre	Total Nitrogen/Solid, mg/kg
CP-AF1-N-0-1	5/19/2014	0-1	8	291	44.4/155	2/7	1630
CP-AF1-N-1-2	5/19/2014	1-2	8.3	207	77.8/272	1.4 /4.9J	1150
CP-AF1-N-2-3	5/19/2014	2-3	8.2	118	75/262	5.3/18.6	599
CP-AF1-N-3-4	5/19/2014	3-4	8.3	64.2	50.6/177	9.3/32.6	334
CP-AF1-N-4-5	5/19/2014	4-5	8.3	34.9	69.5/243	1.4/4.9	254
1-CP-AF1-N Grab 3-5ft	5/19/2014	3-5	8	60.6	137/959	2.2/15.4	407
10-CP-AF1-N Grab 3-5ft	5/19/2014	3-5	8.5	45.3	62.3/436	3.2/22.4	233
CP-AF1-M-0-1	5/20/2014	0-1	7.7	352	38.1/133	1.3/4.6	1850
CP-AF1-M-1-2	5/20/2014	1-2	8.1	177	42.7/132	1/3.5	661
CP-AF1-M-2-3	5/20/2014	2-3	8.1	78	48.3/169	2.8/9.8	380
CP-AF1-M-3-4	5/20/2014	3-4	8.2	64.7	37.3/131	12/42	308

CP-AF1-M-4-5	5/20/2014	4-5	8.2	40.7	23.7/83	11/38.5	298
8-CP-AF1-M Grab 2-4ft	5/20/2014	2-4	8.2	46.4	48.4/339	2.8/19.6	264
CP-AF1-S-0-1	5/20/2014	0-1	7.8	214	37.9/133	1.6/5.6	1490
CP-AF1-S-1-2	5/20/2014	1-2	8.1	82.6	38.1/133	0.9/3.2	543
CP-AF1-S-2-3	5/20/2014	2-3	8	64.7	54.7/191	1.1/3.9	404
CP-AF1-S-3-4	5/20/2014	3-4	7.8	28.4	20.3/71	1/3.5	251
CP-AF1-S-4-5	5/20/2014	4-5	8.3	41.1	50.7/177	0.8/2.8	165
3-CP-AF1-S Grab 3-5ft	5/20/2014	3-5	8.4	15.4	28.3/198	0.53.5	119
5-CP-AF1-S Grab 3-5ft	5/20/2014	3-5	8.4	45.7	38.2/267	0.6/2.1	336
9-CP-AF1-S Grab 3-5ft	5/20/2014	3-5	8	66.6	2.2/15	36/252	795
*PPM X 3.5 = pounds per acre foot Ppm X 7= pounds per 2 acre feet of soil							

112. These results confirm that Cow Palace has applied manure in quantities that exceed agronomic rates on Field 1. The deep soil samples are the most telling. In the 4-5 foot range, Field 1 N had 69.5 ppm nitrate-N, or about 243 lbs./ac; Field 1 M had 23.7 ppm, or about 83 lbs./acre nitrate-N, and Field 1 S had 50.7 ppm, or about 177 lbs./acre nitrate-N. These nitrates are well below the root zone and, because the soils in Field 1 are not suitable for denitrification, have no fate other than to reach groundwater. The 3-5 foot grab samples, generally considered below the root zone, are also strong evidence that Cow Palace's manure management and application practices have placed excess nitrate into the soil. 1-CP-AF1-N Grab 3-5ft, the grab sample from Field 1 N, had a combined nitrate level of 137 ppm, or about 959 lbs./acre, far more than Cow Palace's crops could use as fertilizer. That this exceptionally high residual nitrate level appears in the area below crops' effective root zones demonstrates that this nitrate will *not* be used as fertilizer, and is instead destined to reach groundwater. The grab samples for Field 1 M and Field 1 S also contain high residual nitrate levels and other analytes that correspond to excess manure applications, further confirming my opinions. This is especially true for phosphorus, which in all but one of the 4-5 foot sample exceeded 40 ppm; that level is considered excessive. Total Nitrogen values are also high for subsoil samples indicating that organic nitrogen in addition to nitrate has moved deeper into the soil profile, some of which convert to nitrate over time.

113. In my experience, the nitrate and phosphorus results observed in Plaintiffs' borings are excessive. In fact, a recent study done in Iowa and Wisconsin, Sawyer 2013, Laboski 2012, in the heart of the corn belt, did not find any soil nitrate values to exceed 45 ppm in fields the spring after the drought of 2012 where crop yields and nitrate uptake were reduced and soil nitrate levels were expected to be higher than normal. The following table presents the fall and spring data summary. Sullivan accounts for the decrease in the 0-2 foot nitrate on a wet spring that leached some of the nitrate deeper into the profile.

Table 1. Summary of fall and spring preplant soil profile nitrate sampling in Iowa, 0-2 or 0-3 foot profile depth for common sites and depths sampled in fall and spring.

	0-2 foot			0-3 foot	
	Fall	Spring		Fall	Spring
Number of sites sampled	35	35		22	22
Average profile nitrate (lb nitrate-N/acre)	109	55		119	92
Minimum profile nitrate (lb nitrate-N/acre)	24	16		28	32
Maximum profile nitrate (lb nitrate-N/acre)	248	116		244	196
Standard deviation in profile nitrate-N	68	31		71	52

114. Note that the maximum value found in the 0-2 foot profile is less than most of the surface foot samples from Cow Palace's fields. This sampling was done following the severe drought of 2012. The authors of these studies concluded that there were sufficient carryover nutrients in the soils that future nutrient additions should be reduced.[122] This was even with soil nutrient levels that are substantially lower than found in Cow Palace's fields.

115. In conclusion, Cow Palace Dairy applied more manure than the crops on Field 1 had the capacity to uptake as fertilizer for at least the past ten years. Cow Palace did not make agronomic applications of manure, did not collect the correct information to make agronomic calculations, and failed to follow the instructions contained in its DNMP for determining agronomic rates. The result of these over-applications is nitrate contamination of the soils in Field 1, which in turn has caused, and will continue to cause excess nitrates to leach deeper and deeper into the soil, where they have and will continue to discharge to groundwater.

Cow Palace Field 2

116. Cow Palace Field 2 is located south of Cow Palace Dairy, just south of Field 1.[123] The field is between 71.7 and 75 acres in size, depending upon

[122] *See* Laboski, Carrie, "Wondering how much nitrate might be left in the soil from the 2012 crop?", University of Wisconsin Extension Integrated Pest and Crop Management Newsletter (2012); Sawyer, John, *Soil Profile Nitrate in Corn fields Following the 2012 Drought*, Iowa State University Extension, Crop News (2013).

[123] DAIRIES0002524 (Figure 3 to Cow Palace Application Field Management Plan); *see also* COWPAL000031.

which document one examines.[124] The soil underlying the field is "warden silt loam,"[125] which is a well-drained soil, discussed in detail *supra*.[126]

117. Cow Palace sampled Field 2 in two locations on August 15, 2001. I presume, but cannot be sure, given the date of this sample, that it was a post-harvest test from Field 2. Field 2 North had a residual nitrate content of 121 lbs./ac and an ammonium content of 16 lbs./ac, for a total of 137 lbs./ac total residual available nitrogen. These results all come from the 0-12 inch soil column depth. Phosphorus was also very high at 203 ppm. Field 2 South had 73 lbs./ac nitrate and 16 lbs./ac ammonium, for a residual content of 89 lbs./ac total available nitrogen; phosphorus was also elevated in this sample at 132 ppm.

118. These results suggest that Cow Palace applied more manure nutrients that the crop on Field 2 utilized as fertilizer. I base this opinion on the 137 lbs./ac total residual nitrogen in Field 2 North and the excessive phosphorus and potassium levels in both samples.[127] If a winter crop was planted, it may have been able to effectively uptake some of these excess nutrients; as I discussed earlier, winter crops are less likely to use large amounts of

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[124] *Compare* DAIRES002516 (Application Field Management Plan, 69 acres) to COWPAL000031 (DNMP, 75 acres).

[125] *See, e.g.*, DAIRIES008806; COWPAL000044.

[126] COWPAL000018.

[127] Phosphorus levels over 50 ppm and potassium levels over 800 ppm are considered excessive. *See, e.g.*, Horneck D.A, D.M. Sullivan, J.S. Owen, and J. M. Hart 2011. Soil Test Interpretation Guide, Oregon State University Extension Service, EC 1478 (2011).

nutrients because they grow slower and the ground usually freezes for at least some period of time.[128] If no winter crop was planted, then it is likely the excess nitrate observed in the field moved further into the soil column with additional application, irrigation, snowmelt and precipitation, beyond the crop root zone and eventually discharging to groundwater.

119. Field 2 was sampled 0-12 inch by Cow Palace on March 6, 2002. The Spring 2002 sample had a nitrate result of 71 lbs./ac and an ammonium result of 12 lbs./ac. Phosphorus was elevated at 97 ppm.[129] I do not possess information about whether Cow Palace planted a winter crop on Field 2 between the 2001 sample discussed in Para. 117, above, and this soil sample. If a winter crop was planted, then it failed to utilize all of the nitrogen as fertilizer in the top foot of the soil column; this means that residual nitrates not used by the crop were likely pushed further into the soil column along with precipitation, irrigation, and further application. If no winter crop was planted, then the decrease in nitrate levels from those observed in the August 2001 sample indicates to me that precipitation, irrigation, and further application also likely pushed the residual nitrates deeper into the soil column.

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[128] Crops tend to either die when they freeze or go dormant. The City of Sunnyside shows that there is a frost hazard down to 24 inches, which is within most crop root zones. *See* Residential Design Criteria Table R301.2(1).

[129] COWPAL010642.

120. Field 2 was sampled twice in 2003. The September 25, 2003, sample showed a residual nitrate level of 234 lbs./ac and an ammonium level of 14 lbs./ac, for a total residual nitrogen content of 248 lbs./ac in the top foot of the soil column.[130] The October 21, 2003 sample taken at the 12-24 inch soil depth less than a month later, had a residual nitrate level of 115 lbs./ac, and 7 lbs./ac ammonium, for a total nitrogen content of 122 lbs./ac.[131] These are high post-harvest residual nitrogen levels for Field 2, showing more plant-available nitrogen than I would expect a winter crop to be able to effectively utilize as fertilizer. This is especially true considering there was 122 lbs./ac available nitrogen in the second foot of the soil column depth, where crop roots take time to develop, especially in the winter. While I do not possess information about the specific crop planted on Field 2 at this time, I believe that these late fall soil sample results are indicative of non-agronomic applications of manure to Field 2 during the 2003 crop year. It is likely the excess nitrate observed in the field moved further into the soil column with additional application, irrigation, snowmelt, and precipitation, beyond the crop root zone, and eventually reaching groundwater.

121. Furthermore, there were 4.8 inches of precipitation between November 1, 2003 and the end of March 2004. According to the weather

[130] COWPAL010645.
[131] COWPAL010644.

data in the table below, this above-normal precipitation, along with any subsequent manure application and/or irrigation, would cause excess nitrate applied by Cow Palace to move deeper into the soil profile, past crop root zones, where they cannot be used as fertilizer.

Monthly Total Precipitation for Sunnyside, Washington[132]

2000	1.08	1.12	0.99	0.46	0.85	0.23	0.01	0.01	0.38	0.65	0.83	0.55	7.16
2001	0.20	0.29	0.61	0.49	0.08	0.55	0.14	0.39	0.10	0.51	1.65	1.02	6.03
2002	0.71	0.65	0.24	0.31	0.70	0.60	0.05	0.06	0.03	0.08	0.41	1.83	5.67
2003	1.85	0.36	0.43	1.73	M	0.00	0.00	0.48	0.06	0.17	0.13	1.89	M
2004	1.21	1.11	0.46	0.48	0.54	1.55	0.09	1.47	0.19	0.79	0.16	0.59	8.64
2005	0.73	0.05	0.54	0.96	0.90	0.12	0.06	0.07	0.00	1.26	M	2.17	M
2006	1.37	0.55	0.29	1.17	1.06	1.18	T	0.01	M	0.67	0.86	1.84	M
2007	0.33	0.66	0.37	0.90	0.54	0.78	0.04	0.27	0.32	0.92	1.05	M	M
2008	M	0.41	0.29	0.16	0.46	0.35	T	0.22	0.17	0.36	1.02	0.80	M
2009	1.10	0.61	0.80	0.14	0.61	0.48	0.00	0.06	0.16	0.75	M	0.71	M
2010	1.64	0.86	0.04	0.33	1.72	0.92	0.13	0.10	1.29	0.98	0.80	2.23	11.04
2011	0.55	0.02	1.12	0.34	1.76	0.31	0.18	0.02	0.07	0.84	0.23	0.22	5.66
2012	0.96	0.76	0.61	0.81	0.31	1.53	0.52	0.00	0.01	M	1.28	1.69	M
2013	0.16	0.02	0.55	0.27	1.55	2.43	0.00	M	M	M	M	M	M
2014	M	M	M	M	M	M	M	M	M	M	M	M	M
Mean	0.91	0.53	0.52	0.61	0.85	0.79	0.09	0.24	0.23	0.67	0.77	1.30	7.37
Max	1.85 2003	1.12 2000	1.12 2011	1.73 2003	1.76 2011	2.43 2013	0.52 2012	1.47 2004	1.29 2010	1.26 2005	1.65 2001	2.23 2010	11.04 2010
Min	0.16 2013	0.02 2013	0.04 2010	0.14 2009	0.08 2001	0.00 2003	0.00 2013	0.00 2012	0.00 2005	0.08 2002	0.13 2003	0.22 2011	5.66 2011

122. Cow Palace conducted further soil sampling on Field 2 on March 31, 2004. In the 0-12 inch soil column depth, Field 2 had 141 lbs./ac nitrate and 14 lbs./ac ammonium, for a total nitrogen content of 155 lbs./ac. Residual

[132] Information obtained from the National Oceanic and Atmospheric Administration.

phosphorus was also excessively high, coming in at 106 ppm. In the 12-24 inch soil column depth, Field 2 had 177 lbs./ac nitrate; no other analytes were tested.[133] These are high nitrate levels for a spring soil sample test. The fact that the surface foot nitrate level decreased and the concentration in the second foot increased by 62 pounds per acre is evidence that downward leaching occurred over the winter period. The total residual nitrogen content of the top two feet of soil was at least 332 lbs./ac, which is more than what corn or triticale would require, and slightly less than what an alfalfa crop is expected to uptake based on the DNMP estimate; applications to fertilize alfalfa, however, must be spread out over the entire growing year so that the crop is never overloaded with more nitrogen than it can uptake at any one time.[134]

123. From the records I have reviewed that were produced to Plaintiffs, Cow Palace did not take a Fall 2004 post-harvest soil sample. Assuming Cow Palace applied manure to this field at that time, then the failure to take a sample is a violation of the DNMP.[135] This failure means that Cow Palace did not know the residual nutrient content of its soils following harvest, and therefore could not estimate how much nitrogen, phosphorus, and other

[133] COWPAL010647.
[134] COWPAL000015.
[135] COWPAL000016.

manure nutrients the crop used as fertilizer.

124. From the records I have reviewed, Cow Palace also failed to take a Fall 2005 post-harvest soil sample. This is a violation of the DNMP. Cow Palace nonetheless applied manure between November 15, 2005 and November 18, 2005.[136] Without knowing the post-harvest, residual nutrient content of the soil, these applications by Cow Palace could not have been agronomic.

125. Cow Palace obtained a soil sample from Field 2 on May 15, 2006. This sample showed that Field 2 had 125 lbs./ac nitrate and 23 lbs./ac ammonium in the top foot of the soil column, and 109 lbs./ac nitrate and 15 lbs./ac ammonium in the second foot. Phosphorus was excessive in the top foot at 136 ppm.[137] In total, Field 2 had 272 lbs./ac available nitrogen for fertilization in the top two feet of the soil column. This is a high total amount of nitrogen for the alfalfa crop to use in May.[138] While alfalfa may use a maximum of 480 lbs./ac nitrogen in a growing season according to the DNMP, that fertilizer must be applied evenly throughout the year, also according to the DNMP.[139] In this case, over half of the nitrogen the alfalfa crop could theoretically use as fertilizer was already present in Field 2 as of

[136] COWPAL000321. 4 wheel lines at 800 GPM.
[137] COWPAL010655.
[138] COWPAL003172. Identifies alfalfa (3 cuttings) as crop on Field 2 in 2006.
[139] COWPAL000015.

the date of the soil sampling. This does not include or account for the soil mineralization or carryover of manure nutrients from past years or the amount of nitrogen the alfalfa may fix from atmospheric sources which alone would provide all the nitrogen the alfalfa crop needed.

126. There is no yield data provided by Cow Palace for this timeframe to estimate the actual nitrogen removed by the crop. The USDA Nutrient Removal tool states that alfalfa will remove a maximum of 12 pounds of nitrogen per ton harvested for the 1st cutting. Based on the 2009 crop yield data, this would amount to 46 lbs./ac nitrogen removed at 3.85 tons per acre alfalfa.[140] An additional 9.3 tons/acre sudan silage were harvested accounting for another 70 lbs./ac nitrogen removed, based on a rate 7.5 lbs./ac removed per ton harvested.[141] This means that total nitrogen removal for 2009 would be approximately 116 lbs./acre, far less than the estimate used by Cow Palace in their summary spreadsheet. This is further evidence that the nutrient management plan needs significant revision to provide realistic yield and nutrient removal numbers and a more detailed nutrient budget approach to nutrient management.

127. The soil samples taken by Cow Palace in Fall 2006 showed lower overall nitrate concentrations than those previously observed in the soil. As

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[140] COWPAL003963.
[141] COWPAL003962.

of September 27, 2006, the soil had 45 lbs./ac nitrate and 17 lbs./ac ammonium in the top foot, with 32 lbs./ac nitrate and 7 lbs./ac ammonium being observed in the second foot. Soil phosphorus was still excessive at 138 ppm.[142] A review of Cow Palace's application records indicates that the Dairy only applied manure to Field 2 after the spring soil test between June 20 and June 29, 2006. The low post-harvest fall results suggest that this application along with the already high residual nitrate levels, nitrogen fixation, and nitrate mineralization provided sufficient fertilization to the alfalfa crop.

128. Field 2 also showed lower nitrate concentrations in Cow Palace's October 17, 2007 soil sample. Field 2 had 66 lbs./ac nitrate and 33 lbs./ac ammonium in the top foot, and 48 lbs./ac nitrate and 9 lbs./ac ammonium in the second foot. Phosphorus was tested at 92 ppm.[143] In the midst of obtaining these soil sampling results, however, and after the 5th cutting of alfalfa, Cow Palace applied manure to Field 2 between October 16 and October 28, 2006.[144] In my opinion, there was no need for further manure applications to this alfalfa crop for the winter months. The DNMP states that manure applications to an alfalfa crop should be applied in early spring,

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[142] COWPAL010653.
[143] COWPAL010663.
[144] COWPAL000320.

the beginning of June, and mid-August.[145] Applying manure in October, right before winter and before the Dairy knew what the post-harvest residual nutrient concentrations were, does not result in an agronomic application. It is likely this late application caused excess nitrates to leach further into the soil column with additional application and irrigation, and later with precipitation and snowmelt, moving beyond the crop root zone and eventually discharging to groundwater. This fall application would also increase the amount of phosphorus available for fall, winter and spring runoff.

129. On September 5, 2008, Cow Palace had Field 2 sampled. The field had 232 lbs./ac nitrate and 28 lbs./ac ammonium, and 140 ppm phosphorus in the 0-12 inch soil column depth, and 10 lbs./ac nitrate in the 12-24 inch depth.[146] In total, Field 2 had 270 lbs./ac available nitrogen available for plant use. This is a large increase from the Fall 2007 sample, meaning that manure applications between Fall 2007 and Fall 2008 far exceeded crop uptake and were therefore not done at agronomic rates. This is a high fall soil nitrate result, especially considering the alfalfa crop planted on Field 2 is not expected to use a large amount of nitrogen for fertilization during the

[145] COWPAL000015.
[146] COWPAL010668. The “test date” is listed as September 8, and the “Recv’d Date” is September 5, 2008. I presume this was in error, and the test date is September 5.

winter months. By the end of the growing season, if proper nutrient management techniques were utilized, one would expect soil nitrogen levels to be low, because the crop should have removed the applied nitrate and ammonium as fertilizer. That 270 lbs./ac available nitrogen was present in the 0-24 inch soil column depth indicates that Cow Palace's manure applications during this year were not agronomic; 270 lbs./ac nitrogen is more than half of what an alfalfa crop is expected to uptake as fertilizer during the entire next year, even according to high estimates in the DNMP. In fact, the application logbook for Field 2 states that manure was applied July 28 through August 7, 2008, using four wheel-lines at 1000 GPM, until "lagoon south west" was "empty." [147] It is apparent that Cow Palace did not determine the agronomic need of its alfalfa crop in making these applications; that is, it failed to take into account how much fertilizer was present in the soil, the amount likely to be released from soil organic matter mineralization, the amount available from previous manure applications, how much the crop had used and was expected to continue to use, or how much total fertilizer was applied through these applications. Because the alfalfa crop is unlikely to use the large amount of nitrogen fertilizer found in Field 2's soils in Fall 2008, the excess nitrate likely leached further into the

[147] COWPAL000319.

soil column with additional application, irrigation, and precipitation, moving beyond the crop root zone and eventually discharging to groundwater. These, along with the other consistently high fall soil test results discussed in this report, are good examples of how Cow Palace's manure applications effectively constitute disposal of excess manure, not science-based field fertilization or nutrient management.

130. Despite receiving this high Fall 2008 soil test, Cow Palace applied "lagoon" manure to Field 2 from the "Catch Basin" on Kirks Road between September 29 and October 6, 2008. Mr. Boivin has acknowledged that the nitrogen content of the Catch Basin has not been tested.[148] This "lagoon" manure was mixed with irrigation water.[149] This was not an agronomic application of manure or irrigation water this late in the growing season. Cow Palace's soil sample from September 5 already showed high residual nitrogen and phosphorus levels in Field 2, indicating that no further manure applications were warranted. Additionally, the alfalfa crop is not expected to use large quantities of fertilizer during the winter months, when the crop is in a dormant state. These applications – using four wheel lines at 6 hour sets, at a rate of 1000 GPM – were not calculated by Cow Palace to provide needed fertilizer to the crop. It is likely these late applications caused excess

[148] Boivin Trans. at 375:4-13.
[149] COWPAL000318-319.

nitrate, such as that observed in the September 5 soil test and applied with these applications, to leach further into the soil column, moving beyond the crop root zone and eventually discharging to groundwater. Additional precipitation and snowmelt during the winter months also likely caused excess nitrates to leach deeper into the soil column. As discussed above, most natural groundwater recharge in eastern Washington occurs in the winter and early spring months when precipitation is greater and evapotranspiration is minimal.

131. Cow Palace applied manure to Field 2 between March 4-19, 2009 from the "main lagoon" and between June 13-21, 2009 (no source of liquid manure was stated).[150] At the time these applications were made, Cow Palace did not know the nutrient content of the soil in Field 2, because the Dairy took no spring soil sample – a requirement of the DNMP for dairies that are double-cropping, as Cow Palace did on Field 2 in 2009.[151] The Dairy also did not know the manure nutrient content of the manure it was applying.[152] It therefore lacked the information necessary to determine an agronomic rate of application.

[150] COWPAL000316-317.
[151] COWPAL000016.
[152] The closest pre-application manure sample was from September 19, 2008, and identifies the source of the sample as "lagoon." COWPAL009267. The DNMP requires Cow Palace to obtain manure nutrient sampling *before* applying, so that the Dairy can calculate an agronomic rate of application. COWPAL000016.

132. Field 2's soils were sampled on September 3, 2009. The field had 94 lbs./ac nitrate and 19 lbs./ac ammonium in the 0-12 inch soil column depth, and 132 lbs./ac nitrate and 20 lbs./ac ammonium in the 12-24 inch depth, for a combined total of 265 lbs./ac nitrogen available for fertilization.[153] Cow Palace plowed the alfalfa and planted triticale on Field 2 beginning in Fall 2009.[154] According to the DNMP, triticale can use up to 250 lbs./ac nitrogen as fertilizer.[155] This means that, as of September 3, Field 2 had more available nitrogen in the top two feet of the soil column than the triticale crop could use as fertilizer even if these unrealistic yields and nutrient removal rates were achieved. The alfalfa would also provide some nitrogen by breakdown of the roots in the fall.

133. Despite knowing that Field 2 had more than enough fertilizer for the triticale crop, Cow Palace applied manure to the field between September 7 and September 16, 2009. According to the application logbook, Cow Palace applied liquid manure to a "bare" field from the "main lagoon" at 1000 GPM in 8-hour sets.[156] Based on the information provided by Cow Palace, Field 2 did not need *any* further applications for fertilization purposes, and thus

[153] COWPAL000655.
[154] COWPAL003172.
[155] COWPAL000015.
[156] COWPAL000315.

these applications were not agronomic.[157] It is likely these late applications caused excess nitrate, such as that observed in the September 3 soil test and applied with these applications, to leach further into the soil column, moving beyond the crop root zone and eventually reaching groundwater. Additional precipitation during the winter months also likely caused excess nitrates to leach deeper into the soil column.

134. Cow Palace applied manure to Field 2 between March 23-March 30 and July 20-July 27, 2010. According to the Dairy's field application logbook, approximately 6,720,000 gallons of liquid manure was applied to the field during these applications.[158] At the time these applications were made, Cow Palace did not know the nutrient content of the soil in Field 2, because the Dairy failed to obtain a spring soil sample, as required by the DNMP for double-cropped fields.[159] Cow Palace also did not know the manure nutrient content of the manure it was applying.[160] It therefore lacked the information necessary to determine an agronomic rate of application.

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[157] Cow Palace did not know the nutrient content of its manure until September 25, 2009, more than a week after these applications occurred, where it was sampled at 1.47 lbs. of nitrogen per 1000 gallons of manure. COWPAL009251. The DNMP requires Cow Palace to obtain manure nutrient sampling *before* applying, so that the Dairy can calculate an agronomic rate of application. COWPAL000016.

[158] COWPAL000313-14.

[159] COWPAL000016.

[160] COWPAL009251 is the closest pre-application manure nutrient sample, taken the prior year on September 25, 2009. There is no source indicated for where the sample was taken, other than "manure."

135. Field 2's triticale crop yielded approximately 6.86 tons/acre bagged for silage when harvested in May 2010.[161] The Dairy's DNMP states that triticale can use up to 250 lbs./ac nitrate when the crop yield is 10 tons/acre dry weight basis.[162] Here, Field 2's triticale yield was less than optimal, meaning that the Dairy should have applied less manure fertilizer to Field 2 the following year. In fact, the estimated nitrogen removal using USDA's Nutrient Removal tool data is 10 to 12 pounds per ton, or about 80 pounds maximum.

136. Cow Palace began creating summary spreadsheets for Field 2 in 2010. According to the spreadsheet, Cow Palace applied at least 16,800,000 gallons of liquid manure to Field 2 in 2010. This summary spreadsheet does not indicate the source of the manure that was applied or the actual nitrogen content of that manure, but instead again uses a generic, 1.5 lbs./1000 gallon figure. It also does not take into account the residual nutrients in the soil from the previous crop year, credits from soil organic matter mineralization, previous manure applications or prior alfalfa crop.[163] The spreadsheet calculated that there would be a 239 lbs./ac nitrogen deficit at the end of the

[161] COWPAL003690. 514.46 total tons harvested divided by 75 acres field size = 6.859 tons/acre.
[162] COWPAL000035.
[163] COWPAL000271.

2010 season.[164] If this were true, I would expect there to be little, if any, nitrogen left in the soil at the time of the fall soil sample. This was not the case. Sudan silage harvest totaled 8.6 tons/ac, which based on the USDA Crop Removal tool would have only removed 7.5 lbs./ton nitrogen.[165] This means that the crop would have removed approximately 65 lbs./ac nitrogen, far short of the crop removal rate of 325 pounds/acre used by Cow Palace.[166]

137. Field 2 was sampled again by Cow Palace on September 9, 2010. The field had 149 lbs./ac nitrate, 25 lbs./ac ammonium, and 99 ppm phosphorus in the top foot of the soil column. In the second foot, 192 lbs./ac nitrate and 15 lbs./ac ammonium were present.[167] This is a high fall post-harvest soil sample, and is indicative of over-applications of manure during the 2010 crop year and less plant removal that projected. It is also considerably more nitrogen than Cow Palace's winter triticale crop could utilize as fertilizer (maximum 250 lbs./ac, per the DNMP), meaning that excess nitrates likely leached further into the soil column with additional application, irrigation, and precipitation, moving beyond the crop root zone and eventually discharging to groundwater.

138. Cow Palace again applied more manure to Field 2 after obtaining the

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[164] COWPAL000271.
[165] COWPAL003958-59.
[166] COWPAL000271, 000288.
[167] COWPAL000647.

already-high soil sample results from September 9, 2010. Despite having the information to know that the triticale crop had more nitrogen available to it than it could possibly uptake as fertilizer, Cow Palace applied approximately 2,160,000 gallons of manure to Field 2 between October 14-20, 2010. The source of the manure was not identified, but the manure was labeled as "very light liquid."[168] Field 2, based on the available information, did not need *any* further applications for fertilization purposes, and thus these applications were not agronomic. It is likely these late applications caused excess nitrate, such as that observed in the September 9 soil test and applied with these applications, to leach further into the soil column, moving beyond the crop root zone and eventually discharging to groundwater. The amount of liquid manure applied by Cow Palace is the equivalent of an additional inch of precipitation in the late fall, causing excess nitrate to move further past crop root zones and toward groundwater.[169] Additional precipitation during the winter months also likely caused excess nitrates to leach deeper into the soil column.

139. Furthermore, I believe that the excessively high phosphorus content in

[168] COWPAL000312. Cow Palace's manure nutrient sampling was obtained by the Dairy on September 30, 2010, before the Dairy made these applications. The results, which only identify the source of the sample as "lagoon," were that the sampled manure had a nitrogen content of 1.67 lbs./1000 gallons. COWPAL009250. Nowhere in the application logbook is there a calculation of an agronomic rate based on this result.
[169] One acre-inch of water is 27,150 gallons.

this field, and as reported in the vast majority of Cow Palace's soil tests for all of its fields, poses a serious threat to surface waters from runoff. Applying additional nutrients in the fall to already overloaded soils, as Cow Palace did here and elsewhere, is poor environmental practice, especially considering that the Warden series soil, which is present in this field and most of Cow Palace's other fields, is identified as having a high hazard for soil runoff and erosion.[170]

140. Cow Palace did not take any Spring 2011 soil samples, a violation of the DNMP.[171] The Dairy therefore lacked information about the residual nutrient content of the soil in Field 2 – data necessary to calculate an informed agronomic rate of application. In the absence of this information, Cow Palace applied manure to Field 2 between March 14-18, May 16-May 23, June 6-15; July 25-29; August 12-15; and August 29-September 6, 2011.[172] According to its summary spreadsheet, the Dairy applied 16,800,000 gallons of manure to this field in 2011, without knowing how much nitrogen was already in the soil to begin with.[173] The Dairy again used a generic, 1.5 lbs./1000 gallon figure for assessing the nitrogen content of

[170] *See, e.g.*, COWPAL000018.
[171] COWPAL000016 (spring sample required if double-cropping field).
[172] COWPAL000307-311.
[173] COWPAL000278 (subtracting out 2,160,000 gallons for October 14-19, 2010 application).

the manure it applied.[174] Based on Cow Palace's "N Crop Balance" calculation, Field 2 would have had a 195.8 lbs./ac nitrogen deficit at the end of the 2011 crop year.[175] If this were true, then I would expect that the Dairy's Fall 2011 soil test to show little residual nitrogen in the soil.

141. Cow Palace tested the soil in Field 2 on September 30, 2011. Field 2 had 94 lbs./ac nitrate and 38 lbs./ac ammonium, and 136 ppm phosphorus in the top foot, and 112 lbs./ac nitrate, 13 lbs./ac ammonium, and 65 ppm phosphorus in the second foot of the soil column. In total, Field 2 had 257 lbs./ac nitrogen and 201 ppm phosphorus available for fertilization in the top two feet of the soil.[176] These are high post-harvest sample results, and it is likely that the excess nitrate observed in the field moved further into the soil column with additional application, irrigation, and precipitation, beyond the crop root zone, and eventually to groundwater.

142. Cow Palace did not take any Spring 2012 soil samples from Field 2, a violation of the DNMP.[177] The Dairy therefore lacked information about the residual nutrient content of the soil in Field 2 –data necessary to calculate an agronomic rate of application. In the absence of this information, Cow

[174] Cow Palace did not know the manure nutrient content of the manure it was applying. The only 2011 manure sampling was completed on September 28, 2011, after the 2011 applications took place. That sample indicated that source of the liquid manure ("lagoon") had a total nitrogen content of 2.1 lbs./1000 gallons. COWPAL009249.
[175] COWPAL000278.
[176] COWPAL000638.
[177] COWPAL000016 (Spring sample required if double-cropping field).

Palace applied manure to Field 2 between March 5-9, March 19-21, April 16-19, May 21-25, June 25-29, July 30-August 3, and September 3-7, 2012.[178] According to its summary spreadsheet, the Dairy applied 7,680,000 gallons of manure to this field in 2012, without knowing how much nitrogen was already in the soil to begin with.[179] The Dairy again used a flawed, generic, 1.5 lbs./1000 gallon figure for assessing the nitrogen content of the manure it applied.[180] Based on Cow Palace's "N Crop Balance" calculation, Field 2 would have had a 421.4 lbs./ac nitrogen deficit at the end of the 2012 crop year.[181] If this were true, then I would expect that the Dairy's Fall 2012 soil test to show little, if any, residual nitrogen in the soil.

143. Cow Palace sampled Field 2 on September 26, 2012. The results were that Field 2 had 235 lbs./ac nitrate, 20 lbs./ac ammonium, and 164 ppm phosphorus and 1201 ppm Potassium in the top foot of the soil column, and 212 lbs./ac nitrate and 10 lbs./ac ammonium in the second foot. There was a total of 477 lbs./ac nitrogen available for fertilization in the top two feet of the soil column.[182] These results are very high for a post-harvest soil sample,

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[178] COWPAL000303-306.
[179] COWPAL000285.
[180] Cow Palace did not know the manure nutrient content of the manure it was applying. The only 2012 manure sampling was completed on October 2, 2012, after the 2012 applications took place. That sample indicated that source of the liquid manure ("lagoon") had a total nitrogen content of 2.3 lbs./1000 gallons. COWPAL009248.
[181] COWPAL000285.
[182] COWPAL000262.

indicating that there was nearly double the amount of nitrogen that Cow Palace's triticale crop could utilize as fertilizer (250 lbs./ac per the DNMP). These results are also high for post-harvest sample, meaning it is likely that the excess nitrate observed in the field moved further into the soil column with additional application, irrigation, snowmelt, and precipitation, beyond the crop root zone, and eventually discharging to groundwater. The crop harvest data provided showed that Cow Palace removed 7 tons per acre of sudan grass for silage in 2012. This would only remove 7.5 pounds per ton or 52.5 lbs./ac nitrogen per the USDA Crop Removal tool, far less than the 325 pounds per acre Cow Palace estimated.

144. No further applications of manure to Field 2 were necessary, considering the high fall post-harvest soil sample. Nevertheless, Cow Palace applied an additional 2,400,000 gallons of manure to Field 2 between October 15-19 and November 5-9, 2012.[183] These were not agronomic applications, for Field 2 already had nearly double the amount of nitrogen in the soil than the triticale crop could effectively use as fertilizer. These manure applications amounted to an additional 1.2 inches of water to each acre. It is therefore likely these late applications caused excess nitrate, such

[183] COWPAL000302. The logbook indicates that manure was applied at 1000 GPM at "four hour travel time per day." The source of manure for the October applications is not identified; for the November applications, the source was the "main lagoon." COWPAL009285 states the amount of manure applied during these 2012 applications.

as that observed in the September 26 soil test and applied with these applications, to leach further into the soil column, moving beyond the crop root zone and eventually discharging to groundwater.

145. Cow Palace did not take any Spring 2013 soil samples from Field 2, a violation of the DNMP.[184] The Dairy therefore lacked information about the residual nutrient content of the soil in Field 2 – data necessary to calculate an agronomic rate of application. In the absence of this information, Cow Palace applied manure to Field 2 between April 1-4, May 13-16, June 11-12, July 24-30, August 2-8, and on August 23, 2013.[185] According to its summary spreadsheet, the Dairy applied an additional 9,768,000 gallons of manure to this field in 2013, without knowing how much nitrogen was already present in the soil.[186] The Dairy again used a flawed, generic 1.5 lbs./1000 gallon figure for assessing the nitrogen content of the manure it applied.[187] Based on Cow Palace's "N Crop Balance" calculation, Field 2 would have had a 256.64 lbs./ac nitrogen deficit at the end of the 2013 crop year.[188] If this were true, then I would expect that the Dairy's Fall 2013 soil

[184] COWPAL000016 (spring sample required if double-cropping field).
[185] COWPAL009285.
[186] COWPAL009285 (subtracting out 2012 applications).
[187] Cow Palace did not know the manure nutrient content of the manure it was applying. The only 2013 manure sampling was completed on September 11, 2013, after the 2013 applications took place. That sample indicated that the liquid manure in CP-Lagoon 1 had a total nitrogen content of 3.76 lbs./1000 gallons. COWPAL009388.
[188] COWPAL009285.

test to show little, if any, residual nitrogen in the soil.

146. Cow Palace's September 24, 2013 soil sample was the first to be taken by Agrimanagement, its subcontractor under the AOC. That sample found there to be 226 lbs./ac nitrate and 4 lbs./ac ammonium in the top foot of the soil column. In the second foot, there was 179 lbs./ac residual nitrate. In the third foot, there was 196 lbs./ac residual nitrate.[189] In total, Field 1 had 601 lbs./ac residual nitrate at the end of the 2013 growing season, a number that I would classify as extremely high (Agrimanagement characterized it as "high"). In the top foot, the soil sample also had 72 ppm phosphorus, 886 ppm potassium, 3.0 % organic matter, and 5.9 ppm zinc. Taken together, the high residual nitrate, phosphorus, potassium, organic matter, and zinc results indicate to me that Cow Palace greatly over-applied manure in 2013 (as well as in previous years). The 3 percent organic matter in the soil will likely release an additional 60 to 105 pounds per acre via mineralization, something Cow Palace has failed to account for in its nutrient balance. The high 2- and 3-foot results for nitrate are further indicative of a history of manure applications that were not agronomic, given the amount of nitrogen (in nitrate form) that has moved into the 3-foot soil column depth, deeper than most of the crops' effective root depth for

[189] DAIRES008805.

nitrogen uptake. The excessive residual nitrate found in the soil sample, especially at the second and third-foot depths, are very likely to leach further down through the soil with further application, irrigation, and precipitation, eventually discharging to groundwater.

147. Despite having this excessively high soil sample in hand, Cow Palace proceeded to apply 1,236,000 gallons of manure to Field 2 on October 5, October 9, and between October 10-11, 2013. There was no agronomic reason for making this application; the field already had significantly more nitrogen in it than the winter triticale crop could use as fertilizer. These applications, along any additional irrigation, precipitation, and snowmelt, likely caused excess nitrate to move deeper into the soil column, past crop root zones and toward groundwater.

148. The soil samples obtained by Cow Palace in May 2014 had lower nitrate levels, but a large increase in available phosphorus.[190] There is not an explanation for this, as a winter crop would have removed nitrogen *and* phosphorus, not one or the other. As a result, I believe the decrease in nitrate is likely due to additional leaching losses, especially when examined in conjunction with Plaintiffs' own sampling, discussed *infra*. My opinion is further supported by Cow Palace's triticale yield for 2014, which, based on

[190] COWPAL015741.

the USDA Nutrient Removal tool, would have removed only a small amount of nitrate compared to the decrease observed from fall 2013 to spring 2014.[191] Even with the drop in nitrate observed in the field, however, the concentrations in May 2014 were still excessive at over 330 lbs./ac in the top 3 feet of the soil column, more than the 250 lbs./ac nitrogen that Cow Palace's DNMP indicates a corn crop will utilize.

149. Nevertheless, Cow Palace's applied 3,046,500 gallons of manure to Field 2 on May 24, June 10-11, June 14, June 16, and July 18-19, 2014.[192] There was no agronomic need for these applications, given the amount of nitrogen already present in the soil for the corn crop to use as fertilizer (e.g., more than the 250 lbs./ac figure used in the DNMP). These applications, along with additional irrigation and precipitation, likely caused nitrate to leach further into the soil column, past crop root zones, where it is destined to reach groundwater. The large increase in phosphorus makes contamination of surface water via runoff more probable.

150. In sum, my opinion after reviewing Cow Palace's records for Field 2 is that Cow Palace consistently over-applied manure to this field in quantities that exceeded agronomic rates. Even after receiving soil samples that had high residual nutrient amounts, Cow Palace continued to apply

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[191] COWPAL015761.
[192] COWPAL015791.

manure to Field 2.

151. Plaintiffs in this action conducted their own deep soil sampling on Field 2 on May 20, 2014. Plaintiffs' team sampled Field 2 in 23 locations as depicted on Figure 1, *supra*; the sample results below are broken down into Field 2 North, Field 2 Middle, and Field 2 South.

Sample ID	Sample Date	Depth (ft)	pH, SU	Phosphorus, ppm	Nitrate, ppm/pounds/acre	Ammonium-N, ppm/pounds/acre	Total Nitrogen/Solid, mg/kg
CP-AF2-N-0-1	5/20/2014	0-1	7.9	193	45.7/160	1.5/5.3	1350
CP-AF2-N-1-2	5/20/2014	1-2	8.1	52.3	67.9/238	0.6/2.1	270
CP-AF2-N-2-3	5/20/2014	2-3	7.9	35.8	57.1/200	0.6/2.1	291
CP-AF2-N-3-4	5/20/2014	3-4	7.9	21.8	51.8/181	< 0.4	238
CP-AF2-N-4-5	5/20/2014	4-5	7.8	18.4	44.7/156	0.4/1.4	274
CP-AF2-M-0-1	5/20/2014	0-1	7.9	173	57.2/200	1/3.5	1230
CP-AF2-M-1-2	5/20/2014	1-2	8.2	42.4	46.6/163	1.2/4.2	237
CP-AF2-M-2-3	5/20/2014	2-3	8.1	29.2	45.3/159	0.7/2.5	< 100
CP-AF2-M-3-4	5/20/2014	3-4	7.8	19.8	49.3/173	1.2/4.2	< 100
CP-AF2-M-4-5	5/20/2014	4-5	7.7	7.9	47.7/167	1/3.5	< 100
CP-AF2-S-0-1	5/20/2014	0-1	7.7	190	24.5/86	3.2/11.2	1430
CP-AF2-S-1-2	5/20/2014	1-2	7.9	69.9	25/88	0.8/2.8	368

CP-AF2-S-2-3	5/20/2014	2-3	7.8	29.8	15.6/55	0.8/2.8	179
CP-AF2-S-3-4	5/20/2014	3-4	8.4	62.8	42/147	0.6/2.1	128
CP-AF2-S-4-5	5/20/2014	4-5	7.9	16.5	28/98	1/3.5	< 100

152. In my opinion, these results confirm that Cow Palace has consistently applied manure in quantities that exceed agronomic rates on Field 2. The deep soil samples are the most telling. In the 3-4 foot range, below the crop root zone, Field 2 N had 51.8 ppm or 181 lbs./ac nitrate-N, Field 2 M had 49.3 ppm or 173 lbs./ac nitrate-N, and Field 2 S had 42 ppm or 147 lbs./ac nitrate-N. In the next foot down, the 4-5 foot range, Field 2 N had 44.7ppm or 156 lbs./ac nitrate-N, Field 2 M had 47.7 ppm or 167 lbs./ac nitrate-N, and Field 2 S had 28 ppm or 98 lbs./ac nitrate-N. The entire profile had 935 lbs./ac Nitrate-N in the North section of the field, 862 lbs./ac Nitrate-N in the Middle section of the field, and 474 lbs./ac Nitrate-N in the South section of the field. Most of our results were higher than those taken by Cow Palace except for the south part of the field. These are high nitrate results for soils in and below the crop root zone. Because the soils in Field 2 are not suitable for denitrification, the excess nitrate observed below the crop root zone in Field 2 have no fate other than to move to groundwater. Excessively high soil phosphorus and high nitrate concentrations, all the way down to the 4 and 5-foot levels, are further evidence that Cow Palace has over applied nutrients over many years. Phosphorus results are excessive in the first foot, which is most susceptible to runoff and much higher than normal throughout the profile. This is further evidence of a pattern of over application of nutrients to this field

153. In summary, Cow Palace Dairy applied more manure than the crops on Field 2 had the capacity to use as fertilizer for at least the past ten years. Cow Palace did not make agronomic applications of manure, did not collect the correct information to make agronomic calculations, and failed to follow the instructions contained in its DNMP for determining agronomic rates. The result of these over-applications is nitrate contamination of the soils in Field 2, which in turn has caused and will continue to cause excess nitrates to leach deeper and deeper into the soil, where they have and will continue to discharge to groundwater. The EPA wells results from the 2012 study, the EPA well results from adjacent to the Cluster properties taken in late 2012, and the AOC well results, discussed at length below, all confirm that nitrates are reaching the groundwater in amounts that largely exceed the maximum contaminant levels set by federal regulation to protect human health.

Fields 3, 4, 5, and 6

154. I have reviewed Cow Palace's records for Fields 3, 4, 5, and 6. Similar to the failures I have identified in Cow Palace's management of Fields 1 and 2, there have been serious problems with how Cow Palace has applied manure to these other fields. Generally, my review of the records shows that Cow Palace:

a. Never used a fall, post-harvest soil sample result in its nitrogen crop balance to determine an agronomic rate of manure application;

b. Consistently failed to take a spring soil sample when double-cropping fields, as is required by the DNMP;

c. Applied manure to fields after receiving soil samples showing high residual nitrogen and phosphorus in the soil, demonstrating that further applications were unwarranted and not agronomic- these applications were used to dispose of manure not fertilize crops;

d. Never used manure nutrient sampling to calculate an agronomic rate of manure – in virtually all instances, Cow Palace calculated its N crop balance by using a generic, 1.5 lbs./1000 gallon nitrogen value for its manure;

e. Did not sample for, let alone account for, nitrogen levels in the second foot of the soil most of the time;

f. Did not vary its applications based on prior crop yields to determine agronomic rates;

g. Did not attempt to verify the nutrient removal estimates in its NMP, but rather merely assumed the planted crops would remove the maximum amount of nitrogen identified in the DNMP, which is already an unrealistic goal (as discussed above);

h. Did not take into account nitrogen credits for mineralization of soil organic matter;

i. Did not take into account credits for nitrogen released when alfalfa crop is plowed under; and

j. Did not account for nitrogen released from past years' manure applications.

155. For Field 3, I have reviewed Cow Palace's records and reached the following conclusions:

a. Cow Palace sampled Field 3 on March 2, 2005, showing the field had 275 lbs./ac nitrate, 16 lbs./ac ammonium, and 102 ppm phosphorus in the top foot of the soil column.[193] Cow Palace's records indicate triticale was on Field 3 at the time (seeded November 20, 2004),[194] which per the DNMP can use a maximum of 250 lbs./ac nitrogen.[195] There was already more than enough nitrogen for fertilization of triticale crop – 291 lbs./ac total available nitrogen in the top foot. Cow Palace's applications

[193] COWPAL010646.
[194] COWPAL000365.
[195] COWPAL000015.

between April 10-14 and May 1-7 were therefore unwarranted and not agronomic.[196] This is especially true for the May 1-7 application, as the crop was harvested less than a week later, on May 14. The soil test obtained from Field 3 on June 23, 2005, showed 348 lbs./ac nitrate in the top foot and 188 lbs./ac nitrate in the second foot, for a total of 536 lbs./ac available nitrate, and does not include ammonia or the amount expected to be released via mineralization of organic matter and from past manure applications.[197] This is a very high nitrate number, far more than the *any* of Cow Palace's crops are expected to use as fertilizer. Excess nitrate likely leached deeper into the soil, past crop root zones, with further irrigation, application, and precipitation. No fall soil sample was taken in 2004 or 2005, a violation of the DNMP.

b. The Dairy sampled Field 3 on May 9, 2006, showing the soil had 93 lbs./ac nitrate, 43 lbs./ac ammonium, and 209 ppm phosphorus in the top foot, and 160 lbs./ac nitrate and 26 lbs./ac ammonium in the second foot, for a total of 322 lbs./ac available nitrogen.[198] This

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[196] COWPAL000365.
[197] COWPAL010650.
[198] COWPAL010656.

is more than the Dairy's corn crop is expected to use as fertilizer, per the DNMP.[199] In my opinion, this indicates that Cow Palace's prior applications were not agronomic, such as the September 16, 20, and 22, 2005 applications to Field 2.[200] Excess nitrate likely leached deeper into the soil, past crop root zones, with further irrigation, application, and precipitation.

c. Cow Palace sampled Field 3 on September 27, 2006, showing it had 70 lbs./ac nitrate and 14 lbs./ac ammonium in the top foot, and 141 lbs./ac nitrate and 9 lbs./ac ammonium in the second foot, for a total of 231 lbs./ac available nitrogen.[201] This is more that sufficient to fertilize Cow Palace's winter triticale crop. Cow Palace's manure application on October 28, 2006 to "bare" ground (the triticale was planted nearly a month later, on November 20 had far more than adequate nutrients for any fall growth that might occur) was therefore not agronomic.[202] Furthermore, Cow Palace's records contain no information on whether that application was timely incorporated into the soil. Soil temperatures at that time of year are high enough that any ammonia contained within the

199 COWPAL000016 (250 lbs./ac nitrogen).
200 COWPAL000365.
201 COWPAL010654.
202 COWPAL000364.

manure can be quickly converted to nitrate and become easily leachable. The excess nitrate likely leached deeper into the soil, past crop root zones, with further irrigation, application, snowmelt, and precipitation.

d. Cow Palace failed to take a Spring 2007 soil sample for its double-cropped corn/triticale field, a violation of the DNMP. The Dairy did not know the residual nutrient content of its soil, and therefore could not determine an agronomic rate of application. Cow Palace's manure applications on March 17-22, 27, April 6, April 21, April 28-31, and October 10-15 were therefore not agronomic.[203] The soil sample results for Field 3 obtained on October 10, 2007 support this conclusion: the field had 226 lbs./ac nitrate, 22 lbs./ac ammonium, and 138 ppm phosphorus in the top foot, and 236 lbs./ac nitrate and 17 lbs./ac ammonium in the second foot, for a combined total of 501 lbs./ac available nitrogen. These are high residual nitrate numbers for a post-harvest field, containing more than double what Cow Palace's triticale crop could utilize as fertilizer. Excess nitrate likely leached deeper into the soil, past crop root zones, with further irrigation, application,

[203] COWPAL000361-363.

snowmelt, and precipitation.

e. Cow Palace again failed to take a spring soil sample on Field 3 in 2008. Without knowing the residual nutrient content of the field, Cow Palace applied manure on May 23-25 and September 29-October 3, 2008.[204] Field 3 was sampled on October 2, 2008; the field had 171 lbs./ac nitrate, 26 lbs./ac ammonium, and 125 ppm phosphorus in the top foot, and 173 lbs./ac nitrate and 8 lbs./ac ammonium in the second foot, for a total of 378 lbs./ac available nitrogen.[205] This is substantially more nitrogen than the winter triticale crop could use as fertilizer. Cow Palace applied more manure to this field between October 13-20, 2008, after obtaining this high soil sample result. That application was not agronomic and applied far more nitrogen than the triticale could ever use as fertilizer. The excess nitrate likely leached deeper into the soil, past crop root zones, with further irrigation, application, and precipitation. Cow Palace's crop yield records indicate that only 3.65 tons per acre triticale for silage was harvested; this crop would have only removed 12.5 pounds per ton, or 46 pounds of nitrogen per the USDA Nutrient Removal tool, which is nowhere

[204] COWPAL000360-361.
[205] COWPAL010669.

near the projected 250 pounds per acre identified by the DNMP.

f. Cow Palace did not take a Spring 2009 soil sample, in violation of the DNMP. Without knowing the residual nutrient levels of its soil, Cow Palace applied manure to Field 3 from March 16-21 and April 20-28, 2009.[206] It is very unlikely that the triticale crop on the field could uptake any additional fertilizer. These applications were, therefore, not agronomic, especially when considered in connection to the already-high post-harvest soil sample from 2008. When the triticale crop was harvested in 2009, it yielded only 3.8 tons/acre, well below the 10 tons/acre dry natter that the DNMP indicates will use up to 250 lbs./ac nitrogen.[207] Based on this low yield, I believe the triticale crop did not use much, if any, of the excessive nitrogen found in the soil for fertilization. After the triticale harvest, Cow Palace's records indicate that the Dairy applied irrigation water to Field 3 for an unspecified amount of time, (in the vicinity of May 29, 2009), when the crop was switched to alfalfa.[208] This irrigation water may have pushed the excess residual nitrate observed in the soil deeper into the soil

[206] COWPAL000358-359.
[207] COWPAL009394 (summary); COWPAL003643 (yield data); COWPAL000035.
[208] COWPAL000357.

column, beyond crop root zones. The crop yield data indicated that a total of 5.0 tons of haylage was harvested from this field in August and October. Based on the USDA Nutrient Removal tool, this likely removed, at most, 15 pounds of nitrogen per ton, or 75 pounds total per acre. Again, this is nowhere near the estimated nitrogen removal in their spreadsheets or DNMP. The December 3, 2009 soil sample for Field 3 showed 178 lbs./ac nitrate, 27 lbs./ac ammonium, and 174 ppm phosphorus in the top foot; no two foot sample was taken.[209] It is unclear why this sample was taken in December, when the ground could be frozen. Nonetheless, the residual nitrates observed in the top foot were unlikely to be used by the alfalfa crop as fertilizer at this point in the season. As a result, it likely leached deeper into the soil, past crop root zones, with further irrigation, application, snowmelt and precipitation.

g. Cow Palace did not take a Spring 2009 soil sample, in violation of the DNMP. Without knowing the residual nutrient levels of its soil, Cow Palace applied manure to Field 3 between March 3-10

[209] COWPAL000656.

and June 22-27, 2010.[210] Cow Palace's summary spreadsheet, again using a 1.5 lbs./1000 gallon nitrogen figure, calculated that the field would have a nitrogen deficit of 396 lbs./ac at the end of the season.[211] The October 13, 2010 soil sample from Field 3 showed that it had 64 lbs./ac nitrate, 25 lbs./ac ammonium, and 102 ppm phosphorus in the 0-12 inch soil column depth, and 158 lbs./ac nitrate and 19 lbs./ac ammonium in the 12-24 inch depth, for a total 266 lbs./ac available nitrogen.[212] This is a high post-harvest result for both nitrogen and phosphorus, indicating that Cow Palace applied more manure to Field 3 than the alfalfa crop used as fertilizer. After receiving this sample, Cow Palace applied manure to Field 3 between November 2-13, 2010, putting down 3,600,000 gallons of liquid manure.[213] This was not an agronomic application: the alfalfa crop did not need more nitrogen fertilizer and was unlikely to use more fertilizer during the winter months. Because the alfalfa crop was unlikely to use the excess nitrate as fertilizer, the excess likely leached deeper into the soil, past crop

[210] COWPAL000355-356.
[211] COWPAL000272. Cow Palace only sampled its manure once in 2010, on September 30, 2010 from the "lagoon." The total nitrogen content was 1.67 lbs./1000 gallons. COWPAL009250, more than the 1.5 lbs./1000 gallon figure on the spreadsheet.
[212] COWPAL000648.
[213] COWPAL000354.

root zones, with further irrigation, application, snowmelt, and precipitation.

h. The Dairy applied manure to Field 3 between April 4-11, September 3-9, and September 19-25, 2011.[214] Cow Palace's summary spreadsheet, again using a 1.5 lbs./1000 gallon nitrogen figure, calculated that the field would have a nitrogen deficit of 320 lbs./ac at the end of the season.[215] The September 30, 2011 soil sample for Field 3 shows that the field had 127 lbs./ac nitrate, 26 lbs./ac ammonium, and 135 ppm phosphorus in the 0-12 inch soil column depth, and 103 lbs./ac nitrate, 15 lbs./ac ammonium, and 97 ppm phosphorus at the 12-24 inch depth, for a total of 271 lbs./ac available nitrogen.[216] This is a high, post-harvest soil sample for both nitrogen and phosphorus, indicating that the alfalfa crop did not make use of the nutrients supplied through Cow Palace's manure applications. Because the alfalfa crop was unlikely to use the excess nitrate as fertilizer, the excess likely leached deeper into the soil, past crop root zones, with further irrigation, application, snowmelt, and precipitation.

[214] COWPAL000351.
[215] COWPAL000279. Cow Palace only sampled its manure once in 2011, on September 28, 2011 from the "lagoon." The total nitrogen content was 2.1 lbs./1000 gallons. COWPAL009250, more than the 1.5 lbs./1000 gallon figure on the spreadsheet.
[216] COWPAL000639.

i. Cow Palace applied manure to Field 3 between March 6-13, May 21-28, June 25-July 3, and September 3-9, 2012, for a total of approximately 16,800,000 gallons.[217] Cow Palace's summary spreadsheet, again using a 1.5 lbs./1000 gallon nitrogen figure, calculated that the field would have a nitrogen deficit of 162.6 lbs./ac at the end of the season.[218] The September 13, 2012 soil sample for Field 3 shows that the field had 146 lbs./ac nitrate, 18 lbs./ac ammonium, and 162 ppm phosphorus in the 0-12 inch soil column depth, and 141 lbs./ac nitrate, 5 lbs./ac ammonium, and 99 ppm phosphorus at the 12-24 inch depth, for a total of 310 lbs./ac available nitrogen in the soil.[219] This is a high, post-harvest for both nitrogen and phosphorus, indicating that the alfalfa crop did not make use of the nutrients supplied through Cow Palace's manure applications. Cow Palace plowed down the alfalfa and planted triticale at the end of the 2012 season.[220] Because the triticale crop could remove up to 250 lbs./ac nitrogen according to the high, unproven estimates in the DNMP, it was unlikely to use

[217] COWPAL000348-351; COWPAL000286.
[218] COWPAL000279. Cow Palace only sampled its manure once in 2012, on October 8, 2012 from the "lagoon main." The total nitrogen content was 2.3 lbs./1000 gallons. COWPAL009248, more than the 1.5 lbs./1000 gallon figure on the spreadsheet.
[219] COWPAL000639.
[220] COWPAL003172; COWPAL000348 (triticale seeded October 20, 2012).

the excess nitrate, above even the DNMP estimates, observed in the soil as fertilizer, in addition the alfalfa crop would provide for 60-105 pounds of nitrogen as discussed above my opinion is that the excess likely leached deeper into the soil, past crop root zones, with further irrigation, application, and precipitation.

j. Cow Palace applied manure to Field 3 very early in the season in 2013, beginning an application between January 30-Februrary 8.[221] According to historical weather data, the soil temperature at 8 inches depth during this timeframe was between 34.3 degrees and 38.7 degrees Fahrenheit, and the daily average temperature was between 36.2 degrees and 44.3 degrees Fahrenheit.[222] Cow Palace should not have applied manure on days where the temperature of the air and soil was at or near freezing, as such applications can impact both surface and groundwater.[223] When harvested, the triticale yielded only 5.4 tons/ac as silage, short of the 10 tons/ac dry matter figure that the DNMP indicates could use 250 lbs./ac nitrogen as fertilizer.[224] The USDA Nutrient Removal tool lists 10.5 to 12.5 pounds nitrogen per ton of green chop wheat at 73.5%

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[221] COWPAL000348.
[222] Data obtained from WSU AgWeatherNet, Outlook weather station.
[223] COWPAL000017, COWPAL000021.
[224] COWPAL000015.

moisture content. We do not know the moisture content of their harvest or the actual nitrogen content but the data suggests it has removed well under 100 pounds per acre. While data specific to triticale is lacking, most research indicates wheat, rye, oats and triticale have similar nitrogen contents. The Dairy also applied to Field 3 between April 1-5, May 13-16, July 9-15, and July 16-25, 2013, putting down approximately 14,418,000 gallons of manure to the field.[225] Using the 1.5 lbs./1000 gallon nitrogen figure, Cow Palace calculated that there would be a 288.36 lbs./ac nitrogen deficit at the end of the 2013 growing season.[226] Field 3 was sampled on September 27, 2013, and had 168 lbs./ac nitrate, 5 lbs./ac ammonium, and 134 ppm phosphorus in the 0-12 inch soil column depth; 152 lbs./ac nitrate in the 12-24 inch depth; and 215 lbs./ac nitrate in the 24-36 inch soil column depth.[227] These are very high residual nutrient levels, and indicate that Cow Palace consistently applied manure to Field 3 without regard to agronomic

[225] COWPAL009286.
[226] COWPAL009286. The Dairy sampled the manure from "CP-Lagoon 1" on September 11, 2013, after these applications were made. The results showed a total nitrogen content of 3.76 lbs./1000 gallon, more than double the figure used by Cow Palace in its spreadsheets. COWPAL009388. Cow Palace's contactor, Agrimanagement, calculated that 3.18 lbs./1000 gallons of that nitrogen would be plant-available during the first year. COWPAL009387.
[227] DAIRIES008807.

rates. The nitrate observed at the 24-36 inch depth was unlikely to be used as fertilizer by either the winter triticale or summer corn crop, because that nitrate is below effective rooting zones and will leach further into the soil with additional irrigation, precipitation, snowmelt, and application. Additionally, the winter triticale crop was unlikely to use the available nitrogen in the top two feet of the soil column, as there was already 325 lbs./ac available nitrogen for fertilization – more than the triticale crop could use as fertilizer.

k. After obtaining this excessively high soil sample, Cow Palace applied manure to Field 3 between October 12-14, October 18-19; October 14-25; November 4-5; and March 18-26, 2014, putting down 5,994,000 gallons of manure onto the field for the triticale crop.[228] Based on already-high fall, 2013 soil sample, there was simply no agronomic reason for these applications to be made. These applications, as well as additional precipitation and snowmelt, likely caused excess nitrate to move deeper into the soil column, past crop root zones and toward groundwater.

l. Spring 2014 samples collected on May 6 in Field 2 indicated some overwinter reduction in soil nitrate, but excessive amounts in the

[228] COWPAL015792.

top two feet of the soil column. There is no yield data to suggest the decrease from 320 to 238 lbs./ac nitrogen was due solely to crop removal.[229] Instead, I believe a substantial portion of that decrease is due to leaching losses, especially considering the large amount of manure that Cow Palace applied between October, 2013 and March, 2014. That 238 lbs./ac nitrate is available is still very high going into the growing season. Soil phosphorus also remained excessive at 134 ppm.

m. Even though Field 3 had sufficient nitrogen available to fertilize Cow Palace's corn crop, the Dairy applied a total of 3,600,000 gallons of manure to the Field on May 23, June 2-9, and July 23-24, 2014. These applications were not agronomic, and, in conjunction with additional application, irrigation, and precipitation, likely caused excess nitrate to migrate deeper into the soil column, past crop root zones and toward groundwater.

n. In sum, I believe that Cow Palace consistently over-applied manure to Field 3 without regard to agronomic rates. The records shows that Cow Palace did not obtain information necessary for calculating an agronomic rate and did not, in fact, ever undertake

[229] COWPAL015761 states that Field 3 yielded 4.58 tons/ac triticale, which per the USDA Nutrient Removal tool would only remove approximately 57 lbs./ac nitrogen.

an agronomic rate calculation. As a result, the post-harvest soil samples showed high residual nitrate and phosphorus in the soil, indicative of over-applications of manure. Even after learning of these high numbers, Cow Palace continued to apply manure to Field 3, making applications that had no chance of fertilizing the crop. My opinion is that the excess nitrate observed in Field 3's soil over the past 10+ years was not utilized by crops as fertilizer, but rather leached past crop root zones with irrigation, application, and precipitation, eventually discharging to groundwater.

156. For Field 4 (including both "Field 4A" and "Field 4B"), I have reviewed Cow Palace's records and reached the following conclusions:

a. Cow Palace applied manure to Field 4 (65 acres per the application field logbook) between March 10-17, March 22-27, April 9-16, April 26, September 19-22, and October 2-10, 2007.[230] At that time, the field was in a triticale/corn rotation.[231] Cow Palace did not take Spring 2007 soil samples after harvesting the triticale, a

[230] COWPAL000381-382.
[231] *E.g.*, COWPAL000381.

violation of its DNMP.[232] It therefore lacked information about the residual nutrient content of its soil, a key data set for calculating agronomic rates. The October 17, 2007 soil sample for Field 4 states that the field had 179 lbs./ac nitrate, 43 lbs./ac ammonium, and 108 ppm phosphorus in the 0-12 inch soil column depth, and 161 lbs./ac nitrate and 9 lbs./ac ammonium in the 12-24 inch depth, for a total of 392 lbs./ac available nitrogen.[233] These are high results entering the winter months, showing more nitrogen than Cow Palace's 2007-2008 triticale crop could use.[234] I believe the excess nitrate leached deeper into the soil, past the crop's effective root zone, where it will eventually discharge to groundwater.

b. No spring soil sample was taken from Field 4 in 2008, a violation of the DNMP.[235] Without knowing the residual nutrient content of the soil, Cow Palace applied manure to "Field 4" from March 6-16, April 12-21, and May 18-23, 2008. The soil was tested on Field 4

[232] COWPAL000382 (indicating triticale seeding date of November 4, 2006); COWPAL000016.
[233] COWPAL010665.
[234] Per the DNMP, triticale has the potential to use 250 lbs./ac nitrogen as fertilizer, if the crop yields 10 tons/ac dry matter basis. COWPAL000035. Cow Palace planted the triticale on November 10, 2007, over a month after its October applications. COWPAL000381. With no crop in the ground to utilize the nitrogen between October 10 and November 10, the nitrogen applied by Cow Palace likely leached deeper into the soil with precipitation and snowmelt.
[235] COWPAL000016 (spring sample needed when double cropping fields).

on September 18, 2008, which showed that the field had 189 lbs./ac nitrate, 26 lbs./ac ammonium, and 105 ppm phosphorus in the top foot of the soil; the second foot had 144 lbs./ac nitrate and 24 lbs./ac ammonium, for a total of 383 lbs./ac total nitrogen available.[236] This is 133 lbs./ac more nitrogen than the triticale crop was expected to uptake as fertilizer, if it achieved an optimal yield of 10 tons/ac, as stated in the DNMP.[237] After receiving this already-high fall soil test, Cow Palace made applications to Field 4 between September 22-25 (applications to "bare" ground), October 6-8, and October 16-22, 2008.[238] These applications were not agronomic. First, it appears that Cow Palace only planted a triticale crop on the 35-acre portion of Field 4 later identified as "Field 4B," per the Dairy's records.[239] The triticale crop did not require any more applications for fertilization because there was already *more* nitrogen in the soil than it could use that season,

[236] COWPAL010671 (Field 4 "North"). Field 4 "South" was also sampled at this time, although the field application logbook discusses only applications to "Field 4" during 2008. *Compare* COWPAL010670 (Field 4 "South" – which itself had high Fall results of 149 lbs./ac nitrate, 27 lbs./ac ammonium, and 94 ppm phosphorus at the top foot, and 108 lbs./ac nitrate and 8 lbs./ac ammonium in the second foot – still more than a triticale crop could utilize during one season) *with* COWPAL000379-81 (documenting applications to "Field 4"). COWPAL000378 mentions "Field 4 South," but documents no applications.
[237] COWPAL000035.
[238] COWPAL000379-81.
[239] *See* COWPAL009394 (identifying triticale as only being harvested on Field 4B in 2009; COWPAL003445 (triticale ag-bagged receipts for May, 2009 from Field 4B).

according to the DNMP nitrogen removal rate. Second, no crop was planted on the section of the 65-acre portion of the field later identified as Field 4A,[240] meaning there was no crop present to utilize the nitrogen and phosphorus applied by Cow Palace. As a result of these actions, I believe the excess nitrate observed in the soil test, along with the additional nitrate introduced by these late applications, caused excess nitrate to leach deeper into the soil, moving past the crop's effective root zone, where it will eventually discharge to groundwater.

c. No spring soil sample was taken from Field 4B after the triticale crop was harvested, a violation of the DNMP.[241] The triticale yield was below the 10 tons/ac figure that is expected to use 250 lbs./ac nitrogen as fertilizer according to the DNMP, meaning the crop used less nitrogen than anticipated.[242] Cow Palace records indicate that no manure was applied to Field 4B in 2009 or 2010.actual yield was 6.3 tons for silage with a likely removal of 12 pounds per ton or 75 pounds of nitrogen per acre.

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[240] *See* COWPAL009394 (only corn identified as being harvested on Field 4A in 2009); COWPAL003508-10 (corn yield harvest from Field 4A, all dated in September, 2009); COWPAL000377 (noting that Field 4B was "bare" as of April 2, 2009.
[241] COWPAL000016.
[242] COWPAL009394 (6.3 tons/ac); COWPAL000035 (250 lbs./ac at a yield of 10 tons/ac).

Field 4A

d. Cow Palace applied manure to Field 4A between April 2-11 and September 17-30, 2009.[243] Per the DNMP, the corn crop planted on the field could use up to 250 lbs./ac nitrogen at a yield of 30 tons/ac.[244] The September 16, 2009 soil test showed that the field had 178 lbs./ac nitrate, 28 lbs./ac ammonium, and 182 ppm phosphorus in the top foot; in the second foot, there was 124 lbs./ac nitrate and 18 lbs./ac ammonium, for a total of 348 lbs./ac nitrogen available for fertilization.[245] This is an extremely high residual nitrate concentration after the fall harvest for corn, which is again evidence that Cow Palace did not conduct an actual nutrient budget and did not apply manure agronomically. Phosphorus is also extremely high. There was no winter crop planted on Field 4A.[246] This means that the applications between September 17-30 had no crop to fertilize; even if there was a crop, the field had 348 lbs./ac available nitrogen – more nitrogen than a crop would be expected to uptake in the winter months. These applications were therefore not agronomic. I believe the excess

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[243] COWPAL000376.
[244] COWPAL000035.
[245] COWPAL000658 (Field 4 "North," which I interpret as corresponding to Field "4A," as it is the northern part of Field 4).
[246] COWPAL009394; COWPAL000376 (identifying field as "corn/bare").

nitrate observed in the soil test, along with the additional nitrate introduced by these late applications, caused excess nitrate to leach deeper into the soil. This leaching, compounded by subsequent precipitation and snowmelt, caused excess nitrate to move past the crop's effective root zone, where it will eventually discharge to groundwater. The high phosphorus and lack of a winter cover also is a high risk for runoff.

e. Cow Palace applied manure to Field 4A between October 4-13, 2010, again after the corn crop was harvested. These applications put down 2,016,000 gallons of liquid manure to Field 4A, where there was no winter crop planted to utilize the nutrients contained in the manure.[247] In fact, Cow Palace made the October applications to Field 4A after learning that the soil had 198 lbs./ac nitrate, 40 lbs./ac ammonium, and 122 ppm phosphorus in the 0-12 inch soil column depth, and 179 lbs./ac nitrate and 20 lbs./ac ammonium in the 12-24 inch depth, for a total of 437 lbs./ac available nitrogen for fertilization.[248] This September 29, 2010 test came after Cow Palace's corn crop was harvested, meaning that the nitrogen and phosphorus observed in the soil was unused by

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[247] COWPAL000375 (Field 4A, noting "bare" field after the corn crop was harvested).
[248] COWPAL000649.

the corn crop that had been on the field.[249] There being no winter crop on Field 4A, the excess nitrate observed in the soil test was extremely susceptible to leaching deeper into the soil. Cow Palace's application of an additional two million gallons of liquid manure to Field 4A after learning of this high test was not an agronomic application of manure. The excess nitrate observed in the soil test, along with the additional nitrate introduced by these late applications, caused excess nitrate to leach deeper into the soil. This leaching, compounded by subsequent precipitation and snowmelt, caused excess nitrate to move past the crop's effective root zone, where it will eventually discharge to groundwater.

f. Cow Palace continued to apply manure to Field 4A in 2011 when no crop was planted. The Dairy applied manure to "bare" ground between March 29-April 12 and May 2-May 9, 2011.[250] According to the summary spreadsheet, Cow Palace applied 6,528,000 gallons of manure to the field with these applications, and the field would

[249] Cow Palace's summary spreadsheet for Field 4A in 2010 estimated that there would have been an 170 lbs./ac nitrogen deficit at the end of the season; again, the Dairy used a 1.5 lbs./1000 gallon nitrogen figure for the nutrient value of its manure in calculating its crop balance. COWPAL000273. The manure sampling completed on September 30, 2010, before these applications occurred, showed the sampled manure had a total nitrogen content of 1.67 lbs./1000 gallons.
[250] COWPAL000372-74.

have a 53 lbs./ac nitrogen deficit once the season was over.[251] On September 28, 2011, Cow Palace tested the soil in Field 4A, which had 118 lbs./ac nitrate, 24 lbs./ac ammonium, and 139 ppm phosphorus in the top foot of the soil, and 103 lbs./ac nitrate, 12 lbs./ac ammonium, and 84 ppm phosphorus in the second foot.[252] In total, the field had 257 lbs./ac nitrogen in the top two feet. Cow Palace was in the process of applying manure to the field while this soil test was obtained, a violation of the DNMP.[253] The Dairy applied manure to the field between September 19-25, and then applied more manure after obtaining this high soil sample between October 10-15, 2011, applying approximately 4,224,000 gallons of liquid manure in total.[254] Triticale was planted as a winter crop on Field 4A on October 27, 2011; triticale needs, at most, 250 lbs./ac nitrogen and 95 lbs./ac phosphorus for fertilization, if yielding 10 tons/ac dry matter, according to the DNMP.[255] Based on the

[251] COWPAL000280. The Dairy again used a generic, 1.5 lbs./1000 gallon figure. No manure sampling occurred before these applications took place. Instead, the Dairy sampled the manure from the "lagoon" on September 28, 2011, where it had a total nitrogen content of 2.1 lbs./1000 gallons.
[252] COWPAL000640.
[253] COWPAL000371-72; COWPAL000016; COWPAL000020.
[254] COWPAL000371-72; COWPAL000287 (identifying these applications as part of 2012 crop year).
[255] COWPAL000371; COWPAL000035. Note that Cow Palace's crop yield summaries for 2012 state that no triticale was harvested from Field 4A, but that triticale was

September soil test, there was already more than enough nitrogen and phosphorus in the soil for the triticale crop. The high residual nitrate and phosphorus observed in the fall test show that Cow Palace's manure applications in 2011 were not agronomic, for the corn crop did not make use of all the nutrients that were applied. Cow Palace's October applications were not agronomic, as there was already more than enough fertilizer for the triticale crop present in the soil. The excess nitrate observed in the soil test, along with the additional nitrate introduced by these late applications, caused excess nitrate to leach deeper into the soil, moving past the crop's effective root zone, where it will eventually discharge to groundwater.

g. Cow Palace failed to obtain a 2012 spring soil sample from Field 4A after harvesting the triticale crop, a violation of the DNMP.[256] The triticale yielded only 6.82 tons/ac,[257] meaning the triticale likely did not use much of the nutrients applied by Cow Palace for fertilization, reinforcing the importance of taking a spring soil

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harvested from Field 4B. COWPAL009397. The crop yield receipts, however, indicate that Cow Palace did indeed harvest triticale from Field 4A on May 8, 2012, yielding a total of 443.02 tons or the equivalent of 6.82 tons/ac (443.02/65 acres). COWPAL003500.

[256] COWPAL000016.

[257] COWPAL003500 (443.02/65 acres).

sample when double cropping. The actual nitrogen removal was closer to 85 pounds per acre, only about a third of what they projected. The Dairy applied approximately 4,608,000 gallons of manure to the field between May 10-21, 2012.[258] The October 10, 2012 soil sample showed 136 lbs./ac nitrate, 24 lbs./ac ammonium, and 148 ppm phosphorus in the 0-12 inch soil column depth, and 86 lbs./ac nitrate and 12 lbs./ac ammonium in the 12-24 inch depth, for a total of 258 lbs./ac available nitrogen.[259] This is more than what a triticale crop is expected to utilize, per the DNMP, and there was thus no agronomic need for additional fertilization.[260] Nonetheless, Cow Palace applied manure to Field 4A between March 1-7 and April 1-10, 2013, while the triticale was still in the ground.[261] These applications were not agronomic because the crop could not make use of any additional nutrients as fertilizer. The excess nitrate observed in the soil test, along with the additional nitrate introduced by these applications, caused excess nitrate to leach deeper into the soil. This leaching, compounded by subsequent precipitation and snowmelt, caused excess nitrate to

[258] COWPAL000287.
[259] COWPAL000265.
[260] COWPAL000035 (250 lbs./ac at a yield of 10 tons/ac).
[261] COWPAL000366-367. The summary spreadsheet for 2013 omits the April 1-10 applications. COWPAL009287.

move past the crop's effective root zone, where it will eventually discharge to groundwater.

Field 4B

h. Cow Palace applied manure to Field 4B in 2012, making applications between May 14-20, July 9-16, and September 3-9, 2012, laying down approximately 5,040,000 gallons of manure.[262] The Dairy calculated that these applications, again based on a generic, 1.5 lbs./1000 gallon manure nitrogen figure, would leave a 153 lbs./ac nitrogen deficit at the end of the season.[263] The September 13, 2012 soil test showed 212 lbs./ac nitrate, 14 lbs./ac ammonium, and 120 ppm phosphorus in the 0-12 inch soil column depth, and 183 lbs./ac nitrate, 9 lbs./ac ammonium, and 90 ppm phosphorus in the 12-24 inch depth, for a total of 418 lbs./ac total nitrogen available at the end of the growing season.[264] This is a high post-harvest soil sample result, showing that Cow Palace's 2012 applications to this field were not agronomic. The Dairy applied more nutrients than the sudan grass crop was capable of

[262] COWPAL000288. I have not seen any record of these applications in the field logbooks.
[263] COWPAL000288. The Dairy did not sample the manure in 2012 until October 2, after these applications took place. The sampled manure, from "lagoon main," had a total nitrogen content of 2.3 lbs./1000 gallon. COWPAL009248.
[264] COWPAL000264.

using as fertilizer, considering the high residual nitrogen and phosphorus levels present in the soil post-harvest.[265] Excess nitrate observed in the soil test likely leached deeper into the soil with additional application, precipitation, irrigation, and snowmelt, moving past the crop's effective root zone, where it will eventually discharge to groundwater.

i. Cow Palace did not apply manure to Field 4B during 2013,[266] and made applications to Field 4A between March 1-7 and April 1-10, as discussed above. Both fields had, again, high fall post-harvest soil sample results. Field 4A was sampled on September 17, 2013, and had 68 lbs./ac nitrate, 7 lbs./ac ammonium, and 162 ppm phosphorus in the 0-12 inch soil column depth; 52 lbs./ac nitrate in the 12-24 inch depth; and 63 lbs./ac nitrate in the 24-36 inch depth, for a total of 183 lbs./ac nitrate in all three feet.[267] It was unlikely that the nitrate observed in the 24-36 inch soil column depth would be fully utilized by the alfalfa crop as fertilizer. Instead, that nitrate likely leached further into the soil with additional irrigation, application, snowmelt, and precipitation, eventually discharging to

[265] COWPAL000288 (sudan grass planted on Field 4B).
[266] COWPAL009288.
[267] DAIRES008808.

groundwater.

j. Field 4B was also sampled on September 17, 2013. That field had 52 lbs./ac nitrate, 10 lbs./ac ammonium, and 116 ppm phosphorus in the 0-12 inch soil column depth; 135 lbs./ac nitrate in the 12-24 inch depth; and 224 lbs./ac nitrate in the 24-36 inch depth, for a total residual nitrate content of 411 lbs./ac.[268] This is a high residual nitrogen and phosphorus content for a field heading into the winter months, and in my opinion demonstrates that Cow Palace's applications to Field 4B were not agronomic.[269] It appears that much of the high nitrate found in the surface sample in 2012 has moved deeper into the profile in 2013. The 224 lbs./ac nitrate at 2-3 foot depth are very high for a sub-soil sample. This is likely a result of leaching from additional irrigation, manure application, snowmelt, and precipitation that moved excess nitrate past crop root zones, where it will eventually discharge to groundwater.

k. After obtaining this high fall soil sample for Field 4B, Cow Palace proceeded to apply 60,000 gallons of manure to the Field on September 30 and an additional 720,000 gallons of manure

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[268] DAIRES008809.

[269] These high results indicate that manure might have been applied to Field 4B during 2013.

between October 1-3, 2013.[270] These were not agronomic applications. There was already sufficient plant nutrients in the soil to fertilize Cow Palace's alfalfa crop on Field 4B (even taking into consideration the DNMP's high, 480 lbs./ac nitrogen removal for alfalfa). That these applications were made late in the season just before winter, when the alfalfa crop is unlikely to utilize nutrients, further supports my conclusion. These applications, in conjunction with winter precipitation, irrigation, and snowmelt, likely pushed excess nitrate deeper into the soil column, past crop root zones and toward groundwater.

l. Cow Palace obtained a soil sample from Field 4B on May 23, 2014. While that sample had lower residual nitrate levels – 187 lbs./ac nitrate in the top three feet – they also had much higher phosphorus levels than that documented in the fall soil test.[271] There is not an explanation for this as a winter crop would have removed nitrogen *and* phosphorus, not one or the other. As a result, I believe the decrease in nitrate is likely due to additional leaching losses, especially when examined in conjunction with Plaintiffs' own sampling, discussed *infra*.

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[270] COWPAL015794.
[271] COWPAL015744.

m. In sum, I believe that Cow Palace consistently over-applied manure to Field 4 – both Field 4A and 4B – without regard to agronomic rates. The records shows that Cow Palace did not obtain information necessary for calculating an agronomic rate and did not, in fact, ever undertake an agronomic rate calculation. As a result, the post-harvest soil samples showed high residual nitrate and phosphorus in the soil, indicative of over-applications of manure. Even after learning of these high numbers, Cow Palace continued to apply manure to Field 4, making applications that had no chance of fertilizing the crop and, in some instances, making applications where no crop was planted. The excess nitrate observed in Field 4's soil was not utilized by crops as fertilizer, but rather leached past crop root zones with irrigation, application, and precipitation, eventually discharging to groundwater. Additionally, soil phosphorus values rose from 2007 to 2014, showing an upward trend, which is further indicative of over-application.

157. For Field 5, I have reviewed Cow Palace's records and reached the following conclusions:

a. Cow Palace applied manure to Field 5 between March 4-7, March

17-21, March 31-April 4, April 21-24, and May 12-17, 2008. Alfalfa was planted on the field at this time.[272] On October 2, 2008, Cow Palace tested the soil in Field 5, which had 132 lbs./ac nitrate and 25 lbs./ac ammonium in the 0-12 inch soil column depth, and 47 lbs./ac nitrate and 9 lbs./ac ammonium at the 12-24 inch depth, for a total of 213 lbs./ac nitrogen available for fertilization.[273] This soil test demonstrates that Cow Palace's manure applications in 2008 were not agronomic, for the alfalfa that was harvested sometime in May 2008[274] and the corn crop in the summer of 2008 failed to use all of the nutrients available. With no winter crop in place to utilize the excess nitrate, the nitrate migrated further into the soil column with additional application, irrigation, snowmelt, and precipitation, where it was destined to reach groundwater.

b. Cow Palace switched from alfalfa to a single corn crop rotation on Field 5 beginning on or about June 5, 2008, after the early 2008 manure applications occurred.[275] They apparently did not consider the nitrate already in the soil and the nitrogen credit from the

[272] COWPAL000395-98.
[273] COWPAL010672.
[274] *See* COWPAL000395-96 ("green chop field" where alfalfa was planted on May 21; corn planted on June 5).
[275] COWPAL000395 (noting June 5, 2008 seeding date).

alfalfa crop they plowed down this credit alone would have been between 60 and 100 pounds of nitrogen as discussed above. The Dairy then applied manure between October 5-9, 2008, to a "bare" field, with no crop actively growing.[276] The Dairy also applied manure between March 4-9, 2009, when there was no growing vegetation and well before corn would be planted, meaning there was significant time for leaching to occur."[277] My opinion is that these applications were not agronomic. First, applications to bare ground are likely to cause excess nitrate, such as that observed in the Fall 2008 soil test, to migrate further into the soil column, past crop root zones and toward groundwater. Second, the Fall 2008 soil test showed there was already sufficient nitrogen fertilizer for Cow Palace's corn crop, which can use a maximum of 250 lbs./ac nitrogen if yielding 30 tons/ac, per the DNMP.[278] There was no reason to add more nitrogen and phosphorus to the soil for fertilization purposes. As such, I also believe the extra nitrate applied to the field in these two applications was not used by the crop as fertilizer.

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[277] COWPAL000394.
[278] COWPAL000035.

c. My opinion is further supported by the September 16, 2009 soil sample from Field 5, which showed 184 lbs./ac nitrate, 28 lbs./ac ammonium, and 146 ppm phosphorus in the top foot, and 176 lbs./ac nitrate and 11 lbs./ac ammonium in the second foot, for a combined total of 399 lbs./ac available nitrogen.[279] This is considerably higher than the Fall 2008 total of 213 lbs./ac nitrate indicating that Cow Palace's October 2008 and March 2009 manure applications were not agronomic, as there was a considerable amount of manure nutrients remaining after the crop was harvested. I believe that the excess nitrate found in the soil test moved deeper into the soil column with additional irrigation, application, and precipitation, eventually discharging to groundwater.

158. For Field 6, I have reviewed Cow Palace's records and reached the following conclusions. From the records I have reviewed, Cow Palace began applying manure to Field 6 in 2009.

a. Cow Palace applied manure to Field 6 via the "honey wagon" between March 24-28 (41 loads at 4,000 gallons/load, or 164,000 gallons) and September 21-26 (43 loads at 4,000 gallons/load, or

[279] COWPAL000659.

172,000 gallons). At this time, Field 6 was 30 acres in size and had corn planted in a single rotation.[280] I have not seen a manure nutrient sample for these honey wagon applications at this time; other samples from the honey wagons vary in nitrogen content from 30 lbs./1000 gallon to 50.9 lbs./1000 gallon.[281] Cow Palace tested the soil in Field 6 on September 16, 2009, and the field had 198 lbs./ac nitrate, 40 lbs./ac ammonium, and 246 ppm phosphorus in the top foot, and 202 lbs./ac nitrate and 18 lbs./ac ammonium in the second foot, for a total of 458 lbs./ac available nitrogen. In my opinion, this is a very high fall soil test for both nitrogen and phosphorus, and indicates to me that Cow Palace's March, 2009 applications were not agronomic. It also means that Cow Palace's September 21-26 applications were not agronomic, considering that the field already had high residual nutrient levels *before* the Dairy made those applications. I believe the result of these over-applications is that excess nitrate moved deeper into the soil column with additional irrigation, application, snowmelt, and precipitation, eventually discharging to groundwater.

b. Cow Palace continued to make manure applications to Field 6

[280] COWPAL000408-409.
[281] *See, e.g.*, COWPAL009274-77.

when the ground was "bare" between March 15-April 2 (82 loads at 4000 gallon/load = 328,000 gallons) and April 1-April 8, 2010 (1,260,000 gallons).[282] Corn was seeded on May 1, 2010.[283] In my opinion, these applications were unnecessary and not agronomic. Field 6 had substantially more nitrogen and phosphorus in the soil than Cow Palace's corn crop could utilize as fertilizer, even based on the unrealistic DNMP estimates. The field already had 458 lbs./ac nitrogen and 246 ppm phosphorus per the fall, 2009 soil test; corn is expected to utilize a maximum of 250 lbs./ac nitrogen and 95 lbs./ac phosphorus per the DNMP.[284] There was simply no agronomic need or reason for the field to have additional fertilizer applied to it for the corn crop except to dispose of excess manure.

c. In 2010, Field 6 was increased to 92 acres, per Cow Palace's records.[285] According to Cow Palace's summary spreadsheet, the Dairy calculated there to be a 193.6 nitrogen deficit at the end of the application year.[286] If this were true, then I would expect to see

[282] COWPAL000406-08.
[283] COWPAL000406.
[284] COWPAL000015.
[285] COWPAL000407.
[286] COWPAL000276. The Dairy again used a 1.5 lbs. of nitrogen/1000 gallon figure for calculating agronomic rates, and used 6 lbs. of N/1000 gallon for the "honey wagon" applications. I have not seen a manure nutrient sample from the honey wagons for this timeframe.

little, if any, residual nitrogen in the field at the end of the growing season. Cow Palace tested Field 6 on September 29, 2010; the field had 158 lbs./ac nitrate, 17 lbs./ac ammonium, and 74 ppm phosphorus in the top foot, and 178 lbs./ac nitrate and 18 lbs./ac ammonium in the second foot, for a total of 371 lbs./ac available nitrogen.[287] In my opinion, this is a high, post-harvest soil sample, indicating that Cow Palace's manure applications to Field 6 were not agronomic because a large portion of the nutrients that the Dairy applied went unused by the corn crop as fertilizer. The excess nitrate likely moved deeper into the soil column with additional irrigation, application, snowmelt, and precipitation, eventually discharging to groundwater.

d. Even after receiving this high, post-harvest soil test, Cow Palace applied manure to a "bare" Field 6 between October 25-November 11, 2010, putting down 62 honey wagon loads at 4,000 gallons a piece, or 248,000 gallons of manure.[288] Considering how much residual nitrogen and phosphorus was already in the field – far more than what a corn crop is expected to uptake as fertilizer – these applications were not agronomic. The same is true for Cow

[287] COWPAL000652.
[288] COWPAL000405-06.

Palace's honey wagon applications to a "bare" Field 6 between February 22-April 11, 2011, which applied another 111 loads for a total of 444,000 gallons.[289] The Dairy's summary spreadsheet for Field 6 states that these applications deposited 255.7 lbs. of nitrogen per acre, resulting in a nitrogen balance of "-6."[290] This means that Cow Palace itself calculated that it over-applied 6 lbs./ac nitrogen to this field. If this were true, I would expect there to be only marginal excess nutrients in Cow Palace's fall, post-harvest soil sample. The winter application may also cause problems with leaching and runoff; there was no mention of whether these applications were incorporated or not.

e. Cow Palace tested the soils in Field 6 on September 28, 2011. "Field 6 S" had 128 lbs./ac nitrate, 18 lbs./ac ammonium, and 134 ppm phosphorus in the 0-12 inch soil column depth, and 186 lbs./ac nitrate, 13 lbs./ac ammonium, and 69 ppm phosphorus at the 12-24 inch depth, for a total residual available nitrogen content of 345 lbs./ac. "Field 6 N" had 180 lbs./ac nitrate, 18 lbs./ac ammonium, and 86 ppm phosphorus in the 0-12 inch soil column depth, and 206 lbs./ac nitrate, 10 lbs./ac ammonium, and 35 ppm

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289 *Id.*

290 COWPAL000283.

phosphorus in the 12-24 inch depth, for a total residual available nitrogen content of 414 lbs./ac.[291] These are high post-harvest soil sample results. They show that Cow Palace applied manure to Field 6 in excess of agronomic rates, placing more nitrogen and phosphorus into the soil than the corn crop could utilize as fertilizer. The excess nitrate likely moved deeper into the soil column with additional irrigation, application, and precipitation, eventually discharging to groundwater. Despite receiving this high soil test, the Dairy applied manure on October 27, 2011, to a "bare" Field 6.[292] This was not an agronomic application, and likely caused excess nitrate to leach further into the soil, past crop root zones and toward groundwater.

f. Cow Palace continued applying manure to Field 6 without regard to agronomic rates in 2012. The Dairy applied 3,840,000 gallon to "bare" ground from April 12-20.[293] Again using a generic, 1.5 lbs./1000 gallon nitrogen content for its manure, Cow Palace's summary spreadsheet for Field 6 calculated that there would be a

[291] COWPAL000643-644.
[292] COWPAL000402.
[293] COWPAL000401; COWPAL000290.

181 nitrogen deficit in the soil at the end of the crop year.[294] If this were true, I would expect there to be little, if any, residual nitrogen in the soil. The October 10, 2012 soil sample for Field 6 "North" had 183 lbs./ac nitrate, 21 lbs./ac ammonium, and 100 ppm phosphorus in the 0-12 inch soil column depth, and 175 lbs./ac nitrate and 16 lbs./ac ammonium in the 12-24 inch depth, for a total residual nitrogen content of 395 lbs./ac nitrogen. Field 6 "South" had 120 lbs./ac nitrate, 23 lbs./ac ammonium, and 123 ppm phosphorus in the 0-12 inch depth, and 171 lbs./ac nitrate and 9 lbs./ac ammonium in the 12-24 inch depth, for a total residual nitrogen content of 323 lbs./ac.[295] These are, again, high post-harvest residual nitrogen and phosphorus numbers, showing that Cow Palace's 2011-2012 manure applications to Field 6 were not agronomic. Excess nitrate likely leached further into the soil with additional irrigation, precipitation, and application, moving past the crop root zone and toward groundwater.

g. Cow Palace planted a triticale crop on Field 6 on October 4,

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[294] COWPAL000290. Cow Palace sampled the manure from the "Lagoon Main" on October 2, 2012, after applications to Field 6 had already been made. The result was 2.3 lbs. of nitrogen/1000 gallons. COWPAL009248.

[295] COWPAL000267-68.

2012.[296] Based on the high post-harvest soil samples from October 2012, there was no need to apply additional nitrogen or phosphorus for the triticale crop – it already had more than it could possibly uptake as fertilizer. Nonetheless, Cow Palace applied approximately 1,857,000 gallons of manure to Field 6 between March 1-14, April 4-10, May 17, and May 21, 2013.[297] In my opinion, these applications were not agronomic – the triticale crop did not need, nor could use, any additional fertilizer. In its summary spreadsheet, the Dairy calculated that there would be 181 lbs./ac nitrogen deficit at the end of the season.[298] This was not the case, as the September 17, 2013 soil sample from Field 6 showed 227 lbs./ac nitrate, 5 lbs./ac ammonium, and 105 ppm phosphorus in the top foot of the soil column; 183 lbs./ac nitrate in the second foot; and 115 lbs./ac nitrate in the third foot, for at total residual nitrogen content of 530 lbs./ac.[299] This is a high post-harvest soil sample, again showing that Cow Palace over-applied manure to Field 6 without regard to agronomic rates. I believe that the excess

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[296] COWPAL000400.
[297] COWPAL000399-400; COWPAL009290.
[298] COWPAL009290. The Dairy again used its 1.5 lbs. nitrogen/1000 gallon figure. No 2013 sample was taken before these applications occurred. A sample was obtained on September 11, 2013 from "CP-Lagoon 1," and had a nitrogen content of 3.76 lbs./1000 gallons. COWPAL009388.
[299] DAIRES008811.

nitrate found in the soil test, especially in the 12-24 inch and 24-36 inch depth, is highly likely to leach deeper into the soil column with additional irrigation, application, snowmelt, and precipitation, eventually discharging to groundwater.

h. Despite the fact that there was 530 lbs./ac residual nitrogen in Field 6 for Cow Palace's triticale crop – over double the nitrogen content that the DNMP estimates a triticale crop will use as fertilizer – Cow Palace applied 3,258,000 gallons of manure to Field 6 between October 8-12, 15-16, and 18-21, 2013.[300] These applications were not agronomic. There was no additional nitrogen need for Cow Palace's triticale crop – the Field already had more nitrogen than the crop could uptake as fertilizer before the applications were made. These applications, in conjunction with precipitation, irrigation, and snowmelt, likely caused excess nitrate to leach deeper into the soil, past crop root zones and toward groundwater.

i. Cow Palace sampled Field 6 again on May 13, 2014. The results showed 294 lbs./ac of available nitrate in the top two feet of the soil column, and 140 ppm available phosphorus in the top foot.

[300] COWPAL015796.

This is, again, well above crop needs. While the surface soil sample had lower residual nitrate levels, it also had a higher phosphorus level than that documented in the fall soil test (105 ppm compared to 140 ppm in the May, 2014 test).[301] There is not an explanation for this, as a winter crop would have removed nitrogen *and* phosphorus, not one or the other. As a result, I believe the decrease in nitrate is likely due to additional leaching losses, along with some nitrogen uptake from the triticale crop, but nowhere near the 250 lbs./ac nitrate removal rate estimated by the DNMP.

j. Even though this soil test shows that there was more than enough nitrogen to fertilize Cow Palace's 2014 corn crop, which, per the DNMP, can use up to 250 lbs./ac nitrogen as fertilizer, Cow Palace applied an additional 120,000 gallons of manure to Field 6 on May 22, 2014.[302] This application, along with additional irrigation and precipitation, likely caused excess nitrate to leach deeper into the soil column, past crop root zones and toward groundwater.

k. In sum, I believe that Cow Palace consistently over-applied manure to Field 6 without regard to agronomic rates. The records

[301] COWPAL015746.
[302] COWPAL015796.

shows that Cow Palace did not obtain information necessary for calculating an agronomic rate and did not, in fact, ever undertake an agronomic rate calculation. As a result, the post-harvest soil samples showed high residual nitrate and phosphorus in the soil, indicative of over-applications of manure. Even after learning of these high numbers, Cow Palace continued to apply manure to Field 6, making applications that had no chance of fertilizing the crop and, in most instances, making applications where no crop was planted. The excess nitrate observed in Field 6's soil was not utilized by crops as fertilizer, but rather leached past crop root zones with irrigation, application, snowmelt, and precipitation, eventually discharging to groundwater.

159. Overall, the records I have reviewed show that Cow Palace has applied manure to its fields, as discussed in detail above, in quantities that well exceed agronomic rates. I believe that Cow Palace's history of consistently applying manure without regard to crop uptake, crop yields, or residual soil nutrient levels have caused excess nitrate to move below crop root zones and into groundwater. Cow Palace also fails to take any nutrient credits for soil mineralization of organic matter, or alfalfa credits for past manure applications. The excessively high phosphorus values also pose a serious threat to surface water that should be investigated. Excessive levels of soil potassium are a further indication of over-application of nutrients in excess of what crops were able to use.

OTHER SOURCES OF NITROGEN LOADING AT THE COW PALACE DAIRY FACILITY

160. Besides its application fields, I also believe that there are substantial sources of nitrogen loading at the Cow Palace Dairy facility itself.

161. Cow Palace Dairy has several manure storage lagoons located at the Dairy facility. I have reviewed the limited information available about these lagoons, and understand that they are not lined with any geosynthetic liner. Instead, the Dairy's lagoons are earthen impoundments constructed into the ground. David Erickson, one of Plaintiffs' experts, discusses the Dairy's lagoons at length in his expert report. For purposes of my report, I rely upon Mr. Erickson's opinions and conclusions that the Dairy's lagoons leak manure into the ground in large quantities.

162. In addition to the calculations provided in Mr. Erickson's report, Plaintiffs conducted their own sampling around one of Cow Palace's "stormwater" ponds, in the composting area, and in one of Cow Palace's confinement pens. Figure 1, *supra* at page 72, shows the locations where Plaintiffs' sampled, at CP-SB-04, CP-SB-12, and CP-SB-10, respectively.

163. Plaintiffs obtained one boring sample using a Geoprobe from Cow Palace's manure composting area, CP-SB-12. The composting area is not lined in any way; composting occurs on native soils. The results of Plaintiffs' sampling are depicted in the table below:

Sample ID	Sample Date	Depth	pH, SU	Phosphorus ppm	Nitrate ppm	Ammonium-N, ppm	Total Nitrogen/Solid, mg/kg
CP-SB-12-0-1	5/19/2014	0-1	8.9	330	12.3	100	2170
CP-SB-12-1-2	5/19/2014	1-2	8	270	5.5	70	1680
CP-SB-12-2-3	5/19/2014	2-3	7.6	51.6	1	20	869
CP-SB-12-3-4	5/19/2014	3-4	7.6	59.4	0.9	14	8210
CP-SB-12-4-5	5/19/2014	4-5	7.5	35.3	49.6	4.5	602
CP-SB-12-5-6	5/19/2014	5-6	7.7	20.2	1.6	12	450
CP-SB-12-6-7	5/19/2014	6-7	7.7	26.4	1	100	818
CP-SB-12-7-8	5/19/2014	7-8	8.6	462	0.9	95	2600
CP-SB-12-8-9	5/19/2014	8-9	8.7	1970	6.8	180	5720
CP-SB-12-10-11	5/19/2014	10-11	8	161	1.6	83	1930
CP-SB-12-11-12	5/19/2014	11-12	8.2	65.2	4.2	19	832
CP-SB-12-12-13	5/19/2014	12-13	7.6	5.1	8.4	5.9	276
CP-SB-12-15-16	5/19/2014	15-16	8.1	7.2	5.1	5.2	133
CP-SB-12- 16-17	5/19/2014	16-17	7.9	2.9	2.1	3.5	< 100
CP-SB-12-17-18	5/19/2014	17-18	7.8	1.5	4.3	2.5	< 100

164. In my opinion, these results show that Cow Palace's composting area is another significant source of nitrogen loading from the Dairy, and is responsible for excess nitrate moving deeper into the soil and toward groundwater. At the 4-5 foot depth, there was a "slug" of nitrate contamination observed at 49.6 ppm. This nitrate has nowhere to go but groundwater; there is no crop to utilize it, and the soils are not suitable for denitrification. The ammonium levels are also excessively high. The 100 ppm level at 6-7 feet and the 180 ppm level at 8-9 feet indicate a significant source of contamination in the different layers of soil. The presence of nitrate all the way down through 18 feet indicates that there is oxygen present in the soil, and therefore there is no opportunity for denitrification to occur. The high ammonia amounts will eventually be converted to nitrate under these conditions. The excessively high phosphorus result of 1970 ppm obtained in the 9-10 foot depth also confirms that significant contamination is present in the soil in the composting area. Phosphorus is much less mobile than is nitrate, yet the fact that it was found in higher concentrations underlying the composting area than in any of the field samples is evidence of significant seepage.

165. In conclusion, these boring results demonstrate that Cow Palace's composting area is a significant source of nitrogen loading at the Dairy.

That excess nitrate and phosphorus were present well beneath the composting area show that Cow Palace's manure and composting manure, including the valuable plant nutrients contained in them, such as nitrate and phosphorus, are being leached through the permeable soils upon which composting occurs, moving into the ground where they cannot be used as fertilizer, either by Cow Palace or the recipients of Cow Palace's exported compost.

166. Plaintiffs also obtained two borings in Cow Palace's cow confinement pens using the Geoprobe. I have personally observed that the cows contained in these pens defecate and urinate onto the ground, and that they are covered in manure while in the pens. *See, e.g.*, Exhibit 3 (photographs taken during Plaintiffs' fall 2013 site inspection at Cow Palace). I understand from the depositions of Cow Palace's personnel, including Jeff Boivin, that the pens are only scraped during the winter months, and that the manure in the pens is left to accumulate during summer, where it is susceptible to leaching through the ground.[303]

167. The results of Plaintiffs' sampling of the cow pens are contained in the table below:

[303] Boivin Trans. 76:7-77:4.

Sample ID	Sample Date	Depth	pH, SU	Phosphorus, ppm	Nitrate, ppm	Ammonium-N, ppm	Total Nitrogen/Solid, mg/kg
CP-SB-10-0-1	5/19/2014	0-1	8.2	82	29.9	60	1060
CP-SB-10-1-2	5/19/2014	1-2	7.8	6.5	94.9	8.5	470
CP-SB-10-2-3	5/19/2014	2-3	7.6	5.5	92.1	0.8	295
CP-SB-10-3-4	5/19/2014	3-4	7.9	18.2	40	1.8	358
CP-SB-10-4-5	5/19/2014	4-5	7.9	9.1	8.5	2.4	153
CP-SB-10-5-6	5/19/2014	5-6	8.2	1.5	4.8	3.4	106
CP-SB-10-6-7	5/19/2014	6-7	8.4	1.9	4.7	2.4	126
CP-SB-10-7-8	5/19/2014	7-8	8.5	3.1	2.9	7.1	161
CP-SB-10-9-10	5/19/2014	9-10	8.5	6.5	5.5	2.2	128
CP-SB-11-0-1	5/20/2014	0-1	7.9	39.2	1.9	29	676
CP-SB-11-1-2	5/20/2014	1-2	8.1	75	1.6	160	1090
CP-SB-11-2-3	5/20/2014	2-3	8.7	25.4	14.2	130	591

168. These results demonstrate that cow manure constituents have leached through Cow Palace's pens into the soil, where they are destined to reach groundwater. The results from the first three feet of the boring CP-SB-10 are most telling. There, nitrate was observed in the 0-1 foot depth at 29.9 ppm, at the 1-2 foot depth at 94.9 ppm, and at the 2-3 foot depth at 92.1 ppm. Four feet down, there was 40 ppm nitrate observed in the soil. Because there are no crops planted in the pens, and the soils underneath are not suitable for denitrification, there is no place for this excess nitrate to go but groundwater. This data also suggests that phosphorus and ammonia are moving deeper into the soil profile, providing further corroborating evidence that leaching is occurring, and that manure constituents, including nitrate, will eventually result in groundwater contamination.

169. Cow Palace apparently took its own samples from its confinement pens on January 21, 2002. Those samples showed that in Pen #9, there was 360 lbs./ac nitrate in the top foot, and 190 lbs./ac nitrate in the third foot. In Pen 18, there was 310 lbs./ac nitrate in the top foot, and 95 lbs./ac nitrate in the three foot range.[304] These are very high nitrate numbers, indicating that substantial amounts of contaminants had penetrated the soil and were making their way downward with water movement. Because there are no

[304] COWPAL010641.

crops grown in Cow Palace's pens, and the soils are not suitable for denitrification, there is no place for this excess nitrate to go but groundwater.

170. It is my opinion that results from these borings, and Cow Palace's own samples, demonstrate that Cow Palace's cow pens are a contributing source of nitrogen loading from the Dairy facility. The fact that excess nitrate and phosphorus were present beneath the pens show that Cow Palace's manure, including nitrate and phosphorus, are being leached through the permeable soils upon which the pens are situated, moving into the ground where they cannot be used as fertilizer by Cow Palace. Further remedial investigation is required to determine the extent of the loadings from the pens. The results indicate that further testing is required to determine the preferential flow pathways in the pens. My own research and scientific literature[305] suggest greatest leaching to occur where hoof compaction is the least, such as along the edges of pens or where ponding occurs within the pens. The large volume of urine (5.8 gallons per day[306]) produced per animal unit adds greatly to the leaching potential of pens with

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[305] B. Shaw, N. Turyk, 1992. Effects of Barnyard Management Practices on Groundwater Quality in Central Sands of Wisconsin. Final Report to WI DNR, Groundwater Management Section; Gillham, R.W., and L.R. Weber, 1969. Nitrogen contamination of groundwater by leachates. Journal WPCF, Vol. 41 No.10; Bowen, B. D., 1987. Potential for Nitrogen Groundwater Contamination from Animal confinement Areas in Central WI. MS Thesis, Univ. WI Stevens Point.

[306] ASAE 2005, 'Manure Production and Characteristics', ASAE Standard, D384.2, American Society of Agricultural Engineers, St. Joseph, Michigan, USA. This document uses value of 22 KG/cow per day, which is equal to 5.8 gallons urine per day.

high animal densities and the large areas covered with the pens.

171. Finally, Plaintiffs obtained a Geoprobe sample from between two of Cow Palace's impoundments, a stormwater catch basin that receives stormwater runoff and manure from Cow Palace's pens and other areas and the silage pit which gets run-off from the silage area and other areas. Just like the rest of Cow Palace's lagoons, these lagoons have no geosynthetic liner to prevent the migration of contaminants such as nitrate into the ground and groundwater.

172. The results of Plaintiffs' sampling are depicted in the table below:

Sample ID	Sample Date	Depth	pH, SU	Phosphorus, ppm	Nitrate, ppm	Ammonium-N, ppm	Total Nitrogen/Solid, mg/kg
CP-SB-04C-8-10	5/22/2014	8-10	7.7	38	20.3	1.1	270
CP-SB-04C-10-12	5/22/2014	10-12	7.7	5.1	18.2	0.9	887
CP-SB-04C-13-15	5/22/2014	13-15	7.8	4.9	14.4	0.8	< 100
CP-SB-04C-15-16	5/22/2014	15-16	7.7	5.9	27	1.2	138
CP-SB-04-17.8-18.2	5/19/2014	17.8-18.2	7.2	10.7	22	4.4	112
CP-SB-04-19.5-20	5/19/2014	19.5-20	8	< 1.4	2.9	2	< 100
CP-SB-04C-20-23	5/22/2014	20-23	7.8	< 1.4	7.8	0.5	< 100
CP-SB-04C-27-30	5/22/2014	27-30	7.6	2.1	6.1	0.6	< 100
CP-SB-04C-45.5-47	5/22/2014	45.5-47	7.8	< 1.4	1.2	7.5	< 100

173. The results of Plaintiffs' sampling, even though the sample was not directly below the lagoons, show that contaminant sources are present. The exact cause of the contamination, because Plaintiffs were only allowed one boring around the Cow Palace lagoons, requires further investigation. There are no crops to make use of the nutrients contained therein and there are no soils suitable for denitrification present. Between depths of 8 and 18.2 feet below the lagoon, nitrate was observed at levels twice the maximum contaminant level, and was documented at 22 ppm between 17.8 and 18.2 feet. At 45.5-47 feet below ground surface, ammonium-N was present at 7.5 ppm, a result that I would not expect to find unless there was a nitrogen source located above-surface.

174. In summary, Cow Palace's lagoons, pens, and composting area are contributory nitrogen loading sources at Cow Palace Dairy. Plaintiffs' sampling information demonstrates that manure and manure nutrients, such as nitrogen and phosphorus, are being leached through the soil and through the bottom of unlined lagoons and catch basins. Because Cow Palace does not plant crops in the Dairy facility itself, and given that the soils underlying the facility are not suitable for denitrification, the nitrogen observed in Plaintiffs' sampling will ultimately be discharged to groundwater. These sources must be more fully investigated to determine their respective loadings contributions to the overall nitrate contamination in the area.

COW PALACE'S MANURE MANAGEMENT, STORAGE, AND APPLICATION PRACTICES HAVE CONTRIBUTED TO AND CONTINUE TO CONTRIBUTE TO THE NITRATE CONTAMINATION OF THE GROUNDWATER

175. As discussed above, nitrate is highly mobile and, consequently, manure, which has significant amounts of nitrogen that convert to nitrate, must be carefully managed to prevent leaching to groundwater. Cow Palace's manure application records show that the Dairy has not carefully managed its nitrate loadings, placing massive amounts of excess nitrate into the soil. When this nitrate is not used by a crop as fertilizer, it moves deeper into the soil with water movement, migrating below crop root zones and eventually to groundwater. Because the soils underlying Cow Palace Dairy are not suitable for denitrification, *see* Para. 22, *supra*, the only likely fate of excess nitrate applied to Cow Palace's fields is eventual discharge to groundwater. The same is true for the excess nitrate found near Cow Palace's stormwater catch basin, composting area, and confinement pens. There is simply no other place for this nitrate to go but to groundwater.

176. The travel time of nitrate – that is, how long it takes for excess nitrate found in soil to migrate to groundwater – is highly variable. As discussed above, the geologic conditions in the vicinity of Cow Palace contain preferential pathways of water migration, due to the differing densities of subsurface soils. This means that excess nitrate may travel to groundwater via a shorter path in one location than it would in another. Importantly, however, and as discussed *supra*, the soil conditions around Cow Palace Dairy show that the soils are not suitable for denitrification. It is, therefore, a virtual certainty that the excess nitrate observed in and around the subsurface of Cow Palace will discharge to groundwater.

177. The dominant soils in the area of Cow Palace include the Warden soil series, which is characterized as a well-drained soil with silt loam surface texture originating from wind blown loess. The subsoil grades from the loess to alluvial deposits, originating from soil erosion in the nearby Rattle Snake Hills, many of which are highly permeable. The combination of well-drained, moderate to high permeability soils with coarse subsoil layers makes ideal conditions for rapid movement of nitrate and other contaminants to groundwater. Both the NRCS soil survey and the EPA reports indicate a high leaching potential from these soils and the need for careful irrigation and soil management to avoid groundwater contamination.

178. Estimating groundwater recharge and chemical transport by soil hydraulic conductivity alone often over-estimates the travel time for transfer to groundwater. This is largely due to preferential flow paths that occur in most soils, such as those found in and around Cow Palace Dairy. A combination of macro pores, soil structure properties, and overlapping lenses of soils with different porosities often results in a rapid transport time from soil surfaces to groundwater. One study found that flow became more preferential with depth; at depths of six meters, the flow was moving through less than 1 % of the whole soil matrix. This means that 99% of the soil had insignificant amount of flow compared to the 1 percent where virtually all of the flow occurred. Based on the soil types found in the vicinity of Cow Palace Dairy, I believe similar flow patterns exist.[307] The process of unsaturated flow is summarized by Nimmo, J.R., 2005, Unsaturated Zone Flow Processes Encyclopedia of Hydrological Sciences Part. 13—Groundwater: Chichester, UK, Wiley, v.4, pp. 2299-2392.

179. The rate of nitrate movement is determined by the rate of water movement through the vadose zone, which in turn is determined by the soil texture and amount of water escaping the root zone of a field. The amount of water moving vertically through the vadose zone and recharging groundwater in the Yakima area is largely dependent on, among other

[307] Kung, K.J.S. 1990. Preferential flow in a sandy vadose zone. Geoderma, pp. 46, 51-58. 1990-049956. Other references that discuss and indicate the potential for preferential flow in a wide range of soil conditions include: Sandra M. Eberts, Mary Ann Thomas, and Martha L. Jagucki, "Factors Affecting Public-Supply-Well Vulnerability to Contamination: Understanding Observed Water Quality and Anticipating Future Water Quality;" "Estimating areas contributing recharge to wells," USGS circular 1174, page 14; and "Recharge rates and chemistry beneath playas of the high plains aquifer" USGS 2008/5156.

factors, irrigation management.[308] This means that Cow Palace's irrigation practices have a strong effect on the rate that water and, correspondingly, nitrates, move through the soil matrix.

180. Groundwater contamination by nitrates in the Yakima Valley has been studied by EPA and Washington State Department of Ecology. These studies indicate that the likely source of high nitrates is most closely tied to recent agricultural activities.[309] The USGS has also documented the strong interface in the Lower Yakima Valley between shallow groundwater and nearby surface waters, including the Yakima River. In particular, USGS researchers found that young, shallow groundwater had the greatest interconnectedness with surface waters.[310] Shallow groundwater is most likely to be the first groundwater negatively impacted by agricultural activities, such as Cow Palace's over-application of manure to agricultural fields. Consequently, surface water quality can be detrimentally affected by contamination entering the shallow groundwater from anthropogenic sources.

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[308] J.J. Vaccaro and T.D. Olsen, "Estimates of Ground-Water Recharge to the Yakima River Basin Aquifer System, Washington, for Predevelopment and Current Land-Use and Land-Cover Conditions," USGS 2009, p. 24.
[309] Quality of Ground Water in Private Wells in the Lower Yakima Valley, 2001-02 Ecology Publication 02-10-074, pp. 14, 34; Lower Yakima Valley Groundwater Quality: Preliminary Assessment, Ecology Publication 10-10-009.
[310] River-Aquifer Exchanges in the Yakima River Basin, Washington, USGS Scientific Investigations Report 2011-5026, pp. 86-87.

181. While surface waters can be impacted by discharges from interconnected shallow groundwater, another cause for concern is the threat of runoff to surface waters from overloaded application fields. Manure nutrients, especially phosphorus, have a strong tendency to runoff fields with over-application, over-irrigation, and precipitation. The likelihood that nutrient runoff reaches surface waters is directly related to the degree to which the fields have been overloaded; in Cow Palace's case, the Dairy's application fields have very high levels of nitrate and phosphorus, placed there by a history of consistent manure over-application. I believe there is a strong chance that some of the nutrients have already made their way to nearby surface waters.

182. I have reviewed the well installation reports and data, well logs, general lithology, sampling results, data usability reports, and the EPA study, including its tables and appendices, in analyzing whether Cow Palace Dairy's manure application practices have contributed and are contributing to the nitrate contamination observed in the groundwater beneath and nearby the Dairy.

183. Cow Palace's contractor for completion of the AOC activities, Arcadis, has developed a site model that corresponds to my opinion about whether Cow Palace's manure management practices have contributed to the nitrate contamination of the groundwater. Arcadis's "conceptual site model" is reproduced below:

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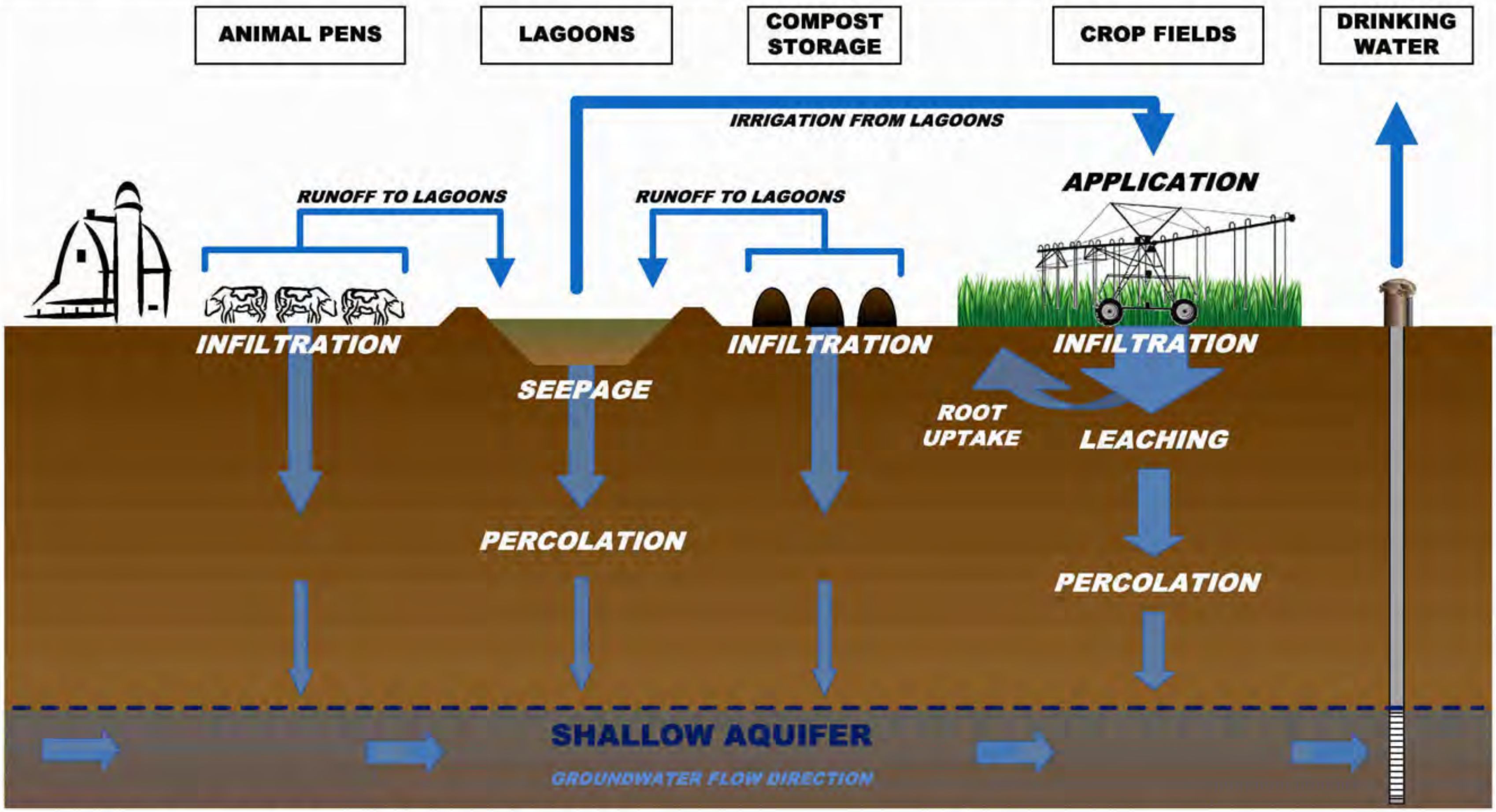

REPRESENTATION ONLY – NOT TO SCALE

YAKIMA VALLEY DAIRIES
SDWA-10-2013-0080
QUARERLY GROUNDWATER MONITORING

CONCEPTUAL SITE MODEL

ARCADIS

FIGURE
5

184. Arcadis' model indicates that nitrate contamination comes from multiple sources: Cow Palace's unlined manure storage lagoons, its application of manure to cropland in quantities that exceed agronomic rates, animal pen infiltration, and infiltration from compost areas. If the conceptual model is correct, and Cow Palace's manure management practices can be said to have caused or contributed to the nitrate contamination observed in the groundwater, then I would expect to see the following:

a. Few or no hydrologically upgradient nitrogen sources near Cow Palace Dairy;
b. Upgradient monitoring wells that have lower nitrate numbers and little to no other significant levels of tracer chemicals associated with cow manure; and
c. Higher levels of nitrate and tracer chemicals associated with cow manure, and possibly dairy related pharmaceuticals found in the groundwater hydrologically downgradient of Cow Palace Dairy and its application fields.

185. There are many "tracer" chemicals associated with cow manure that appear in groundwater. The presence of these chemicals, along with the presence of nitrate, can establish whether the nitrate observed in groundwater is from cow manure or some other potential source. Parameters such as chloride, sodium, potassium, phosphorus, sulfate, magnesium, calcium, bicarbonate or alkalinity, and ammonia are some of the types of tracers that can be used to "trace" the source of nitrate contamination.

186. In addition, the presence of dairy pharmaceuticals in downgradient monitoring wells can provide further support that the source of nitrate contamination is dairy-related. In this case, the EPA tested downgradient wells from Cow Palace for the presence of dairy-related pharmaceuticals, including monensin, which is used by Cow Palace.[311] The results of EPA's pharmaceutical sampling are produced below:

[311] Boivin Trans. at 105:12-106:4.

Table 21: Dairy Cluster – Concentrations of Five Veterinary Pharmaceuticals in Wells, Lagoons, Manure Piles, and Application Fields

Sample Location[a]	Chlortetracycline	Monensin	Tetracycline	Tylosin	Virginiamycin
Upgradient Water Well (reported as µg/L)					
WW-06	ND	ND	0.051 (J)	ND	ND
Dairy Supply Wells (reported as µg/L)					
WW-07	ND	0.109	0.041 (J)	ND	0.023 (J)
WW-08	ND	ND	5.17	ND	ND
WW-09	ND	0.023	ND	ND	ND
Dairy Lagoons (reported as µg/L)					
LG-05	0.075 (J)	430.2 (J)	4.48 (J)	1.7(J)	0.334 (J)
LG-06	ND	463.8 (J)	5.41 (J)	10.22(J)	R
LG-07	R	R	0.442 (J)	0.184 (J)	R
LG-08	R	449.6 (J)	6.07 (J)	R	R
LG-09	R	337.7 (J)	3.6 (J)	1.07 (J)	R
LG-10	0.079 (J)	2.24 (J)	6.55 (J)	R	0.816 (J)
LG-11	R	85 (J)	1.76 (J)	R	0.413 (J)
LG-12	R	135 (J)	1.91 (J)	R	0.314 (J)
LG-13	R	662 (J)	10.3 (J)	0.139 (J)	0.184 (J)
LG-14	R	498 (J)	8.6 (J)	R	R
LG-15	R	426 (J)	7.55 (J)	R	1.0 (J)
Dairy Manure Piles and Dairy Application Fields (reported as µg/kg)					
SO-03	0.7	109	954	14.8	ND
SO-04	0.6	5.1	27.4	2.1	ND
SO-05	17.7	1329	17.9	ND	ND
SO-06	3.0	5.1	16.5	ND	ND
SO-07	2303	283	2484	21.1	ND
SO-08	13.5	7.9	104	ND	ND
SO-09	ND	437	309	ND	ND
SO-10	ND	7	53	ND	ND
Downgradient Water Wells (reported as µg/L)					
WW-10	ND	0.499	ND	ND	ND
WW-11	ND	ND	0.038	0.029	ND
WW-13	ND	ND	ND	ND	0.041
WW-14	ND	0.033	ND	ND	0.024
WW-15	0.119	ND	ND	ND	ND
WW-17	ND	ND	0.049	ND	ND

[a]Water wells WW-12 and WW-16 had no detections and dairy lagoon sample LG-04 had no detections of these five compounds.

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

ND – not detected.

R – the data are unusable for all purposes because of analytical problems with the sample.

187. I have also reviewed excerpts of Cow Palace manger Jeff Boivin's testimony where he testified that he had spoken with Mr. Freeman from Arcadis and Mr. Freeman indicated the potential for Fields 1 and 2, discussed in detail previously, to be contributing to the groundwater contamination.[312] I not only agree that Fields 1 and 2, along with other sources, are potential contributors, but that they are past and active contributors to the nitrate contamination found in the groundwater.

188. In coming to my conclusions, I examined whether there are other hydrologically upgradient sources that may contribute to the nitrogen loading of the soils and, eventually, groundwater. From the aerial maps I have reviewed, there are no major nitrogen loading sources located upgradient from the Cow Palace Dairy. Water flows down from the Rattlesnake Hills, which are higher in elevation than the Dairy and located just to the north of the facility. There are a few agricultural fields located north of Cow Palace; given the low nitrate concentrations observed in the upgradient wells, however, I do not believe these fields to be a major contributor to the nitrate contamination of the groundwater found down gradient of Cow Palace facility and fields. Some of these areas above Cow Palace, however, have had manure and/or fertilizer applications in the past, and one area has been used by the DeRuyter Dairies for manure storage.[313]

189. Cow Palace's own well information shows that there is a steep drop in elevation – both topographically and hydrologically – between its upgradient wells

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[312] Boivin Transcript at 68:6-69:1 and 70:23-71:15.
[313] George DeRuyter Transcript at 52:4-53:9 and Ex. 204.

and downgradient wells:

a. One of Cow Palace's cross-section maps shows a nearly 230 foot difference in surface elevation (feet AMSL) between the top of YVD-02, one of the Dairy's upgradient wells, and the top of YVD-07, a well located just east of the Cow Palace Dairy.[314] The difference in groundwater elevation is similar, in that that water was observed at a much lower elevation in YVD-07 than YVD-02. When drilled, weathered basalt was located at YVD-02 at a depth of only twelve feet below the top of the wellhead.[315]

b. Similarly, the top of upgradient well DC-01 is nearly 80 feet higher in elevation than the top of YVD-03; 140 feet higher in elevation than the top of YVD-05; approximately 230 feet higher in elevation than the top of YVD-09; and nearly 280 feet higher in elevation than YVD-14. Again, groundwater elevation was closely related to surface elevation, with the top of the groundwater located at DC-01 being nearly 100 feet higher in elevation than the water observed in YVD-03 and nearly 200 feet higher in elevation than the groundwater observed in YVD-17.[316]

c. This pattern repeats itself throughout Cow Palace's cross-sectional

[314] DAIRIES009811 (Figure 12 of Draft "Final" 3Q2013 groundwater report, dated April 29, 2014).
[315] DAIRIES10831 (well log for YVD-02, static water level was 20.2 ft. below ground surface or "bgs").
[316] DAIRES009809 (Figure 10).

diagrams: groundwater elevation is higher in the topographically elevated, upgradient well locations to the north; the surface topographical elevation decreases the further south one moves away from the Rattlesnake Hills, and the groundwater elevation closely matches the change in surface elevation.[317]

d. These very steep gradients in the water table translate into very high groundwater flow rates in the northern part of the area monitored by this project.[318] Arcadis estimates the linear flow velocities for groundwater flows to be up to 47.7 feet per day in the upslope areas, 14.3 feet/day in the central area and 1.0 foot per day in the southern area.[319] These are only estimates, but are realistic based on the slope and soil materials. This means that the groundwater is moving very rapidly in the northern part of the site, making it more difficult to monitor local recharge with the monitoring system used. I believe that flow and clean water quality from upgradient groundwater will mix with the local contaminated recharge due to increasing mixing with the more rapidly flowing water, and the fact that 20 foot well screens were used means that the water being sampled is from the top 20 feet of the aquifer. or however many

[317] *See, e.g.*, DARIES009807-13. The other cross sectional diagrams I have reviewed further confirm this analysis. *See* DAIRIES010199-205 (cross-sectional diagrams from 2013 4th Quarter groundwater monitoring report.
[318] DAIRIES010138.
[319] *Id.*

feet the well screed penetrated into the aquifer. I also believe that relatively small amounts of recharge will occur until the irrigation canal and Cow Palace facilities are encountered.

190. It is a given that water does not naturally flow uphill. Consequently, the groundwater observed in monitoring well YVD-02, which is the highest hydrologically and topographically from Cow Palace Dairy, represents the condition of the groundwater without any inputs from Cow Palace's manure management practices or other Cow Palace sources. This well is the only one that does not have any agricultural fields upgradient and therefore is the best to represent predevelopment groundwater quality; it is, however, located on the edge of an agricultural field. DC-01 is also identified as an upgradient monitoring well; that well, however, is approximately 220 feet lower in surface topographical elevation than YVD-02, and is likely influenced by some of the agricultural fields located above and upgradient of it.

191. There have been small quantities of nitrate, ammonia, dairy pharmaceuticals, or other tracer chemicals associated with cow manure found in the monitoring wells upgradient of Cow Palace Dairy. I have reviewed sampling records for these wells, and reached the following conclusions:

a. The upgradient well sampled by EPA as part of its Study, "WW-06," reported only 0.71 ppm nitrate when tested, with ammonia not being detected at all in the sampled water.[320] Based on this result, I do not believe that there are nitrogen loading sources affecting the water samples in this well, however, the well screen is not located at the top of the water table and would not be sampling the water recharging groundwater in the immediate well vicinity.[321]. As such, I do not believe this well is the best well to be used to evaluate local water quality conditions.

b. Based on groundwater contour maps,[322] the only true upgradient well for purposes of the AOC is identified as YVD-02. I believe that this well represents the best example of the chemical condition of groundwater that is not in most seasons impacted by other human-influenced sources, unless the adjacent agricultural field where the well is located has some impact such as observed in the March 2014 sample. YVD-02 is located at a ground elevation of 1,285.81 ft. AMSL, with a depth of 35 ft. bgs. The static water level is 24.2 ft. bgs. The water table elevation at YVD-02 is 1264.8 ft. AMSL.[323] From the well log I have seen, YVD-02 encountered weathered basalt only 12 feet below the surface, which is

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[320] EPA Report at p. 52, Table 20.
[321] DAIRIES000968.
[322] *See, e.g.*, DAIRIES009814 (groundwater contour map, third quarter 2013 sampling report)
[323] DAIRIES010820 (final groundwater monitoring well installation report).

consistent with its location near the Rattlesnake Hills.[324] From the maps I have reviewed, there do not appear to be any upgradient agricultural activities near this well; to the north is the Rattlesnake Hills and land that does not appear to receive any irrigation. I have seen the following sampling events for that well; I believe the jump in nitrate observed during the March 16 sampling event may be due to either lab error or nearby fertilizer application, as the June 2 sampling showed the nitrate number decreased back down to the level observed previously.

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-02	35	1264.8 ft.	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)
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

c. Another well identified by Cow Palace Dairy as upgradient is YVD-03. YVD-03 is located at a ground elevation of 1118.15 ft. AMSL, with a total well depth of 200.1 ft. bgs. The static water level in the well is 189.7 ft. bgs, and the well is screened – that is, the depth that it allows

[324] DAIRIES010831.

water into the well – between 180.1 ft. bgs to 199.6 ft. bgs.[325] I have seen the following sampling events for that well:

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-03	200.1	931	AOC - upgradient

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)
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

d. Another well identified by Cow Palace Dairy as upgradient is YVD-04. YVD-04 is located at a ground elevation of 1116.06 ft. AMSL, with a total well depth of 245.2 ft. bgs and a static water level of 223.8 ft. bgs. The well is screened between 225.2 ft. to 244.7 ft. bgs.,[326] and the top of the screen is approximately 1.5 feet below the top of the water table, meaning that this well misses the very top part of the saturated zone. This well is useful in monitoring the agricultural activity upgradient of its location but is not a true background well. I have seen the following sampling events for that well:

[325] DAIRIES010820.
[326] DAIRIES010820.

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-04	245.2	894.9	AOC - upgradient

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)
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

e. YVD-05 is located just south of the Cow Palace Dairy, at a ground elevation of 1052.26 ft. AMSL. The well was drilled to 182.2 ft. bgs, with an observed static water level of 167.5 ft. bgs. It is screened between 162.2-181.7 ft. bgs.[327] Cow Palace designated YVD-05 as an upgradient well.[328] While the well screen is within the parameters of the AOC well construction plan, the use of a 20-foot screen means that the well is sampling a wide range of groundwater, especially in the northern part of the site where flow is fast and upgradient groundwater, including seepage from the irrigation canal, is likely making up a significant part of the sample. As a result, the nitrate levels observed are higher than the true background of <1mg/L and are probably due to leaching from the cow pens upgradient of this well. The well was sampled on the following dates:

[327] DAIRIES010820.
[328] DAIRES000123 (Groundwater Monitoring Well QAPP).

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-05	182.2	884.3	AOC - downgradient

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)
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

i. These low nitrate results combined with the presence of low cow manure tracer chemicals indicate to me that the water being sampled from YVD-05 is from aquifer mixture of upgradient water and local recharge from the cow pens.

f. Another well identified by Cow Palace Dairy as upgradient is DC-01. DC-01 is located at a ground elevation of 1,199.64 ft. AMSL, is 160.0 ft. bgs in depth, and is screened at 140 ft. to 160 ft. bgs. The static water level observed in DC-01 is 150.5 ft. bgs.[329] In my opinion, this is not an ideal upgradient well, because it is not fully hydrologically upgradient from Cow Palace Dairy or other possible sources of nitrogen loading, such as the agricultural fields located above and north of the well. Additionally, groundwater contour maps show that the flow of groundwater is from the northeast and to the southwest,

[329] DAIRIES010820.

meaning the water observed in DC-01 has likely been impacted by at least some surface activities. One of these activities may be manure applications by the D &A Dairy or George DeRuyter & Son Dairy, which own the agricultural field upon which YVD-02 is situated – a field that is upgradient from DC-01.[330] The results of this well are, therefore, higher in nitrate than the other upgradient wells. This well does not represent groundwater that is not impacted by agricultural activity and is not suited for representing true background water quality conditions.

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
DC-01	160	1048.7	AOC - upgradient

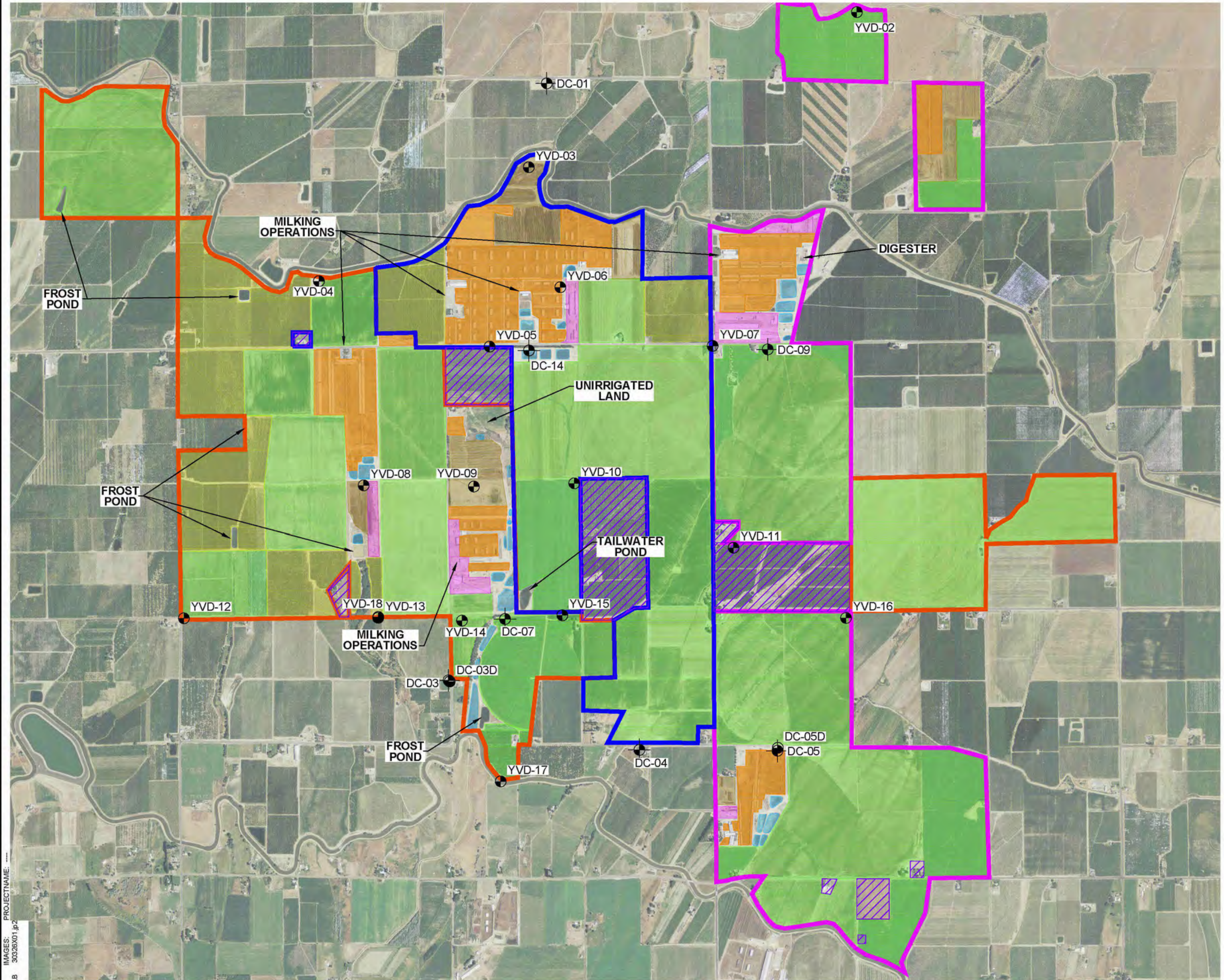
Date	DTW (ft bTOC)	Chloride (mg/l)	Calcium (mg/l)	Nitrate (mg/l)	Phosphorus (mg/l)	Sodium (mg/l)	Sulfate (mg/l)	Magnesium (mg/l)
01/04/13	150.5			9.8				
09/24/13	15.47*	44	88.9	11.1	0.123 J	43	223	32.5
12/11/13	150.49	47.8	91.4	11.5	0.186	41.9	280 J	32.6
03/17/14	unavailable	48.2	90.5	11.2	0.079	40.2	250	31.4
06/02/14	unavailable	41.4	<1.00 J	10	<0.050 J	<0.500 J	224	31.9
* appears to be a transposition error.								

192. In my opinion, the upgradient monitoring well results documented thus far

[330] *See, e.g.*, DAIRIES009814 (groundwater contour map from Third Quarter 2013 sampling event, showing groundwater flow moving across DeRuyter's application field and toward DC-01).

demonstrate that there is little nitrogen loading occurring from any sources upgradient of Cow Palace Dairy. While DC-01 is being affected by some nitrogen source, the rest of the upgradient wells show that the groundwater quality and chemistry is quite different –including lower nitrate and chloride contamination – than that observed in wells downgradient from the facilities.

193. There are downgradient monitoring wells located both on the Cow Palace Dairy, the other Defendants' facilities, and on land located downgradient from Cow Palace. Below is a map showing the location of the relevant wells, along with surface land use activities.



LEGEND:

DC-01 EPA SHALLOW SURFICIAL AQUIFER MONITORING WELL

YVD-10 YVD SHALLOW SURFICIAL AQUIFER MONITORING WELL

DC-03D YVD DEEP SURFICIAL AQUIFER MONITORING WELL

APPROXIMATE BOUNDARY OF DAIRY FACILITIES

RESPONDENTS OWNERSHIP BOUNDARIES

LAND WITHIN BOUNDARY NOT OWNED OR OPERATED BY RESPONDENTS

LAGOONS

IRRIGATED CROPLAND/ORCHARDS

APPLICATION FIELDS

MANURE STORAGE

UNLINED CORALS

SILAGE STORAGE

COW PALACE OWNED PROPERTY

GEORGE DERUYTER & SON OWNED PROPERTY

BOSMA OWNED PROPERTY

NOTE:
ALL LANDS UNDER AGRICULTURAL USE ARE IRRIGATED AND FERTILIZED.

0 2000' 4000'
GRAPHIC SCALE

YAKIMA VALLEY DAIRIES
SDWA-10-2013-0080
GROUNDWATER MONITORING

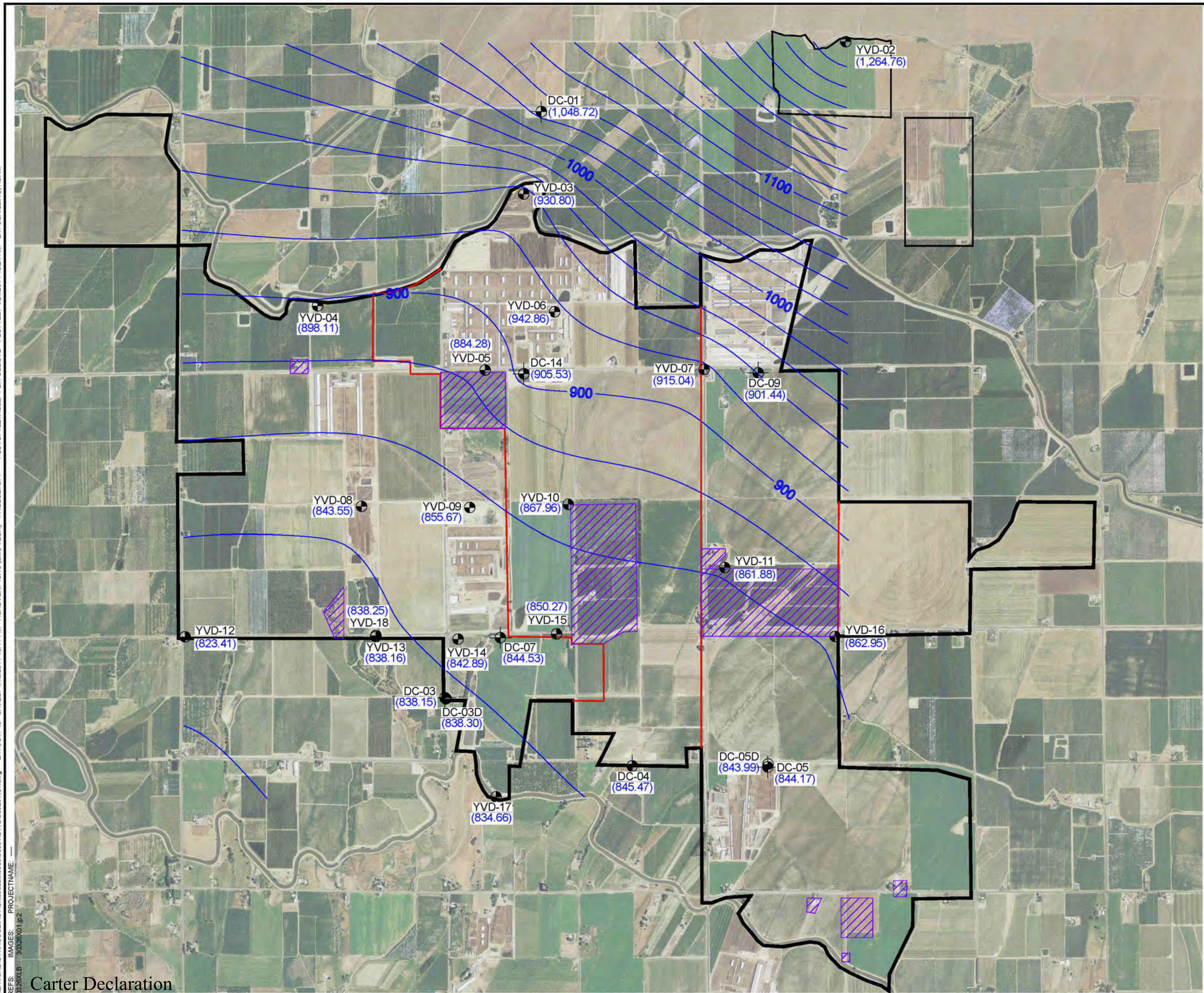
FACILITY PLAN

ARCADIS

FIGURE
3

SOURCE: WASHINGTON 2011 NAIP ORTHO-IMAGERY-18 INCH DATA, WASHINGTON STATE ORTHOIMAGE PORTAL [HTTP://GEOGRAPHY.WA.GOV/ORTHO]

194. From the results that have been obtained thus far, the predominant groundwater flow in the vicinity of Cow Palace Dairy is from the northeast and to the southwest, with some localized variations being more north-south. Two groundwater contour maps showing this flow are reproduced below:



SOURCE: WASHINGTON 2011 NAIP ORTHO-IMAGERY-18 INCH DATA, WASHINGTON STATE ORTHOIMAGE PORTAL [HTTP://GEOGRAPHY.WA.GOV/ORTHO]

LEGEND:

- DC-01 — EPA SHALLOW SURFICIAL AQUIFER MONITORING WELL
- YVD-10 — YVD SHALLOW SURFICIAL AQUIFER MONITORING WELL
- DC-03D — YVD DEEP SURFICIAL AQUIFER MONITORING WELL
- APPROXIMATE BOUNDARY OF DAIRY FACILITIES
- RESPONDENTS OWNERSHIP BOUNDARIES
- LAND WITHIN BOUNDARY NOT OWNED OR OPERATED BY RESPONDENTS
- (930.80) — GROUNDWATER ELEVATION IN FEET MEAN SEA LEVEL (FT MSL)
- GROUNDWATER POTENTIOMETRIC CONTOUR (FT MSL)

NOTE:

GROUNDWATER ELEVATION MEASUREMENTS COLLECTED ON SEPTEMBER 16, 2013

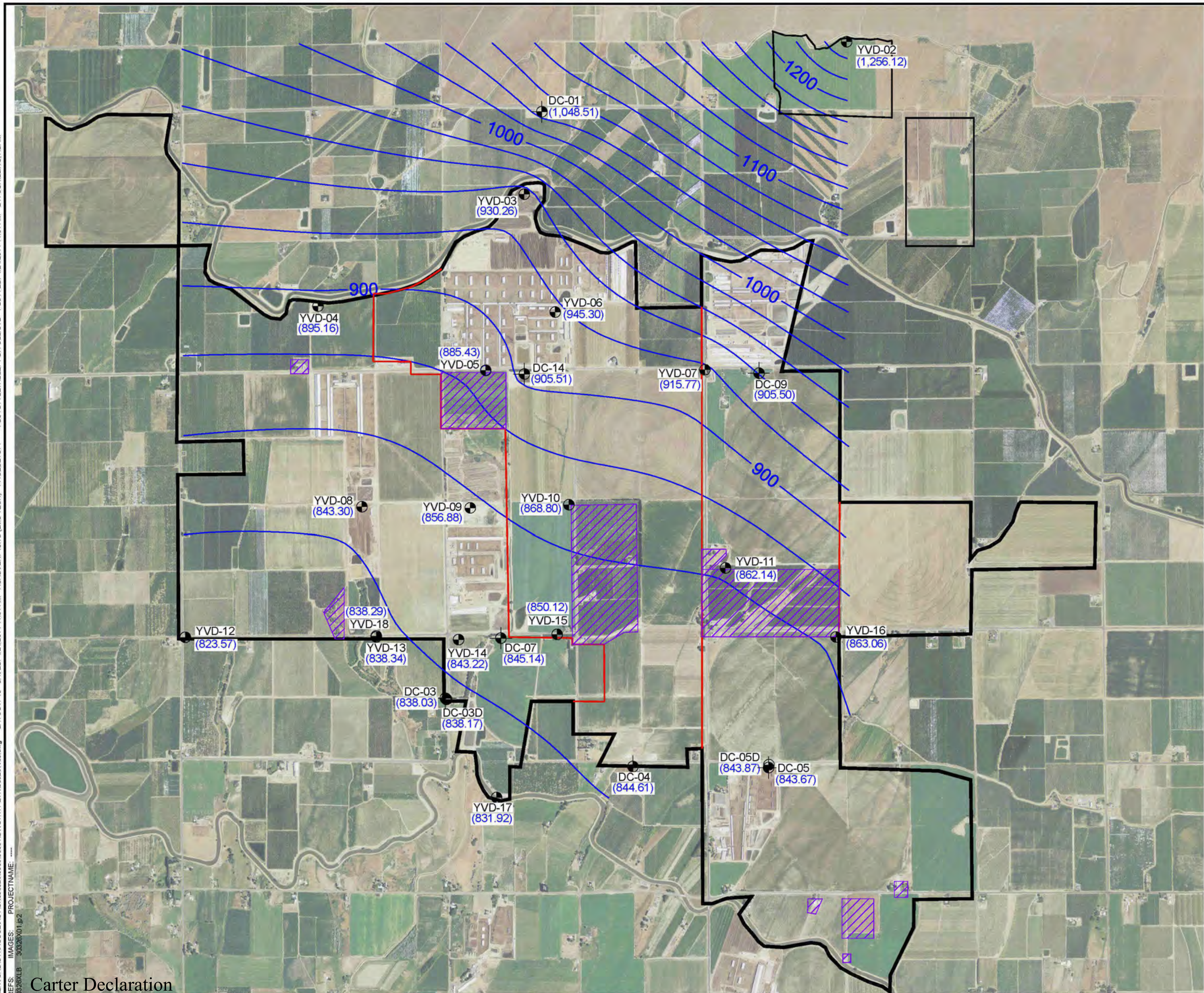
0 2000' 4000'
GRAPHIC SCALE

YAKIMA VALLEY DAIRIES
SDWA-10-2013-0080
GROUNDWATER MONITORING

THIRD QUARTER 2013 GROUNDWATER POTENTIOMETRIC CONTOUR MAP

ARCADIS

FIGURE **15**



LEGEND:

- DC-01 — EPA SHALLOW SURFICIAL AQUIFER MONITORING WELL
- YVD-10 — YVD SHALLOW SURFICIAL AQUIFER MONITORING WELL
- DC-03D — YVD DEEP SURFICIAL AQUIFER MONITORING WELL
- APPROXIMATE BOUNDARY OF DAIRY FACILITIES
- RESPONDENTS OWNERSHIP BOUNDARIES
- LAND WITHIN BOUNDARY NOT OWNED OR OPERATED BY RESPONDENTS
- (868.80) — GROUNDWATER ELEVATION IN FEET MEAN SEA LEVEL (FT MSL)
- GROUNDWATER POTENTIOMETRIC CONTOUR (FT MSL)

NOTE:

1. DATA FROM YVD-06 AND DC-09 WERE NOT USED TO CALCULATE GROUNDWATER ELEVATION CONTOURS
2. GROUNDWATER ELEVATIONS COLLECTED ON DECEMBER 9, 2013

0 2000' 4000'

GRAPHIC SCALE

YAKIMA VALLEY DAIRIES
SDWA-10-2013-0080
GROUNDWATER MONITORING

FOURTH QUARTER 2013 GROUNDWATER POTENTIOMETRIC CONTOUR MAP

ARCADIS

FIGURE
15

SOURCE: WASHINGTON 2011 NAIP ORTHO-IMAGERY-18 INCH DATA, WASHINGTON STATE ORTHOIMAGE PORTAL [HTTP://GEOGRAPHY.WA.GOV/ORTHO]

195. I have reviewed the sampling information obtained from these wells, and discuss the relevant parts in the paragraphs that follow. Produced below are tables summarizing the results of sampling events from both upgradient and downgradient wells.

196. YVD-06 is located within the Cow Palace Dairy facility, just south of a lagoon and east of confinement pens. The well is located at a ground elevation of 1053.88 ft. AMSL and was drilled to a total depth of 169 ft. bgs. The static water level in the well was observed at 110.7 ft. bgs, and the well was screened between 149-168.5 ft. bgs.[331] This means the top of the well screen is 39 feet below the top of the water table and is not sampling groundwater originating near this well site, but rather most likely groundwater originating some distance to the north. I believe this well was drilled and screened within the deeper part of the aquifer in the area, and is not capable of showing nitrate contributions from Cow Palace Dairy to the shallower part of the aquifer, especially considering that the predominant groundwater flow in the area shows that this well is likely intercepting deep groundwater flowing from the northeast.

197. I believe that the sampling results for YVD-06, along with the well screening depth, show that the groundwater intercepted by the well has not been impacted by Cow Palace Dairy's manure management practices. The well was

[331] DAIRIES010820.

sampled on the following dates:

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-06	169	942.8	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)
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
*labeled as "field blank," duplicate labeled YVD-D1								

198. These low nitrate results combined with the presence of low to no cow manure tracer chemicals indicate to me that the water being sampled from YVD-06 is from the areas upgradient of the agricultural area and should be considered a good example of upgradient water quality that is not presently impacted by Cow Palace's manure management practices.

199. YVD-09 is located on the Henry Bosma Dairy facility, which itself is due south of Cow Palace Dairy and southwest of Cow Palace's application fields. The well is located at a ground elevation of 964.28 ft. AMSL, and was drilled to a depth of 122.3 ft. bgs. The static water level is identified as 110 ft. bgs, and the well is screened between 102.3-121.8 ft. bgs.[332] Based on the location of this well, which is downgradient from Cow Palace's application fields, and the sampling results discussed below, Cow Palace's manure management practices have

[332] DAIRIES010820.

contributed to the nitrate contamination observed in the groundwater intercepted by this well. While this well may also be influenced by surface activities at the Henry Bosma Dairy facility, its location downgradient from Cow Palace's application fields means that Cow Palace is a likely contributor to the contamination found in the well.

200. The sampling results for YVD-09 show that the groundwater intercepted by the well has likely been impacted by both Bosma Dairy and Cow Palace. The well was sampled on the following dates:

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-09	122.3	856.8	AOC - downgradient

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)
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

201. These values indicate that the water intercepted by YVD-09 is impacted by manure management practices, likely primarily from Bosma Dairy, but may be in part impacted by Cow Palace, including over-application of manure to fields, leaking lagoons, and pen and compost area infiltration, which have caused excess nitrate to move through the soil and into groundwater, and that that excess nitrate is contributing to the nitrate contamination observed in YVD-09. The nitrate values observed in the well, as well high levels of manure tracers such as sodium, chloride, and sulfate levels, lead me to this conclusion.

202. YVD-10 is located due south of Cow Palace Dairy and south of Cow Palace's application fields. The well is located at a ground elevation of 955.45 ft. AMSL, and was drilled to a depth of 103.1 ft. bgs. The static water level is identified as 90.4 ft. bgs, and the well is screened between 83.1 to 102.6 ft. bgs.[333] Based on the location of this well, which is immediately downgradient from and in a direct groundwater flow path from Cow Palace's application fields, and the sampling results discussed below, Cow Palace's manure management practices have contributed to and are the main cause of the nitrate contamination observed in the groundwater intercepted by this well. While this well may also be influenced by surface activities at the George DeRuyter & Son facility, its location immediately downgradient from Cow Palace's application fields means that Cow Palace is a major contributor to the contamination found in the well.

203. The sampling results for YVD-10 show that the groundwater intercepted by the well has been impacted by Cow Palace Dairy's manure management practices, especially its consistent over-applications to agricultural fields located south of the Dairy and north of the well. The well was sampled on the following dates:

[333] DAIRIES010820.

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-10	103.1	867.6	AOC - downgradient

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)
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

204. These values indicate that the water intercepted by YVD-10 is impacted by Cow Palace's manure management practices. Cow Palace's history of applying manure to its upgradient fields in quantities exceeding agronomic rates, along with the other mentioned manure loading sources, have caused excess nitrate to move through the soil and into groundwater, and that excess nitrate is contributing to the nitrate contamination observed in YVD-10. The nitrate values observed in the well, in addition to the presence of higher amounts of tracer chemicals associated with cow manure, lead me to this conclusion.

205. YVD-14 is located to southwest of Cow Palace Dairy and its application fields, and is south of the Henry Bosma Dairy. The well is located at a ground elevation of 917.64 ft. AMSL, and was drilled to a depth of 91 ft. bgs. The static water level is identified as 77.2 ft. bgs, and the well is screened between 71-90.5 ft. bgs.[334] Based on the location of this well, which is downgradient from Bosma

[334] DAIRIES010820.

Dairy and Cow Palace's application fields, and the sampling results discussed below, I believe that Cow Palace's manure management practices may have contributed to the nitrate contamination observed in the groundwater intercepted by this well. While this well is influenced by surface activities at the Henry Bosma Dairy facility, its location downgradient from Cow Palace's application fields, as depicted in Arcadis' groundwater contour map, means that Cow Palace is a likely contributor to the contamination found in the well.

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-14	91	843	AOC - downgradient

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)
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 J	64.50
06/04/14	unavailable	109	240 J	102	0.078 J	112 J	191	63.2

206. These values indicate that the water intercepted by YVD-14 may be impacted by Cow Palace's manure management practices (along with the practices at the Henry Bosma Dairy facility). Cow Palace's history of applying manure to its upgradient fields in quantities exceeding agronomic rates, along with the other mentioned manure loading sources, have caused excess nitrate to move through the soil and into groundwater, and that excess nitrate is contributing to the nitrate contamination observed in YVD-14. The degree to which Cow Palace is contributing to the likely loading from Henry Bosma Dairy requires further investigation. In any case, the nitrate values observed in the well, in addition to the presence of higher amounts of tracer chemicals associated with cow manure, lead me to the conclusion that manure is causing the problem at this well.

207. YVD-15 is located to the south of Cow Palace Dairy and its application fields. The well is located at a ground elevation of 938.08 ft. AMSL, and was drilled to a depth of 105.1 ft. bgs. The static water level is identified as 91.4 ft. bgs, and the well is screened between 85.1-104.6 ft. bgs.[335] The location of this well is immediately downgradient from Cow Palace's application fields and entire Cow Palace Dairy, and is therefore a very good well for evaluating the groundwater impacts from this CAFO. Based on this location and the sampling results discussed below, I believe that Cow Palace's manure management practices have contributed to the nitrate contamination observed in the groundwater intercepted by this well.

208. In my opinion, the sampling results for YVD-15 show that the groundwater intercepted by the well has been impacted by Cow Palace Dairy's manure management practices, especially its consistent over-applications to agricultural fields located south of the Dairy and north of this well. The well was sampled on the following dates:

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Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
YVD-15	105.1	849.2	AOC - downgradient

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)
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

209. In my opinion, these values indicate that the water intercepted by YVD-15 is impacted by Cow Palace's manure management practices. I believe Cow Palace's history of applying manure to its upgradient fields in quantities exceeding agronomic rates has caused excess nitrate to move through the soil and into groundwater, and that that excess nitrate is contributing to the nitrate contamination observed in YVD-15. The nitrate values observed in the well, in addition to the presence of higher amounts of trace chemicals associated with cow manure, lead me to this conclusion.

210. DC-14 is one of the EPA wells located south of the Cow Palace Dairy facility and just north of Lagoons 3, 4, and 5. The well is located at a ground elevation of 1036.92 ft. AMSL, and was drilled to a depth of 151 ft. bgs. The static water level is identified as 130 ft. bgs, and the well is screened between 128.5-148.5 ft. bgs.[336] 18 feet of the well screen is below the water table, meaning

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this well is likely mixing with a significant amount of upgradient groundwater and leachate from Cow Palace. I believe this well is situated in an area where it is likely to show whether contamination from the Dairy facility itself is impacting groundwater. Based on the sampling results discussed below, I believe that Cow Palace's manure management practices – including lagoons that leak manure, cow pens that have substantial nitrate build-up, and potentially the composting area – have contributed to the nitrate contamination observed in the groundwater intercepted by this well.

211. In my opinion, the sampling results for DC-14 show that the groundwater intercepted by the well has likely been impacted by Cow Palace Dairy's manure management practices. The well was sampled on the following dates:

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
DC-14	151	906.6	AOC - downgradient

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)
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

212. In my opinion, these values indicate that the water intercepted by DC-14 is impacted by Cow Palace's manure management practices. I believe Cow Palace's storage of manure in unlined earthen lagoons, composting of manure on unlined surfaces, and keeping of animals in unlined confinement pens, where manure is allowed to accumulate, has caused nitrate to enter the ground, and that that nitrate is contributing to the contamination observed in DC-14. The nitrate values observed in the well, in addition to the presence of trace chemicals associated with cow manure, especially chloride and sodium, lead me to this conclusion. The fluctuation of water quality values at this location is likely due to the rapid groundwater flow rate in this part of the project area. There may also be seasonal impacts from the irrigation canal, which would only recharge groundwater during the irrigation season, while lagoons and pens would have leaching potential year-round.

213. DC-3 is one of the EPA wells located south of the Cow Palace Dairy facility and south of the Henry Bosma Dairy. The well is located at a ground elevation of 911.04 ft. AMSL, and was drilled to a depth of 85 ft. bgs. The static water level is identified as 72.4 ft. bgs, and the well is screened between 62.5-82.5 ft. bgs.[337] DC-03 is a shallow well, intended to intercept groundwater found in the shallower level of the aquifer. Based on the sampling results discussed below, I believe that Bosma Dairies and Cow Palace's manure management practices, including the over-application of manure to Cow Palace's fields located upgradient from DC-03,

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have contributed to the nitrate contamination observed in the groundwater intercepted by this well.

214. The sampling results for DC-03 show that the groundwater intercepted by the well has potentially been impacted by Cow Palace Dairy's manure management practices, although Henry Bosma Dairy is likely the major source. The well was sampled on the following dates:

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
DC-03	85	838.2	AOC - downgradient

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)
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 J	66.80
06/04/14	unavailable	201	259 J	234	0.120 J	177 J	214	67.7

215. In my opinion, these values indicate that the water intercepted by DC-03 is impacted by both Bosma Dairies' and Cow Palace's manure management practices. Even though DC-03 is located close to the Bosma Dairies, another nitrogen loading source, Cow Palace's consistent over-application of manure to fields upgradient of DC-03 has caused nitrate to enter the ground, and that that nitrate is likely contributing to the contamination observed in DC-03. The very high nitrate values observed in the well, in addition to the presence of tracer chemicals associated with cow manure such as chloride, calcium, sodium, and sulfate lead me to this conclusion.

216. DC-03D is located adjacent to DC-03. The well is located at a ground elevation of 908.83 ft. AMSL, and was drilled to a depth of 116.1 ft. bgs. The static water level is identified as 73 ft. bgs, and the well is screened between 106.1-115.6 ft. bgs.[338] DC-03D is considered a "deep" well pair to DC-03. Based on the sampling results discussed below, Cow Palace's manure management practices, including the over-application of manure to fields located upgradient from DC-03D, may have contributed to the nitrate contamination observed in the groundwater intercepted by this well. Similar to DC-03, Bosma Dairies' operations are also a contributor to the water quality observed in this well.

217. The sampling results for DC-03D show that the groundwater intercepted by the well has likely been impacted by Cow Palace Dairy's manure management practices. The well was sampled on the following dates:

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
DC-03D	116.1	838.3	AOC - downgradient

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)
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 J	43.90
06/03/14	unavailable	65.5	<1.00 J	42.0	<0.050 J	<0.500 J	103	40.9

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218. These values indicate that the water intercepted by DC-03D is likely impacted, in part, by Cow Palace's manure management practices along with those of Henry Bosma Dairy. Cow Palace's consistent over-application of manure to fields upgradient of DC-03 has caused nitrate to enter the ground, and that nitrate is contributing to the contamination observed in DC-03D. The exact contribution from Cow Palace Dairy and Bosma Dairies cannot be fully determined without further investigation, but each are significant contributors. The high nitrate values observed in the well, in addition to the presence of tracer chemicals associated with cow manure similar to those found in the shallow well, lead me to this conclusion.

219. DC-04 is located south and slightly southwest of Cow Palace Dairy and its application fields. The well is located at a ground elevation of 877.62 ft. AMSL, and was drilled to a depth of 51 ft. bgs. The static water level is identified as 32.6 ft. bgs, and the well is screened between 29.5-49.5 ft. bgs.[339] Based on the sampling results discussed below, I believe that Cow Palace's manure management practices, including the over-application of manure to fields located upgradient from DC-04, have contributed to the nitrate contamination observed in the groundwater intercepted by this well.

220. The sampling results for DC-04 show that the groundwater intercepted by

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the well has likely been impacted by Cow Palace Dairy's manure management practices. The well was sampled on the following dates:

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
DC-04	51	844.6	AOC - downgradient

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)
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 J	28.00
06/03/14	unavailable	36.2	<1.00 J	36.4	<0.050 J	<0.500 J	104	28.9

221. These values indicate that the water intercepted by DC-04 is impacted by Cow Palace's manure management practices, and possibly DeRuyter Dairies' fields as well. Cow Palace's consistent over-application of manure to fields upgradient of DC-04, particularly Fields 4A and 4B, have caused nitrate to enter the ground, and that nitrate is contributing to the contamination observed in DC-4. The nitrate values observed in the well, in addition to the presence of tracer chemicals associated with cow manure, lead me to this conclusion.

222. I have also reviewed the well installation and sampling information data for DC-07, which is located at the south end of Liberty Dairy, close to the southwest corner of Cow Palace Field 2. I understand that Cow Palace pipes water that runs onto its property from nearby neighbors through its fields, down to the corner of

Field 2, where it is discharged into a drainage system. Based on the location of DC-07, the sampled water chemistry from the well and the adjacent tailwater recovery pond, and the fact that excess irrigation water is being discharged nearby, I believe that the groundwater intercepted by this well has been diluted and mixed with cleaner water, thereby influencing the water quality of DC-07. Plaintiffs obtained a water quality sample from the tailwater recovery pond on October 30, 2013, during their site inspection. The chemistry of that water showed, in relevant part, that it had 11 mg/L chloride, 5 mg/L sulfate, 0.34 mg/L nitrate as nitrogen, 3.2 mg/L nitrogen as ammonia, 4.51 mg/L total phosphorus, 38 mg/L calcium, 12 mg/L magnesium, and 12 mg/L sodium.[340] This chemistry is similar to what has been observed in DC-07. That well, which is drilled to 61 ft. bgs and screened between 38.5 and 58.5 bgs., has a static water table of 44.1 ft. bgs.[341] The sampling data, presented in the chart below, contains similar water chemistry results to that observed in the tailwater recovery pond:

[340] Laboratory Analytical Report from Energy Laboratories, dated November 27, 2013, Lab ID H13110003-003.
[341] DAIRIES010820.

Well	Well Depth (ft bgs)	Water Table Elevation (ft AMSL) (reported once in well installation rpt)	AOC-upgradient/ AOC-downgradient/ Background
DC-07	61	845.2	AOC - downgradient

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)
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

223. The results show that the water intercepted by DC-07 is being impacted by several sources. Based on the similarity in water chemistry between the well and the water in the tailwater recovery pond, including low nitrogen, nitrate, chloride, and phosphorus levels, I believe that the well is significantly influenced by seepage from the tailwater recovery pond and from the drainage ditch into which excess irrigation water is discharged. As such, I do not believe DC-07 is a representative well to evaluate nitrogen contributions from upgradient sources, such as Cow Palace Dairy.

224. The EPA also sampled a number of downgradient wells from Cow Palace as part of their study. The results of those samples are discussed below:

a. WW-11. This downgradient well, located southwest of Cow Palace and its application fields, and south and west of Henry Bosma Dairy operations, had 23 mg/L nitrate (noted in terms of parts-per-million or "ppm"). Recent sampling of this well found 64 ppm nitrate N.

b. WW-12. This downgradient well, located to the south-southwest of Cow Palace and south of Henry Bosma Dairy, had 46.7 mg/L nitrate.

c. WW-13. This downgradient well, located to the south-southwest of Cow Palace and Henry Bosma Dairy, had 44.4 mg/L nitrate.

d. WW-14. This downgradient well, located to the south-southwest of Cow Palace and Henry Bosma Dairy, had 43.4 mg/L nitrate.

e. WW-15. This downgradient well, located to the south of Cow Palace and its application fields, had 30.2 mg/L nitrate.

f. WW-16. This downgradient well, located to the south of Cow Palace and adjacent to Cow Palace application fields, had 23.4 mg/L nitrate.

g. WW-17. This downgradient well, located to the south of Cow Palace and adjacent to Cow Palace application fields, had 22.7 mg/L nitrate.[342]

225. These high, downgradient results for nitrate, along with the data that has been collected by Cow Palace under the AOC, demonstrate that Cow Palace's manure management, storage, and application practices have contributed to the nitrate contamination of the groundwater.

226. I have also reviewed laboratory results from water samples collected from wells at Cow Palace employee housing during the fall of 2012.[343] I understand that those samples were provided to Plaintiffs by The Dolsen Companies, a member of

[342] EPA Report at 52, Table 20.
[343] DOLSEN002078-2085.

Cow Palace, LLC, in response to Plaintiffs' subpoena for certain documents.[344] All but one of those samples showed levels of nitrate above 10 mg/L; those results are produced below:

Sample Location	Date	Nitrate	Units
41 Knowles Rd	9/11/12	72.8	mg/L
51 Knowles Rd	9/11/12	14.5	mg/L
101 Knowles Rd	9/11/12	31.4	mg/L
461 Knowles Rd	9/11/12	40	mg/L
510 Arms Rd. (illegible handwritten note)	9/11/12	34.2	mg/L
3905 Isabella Way (street name crossed out; no other street name listed)	9/11/12	59.5	mg/L
3770 E. Zillah Dr.	9/11/12	30.6	mg/L
6891 East Zillah Dr.	9/11/12	9.18	mg/L

227. Overall, based on the totality of groundwater sampling data I have reviewed, and considering that data with reference to Cow Palace's history of manure over-applications, storage of manure in unlined lagoons, and composting and keeping of cows on permeable soils, Cow Palace's manure management, storage, and application practices have caused and contributed to the nitrate contamination of the groundwater. Groundwater observed from wells hydrologically upgradient from Cow Palace has very little nitrate and chemical tracers associated with cow manure. On the other hand, the groundwater observed downgradient from Cow

[344] I understand that there are various entities related to Cow Palace, including The Dolsen Companies and Three D Properties, who may own some of the residential properties on which Cow Palace dairy employees reside.

Palace shows high levels of nitrate and the elevated concentrations of chloride, calcium, magnesium, sodium, sulfate, and other chemical tracers associated with cow manure. In light of all this data, there is no reasonable question that Cow Palace has caused or contributed to the nitrate contamination of the groundwater.

228. Based on the groundwater contour maps I have seen and the general flow pattern observed, it is likely that Cow Palace Dairy's manure management, storage, and application practices have also impacted other wells identified in the AOC study area. The exact contributions cannot be determined without further investigation.

RECOMMENDATIONS ON REMEDIAL EFFORTS AT COW PALACE DAIRY

229. I have concluded above that Cow Palace Dairy has consistently over-applied manure to its fields and, as a result, caused or contributed to the nitrate contamination observed in local groundwater. In order to remedy these problems, I propose the following solutions.

230. First, given the number of residential homes located near the facility that rely upon groundwater for drinking water, Cow Palace Dairy should be required to provide and maintain alternative water supplies to any home within a three mile radius of the facility that has a well which tests higher than 5 mg/L nitrate. This could include the installation of a reverse osmosis and activated carbon machine maintained by a third party contractor or the provision of clean, bottled water. The presence of several trace organics indicates that both nitrate removal and activated carbon treatment should be used. Cow Palace should be required to test the well of any residence which accepts an alternative water supply twice per year, and should continue to provide an alternative water supply until the levels of nitrate are consistently less than 5 mg/L (at least three tests consecutively). All outreach, communication, testing, and provision of alternative water supplies should be completed by a neutral third-party. These treatment systems should be maintained and water supplies sampled until the area's groundwater drops below 5 mg/l.

231. Second, the parties should work cooperatively to specifically identify and remediate all sources of contributions of contaminants to the groundwater. This includes application fields, pens, lagoons, composting areas, tailwater ponds, and any other possible nitrogen and related contaminant sources. Cow Palace should be required to work cooperatively with Plaintiffs and their experts throughout this investigation, including agreement about assessment completion and remedial action and implementation.

232. Third, because they are an obvious contributor to the nitrate found in the groundwater, Cow Palace should be required to line all manure storage impoundments (excepting concrete impoundments already in existence) with an appropriate double-lined synthetic liner with leak detection system. Given the amount of manure generated by Cow Palace, I believe it would be appropriate for

Cow Palace to line its lagoons, beginning with the oldest first, at a rate of three per year.

233. Fourth, to address the major issues with Cow Palace's manure application practices, Cow Palace should be required to develop an independent, scientifically-based nutrient management plan that requires the following:

a. Accurately sample and analyze all nutrient sources, including lagoons, honeywagon manure, compost, and other fertilizers, before application occurs, and apply the appropriate nutrient credits for each. Each lagoon should be thoroughly mixed prior to collecting manure samples.

b. Accurately measure the amount of each crop harvested, including total tons per acre, moisture content, and total nitrogen and total phosphorus content. Use this data to quantify nutrients removed from each field for future application planning.

c. Before any manure is applied to a field, calculate the actual nitrogen and phosphorus expected to be removed by the new crop, based on yield data over the past 5 years, and subtract from this the available nutrients already in the top two feet of the field based on pre-application soil sampling, the amount of nitrogen that would be released from soil organic matter mineralization, and the amount of nitrogen that should be credited from past manure and alfalfa credits. Only if this results in additional needs for nitrogen or phosphorus should any additional manure or fertilizer be applied to the field and only at amounts needed by the next crop.

d. Manure applications are to be timed as close as possible to the stage when the crop will use the nutrients. No liquid manure shall be applied to frozen soil or during the months of December, January, or February.
e. All manure shall be incorporated within 3 days of application unless applied to a growing crop.
f. An irrigation schedule designed to minimize the leaching of nutrients from application fields, with stringent record-keeping requirements.
g. No manure or other fertilizer is to be applied to fields that exceed 25 ppm nitrate plus ammonium at the 0”-24” level or 30 ppm phosphorus at the 0”- 12” level. Soil samples should be taken by agreed-upon third-party at Defendants’ expense, with Plaintiffs retaining access to all samples.
h. A requirement that the Dairy have one acre of land per animal unit for manure applications in the future once nutrient levels in fields have been satisfactorily reduced. Alternatively, Cow Palace could compost and export all manure produced above the one acre per animal amounts to facilities that can use manure safely, within agronomic rates. In order to ensure that such facilities are capable of using the manure safely,

publicly-available export logs shall be kept identifying:

i. Name and address of recipient;

ii. Date of shipment;

iii. Quantity shipped;

iv. Certification that recipient shall use manure safely;

v. Nitrate test results shall not exceed 25 ppm at 0”-24” level;

vi. Phosphorus test results shall not exceed 30 ppm at 0”-12” level;

vii. Results of nitrate, ammonium, total nitrogen, and total phosphorus content in each shipment, identifying the source of manure (e.g., lagoon, compost system, separator);

viii. Confirmation the recipient has not been found in violation of land application laws within the last 5 years.

234. In addition, Cow Palace should be required to compost on a lined pad constructed of concrete or similarly impervious material. This will ensure that the transport of nitrate through leaching is minimized. The maximum permeability of the material shall not exceed 1x10-9 cm/second, all joints must be watertight (using waterstop devices or similar), and the design must include provisions to collect leachate and runoff from lined areas and stored in a lined lagoon until land spread. Plaintiffs should have access to Cow Palace’s construction plans and specifications for review and approval prior to construction, along with Defendants construction QA/QC testing results. Cow Palace should also be required to provide access during construction so that independent, third-party QA/QC testing may be conducted.

235. Furthermore, Cow Palace should be required to line its cow pens at a rate of at least two per year until complete. This will ensure that the transport of nitrate through leaching from the cow pens is minimized. The maximum permeability of the material shall not exceed 1x10-9 cm/second, all joints must be watertight (using waterstop devices or similar), and the design must include provisions to collect leachate and runoff from lined areas. Plaintiffs should have access to Cow Palace's construction plans and specifications for review and approval prior to construction, along with Defendants construction QA/QC testing results. Cow Palace should also be required to provide access during construction so that independent, third-party QA/QC testing may be conducted.

236. Finally, Cow Palace should be required to obtain the General National Pollutant Discharge Elimination System Permit CAFO permit (individual if desired or required). The CAFO permit contains record-keeping and nutrient management requirements that will work to minimize the amount of excess nitrogen that enters Cow Palace's fields. Because the current permit is set to be replaced, I believe Cow Palace should be required to obtain the current permit and any newly-issued permit by the Washington Department of Ecology.

Dated: September 22, 2014

Byron H. Shaw, Ph.D.
Professor Emeritus, Water Resources
University of Wisconsin, Stevens Point

Byron H. Shaw, Ph.D.
Curriculum Vitae
September 2014

Education
- Bachelor of Science, soil science, University of Wisconsin, Madison (1964).
- Master of Science, soil science, University of Wisconsin, Madison (1966).
- Ph.D., soil science (major), water chemistry (minor), University of Wisconsin, Madison (1968).

Experience
- Soil and water Consultant (2000-present).
- Emeritus Professor Water Resources, University of Wisconsin-Stevens Point, College of Natural Resources (2001).
- Professor of soil and water science, University of Wisconsin-Stevens Point, College of Natural Resources (1978-Present).
- Associate Professor (1973-78), Assistant Professor (1968-73), University of Wisconsin-Stevens Point, College of Natural Resources.
- Discipline Coordinator, Water Resources, University of Wisconsin-Stevens Point, College of Natural Resources (1983-86).
- Water Resource Specialist, University of Wisconsin-Extension (1977-2000).
- Director, Environmental Task Force Program, University of Wisconsin-Stevens Point, College of Natural Resources (1973-2000).
- Major Professor to over 50 MS graduate students (1971-2000).

Courses Taught (last 5 years at University of Wisconsin-Stevens Point)
- Water 492/692 - Advanced Techniques of Environmental Analysis
- Water 350 - Current Issues in Water Resources
- Water 475/675 - Groundwater Management
- Water 381 - Internship - Supervise about 40 interns/semester in ETF Lab
- Water 499 - Special Studies
- Water 799 - Thesis, advise four-six graduate students/semester
- Water 385/585 - Techniques in Hydrogeology
- NR 475 - International Environmental Studies

Publications (past 10 years)
- Russelle, M.P., J.F.S. Lamb, M.B. Turyk, B.H. Shaw and B. Peterson. 2007. Managing Nitrogen Contaminated Soils: Benefits of N2-Fixing Alfalfa. Agron. J. 99:738-746.

Consulting activities (past 4 years)
Byron Shaw Soil and Water Consulting, LLC

- Midwest Environmental Advocates: reviewed and commented on nutrient management plan and related documents relative to a dairy CAFO expansion and potential environmental impacts; testified at hearing in February, 2014 (2012-2014).
- Law Offices of Charles M. Tebbutt: reviewed documents and presented opinion relative to groundwater pollution from dairies in Yakima Valley, WA (2013).
- Cornelli Law Group: reviewed data and depositions in case *Preisler v. Kuettel's Septic Service, Inc.*; produced report on likely source of nitrate to groundwater (2012).
- Nick Karris, Nekoosa Farms: reviewed application material for proposed Golden Sands Dairy and Comment Letter to DNR for EIS development (2012).
- Monterey Coastkeeper: reviewed and commented on nutrient management plan for Gallo Farms, Monterey CA (2010).
- Law Offices of Charles M. Tebbutt: reviewed groundwater data and proposed groundwater monitoring program for Faria Dairy CAFO in central WA (2009-10).
- Town of Little Black, Taylor Co., WI: reviewed and commented on environmental adequacy of nutrient management plan for a proposed 5000+ head dairy operation (2009-10).
- Town of Magnolia: reviewed Nutrient Management Plan and evaluated environmental impacts from a large dairy operation; testified at several town Board hearings (2007-10).

Depositions and trials (past 4 years)

- *In the Matter of the Wisconsin Pollutant Discharge Elimination System Permit No. WI-0059536-03-0 (WPDES Permit) Issued to Kinnard Farms, Inc.*, Case No. IH-12-071: testified in administrative law hearing on case involving dairy expansion (Feb. 2014).
- *Community Association for Restoration of the Environment, Inc. (CARE) vs. Nelson Faria Dairy*, Case No. CV-04-3060-LRS (E.D. Wash.): testified on nutrient contributions to groundwater and need for groundwater monitoring (2011).

Presentations (past 10 years)

- Keynote presentation: "Do Current Laws and Policies Protect Wisconsin's Water Resources?," Wisconsin Association of Land Conservation Employees annual meeting, 2007.

Committees and boards (past 10 years)

- Phosphorus Standards Advisory Committee, Wisconsin Dept. of Natural Resources (2008-2010).
- River Alliance of Wisconsin, Member-Board of Directors (2002 to 2010).

Awards

- Wisconsin Clean Water Achievement Award. Wisconsin Dept. of Natural Resources (2002).
- Emeritus Professor, Water Resources, University of Wisconsin Stevens Point (2001)
- Distinguished Service Award, American Water Resources Association-Wisconsin chapter (2000).
- Distinguished Service Award, University of Wisconsin Stevens Point (2000).

Professional Licenses

Wisconsin Professional soil scientist #104-112

Wisconsin Professional Hydrologist #162-111

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

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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												

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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