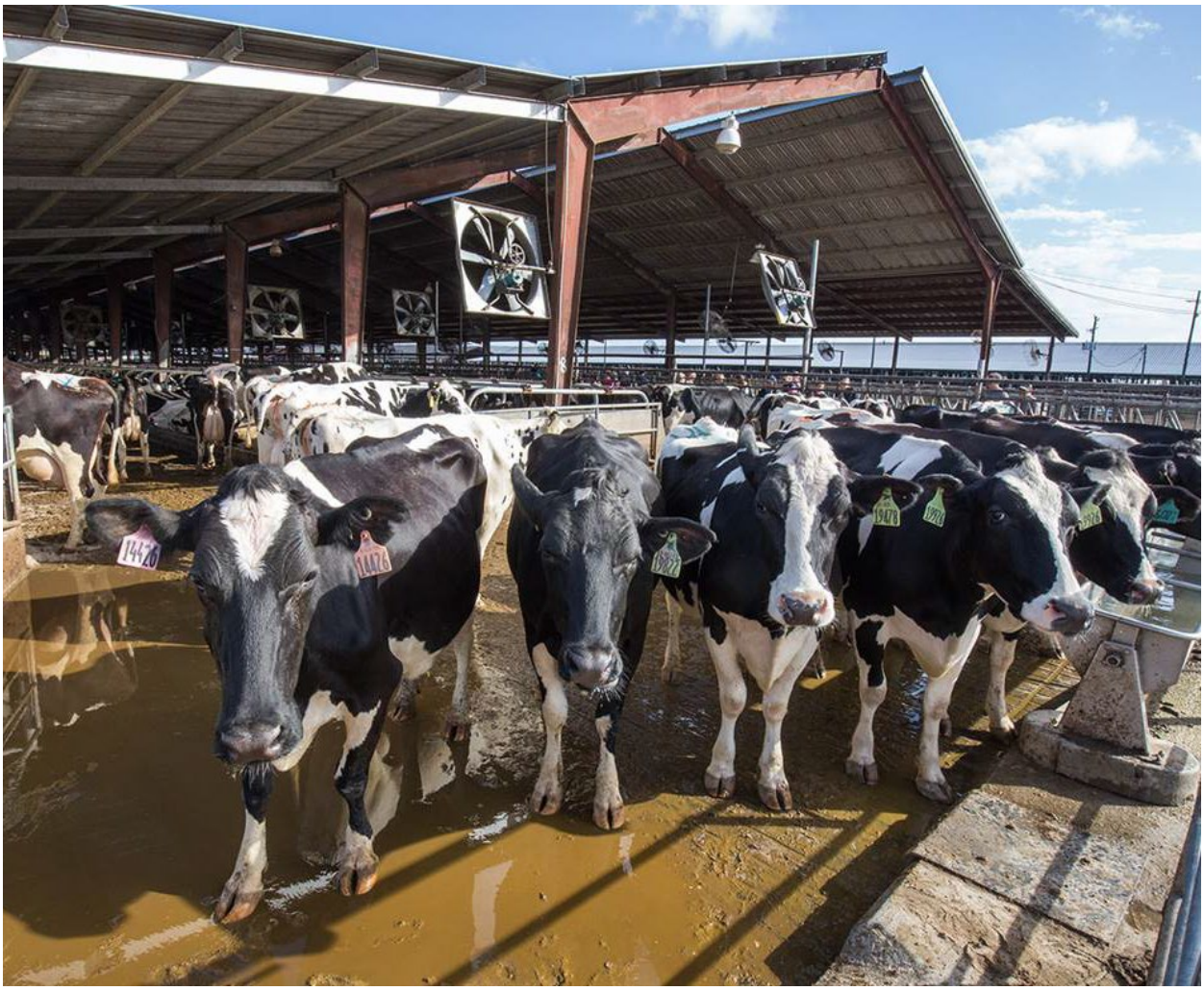
Nitrate Contamination and Groundwater Depletion by Dairy Farms Located in North Florida's Springs Region



A Special Report by:

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List of Acronyms and Abbreviations

BMAP……Basin Management Action Plan

BMP……Best Management Practice

CAFO……Concentrated Animal Feeding Operation

F.A.C……Florida Administrative Code

FAS……Floridan Aquifer System

FDACS……Florida Department of Agriculture and Consumer Services

FDEP……Florida Department of Environmental Protection

FDOH……Florida Department of Health

FSI……Florida Springs Institute

Mgd……Million gallons per day

N……Nitrogen

N_2…… Nitrogen gas

NMP…… Nutrient Management Plan

NO_2-N…… …. Nitrite nitrogen

NO_3-N……Nitrate nitrogen

NOx-N…… …. Nitrate+nitrite nitrogen

NSILT…… ……Nutrient Source Inventory Loading Tool

OFS…… ……Outstanding Florida Spring

Org-N…… Organic nitrogen

PPM…… Parts per million

PWS……Public Water System

SRA…… Springs Restoration Area

TMDL…… Total Maximum Daily Load

USDA……U.S. Department of Agriculture

WHO……World Health Organization

WMD…… Water Management District

WUP……Water Use Permit

Acknowledgements

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Report authors were Dr. Robert Knight, President of the Howard T. Odum Florida Springs Institute (FSI) and Heather Vick, retired hydrogeologist with the Washington State Department of Ecology.

Reviewers included Dr. Robert Palmer and Dr. Stephen Walsh, both members of the FSI board of directors; Haley Moody, FSI executive director; and Sky Notestein, FSI environmental scientist.

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Executive Summary

The Howard T. Odum Florida Springs Institute (FSI) conducted an evaluation of the potential impacts of dairy farms on Outstanding Florida Springs (OFS) and other surface and groundwater resources in the North Florida Springs Region with a focus on the Suwannee Springs Restoration Area (SRA, Figure 1). At least fifteen large dairy Confined Animal Feeding Operations (CAFOs) are permitted to operate in this region with a combined population of more than 72,000 dairy cows are permitted to operate in this region. An estimated additional 13,558 dairy cows are kept on at least 36 non-permitted dairies that are below the Florida Department of Environmental Protection (FDEP) CAFO threshold of 700 cows (non-CAFO dairies). Design, management, and operational information from these dairies were collected and reviewed for this dairy impact assessment, with emphasis on the 15 permitted dairies who collect and report groundwater monitoring data to state regulators.

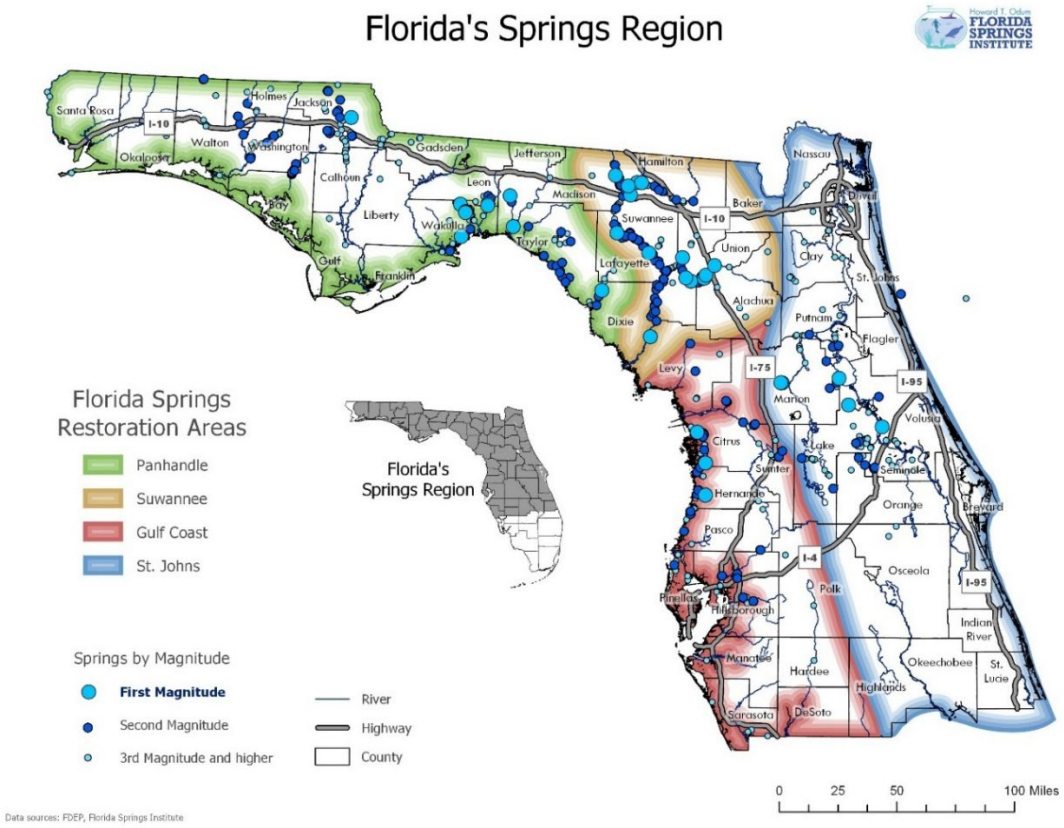

Figure 1. Map of the Florida Springs Region showing locations of all 1st, 2nd, and 3rd magnitude artesian springs. The Florida's Springs Region is divided into four groundwater basins that are identified as Springs Restoration Areas (SRA). This report focuses on potential impacts by dairies located in the northern portion of the Florida Springs Region, primarily in the Suwannee SRA.

These large and smaller dairies produce a combined estimated nitrogen (N) waste of 20 million pounds (lbs-N/y) per year. Following waste treatment and natural attenuation, a sizable portion of this nitrogen load, or about 2.1 million lbs-N/y, is estimated to reach the Floridan Aquifer System (FAS) that exists below ground throughout the Florida Springs Region. This excessive nitrogen load contributes to impairment of north Florida springs/river health and pollution of the regional FAS potable water supply.

Groundwater monitoring in and around these dairies indicates that nitrate-nitrogen (NOx-N) concentrations are frequently elevated in monitor wells and in the area's natural artesian springs. Years of CAFO dairy groundwater monitoring, including sampling from background, intermediate, and compliance monitor wells, has demonstrated widespread incidences of nitrate concentrations above the state drinking water criterion of 10 milligrams of nitrogen per liter (mg-N/L). Exceedance of this benchmark in drinking water may result in acute nitrate toxicity (methemoglobinemia) in babies and seniors. Ongoing research worldwide indicates that nitrate concentrations much less than 10 mg-N/L in drinking water supplies are also implicated in a variety of chronic human health outcomes, including several cancers and birth defects. A review of local public health records from the counties with the highest north Florida dairy cow populations indicates that there is an above average incidence of colorectal cancer in the study area (Centers for Disease Control 2025; Florida Health Charts 2025).

The region's OFS are vulnerable to much lower nitrate levels than the 10 mg-N/L drinking water criterion. Sensitive biotic communities in the Suwannee SRA (and in all other SRAs) are considered by FDEP to be impaired by an average nitrate concentration exceeding the Total Maximum Daily Load (TMDL) of 0.35 mg-N/L. Based on regional nitrate levels above this criterion in 2018 and again in 2025 FDEP implemented Basin Management Action Plans (BMAPs) for all OFS in this region. The 2025 Suwannee River BMAP calls for a reduction of existing nitrogen loads to the Floridan Aquifer by 85 percent for all sources, including permitted and unpermitted dairies (FDEP 2025). Our evaluation indicates that given the practical limitations of existing nitrogen load reduction methods, the dairy herd size at these 51 permitted and unpermitted dairy farms should be reduced by as many as 72,000 cows to achieve this legal mandate.

The large and smaller dairies included in this study consume an estimated 48 million gallons per day of potable groundwater for cow watering, cooling, washing, and crop irrigation. Existing spring and river flows in the Suwannee River groundwater basin are already below regulatory minimum levels (*e.g.*, Fanning and Manatee) due to regional and local groundwater pumping. Minimum flows in the Santa Fe and Ichetucknee Rivers, both tributary to the Suwannee, are exceeded and these rivers and their feeder springs are included in a regional groundwater flow recovery strategy. In addition to unacceptable nitrate nitrogen pollution, groundwater withdrawals by these dairies result in lower spring and river flows adding to the regional impairment of surface water resources.

Based on this review and analysis of dairy contributions to aquifer pollution and depletion, FDEP should initiate efforts to correct documented deficiencies with CAFO and non-CAFO dairy management, monitoring, and permit compliance. FDEP''s Industrial Wastewater Program should maintain and publish a list of all dairies in Florida updated at least annually. A recommended second step is to require FDEP to provide greater regulatory oversight and groundwater monitoring at non-CAFO dairies.

FDEP should also expeditiously enforce the 2025 Suwannee River BMAP by requiring both permitted and unpermitted dairies to reduce their nitrogen loads to the aquifer to comply with the state's 85 percent nitrogen load reduction target. Based on scientific evidence reviewed for this report, implementation of dairy Best Management Practices (BMPs) for this necessary nitrogen load reduction is not a viable or defensible approach to achieve the Suwannee River BMAP nitrogen reduction goals.

Given the known links between elevated nitrogen concentrations in potable groundwater and human cancers, the Florida Department of Health (FDOH) should conduct an epidemiological investigation of private and public drinking water supplies around all the North Florida Springs Region dairies and work with FDEP and the U.S. Environmental Protection Agency to lower the 10 mg-N/L compliance level for potable groundwater nitrate concentrations to better protect public health.

FSI concludes that the State of Florida has been ineffective at controlling and minimizing the pollution caused by dairy operations in the North Florida Springs Region and Suwannee SRA. Dairies, both large and small, are industrial milk factories. Like other for-profit corporations, dairies that are negatively affecting the environment and public health need to be accountable and to avoid onsite and off-site impacts to neighboring landowners and protected aquatic resources.

Introduction to Dairies in the North Florida Springs Region

Overview and Background

Florida Statutes (Chapter 502) defines a "dairy farm" as "any place or premises where one or more cows are kept and from where milk is sold". According to the U.S. Department of Agriculture (USDA) Economic Research Service (https://www.ers.usda.gov/data-products/dairy-data), the number of dairy cattle in Florida declined from about 191,000 cows in 1970 to about 96,000 cows in 2023. Farms data indicates that there are currently 201 dairy farms in Florida. One other published source (Florida Dairy Farmers website https://www.floridamilk.com/on-the-farm/florida-dairy-facts.stml) estimates there are currently about 125,000 milk cows in Florida with highest densities in Lafayette and Okeechobee counties. In 2018 it was reported that there were more than 89,000 dairy cows in south Florida dairy farms (PEER 2018).

There is no available official summary of Florida dairy farms reported by FDEP or by the Florida Department of Agricultural and Consumer Services (FDACS). For this report FSI obtained a 2011 FDEP spreadsheet of all operating dairies that listed 136 dairies in Florida with a total herd size estimated at 105,092 cows (Table 1). Based on 2011 data, the highest number of dairies and the largest herd sizes were in Okeechobee and Hardee counties in south Florida and Lafayette, Gilchrist, and Suwannee counties in north Florida.

In the 1970s and 1980s, Florida's Lake Okeechobee was receiving significant pollution loads from 52 active dairies located north of the lake. In1986, the State of Florida required the relocation of 32 of south Florida's active dairies to north Florida (Gainesville Sun, June 20, 2004: https://www.gainesville.com/story/news/2004/06/20/squeezed-in-s-florida-dairy-farms-flourish-here/31669087007/). This move resulted in the current relatively high concentration of dairies and dairy cows in Lafayette, Gilchrist, and Suwannee counties and an inevitable relocation of excessive agricultural pollution and aquifer depletion from Lake Okeechobee to the Suwannee River, the FAS, and neighboring artesian springs.

The average mature dairy cow weighs about 1,400 pounds (lbs) and excretes about 300 lbs-N/y in urine and manure (roughly equivalent to the daily nitrogen waste from 30 to 40 humans). For this reason, FDEP as part of its Industrial Wastewater Program, regulates the CAFO dairy wastewater discharges to Florida's surface waters and groundwaters.

Dairy farms with more than 700 mature (milked or dry) dairy cattle are defined as CAFOs and are regulated by permits issued under FDEP (Chapter 62-670 [Florida Administrative Code, F.A.C.]). To obtain an Industrial Wastewater Permit, these permitted CAFO dairies are required to submit and follow a dairy nutrient management plan (NMP) prepared by an agricultural engineer licensed in Florida. Of the 136 Florida

dairies that were listed in the FDEP 2011 spreadsheet, 54 required industrial wastewater CAFO permits and reported a total of 80,845 cows.

Table 1. Summary of all Florida Dairies by Location and Size as of 2011 (FDEP data).

County	No. Dairies	Milking/Dry Cows
Alachua	5	1,343
Baker	1	184
Calhoun	2	301
Citrus	1	690
Clay	1	490
Desoto	3	3,548
Dixie	2	980
Duval	2	1,466
Escambia	2	134
Gilchrist	8	12,621
Glades	2	1,999
Hardee	10	11,178
Hernando	2	575
Highlands	5	6,362
Hillsborough	3	626
Holmes	2	460
Jackson	4	771
Jefferson	3	3,895
Lafayette	21	9,865
Levy	1	1,050
Madison	2	2,400
Manatee	3	4,080
Nassau	1	330
Okeechobee	19	26,883
Pasco	4	1,073
Polk	1	450
Putnam	2	520
Sarasota	1	1,000
St. Lucie	1	1,121
Sumter	1	670
Suwannee	17	7,214
Volusia	1	500
Washington	3	313
Totals	136	105,092

The remaining estimated 24,247 cows were located at 82 non-CAFO dairies with less than the 700-cow regulatory cutoff for dairy CAFOs. Non-CAFO dairies are not subject to any specific CAFO dairy regulations such as waste treatment/management practices,

preparation of an NMP, or groundwater monitoring/compliance. Instead, non-CAFO dairies must comply with Section 403.067, Florida Statutes (F.S.), which requires agricultural producers in adopted BMAPs to either enroll and properly implement the applicable FDACS BMPs for their operation or to conduct water quality monitoring activities as required by Chapter 62-307, F.A.C. The relevant non-CAFO dairy BMP manual is referenced as FDACS (2024).

Florida's five water management districts (WMDs) regulate groundwater extractions for all anthropogenic uses, including agricultural operations such as dairies. Groundwater use permits (WUPs) are issued to applicants requesting extraction of 100,000 gallons per day (gpd) or more through a well of 6 inches diameter or greater. Section 373.223, F.S., requires applicants for WUPs to meet three criteria prior to obtaining permits: (1) the proposed use of water must be a reasonable-beneficial use; (2) the proposed use must not interfere with any presently existing legal use of water; and (3) the proposed use must be consistent with the public interest. Water use permits may be issued for up to 30 years before requiring renewal. For north Florida CAFO and non-CAFO dairies, the Suwannee River WMD has issued permits that define reasonable beneficial use of up to 150 gpd per milking cow, 15 to 50 gpd for dry milk cows, 15 to 30 gpd for immature cows (heifers), and substantial groundwater withdrawals for crop irrigation.

Regulated and Unregulated Dairies in the North Florida Springs Region

As delineated by FSI (Figure 1), the Florida Springs Region includes about 27 million acres of land in north and central Florida that overlies portions of the FAS that are sources of fresh groundwater (FSI 2018). Based on initial review of FDEP online files there were 15 permitted CAFO dairies in the northern portion of the Florida Springs Region Suwannee SRA, encompassing all or portions of the Suwannee River WMD and the Northwest Florida WMD (Figure 2).

As shown in Figure 2, most of these facilities are located within the springsheds of the Withlacoochee and Suwannee River OFSs. Eight OFS are included in these springsheds. Table 2 provides a list of these permitted facilities, the responsible CAFO permit agent/owner, and the water use permit number authorizing extraction of groundwater for cows and crops. In 2011, these north Florida CAFO dairies had an estimated total milk cow population of 25,330. Between 2011 and 2024, some of these dairies reorganized, consolidated, and expanded. Based on FDEP's NEXUS database through 2024, the current reported CAFO milk cow population, including lactating and dry milk cows, heifers, springers, and bulls in north Florida is estimated by FSI as more than 70,000.

Based on information from FDEP's 2011 spreadsheet, there were an additional 36 operational but unpermitted (non-CAFO) dairies in the North Florida Springs Region impacting the Suwannee River drainage area (Table 3). In 2011 these dairies were operating without regulatory permits and had an estimated total dairy cow herd of 13,558. No updated animal population data for these non-CAFO dairies was available

for this analysis so FSI conservatively assumes the herd size has remained the same. Note that the UF IFAS Dairy Research Unit is included in this analysis because it was originally permitted as a CAFO even though it was below the 700-cow threshold.

Nitrogen in the Florida Karst

Nitrogen Chemistry

Elemental nitrogen occurs in the environment in a variety of different compounds with differing oxidation (electronic) states. The most reduced (energetic) form of nitrogen is organic nitrogen (Org-N) present in all living matter, including animal wastes. In the presence of oxygen, water, and microbial intermediaries, organic nitrogen readily degrades through a series of chemical transformations to ammonia nitrogen (NH_3-N), next to nitrite nitrogen (NO_2-N), and ultimately to a fully oxidized nitrogen compound called nitrate (NO_3-N). In the absence of biological activity, this lowest energy nitrogen compound is stable in the aquatic environment, especially in groundwater such as the FAS that is generally free of organic matter. Nitrate nitrogen is very soluble in water, rendering nitrate invisible, odorless, and tasteless in potable water. For analytical purposes nitrate and nitrite are commonly analyzed together and denoted as NOx-N.

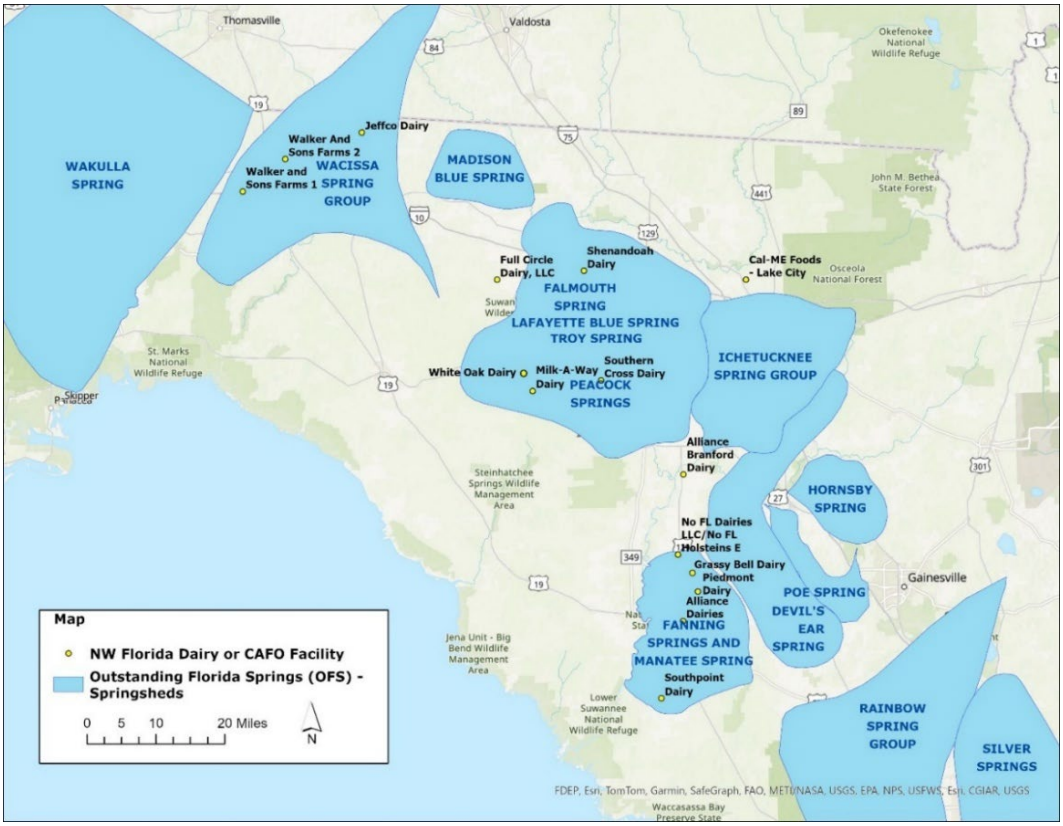

Figure 2. CAFOs in the North Florida Springs Region with Mapped Springsheds for Outstanding Florida Springs (FDEP data).

In the presence of organic matter and the absence of oxygen, denitrifying bacteria can convert nitrate nitrogen to nitrogen gas (N_2). Nitrogen gas is the most abundant form of nitrogen in the environment and comprises roughly 80 percent of the earth's gaseous atmosphere. Nitrogen gas is also invisible and odorless. Nature has developed routes to convert N_2 in the atmosphere to organic nitrogen by certain nitrogen-fixing plants and microbes. Within just the past few hundred years, humans have developed the technology to produce abundant ammonia N from N_2 by using an electrical current, creating a growing quantity of this bioactive form of nitrogen in fertilizers and foodstuffs.

Table 2. Dairy CAFO Groundwater Use Permits in the North Florida Springs Region and Permit Agent/Owner (WMD Data).

Facility Name	County	Agent/Owner	WUP ID
Alliance Dairy Loncala	Gilchrist	Jan Henderson	2-041-220606-4
Alliance Dairy	Gilchrist/Levy	Jan Henderson	2-075-217981-12
Alliance Dairy Branford	Gilchrist/Levy	Jan Henderson	2-041-216102-7
Alliance Branford Suwannee	Suwannee	Jan Henderson	2-121-221429-3
Full Circle Dairy	Madison	Greg Watts	2-079-218879-2
Grassy Bell Dairy (Piedmont Farms)	Gilchrist	Jan Henderson	2-041-218311-3
Hilltop Dairy (with Alliance Feb 2013)	Gilchrist	Marcia St.John/Jan Henderson	2-041-216471-6
Jeffco Dairy	Jefferson/Madison	Calvin Moody (GA resident)	2-065-220044-4
Lafayette Dairy (Milk-A-Way)	Lafayette	Louis Larson	2-84-01229R
North Florida Holsteins East	Gilchrist	Don Bennink	2-041-216430-7
Piedmont Dairy	Gilchrist	Jan Henderson	2-041-220607-5
Shenandoah Dairy (dairy permit)	Suwannee	Ed Henderson	2-121-217514-6
Shenandoah Dairy (crop permit)	Suwannee	Ted Henderson	2-121-218396-3
Southern Cross Dairy	Suwannee	Davis Temple	2-121-216465-8
Southpoint Dairy	Levy	Ron St. John/Jan Henderson	2-075-217150-6
Walker & Sons Farms 1	Jefferson	Walker & Sons Farm	20120016
Walker & Sons Farms 2	Jefferson	Robert Walker/Jenny Tuten	2E-065-6847-2
White Oak Dairy w/ Edwards Addition	Lafayette	Ryan Sullivan/Hugh Edwards	2-067-219279-7

Dairy Nitrogen Management

Most large animal CAFOs, including dairies and other intensive animal-feeding operations, manage high nutrient loads from animal excrements through collection in lined or unlined lagoons, followed by processes such as solids separation and offsite disposal, irrigation of animal food crops with liquid manure (fertigation), and subsequent plant uptake of nitrogen into biomass that is fed back to the cattle (Figure 3). Other biochemical processes that may reduce a portion of nitrogen loads on a dairy farm include ammonia volatilization and denitrification, natural processes that return nitrogen

to the atmosphere. As a dairy CAFO permitting prerequisite, Florida law (Chapter 62-640.500, F.A.C.) requires that an agricultural engineer develop a dairy NMP that accounts for the fate of dairy nutrient and water mass balances and demonstrates that groundwater quality will be protected.

Considerable evidence already exists concerning the effects of north Florida large animal populations, including CAFO and non-CAFO dairies, on elevated nitrate concentrations in groundwater. Pittman et al. (1997) summarize their Middle Suwannee River nitrate mass balance study as follows:

> *"…The increase in nitrate load in the study reach is related to the effects of land use on groundwater. Because the Upper Floridan aquifer is unconfined in the vicinity of the Suwannee River, nitrate from animal wastes, fertilizers, septic tanks, and other sources can readily enter the groundwater by downward percolation through surface soils into the upper part of the aquifer."*

Additional studies by the U.S. Geological Survey, in collaboration with FDEP found elevated nitrate concentrations above the 10 mg-N/L (parts per million [ppm]) human health standard at four dairies in the Suwannee Basin (Andrews 2002, 2004). Elevated groundwater nitrate concentrations were also documented in the Santa Fe River groundwater basin adjacent to dairies, with maximum nitrate-N concentrations in groundwater above 60 mg-N/L (FDEP 2017; FSI 2018).

Dairy nitrogen groundwater data evaluated for this report provide ample evidence that CAFO and non-CAFO dairy nitrogen waste management systems and NMPs prepared and sealed by certified agricultural engineers are not 100 percent efficient.

Dairy Nitrogen in the FAS

Of particular concern in Florida's karst regions is the possible migration of nitrogen, primarily as inorganic nitrate N, from animal urine and manure wastes, as well as cow carcasses, into the underlying potable groundwater of the FAS. The porous nature of the surficial sands and underlying FAS limestones, and the potentially high recharge rate of rainwater to this groundwater aquifer, result in incomplete nutrient assimilation in the crop root zone and rapid travel of some contaminants from the ground surface vertically downward into the limestone aquifer. In the Suwannee SRA this contaminated groundwater subsequently travels downgradient through the limestone aquifer, across lines of declining potentiometric pressure and naturally discharges into rivers at the region's numerous artesian springs. Alternatively, this nutrified groundwater may be extracted through agricultural crop irrigation wells. A third potential migration pathway and human exposure route for nitrate in groundwater is through public and private water supply wells where nitrogen contaminated groundwater is withdrawn for human and livestock potable uses.

Table 3. North Florida Unpermitted Dairy Farms (FDEP Data 2011).

Dairy Name	Location	Listed Owner	County	Milk Cows
Moses & Son, Inc.	Branford, FL 32008	Mr. Randall Moses	Lafayette	698
Suwannee Dairy	McAlpin, FL 32062	Mr. Carl Lowe	Suwannee	675
White Oak Dairy, Inc.	Mayo, FL 32066	Mr. Jody Sullivan	Lafayette	656
Byrd Brothers Dairy	Mayo, FL 32066	Mr. J. W. Byrd	Lafayette	650
Ronnie Land Dairy	Mayo, FL 32066	Mr. Ronnie Land	Lafayette	621
Shiver's Dairy Farm, Inc.	Mayo, FL 32066	Mr. Louis Shiver	Lafayette	610
Lussier Dairy	Hawthorne, FL 32640	Mr. Matthew Lussier	Alachua	600
McAdams Dairy Farm, Inc.	Mayo, FL 32066	Mr. Brian McAdams	Lafayette	589
Alliance Dairies	Trenton, FL 32693	Mr. Pete Hetherington	Gilchrist	565
Olcott Dairy II	Branford, FL 32008	Mr. Earl H. Olcott	Suwannee	550
Trawick Farms, Inc.	Mayo, FL 32066	Mr. David Trawick	Lafayette	530
Florida Agricultural Experiment Station	Gainesville, FL 32606	Mr. David Armstrong	Alachua	500
ATR Dairy	Mayo, FL 32066	Mr. Eddie Fredriksson	Lafayette	475
Johnson & Sons Dairy	Live Oak, FL 32060	Ms. Iogene Johnson	Suwannee	460
Morris Jackson & Sons Dairy	Mayo, FL 32066	Mr. Morris Jackson	Lafayette	425
Jackson Dairy	Mayo, FL 32066	Mr. Foye Brock Jackson	Lafayette	418
Kerby Dairy	Mayo, FL 32066	Mr. Everett Kerby	Lafayette	399
Misty Farm	Trenton, FL 32693	Mr. Rodney Tompkins	Gilchrist	390
Brantley's Dairy Farm, Inc.	McAlpin, FL 32062	Mr. Mike Brantley	Suwannee	375
Shady Ranch, Inc.	Live Oak, FL 32060	Mr. Tim Norris	Suwannee	330
Alton Dairy	Mayo, FL 32066	Mr. Kevin Jackson	Lafayette	325
Providence Dairy, LLC	McAlpin, FL 32062	Ms. Ashley Bailey	Suwannee	320
Riley O'Steen	Mayo, FL 32066	Mr. Riley O'Steen	Lafayette	275
Edward Koon & Son Dairy	Mayo, FL 32066	Mr. James E Koon	Lafayette	240
Shaw Dairy	Mayo, FL 32066	Mr. Gary Shaw	Lafayette	240
A. Jackson & Family Dairy	Mayo, FL 32066	Mr. Anthony Jackson	Lafayette	207
Wainwright & Sons Dairy	Live Oak, FL 32060	Mr. James Wainwright	Suwannee	200
Lonesome Meadow Farm	Live Oak, FL 32060	Mr. George D Wedsted	Suwannee	195
Musgrave Dairy	Mayo, FL 32066	Mr. Arlie Musgrave	Lafayette	178
Rex Run Dairy	Hawthorne, FL 32640	Mr. John C. Mims	Alachua	153
Reliable Fence Land Clearing and Hauling	Mayo, FL 32066	Mr. Tommy Pearson	Lafayette	150
McKinney Dairy	McAlpin, FL 32062	Mr. Al Cumby	Suwannee	150
McMillian Dairy	Live Oak, FL 32060	Mr. Philmore McMillian	Suwannee	130
D'Udder Dairy # 1	McAlpin, FL 32062	Ms. Grace Reneveld	Suwannee	120
Arndt's Dairy	High Springs, FL	Mr. Bernard Arndt	Alachua	90
Islabela Dairy	Live Oak, FL 32066	Mr. Jose L Gomez Colon	Suwannee	40
Kurtz & Sons Dairy	Live Oak, FL 32060	Mr. Howard Kurtz	Suwannee	29
			Total	13,558

Nitrogen in Drinking Water Human Health Effects

Florida law (Chapter 62-550.310, F.A.C.) prohibits concentrations of nitrate + nitrite nitrogen (NOx-N) in potable groundwater at concentrations above 10 mg-N/L except in permitted areas. In Florida, CAFO permits allow NOx-N concentrations above the 10 mg-N/L drinking water standard inside the property boundaries or “zone of discharge” of a permitted CAFO facility. However, no groundwater contamination from an adjacent or nearby dairy is allowed to cause or contribute to an exceedance of this standard at off-site compliance wells.

This law derives from the recognition that concentrations of NOx-N above 10 mg-N/L in potable drinking water can result in a relatively rare acute toxicity known as methemoglobinemia or “blue baby syndrome”, especially to young children and older adults. The acute toxicity of NOx-N to these vulnerable populations may be fatal. The clinical presentation of methemoglobinemia is based on a spectrum illness that is

associated with cyanosis, pallor, fatigue, weakness, headache, central nervous system depression, metabolic acidosis, seizures, dysrhythmias, coma, and death (National Institute of Health, 2023 https://www.ncbi.nlm.nih.gov/books/NBK537317/#:~:text=The%20clinical%20presentation%20of%20methemoglobinemia,dysrhythmias%2C%20coma%2C%20and%20death).

Figure 3. Most North Florida Dairies Feed Silage Produced from On-Site Crop Production (Photo by John Moran).

Of additional importance concerning the possible effects of animal wastes on elevated concentrations of NOx-N in groundwater is the finding that concentrations less than 10 mg-N/L may contribute to chronic human health effects, including bladder cancer, thyroid cancer, and birth defects (Ward et al. 2005, 2010; Weyer et al. 2001). Although numerous epidemiological studies have investigated the relationship between exposure to nitrate or nitrite in drinking-water and cancer occurrence, the World Health Organization (WHO) has concluded that the weight of evidence does not clearly support an association between cancer and exposure to nitrate or nitrite per se (WHO 2016). However, the U.S. National Institute of Health's most recent review of all studies of the relationship between drinking water nitrate and chronic effects concludes that *"…the strongest evidence for a relationship between drinking water nitrate ingestion and adverse health outcomes (besides methemoglobinemia) is for colorectal cancer, thyroid*

disease, and neural tube defects. Many studies observed increased risk with ingestion of water nitrate levels that were below regulatory limits" (Ward et al. 2018).

The WHO concludes that the most appropriate means of controlling nitrate concentrations, particularly in groundwater, is the prevention of source water contamination, which may take the form of appropriate management of agricultural activities (*e.g.,* management of fertilizer and manure application and storage of animal manures).

Overall, in response to the growing evidence of the occurrence of these chronic human health effects of NOx-N in drinking water, concerned organizations in other regions of the world such as the United Nations Food and Agriculture Organization (FAO) have established a nitrate-nitrogen standard of 4.5 mg-N/L for potable drinking water (Abascal et al. 2022). This standard is less than one half of the US and Florida drinking water limits of 10 mg-N/L and better reflects the potential for chronic toxicity of nitrate to humans of all ages.

In the United States the non-profit Environmental Working Group (Temkin et. al. 2019) has reported a much lower NOx-N concentration cancer threshold for drinking water of 0.14 mg-N/L (95% confidence interval range 0.08 to 0.63 mg-N/L). This level is based on a peer-reviewed meta-analysis of five published studies relating to the nitrate concentration resulting in a less-than one-in-one million increased risk of colorectal cancer.

Nitrogen in Springs and Adjacent Surface Waters

Organic nitrogen is an essential ingredient for the synthesis of amino acids present in all living organisms, including plants and animals. In the natural environment, inorganic nitrogen in the form of ammonia and nitrate is relatively scarce and limits plant growth. However, due to massive anthropogenic production and inevitable loss of nitrogen fertilizers and discharge of animal and human waste, excessive dissolved nitrogen is now common in Florida's surface waters, including springs, rivers, and estuaries. This environmental nitrogen may cause eutrophication (excessive nutrient enrichment) of water bodies by nuisance algal species that in turn impairs the ecological health of these aquatic environments (https://www.epa.gov/nutrientpollution).

In recognition of this fact, the State of Florida has adopted by rule (Chapter 62-302.531, F.A.C.) maximum criteria for concentrations of NOx-N in springs (range in different springs from 0.286 to 0.35 mg-N/L), and concentrations of total nitrogen (NOx-N+NH_4-N+Org-N=TN) in lakes, streams, and estuarine waters (varying regionally from 0.61 to 1.87 mg-N/L).

Through the development of TMDLs for waters impaired by excessive nitrogen concentrations, the State of Florida is required to limit nitrogen inputs from all anthropogenic sources, including agricultural operations. In some cases, dairy CAFOs are a significant source of total nitrogen negatively affecting springs and other surface

waters in Florida's karst region and are included in BMAPs intended to comply with nitrogen TMDLs (FDEP 2025).

Twenty-six of 30 OFSs have been determined to be impaired by excessive concentrations of NOx-N and BMAPs have been prepared for eventual (>20 years) compliance with the OFS TMDLs (FSC 2022: https://floridaspringsinstitute.org/wp-content/uploads/2022/11/2022-FSC-BMAP-REPORT-10-18-2022.pdf). Each of these BMAPs estimates the sum of all known loads of nitrogen based on the FDEP methodology using an algorithm called the Nitrogen Source Inventory Loading Tool (NSILT). This spreadsheet tool involves estimating N input to the land surface from sources like septic systems, fertilizers, and animal wastes, applying source-specific attenuation factors for biochemical transformations on and in the soil, and incorporating regional recharge rates to estimate nitrogen loads to the aquifer (FDEP website: https://floridadep.gov/dear/water-quality-evaluation-tmdl/content/groundwater-management-section#:~:text=Nitrogen%20Source%20Inventory%20and%20Loading%20Tool%20(NSILT)%20Assessments,Source%20Inventory%20and%20Loading%20Tool).

North Florida Groundwater Use and Depletion

Knight and Clarke (2018) quantified historic and recent changes in artesian spring flows in the Florida Springs Region. Predevelopment data were used by Bush and Johnston (1988) to estimate a predevelopment groundwater mass balance for the entire 100,000 square mile FAS. Estimated average historic combined fresh (non-saline) groundwater discharge for the entire Floridan Aquifer, including Georgia, South Carolina, Alabama, and Florida was about 12 billion gallons per day (BGD). Approximately 10.5 BGD of this predevelopment spring and diffuse discharge was identified as entering Florida's Springs Region. Based on measured spring flows and reasonable assumptions for unmonitored springs, Knight and Clarke (2018) documented a more than 30 percent decline in average spring flows through 2010 for Florida's 1,090+ artesian springs. The highest estimated regional spring flow decline was 48 percent for the 314 documented springs in the Suwannee River WMD.

Based on extensive research by the four water management districts that oversee water uses in the Florida Springs Region, spring flow reductions greater than 3 to 10 percent of historic average flows are "significantly harmful" to Florida's artesian springs. FSI has repeatedly reported evidence that many if not all of Florida's springs are indeed impaired by flow reductions that exceed this range (FSI 2018).

Independent estimates of recent average groundwater pumping from the FAS are about 4 BGD for the entire FAS and up to 3 BGD from the Florida portion of the aquifer (https://fl.water.usgs.gov/floridan/intro.html). FSI has estimated that there are nearly 1 million wells extracting groundwater in the Florida Springs Region (Knight 2021). Based on WUP data through 2010 there are nearly 30,000 large groundwater use permits (greater than 100,000 gpd) in the Florida Springs Region, with an allocated maximum

withdrawal of about 4.3 BGD of groundwater. Based on the most recent estimation of water uses in Florida by the U.S. Geological Survey (Marella 2020), agricultural uses account for about 39 percent of the total average annual groundwater extraction.

Estimated fresh groundwater use in north Florida in 2015 was 461 MGD and is projected to increase to 596 MGD by 2045 (SJRWMD and SRWMD 2023). These agencies concluded that in 2023 *"…current groundwater use has already exceeded the fresh groundwater sustainable yield of the system."*

Methods

Introduction

Efforts to quantify forms and quantities of nitrogen negatively affecting potable groundwater, springs, rivers, and estuaries are ongoing by the State of Florida through development of TMDLs and utilization of FDEP's NSILT methodology. These nitrogen load assessments form the basis for developing compliance plans (BMAPs) for remediation timelines and legal responsibilities for those corrective actions.

Through a series of TMDLs and BMAPs conducted for the OFS, large dairy CAFOs and smaller, unpermitted dairy farms, have been implicated as sources of excessive nitrogen loads to the FAS, and subsequently to the outstanding springs and downstream surface waters. In the Suwannee River springs groundwater basin, the current OFS BMAP requires a reduction in total nitrogen loads to groundwater of 85 percent or 3,164 tons of nitrogen per year (FDEP 2025). Based on the FDEP's NSILT for the Suwannee Basin, the ratio between nitrogen loading at the land surface prior to attenuation and the nitrogen loading to the FAS is 6.72. Applying this ratio to the FDEP Suwannee BMAP nitrogen reduction goal above, achieving the BMAP target will require a nitrogen load reduction at the land surface of about 21,000 tons of nitrogen per year. Analyses by FDEP utilizing NSILT indicate that dairy cow populations and dairy fertilizer inputs in the Suwannee River TMDL account for about 14 percent of the total nitrogen load to the area's groundwater and springs (FDEP 2025).

Declining aquifer levels and spring/river flows are also an environmental concern throughout the Florida Springs Region as described above. Florida law requires determination of minimum flows and levels (MFLs) to avoid significant harm to the ecological health of these important natural ecosystems (Florida Statute 373.042 and Rule 62-40.473, F.A.C.). In the Florida Springs Region MFLs have been promulgated for the following OFSs: Wekiva, Volusia Blue, Silver, Rainbow, Weeki Wachee, Homosassa, Crystal River/Kings Bay, Fanning/Manatee, and six of the springs that feed the Santa Fe River. Additional MFL determinations are underway in the Suwannee River WMD and the Northwest Florida WMD to include Wakulla and multiple springs feeding the Suwannee and Wacissa Rivers. Existing OFS MFLs require protection of between 90 and 97 percent of historic spring flows (HSW 2021; WRA 2005).

Dairy Nitrogen Loading

This report provides independent detailed assessments of nitrate-N concentrations and mass loads to the underlying FAS from the existing permitted CAFO and non-CAFO dairies in the North Florida Springs Region. All the CAFO dairy facilities are required to conduct groundwater monitoring to assess compliance, and these data are publicly available through the NEXUS system hosted by the FDEP. This report also provides an estimate of nitrogen loading from the region's smaller unpermitted dairies.

It is important to understand that there is no official or up-to-date inventory of dairies or numbers of dairy cows for the North Florida Springs Region covered in this report. While NMPs and permit compliance reports are available to make estimates of numbers and classes of dairy cattle (*i.e.,* lactating, dry, heifers, springers, calves, etc.), those numbers are changing daily due to cows coming into or out of production and ongoing losses due to illness and mortality. These shifting dairy cow populations are a moving target and all estimates and conclusions concerning groundwater pollution and depletion due to dairies in north Florida should be considered as estimates and subject to error.

Groundwater Nitrogen Concentrations

Groundwater monitoring requirements for CAFOs are established in accordance with Chapters 62-520, 532, 620, 660, and 670, Florida Administrative Code (F.A.C.). The installation of monitor wells at each CAFO facility is required to detect the presence and migration of contaminants in groundwater. As a minimum, at least one of each of the following monitor wells is required at each permitted CAFO dairy facility:

- Background (B) well - upgradient well located as close as possible to the site, without being affected by that site's discharge, to determine the natural background quality conditions of the groundwater.

- Intermediate (I) well - well downgradient from the site and within the zone-of-discharge designed to detect the chemical, physical, and microbiological characteristics of the discharge plume.

- Compliance (C) well - well at the edge of the zone of discharge, downgradient from the site.

Additional monitor wells are dictated by the complexity of the hydrogeology of the site, the magnitude and direction of the groundwater contaminant plume, or the likelihood of threats to the public health, and to ensure adequate and reliable monitoring data collected with generally accepted engineering or hydrogeological practice.

This report summarizes and interprets available groundwater biological and chemical concentration data from each of the permitted CAFO facilities in North Florida's Springs Region (see appendices).

Permitting and operational groundwater monitoring data were obtained through the NEXUS web portal maintained by FDEP's Office of Industrial Permitting. A list of industrial wastewater facilities which contains the CAFO information may be obtained from the FDEP Wastewater Facility Information webpage at:

https://floridadep.gov/water/domestic-wastewater/content/wastewater-facility-information

On the Wastewater Facility Information webpage is a section titled "Wastewater Facility Lists – Standard Database Retrievals." This part has a list of database retrievals to select from. From that database retrievals list, click on "Industrial Wastewater Facilities" which will provide an Excel spreadsheet with a list of all the Industrial Wastewater permitted facilities. To find AFOs and CAFOs with a wastewater permit you need to sort the column titled "FacType" for "Animal Feeding Operations" and for "Concentrated Animal Feeding Operations". This list also includes information on facility names, agents/owners, locations, permit issue dates and expiration dates.

Specific permit information by facility number is available at the FDEP NEXUS website portal:

https://prodenv.dep.state.fl.us/DepNexus/public/searchPortal

Current and historic facility permits were retrieved and reviewed. Submitted groundwater sampling data for all the subject CAFO dairies were provided in a summary EXCEL table by FDEP industrial wastewater program staff and can be found at this link: https://floridaspringsinstitute.org/wp-content/uploads/2025/12/Florida-FDEP-CAFO_MW_data_112025.xlsx.

Nitrogen Load Estimation

Land surface and groundwater nitrogen mass loads were estimated using two related approaches. The first approach was direct calculation of nitrogen loads in dairy cow urine and manure to the dairy's wastewater management system using standard daily waste loading rates and the number and type of dairy cows at each dairy facility. The second approach was to use FDEP's NSILT estimates for OFS springsheds. NSILT provides estimates for both nitrogen load to the land surface and an estimated load to the groundwater based on estimated recharge characteristics and attenuation factors. Some additional dairy nitrogen loads are likely from the application of nitrogen fertilizers to dairy crops but are not estimated based on insufficient fertilizer data availability.

A literature review found a range of nitrogen waste factors for dairy cows. FDEP's NSILT 2018 technical support document included the nitrogen waste factors for six different types of dairy cows, including bulls and calves summarized in Table 4 (Cabrera et al. 2006 a and b).

Table 4. Daily Nitrogen Waste Factors for Dairy Cattle (FDEP 2018).

Dairy Cattle Type	Waste Factor (lbs-N/day)
Lactating dairy cow	0.794
Dry dairy cow	0.397
Heifer/springer	0.243
Springers	0.198
Bulls	0.375
Calves	0.088

In their 2025 NSILT analysis, FDEP used a dairy cow waste factor of 0.997 lbs-N/d per lactating cow (FDEP 2025). Note that the nitrogen waste factors are more than twice as high for lactating cows than for other cattle types.

Additional publications reviewed by FSI provided the following dairy cow total nitrogen waste production estimates:

- Taverier et al. 2023 – 0.89 lbs-N/day for mature cows (assume average milk cow weight of 1,400 lbs)
- Cornell Dairy Science – 0.75 to 1.37 lbs-N/day
- Natural Resources Conservation Service estimates for dairy waste management – 0.50 to 0.72 lbs-N/day per cow

For this report FSI applied two conservative nitrogen waste factors at 0.7 lbs-N/day for dairies where different cow and bull classifications were not available; or for dairies that have provided a breakdown of dairy cattle classifications, 0.8 lbs-N/day for lactating cows and a nitrogen waste factor of 0.4 lbs-N/day for all non-lactating dairy cows, calves, and bulls.

Nitrogen loads from dairies to the land surface and to the underlying FAS are attenuated to some extent by a combination of ammonia volatilization, wastewater treatment in waste lagoons with sludge disposal offsite, crop uptake, soil N storage, and percent recharged. Details for nitrogen mass removals by these processes are generally not known so an overall nitrogen biochemical attenuation (*i.e.,* waste management) factor can be used to estimate nitrogen transport to the ground surface. For CAFO dairies FDEP's estimated nitrogen biochemical attenuation factor was 85 percent. This assumed attenuation is based on the NMP requirement and the agricultural engineer's certification for these larger dairies. In the absence of more detailed dairy waste treatment performance, FSI also adopted this factor.

For smaller, non-CAFO dairies FDEP's NSILT generally assumed a 50 percent biochemical attenuation factor. FSI has not made an independent assessment of nitrogen loading from the smaller dairies so FDEP's estimates for non-CAFO dairies are adopted for FSI's analysis.

FDEP's NSILT methodology also applies a second nitrogen attenuation assumption based on estimated groundwater recharge in this karst landscape as high, medium, or low. Additional nitrogen attenuation during groundwater recharge is estimated by NSILT to be 10 percent in the highest recharge areas, 50 percent in medium recharge areas, and 90 percent in the lowest recharge areas. For FSI's analysis for CAFO dairies we assumed a 50 percent recharge attenuation factor for the 15 larger dairies.

Due to the variety of assumptions inherent in estimating nutrient loading from dairy cows to the FAS, there is room for considerable uncertainty of estimate validity. The best method for testing the accuracy of these estimated nitrogen assimilation processes is to compare them to a nitrogen mass balance using data from the principal springs discharging from this groundwater basin. Four published data sets, three empirical and one based on an independent groundwater recharge model, that directly quantify nitrogen loads to the aquifer and springs in the Suwannee River BMAP area were available for comparison and are described below in the results presentation.

Cow Carcass Disposal

Typical dairy practice is to remove cows from the milking herd if their milk production is below acceptable levels. Non-producing cows may be sold individually or sent to a rendering facility. Some milk cows die from old age, disease, and excessive production. Typical mortality of dairy cattle is reported to be between 8 and 10 percent per year (McConnel no date) and up to 16 percent per year (Sarjokan et al. 2018). For the North Florida dairy analysis, we assume a 10 percent mature cow mortality rate per year.

Carcass disposal methods include rendering off site, incineration on site, burial, and composting (Shearer et al. 2008). The Pennsylvania State University agronomy extension states that *"… burial sites need to be chosen carefully to prevent groundwater and well water contamination."*

Based on a review of historical aerial photos of operational dairies the most common cow carcass disposal methods in the North Florida Springs Region are assumed to be burial and composting. The University of Florida IFAS office of veterinary medicine estimates a total nitrogen load of about 25 pounds of nitrogen fertilizer value per ton of cow carcass composted. At an assumed average weight per mature cow of 1,400 pounds, the estimated nitrogen load at the ground surface is about 17.5 pounds-N per composted cow. This estimate is used below in assessing possible groundwater nitrogen pollution from carcass disposal at north Florida dairies.

Dairy Groundwater Use

All the dairy CAFOs in the Florida Springs Region utilize groundwater from the FAS as their primary source of water for cattle watering, washing, cooling, and crop irrigation. Actual groundwater pumping data were requested from FDEP but due to a government charge for data retrieval as a "public records request", those data were not available for this assessment. WUP data and published dairy water use estimates are used by FSI

as a surrogate for actual measured and reported groundwater use quantities (Table 5). The Blue Water Audit analysis of actual metered groundwater extractions determined that on average, actual water use averages about 56 percent of permitted quantities (FSI 2021). However, this report assumes that the full WUP amount is the best conservative estimate of the actual groundwater used by the North Florida dairies.

Results and Discussion

North Florida Permitted Dairies

Various estimates are available for the dairy cow population in North Florida's Springs Region. Three FDEP estimates of the North Florida dairy herd size were reviewed. These included a 2011 FDEP spreadsheet for all Florida dairies, the 2018 NSILT analysis by FDEP for the Middle Suwannee River Basin OFSs, and the 2018 NSILT analysis for the Lower Suwannee River Basin BMAP. Earlier 2011 and 2018 cow population data are provided here because there was no estimate of cow numbers in the 2025 BMAP or NSILT spreadsheets.

Table 5. Summary of North Florida Springs Region CAFO Dairies Permitted Groundwater Use, Irrigated Acreage, and Number of Production Wells (FDEP and SRWMD data).

Facility Name	County	WUP ID	Permit Start	Permit End	Max Daily (MGD)	Max Crop Irrig. (MGD)	Max Cow Water (MGD)	Total Area (ac)	Irrig. Area (ac)	# of Wells
Alliance Dairy Loncala	Gilchrist	2-041-220606-4	4/7/2021	5/8/2032	3.59	3.39	0.21		1505	12
Alliance Dairy	Gilchrist/Levy	2-075-217981-12	9/2/2022	4/12/2031	4.77	3.36	1.41	2856	1718	30
Alliance Dairy Branford	Gilchrist/Levy	2-041-216102-7	1/12/2021	5/13/2029	2.17			725	488	11
Alliance Branford Suwannee	Suwannee	2-121-221429-3	6/29/2018	11/7/2032	0.24	0.24		153	133	1
Full Circle Dairy	Madison	2-079-218879-2	7/14/2015	12/13/2034	1.77	1.23		1260	875	7
Grassy Bell Dairy (Piedmont Farms)	Gilchrist	2-041-218311-3	9/8/2015	9/8/2035	1.11	0.48	0.63	786	583	6
Hilltop Dairy (with Alliance Feb 2013)	Gilchrist	2-041-216471-6	11/1/2018	7/13/2034	2.58	1.95	0.63	1279	1002	19
Jeffco Dairy	Jefferson/Madison	2-065-220044-4	5/14/2015	5/16/2032	1.27	0.82	0.46	2174	681	15
Lafayette Dairy (Milk-A-Way)	Lafayette	2-84-01229R	9/13/2011	9/13/2031	8.42	1.25	0.19			11
North Florida Holsteins East	Gilchrist	2-041-216430-7	10/10/2022	4/7/2030	2.24	1.48	0.77			30
Piedmont Dairy	Gilchrist	2-041-220607-5	3/16/2021	5/8/2032	1.80	1.26	0.53	2336	1109	13
Shenandoah Dairy (dairy permit)	Suwannee	2-121-217514-6	2/20/2020	7/26/2029	3.06	2.31	0.75	2410.5	1625	25
Shenandoah Dairy (crop permit)	Suwannee	2-121-218396-3	6/22/2015	4/29/2027	0.91	0.91	--	635	580	5
Southern Cross Dairy	Suwannee	2-121-216465-8	10/10/2023	10/11/2043	1.50	0.42	1.08	327	203	6
Southpoint Dairy	Levy	2-075-217150-6	9/29/2022	11/13/2027	1.51	0.86	0.65	1086	754	17
Walker & Sons Farms 1	Jefferson	20120016	5/24/2012	6/1/2032	1.76	--	--	--	100	6
Walker & Sons Farms 2	Jefferson	2E-065-6847-2	10/27/2017	11/1/2037	0.49	--	0.49	--	138	2
White Oak Dairy w/ Edwards Addition	Lafayette	2-067-219279-7	9/10/2018		1.32	1.13	0.19	911	692	13
				Total	40.51	21.07	7.98	16,939	12,186	229

The 2011 FDEP spreadsheet (Table 6) listed the presence of 57 dairies and a total of 38,388 cows in the seven north Florida counties that contribute groundwater to the Suwannee SRA. This list indicates that in 2011 there were up to 37 dairies that were below the CAFO threshold of 700 cows with a total estimated population of 13,558 cows. Dairy cow populations and nitrogen loading impacts at these unregulated dairies are subject to considerable uncertainty.

For the 2018 Middle Suwannee NSILT and nitrogen BMAP analysis a total of 12 dairies were identified in Lafayette County with a total of 7,900 dairy cows and 13 active dairies were identified in Suwannee County with 19,316 dairy cows, for a total population estimate of 27,216 dairy cows (see Table 7). Nineteen of these Middle Suwannee dairies were below the CAFO cutoff of 700 cows and were not included in our detailed CAFO dairy analysis. Table 7 provides FDEP's estimated 2018 dairy nitrogen loading to the land surface of 1.66 million lbs-N per year. FDEP's 2025 Middle Suwannee NSILT reported 1.12 million lbs-N/y from dairies to land surface.

For the Lower Suwannee NSILT and BMAP, FDEP (2018) listed four CAFO dairies in Gilchrist County with 13,156 dairy cows and two CAFO dairies in Levy County with18,705 dairy cows, for a total population estimate of 31,861 cows (see Table 8) for a total nitrogen load to the ground surface of 1.87 million pounds-N per year. FDEP's 2025 NSILT reported 2.94 million lbs-N/y from dairies to the Lower Suwannee land surface.

Table 6. Inventory of All Known Dairies Located in the North Florida Springs Region in 2011 (FDEP data).

County	Number of Dairies	Milking/Dry Cows
Alachua	5	1,343
Gilchrist	8	12,621
Jefferson	3	3,895
Lafayette	21	9,865
Levy	1	1,050
Madison	2	2,400
Suwannee	17	7,214
Totals	57	38,388

The total numbers of dairy cattle from these two NSILT tables was 59,077 dairy cows at 39 dairies located in the Suwannee River OFS BMAP areas. FDEP's estimated combined nitrogen load from dairies to the land surface in these two Suwannee basins was 3.53 million lbs-N per year. For the FDEP's 2025 NSILT reported 4.06 million lbs-N/y from these dairies to the land surface.

Based on the state's published data through 2024 there are currently at least 20 producing dairies in the North Florida Springs Region, including in Duval, Gilchrist,

Levy, Lafayette, Suwannee, Jefferson, Madison, and Alachua counties. Five of these dairies do not have industrial wastewater permits because they operate under the state's CAFO definition of a minimum of 700 milk/dry cows. The other 15 dairy farms are permitted under FDEP's industrial wastewater permits and are included in FSI's analysis. One additional dairy with fewer than 700 cows, the University of Florida IFAS dairy in Alachua County was previously permitted (until 2016) and required to monitor and report groundwater data and is also included in this report.

Based on FDEP NEXUS records for the 15 monitored CAFO dairies in North Florida's Springs Region, the current estimated population of dairy cows at these CAFO dairies is 72,250 dairy cows with an estimated land area of 20,572 acres (Table 9).

FSI's Estimated Nitrogen Loading from Permitted and Unpermitted Dairies

Table 10 utilizes the most recent dairy permit information for numbers and classes of dairy cows and the nitrogen waste loading factors summarized above to estimate permitted CAFO dairy nitrogen loading in North Florida. The estimated total nitrogen waste load from these 15 CAFO dairies is about 16.55 million lbs-N/y (8,273 tons-N/y). FSI's estimated nitrogen load to the land surface following biochemical attenuation and prior to recharge is 2.48 million lbs-N/yr (1,241 tons-N/y). The dead cow disposal at these dairies is estimated as 105,000 lbs-N/y at the land surface or less than 3 percent of the total estimated nitrogen load to the land surface. Due to lack of confirming data concerning dead cow disposal this load estimate is not included in further calculations.

Based on an assumed annual overall average nitrogen recharge attenuation factor of 50 percent, the estimated nitrogen load from permitted CAFO dairies in the North Florida Springs Region to the FAS is 1.24 million lbs-N/y (620 tons-N/y).

Relying on the 2011 FDEP dairy inventory data, there were a reported 13,558 cows of unidentified classification present at unpermitted dairies in the North Florida Springs area. Based on the 0.70 lbs-N/y generic waste loading factor and the 50 percent waste attenuation factor, FSI estimates that these non-CAFO dairies contribute a nitrate nitrogen waste load of 3.46 million lbs-N/y (1,73 tons-N/y). Based on a 50 percent biochemical attenuation the nitrogen load from these unpermitted dairies is estimated to be 1.73 million lbs-N/y (866 tons-N/y) to the land surface. Based on a 50 percent recharge attenuation factor the additional nitrogen load to the FAS is 0.866 million lbs-N/y (433 tons-N/y) to the FAS.

The combined estimate from the CAFO and non-CAFO dairies in the North Florida Springs Region is a total dairy nitrogen waste load of 20 million lbs-N/y (10,000 tons-N/yr) and an estimated 2.10 million lbs-N/y (1,053 tons-N/y) to the FAS (Table 11).

Table 7. Estimated Herd Size and Nitrogen Loading to Land Surface for Permitted and Unpermitted Dairies in Suwannee and Lafayette Counties, Middle Suwannee BMAP Basin (FDEP NSILT 2018).

Dairy Name	County	Herd Size	Annual Input (lb-N)
Dairy 1	Lafayette	1400	138,071
Dairy 2	Lafayette	1403	146,212
Dairy 3	LAFAYETTE	250	27,801
Dairy 4	LAFAYETTE	699	65,974
Dairy 5	LAFAYETTE	225	23,339
Dairy 6	LAFAYETTE	699	64,538
Dairy 7	LAFAYETTE	600	56,223
Dairy 8	LAFAYETTE	600	43,936
Dairy 9	LAFAYETTE	600	56,223
Dairy 10	LAFAYETTE	75	7,239
Dairy 11	LAFAYETTE	650	61,148
Dairy 12	LAFAYETTE	699	65,400
Dairy 13	Suwannee	7900	569,635
Dairy 14	Suwannee	8391	80,783
Dairy 15	SUWANNEE	0	-
Dairy 16	SUWANNEE	375	39,158
Dairy 17	SUWANNEE	210	-
Dairy 18	SUWANNEE	510	38,954
Dairy 19	SUWANNEE	200	15,276
Dairy 20	SUWANNEE	0	-
Dairy 21	SUWANNEE	120	11,130
Dairy 22	SUWANNEE	600	55,649
Dairy 23	SUWANNEE	50	4,637
Dairy 24	SUWANNEE	510	47,302
Dairy 25	SUWANNEE	450	41,737

Suwannee Herd	**19316**	Suwanne Input Permitted	**650,418**
		Suwanne Input Non-P	**253,843**
Lafayette Herd	**7900**	Lafayette Input Permitted	**284,282**
		Lafayette Input Non-P	**471,822**

Note: this FDEP spread sheet has calculation errors and inconsistences.

Table 8. Estimated Herd Size and Nitrogen Loading to Land Surface for Permitted CAFO Dairies in Gilchrist and Levy Counties (Lower Suwannee BMAP Basin, FDEP NSILT 2018).

Dairy Name	County	Herd Size	Annual Input (Lb-N)
Dairy A	Gilchrist	2,375	**127,563**
Dairy B	Gilchrist	2,340	**222,574**
Dairy C	Gilchrist	2,641	**248,682**
Dairy D	Gilchrist	5,800	**652,903**
Dairy E	Levy	15,002	**341,896**
Dairy F	Levy	3,703	**273,723**
Gilchrist Dairy Population	13,156		**1,251,723**
Levy Dairy Population	18,705		**615,619**

Table 9. Current Estimated North Florida Permitted CAFO Dairy Areas and Numbers of Dairy Cattle (FDEP Permit Data and NMPs).

Facility Name	County	Dairy Acreage	Dairy Herd			
			Lactating Cows	Dry Cows	Springers Heifers Calves Bulls	Total
Alliance Dairy	Levy/Gilchrist	1,600	10,700	3,470	7,328	21,498
Alliancnce Branford	Gilchrist	725	2,300	UN	UN	2,300
Full Circle Dairy	Madison	2,467	3,970	593	3,600	8,163
Grassy Bell Dairy (Piedmont Farms)	Gilchrist	819	1,829	495	16	2,340
IFAS UF Dairy Research Unit	Alachua	850	550	120	UN	670
Jeffco Dairy	Jefferson/Madiso	2,233	2,400	UN	35	2,435
Milk-A-Way (Lafayette) Dairy	Lafayette	1,100	1,435	315	UN	1,750
North Florida Holsteins East	Gilchrist	2,786	3,900	900	600	5,400
Piedmont Dairy	Gilchrist	1,992	1,526	1,060	330	2,916
Shenandoah Dairy (dairy permit)	Suwannee	2,750	3,500	700	1,970	6,170
Southern Cross Dairy	Suwannee	960	2,400	400	7,375	10,175
Southpoint Dairy	Levy	1,090	2,469	UN	1,234	3,703
Walker & Sons Farms 1	Jefferson	UN	1,050	200	UN	1,250
Walker & Sons Farms 2	Jefferson	UN	1,200	180	UN	1,380
White Oak Dairy w/ Edwards Add'n	Lafayette	1,200	1,850	250	UN	2,100
	Totals	20,572	41,079	8,683	22,488	72,250

Table 10. FSI's Estimated North Florida Permitted CAFO Dairy Nitrogen Loads.

Facility Name	County	Dairy Acreage	Dairy Herd	Est. Total Nitrogen Load (lbs-N/year)		
			Total	Est. Total N Wasteload	Est. Total N to Land Surface	To Floridan Aquifer
Alliance Dairy	Levy/Gilchrist	1,600	21,498	4,700,908	705,136	352,568
Alliancnce Branford	Gilchrist	725	2,300	671,600	100,740	50,370
Full Circle Dairy	Madison	2,467	8,163	1,771,418	265,713	132,856
Grassy Bell Dairy (Piedmont Farms)	Gilchrist	819	2,340	608,674	91,301	45,651
IFAS UF Dairy Research Unit	Alachua	850	670	178,120	26,718	13,359
Jeffco Dairy	Jefferson/Madiso	2,233	2,435	705,910	105,887	52,943
Milk-A-Way (Lafayette) Dairy	Lafayette	1,100	1,750	465,010	69,752	34,876
North Florida Holsteins East	Gilchrist	2,786	5,400	1,357,800	203,670	101,835
Piedmont Dairy	Gilchrist	1,992	2,916	648,532	97,280	48,640
Shenandoah Dairy (dairy permit)	Suwannee	2,750	6,170	1,411,820	211,773	105,887
Southern Cross Dairy	Suwannee	960	10,175	1,835,950	275,393	137,696
Southpoint Dairy	Levy	1,090	3,703	901,112	135,167	67,583
Walker & Sons Farms 1	Jefferson	UN	1,250	335,800	50,370	25,185
Walker & Sons Farms 2	Jefferson	UN	1,380	376,680	56,502	28,251
White Oak Dairy w/ Edwards Add'n	Lafayette	1,200	2,100	576,700	86,505	43,253
	Totals	20,572	72,250	16,546,034	2,481,905	1,240,953

Nitrogen Mass Balance Validation Data Sets and Uncertainty

Four independent data sets summarizing nitrogen mass balances for the Suwannee River Basin are available for comparison to FSI and FDEP total nitrogen load estimates. These data provide an independent baseline to validate estimates of FAS overall nitrogen loading impacts.

Pittman et al. (1997) published a base flow nitrogen loading measurement at Branford (downstream of the Middle Suwannee basin) of 4.82 million lbs-N/y (2,410 tons-N/y). FSI published Middle (FSI 2017) and Lower (FSI 2015) Suwannee Basin nitrogen mass balances that estimated a combined nitrogen mass loading to the FAS of 6.21 million lbs-N/yr (3,107 tons-N/y). FSI's Blue Water Audit (FSI 2021) estimated a total nitrogen load to the FAS in the Middle Suwannee basin as about 3.68 million lbs-N/yr (1,842 tons-N/y). Finally, Knight and Clarke (2023) published an empirical nitrogen mass balance using Suwannee River and springs data for water flow and water quality for the period from 1996 to 2021. Their analysis reported an average loading rate of 4.28 million lbs-N/y (2,142 tons-N/y) from the Middle Suwannee Basin. These independent estimated nitrogen loads to the Suwannee River basin range from about 3.7 to 6.2 million lbs-N/y. The three lower estimates are for partial areas of the basin and are expected to be lower than the combined FSI total of 6.21 million lbs-N/y (3,107 tons-N/y) for the entire Suwannee River groundwater basin. FDEP's 2025 NSILT total nitrogen load estimate to the FAS is 7.41 million lbs-N/y (3,705 tons-N/y) for the

Suwannee River BMAP area and is reasonable considering these independent nitrogen load estimates.

Table 11. FSI's Summary of Estimated Total Nitrogen Loading from CAFO and Non-CAFO Dairies in the North Florida Springs Region.

Estimated Dairy Nitrogen Dynamics North Florida Springs Region				
Subregion	Units	Est. Raw Wasteload	Est. to Land Surface	Est. to FAS
Upper/Middle Suwannee	lbs-N/y	6,766,808	1,015,021	507,511
	tons-N/y	3,383	508	254
Lower Suwannee	lbs-N/y	8,888,626	1,333,294	666,647
	tons-N/y	4,444	667	333
Outside Basin	lbs-N/y	890,600	133,590	66,795
	tons-N/y	445	67	33
Non-CAFO Dairies	lbs-N/y	3,451,294	1,725,647	862,824
	tons-N/y	1,726	863	431
Total	lbs-N/y	19,997,328	4,207,552	2,103,776
	tons-N/y	9,999	2,104	1,052

Notes: Raw dairy N loads are estimated with standard waste factors for milking and dry cows. CAFO dairies assume an 85 percent attenuation of raw wastewater N and non-CAFO dairies assume 50 percent biochemical attenuation. All subsequent loads are assumed to be attenuated by 50 percent during recharge to the FAS.

For the entire Suwannee 2025 BMAP area (Upper, Middle, Lower, and Outside Subbasins), and for CAFO and non-CAFO dairies, FDEP estimated about 0.99 million lbs-N/yr (495 tons-N/yr) to the Floridan Aquifer (FDEP 2025). This total is about 14 percent of the total BMAP NSILT estimated load to the FAS of 7.41 million lbs-N/y (3,705 tons-N/y). Our combined estimated nitrogen loading rate by dairies to the FAS for all dairies (2.10 million lbs-N/y or 1,052 tons-N/y) is about twice the FDEP dairy estimate. Based on the uncertainty of dairy cattle waste factors, biochemical attenuation, and realistic recharge attenuation rates, FDEP's and FSI's estimated nitrogen loads may bracket reality and provide a useful range from optimistic to conservative for the actual impacts of dairies on FAS nitrogen loading in the North Florida Springs Region.

Achieving the Nitrogen TMDL Goal

This analysis indicates that in portions of North Florida Springs Region dairies are a significant source of groundwater nitrate nitrogen contamination affecting springs and drinking water supplies. FDEP has published the updated 2025 OFS restoration BMAP for the study area, including the Suwannee Upper, Middle, Lower, and adjacent groundwater basins (FDEP 2025). Using their NSILT tool, FDEP estimated that a total of 7.41 million lbs-N/y (3,705 tons-N/y) from all sources are impacting the springs discharging from the FAS in this springshed. The FDEP nitrogen load reduction goal for the basin is to achieve the nitrogen TMDL of 0.35 mg-N/L in the springs by reducing loading by 6.33 million lbs-N/y (3,165 tons-N/y) or an overall mass reduction of 85 percent. The Suwannee Basin 2025 BMAP describes general measures that are proposed by FDEP to achieve this TMDL by 2038.

The 2025 Suwannee River BMAP provides limited guidance for achieving agriculture's nitrogen load reduction goals:

> *"While agriculture is essential, it is important to manage potential environmental impacts associated with agricultural operations. To address nutrient loading from agricultural operations effectively, it is necessary to have a balanced approach that supports agricultural productivity while safeguarding water resources. This entails promoting farming practices that optimize nutrient and water use efficiency, minimize runoff and enhance soil health.*
>
> *"Section 403.067, F.S., requires agricultural producers in adopted BMAPs to either enroll and properly implement the applicable FDACS BMPs for their operation or to conduct water quality monitoring activities as required by Chapter 62-307, F.A.C. BMPs include practices such as nutrient management, irrigation management, and water resource protection. They can mitigate nutrient loading while promoting environmental stewardship**. In many BMAPs, however, the implementation of BMPs alone will not be sufficient to meet water quality restoration goals, and regional projects and innovative technologies will be needed.**"*

Dairies and other CAFO nitrogen removal responsibilities are further addressed by the following language in the 2025 Suwannee River BMAP:

> *"Dairies and other CAFOs permitted under Chapter 62-670, F.A.C., located within a BMAP, may not cause or contribute to a violation of water quality standards and must implement nutrient management practices identified in their permits. To minimize infiltration of liquid manure, if a dairy uses a clay liner or some other type of engineered waste storage pond system, within two years of the BMAP adoption, the dairy will submit to DEP an evaluation identifying the environmental, technical and economic feasibility of upgrading to a concrete or geosynthetic liner. The evaluation may alternatively demonstrate that the existing*

liner/pond does not allow leaching that causes or contributes to water quality exceedances. Upon review of the evaluation, the DEP may identify required upgrades in a subsequent BMAP update."

CAFO Dairy Compliance with BMAP Target

Since all CAFO dairies are already required to have and follow an NMP certified by an agronomic engineer, there is likely to be little, if any, additional improvement of nitrogen load attenuation that can be obtained by traditional agricultural engineering or operational controls. This reality dictates two basic options for dairy owners to achieve the nitrogen TMDL, either they must apply advanced nitrogen removal technologies on their farm, or they must reduce the nitrogen waste load by reducing the dairy herds.

The only potentially viable technology options to achieve the Suwannee Basin BMAP mandate for 85 percent nitrogen removal are (1) to collect all polluted waters from all dairies and truck or pump them by pipelines to one or more regional advanced wastewater treatment facilities designed to provide a high efficiency of nitrogen reduction, or (2) to provide advanced nitrogen removal technologies at each individual dairy farm. These two options are feasible but very expensive, likely to cost in the hundreds of millions of dollars each year for the existing north Florida dairies.

While it is technically feasible to build and operate advanced wastewater treatment plants on every dairy farm, this is not likely to be economically feasible. The most feasible approach to lowering the CAFO dairy nitrogen loading to the FAS to achieve compliance with the 2025 BMAP appears to be herd size reduction. Based on the 72,250 estimated dairy cattle in the 15 dairy CAFOs in the North Florida Springs Region and the 85 percent reduction goal, it is concluded that BMAP compliance for these permitted dairies may require an overall herd reduction of about 61,412 cows.

Non-CAFO Dairy Reliance on Best Management Practices

Compliance suggestions for non-CAFO dairies are covered in the 2025 BMAP as follows:

"Livestock operations may not cause or contribute to a violation of water quality standards. Not all livestock operations are large enough to require an NPDES CAFO permit under Chapter 62-670, F.A.C. For these operations, section 403.067, F.S., requires the operation to enroll in the FDACS BMP Program and implement applicable Best Management Practices (BMPs) or to conduct a monitoring program according to Chapter 62-307, F.A.C., that is approved by DEP or the applicable WMD."

FDEP's BMAP plans for reducing nitrogen loads from non-CAFO dairies are focused on the construction and use of dairy BMPs (FDACS 2024). A review of the FDACS dairy BMP document does not provide insight into the expected nitrogen removal benefits attained by following the dairy BMP. Unpermitted dairies are not required to be constructed or operated following a site-specific dairy NMP developed by a certified

agricultural engineer. Only one published detailed study of the efficacy of a dairy BMP/NMP for controlling nitrogen loading to the FAS using this approach was found in the project area.

This full-scale dairy BMP study of an animal waste management system and associated operation and maintenance plan was developed and implemented at the T.W. Byrd Dairy by NRCS engineers in Lafayette County, Florida (UF IFAS 2007) in the Lower Suwannee River Basin. This NMP relied principally on at-the-time-current state-of-the-art waste treatment facilities and methods and use of treated dairy wastewaters for irrigation/disposal on crop lands. The following text is excerpted from the summary of that study:

> *"Groundwater nitrate concentrations at the dairy farm were the highest of the land-uses monitored. Average nitrate-N concentrations for the dairy ranged from 30 to 50 mg-N/L. The highest concentrations (often over 100 mg-N/L nitrate-N) were observed in one of the wells near the lagoon and in the denuded areas where cattle are fed and lounged before milking. The lowest concentrations were observed in the area that is going to become the sprayfield. These concentrations were generally 20 mg-N/L or below except when lagoon slurry was applied during the lagoon cleanout process."*

Dairy BMPs currently offer little-to-no hope for achieving their share of allowable dairy-derived nitrate nitrogen leaching to the regional groundwater and springs. Given the expense of building and operating advanced wastewater treatment plants on each small dairy, for the estimated 13,058 cow non-CAFO dairies in the Suwannee Basin the only practical approach to achieving the 85 percent reduction goal in the statutorily required time may be to reduce overall dairy cow herd size. Based on the estimated nitrogen loading rates estimated in this report for the unpermitted North Florida dairies, this load reduction is equivalent to a proposed additional basin-wide dairy herd reduction of about 11,099 cows.

Groundwater and Springs Nitrate Concentrations

Springs provide a natural integration of multiple groundwater pathways to a point of surface water discharge. These pathways include portions of the aquifer beneath relatively less affected landscapes as well as under areas that are in intensive uses. Examples of these intensive land uses include fertilized cattle/hay pasture, row crops, dairies, and other CAFOs, including intensive poultry operations and crowded suburban septic tanks and lawn/garden fertilization. Examples of less intensive land uses are unfertilized long leaf pine forests, mixed hardwood forests, and natural wetlands. This blending of groundwater sources helps to partially mitigate high groundwater nitrate concentrations from areas of intensive nitrogen loading.

Average measured concentrations of nitrate nitrogen in representative OFS were summarized by FSI and the non-profit Florida Springs Council (FSC) and are

summarized in Figure 4. All OFS combined have a nitrate-N concentration average that has risen from about 1 mg-N/L in 2000 to about 1.8 mg-N/L in 2022. This average concentration is more than 5 times higher than the 0.35 mg-N/L Suwannee Basin springs TMDL compliance criterion. Site specific springs data from the Middle Suwannee groundwater basin has a reported average nitrate-N concentration of 2.4 mg-N/L (Knight and Clarke 2023), more than 6.8 times higher than the 0.35 mg-N/L OFS standard.

The observed rising trend in OFS NOx-N concentrations documents that the original and revised OFS BMAPs and BMPs are not working and that additional intensive nutrient-polluting sources (*e.g.,* numbers of cows, chickens, cattle, and fertilized crops and pastures) are entering the Suwannee Springshed, making BMAP compliance even more difficult and expensive. This alarming trend indicates that to avoid continuing worsening pollution of these OFS, immediate corrective actions need to be implemented both at dairies and for other intensive agricultural land uses.

Individual springs adjacent to and down gradient from dairies often have much higher measured NOx-N concentrations than combined averages for all OFS in Figure 4. For example, Troop Spring on the Santa Fe River is located just to the north and downgradient from Alliance Branford Dairy in Gilchrist County. Sampled by FSI as part of a comprehensive study of the Santa Fe River springs, at 40 to 60 mg-N/L, Troop Spring had the highest NOx-N concentrations reported for any artesian spring in Florida (FSI 2018).

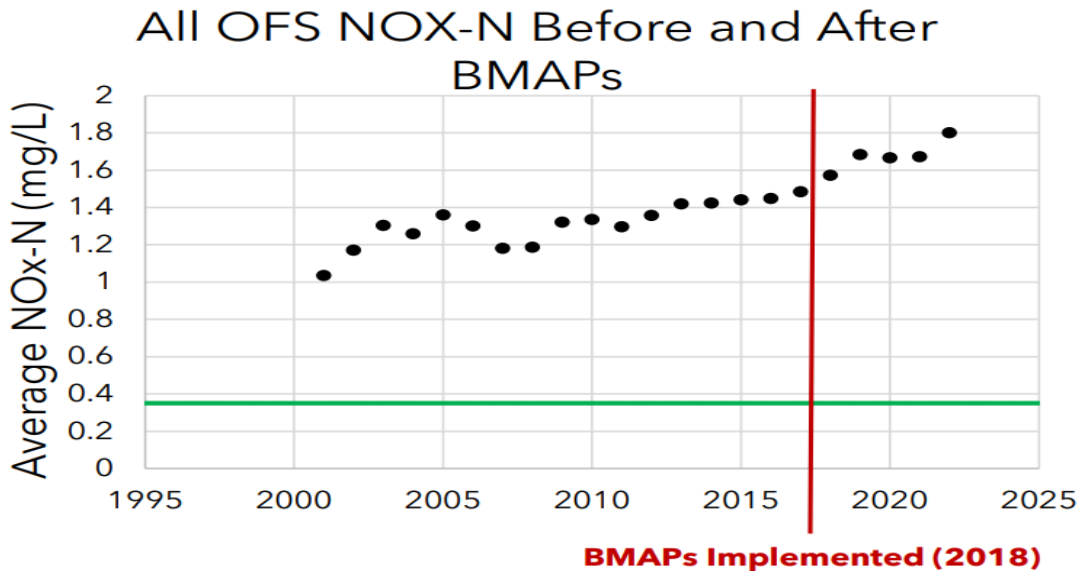

Figure 4. Rising trends in nitrate nitrogen concentrations in Outstanding Florida Springs before and after BMAP implementation. The green line indicates the 0.35 mg-N/L NOx-N compliance standard for springs (FSI/FSC analysis).

First magnitude Fanning Spring is in the Lower Suwannee River BMAP area and typically has NOx-N concentrations between 5 and 8 mg-N/L, more than 14 to 22 times higher than the springs standard (Figure 5). The following permitted dairies in Gilchrist County are in the Fanning Springshed and likely contribute excessive nitrate to the springs: North Florida Dairies, Grassy Bell, Piedmont, and Alliance.

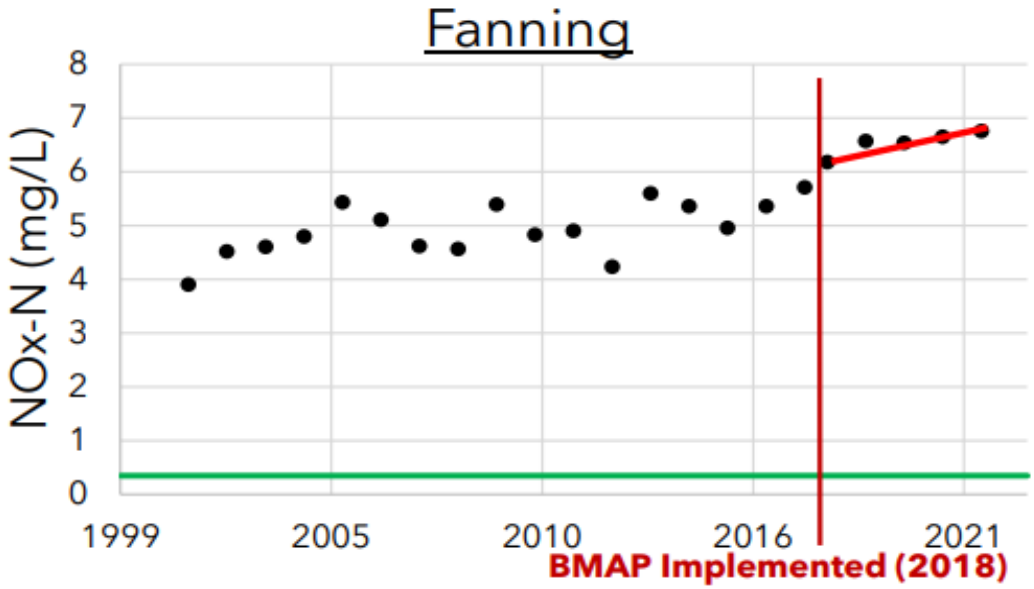

Figure 5. Rising trends in nitrate nitrogen concentrations in Fanning Spring in Suwannee County before and after BMAP implementation. The green line indicates the 0.35 mg-N/L NOx-N compliance standard for springs (FSI/FSC analysis).

For comparison, historic groundwater NOx-N concentrations unaffected by dairy wastes and other anthropogenic nitrogen sources were typically much lower than current values, less than 0.05 mg-N/L (Scott et al. 2004). The FDEP NOx-N criterion for springs is 0.35 mg-N/L, seven times higher than this natural background concentration. Based on published well data, FSI (2020) has estimated that the current average groundwater NOx-N concentration throughout the north Florida karst region is above 1 mg-N/L, or about 20 times higher than the natural background.

FDEP maintains a Drinking Water Database reporting nitrate data for all public water systems (PWS) on an annual basis. A PWS is defined by FDEP as any system that provides drinking water to 25 or more persons for at least 60 days per year, and includes both public and private convenience stores, schools, retirement homes, all the way up to municipal water supplies. Figure 6 is a map of the most recent PWS data analysis available from FSI's Blue Water Analysis project (FSI 2021). This map clearly shows the relationship between groundwater nitrate contamination and the most

vulnerable and heavily nitrogen-loaded unconfined karst areas in north Florida. A total of 5,661 PWS systems located in the entire Florida Springs Region were tested between 2014 and 2019. About 64 percent of those PWS reported nitrate nitrogen concentrations less than 0.35 mg-N/L (the OFS standard). During this reporting period, none of those systems reported values above 10 mg-N/L, the drinking water standard.

Average and maximum groundwater NOx-N in public water supplies for the counties with dairies included in this report are summarized in Table 12. County average concentrations range from 0.45 to 1.32 mg-N/L. Maximum concentrations by county ranged from 2.0 to 9.5 mg-N/L. Lafayette County has the highest average and median nitrate nitrogen drinking water concentrations. Gilchrist County has the highest number of CAFO dairy cows (19,041) and is ranked No. 2 of all Florida counties for incidence of colorectal cancers. All the counties in Table 12 have some wells with nitrate concentrations less than 0.05 mg-N/L.

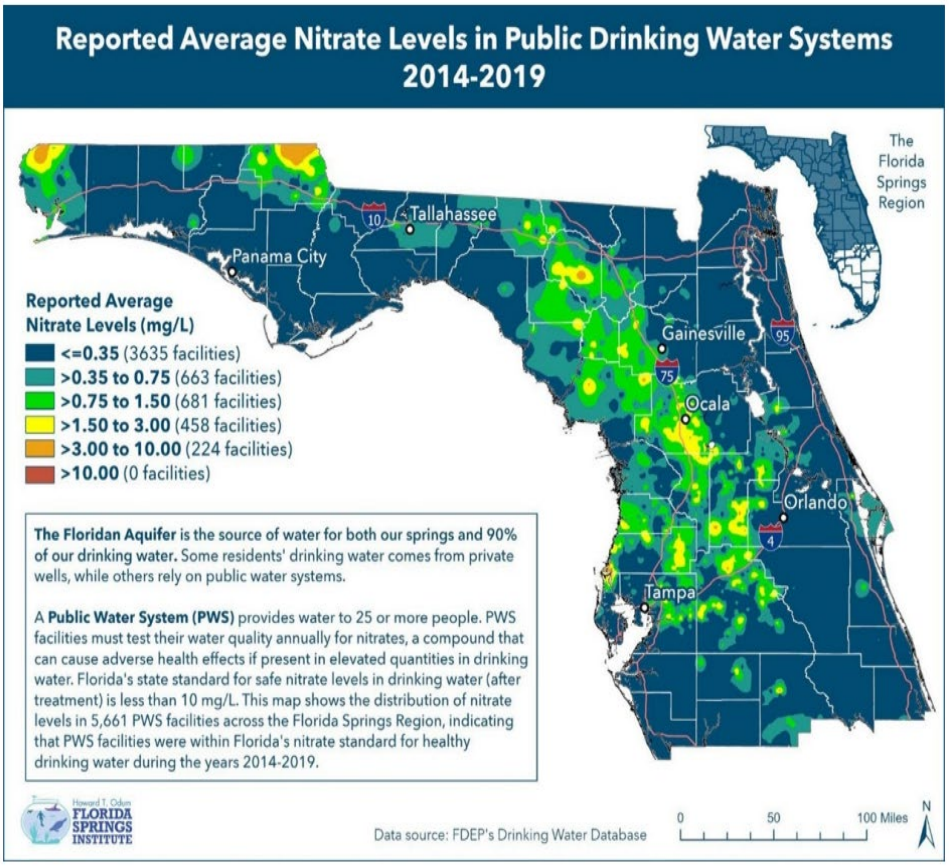

Figure 6. Public Water System Average Nitrate Nitrogen Concentrations for the Reporting Period From 2014 – 2019 (FSI BWA 2021 Figure, Data from FDEP Drinking Water Database).

Table 12. Summary of Nitrate Nitrogen (mg-N/L) Data from the 2014 to 2019 FDEP Inventory of Public Drinking Water Supplies. All Systems Draw Water from the FAS, the Same Source of Groundwater for Spring Flows (FSI analysis).

County	Average	Max	Min	Median	Count
Alachua	1.020	9.500	0.011	0.710	261
Gilchrist	1.199	5.400	0.045	0.887	146
Jefferson	0.454	2.000	0.010	0.415	48
Lafayette	1.318	6.600	0.021	1.002	44
Levy	1.223	6.400	0.024	0.998	201
Madison	0.996	4.400	0.037	0.691	69
Suwannee	1.186	6.700	0.013	0.679	206

North Florida Dairy Groundwater Nitrate Concentrations

The range of all groundwater NOx-N concentration monitoring data from dairies included in this report are summarized in Figure 7. This analysis is just for data collected at permitted dairies and reported to FDEP during the past 15 to 20 years.

As a caution for data interpretation, significant irregularities were observed in the dairy groundwater monitoring information reviewed by FSI (see appendices). The following permitted dairies have inappropriate and possibly unreliable well locations with respect to well construction and/or groundwater levels and flow directions: Alliance, Alliance Branford, IFAS, Jeffco, Milk-A-Way, Piedmont, Shenandoah, and White Oak.

The following dairies have high background well nitrate concentrations indicative of unexplained FAS contamination: Alliance Branford, Milk-A-Way, North Florida Dairies, Shenandoah, and Southern Cross.

The following dairies had significant historic or current compliance well nitrate concentrations greater than 10 mg-N/L: Alliance Branford, Full Circle, Grassy Bell, IFAS, Milk-A-Way, North Florida Dairies, Southern Cross, Southpoint, and White Oak.

With those caveats in mind, this review found that “background” monitoring wells had an overall average of 10.6 mg-N/L NOx-N and a maximum of 165 mg-N/L. “Intermediate” wells, those within the dairy property boundaries, had an average of 16.9 mg-N/L and maximum annual average of 160 mg-N/L. “Compliance” wells, those intended to be

downgradient from active dairy areas, including wastewater lagoon and land application areas, had a reported average of 5.7 mg-N/L and a maximum of 285 mg-N/L.

The regional average NOx-N for the dairies reviewed in this report was above 10 mg-N/L or about 200 times higher than natural FAS background concentrations. The bottom-line conclusion is that dozens if not hundreds of artesian springs in the North Florida Springs Region are negatively impacted by groundwater inputs bearing excessive nitrate concentrations from private, for-profit dairies in the region. There is currently little effective effort to curtail these harmful practices and to protect the public's access to unpolluted springs and drinking water.

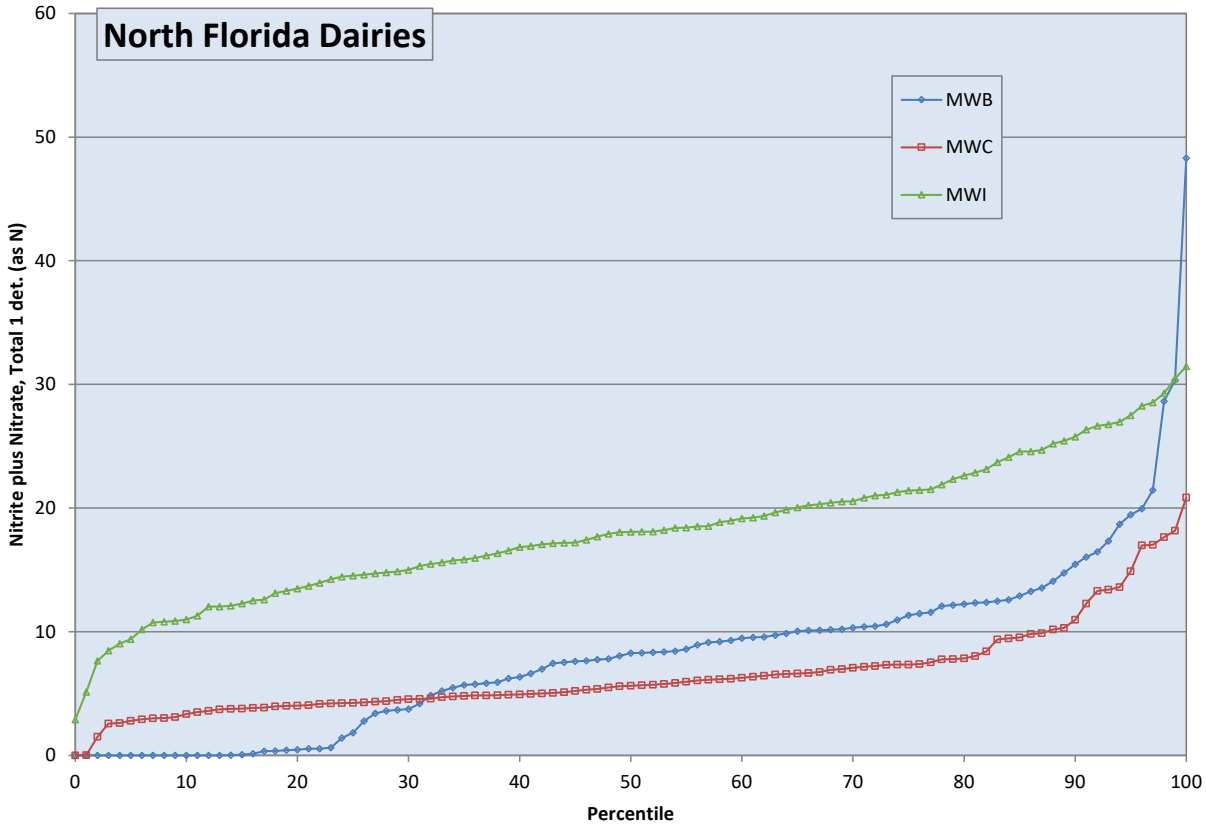

Figure 7. Combined Percentile Plot of Reported Monitor Well NOx-N Data from All the North Florida CAFO Dairies Included in This Report (Well Legend: B is Background, I is Intermediate, and C is Compliance).

The effects of elevated groundwater nitrates from dairies and other intensive agricultural operations in the North Florida Springs Region require more thorough study. Nine of the 15 dairies examined in this report had multiple records of elevated groundwater nitrate concentrations above 10 mg-N/L in background and compliance wells. Given the less-than-perfect locations of some upgradient and downgradient wells, it appears likely that

higher nitrate concentrations typical of the intermediate monitor wells may also be impacting offsite private wells in the vicinity of some dairies.

Remedial actions by FDEP and dairy owners are needed to eliminate/reduce anthropogenic nitrate contamination of public and private springs and water supplies in North Florida.

Regional Cancer Health Impacts in the North Florida Springs Region

The review of potable public water supplies indicated regional nitrate nitrogen concentrations are typically greater than 1 mg-N/L. The Environmental Working Group analysis (Temkin et al. 2019) evaluating the effects of elevated drinking water nitrate on cancer incidence identified a health guideline threshold concentration of 0.14 mg-N/L (95% confidence interval range 0.08 to 0.63 mg-N/L) to prevent no more than a one-in-one-million risk of colorectal cancers. Epidemiological evidence reviewed above confirms that NOx-N concentrations in drinking water significantly lower than the Florida standard of 10 mg-N/L are necessary to avoid the risk of chronic health impacts.

Recent data from State Cancer Profiles and the Federal Center for Disease Control's National Cancer Institute were reviewed for the counties occupied by these dairies, with particular focus on the incidence of colorectal cancers. Three of the dairy counties evaluated for this report were in the Florida top ten colorectal cancer counties over the past five years out of the 67 counties in Florida. Gilchrist County was ranked No. 2 with a colorectal cancer rate of 52 per 100,000 population. Levy County was next with a rank of No. 7 with a colorectal cancer incidence of 46 per 100,000. Lafayette County was ranked No.8 with an incidence rate of 45 per 100,000. Suwannee County was ranked No.12 of Florida's counties with an incidence rate of 41 per 100,000.

A review of data for other types of cancers from the same sources did not reveal any additional elevated cancer occurrences in the dairy counties reviewed for this report.

North Florida Dairy Groundwater Use

The estimated groundwater use by the 15 permitted dairies evaluated in this report is 40.51 MGD (Table 3). Applying the same estimate of water use per cow of about 560 gallons per day, the non-CAFO dairies may be using about 7.59 MGD for a combined groundwater use estimate of 48.1 MGD. This water use contributes to the ongoing aquifer depletion documented in the North Florida springs region (Knight and Clarke 2016). Based on a regional evaluation of historic and current spring flow data through 2010, those authors estimated an existing 48 percent reduction (2,296 MGD) in spring flows in the entire Suwannee River Water Management District. Over the past 45 years of discharge data, FSI (unpublished) documented a 26 percent flow reduction at the Suwannee River Wilcox gauge equal to about 1,744 MGD. The estimated 48 MGD total water used by these dairies accounts for a relatively small but nevertheless important fraction of the overall decline in regional spring flows.

Summary and Recommendations

North Florida dairies are discharging an estimated 2.1 million lbs-N/y (1,052 tons-N/y) NOx-N to the local and regional groundwater, springs, and water supply wells. Given that NOx-N is very stable in groundwater (Andrews 1994; Pittman et al. 1997), the majority of this nitrogen load is exiting the aquifer either through drinking water and irrigation wells or through springs, most of which are already legally beyond nitrogen impairment concentrations. Nitrogen loads from all sources in the Suwannee SRA, including these dairies, must be expeditiously reduced to comply with the spring TMDL standard of 0.35 mg-N/L and to protect the public from the heightened risk of chronic illness and cancer by drinking contaminated groundwater from public and private wells.

The reviewed CAFO dairies were found to be inconsistent in dairy operational management, dairy herd size, and groundwater nitrate compliance (see appendices for details). Based on our review of dairy design, waste management methods, and groundwater contamination, we recommend that an independent review be expeditiously conducted, and the most impactful dairies be put under consent orders to increase waste treatment and reduce herd size to comply with the most restrictive state NOx-N standards. Advanced nitrogen treatment should be increased, and allowable herd size and density should continue to be reduced, using an accelerated adaptive management strategy until all permitted dairies are complying with the regional NOx-N BMAPs. We recommend that all dairies in the region, including those with herd sizes below the FDEP CAFO threshold, be subject to the same requirements as the permitted dairies.

Based on this summary review of nitrate-nitrogen pollution and groundwater depletion resulting from permitted dairies located in North Florida's Springs Region, and the dire consequences both to public health and protection of surface water resources, Florida's government officials and the concerned public should consider these findings to be an ongoing emergency. FSI recommends that implementing corrective actions should be of the highest importance for FDEP, county health department officials, local elected officials, and the dairy owners who may be subject to civil or criminal penalties for their harmful practices.

FDEP's Industrial Wastewater Program should hire an independent contractor to expeditiously complete detailed groundwater assessments at every Florida dairy, including permitted and unpermitted dairies. These assessments should include a review of existing monitor well locations and design specifications (depth, diameter, stratigraphical zones screened, and productivity); a survey of well and water surface elevations; establishment of additional clearly up- and down-gradient groundwater sampling points if warranted; comprehensive multi-year well sampling for water levels, specific conductance and NOx-N; and review/verification of existing historic data.

FDEP and FDOH should initiate a comprehensive groundwater sampling network of public and private wells within the north Florida springsheds and FAS impact zones

affected by these permitted and unpermitted dairies. These data should be publicly reported, and this monitoring needs to be ongoing into the foreseeable future.

FDOH should also conduct a detailed review of all cancers and chronic health effects reported in the counties covered by this study and make the results available to the public as soon as possible. If this epidemiological evaluation verifies an increased risk of cancers in this region, FDEP in consultation with the Environmental Protection Agency should lower the potable drinking water nitrate standard to a truly protective level.

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Appendix A: Alliance Dairies - FLA116521, Levy and Gilchrist Counties

Detailed Description

Alliance Dairies is located in Gilchrist County, Florida. The street address is 4951 Northwest 170th Street in Trenton. Alliance Dairies are situated in the Chiefland Karst Plain geomorphologic province.

Based on the Alliance Dairy's most recent NMP (2024), the dairy's waste management system accommodates 10,700 lactating cows with an average weight of 1,400 pounds, 3,470 dry cows with an average weight of 1,450 pounds, 400 springers with an average weight of 1,200 pounds, 6,903 heifers with an average weight of 950 pounds, and 24 bulls. The facility consists of nine (9) free stall barns for lactating cows and five (5) free stall barns for dry cows and springers, two (2) covered milking parlors, a hospital barn, travel lanes, commodities storage area, on-site composting operation under the same ownership, sand separation lanes, collection sump, screen separators, surge tanks, concrete lined solids storage area, and a 4.5-million gallon (MG) concrete-lined wastewater storage pond. The effluent from the screens drains to the existing large waste storage pond (400 feet (ft) x 140 ft x 18 ft). In addition, there is a 7 MG anaerobic digester. The facility is located at latitude 29° 35' 8.8832" N, longitude 82° 51' 36.3987" W. This facility's permit was issued under Chapter 403, Florida Statutes (F.S.).

The lactating cows are divided into 20 herds and are housed in sand-bedded free stall barns. Dry cows and springers are also housed in the free stall barns and pastures of the former Hilltop portion of the property. Dairy heifers, bulls, and calves are also kept onsite in pastures. The dairy design provides that the lactating cows and springers will deposit 100% of their nutrients in free stall barns, while the dry cows will deposit about 70% of their nutrients in free stall barns, and the remaining 30% in surrounding pastures, while the heifers will only be pastured. Excess nutrients from the confinement barns are either hauled offsite as solids or surface applied to forage fields via sprinkler irrigation and manure spreaders. Pastures also receive direct manure deposition by grazing animals. Application rates are based on crop uptake levels and are below levels assumed to impair surface or groundwater resources.

Groundwater Monitoring

The current groundwater monitoring network at Alliance Dairy consists of twelve monitor wells screened in the Floridan Aquifer:

- One Background well – MWB-1
- Four Intermediate wells – MWI-2H, MWI-3, MWI-5 and MWI-9
- Seven Compliance wells – MWC-3H, MWC-4H, MWC-8R, MWC-10, MWC-12, MWC-13 and MWC-14.

Locations of the monitor wells are shown in Figure A-1. The monitor wells range in depth from 40 to 65 feet. Monitor wells numbering 1 through 9 were originally installed to check water quality in the vicinity of the former Hilltop Dairy. Those wells were converted to be included in the monitor well network for Alliance Dairy.

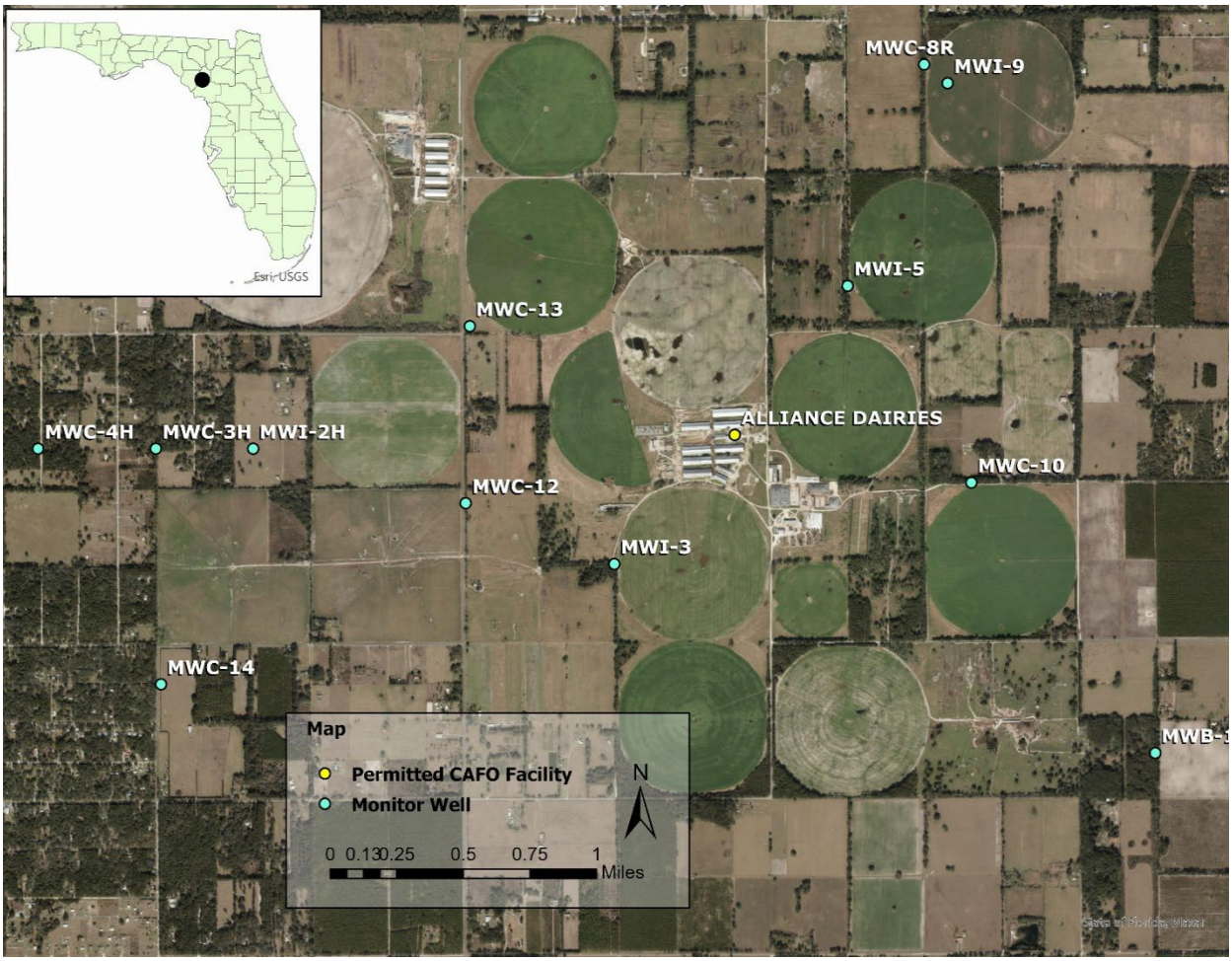

Figure A-1. Locations of Monitor Wells, Alliance Dairies - FLA116521 (Levy/Gilchrist Counties).

Groundwater Flow Direction

Figure A-2 provides a regional look at the upper Floridan Aquifer System (FAS) potentiometric surface in the vicinity of Alliance Dairy in September 2021. The groundwater flow direction is to the west toward the Suwannee River; however, background monitor well MWB-1 is located too far south to be considered directly upgradient of Alliance Dairy. Four intermediate wells were placed to indicate groundwater quality within the property boundaries. The groundwater flow direction is consistent with data collected in September 2017. Figure 12 in the 2025 permit indicates that the seven compliance wells are located close to and downgradient of

wastewater disposal locations. Compliance wells MWC-12, and MWC-13 are downgradient of the northwest corner of sprayfields. Compliance wells MWC-10 and MWC-8 are located upgradient of much of the dairy property and not sited correctly for their stated purpose.

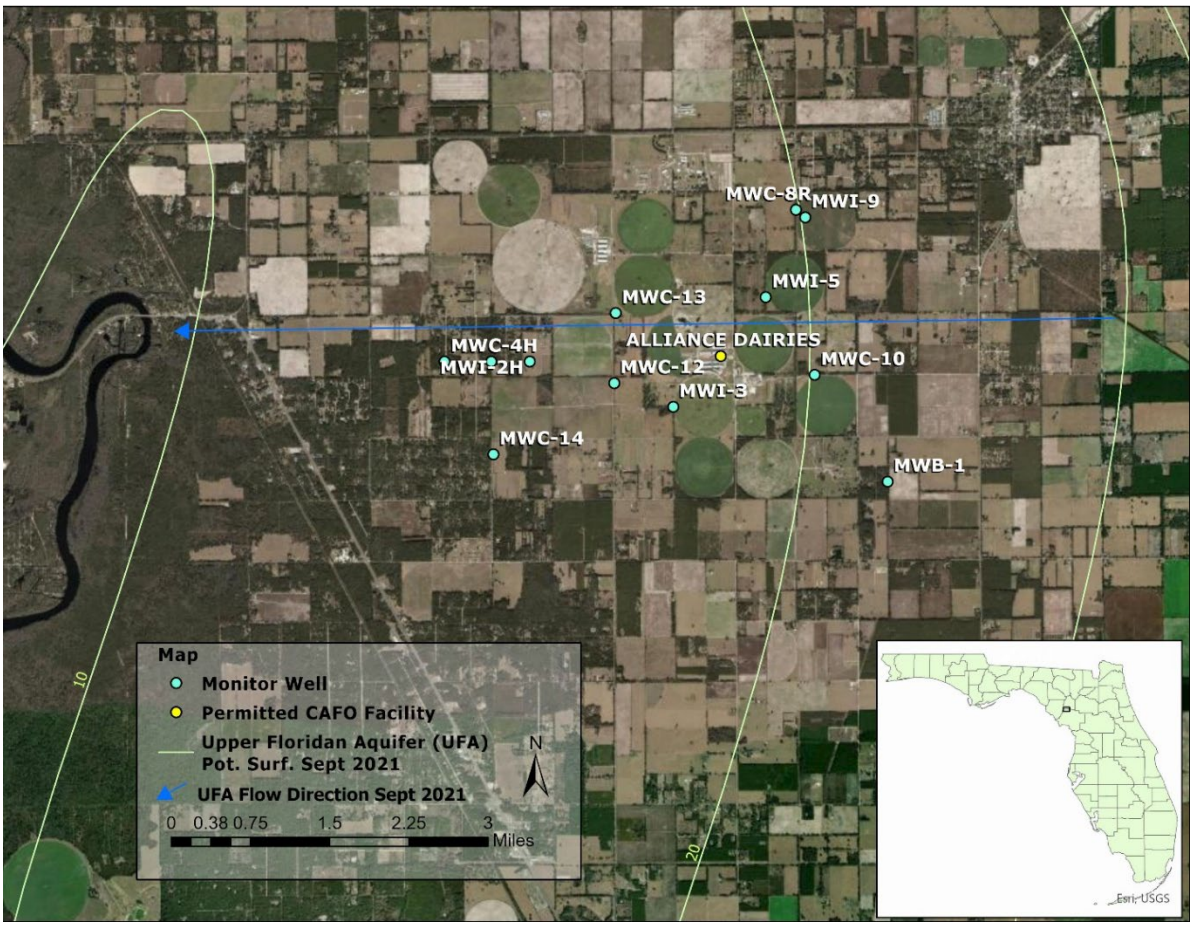

Figure A-2. Floridan Aquifer System September 2021 Potentiometric Surface Contours in the Vicinity of Alliance Dairies With the Estimated Regional Groundwater Flow Direction (Blue Arrow).

Groundwater General Water Quality

Table A-1 presents a summary of reported groundwater monitoring data for the period-of-record from March 2004 through September 2023. Background well data are representative of typical FAS conditions in the north Florida karst area with an average specific conductance of 361 umho/cm, slightly basic pH of 7.5 s.u., elevated NOx-N of 1.57 mg-N/L, and orthophosphorus of 0.11 mg-P/L and low levels of fecal coliforms of 2.0 #/100mL. Average specific conductance is higher in the intermediate wells at 585 us/cm, indicating pollution by the average elevated NOx-N of 16.05 mg-N/L.

Orthophosphate, pH, and fecal coliform counts are not elevated. NOx-N and specific conductance are reduced in the compliance wells compared to the intermediate wells. One concern about well location and data quality at this dairy is that the groundwater elevations do not indicate a normal declining profile from background to compliance, indicating the need for monitoring well relocation.

Table A-1. Alliance – Levy/Gilchrist County Dairy FAS Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	2.0	1.0	21.0	1.7	1.0	10.0	2.6	0.0	196.0
Conductivity	UMHO/CM	361	356	369	585	489	730	462	5	715
Nitrite plus Nitrate, Total (as N)	mg/L	1.57	0.03	12.80	16.05	0.00	61.65	4.78	0.00	26.00
Nitrogen, Total (as N)	mg/L	1.16	0.69	2.05	16.12	9.50	26.00	10.41	0.90	27.00
pH	s.u.	7.50	6.67	8.70	7.26	0.00	9.02	7.50	6.82	8.01
Phosphate, Ortho (as P)	mg/L	0.110	0.032	0.520	0.068	0.000	0.186	0.090	0.000	0.357
Water Level Relative to NGVD	ft-NGVD	10.14	5.36	20.60	9.06	4.45	18.66	12.50	1.15	30.20

Groundwater Nitrate Concentration and Trends

Based on the reported data from monitoring wells in and around the Alliance – Levy/Gilchrist County Dairy (FLA116521), there is a substantial buildup of NOx-N under and in the vicinity of the dairy property. The background monitoring well MWB-1 averaged 1.5 mg-N/L with a minimum annual average of 0.32 mg-N/L and a maximum annual average of 5.9 mg-N/L.

Over the past 20 years of operational data reviewed for this report, NOx-N concentrations in the intermediate well MWI-3 averaged 25.4 mg-N/L, with annual averages ranging from 18 to 38 mg-N/L (Tables A-1 and A-2 and Figure A-3). This well is located immediately west of the high intensity milking facility and waste storage ponds. Intermediate well MWI-9 also has elevated NOx-N concentrations averaging 14.6 mg-N/L, with annual averages ranging from 3.6 to 28.8 mg-N/L. A third intermediate well, MWI-4H, averaged 3.8 mg-N/L, with a range of average annual concentrations from 0.6 to 6.6 mg-N/L. The fourth intermediate well is MWI-2H with an 11-year average of 9.1 mg-N/L and a range of annual averages from 7.1 to 12 mg-N/L.

Compliance wells that historically had elevated NOx-N concentrations and were discontinued from routine monitoring include the following, with their maximum annual average reported values: MWC-4 (12.8 mg-N/L), MWC-5 (16.5 mg-N/L), MWC-6 (15.2 mg-N/L), and MWC-11 (15 mg-N/L). Current compliance wells and their maximum annual average values include: MWC-3H (14.8 mg-N/L), MWC-4H (6.6 mg-N/L), MWC-8R (6.5 mg-N/L), MWC-10 (6.8 mg-N/L), MWC-12 (3.6 mg-N/L), MWC-13 (9.6 mg-N/L), and MWC-14 (13.5 mg-N/L).

Table A-2. Alliance Dairies Average Annual Nitrate+Nitrite Nitrogen Concentrations in FAS Monitoring Wells.

Alliance Dairy FLA116521 Levy County																	
Year	**MWB-1**	**MWC-10**	**MWC-11**	**MWC-12**	**MWC-13**	**MWC-14**	**MWC-2**	**MWC-3H**	**MWC-4**	**MWC-4H**	**MWC-5**	**MWC-6**	**MWC-8R**	**MWI-2H**	**MWI-3**	**MWI-5**	**MWI-9**
2004	0.89	1.98	15	1.33			7.3		9.73		18	14.9	6.47		19		13.83
2005	0.73	1.44		1.73					12.75		16.5	15.25	4.83		31		10.78
2006	0.68	1.07		1.95					14		6.93	9.27	3.88		28.25		10.48
2007	0.32	0.66		0.7					12.53		1.31	9.78	2.85		29.59		14.7
2008	0.36	0.34		0.24					7.88		2	10.32	1.15		18.05		11.7
2009	0.41	0.96		0.1	7.58				12.65		0.04	11.11	4.9		21.15		12.38
2010	0.62	4.04		0.17	3.8						3.36	11.9	2.94		25.37		16.3
2011	3.15	0.42		0.18	4.73						0.48	13.24	5.38		32.5		12.9
2012	3.85	6.75		3.58	4.83						3.29	8.6	4.59		18.3		7.22
2013	0.93	0.92		0.01	4.87	8.4		13	7.13	2.13	4.95	7.23	5.54	7.86	27.2		28.75
2014	1.38	0.51		0.04	3.35	9.93		14.85		1.63	2.37		2.8	11.56	38.25		21
2015	1.58	0.31		0.02	1.65	11.43		14.75		1.17	0.13		3.15	12	34		19.67
2016	0.96	0.55		0.13	3.14	9.04		6.99		4.83	3.9		3.78	10.09	32.45		19.16
2017	1.63	0.87		0.5	4.33	8.2		6.45		5.05	0.97		6.4	9.08	22.67		11.7
2018	1.8	1.1		0.31	1.68	3.18		8		5.13	0.05		2.98	9.1	21	2.23	17.5
2019	1.6	1.33		0.61	2.75	5.61		7.54		5.48			2.66	9.78	18.75	9.05	12.58
2020	1.25	1		0.57	4.63	10.4		10.58		4.45			3.45	7.7	25.75	3.1	10.3
2021	5.93	3.82		0.4	5.05	13.47		5.6		4.57			2.87	8.89	22.13	13.27	26.8
2022	0.65	2.34		3.62	2.23	3.64		3.6		0.55			5.02	7.07	21.65	0.88	3.55
2023	1.63	4.73		0.53	9.55	5.72		5.05		6.56	13.4		3.14	7.47	20.17	0.2	11.18
AVERAGE	1.5175	1.757	15	0.836	4.278	8.092727	7.3	8.764545	10.95286	3.777273	4.855	11.16	3.939	9.145455	25.3615	4.788333	14.624

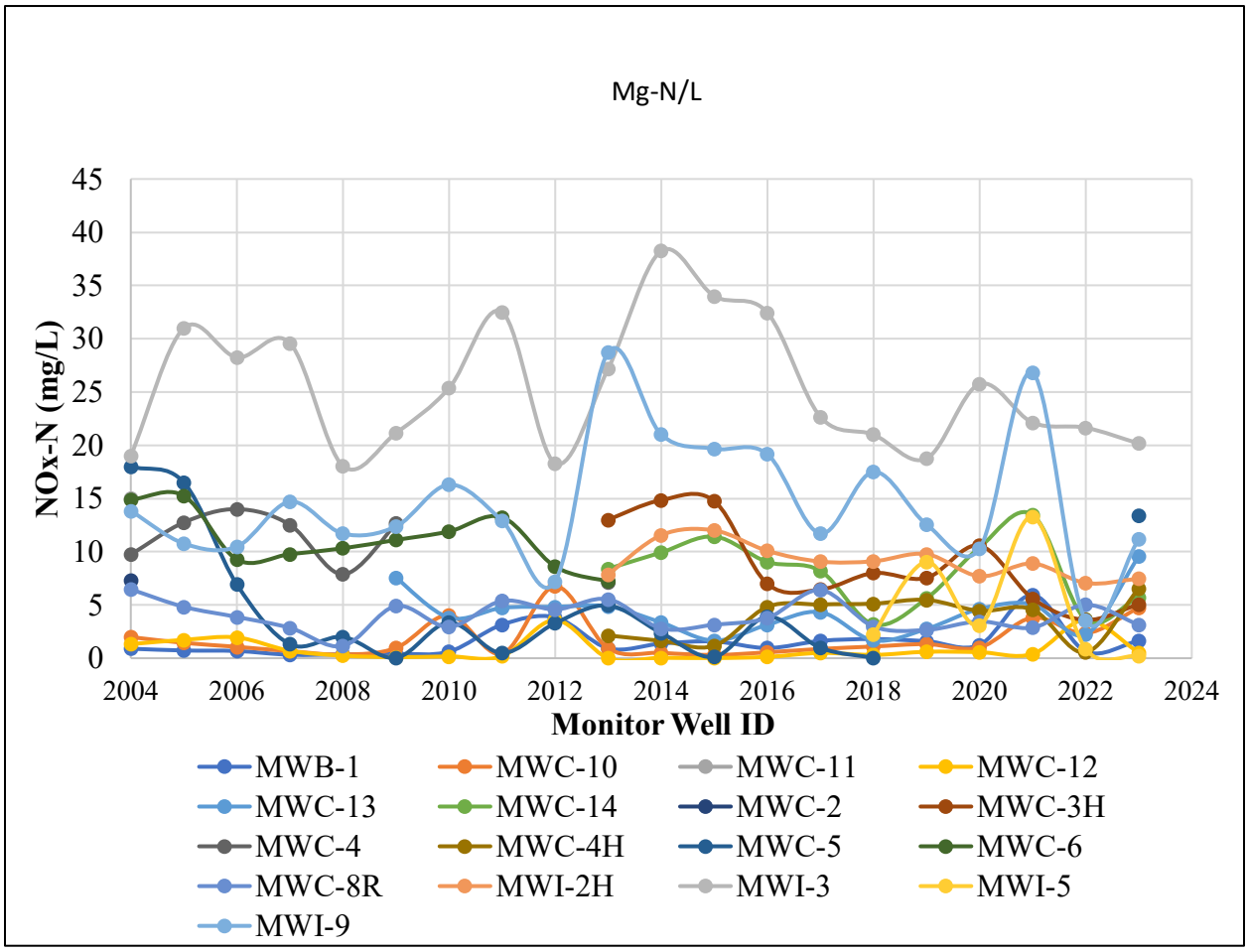

Figure A-3. Time Series Plots of Average Annual Groundwater Nitrate+Nitrite Nitrogen Concentrations at the Alliance – Levy/Gilchrist County Dairy.

Groundwater Consumption

Alliance Dairies has 42 reported FAS wells permitted to extract up to 8.36 MGD. Of this total, 6.74 MGD or 81 percent is allocated for crop irrigation on about 3,223 acres. The remainder of this permitted groundwater withdrawal or 1.62 MGD is allocated for livestock watering of an estimated 12,165 dairy cows.

Adjacent Potable Water Wells

Figure A-4 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the Alliance Dairy. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

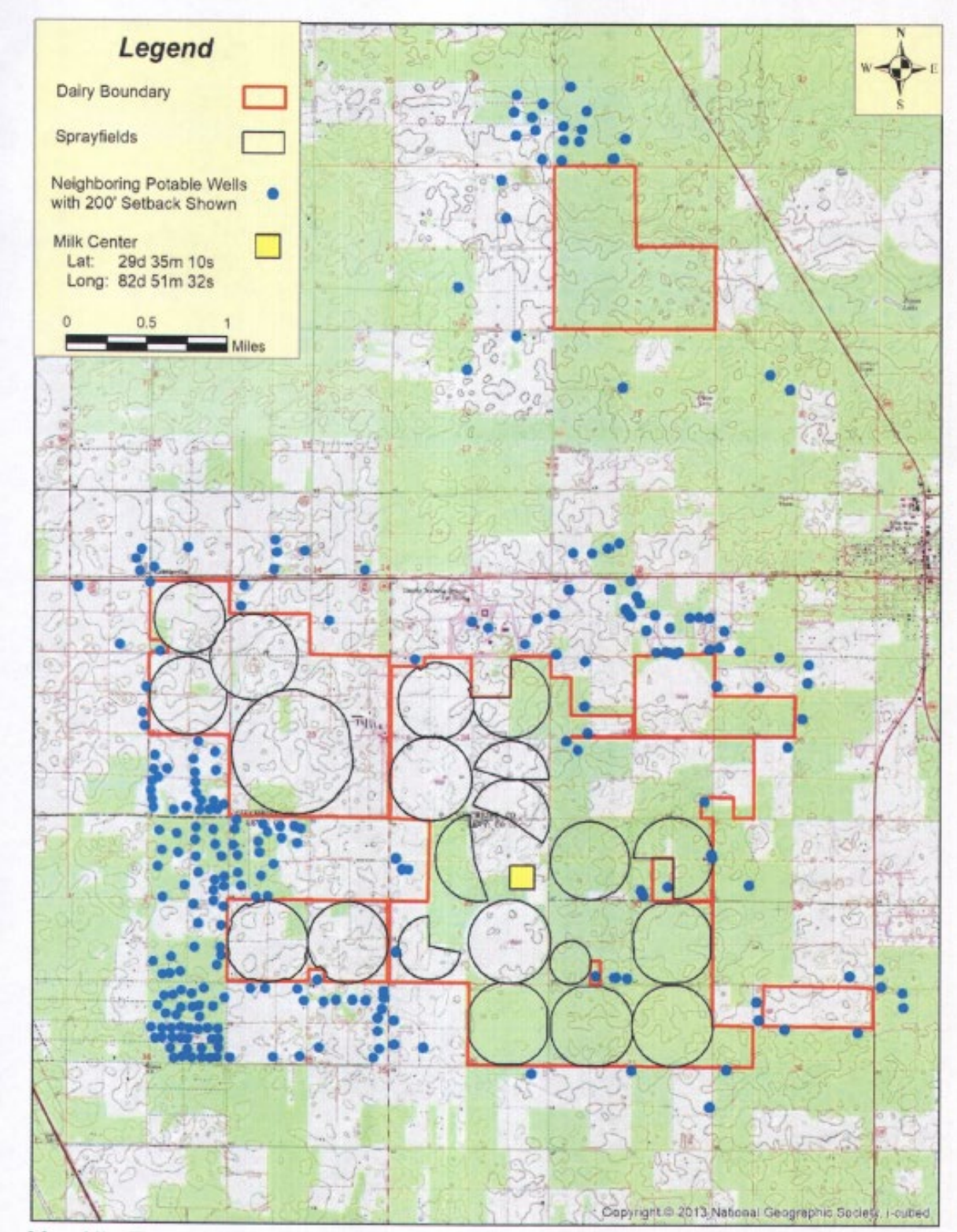

Figure A-4. Private Self-Supply Wells on and Adjacent to the Alliance Dairy, Levy/Gilchrist County.

Appendix B: Alliance Branford Dairy - FLA116173, Gilchrist County

Detailed Description

The Alliance Branford Dairy (formerly American Branford Dairy) is an existing dairy farm constructed in 1989 under the ownership of GenFarm Limited Partnership. Since then, the property has changed ownership four times - US Dairy Co to Aurora Dairy to Dairy Production Systems, LLC to American Dairy Co – Florida LLC. – before the sale to its current owners, Alliance Branford, LLC on May 17, 2018 (Table B-1).

Table B-1. Facility Ownership Dates and Permit Numbers.

Facility Name	Facility ID	Begin Date	End Date
GenFarm Limited Partnership IV	3121P04413	1989	1995
US Dairy Co	FLA011617	1996	1998
Aurora Dairy FL Unit 2	FLA0116173	1999	2004
Dairy Production Systems, LLC	FLA0116173	2004	2011
American Dairy Co	FLA0116173	2012	2018
Alliance Branford, LLC		2018	present

The currently permitted facility (Alliance Branford Dairy) is an existing total confinement dairy farm operation with an annual average lactating herd size of 2,300 cows. Dry cows and young stock are housed at other facilities. Cows spend 100% of the time confined on concrete. The facility consists of six sprayfields with center pivot irrigation systems, a milking parlor, six free stall barns with associated animal working areas, travel lanes between the milking parlor and free stall barns. Manure products flushed from the concrete surfaces in the milking parlors and free stall barns are directed to the wastewater treatment system. Effluent from the wastewater treatment system is land-applied to 468 acres of cropland.

The facility is located in Gilchrist County in the Chiefland Karst Plain geomorphologic province of Florida on 725 acres along US 129 and CR 138 approximately six miles southeast of Branford. The dairy wastewater treatment system consists of appurtenances necessary to collect all wastewater and contaminated storm water runoff from the milking parlor area, and free stall barns, and consists of a concrete lined solids trap with a screen type mechanical solids separator, three lined waste storage ponds, including a 185,500 ft^3 first stage pond, a 121,000 ft^3 second storage pond, and an 89,734 ft^3 aerated third storage pond.

In the mid-90's, Olcott Dairy operated southeast of the Alliance Branford Dairy property ceasing operations in the early 2000's. It was designed to handle an annual average

herd size of 350 cows. Four monitor wells were installed on the property. All wells were sampled and analyzed quarterly for water elevation, specific conductance, nitrate+nitrite nitrogen, pH, fecal coliform, and total nitrogen. The northern and western property lines are the southeastern boundary lines of the former American Branford Dairy property

Groundwater Monitoring

The current groundwater monitoring network at Alliance Branford Dairy consists of 14 wells screened in the Floridan Aquifer:

- Two Background wells – MWB-1 and MWB-13R
- Six Intermediate wells – MWI-11, MWI-17D, MWI-18, MWI-19, MWI-20 and MWI-23
- Six Compliance wells – MWC-3, MWC-7, MWC-8, MWC-16DR, MWC-21 and MWC-22.

Locations of the monitor wells are shown in Figure B-1. The monitor wells range in depth from 40 to 60 feet.

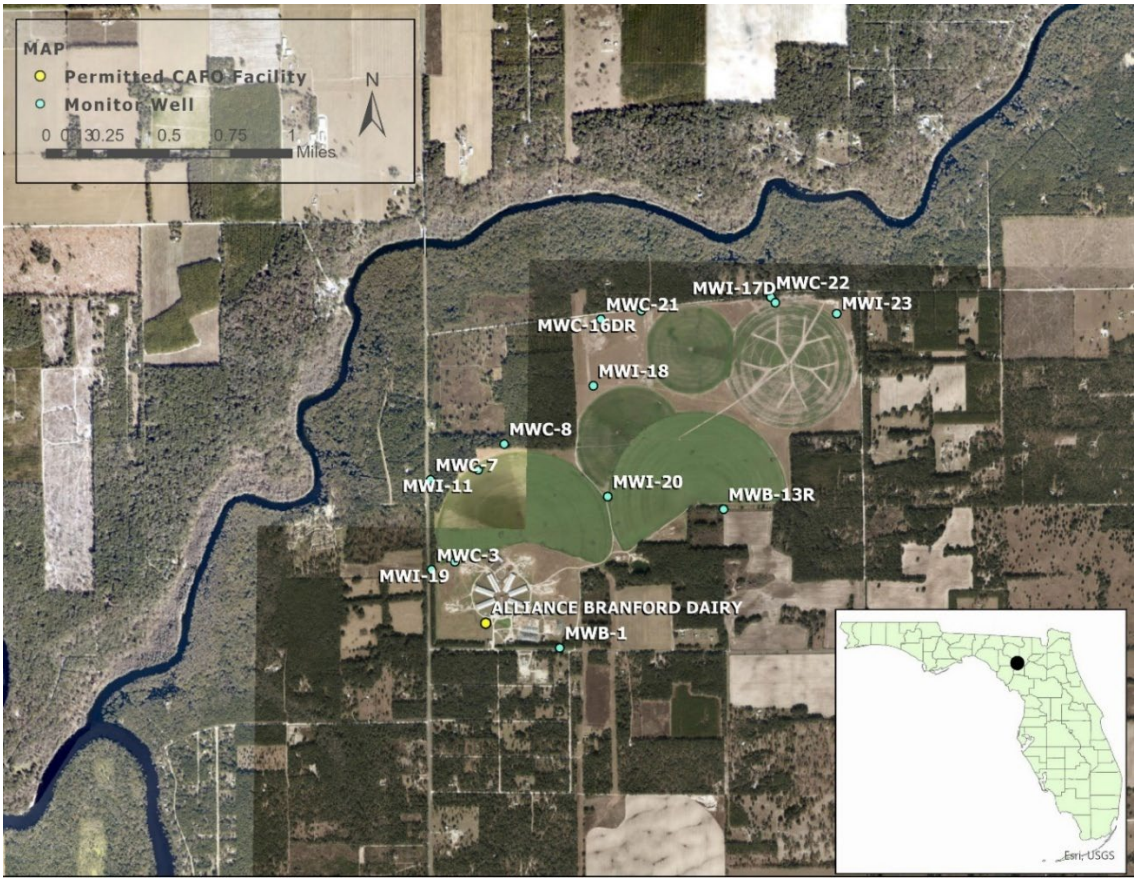

Figure B-1. Locations of Monitor Wells, Alliance Branford Dairy, Gilchrist County.

Figure B-2 shows the FAS potentiometric surface in the vicinity of Alliance Branford Dairy in September 2021. The groundwater flow direction is to the northwest, toward the Sante Fe River. Background wells MWB-1 and MWB-13R are sited to be representative of background groundwater conditions upgradient of the Alliance Branford Dairy. Five intermediate wells are correctly placed to indicate groundwater quality within the property boundaries. Former compliance well MWC-18 was changed to an intermediate well (MWI-18) in October 2024. The six compliance wells are located close to downgradient property boundaries and wastewater disposal locations.

Figure B-2. Floridan Aquifer System Potentiometric Surface Contours A\and Groundwater Flow Direction in the Vicinity of the Alliance Branford Dairy in September 2021.

Groundwater General Water Quality

Table B-1 presents a summary of reported groundwater monitoring data for the period-of record from March 2012 through September 2023. Background well data are not representative of typical FAS conditions in the north Florida karst area. The background

wells are highly contaminated by nitrate nitrogen (average 20 mg-N/L NOx-N) and fecal coliforms (13.8 col/100 mL). The low pH (6.76 s.u.) also indicates groundwater contamination at these two wells. Average NOx-N concentrations in the intermediate wells was 28 mg-N/L and pH was low (average 6.75 s.u.). The average nitrate concentration in the compliance wells was 7 mg-N/L. Orthophosphate, pH, and fecal coliform counts are not elevated. One concern about well location and data quality at this dairy is that the groundwater elevations do not indicate a declining hydraulic gradient from background to compliance (i.e. compliance wells have higher water level elevations than intermediate wells), indicating the possible need for monitoring well relocation based on measured hydraulic gradients in existing wells.

Table B-2. Alliance Branford Dairy FAS Monitor Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	13.8	0.0	800.0	2.3	0.0	63.0	9.4	0.0	2000.0
Nitrite plus Nitrate, Total (as N)	mg/L	20	0	88	28	0	160	7	0	102
pH	s.u.	6.76	0.00	8.23	6.75	0.00	8.38	7.27	0.00	10.92
Phosphate, Ortho (as P)	mg/L	0.045	0.008	0.320	0.075	0.010	0.430	0.075	0.002	0.400
Water Level Relative to NGVD	ft-NGVD	20.75	0.00	49.87	14.50	-3.49	37.27	16.42	0.00	37.68

Groundwater Nitrate Concentration and Trends

Table B-2 and Figure B-3 provide a summary of long-term and annual average concentrations of nitrate nitrogen in and around the Alliance Branford Dairy. Based on the reported data from two background monitoring wells south and east of the Alliance Branford Dairy, there is a substantial buildup of NOx-N near the southeast corner of the dairy property. Background monitoring well MWB-13R in this area has a period-of-record NOx-N concentration of more than 40 mg-N/L, and a range of annual averages from 5.2 to 71 mg-N/L. A former, closed dairy just south of this well has been cited as a possible source of this contamination, but its persistence over the past 20 years of data collection is a strong indication that this well is subject to contaminated groundwater from the current Alliance Branford dairy operation. Adjacent background well MWB-1 has a much lower average nitrate concentration of 3.6 mg-N/L, with a range of annual averages from 0.35 to 19.1 mg-N/L. Seven intermediate monitoring wells have a range of long-term averages from 1.9 to 83 mg-N/L of NOx-N. Annual average NOx-N in these seven wells range from 0.24 to 149 mg-N/L.

Compliance well MWC-17D had historically elevated NOx-N concentrations (16-year average 28.1 mg-N/L) with a peak annual average of 70 mg-N/L. This well was no longer reported after 2019. Current compliance well MWC-22 has a five-year NOx-N average concentration of 24.3 mg-N/L with a high annual average of 35.3 mg-N/L. The

remaining six compliance wells average less than 4 mg-N/L with annual averages less than 16 mg-N/L.

Table B-3. Annual Average NOx-N Concentrations in Monitor Wells at Alliance Branford Dairy.

Alliance Dairy Branford - FLA116173 (Gichrist County)																				
Year	MWB-1	MWC-3	MWC-7	MWC-8	MWI-4	MWB-13R	MWC-16DR	MWC-18	MWC-21	MWC-22	MWI-11	MWI-17D	MWI-19	MWI-20	MWI-23	MWC-17D	MWI-12	MWC-15D	MWC-15S	MWC-18D
2004	19.1	2.43	31.65	0.5	48.25	29.5	1.45				4.55					19	30	10.2		9.8
2005	7.2	2.15	0.92	0.01	32.55	27	0.86				32					17.75	29	15		3.75
2006	7.75	3.37	0.6	0.23	36	41.67	1.07	0.1			30.67					13	30.33	16.67		8.7
2007	6.95	3.65	1.04	0.03	48.1	56.99	0.48	0.71			29.42					30.1	46.7	17.07	0.68	
2008	3.44	1.59	0.49	0.01	51.13	32.47	0.12	2.25			30.43					28.2	34.6	12.27		
2009	4.42	3.69	0.45	0.03	39.91	62.77	1.13	0.22			21.66					17.66	30.25	14.3		
2010	3.12	3.8	0.36	0.34	38.8	43	1.27	2.06			20.46					15.24	25.43			
2011	1.64	4.07	13.27	0.02	56.75	53.33	13.38	13.06			39.39					20.4	21.76			
2012	1.31	1.12	0.13	0.07	77.67	71.25	0.27	0.47			81					17.1	24			
2013	1.45	0.66	0.21	0.03	65	43.25	1.09	2.45			17.93					23.5	20			
2014	2.3	6.13	0.18	14.51	79	26.42	7.15	2.34			50		2.1	12		7.7	18			
2015	0.62	0.01	0.25	0.01		33.33	1.03	0.15			34.33		0.24	14		23.67				
2016	1.87	0.32	0.69	0.01		38.5	0.92	1.71	0.02		49.5		2	14.5		60				
2017	3.13	2.76	0.51	0.02		58.5	0.88		2.4		60.25		5.2	25		70				
2018	1.23	4.93	6.04	0.13		45.75	0.43				28.03		1.53	9.58		36.68				
2019	1.33	3.76	1	0.69		40.73	2.38	1.8	1.28	23	34.71	94	2.58	8.2	23.5	49.5				
2020	0.87	3.1	0.76	0.7		54	1.4	8.38	0.8	33.75	24.5	149.3	1.37	16.4	25.5					
2021	1.11	3.96	0.65	0.35		30.7	5.58	16.03	0.53	18.38	0.34	77.23	1.93	13.41	17.27					
2022	0.35	3.11	0.48	0.2		5.19	0.76	0.2	0.2	10.93	7.65	43.65	0.84	7.13	16.26					
2023	3.22	7.02	0.24	0.5		13.36	0.2	6.98	0.2	35.34	50.33	49.45	1.74	30.4	17.49					
AVERAGE	3.62	3.08	3.00	0.92	52.11	40.39	2.09	3.68	0.78	24.28	32.36	82.73	1.95	15.06	20.00	28.09	28.19	14.25	0.68	7.42

Off-Site Impacts to Surface Waters and Private Potable Water Supplies

There are numerous ongoing records of groundwater NOx-N exceedances at the Alliance-Branford Dairy, both upgradient and downgradient. This off-site groundwater contamination was previously reported to FDEP by the Florida Springs Institute (FSI 2018) based on highly elevated NOx-N concentrations at Troop Spring, to the north of and immediately downgradient of the Alliance Branford Dairy. In 2016, FSI

began comprehensively sampling the Lower Santa Fe River and its associated springs. During that time, new sampling stations were being assessed including Troop Spring. Troop Spring is a natural artesian, 3rd magnitude spring and spring run located on private property on the south shore of the Santa Fe River, approximately 1.25 miles upstream from the U.S. Hwy 129 bridge and 3.8 miles from the confluence with the Suwannee River (Figure B-3). Initial analysis for nitrate-nitrogen at Troop Spring was 49 mg-N/L with subsequent samples over the last two years averaging 53 mg-N/L with a maximum observed value of 61 mg-N/L. Analysis of nitrate-nitrogen concentrations in

neighboring springs showed Troop Spring to be considerably higher. Given this information, surrounding land use practices were examined for potential source(s) of nitrogen contamination. The most likely upgradient pollution sources were this existing and historic dairies on this property.

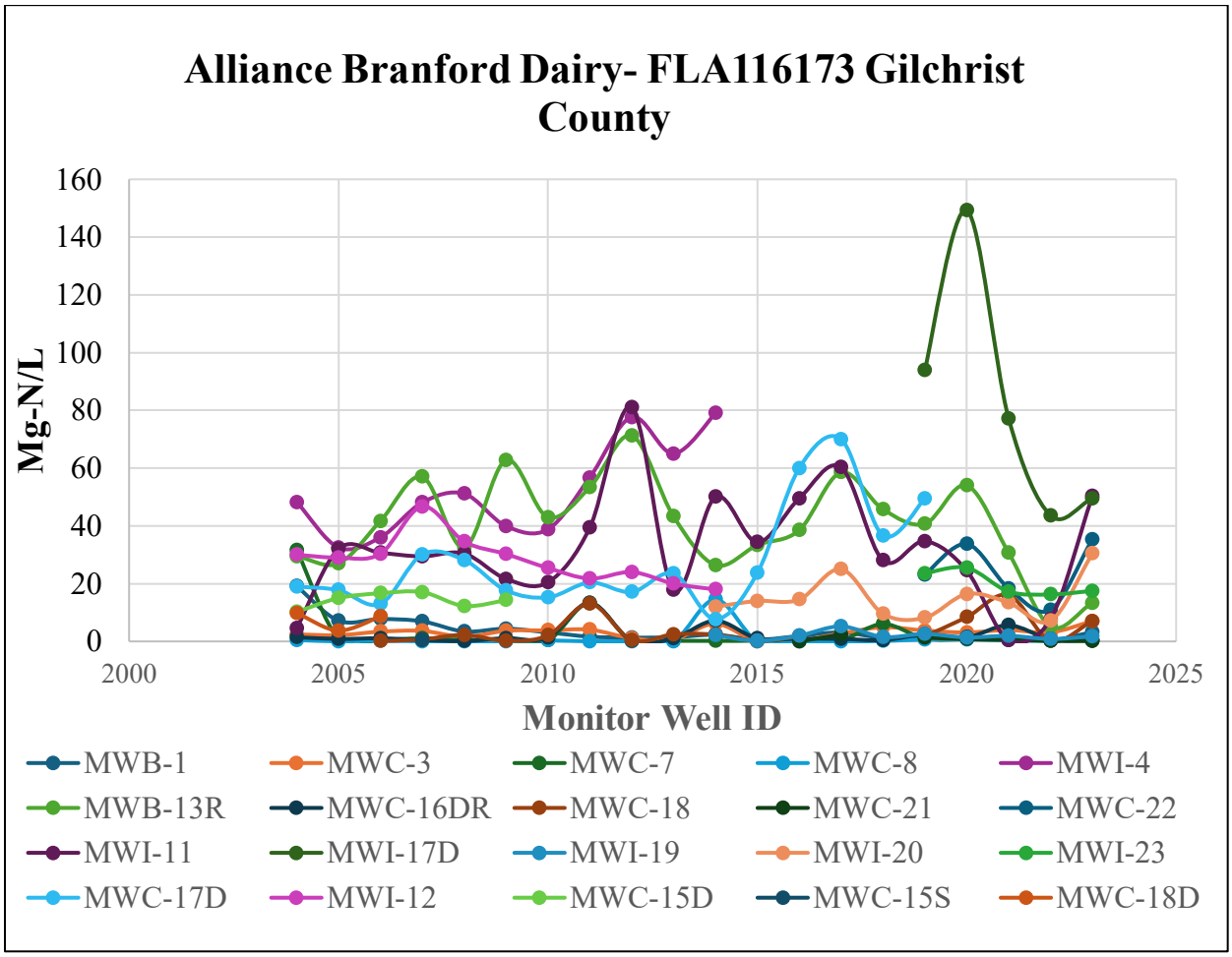

Figure B-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Alliance Branford Dairy.

On November 28, 2017, FSI sent an email to Drew Bartlett with the Florida Department of Environmental protection (FDEP), highlighting concerns about this apparent groundwater nitrate contamination and requesting agency action. On December 6, 2017, FDEP conducted an inspection of the American Dairy operation and reported groundwater data, and on February 13, 2018, sent a Consent Order noticing violations of groundwater standards and nitrogen application rates. On June 6, 2018, FDEP fined American/Branford Dairy $3,000 for civil penalties and enforcement costs.

Based upon the evidence detailed in this report, it is evident that the operations of the American Branford Dairy and the former Olcott Dairy are continuing to cause impairment of the water quality in neighboring groundwater and artesian springs.

Surface elevation and potentiometric contours show groundwater moving from beneath these dairies towards the Santa Fe River and springs in this area in addition to a defined surface flow channel trace between the American Branford Dairy and Troop Springs. Troop Spring has nitrate concentrations well above both the spring numeric nutrient limit of 0.35 mg-N/L and the human drinking water criterion of 10 mg-N/L.

Figure B-4 provides a map of recorded and potential home septic systems in the vicinity of the Alliance Branford Dairy. Green dots are indicative of installed systems, providing a surrogate of locations of private self-supply potable wells. More than 17 potable wells are immediately downgradient from the dairy and should be tested for elevated nitrate concentrations. The FDEP permit allows use of data from contaminated upgradient wells to be used as a baseline for compliance of downgradient wells. This permit condition is not protective of human or environmental health near the American Branford Dairy and Troop Spring. There are numerous private domestic supply wells in this area that are also likely to have nitrate concentrations above the human health standard.

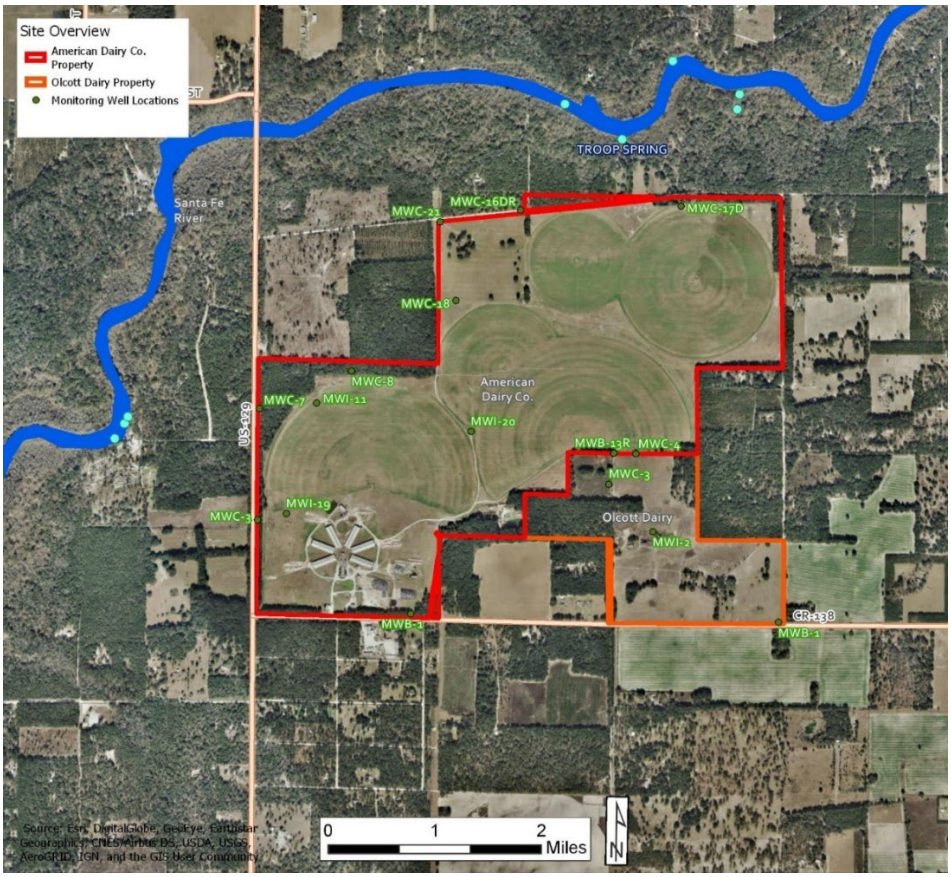

Figure B-4. Location of the Alliance-Branford Dairy in relation to the Santa Fe River and springs. The location of former Olcott Dairy is also indicated.

Variable groundwater nitrate and specific conductance data in the Alliance Branford Dairy monitoring wells indicate likely well construction limitations. Wells that are clearly downgradient but relatively close to others upgradient, do not have believable nitrate and specific conductance values. These data indicate likely problems with well installation/sampling.

Focused and intensive monitoring and analysis of water quality and ecological data are necessary to assess and mitigate the severity of impacts from the American Branford Dairy on groundwater and surface water resources along this reach of the Santa Fe River. FDEP and the Florida Department of Health should design and implement a thorough study of the efficacy of the monitor wells and groundwater and surface water resources in this area. Additional analysis is also required to assess any potential impacts on neighboring springs.

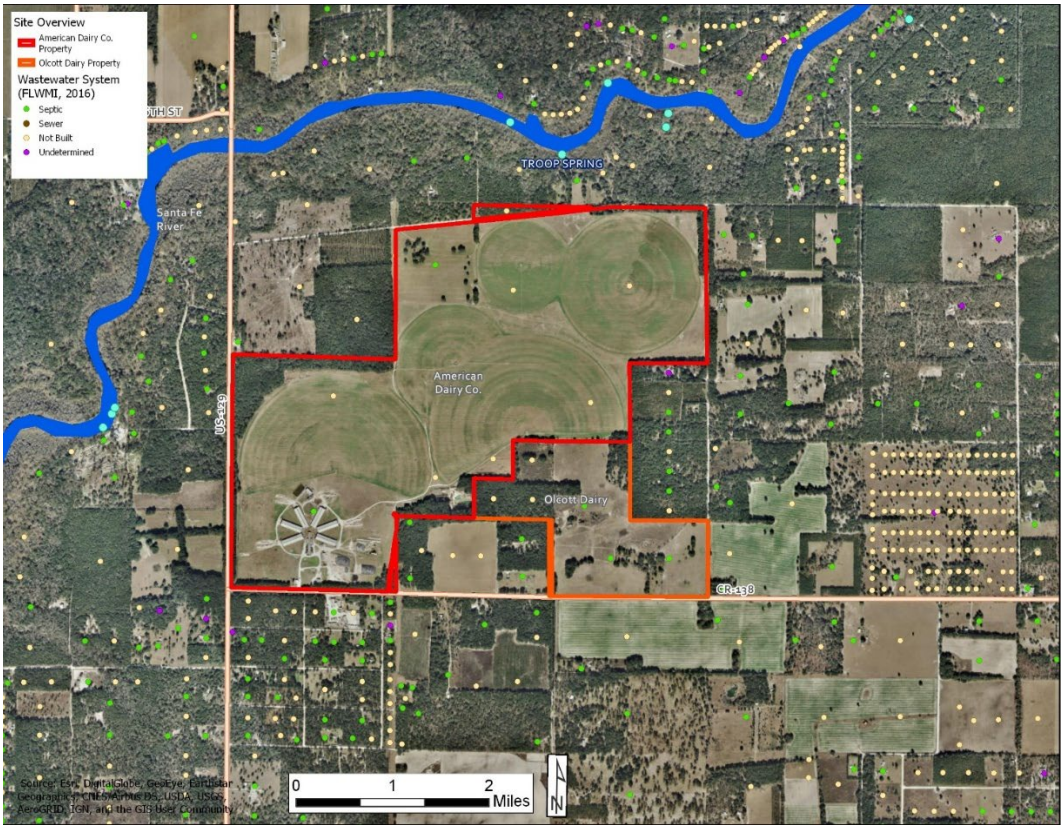

Figure B-5. OSTDS for the American Branford Dairy and Troop Spring Study Area.

Groundwater Consumption

The Alliance–Branford Dairy has 11 reported FAS wells permitted to extract up to 2.17 MGD. This total permitted groundwater use is intended to water 2,300 cows and irrigate 488 acres of crops.

Adjacent Potable Water Wells

Figure B-5 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the Alliance Branford Dairy. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

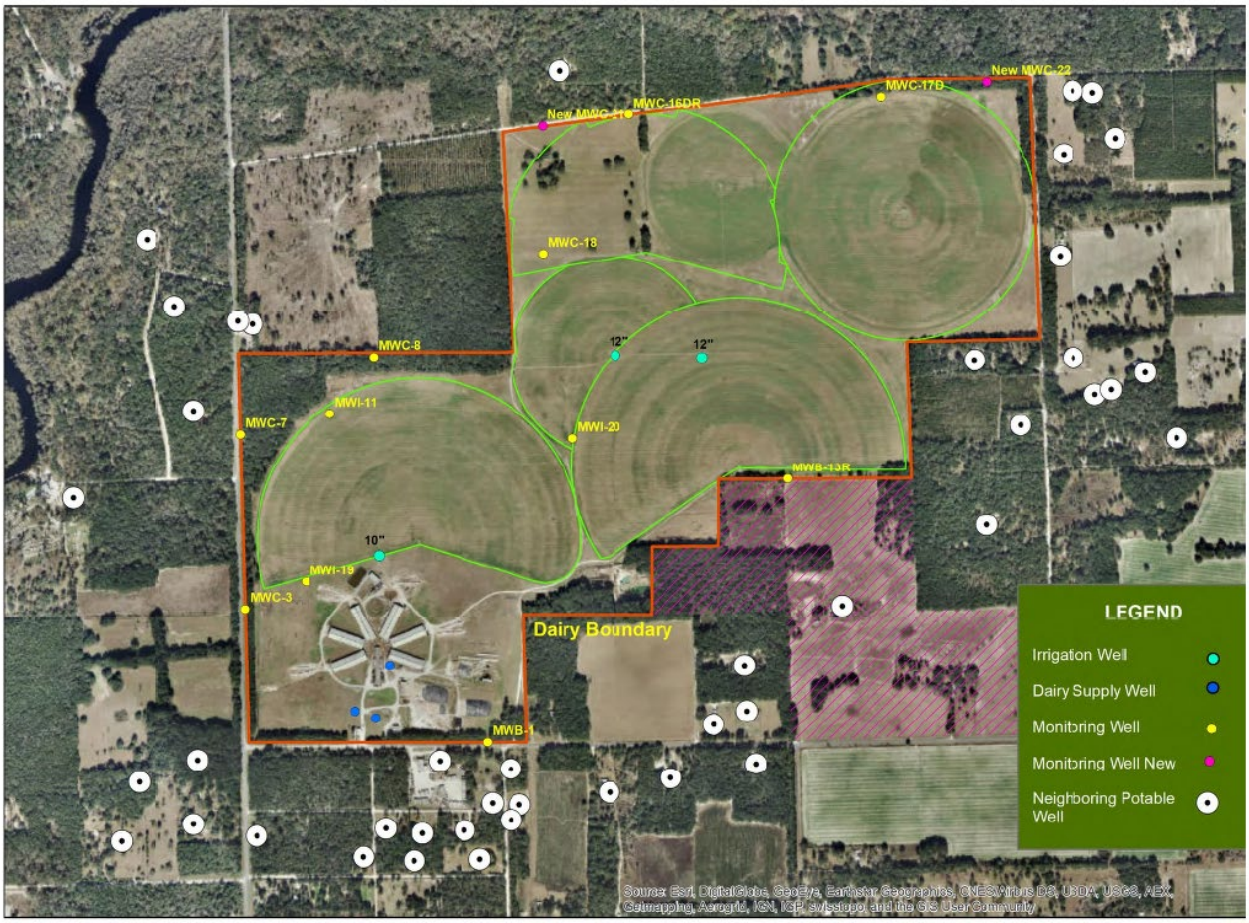

Figure B-6. Private Self-Supply Wells on and Adjacent to the Alliance Branford Dairy, Gilchrist County.

Appendix C: Full Circle Dairy LLC - FLA371912, Madison County

Description

Full Circle Dairy LLC is an existing dairy farm operation with a herd size of 4,563 mature dairy cows (maximum annual average), including 3,970 lactating cow, 593 dry cows,1,200 heifers, and 2,400 calves. The facility currently has four milking herd free stall barns, a dry cow freestall barn, two heifer freestall barns, and two calf barns. The Dairy plans to construct an additional barn on the east side of the milking center.

The wastewater system, which was designed based on an average of 794,520 gallons per day of wastewater, consists of sand separators, surge basin, sand separation system, screen separators, clarifier, waste storage ponds, aerobic digester, and sprayfields. The wastewater is directed to the sand separation system for the collection of sand for reuse in the free stall barns. From the sand separator the wastewater flows into the surge basin for transportation via a pump to the screen separators. The solids from the screen separators are removed and sent to the composting area or used on site or sent offsite. Prior to placing the anaerobic digester into operation, wastewater flowing through the screen separators is directed to the clarifier.

Sludge from the bottom of the clarifier is removed by a front-end loader and then may be used onsite, transferred to the composting facility, or removed from the site. From the clarifier, wastewater then flows to the waste storage pond. Recycle water for use in flushing and the sand separation system is pumped from this final pond or from the clarifier. After completion and placing into service of the anaerobic digester, the wastewater flowing through the screen separators is directed to a thickening pit, where it is used to capture thickened manure for feeding a plug-flow anaerobic digester. Digester effluent flows over a weir wall into an effluent pit that is part of the digester structure. The effluent flows to the existing polishing screens for solids removal, with the liquid supernatant directed to the waste storage ponds. The separated solids are stacked below the screen separator before being hauled offsite. All other wastewater from this final treatment pond is pumped to double crop or triple crop sprayfields, totaling 1,649 acres, for use as irrigation water.

Groundwater Monitoring

The current groundwater monitoring network at Full Circle Dairy LLC consists of six wells screened in the Floridan Aquifer:

- One Background well – MWB-1
- One Intermediate well – MWI-2
- Five Compliance wells – MWC-4, MWC-5, MWC-6 and MWC-7

The monitor well locations are shown in Figure C-1.

Figure C-1. Locations of Monitor Wells, Full Circle Dairy LLC.

Figure C-2 provides groundwater elevation contours of the FAS potentiometric surface around the Full Circle Dairy in 2021. The groundwater flow direction is east-southeast toward the northern Withlacoochee River. MWB-1 is sited to be representative of background groundwater conditions upgradient of the Full Circle Dairy except for an unexplained NOx-N exceedance in 2012.

A single intermediate well (MWI-2) is sited to indicate groundwater quality within the property boundaries. Five compliance wells were also located close to and downgradient from wastewater disposal locations.

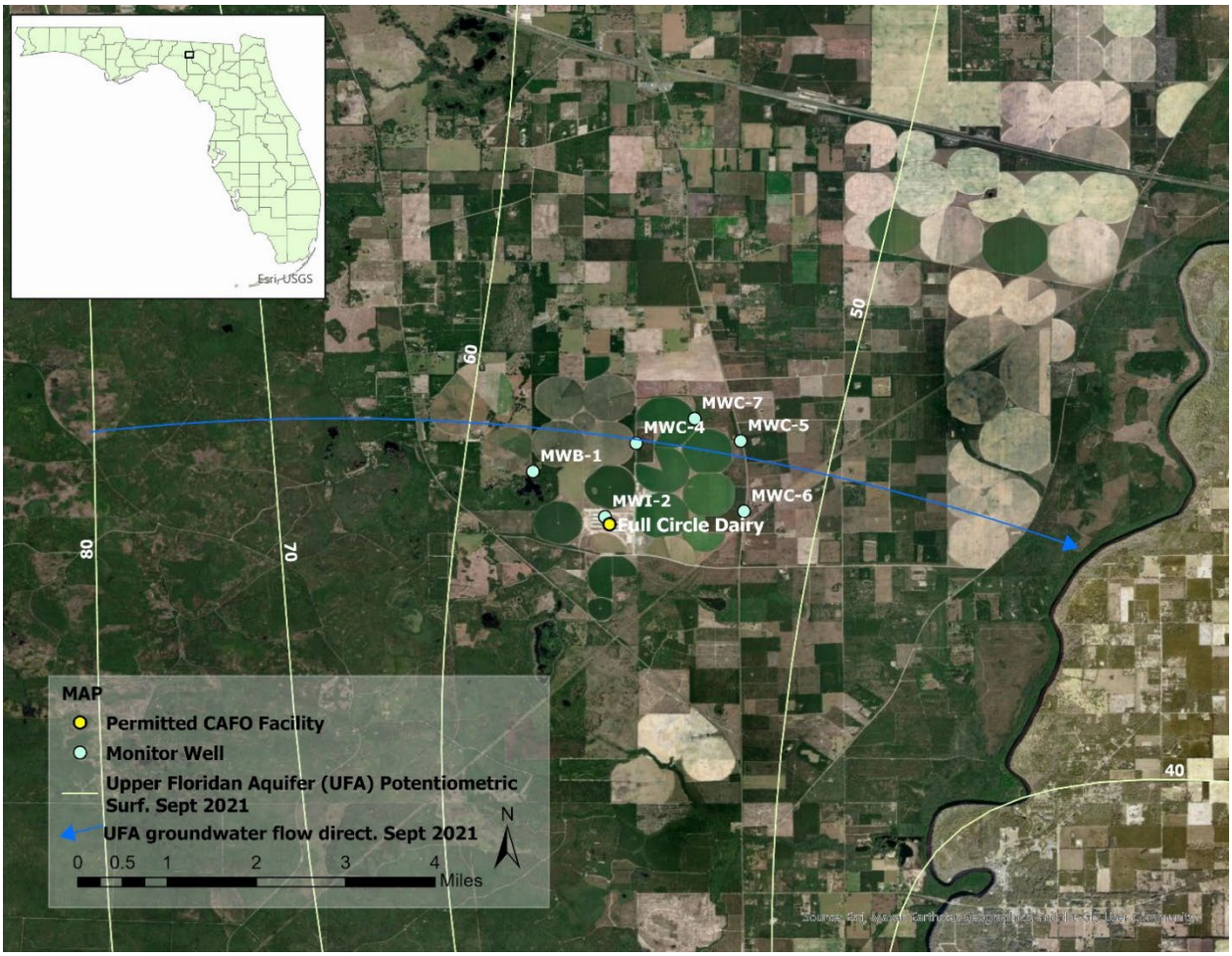

Figure C-2. Groundwater Elevation Contours of the Potentiometric Surface of the the Upper Floridan Aquifer in September 2021.

Groundwater General Water Quality

Table C-1 presents a summary of reported groundwater monitoring data for the period-of-record from September 2007 through June 2023. Background well data indicate some elevated nitrate concentrations and low pH values. Intermediate and compliance wells show elevated nitrate concentrations that are below the compliance level of 10 mg-N/L. Average groundwater elevations indicate a normal declining profile from background to compliance, indicating appropriate siting of these monitoring wells.

Table C-1. Full Circle Dairy FAS Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	3.7	1.0	81.8	10.3	1.0	270.0	1.5	0.0	35.4
Nitrite plus Nitrate, Total (as N)	mg/L	4.37	0.00	165.00	4.85	0.14	13.00	3.42	0.02	12.80
pH	s.u.	6.90	6.30	8.20	6.97	6.50	8.20	7.13	6.50	8.40
Phosphate, Ortho (as P)	mg/L	0.09	0.07	0.12	0.09	0.04	0.16	0.05	0.00	0.11
Water Level Relative to NGVD	ft-NGVD	70.01	62.20	85.81	77.70	57.10	565.00	61.12	51.30	71.94

Groundwater Nitrate Concentration and Trends

Concentrations of NOx-N in background monitor well MWB-1 during the period of record have been below 10 mg-N/L and mostly less than 1 mg-N/L except for 2012 when 165 mg-N/L was detected in the 3rd quarter sampling round. Compliance monitor well MWC-3 had NOx-N concentrations below 10 mg-N/L until March 2015 when it contained 11 mg-N/L after which sampling was discontinued. The remaing four compliance wells have shown consistently lower NOx-N concentrations, averaging 0.22 to 6.9 mg-N/L (Table C-2 and Figure C-3). Compliance monitor well MWC-4 has contained NOx-N concentrations below 10 mg-N/L for the period of record. Compliance monitor wells MWC-5, MWC-6 and MWC-7 were installed and sampled beginning in 2015. NOx-N concentrations in those wells have been below 10 mg-N/L and stable for the period-of-record.

Table C-2. Annual Average NOx-N Concentrations in Monitoring Wells at Full Circle Dairy – FLA371912 (Madison County).

Full Circle Dairy, LLC - FLA371912 (Madison County)							
Year	**MWB-1**	**MWC-3**	**MWC-4**	**MWC-5**	**MWC-6**	**MWC-7**	**MWI-2**
2006	0.6	1.03	0.06				1.29
2007	0.56	4.52	7.77				0.7
2008	0.16	7.47	8.62				5.25
2009	0.29	8.63	8.25				7.31
2011	0.08	8.29	6.31				4.13
2012	41.52	7.9	6.32				2.51
2013	0.53	9	7.34				4.21
2014	2.05	9.03	6.73				10.42
2015	0.15	11	8.06	0.09	0.17	1.52	7.99
2016	0.02		7.63	0.12	0.2	0.51	6.57
2017	0.02		6.68	0.13	0.15	0.89	3.04
2018	0.06		5.62	0.17	0.15	2.33	3.79
2019	0.27		5.84	2.25	0.15	3.53	5.18
2020	1.11		8.15	0.14	0.2	2.86	5.83
2021	0.02		7.15	0.12	0.16	1.47	3.94
2022	0.02		8.07	0.12	0.39	1.39	4.84
2023	0.01		7.95	0.11	0.44	2.2	3
AVERAGE	2.79	7.43	6.86	0.36	0.22	1.86	4.71

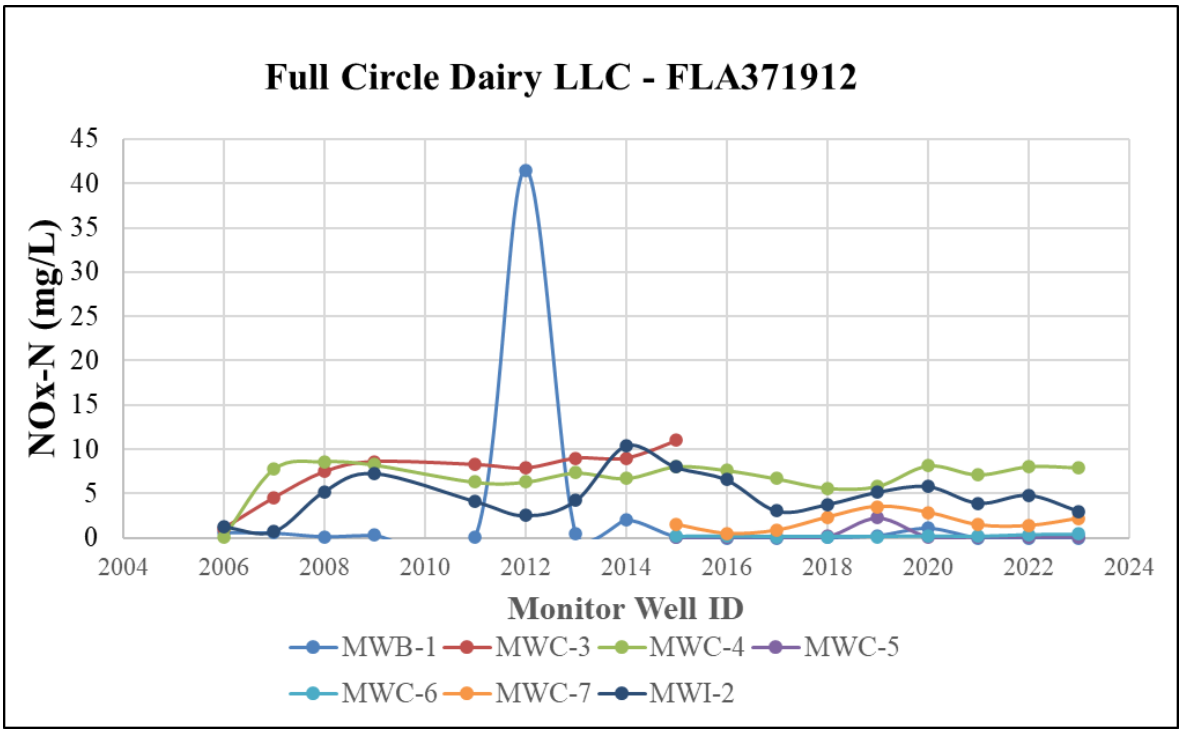

Figure C-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Full Circle Dairy - FLA371912 (Madison County).

Groundwater Consumption

The Full Circle Dairy has seven reported FAS production wells permitted to extract up to 1.77 MGD. An allocated 1.23 MGD is used for irrigating 875 acres of cropland and the remaining 0.54 MGD is intended to water 3,870 milking and dry cows and 1,650 calves and steers.

Adjacent Potable Water Wells

The Full Circle NMP identified 59 domestic potable supply wells within one half mile of the Full Circle Dairy in Madison County. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

Appendix D: Grassy Bell Dairy - FLA728004 (Gilchrist County)

Description

Grassy Bell Dairy encompasses approximately 819 acres east of U.S. 129, about five miles northwest of Trenton, Florida and located at 2301 SW 32nd Place in Bell, Gilchrist County, Florida. The Grassy Bell dairy is an existing rotationally grazed dairy with a maximum annual average mature cow population of 2,324 (1,829 lactating/pot/cripple and 495 dry) and 16 bulls. Lactating cows are walked daily from the rotational grazing areas for milking/feeding. Dry cows may be grazed offsite on the 179-acre pasture. Two fields (179 acres) are offsite and are used as either irrigated dry cow pastures or forage production.

The dairy consists of a milk barn (pre-milking crowd area and milking parlor), cooling ponds, feed area and a waste management system. The waste management system for the milk/feed barn area consists of a perimeter ditch, existing two lagoon system, a waste storage pond and seepage irrigation fields. The dairy is surrounded mostly by semi-improved beef cattle pasture.

A wastewater permit was drafted in 2010 for the Martin Dairy; the dairy name was subsequently changed to Grassy Bell which was first permitted in 2011. Prior to issuance of the permit, a photo lineament analysis was conducted in response to a Request for Additional Information from FDEP. The purpose of the analysis was to investigate the possibility of linear fractures in the underlying limestone aquifer at the dairy. While a photo lineament analysis does not constitute proof that there are fractures in the limestone, in Florida there is a higher probability that at least some of the possible linear fractures represent locations for enhanced conduit flow in the limestone. Therefore, photo lineament analysis is potentially helpful for designing groundwater monitoring plans.

In the case of the Grassy Bell Dairy, there was a concern that there are direct connections to the underlying Floridan aquifer system, specifically the Fanning Springshed. The results of the analysis indicated predominant photo lineament sets trending northwest-southeast, northeast-southwest, and north-south. This is consistent with the results of similar studies in the area and reflects the regional stresses known to affect the limestone bedrock comprising the Floridan Aquifer. Intersections of photo linear features are considered most likely to be represented by interconnections of karst conduit systems and the land surface. Land features at three areas near the dairy were identified as the most likely areas of concern. (SDII Global Corporation, 2011).

Groundwater Monitoring

Grassy Bell Dairy is located at the eastern edge of the Chiefland Karst Plain geomorphologic province; the Ocala Limestone is at or near the land surface. The site lies within the Fanning Springshed.

The current groundwater monitoring network at Grassy Bell Dairy consists of four wells screened in the Floridan Aquifer:

- One Background well – MWB-1
- One Intermediate well – MWI-2
- Two Compliance wells – MWC-3 and MWC-4

The monitor well locations are shown in Figure D-1. The four monitor wells range in depth from 59 to 63 feet below the ground surface and are most likely screened in the Upper Floridan Aquifer, however boring logs for the monitor wells were not available to confirm lithologies in the screened intervals.

Based on groundwater elevation contours of the Upper Floridan Aquifer potentiometric surface in September 2021 (Figure D-2), groundwater flows to the southwest towards the Suwannee River in the vicinity of Grassy Bell Dairy. A 2017 groundwater contour map also indicated a southwest flow direction. Background monitor well MWB-1 is located upgradient of the dairy and pivot fields. Monitor well MWI-2 is in Sprayfield SP-2. Monitor well MWC-3 is located downgradient of Sprayfield SP-2 and Pivot 4; monitor well MWC-4 is located downgradient of Pivots 2 and 3.

Figure D-1. Monitor Well Locations, Grassy Bell Dairy.

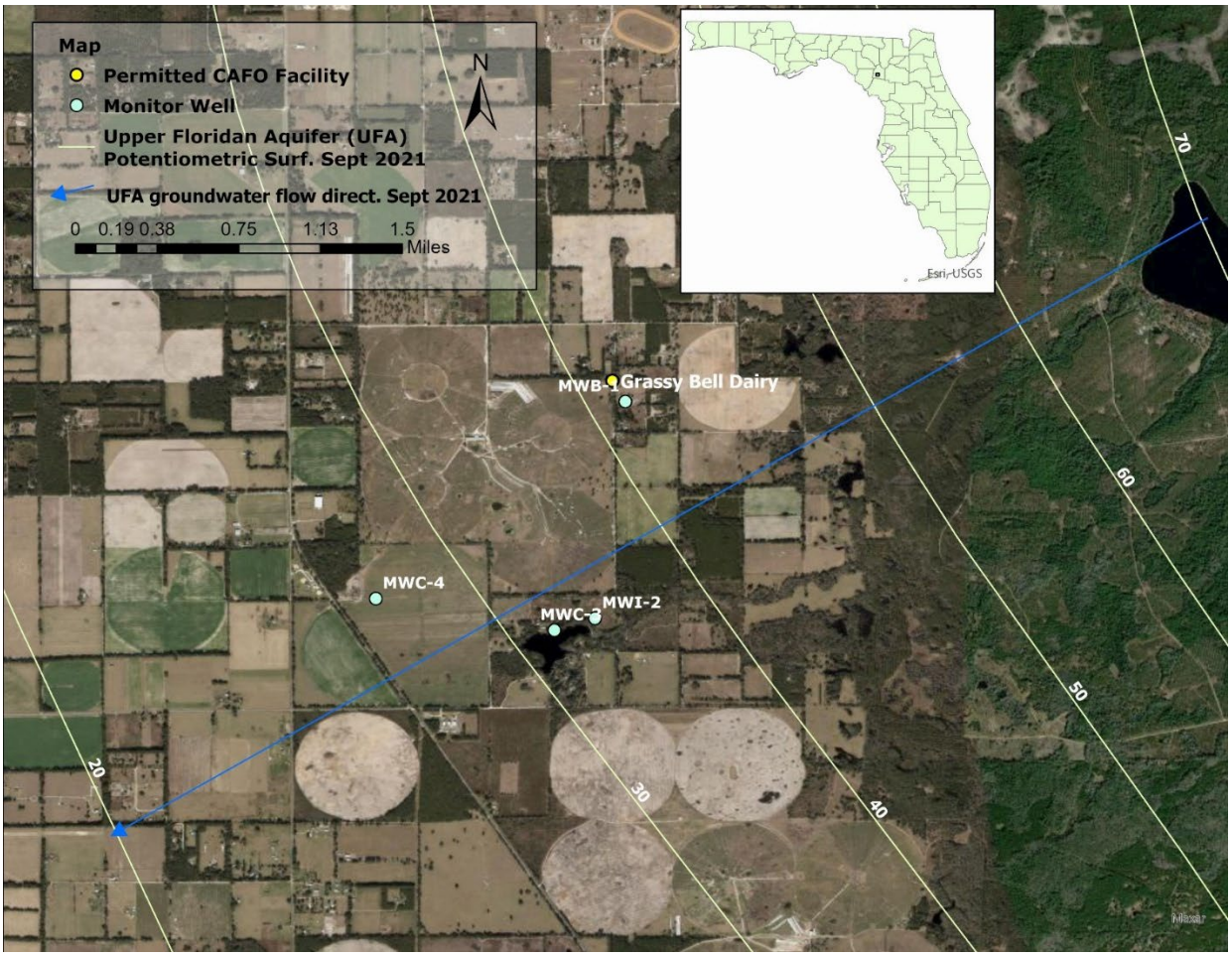

Figure D-2. Groundwater Elevation Contours, Upper Floridan Aquifer Potentiometric Surface near Grassy Bell Dairy, September 2021.

Groundwater General Water Quality

Table D-1 presents a summary of reported groundwater monitoring data for the period-of-record from September 2011 through September 2023. Background well data indicate some elevated nitrate concentrations and high pH, possibly indicating some source of contamination. Intermediate and compliance wells show reduced pH values and elevated nitrate concentrations that are below the compliance level of 10 mg-N/L. Average groundwater elevations indicate a normal declining profile from background to compliance wells, indicating appropriate siting of these monitoring wells.

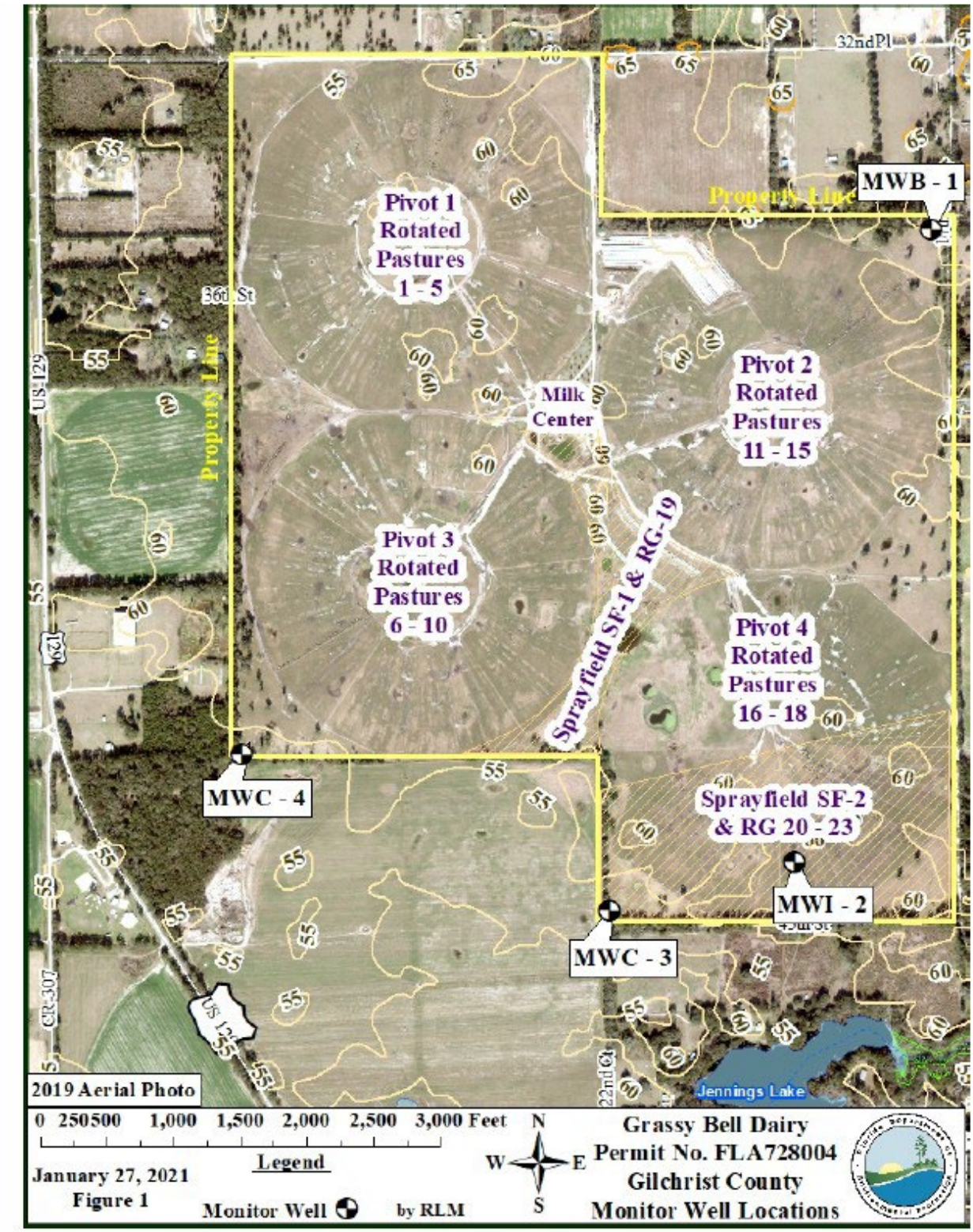

Figure D-3. Monitor Well Location Map from 2021 Permit.

Table D-1. Grassy Bell Dairy FAS Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	3.2	1.0	20.0	2.6	1.0	12.0	2.0	1.0	4.0
Nitrite plus Nitrate, Total (as N)	mg/L	1.37	0.03	5.50	2.52	0.02	18.00	3.35	0.02	21.40
pH	s.u.	8.67	6.55	10.93	6.77	4.76	8.43	6.89	6.01	7.88
Phosphate, Ortho (as P)	mg/L	0.190	0.010	1.140	0.059	0.003	0.282	0.079	0.002	0.157
Water Level Relative to NGVD	ft-NGVD	23.82	6.06	32.04	19.11	8.10	27.99	16.54	4.78	37.70

Groundwater Nitrate Concentration and Trends

Over the 12-year period-of-record summarized in Table D-2 and Figure D-4, the Grassy Bell Dairy background well MWB-1 had an average long-term NOx-N concentration of 1.4 mg-N/L, with a range of annual averages from 0.2 to 4.2 mg-N/L. The one intermediate well MWI-2 is located to the east of the primary grazing area and had a long-term average NOx-N of 2.42 mg-N/L with a range of annual averages from 0.4 to 9.6 mg-N/L. The two compliance wells, MWC-3 and MWC-4, averaged 4.57 and 2.11 mg-N/L, with a range of annual averages from 0.04 to 10.1 mg-N/L.

Table D-2. Annual Average NOx-N Concentrations in Monitoring Wells at Grassy Bell Dairy – FLA728004 (Gilchrist County).

Grassy Bell Dairy				
Year	**MWB-1**	**MWC-3**	**MWC-4**	**MWI-2**
2011	2.79	1.46	2.07	1.68
2012	0.51	2.63	0.04	1.78
2013	0.43	6.03	0.08	1.46
2014	1.12	5.4	0.55	4.63
2015	4.25	5.69	1.11	2.87
2016	3.38	5.65	0.79	4.83
2017	2.26	4.98	1.2	0.49
2018	1.09	3.65	1.86	0.39
2019	0.81	5.35	6.58	9.6
2020	0.77	4.45	4.93	2.3
2021	0.4	2.96	3.21	0.45
2022	0.2	1.07	2.05	0.63
2023	0.23	10.11	3	0.4
AVERAGE	1.403077	4.571538	2.113077	2.423846

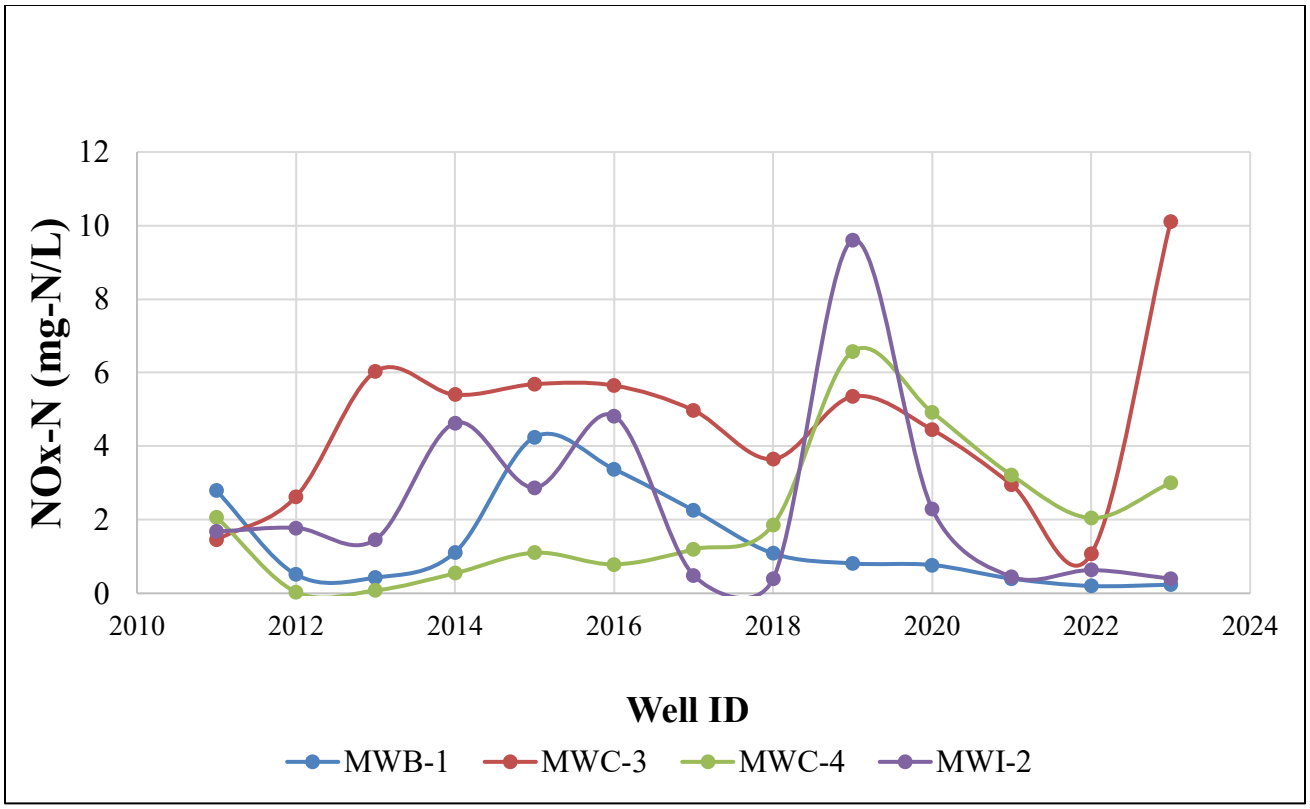

Figure D-4. Groundwater Nitrate (NOx-N) Concentration Time Series, Grassy Bell Dairy, Gilchrist County.

Groundwater Consumption

The Grassy Bell Dairy in Gilchrist County has six permitted FAS wells. The total permitted withdrawal is 1.11 MGD with 0.476 MGD to irrigate 583 ac of crops and 0.631 MGD to water 2,300 dairy cows.

Adjacent Potable Water Wells

Figure D-5 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the Grassy Bell Dairy. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

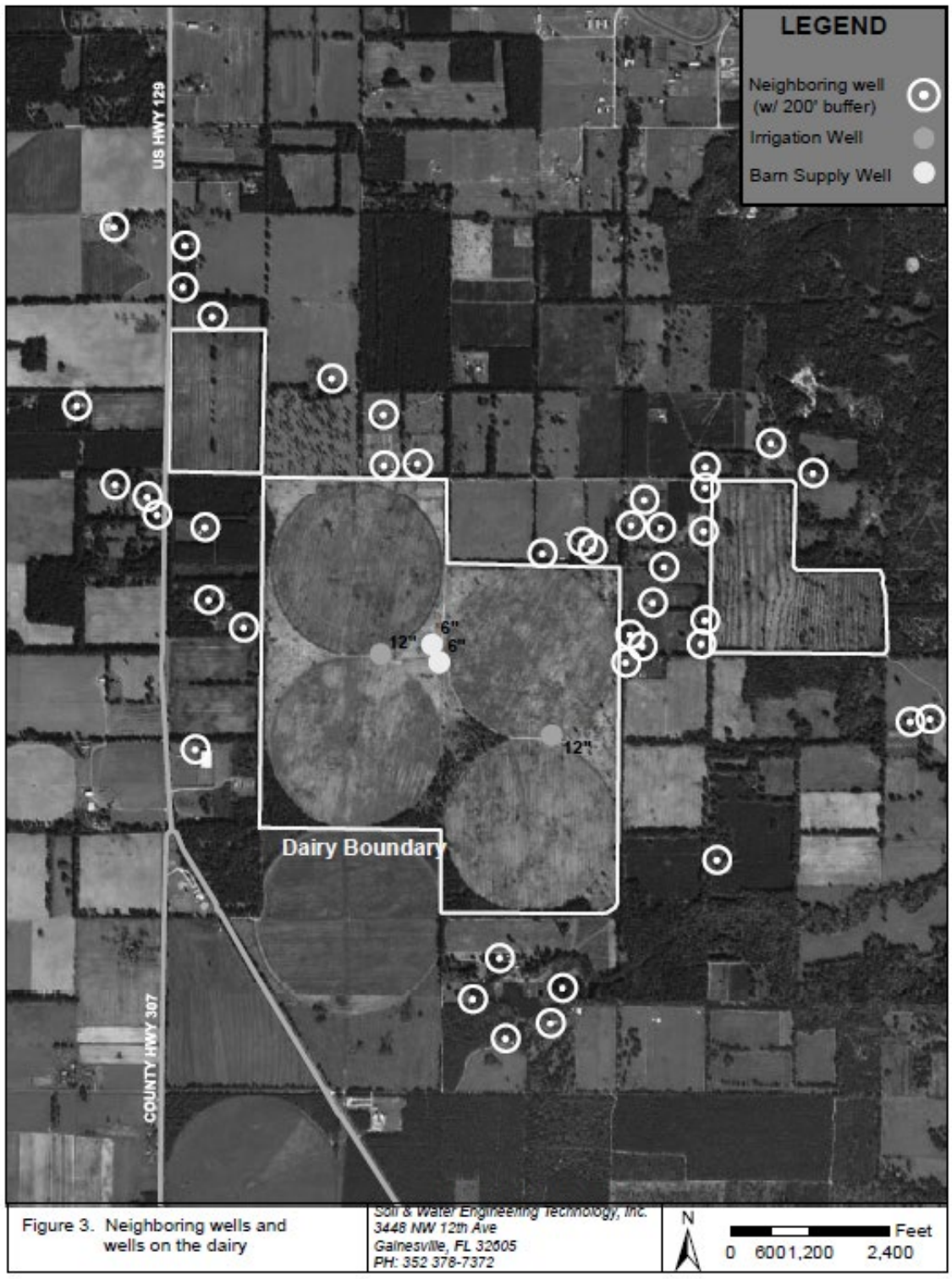

Figure D-5. Private Self-Supply Wells on and Adjacent to the Grassy Bell Dairy, Gilchrist County.

Appendix E: IFAS Dairy Research Unit - FLA011323, Alachua County

Background

Although currently not permitted, the University of Florida Food and Agriculture Sciences Dairy Research Unit (UF IFAS Dairy) previously operated as a permitted total confinement dairy from 2000 to 2016. Dairy permits were issued in 2000 and 2005 and renewed in 2011; the final permit expired in September 2016.

The facility is an existing dairy farm operation with an estimated herd size of 550 lactating dairy cows (maximum annual average) and 120 dry cows. Dry cows are maintained on 68 acres of open pastures. The facility consists of four free stall barns, a milking parlor, feed storage area and a wastewater treatment system which collects wastewater generated from water usage in the barns. The barns are flushed with recycled wastewater. All contact stormwater is directed into the wastewater treatment system.

A Nutrient Management Plan was developed for this facility. The wastewater treatment system consists of a sand trap, a screen separator, a 2,700-cubic foot solids separator basin, an 85,000-gallon steel tank methane digester, a 1.6 acre-feet sediment basin, a 1.7 acre-feet detention pond, a transfer pump, and a 24.7 acre-feet wastewater treatment pond for the collection of wastewater, manure solids and contaminated storm water runoff from the milking center, cattle housing areas and concrete travel lanes. The pond system is designed to contain a 25-year, 24-hour storm event. Clean water from the barn roof run-off is diverted away from the waste collection system.

The free stall barns are routinely flushed with recycled wastewater which then flows into the drainage channels. The wastewater is then directed through the sand trap, screen separator, and basin separator. From the basin separator, the water flows into two smaller waste storage ponds for further solids removal and is then pumped to the main waste storage pond. Flush water is pumped from the waste storage pond into the flush storage tank for recycling through the system. Wastewater from the waste storage pond is applied at agronomic rates to 169 acres of cropland.

The UF-IFAS Dairy is located in the Alachua Karst Hills geomorphic province of north central Florida. The groundwater monitoring network at the UF IFAS Dairy consisted of four wells screened in the Surficial aquifer and one well (MWC-2) screened in a water-bearing zone in the Upper Floridan Aquifer Confining Unit/Hawthorn formation:

- One Background well – MWB-1
- One Intermediate well – MWI-4
- Three Compliance wells – MWC-2, MWC-3 and MWC-5

The monitor well locations are shown in Figure E-1.

Figure E-1. Locations of Monitor Wells, UF IFAS Dairy.

The IFAS Dairy is located above approximately 30 feet of undifferentiated surficial (sand, silt and clay) deposits which are underlain by the Upper Floridan confining unit (UFCU)/Hawthorn formation). The UFCU in this area extends vertically approximately 75 to 100 feet to rest on the Ocala Limestone (Scott, 1988; Williams and Kuniansky, 2016) which is considered the top of the Floridan Aquifer (Miller, 1986) in this area.

The UFCU/Hawthorn formation underlying the surficial deposits at the IFAS Dairy Unit is the upper informal member of the Coosawhatchie Formation which consists most commonly of sandy to very sandy dolomite interbedded with quartz sand and clays (Scott, 1988).

Groundwater Monitoring

The monitor wells are all 21 feet deep except MWC-2 which is 30 feet deep. Borings for the four 21-foot-deep wells encountered groundwater at depths of 8 to 10 feet bgs although first encountered water was most likely shallower because the wells were

logged using hollow stem auger drill cuttings rather than discrete sampling. Wells MWB-1, MWC-3, MWI-4 and MWC-5 wells are all screened in undifferentiated surficial deposits which constitute the Surficial Aquifer at this location; water levels measured in these wells are consistent with water table conditions.

A hydrograph of groundwater elevation data (Figure E-2) indicates that groundwater elevation measurements submitted to FDEP from December 2006 to June 2009 were identical since no new measurements were reported during that period. The hydrograph also indicates that the measuring point elevation of MWC-3 may have been resurveyed in ~2010 however no information is available to confirm this correction.

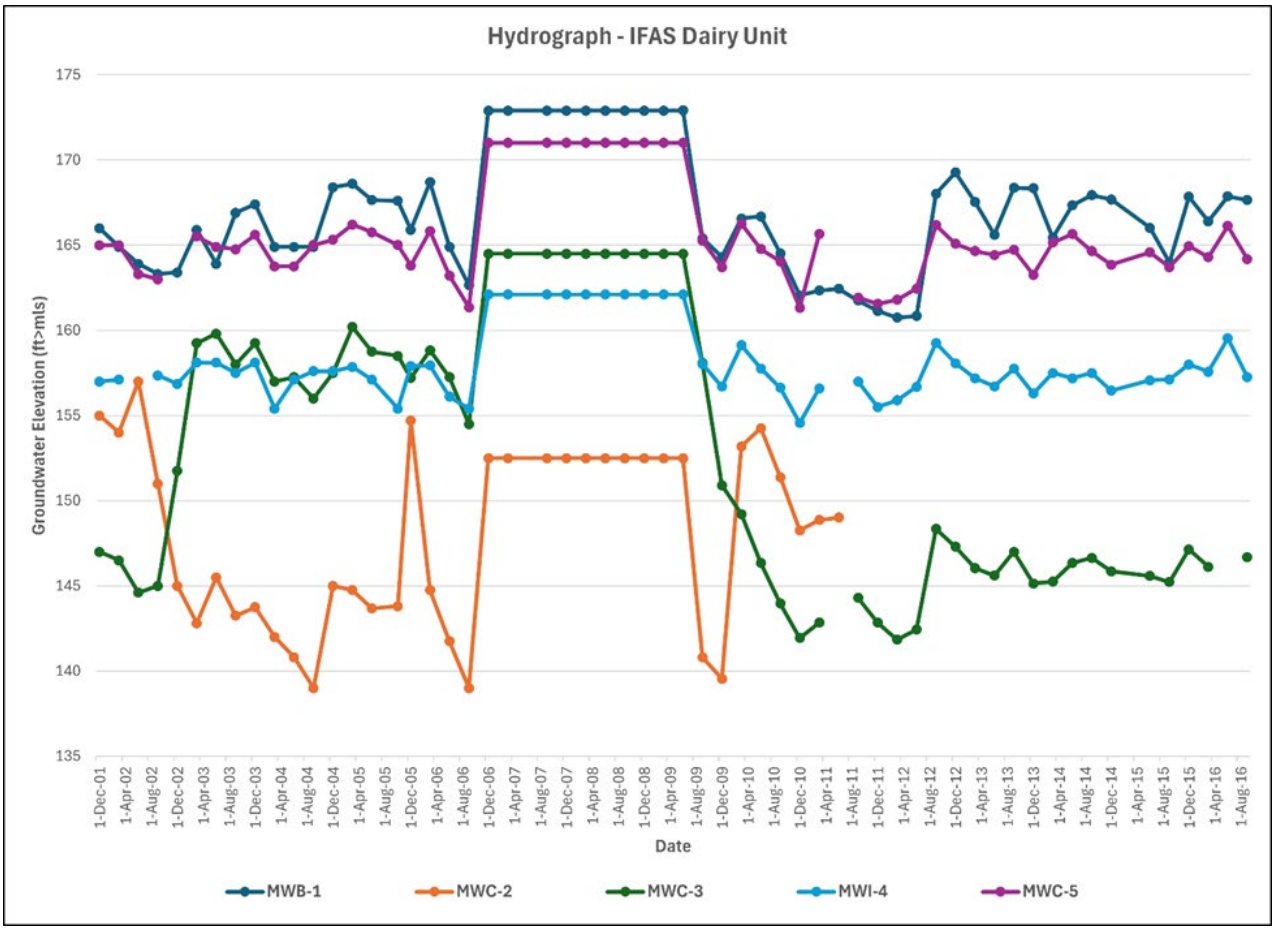

Figure E-2. Hydrograph for IFAS Dairy Unit.

Based on groundwater elevation data collected in 2013 through 2015, the flow direction in the Surficial Aquifer at the UF IFAS Dairy is to the west-northwest (Figure E-3). Monitor well MWB-1 is correctly sited as an upgradient well however MWC-5 could also be considered a background well as it is on the east property line and upgradient of the

pivot fields. Monitor well MWC-2 was downgradient of dairy agricultural fields/pastures. Monitor wells MWC-3 and MWI-4 are downgradient of dairy pivot fields.

Figure E-3. Groundwater Elevation Contour Map of Surficial Aquifer, IFAS Dairy Unit, March 2013.

Lithologies encountered in the boring for monitor well MWC-2 contained more clay than other well locations. Weathered limestone and initial water in the borehole were encountered at 24 feet bgs so drilling continued another 6 feet to set the well. It is likely that the material logged as 'weathered limestone' in MWC-2 is weathered dolostone of the upper Coosawhatchie Formation.

Water in the completed well MWC-2 ranged from 1.4 to 17.4 feet (average 10.5 feet) higher than where water was encountered during drilling, indicating that the water in the weathered dolostone is most likely semi-confined by the overlying clay-rich sediments. This suggests that groundwater in MWC-2 constitutes a separate water-bearing zone

near the top of the Coosawhatchie Formation. The water column in the well ranged from 7.4 to 25.4 feet in height. Although the well was never measured as dry during the monitoring period, the large fluctuations in water levels also suggest that it is screened in an isolated water-bearing zone. Water level measurements and groundwater sampling in MWC-2 were discontinued after June 2010.

The top of the Floridan aquifer (Ocala Limestone) at this location is approximately 100 feet below ground surface (bgs) (Holloway, 2001; Williams and Dixon, 2015) to 125 feet bgs (Scott, 1988) or elevations of 65 to 90 feet above mean sea level.

Based on data collected by the Florida Geological Survey, the potentiometric surface of the Floridan aquifer in the vicinity of the IFAS Dairy is 40 to 50 feet above mean sea level. The Floridan aquifer at this location flows to the northwest, toward the Sante Fe River.

Groundwater General Water Quality

Groundwater data for this analysis were obtained by requesting a download from FDEP in November 2023. The download consisted of analytical data collected at the UF IFAS Dairy from September 2001 through September 2016. No groundwater sampling data have been reported since 2016 when the dairy was reclassified.

Table E-1 presents a summary of reported groundwater monitoring data for the period-of-record from September 2001 through September 2016. Background well data indicate very low nitrate and pH levels. Nitrogen concentrations are quite high at the intermediate wells and close to or above 10 mg-N/L at the downgradient compliance wells. pH values are relatively acidic in all wells, confirming that all wells at this site are sampling surficial and/or intermediate aquifer levels.

Table E-1. UF IFAS Dairy Surficial Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	1.3	1.0	3.0	1.2	1.0	2.0	1.3	1.0	3.0
Nitrite plus Nitrate, Total (as N)	mg/L	0.01	0.00	0.05	23.05	0.43	45.00	8.69	0.00	285.00
Nitrogen, Total	mg/L	0.45	0.01	2.00	19.94	0.00	37.30	9.39	0.00	34.70
pH	s.u.	5.53	4.60	7.58	5.78	5.26	7.58	5.87	5.47	7.57
Phosphate, Ortho (as P)	mg/L	0.043	0.043	0.043	0.410	0.410	0.410	0.351	0.344	0.358
Water Level Relative to NGVD	ft-NGVD	166.83	160.84	169.27	157.48	156.29	159.53	154.49	118.02	166.17

Groundwater Nitrate Concentration and Trends

Table E-2 provides the annual averages of NOx-N concentrations detected in groundwater in each of the five monitor wells. A graph of the annual mean concentrations in the five monitor wells is shown in Figure E-4.

NOx-N concentrations in background well MWB-1 ranged from 0.003 to 0.053 mg-N/L during the sampling period. These low levels and the fact that groundwater elevations measured in MWB-1 were consistently higher than the other four wells indicate that this well is most likely upgradient of the discharges and represents true background conditions.

NOx-N detected in compliance well MWC-2 mostly ranged from 0.004 to 29 mg-N/L with an outlier result of 285 mg-N/L in March 2011 (Figure E-4). The regulatory level of 10 mg-N/L was first exceeded (13.3 mg-N/L) in March 2007 with concentrations measured after that continuing to increase. FDEP conducted a site visit on April 16, 2008, to investigate the exceedances after the first quarterly sample in 2008 contained 10.8 mg-N/L. The well was found to be in a heifer-grazing pasture and vegetation around the well had been removed by the cows who took cover beneath shade trees near the well. FDEP surmised that manure from the cows may have been impacting the well since no manure solids or sludge were being spread in this pasture. The dairy staff agreed to keep cows away from the well and FDEP recommended that the well be sampled for two more quarters to see if the levels dropped below 10 mg-N/L. The second quarter sample contained 8.35 mg-N/L but quarterly levels following that event exceeded 10 mg-N/L and continued to increase over time.

In February 2011, Consent Order (CO) 10-1703 was executed by FDEP which established an interim limit in monitor well MWC-2 of 40 mg-N/L for NOx-N.

The CO specified the installation of two new monitor wells to be located east and northeast of MWC-2. The CO also specified that sampling of these monitoring wells would begin in the first quarter of 2011 and continue until NOx-N in MWC-2 decreased to 10 mg-N/L or less for a minimum of three quarterly sampling events.

The CO also stated that additional monitor wells might be needed. An Evaluation Report was to be submitted 225 days following issuance of the CO however this document was not available on FDEP's public data portal. An email from FDEP dated May 25, 2011, indicates that shallow monitor wells MW-6, MW-7 and MW-8 were installed but documentation of these well installations and any sampling results were not available on the agency's website.

After the March 2011 exceedance of 285 mg-N/L NOx-N in MWC-2, a sample was collected in June 2011 with a result of 28.1 mg-N/L.

FDEP stated in a May 25, 2011, email that based on the boring log for MWC-2 and geotechnical logs obtained from the Suwanee River Water Management District, the limestone encountered in the boring is 'an isolated feature' which did not constitute a shallow water table aquifer in the vicinity of MWC-2. Geotechnical logs used in the above evaluation were not available.

Because water in MWC-2 is in the UFCU/Hawthorn formation, it is likely a localized water-bearing zone in permeable materials within the confining unit.

Based on the above conclusion, MWC-2 was eliminated from the groundwater monitoring plan in the facility wastewater permit issued on September 29, 2011, and no further sampling results from monitor well MWC-2 are available. The CO expired on December 31, 2012.

Monitor well MWC-3 contained exceedances of NOx-N at concentrations up to 34.6 mg-N/L in 2001 and 2002. After the first five quarters of sampling, the levels decreased to below 10 mg-N/L through 2016 with one exception of 12 mg-N/L NOx-N in 2015.

Monitoring well MWI-4 contained exceedances of NOx-N throughout the sampling period-of record.

MWC-5 contained NOx-N at concentrations up to 24.9 mg-N/L from 2001 to 2007, when the levels in this well dropped below 10 mg-N/L until 2016.

Table E-2. Annual Average NOx-N Concentrations in Monitoring Wells at the UF IFAS Research Dairy.

IFAS Dairy Research Unit					
Year	**MWB-1**	**MWC-2**	**MWC-3**	**MWC-5**	**MWI-4**
2001	0.01	3.65	31.25	14.5	14.25
2002	0.01	5.57	20.87	22.25	18.45
2003	0	3.18	7.51	23.9	27.13
2004	0	3.67	1.62	21.45	27.28
2005	0	2.47	0.03	18.83	28.85
2006	0	4.07	0.02	14.2	18.23
2007	0.01	13.8	0.03	7.49	18
2008	0.01	9.73	0.01	0.97	13.82
2009	0.01	15.85	0.04	0.11	18.7
2010	0.01	25.33	0	0.06	14.28
2011	0	156.55	0.01	0.03	19.65
2012	0		0.5	0.01	26.11
2013	0.02		4.02	0.02	37.75
2014	0.01		5.3	0.01	26
2015	0		7.8	0	21.67
2016	0.01		0.46	0	33.67
AVERAGE	0.00625	22.17	4.966875	7.739375	22.74

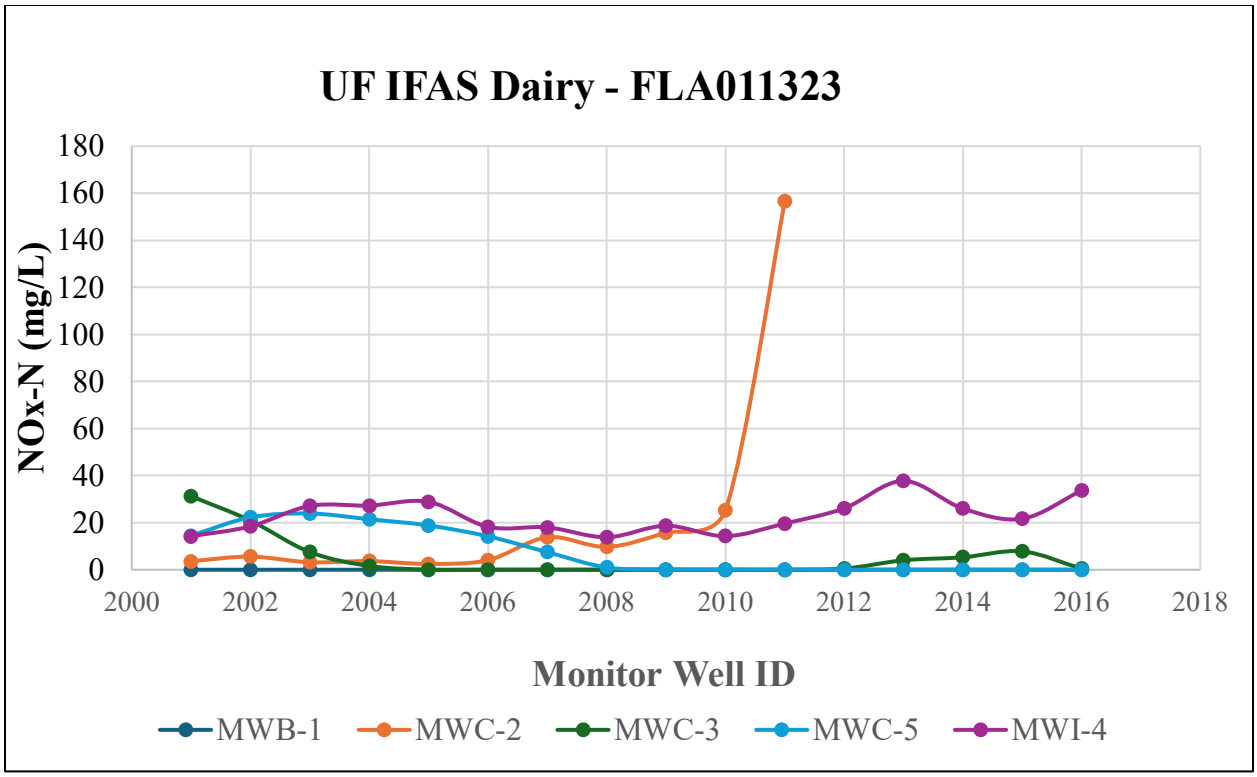

Figure E-4. Annual Mean Concentrations of NOx-N in Groundwater, IFAS Dairy Research Unit.

Appendix F: Jeffco Dairy FLA183911, Jefferson County

Description

Jeffco Dairy, located at 622 Milky Way Lane in Greenville, Jefferson County, Florida, is an existing dairy farm operation with a herd size of 2,350 mature, lactating cows (maximum annual average) and 35 bulls (maximum annual average). In addition, the operation houses heifers, bulls, and non-lactating cows in pasture. The facility consists of six total confinement free stall barns, a milking parlor, a wastewater treatment system and land application areas. All lactating cows are housed in the total confinement free stall barns. The dry cows and heifers reside on open pasture. Manure in the free stall barns is flushed and directed to the wastewater treatment system. The milking parlor flush and clean up wastewater is also directed to the treatment system.

A Nutrient Management Plan (NMP) was developed for this facility. It consists of a system design based on an average of 252,000 gallons per day of wastewater and includes a solids separator, a 14.1 million-gallon two-cell earthen-lined waste storage pond, and 540 acres for wastewater irrigation, based on agronomic rates for nitrogen. The wastewater system is designed, constructed, operated, and maintained to contain run-off from the production area. The production area consists of animal confinement areas, the wastewater collection system, and the manure staging areas, and is 6.9 acres in size, for a 25-year 24-hour storm. Clean water from the roof runoff is diverted away from the waste collection system.

The treatment system is designed as follows: wastewater is generated from the milking parlor, work area, and free stall barn flushes; milk room and parlor wash water, cow washers, cooling sprinklers; and stormwater runoff from the production area. The wastewater is directed to the solids separator. From the solids separator the wastewater flows into the waste storage pond. Wastewater from the waste storage pond is pumped to nine sprayfields, totaling 540 acres, for use as irrigation water. A second settling waste storage pond was proposed dependent on cost sharing funds. The waste solids removed from the solids separator is spread on forage fields onsite or hauled offsite for land application at agronomic rates. Solids application sites include the following fields for a total of 48 acres: A1 and A10. Field RA is a small application area that may be expanded into a 92-acre irrigated field in the future but is not required. Wastewater and solid application sites include the following fields for a total of 540 acres: D2 (72 acres), D4 (76 acres), D6 (45 acres), B2 (104 acres), D8 (94 acres), A10 (15 acres), 221 Pivot (41 acres), YP North (43 acres), and YP South (50 acres). These sprayfields are planted in a crop rotation in accordance with the NMP.

Groundwater Monitoring

Jeffco Dairy is located in the Madison Hills geomorphic province of northern Florida. The current groundwater monitoring network at Jeffco Dairy consists of three wells

screened in the Floridan Aquifer and one well (MWC-3) screened in the Surficial Aquifer:

- One Background well – MWB-1
- One Intermediate well – MWI-2
- Two Compliance wells – MWC-3 and MWC-4

The monitor well locations are shown in Figure F-1. The historical groundwater sampling results include a well named MWW-2, a dog kennel supply well located west of Sprayfield D-2. The well was sampled from 2008 to 2010 with all NOx-N concentrations below 1 mg-N/L. In 2015, the well was renamed MWI-2 and has been sampled quarterly since then. The other monitor wells were installed in 2006.

The 2005 and 2010 permits referred to MWC-3 as being screened in the Floridan aquifer. Subsequent permits designated MWC-3 as screened in the Surficial Aquifer. No monitoring well boring logs or installation specifications were available for review. MWC-3 is 55 feet deep. The three wells screened in the Floridan Aquifer are 89 to 139 feet deep.

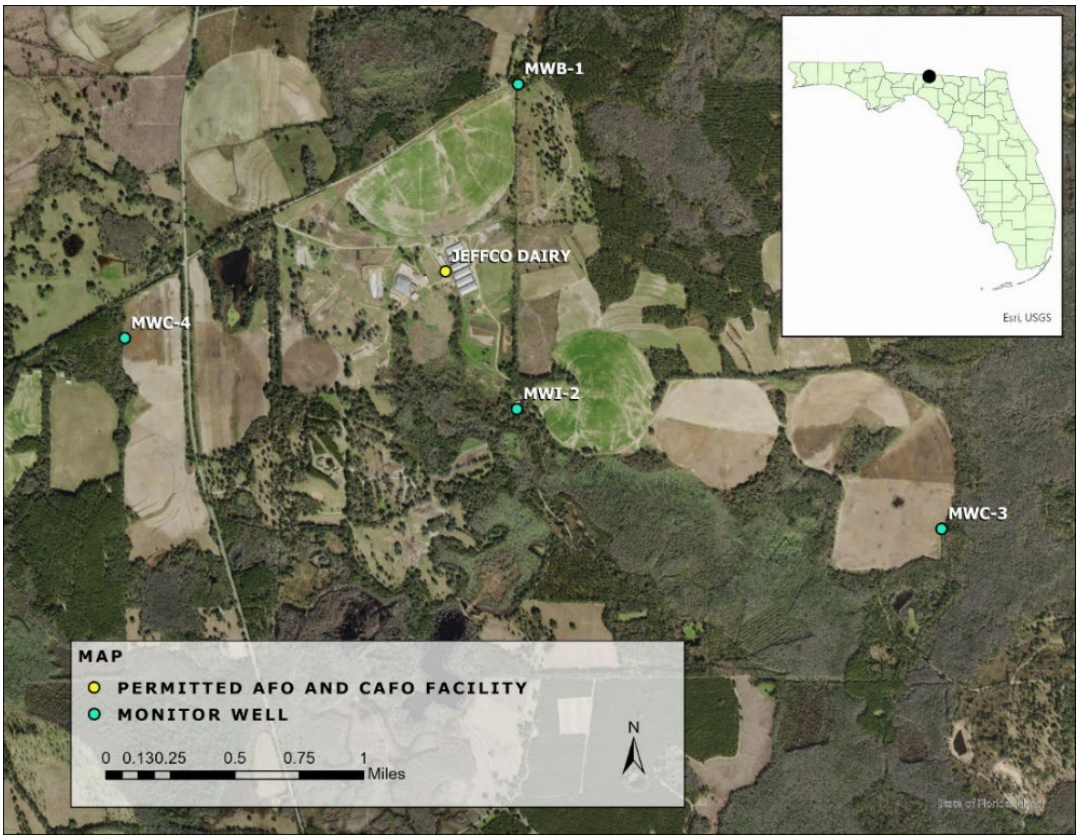

Figure F-1. Locations of Monitor Wells, Jeffco Dairy, Jefferson County.

The groundwater flow gradient in the vicinity of the Jeffco Dairy is to the north (Figure F-2). Although the Upper Floridan potentiometric surface elevation contours do not extend to the north across the state line, the northward flow direction shown at Jeffco Dairy is most likely correct.

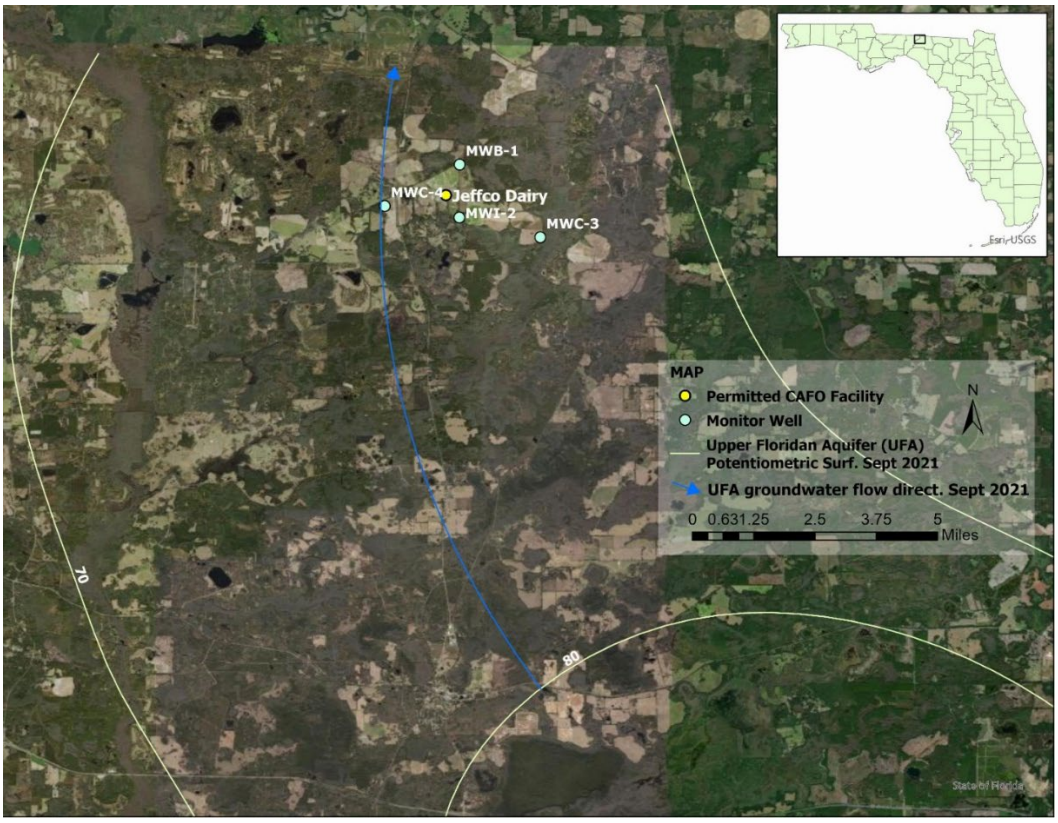

Figure F-2. Groundwater Elevation Contours of the Potentiometric Surface of the Upper Floridan Aquifer, Jeffco Dairy, September 2021.

Groundwater General Water Quality

Table F-1 presents a summary of reported groundwater monitoring data for the period-of-record from March 2007 through June 2022. Background well data indicate elevated nitrate and normal aquifer pH levels. Nitrogen concentrations are unexpectedly lower in the intermediate well data but higher than the background wells in the compliance well data. pH values are relatively acidic in the intermediate and compliance wells, indicative of possible dairy pollution.

Groundwater Nitrate Concentration and Trends

The background monitoring well, MWB-1, is downgradient of the eastern portion of the dairy and has a period-of-record NOx-N concentration of 0.73 mg-N/L, with little

variation from year-to-year (0.35 to 1.3 mg-N/L). The intermediate well, MWI-2, could be considered as the background well as it is upgradient of the dairy with an average NOx-N concentration of 0.44 mg-N/L, lower than MWB-1. Compliance well, MWC-4, has recorded NOx-N concentrations less than the background and intermediate wells and is likely not indicative of a plume of nitrate in migrating groundwater. Compliance well MWC-3 has recorded NOx-N concentrations above the background and intermediate wells, starting in 2019 and continuing to increase to 7.7 mg-N/L during the most recent year of data (2023). Neither MWC-3 nor MWC-4 are accurately sited as compliance wells.

Table F-1. Jeffco Dairy Floridan Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	2.9	1.0	23.0	6.8	1.0	105.0	2.1	1.0	41.6
Nitrite plus Nitrate, Total (as N)	mg/L	0.62	0.05	1.44	0.29	0.02	1.26	0.90	0.02	7.70
pH	s.u.	7.28	6.24	7.89	6.77	5.82	8.10	6.29	4.04	8.06
Phosphate, Ortho (as P)	mg/L	0.063	0.063	0.063	0.021	0.021	0.021	0.339	0.002	0.675
Water Level Relative to NGVD	ft-NGVD	63.17	6.78	134.70	40.24	0.00	72.24	78.03	6.55	134.77

Table F-2. Annual Average NOx-N Concentrations from the Jeffco Dairy FAS Monitoring Wells.

JeffCo Dairy						
Year	**MWB-1**	**MWC-2**	**MWC-3**	**MWC-4**	**MWI-2**	**MWW-2**
2007	1.3		0.61	0.55	2.48	
2008	0.94		0.34	0.38	0.18	0.19
2009	1.05		0.78	0.92		0.41
2010	1.19		0.38	0.46		0.15
2012	0.91	0.14	0.2	0.31		
2013	0.55	0.06	0.21	0.13		
2014	0.64	0.17	0.23	0.18		
2015	0.74	0.16	0.59	0.59	0.89	
2016	0.61		0.44	0.15	0.12	
2017	0.6		0.62	0.39	0.12	
2018	0.38		0.57	0.33	0.71	
2019	0.62		0.97	0.54	0.02	
2020	0.56		2.24	0.12	0.02	
2021	0.62		4.03	0.13	0.06	
2022	0.35		4.92	0.07	0.23	
2023	0.64		7.7	0.13	0.06	
AVERAGE	0.73125	0.1325	1.551875	0.33625	0.444545	0.25

NOx-N concentrations in MWC-3 have risen steadily since 2018 but not yet to levels above 10 mg-N/L. This Surficial Aquifer well is at the edge of sprayfield D-8 and is potentially impacted by it.

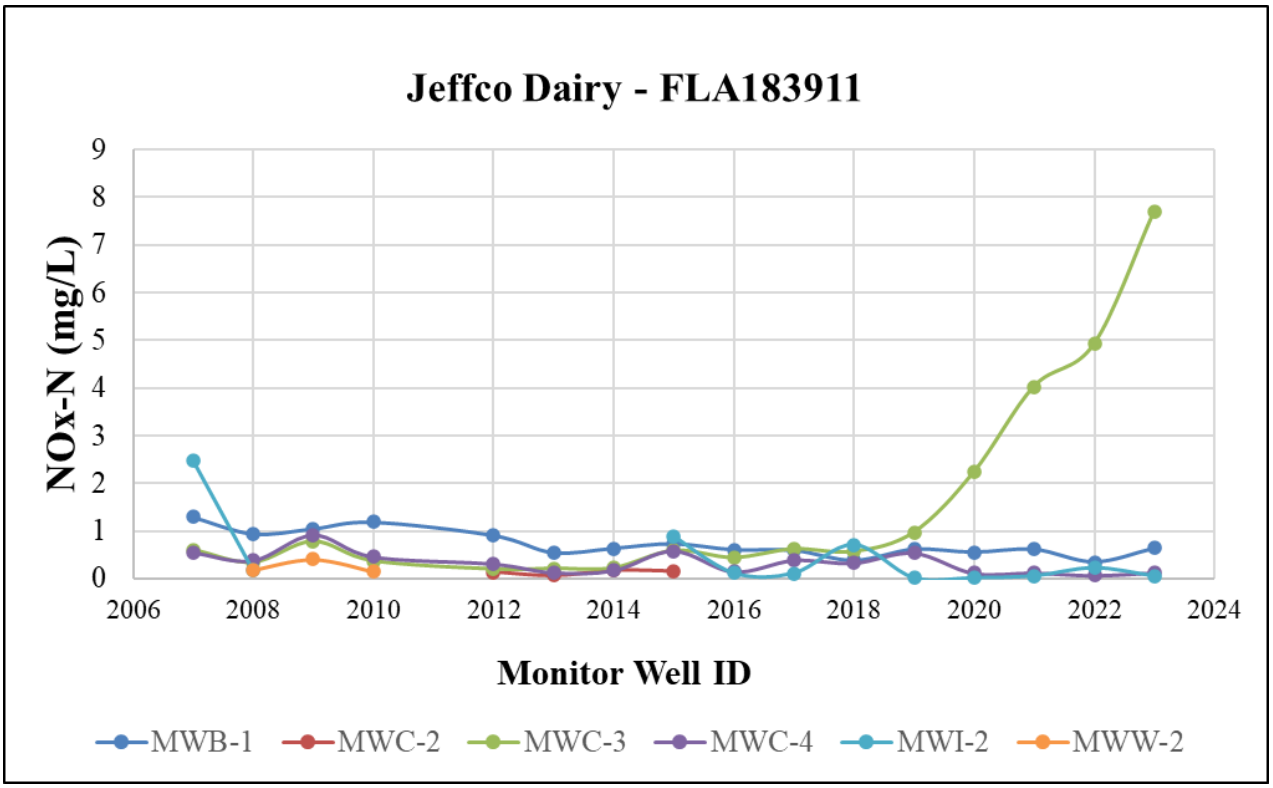

Figure F-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Jeffco Dairy.

Groundwater Consumption

The Jeffco Dairy in Jefferson and Madison counties has 15 permitted FAS wells. The total permitted withdrawal is 1.27 MGD with 0.816 MGD to irrigate 681 ac of crops and 0.455 MGD to water 3,200 dairy cows.

Adjacent Potable Water Wells

Figure F-4 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the Jeffco Dairy. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

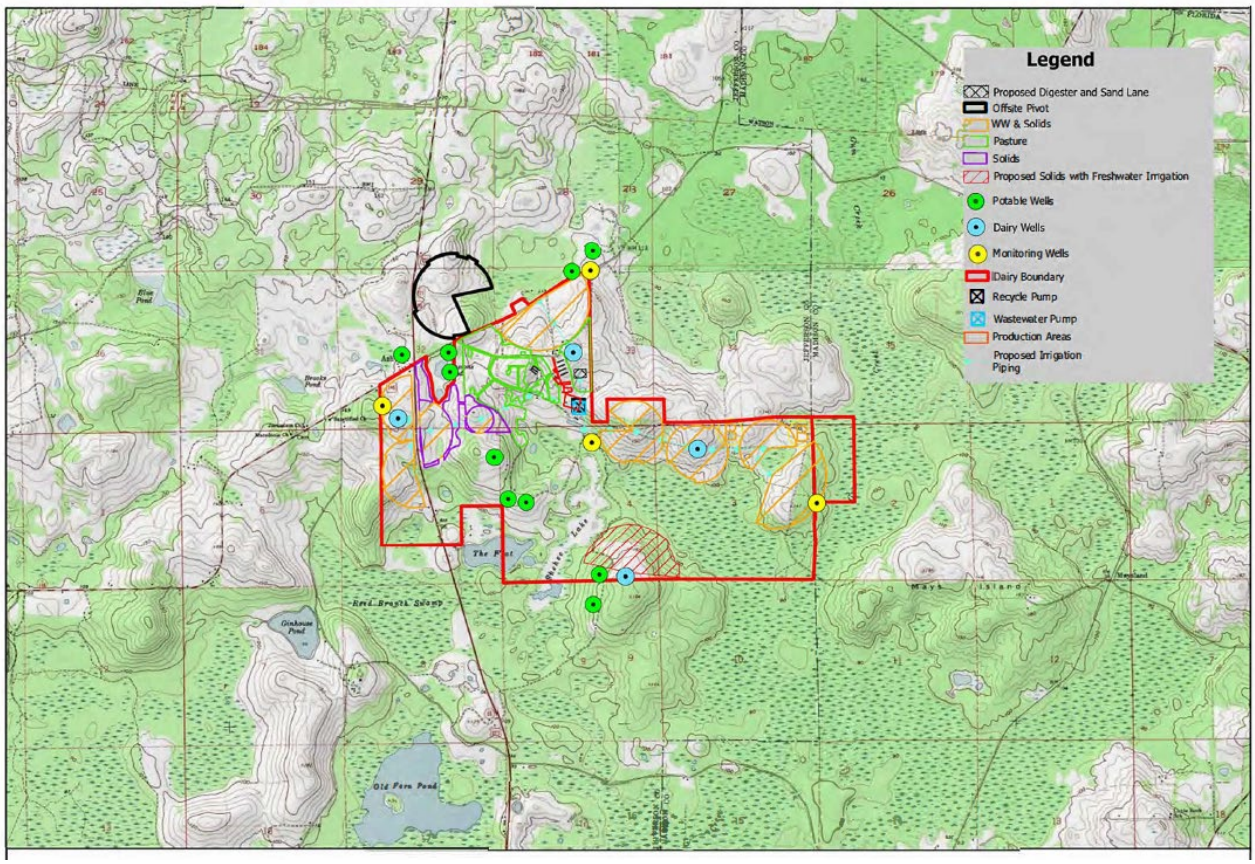

Figure F-4. Private Self-Supply Wells on and Adjacent to the Jeffco Dairy, Jefferson County.

Appendix G: Milk-A-Way Dairy FLA184047, Lafayette County

Description

The Milk-A-Way Dairy was formerly the Ed Perry Dairy first permitted in 2005 and then the Lafayette Dairy first permitted in 2007.

The Milk-A-Way Dairy, first permitted in 2022, is an existing concentrated animal feeding operation which operates as a rotational grazing dairy. The dairy operation currently has a herd size of 1,150 mature dairy cows (maximum annual average) however the facility is designed for 1,750 lactating cows. The facility consists of a cooling barn, a milking parlor, silage storage area and a 0.54-acre waste storage pond system. Manure is flushed from the milk parlor and barn then directed to the wastewater treatment system. Lactating cows currently spend a portion of the day in the cooling barns and a portion of the day in pastures. The herd size may increase up to 1,750 mature dairy cows (maximum annual average), including 315 dry cows. Heifers and other cattle will be on the site, but not confined, and located entirely on pastures.

Groundwater Monitoring

Milk-A-Way Dairy is located in the Branford Karst Plain geomorphic province of north Florida. Five monitor wells (MWB-1, MWC-2, MWI-3, MWB-4 and MWC-5) were first installed for the Ed Perry Dairy in October 2004. The wells were screened in the Upper Floridan Aquifer and ranged in depth from 59 to 63 feet.

The groundwater monitoring network at the Milk-A-Way Dairy currently consists of five wells screened in the Floridan aquifer:

- Two Background wells – MWB-4 and MWB-7
- Three Compliance wells – MWC-5, MWC-6 and MWC-8

The current monitor well locations are shown in Figure G-1. The monitor wells are all 60 to 62 feet deep except for MWB-7 which is 28 feet deep. Based on groundwater elevation contours of the potentiometric surface of the Upper Floridan Aquifer (Figure G-2), the flow direction is to the northeast toward the Suwanee River.

The 2005 permit indicates that the two original background wells were installed approximately 3,000 feet apart, with MWB-1 sited in the west margin of Field 16 and MWB-4 sited in the south margin of the southeast quadrant of Field 5. Sampling of monitor well MWB-1 was discontinued in 2016 after the well exhibited increasing concentrations of NOx-N beginning in 2011, most likely due to being downgradient of Primary Sprayfield Pivot 5.

A third background well, MWB-7, was installed in 2015 upgradient of the sprayfield at a depth of 28 feet below the ground surface. Monitor wells MWC-6 and MWC-8 were also

installed in 2015 but boring logs for the three newest wells were not available. NOx-N concentrations in background well MWB-7 have exceeded 10 mg-N/L in all sampling rounds. It's location is upgradient of the dairy, but it is shallow and that may be impacting groundwater in that location.

Milk-A-Way Dairy currently has no intermediate monitor wells in use. The three compliance wells MWC-5, MWC-6 and MWC-8 are all downgradient of dairy operation areas and sprayfields.

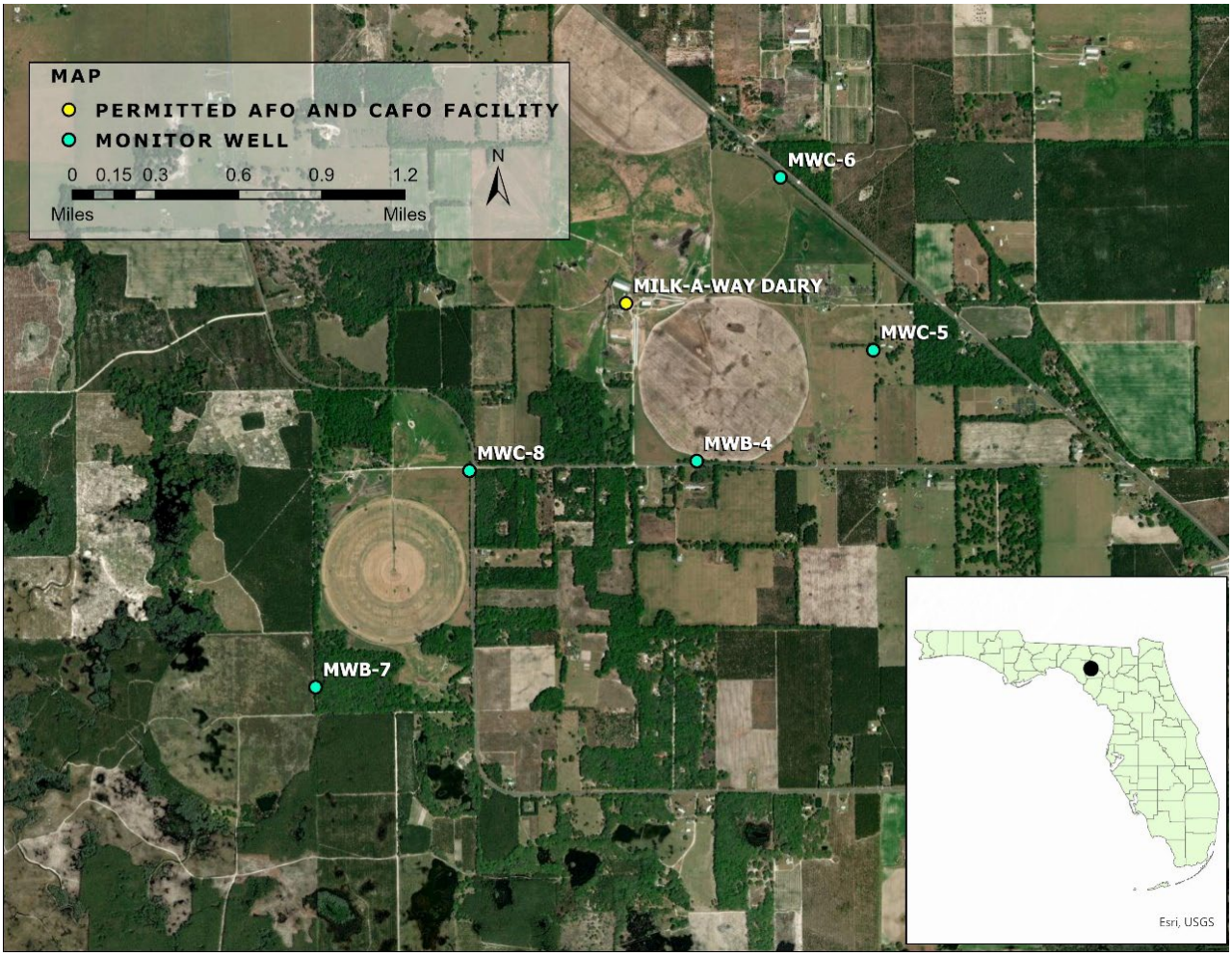

Figure G-1. Monitor Well Locations, Milk-A-Way Dairy.

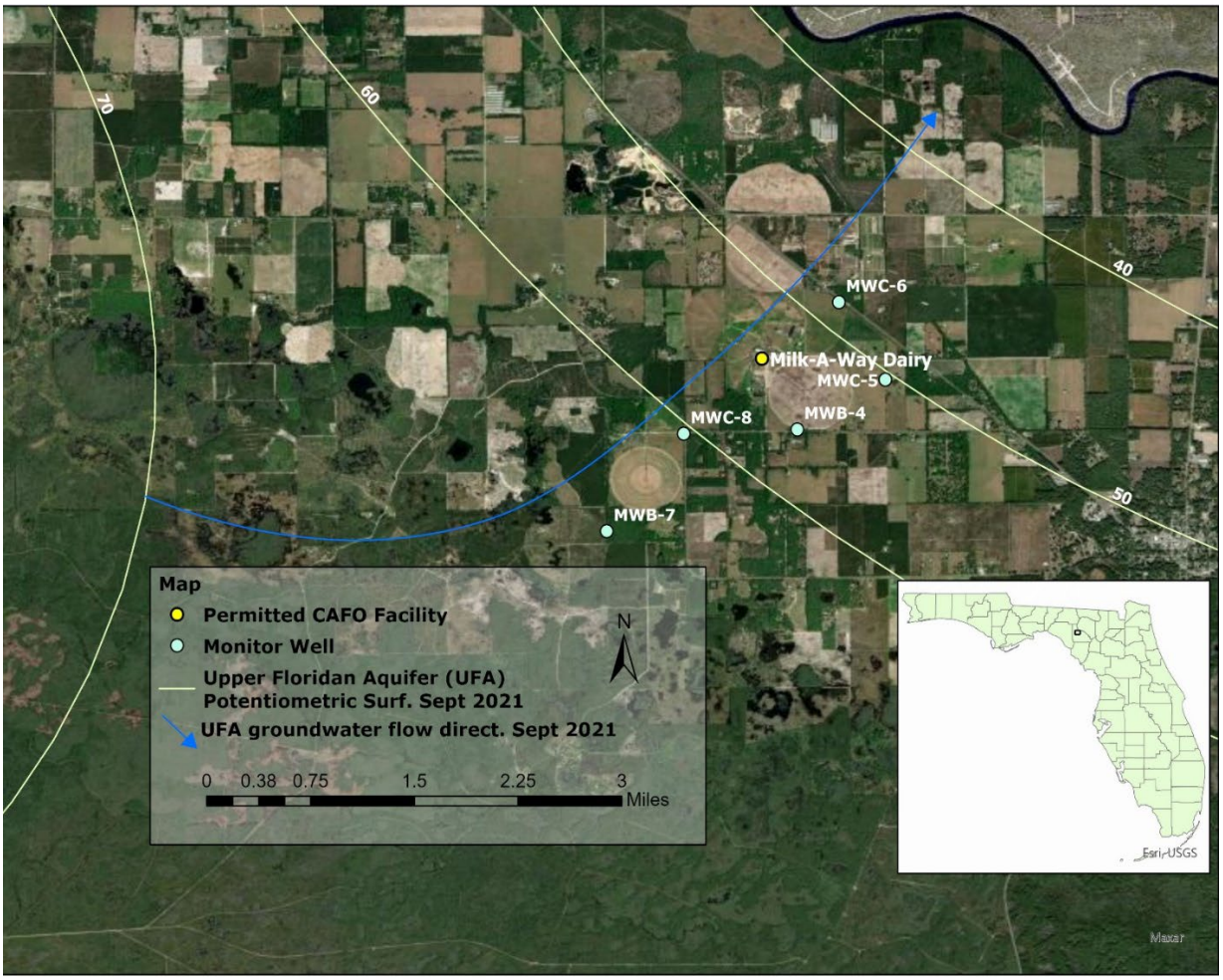

Figure G-2. Groundwater Elevation Contours of the Potentiometric Surface of the Upper Floridan Aquifer, Milk-A-Way Dairy-, September 2021.

Groundwater General Water Quality

Table G-1 presents a summary of reported groundwater monitoring data for the period-of-record from June 2022 through September 2023. Background well data indicate very low nitrate and pH levels. Nitrogen concentrations were quite high at the intermediate wells when monitored and close to or above the compliance concentration at the downstream wells. pH values are relatively acidic in all wells, confirming that all wells at this site are sampling surficial and/or intermediate aquifer levels. No intermediate well data were reported since 2017.

Table G-1. Milk-a-Way Dairy Floridan Aquifer Monitoring Wells General Water Quality.

Parameter	Units	Background Wells			Compliance Wells		
		Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	1.0	1.0	1.0	1.0	1.0	1.0
Nitrite plus Nitrate, Total (as N)	mg/L	9.48	6.00	14.00	4.08	0.20	16.00
pH	s.u.	7.24	6.88	7.53			
Phosphate, Ortho (as P)	mg/L	0.026	0.014	0.038	0.061	0.016	0.130
Water Level Relative to NGVD	ft-NGVD	52.95	37.51	68.19	34.57	27.50	46.69

Groundwater Nitrate Concentration and Trends

Nitrate concentrations and trends are summarized in Table G-2 and Figure G-3. Concentrations of NOx-N in background monitor well MWB-4 have been below 10 mg-N/L since 2016. Background monitor well MWB-7 has had exceedances of NOx-N in all years sampled suggesting a source upgradient of this well.

Table G-2. Annual Average NOx-N Concentrations in FAS Monitoring Wells at the Milk-A-Way Dairy, Lafayette County.

Milk-a-Way Dairy								
Year	**MWB-1**	**MWB-4**	**MWB-7**	**MWC-2**	**MWC-5**	**MWC-6**	**MWC-8**	**MWI-3**
2006	7.89	16.55		43.25				24.45
2007	1.41	15.33		40.5	0.02			19.9
2008	27.92	10.54		41.4	0.05			23.58
2009	53.8	8.04		31.28	0.01			21.8
2010	61.13	6.24		19.08	4.48			28.78
2011	136.13	7.21		25	0.05			30.18
2012	10.13	6.58		18.13	5.29			32.25
2013	8.93	20.78		36.25	6.04			42.25
2014	5.33	8.43		41	6.61			40.25
2015	6.98	14.7		26.25	1.33			33.25
2016	5.05	9.9	39	21.5	0.11	4.9	0.83	40.5
2017		8.75	39.5		0.89	4.05	0.73	
2018		9.01	33		4.9	4.12	1.59	
2019		9.65	20.26		2.76	6	0.21	
2020		9.14	15.68		0.02	5.68	2.13	
2021		6.05	16.18		0.64	6.44	5.1	
2022		6.42	10.47		0.68	7.96	0.89	
2023		6.43	12.67		0.33	12.67	2.8	
AVERAGE	29.51818	9.986111	23.345	31.24	2.012353	6.4775	1.785	30.65364

Sampling of Intermediate monitor well MWI-3 and compliance monitor well MWC-2 was discontinued in 2017 after exceedances in both wells for the period-of-record.

Compliance monitor wells MWC-5, MWC-6 and MWC-8 have all had NOx-N below 10 mg-N/L for the period of record except MWC-6 which had exceedances averaging 12.67 mg-N/L in 2023.

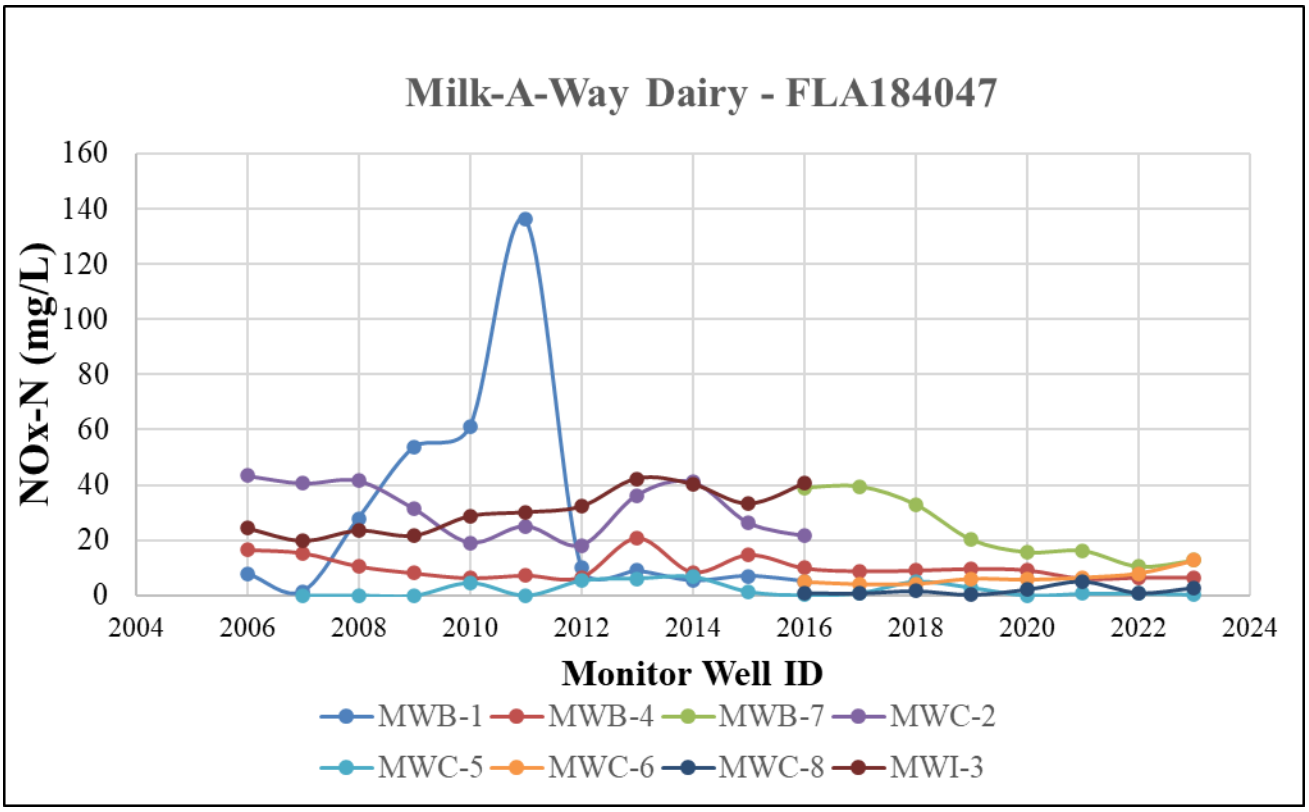

Figure G-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Milk-A-Way Dairy.

Groundwater Consumption

The Milk-A-Way Dairy in Lafayette County has eleven permitted FAS wells. The total permitted withdrawal is 8.42 MGD with 1.253 MGD to irrigate crops and 0.187 MGD to water dairy cows.

Adjacent Potable Water Wells

Figure G-4 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the Milk-A-Way (Lafayette) Dairy. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

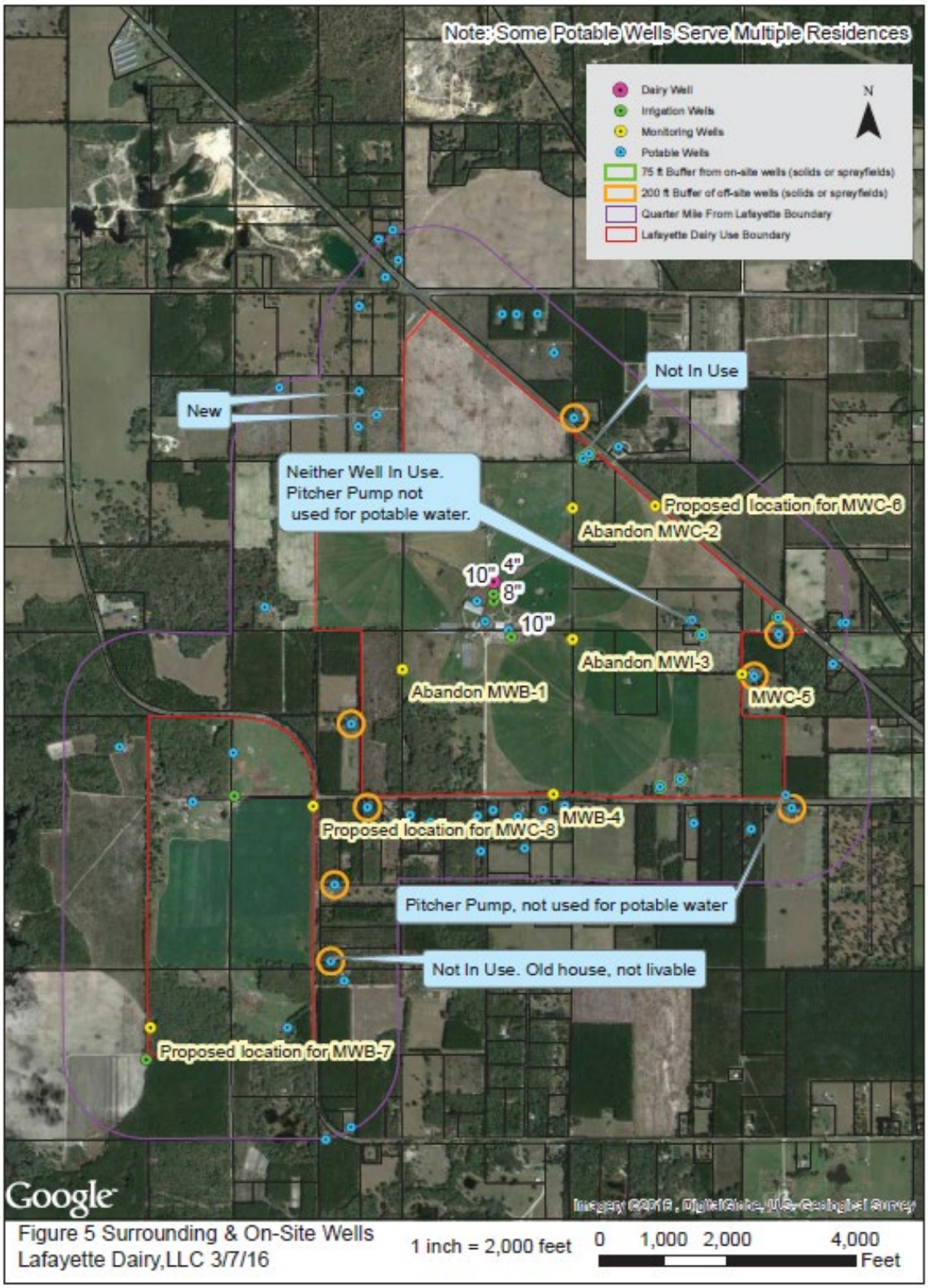

Figure G-4. Private Self-Supply Wells on and Adjacent to the Milk-A-Way (Lafayette) Dairy, Lafayette County.

Appendix H: North Florida Dairies LLC, FLA285331, Gilchrist County

Description

North Florida Dairies LLC is a total confinement dairy located at 2740 West County Road 232 in Bell, Florida. Originally called Bell Farm and then North Florida Holsteins LLC, North Florida Dairies LLC is currently composed of two dairies (East Facility and West Facility). The East Facility, built in 1980, was issued an FDEP NPDES permit (FLA282821) on December 16, 2005. In 2018, North Florida Holsteins LLC purchased an additional dairy across the road to the west from the East Facility that is now called the West Facility. North Florida Dairies, LLC most recent NPDES permit (FLA285331) was issued in draft form on July 25, 2025.

A 2021 Engineering Report and Nutrient Management Plan (NMP) prepared for permit renewal and to combine the existing west and east waste management systems requested a single permit for both operations (Holloway 2021).

The East Facility started with 125 milk cows and grew steadily until reaching an annual average of 3,100 milk cows in 1993. The facility maintained an average of 3,100 milk cows from 1993 until around 2007. Additional free stall barns were added, and the mature cow numbers were increased to around 4,800. Most mature cows now reside in the cooled barns. The East Facility can currently support 3,900 lactating cows in confinement; 900 dry cows in confinement; and 600 calves in barns and semi open pens. The West Facility can support 1,800 lactating cows in confinement. Both facilities have nearby pastured animals that are not included in the 2021 NMP.

According to Holloway (2021) the dairy was without a manager for several years and some parts of the farm were neglected. As of 2021, a new manager was improving the situation but there are many areas of the farm that need significant work.

The West Facility's original owner, American Dairy Co. Florida LLC, went bankrupt; the facility needed maintenance and did not have sufficient land to apply nutrients. The West Facility has gone through a complete change and is now in good working condition. Key issues included better record keeping, establishing more grass on pasture areas that have become denuded, addressing the calf wastewater from the large calf barn, not applying solids to wastewater areas, continuing to improve the North and University pivots, and improving the calf sprayfield.

The West Facility is a concentrated animal feeding operation (SIC Code: 0241), which encompasses approximately 2,400 acres. In its most recent permit (dated May 16, 2016), the West Facility is described as an existing dairy with a maximum annual average mature cow population of 3,600 lactating cows and 300 dry cows in confinement. There are 920 calves in barns and 200 calves in semi-open pens.

Additional dry cows, heifers and bulls may be grazed on pastures of approximately 386-acres.

The West Facility consists of six free stall barns, two milking parlors, a commodities area, and a waste storage pond system. One additional free stall barn was planned for construction. The waste management system consists of four waste storage ponds for separate areas, solids separation, irrigation fields, and solids application fields. Manure is flushed from the calf barns and milking centers to waste storage ponds and all free stall barns are scraped to pits.

Upon completion of the additional free stall barn and expansion of the sprayfield, bringing the total sprayfield acreage to 417 ac and completion of all actions listed in the Administrative Order (AO 184 NE), the herd size was permitted to increase to a maximum annual average of 4,200 lactating cows and 480 dry cows in confinement.

FDEP issued a consent order in October 2021 citing multiple violations at the West Facility for over-application of nutrients to spray fields and exceedances of NOx-N concentrations in compliance monitor wells MWC-2, MWC-4, and MWC-9. The Consent Order required the permittee to submit a Compliance Plan within 90 days. The Consent Order called for a three-year period of relaxation of the nitrate compliance limit for the three compliance wells with exceedances.

According to the January 2023 quarterly consent order compliance progress report, both the West and East facilities were sold to a new, unidentified, owner and renamed as North Florida Holsteins, LLC which combined the two former facilities into one.

Groundwater Monitoring

North Florida Dairies, LLC is in the Bell Ridge geomorphologic province of north Florida. The current groundwater monitoring network at North Florida Dairies, LLC currently consists of 16 wells screened in the Floridan Aquifer:

- Four Background wells – MWB-1W, MWB-2W, MWB-5P and MWB-8E
- Two Intermediate wells – MWI-3W and MWI-5W
- Eleven Compliance wells – MWC-4W, MWC-5W, MWC-6W, MWC-7W, MWC-8W, MWC-9W, MWC-2E, MWC-4E, MWC-6P, MWC-7P and MWC-9E.

The monitor well locations are shown in Figure H-1.

Groundwater Flow Direction

Figure H-2 is a map of the potentiometric surface of the Upper Floridan Aquifer near North Florida Dairies in September 2021. The map indicates that the groundwater flow direction is to the west toward the Suwannee River. Groundwater contours for data collected in September 2017 confirm this flow direction.

The potentiometric surface contours in Figure H-2 indicate that background monitor well MWB-8E is upgradient of the East Facility and MWB-1W and MWB-2W are upgradient

of the West Facility. Background monitor well MWB-5P is upgradient of the Piedmont tract. The intermediate and compliance monitor wells are all directly downgradient of sprayfields or wastewater pivots.

Figure H-1. Locations of Monitor Wells, North Florida Dairies East and West Facilities.

Groundwater General Water Quality

Table H-1 presents a summary of reported groundwater monitoring data for the period-of-record from 2007 through September 2023. Background well data indicate elevated average nitrate nitrogen concentrations, averaging 23 mg-N/L with a maximum recorded value of 140 mg-N/L, either from the dairy or some upgradient source of pollution. Nitrate nitrogen concentrations were much lower in the intermediate (average 7.3 mg-N/L) and background (average 9.4, maximum 61 mg-N/L) wells.

Background well data for pH were uncharacteristically low for the Floridan Aquifer (average 6.75 s.u.) and maximum values for pH were high in the intermediate and compliance well samples. Ortho phosphorus was high for the Floridan Aquifer.

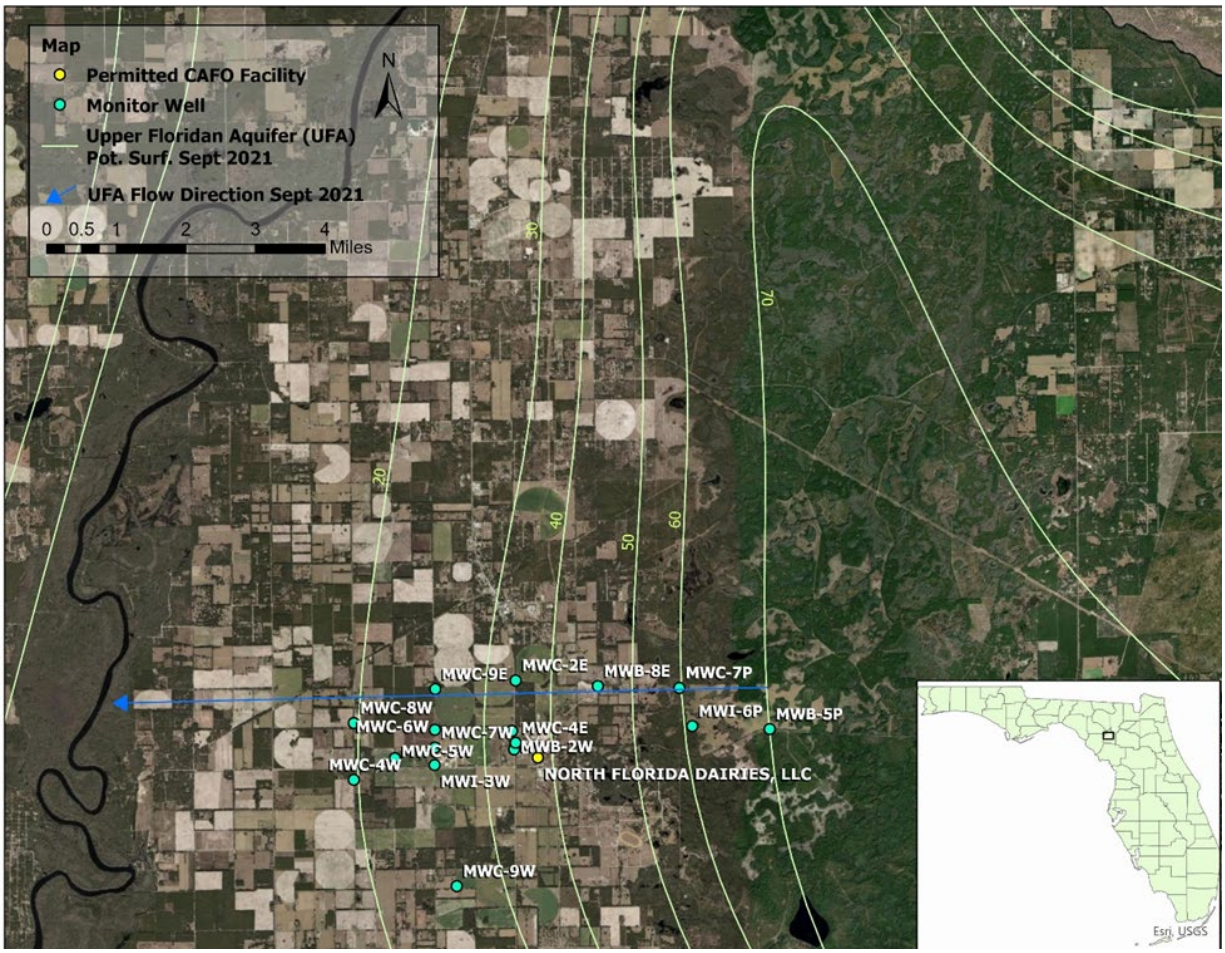

Figure H-2. Potentiometric Surface and Flow Direction, Upper Floridan Aquifer at North Florida Dairies, LLC September 2021.

Table H-1. North Florida Dairies LLC Floridan Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	2.9	1.0	68.0	2.0	1.0	4.0	7.0	1.0	300.0
Nitrite plus Nitrate, Total (as N)	mg/L	23.91	0.19	140.00	7.31	0.00	41.00	9.41	0.00	61.40
pH	s.u.	6.75	4.45	8.75	7.12	6.57	8.01	7.01	5.37	9.75
Phosphate, Ortho (as P)	mg/L	0.162	0.002	1.700	0.242	0.033	0.727	0.086	0.002	0.370
Water Level Relative to NGVD	ft-NGVD	50.38	9.81	86.25	64.00	10.74	80.20	29.09	5.03	76.80

Groundwater Nitrate Concentration and Trends and Proposed Groundwater Monitoring Changes

Figure H-1 from Holloway (2021) shows the monitor wells located at both the West and East facilities and the Piedmont tract biosolids disposal site. All monitor wells are

constructed of 2- or 4-inch diameter PVC installed to screen the upper Floridan aquifer while the wells on the Piedmont tract monitor the Surficial aquifer that exists there.

Holloway's NMR requested changing wells MWC-4E, MWB-2W, and MWB-1W to intermediate wells since they are between the West and East dairy operations. All wells (except those in the Piedmont tract) were renamed with the new numbering system adding E or W to the well number. Two new compliance wells, MWC-8W and MWC-9W, were proposed in a 2022 permit and installed by 2025 for the new Milling-Pile pivot and the Gray tract due to the sprayfield expansion. Two additional new compliance wells (MWC-10 and MWC-11) were proposed in the 2025 draft permit to monitor west of Pivot H and west of Pivot E respectfully. A potential new background well (MWB-12W) was also proposed to monitor the east side of East Gray Pivot.

Table H-2 and Figure H-3 illustrate the nitrate trends from the wells from 2016 to 2020 for the East Facility, Piedmont tract, and the West Facility. Elevation data shows that water levels in the background wells on the east side of each monitored area were higher than the wells to the west, indicating that the background wells to the east are most likely upgradient of the facility.

The East Facility background well MWB-8E's NOx-N concentration has remained below 5 mg-N/L. The background well at the Piedmont tract has exceeded the 10 ppm NOx-N groundwater standard until 2019, when it dropped below the standard. However, in the 2020 sampling round it again exceeded the standard.

There are currently no other farming activities around the Piedmont tract except for silviculture. Pines are sometimes fertilized, but large amounts of nitrogen are almost never used; some small deer food plots may exist. The farming activities of the dairy are close enough that they may have affected this well, so a fence was proposed to be built 100 feet around the well.

Monitor wells MWB-5P, MWC-2E, MWC-4E, and MWC-9E have exceeded standards for nitrate in most quarters since 2016. MWC-4E and MWC-9E have been the only wells elevated in nitrate at the East Facility for the last three quarters of 2023. All the wells for the West Facility have been high in nitrate since 2016 including MWC-6W and MWC-4W, which were high in nitrate before the facility was purchased by NFH.

There appears to be an error in the 2019 4th quarter laboratory or recording results since almost all wells drop to below 1.0 ppm nitrate for this round and subsequently rebound to the previous levels.

Figures H-6 and H-7 illustrate the locations of potable self-supply wells that are within a one-half mile buffer area around the North Holsteins Dairy. There are an estimated 1,000+ private potable wells estimated in the map sections occupied by the North Florida Dairies, LLC.

Table H-2. North Florida Dairies, LLC Annual Summary of Groundwater Nitrate (NOx-N) and Time Series.

North Florida Holsteins West											
Year	MWB-1	MWB-2	MWB-5P	MWC-4	MWC-5	MWC-6	MWC-7	MWC-7P	MWI-3	MWI-6P	MWB-1W
2007	3.28	13.97		0.64	15	3.53	14.48		36.05		
2008	2.23	14.73		0.24	18.4	5.3	15.24		44.65		
2009	1.24	13.55		0.12	13.88	8.48	11.7		37.4		
2010	1.24	12.71		0.06	20.4	10.07	11.15		33.78		
2011	0.66	9.83		0.11	9.84	5.61	8.95		37.88		
2012	0.58	11.58		0.14	5.25	9.3	8.3		51		
2013	1.93	20		0.01	15.29	10	7.1		40.5		
2014	4.98	20.75		2.36	33.25	10.88	6.98		41.75		
2015	5.37	23.67		0.02	40.33	12.33	16.33		38		
2016	9.3	27		0.04	44.75	11.5	14.75		36.25		
2017	19	31.25		0.06	37.5	9.48	13.18		35.75		
2018	27	26		0.26	50.5	6.8	16		35.5		
2019	30.17	14.08		0.54	37.58	4.45	11.48		28		
2020	44.67	13.33		0.9	42.33	6.8	17.33		30.67		40
2021											25.4
2022			1.87					0.2		0.2	30.35
2023			7.13					0.2		0.2	32.1
AVERAGE	10.83	18.03	4.50	0.39	27.45	8.18	12.36	0.20	37.66	0.20	31.96

Table H-2 (continued). North Florida Dairies, LLC Annual Summary of Groundwater Nitrate (NOx-N) and Time Series.

North Florida Holsteins West												
Year	MWB-2W	MWB-8E	MWC-2E	MWC-4E	MWC-4W	MWC-5W	MWC-6W	MWC-7W	MWC-8W	MWC-9E	MWC-9W	MWI-3W
2007												
2008												
2009												
2010												
2011												
2012												
2013												
2014												
2015												
2016												
2017												
2018												
2019												
2020	16				0.5	50	11	19				33
2021	12.73				0.43	52.95	12.39	17.85				34.73
2022	11.98	0.87	6.12	15.2	0.2	60.35	7.04	15.1	2.71	36.63	21.33	33.05
2023	14.27	0.69	8.69	17.77	0.14	63	13.27	20.67	3.62	36.23	11.48	32.83
AVERAGE	13.75	0.78	7.41	16.49	0.32	56.58	10.93	18.16	3.17	36.43	16.41	33.40

The 2025 draft permit proposes abandonment of nine monitor wells including MWI-1W, MWI-2W, MWI-3W, MWI-7W, MWI-8W, MWI-4E, MWB-5P, MWI-6P and MWC-7P. The permit states that water levels will be routinely measured in these wells prior to abandonment.

Groundwater Consumption

The North Florida Dairies LLC Dairy in Gilchrist County has 30 permitted FAS wells. The total permitted withdrawal is 2.245 MGD with 1.476 MGD to irrigate crops and 0.767 MGD to water 6,345 dairy cows.

Adjacent Potable Water Wells

Figure H-6 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the North Florida Dairies LLC East and West facilities. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

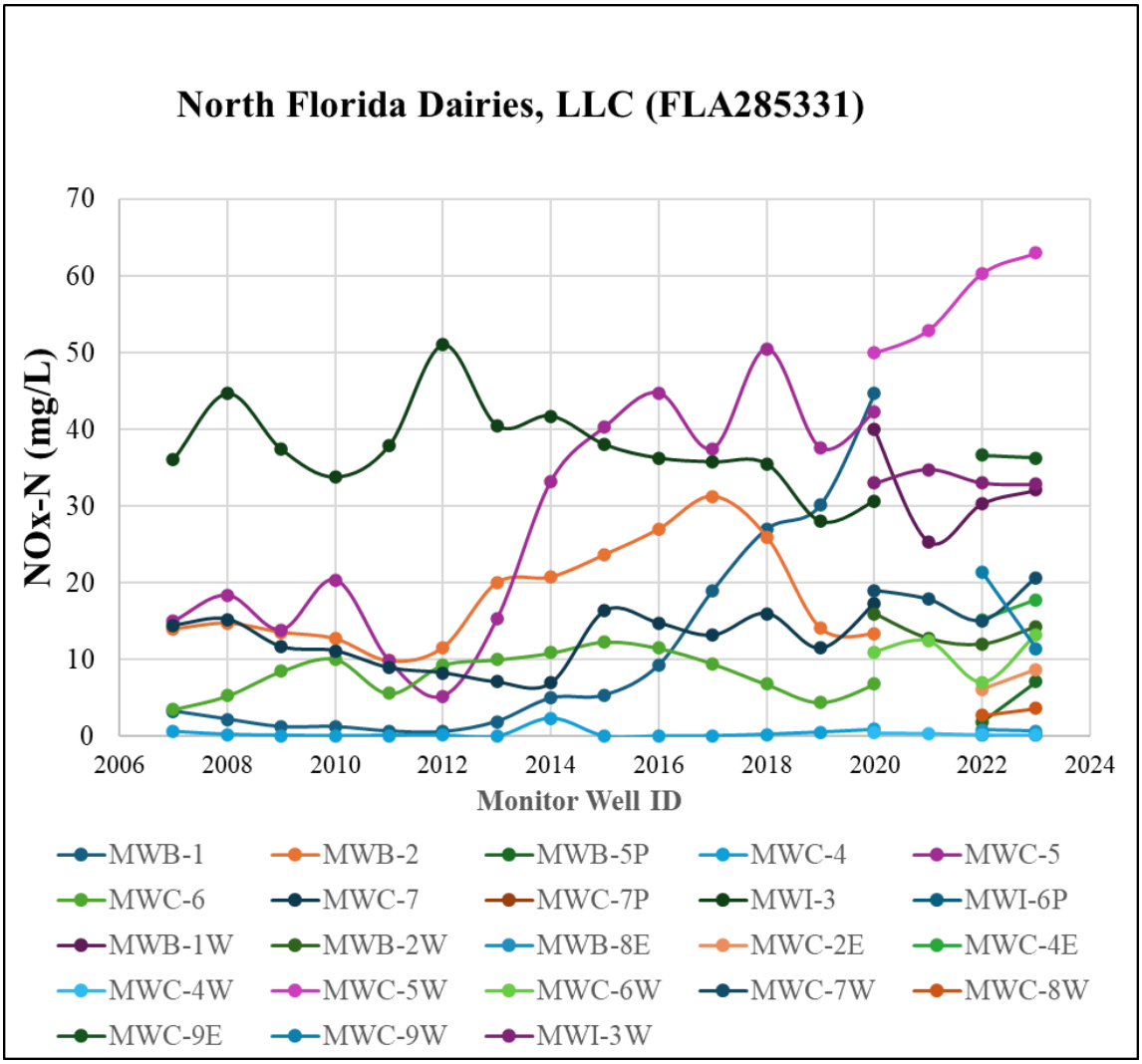

Figure H-3. Groundwater Nitrate (NOx-N) Concentration Annual Average Time Series, North Florida Dairies LLC.

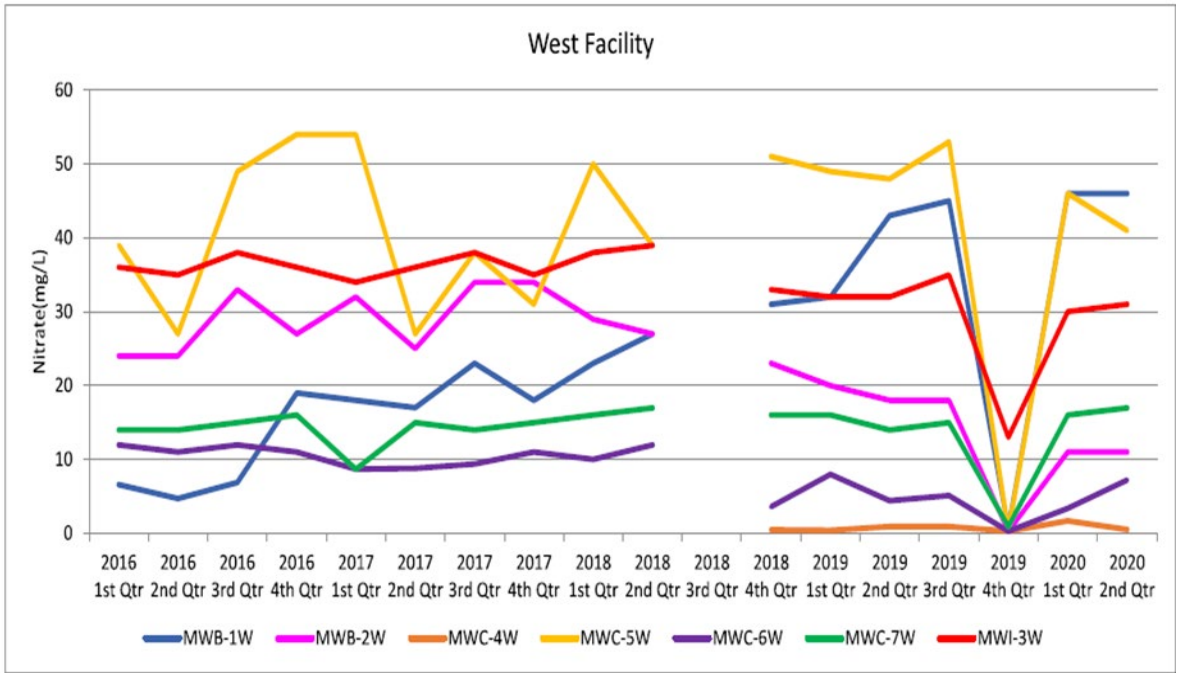

Figure H-4. Groundwater Nitrate (NOx-N) Concentration Quarterly Time Series, North Florida Dairies LLC West Facility.

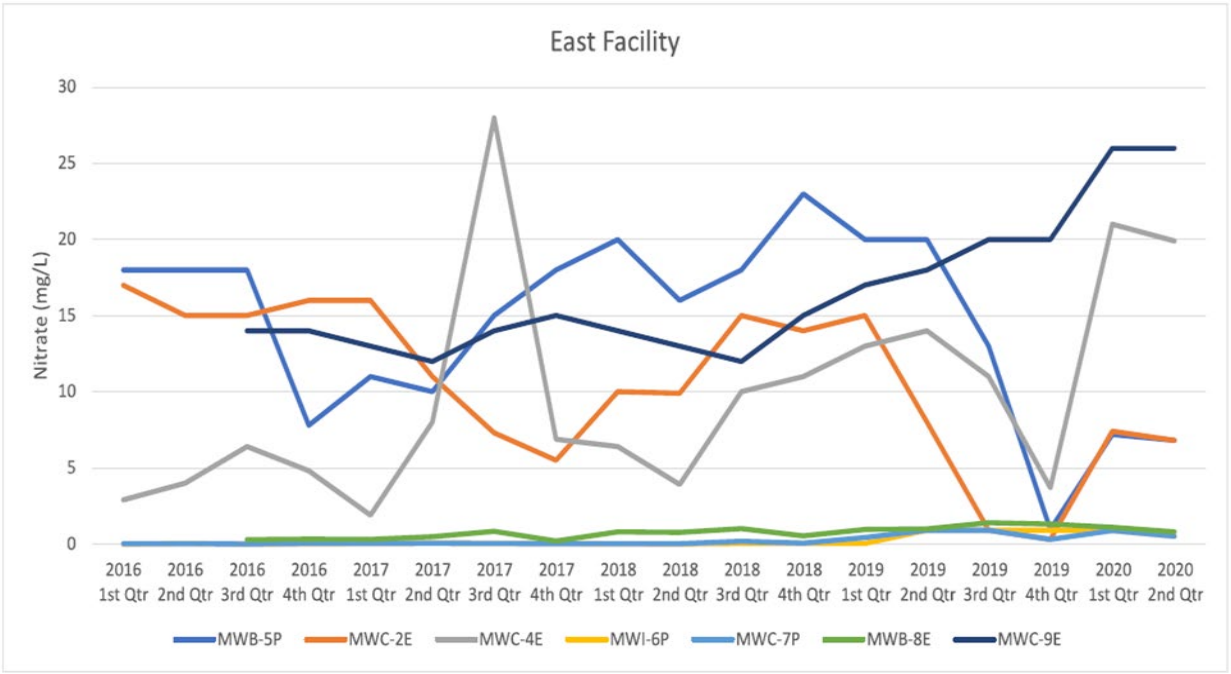

Figure H-5. Groundwater Nitrate (NOx-N) Concentration Quarterly Time Series, North Florida Dairies LLC East Facility.

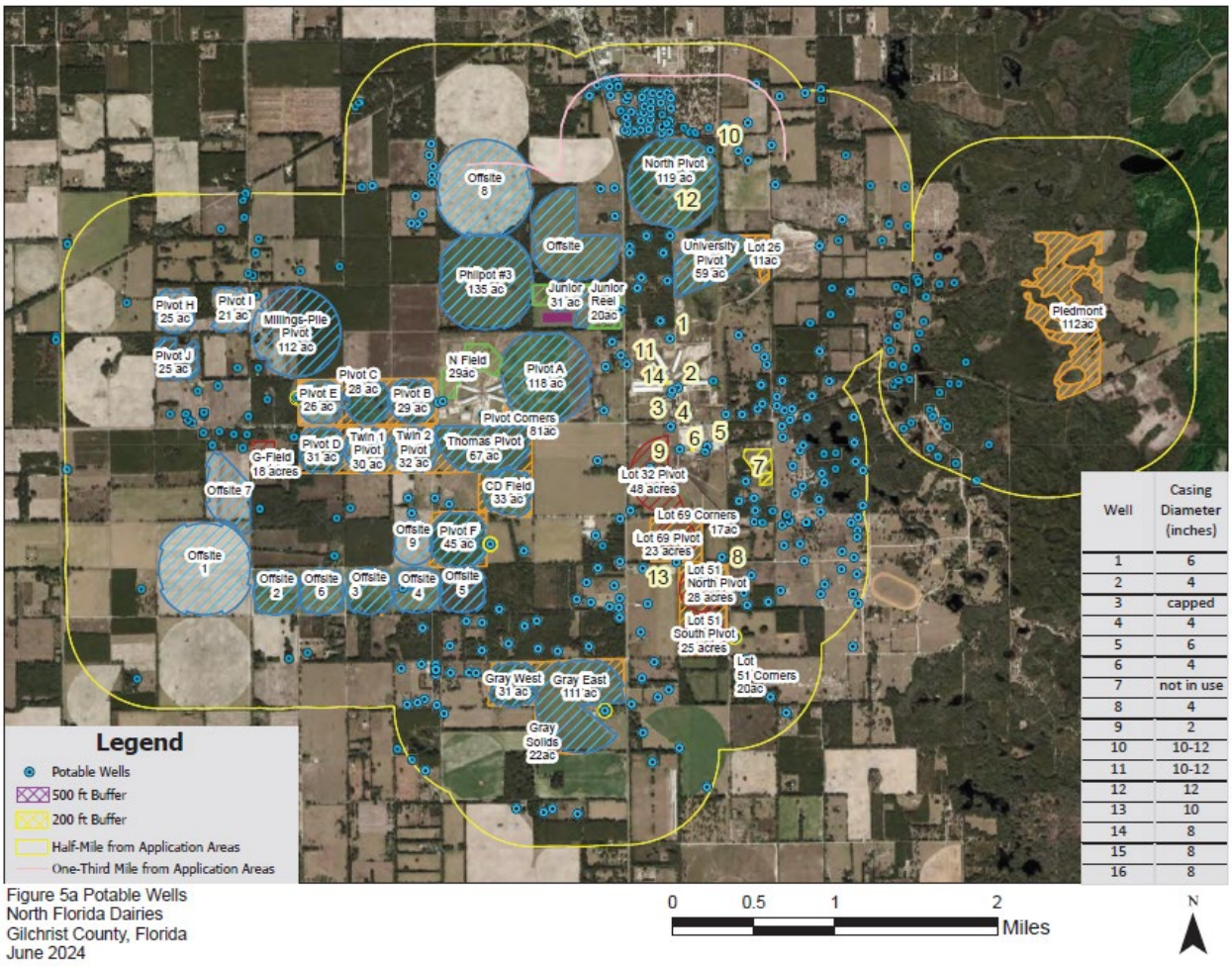

Figure H-6. Domestic Self-Supply Potable Wells in the Vicinity of the North Florida Dairies LLC East and West Facilities, Gilchrist County.

Appendix I: Piedmont Dairy FLA116190, Gilchrist County

Description

Piedmont Dairy, located at 6400 South U.S. Highway 129 in Trenton, Gilchrist County, Florida is an existing confinement dairy that was previously a rotationally grazed dairy facility. The most recent permit application indicates that the dairy is being converted to a confinement dairy where all lactating and some dry cows will be housed in new free stall barns to be constructed. This dairy is located on 1,992 acres and will have an annual average total mature dairy cow population of 2,586 (1,526 lactating/pot/cripple and 1,060 dry cows) with approximately 25 bulls and 305 heifers that will also be grazed on the dairy. The permit application states that the dairy will maintain flexibility in the future to house fewer dry cows compared to lactating cows to maintain the nutrient balance. The facility consists of a milking parlor, a feed storage area, and a three-celled lined wastewater treatment system. Manure will be flushed from the milk parlor and barns, then directed to the wastewater treatment system.

The dairy wastewater management system consists of appurtenances necessary to collect all wastewater and contaminated storm water runoff for a 25-year 24-hour storm event from the milking parlor. The wastewater treatment system consists of a solids separator and three lined wastewater storage ponds: first is 70,800 cubic foot, second is 39,200 cubic foot and the third is 485,600 cubic feet. Runoff from the commodities area is collected in a retention pond that is designed to contain a 25-year 24-hour storm event. Clean water from roof-runoff is diverted away from the waste collection system. The effluent from the wastewater storage ponds is applied to four spray fields that have forage production. Solids collected at this revised facility is applied to 700 acres of dryland and forage fields and 59 acres of pineland. Calves are maintained off-site.

The permit authorizes the discharge of treated process wastewater or contaminated storm water to surface waters of the state. Effluent overflows by gravity from WSP1 into WSP2, which provides additional storage, solids settling, and nitrogen volatilization. Effluent overflows by gravity from WSP2 into WSP3, which has about 7 days of storage capacity to allow for better control over the pumping of the effluent to one of four sprayfields. The separated solids will be land applied in accordance with the nutrient management plan. The sprayfield acreage is 609 acres and all fields will continue to be in nitrogen balance as described in the NMP. The third stage waste storage pond (WSP3) has about 7 days of storage (3.63 MG). The pond is lined with either 60 mil HDPE or concrete. The three waste storage ponds provide the following capacities: WSP1 = 0.52 MG, WSP2 = 0.29 MG, and WSP3 = 3.63 MG.

Groundwater Monitoring

Piedmont Dairy is located at the eastern edge of the Chiefland Karst Plain geomorphologic province. Limestone bedrock was encountered at depths of 13 to 46 feet in four of the five original monitor wells installed at the dairy in 1994.

The current groundwater monitoring network at the Piedmont Dairy consists of five wells screened above or in the Floridan Aquifer:

- One Background well – MWB-1
- One Intermediate well – MWI-2
- Three Compliance wells – MWC-4, MWC-5 and MWC-6

The monitor well locations are shown in Figure I-1. The 5 original monitor wells are 36 to 48 feet deep with 10-foot-long screens. Monitor well MWB-1 did not encounter limestone bedrock and is screened in sandy clay. Monitor well MWI-2 is screened in clay except for the bottom 2 feet which is in limestone. Well screens that straddle more than one different stratigraphic formation may compromise the accuracy of water level elevations. The remaining two original wells (MWC-4 and MWC-5) are screened in limestone. Monitor well MWI-3 (not currently monitored) is also screened in limestone.

Monitor well MWC-6, installed in 2017, is screened from 46 to 56 feet below the ground surface presumably in limestone however a well log was not available to confirm lithologies within the screened interval.

The direction of groundwater flow in the Upper Floridan Aquifer at Piedmont Dairy is to the southwest toward the Suwanee River, based on potentiometric surface elevation contours in September 2021 (Figure I-2). The flow direction in 2017 was similar; to the west-southwest, toward the Suwanee River.

The background well, MWB-1, is upgradient of the dairy but as mentioned above, the well is screened in sandy clay above the limestone so may not accurately represent background conditions in the Floridan Aquifer.

The 2019 permit reclassified MWC-2 as an intermediate monitor well. MWI-2 is downgradient of Sprayfield 1 and the northern portions of Sprayfields 2 and 3 and should potentially be reclassified as a compliance well.

The 2024 permit eliminates sampling of monitor well MWI-3 which has had NOx-N exceedances since 2004.

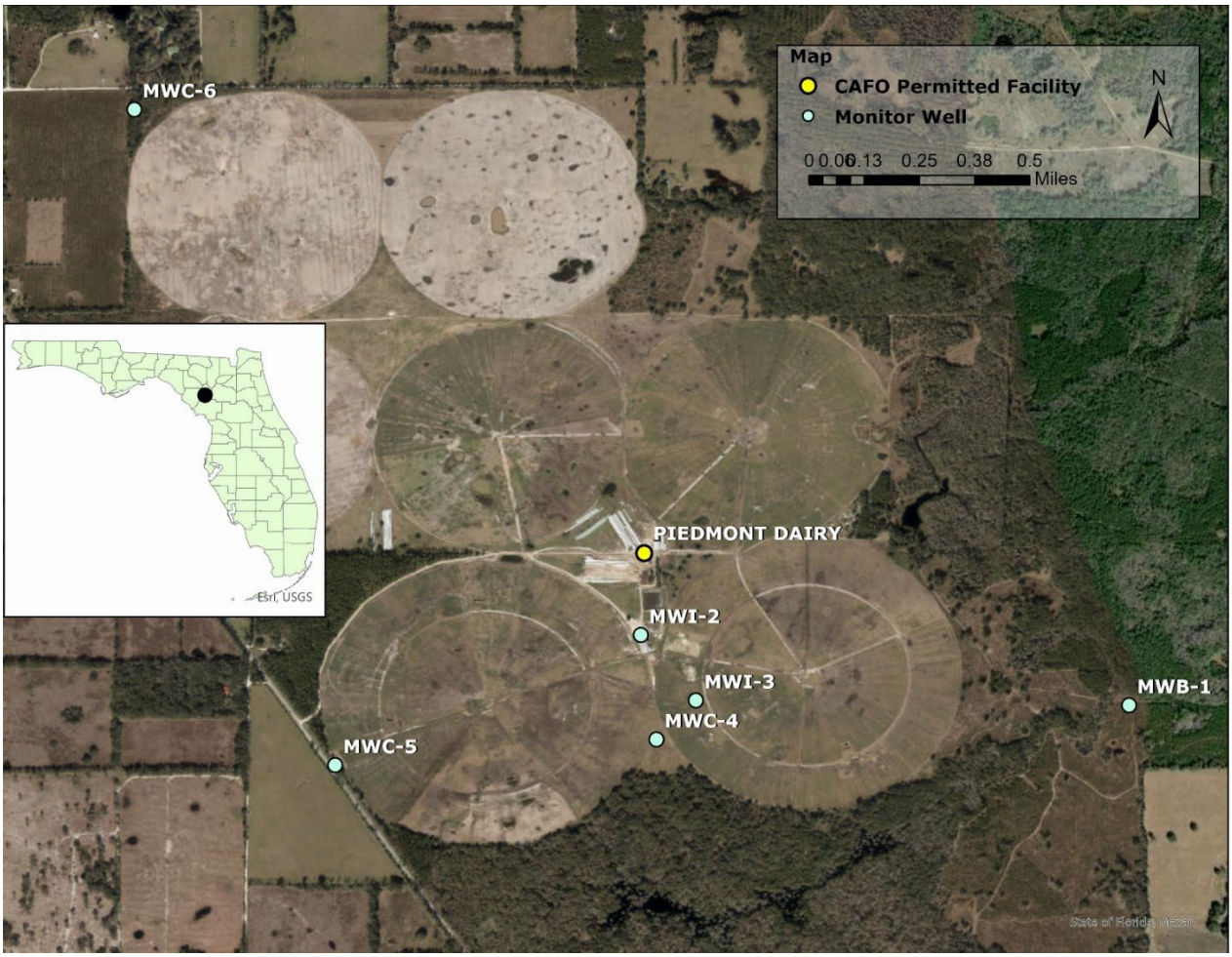

Figure I-1. Monitor Well Locations, Piedmont Dairy.

Groundwater General Water Quality

Table I-1 presents a summary of reported groundwater monitoring data for the period-of-record from March 2004 through September 2023. Background specific conductance is typical of unimpacted aquifer water. Specific conductance values are elevated by nearly 3 times in the intermediate wells, indicating their proper order in groundwater travel downgradient. Conductance is also elevated in the compliance wells but with some dilution. Groundwater nitrate averages are high in the background wells, which indicates a potential upgradient source of contamination. Nitrate levels in the intermediate wells are elevated by about 4 times that of the background wells. The compliance wells have nitrate concentrations like the background wells. Well water quality data indicate normal basic values typical of water in the Floridan Aquifer.

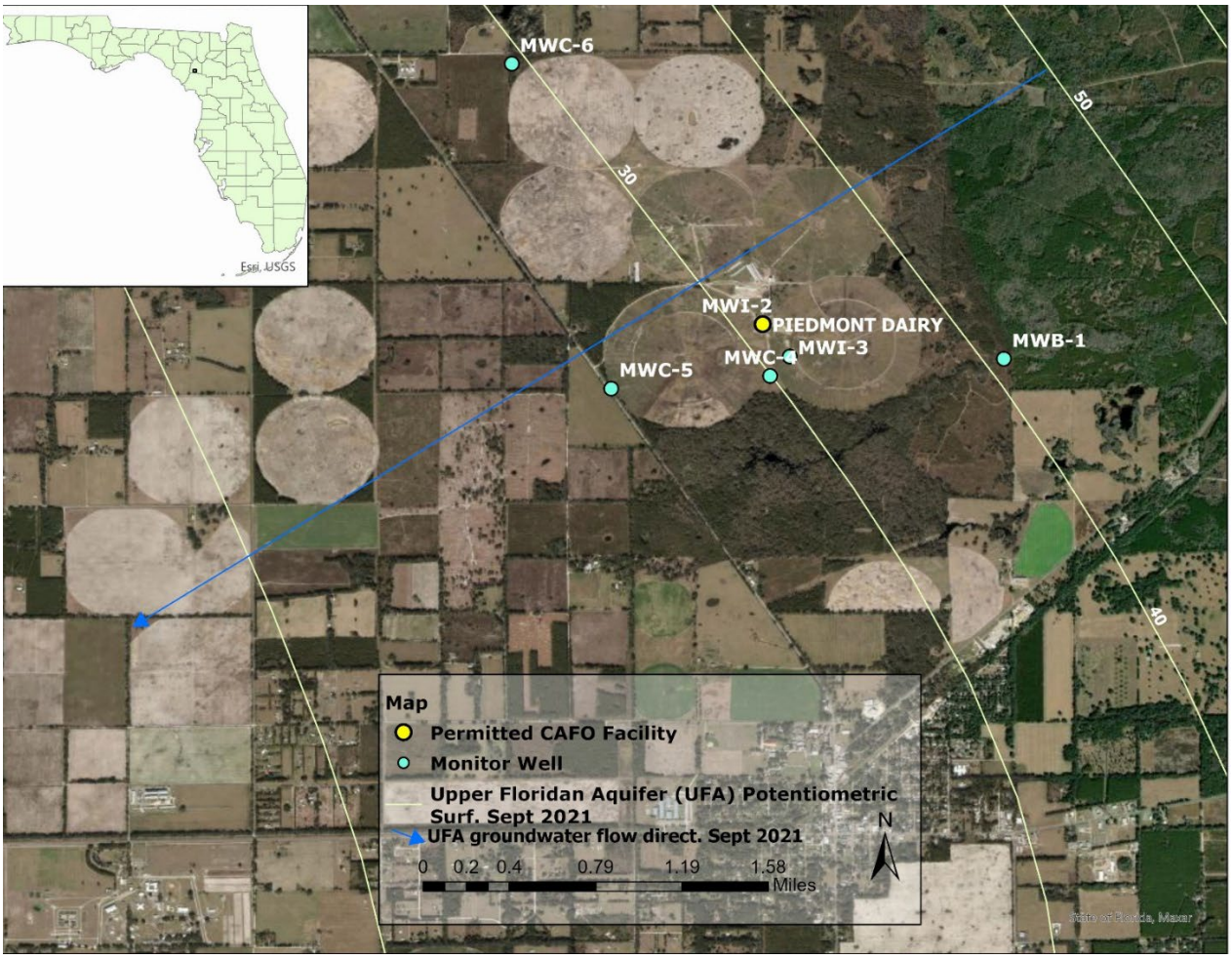

Figure I-2. Groundwater Contour Map of Upper Floridan Aquifer Potentiometric Surface at Piedmont Dairy, September 2021.

Table I-1. Piedmont Dairy Floridan Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	2.0	1.0	16.0	44.2	1.0	2420.0	3.7	1.0	142.0
Conductivity	UMHO/CM	230	230	230	727	727	727	614	548	662
Nitrite plus Nitrate, Total (as N)	mg/L	6.03	0.00	46.00	21.26	0.00	64.00	6.10	-3.00	61.40
pH	s.u.	7.03	0.00	9.99	7.20	6.11	8.17	7.19	6.29	8.00
Phosphate, Ortho (as P)	mg/L	0.360	0.010	1.700	0.172	0.010	0.690	0.363	0.010	4.870
Water Level Relative to NGVD	ft-NGVD	43.32	4.04	52.90	19.26	12.09	33.69	15.00	5.49	40.40

Groundwater Nitrate Concentration and Trends

Concentrations of NOx-N in monitor wells have been below 10 mg-N/L for the period of record except for MWI-3 which had exceedances in most of the years sampled except

2010 and 2011. Concentrations of NOx-N in background well MWB-1 were below other wells except for 2021 when all of the wells had spikes but none exceeding 10 mg-N/L. After a NOx-N detection of 9.8 mg-N/L in fourth quarter 2022 sampling round, MWI-3 was taken offline in January 2023. An email to FDEP dated December 19, 2022 stated that the well would be abandoned due to its location within the footprint of two proposed free stall barns. The email indicated that MWI-3 would not be replaced because there was already an intermediate well (MWI-2) within the sprayfields.

Figure I-3 shows the locations of current monitor wells as shown in the 2024 permit. Monitor well MWI-2 is mislocated in Figures I-1 and I-2 above.

Groundwater Consumption

The Piedmont Dairy in Gilchrist County has 13 permitted FAS wells. The total permitted withdrawal is 1.800 MGD with 1.257 MGD to irrigate 1,109 ac of crops and 0.542 MGD to water 2,242 dairy cows.

Adjacent Potable Water Wells

Figure I-5 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the Piedmont Dairy. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

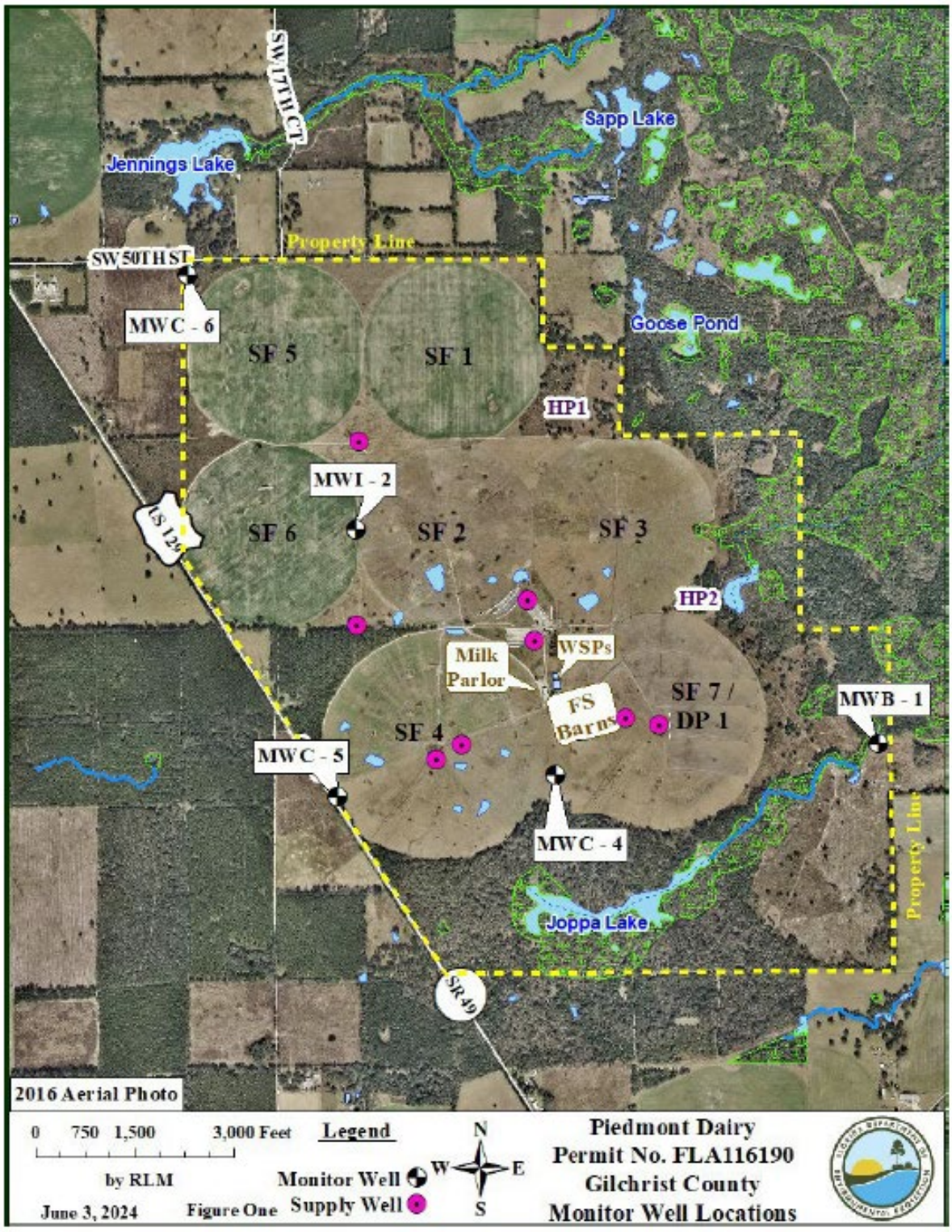

Figure I-3. Figure from 2024 Permit Showing Correct Location For MWI-2.

Table I-2. Annual Average NOx-N Concentrations in FAS Monitoring Wells at the Piedmont Dairy, Gilchrist County.

PIEDMONT DAIRY							
Year	**MWB-1**	**MWC-2**	**MWC-4**	**MWC-5**	**MWC-6**	**MWI-2**	**MWI-3**
2004		0.71	6	4.7			29
2005		1.38	6.7	1.8			26
2006	0.02	0.59	3.28	2.63			18.67
2007	0.01	1.08					
2008	0.02	0.21		3.69			
2009	0.92	0.35	1.33	1.77			19.25
2010	0.01	0.52	0.08	3.63			2.23
2011	0.04	0.7	0.6	3			4.86
2012	0.02	1.29	0.22	5.52			28.04
2013	0.01	1.65	1.82	9.41			18.53
2014	0.01	3.73	3.4	8.32			41
2015	1.11	3.43	3.53	3.08			37.25
2016	0.01	1.8	3.45	3.78			33
2017	0.54	3.75	4.95	3.53	0.03		30.5
2018	0.05	4.58	3.23	7.18	2.77		27.6
2019	0.9	5.6	4.33	3.08	0.69	3.2	39.75
2020	0.7		3.25	2.75	0.7	3.2	27.75
2021	6.31		2.19	5.78	4.99	8.48	16.1
2022	1.65		4.16	1.81	1.26	4.23	21.1
2023	0.2		4.95	1.32	0.2	3.58	
AVERAGE	0.696111	1.960625	3.192778	4.041053	1.52	4.538	24.74294

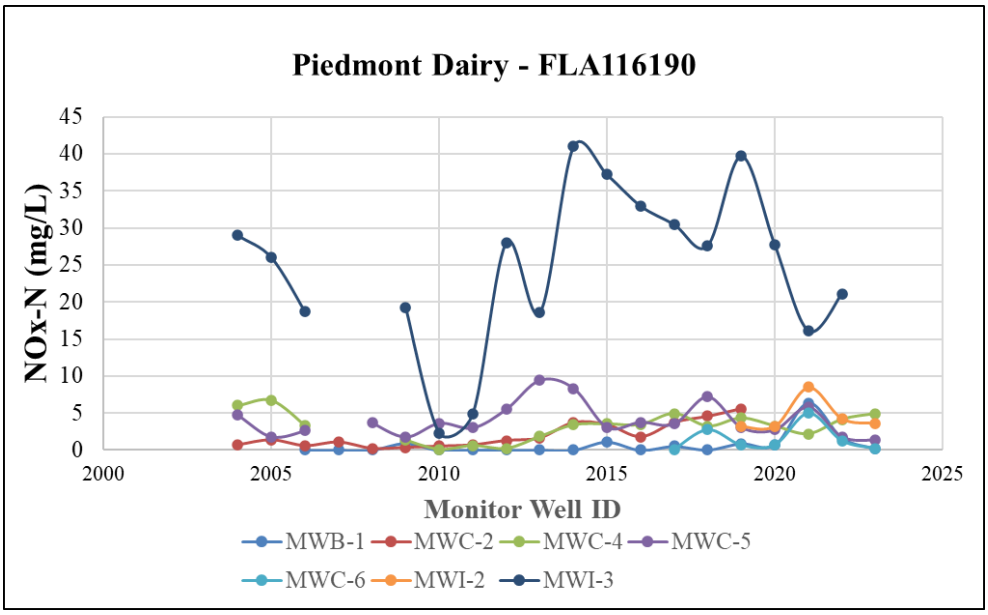

Figure I-4. Groundwater Nitrate (NOx-N) Concentration Time Series, Piedmont Dairy, Gilchrist County.

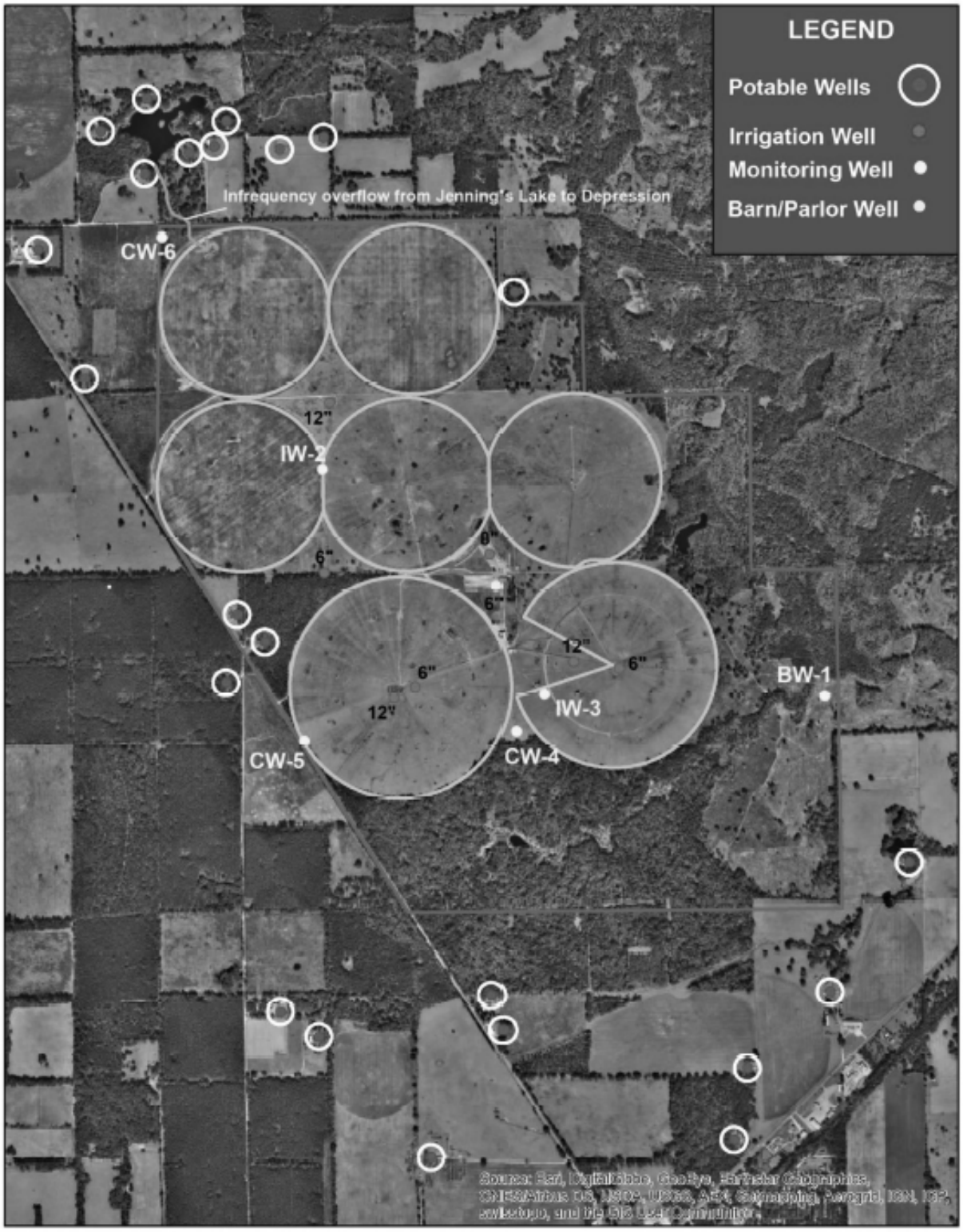

Figure I-5. Domestic Self-Supply Potable Wells in the Vicinity of the Piedmont Dairy, Gilchrist County.

Appendix J: Shenandoah Dairy FLA362778, Suwanee County

Description

Shenandoah Dairy is an existing dairy facility located at 16540 68th Place in Live Oak, Florida in Suwanee County. First permitted in 2006, the Shenandoah Dairy currently handles 4,200 mature cows (3,500 lactating and 700 dry cows), 1,950 heifers, and 20 bulls.

The existing facility structures include four tunnel-ventilated free stall barns, three open ventilated free stall barns, one heifer feed barn and two milking parlors. The latest permit application states that three additional free stall barns will be constructed. After the completion of the additional construction, the dairy facility will consist of seven tunnel-shaped, ventilated free stall barns, three open ventilated free stall barns, one heifer feed barn and two milking parlors.

Upon completion and placing the new construction into service, the herd size was planned to be increased to a maximum annual average of 5,000 lactating cows, 440 springer cows, 440 dry cows, 1,950 heifers, and 20 bulls will be housed in the total confinement free stall barns. The remaining animals on the farm consisting of 2,050 heifers and 20 bulls are grazed on pastures that do not contribute to the waste management system. Manure in the free stall barns and new concrete feed faces will be flushed and directed to the wastewater treatment system. The milking parlor flush and clean up wastewater is also directed to the treatment system.

Groundwater Monitoring

Shenandoah Dairy is located in the Branford Karst Plain geomorphologic province of north Florida. The current groundwater monitoring network at the Shenandoah Dairy consists of eight wells screened in the Upper Floridan Aquifer (Figure J-1):

- One Background well – MWB-5
- Two Intermediate wells – MWI-2 and MWI-3
- Five Compliance wells – MWC-1, MWC-6, MWC-7, MWC-8 and MWC-9

Monitor wells MWC-1 through MWC-7 were installed in 2004. Background wells MWB-4 and MWB-5 were both sampled until September 2022 when sampling was discontinued in MWB-4. The 2022 permit indicated that MWB-4 would be abandoned. Monitor well MWI-2 was a compliance well (MWC-2) until it was renamed in the 2022 permit. Monitor well MWC-8 was installed in 2018 and MWC-9 was installed in 2024 (after data for this study was acquired from FDEP). The monitor wells are 59 to 80 feet deep.

Based on groundwater elevation contours of the potentiometric surface of the Upper Floridan Aquifer in September 2021 (Figure J-2) and groundwater elevation data collected at the dairy in September 2021, a groundwater trough is present in the vicinity

of Shenandoah Dairy. Depending on the position of the axis of the trough, groundwater flow directions in the Upper Floridan Aquifer at Shenandoah Dairy may vary but are generally to the south toward the Suwanee River. Based on the gradient direction, background well MWB-5 (and former background well MWB-4) are sited downgradient to cross-gradient of the dairy and do not represent background conditions.

Figure J-1. Locations of Monitor Wells, Shenandoah Dairy.

Figure J-2. Groundwater Elevation Contours of the Potentiometric Surface of the Upper Floridan Aquifer Near Shenandoah Diary in September 2021.

Groundwater General Water Quality

Table J-1 presents a summary of reported groundwater monitoring data for the period-of-record from September 2001 through September 2016. Background and intermediate well data indicate significant nitrate contamination. The compliance well also has elevated nitrates at a much lower concentration. The pH values are missing for the compliance wells and otherwise not conclusive of pollution.

Groundwater Nitrate Concentration and Trends

MWI-2 (formerly MWC-2) was renamed as an intermediate well in the 2022 permit, most likely due to increasing concentrations of NOx-N with exceedances since 2014. The permit specifies that MWB-4 be abandoned within 90 days of the permit's effective date. However, if not yet abandoned, it is recommended monitor well MWB-4 be kept and

renamed as a downgradient compliance well. The 2022 permit also specifies that within 30 days of the permit's effective date, a 100-foot buffer will be established around MWB-5 to prevent cattle access and other activities that may bias groundwater quality assessment. Because of the groundwater flow trough, MWC-8 may be better designated as an upgradient background well but the best location for monitoring background groundwater would be an upgradient well sited north of the dairy.

Table J-1. Shenandoah Dairy Floridan Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	4.2	1.0	151.0	4.5	1.0	58.0	25.4	1.0	2420.0
Nitrite plus Nitrate, Total (as N)	mg/L	27.20	4.27	83.00	33.78	2.50	52.00	5.74	0.00	35.00
pH	s.u.	7.46	7.30	7.59	7.04	7.01	7.10			
Phosphate, Ortho (as P)	mg/L	0.075	0.037	0.113	0.073	0.059	0.100	0.038	0.002	0.100
Water Level Relative to NGVD	ft-NGVD	50.40	32.82	62.74	53.82	32.68	65.55	47.04	30.23	64.90

Due to their downgradient/cross gradient locations, both background wells MWB-4 and MWB-5 have exhibited NOx-N concentrations exceeding 10 mg-N/L beginning in 2013 during the period-of-record. Compliance well MWC-2 had exceedances during the period-of-record was converted to an intermediate well, MWI-2, in the 2022 permit. Sampling of compliance well MWC-4 (not shown on map) was discontinued in 2012 after NOx-N exceedances in nearly all years.

Groundwater Consumption

The Shenandoah Dairy in Suwannee County has 30 permitted FAS wells. The total permitted withdrawal is 3.97 MGD with 3.22 MGD to irrigate 2,205 ac of crops and 0.75 MGD to water 5,000 dairy cows.

Table J-2. Annual Average FAS Nitrate (NOx-N) Concentrations at the Shenandoah Dairy, Suwanee County.

Shenandoah Dairy									
Year	**MWB-4**	**MWB-5**	**MWC-1**	**MWC-2**	**MWC-4**	**MWC-6**	**MWC-7**	**MWC-8**	**MWI-3**
2006		6.19	0.23	7.36	12.49				31.86
2007		8.02	0.09	5.2	9.67				31.03
2008		7.37	0.22	6.39	15.93				36.77
2009		6.29	0.33	4.76	18.88	0.22			37.13
2010		10.03	0.35	5.87	24.63	0.17	1.42		35.5
2011	18.27	8.45	0.24	3.59	21.7	0.43	1.25		32.63
2012	27.5	18.3	0.5	5.73		0.22	3.26		28.63
2013	23.25	21	2.4	8.93		0.81	3.63		34.25
2014	23	20	3.35	10.13		0.98	2.92		35.75
2015	24.25	22.75	3.43	15.75		0.49	2.58		31.25
2016	27	24	2.7	8.7		0.35	2.28		35.5
2017	29.25	24.5	2.88	11.45		0.55	2.15		32.5
2018	30.18	27.83	4.45	11.45		1.89	3.8	0.21	35.03
2019	47.03	29.08	5.05	14.55		2.37	3.21	4.19	34.99
2020	51.8	32.73	2.33	18.52		3.53	7.01	5.5	38.45
2021	49.8	20.4	2.79	18.13		5.54	9.62	4.97	29.9
2022	68.6	24	1.91	17.96		5.09	7.35	5.96	36.3
AVERAGE	34.99	18.29	1.96	10.26	17.22	1.62	3.88	4.17	33.97

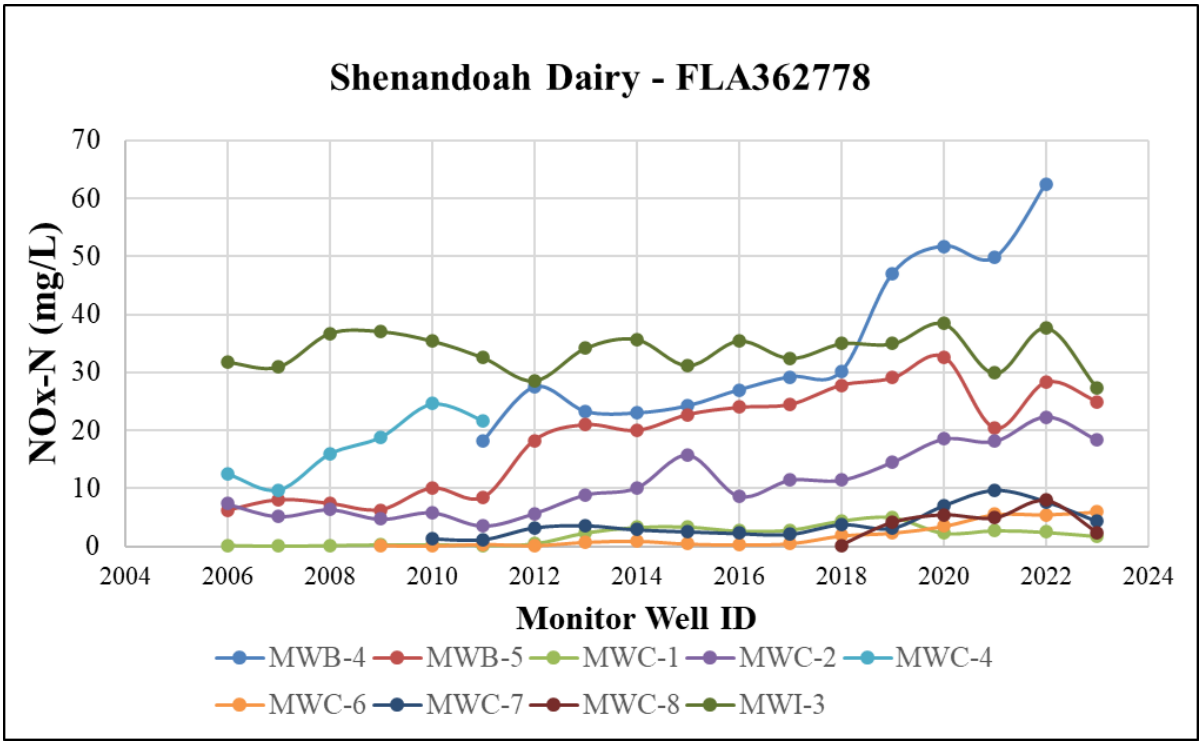

Figure J-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Shenandoah Dairy.

Appendix K: Southern Cross Dairy FLA470031, Suwanee County

Description

Southern Cross Dairy LLC, located at 20078 137th Road in O'Brien, Suwanee County, Florida, is a vegetable-forage-cattle production and dairy farm encompassing approximately 7,500 acres. The facility also has a total confinement beef cattle operation with a maximum herd size of 5,000 cows (annual average of 4,521) and allows for an expansion to add a new total confinement dairy operation with a maximum herd size of 2,800 mature dairy cows (2,400 lactating and 400 dry cows and springers). An annual average of 700 of the beef cattle and an additional 1,550 dairy heifers are rotationally grazed on specified sprayfields under various sprayfield pivots and pivot corners, plus an additional 700 to 825 young heifers and calves kept in pens and rotated within the sprayfield pivot corners (grass and pine trees). From this operation, of the total animals, offsite fields have approximately 225 calves, 965 heifers and 90 beef cattle on annual average.

The beef cattle facility consists of five total confinement concrete lined barns, a bunker silo, two covered commodity barns, a covered bedding\solids storage building, seven concrete-lined holding pens, a stormwater retention basin, a 2.5-million gallon methane digester (with a 600-KW power generating system), screw presses, 0.47-million gallon concrete solids settling tank, and a 1.7-million gallon (0.6 acre) polymer-lined wastewater storage pond. The dairy facility consists of five free stall total confinement barns (the 2025 permit indicates five additional free stall barns are planned), milk center/parlor, travel lane, sand lane and storage area, collection pit from which wastewater is pumped to the methane digester and an expanded commodities area. Both the dairy wastewater and manure from the beef facility go through the methane digester and then to the existing solids settling tank and wastewater storage pond described above.

Groundwater Monitoring

The facility is located in the Branford Karst Plain geomorphologic province of north Florida. The current groundwater monitoring network at the dairy consists of ten wells screened in the Floridan Aquifer (Figure K-1):

- Two Background wells– MWB-1 and MWB-2
- Three Intermediate wells – MWI-2, MWI-3, MWP-9 and MWI-10
- Four Compliance wells – MWC-4, MWC-6, MWC-7 and MWC-8

The monitor wells range in depth from 40 to 69 feet. The current monitor well locations are shown in Figure K-1.

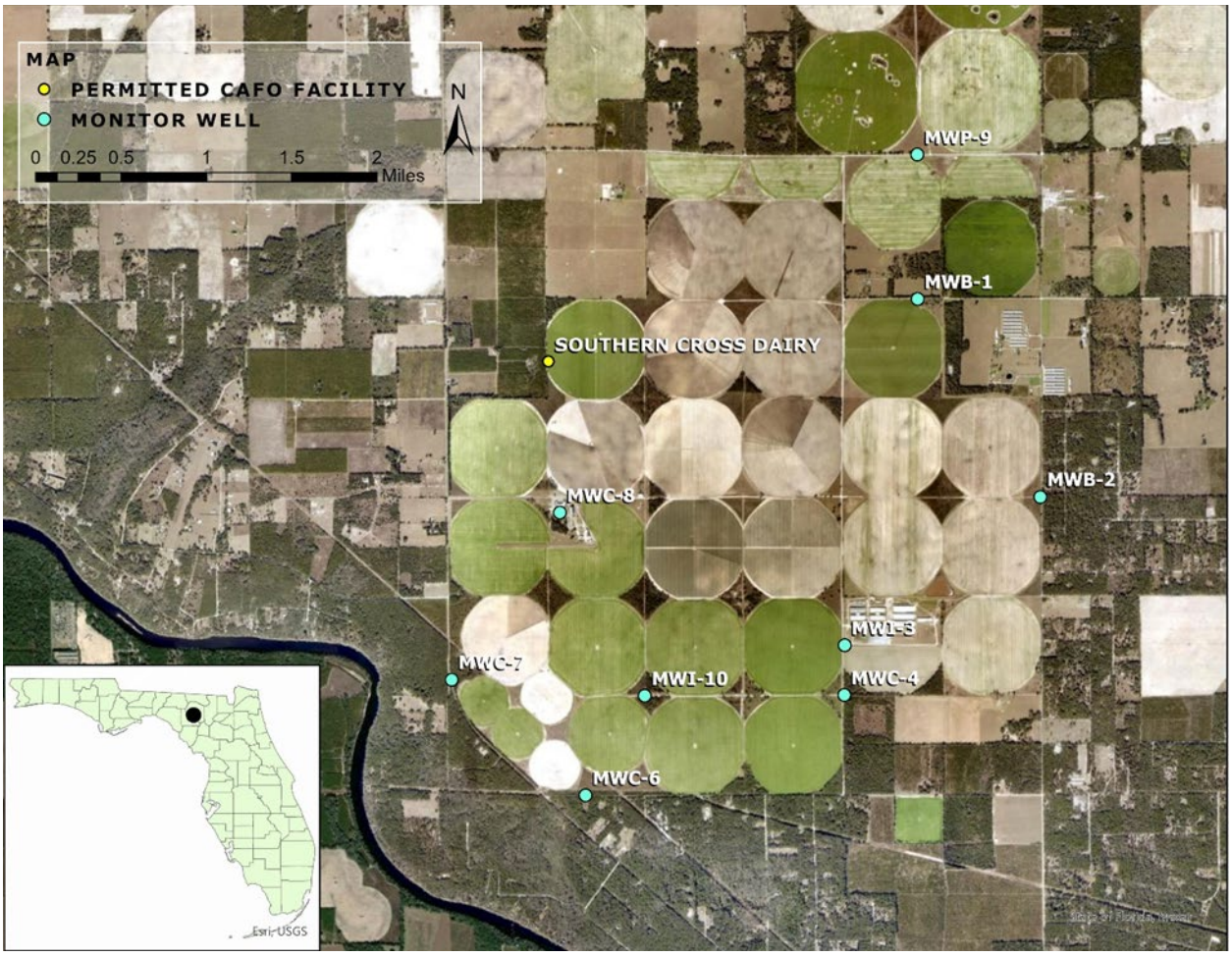

Figure K-1. Locations of Monitor Wells, Southern Cross Dairy, Suwannee County.

Sampling of former monitor well MWI-5 ceased in 2014 following NOx-N detections ranging from 22.5 to 29.28 mg-N/L during monitoring. In 2017, MWI-5 was replaced by MWI-10 installed in approximately the same location but 6.5 feet deeper than MWI-5 which was 40 feet deep. Concentrations of Nox-N in MWI-10 have ranged from 11.67 to 14.83 mg-N/L since monitoring began in 2017.

Former monitoring well MW-9, installed in 2016, was not given a location reference designation but was referred to as an observation well. The 2020 permit indicates that MW-9 would continue to be used for water levels and NOx-N analysis only. For the June 2020 sampling round the name of the well was changed to MWP-9 (P designating piezometer). Water level data was collected through 2022, but NOx-N analysis appears to have ended in 2020. Detected NOx-N concentrations were all below 1 mg-N/L.

Based on the potentiometric surface of the upper Floridan Aquifer in September 2021, the groundwater flow direction is to the south-southwest (Figure K-2) at Southern Cross

Dairy, toward the Suwannee River. Groundwater elevation data collected in monitor wells at the dairy in 2021 confirm this flow direction.

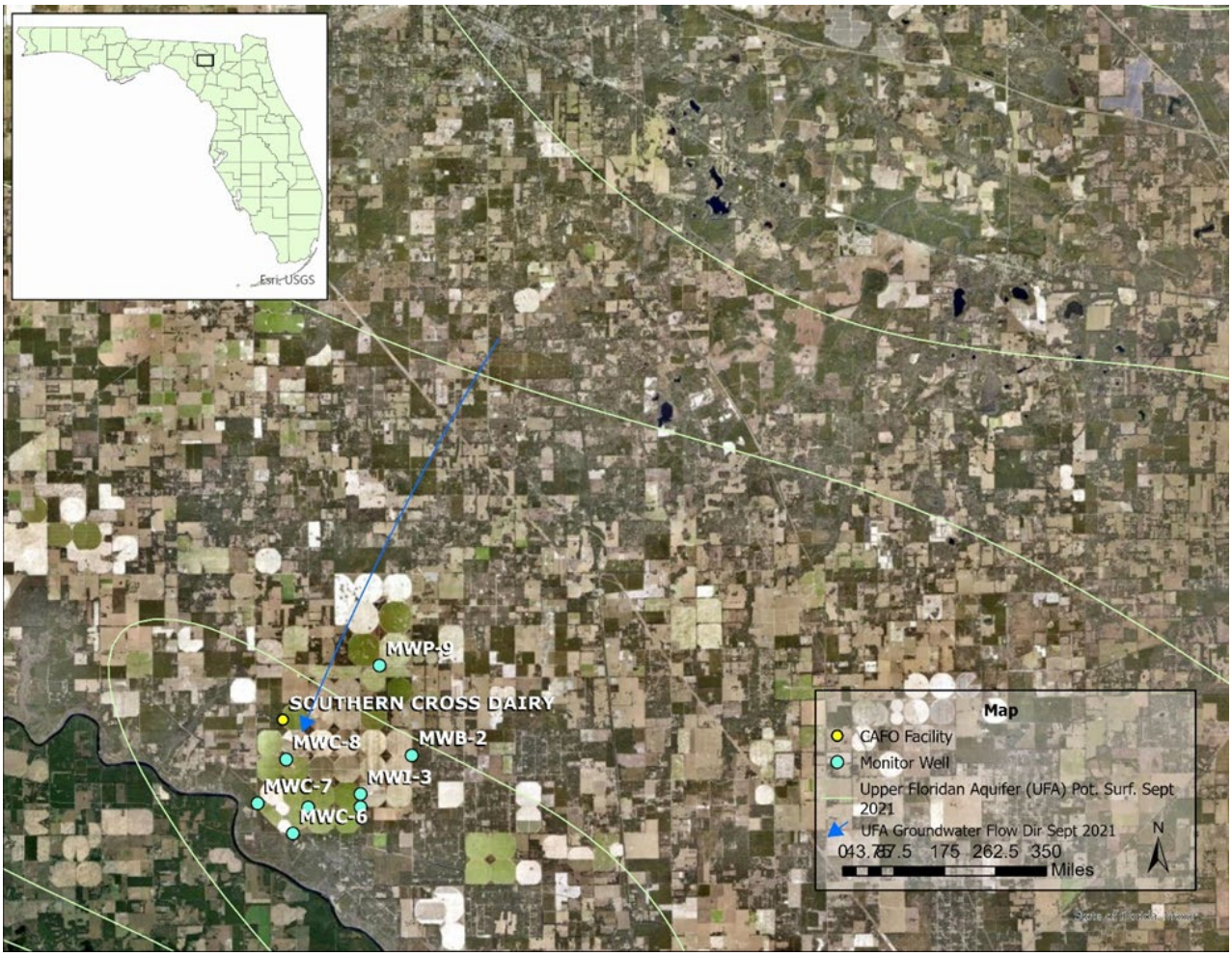

Figure K-2. Potentiometric Surface of the Upper Floridan Aquifer at Southern Cross Dairy, Sept. 2021.

Groundwater General Water Quality

Table K-1 presents a summary of reported groundwater monitoring data for the period-of-record from June 2016 through June 2023. Background well data indicate significant nitrate contamination. The compliance well also has elevated nitrates at a slightly lower concentration. The pH values are generally higher than normal for the FAS.

Table K-1. Southern Cross Dairy Floridan Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	1.6	1.0	12.0	22.4	0.0	1110.0	1.8	1.0	10.0
Nitrite plus Nitrate, Total (as N)	mg/L	10.10	0.90	26.00	15.47	0.99	44.00	8.75	0.20	24.00
pH	s.u.	7.59	6.73	9.08	7.54	6.40	8.66			
Phosphate, Ortho (as P)	mg/L	0.032	0.003	0.190	0.044	0.000	0.417	0.041	0.008	0.294
Water Level Relative to NGVD	ft-NGVD	23.63	17.96	33.20	20.62	9.18	33.80	18.86	11.20	29.90

Groundwater Nitrate Trends

Table K-2 and Figure K-3 provide a summary of annual average monitor well NOx-N concentrations. The two background wells plus MWP-9 are upgradient of the dairy. Both background wells but especially MWB-2 have had exceedances of NOx-N which suggests an upgradient source(s). The two intermediate wells and four compliance wells are correctly sited downgradient of the facility.

Compliance wells MWC-6 and MWC-8 had exceedances throughout the period of record, but both averaged exactly 10 mg-N/L from 2020 to 2023.

Groundwater Consumption

The Southern Cross Dairy in Suwannee County has six permitted FAS wells. The total permitted withdrawal is 1.502 MGD with 0.425 MGD to irrigate 203 ac of crops and 1.077 MGD to water 8,400 dairy cows.

Table K-2. Annual Average FAS Groundwater Nitrate (NOx-N) Concentrations at the Southern Cross Dairy, Suwannee County.

Southern Cross Dairy LLC										
Year	MWB-1	MWB-2	MWC-4	MWC-6	MWC-7	MWC-8	MWI-3	MWI-5	MWI-10	MW-9
2007	3.69	5.32	21.63	10.93	1.06		38.88	28.27		
2008	0.46	0.65	14.71	5.7	0.89		52.4	23.39		
2009	7.21	5.91	16.18	10	1.6		34.5	29.28		
2010	6.33	39.33	15.65	9.7	1.64		24.35	21.63		
2011	6.98	2.59	15.5	10.58	5.6		11.58	24.58		
2012	13.4	7.68	18	11.3	1.05		21.8	26.67		
2013	6.6	6.9	13.03	9.63	2.17		42.03	23.67		
2014	8.75	10.23	21.75	12.1	1.8		38.75	22.5		
2015	10.15	11.5	17	8.5	1.69		35			
2016	6.25	10.68	23	11.28	2.27	15.75	34.75			0.28
2017	14.15	10.73	21.75	10.7	2.35	13	17.25		11.67	0.03
2018	7.63	9.1	18.25	11.7	2.55	11.63	13.98		11.75	0.73
2019	8.55	9.25	3.65	10.75	3.53	9.75	16.9		13.75	0.78
2020	14.93	11.83	7.35	10	1.6	10	13.67		12.25	0.88
2021	7.85	11.92	7.54	10	1.79	10	21.05		14.55	
2022	6.41	10.9	2.78	10	2.66	10	12.04		14.83	
2023	8.37	14	0.2	10	4.13	10	5.18		13.55	
AVERAGE	8.100588	10.50118	13.99824	10.16882	2.257647	11.26625	25.53588	24.99875	13.19286	0.54

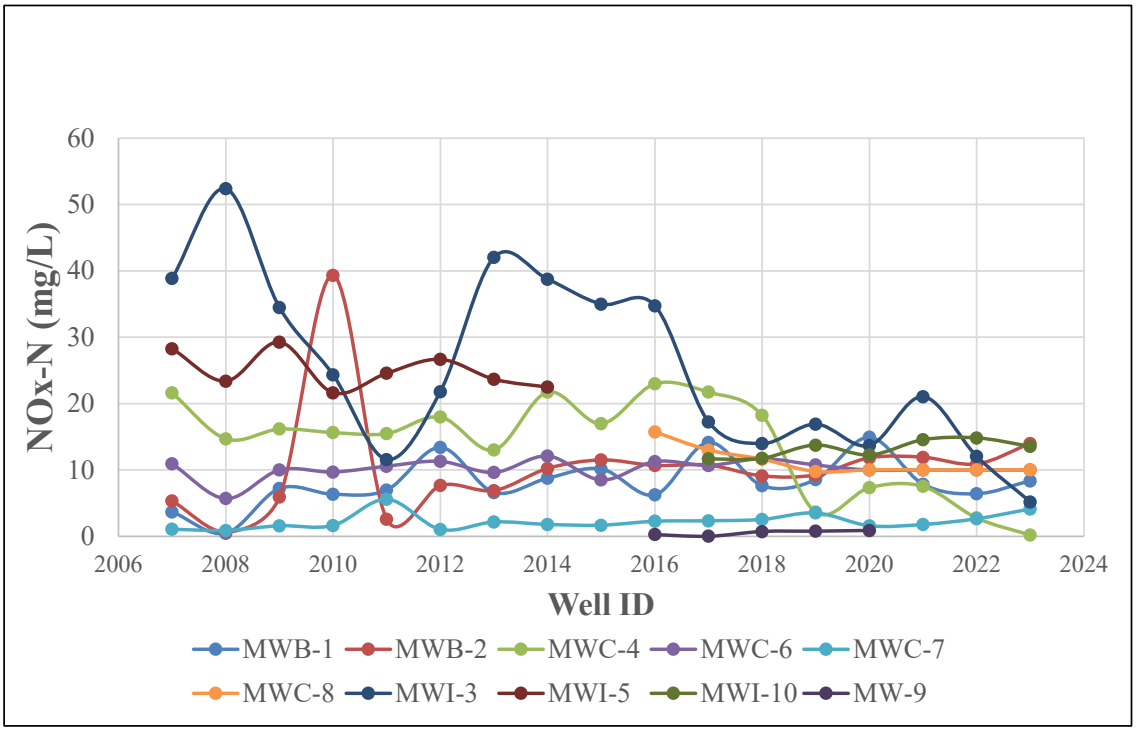

Figure K-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Southern Cross Dairy, Suwannee County.

Appendix L: Southpoint Dairy FLA285374, Levy County

Description

The Southpoint Dairy is in Levy County at 4951 NW 170th Street in Trenton, Florida. Southpoint Dairy operates 1,090 acres along County Road 330 about six miles southwest of Chiefland.

Beginning in 1987, the property was the location of Levy County Dairy which was first permitted in 2005. All of the previous dairy facilities were removed prior to establishment of Southpoint Dairy except for a maintenance area and a small commodity barn. The next permit issued was in 2011 for Southpoint Dairy.

Southpoint Dairy is an existing permitted dairy farm operation operating as a rotationally-grazed dairy with a herd size of 2,469 mature dairy cows (maximum annual average), 1,197 dairy heifers/calves, and 37 bulls. The most recent permit application states that the facility is changing the breed of dairy cows that they are using to a smaller cow. This will increase their cow numbers, but the facility will remain in nutrient balance. The dairy will also be adding an 80-acre pasture that will have a 64-acre half pivot installed on it for irrigation with fresh water.

The wastewater treatment system is designed to be a rotational grazed, low intensity management system. The average nitrogen loading rates for the pastures shall not exceed 516 pounds-N/acre/year for irrigated pastures, 406 pounds-N/acre/year for partially irrigated pastures, and 265 pounds-N/acre/year for non-irrigated pastures. Wastewater will be collected from the milk/feed center and will gravity flow to a collection sump with an off-line overflow pond. Wastewater collected in this pond will be applied to an 87-acre sprayfield. All non-contact stormwater will be collected and treated separately from the wastewater treatment system.

Groundwater Monitoring

Southpoint Dairy is in the Chiefland Karst Plain geomorphologic province along Florida's Nature Coast. Bedrock (Ocala Limestone) was encountered at depths of 4 to 24 feet below the ground surface in borings drilled for monitor wells on the dairy property.

A 1992 letter from the Florida Department of Environmental Regulation (pre-FDEP) indicated that there were residential wells adjacent to the Levy County Dairy that had NOx-N levels exceeding 10 mg-N/L. At that time, filters were provided to homes that had exceedances. In 1993, seven monitor wells (MW-1 through MW-7) were installed at the Levy County Dairy to determine the source of contamination in private wells adjacent to the dairy. Potable private wells on the Southpoint Dairy property sampled in 2004 contained NOx-N concentrations up to 62 mg-N/L.

In the 2005 permit, monitor wells MW-1, MW-5 and MW-6 were renamed as a background and two compliance wells respectively for Southpoint Dairy which is also when compliance wells MWC-8 and MWC-9 were installed. The 2005 permit also

specified sampling of two potable wells on the dairy property, MWI-2 and MWI-5. An additional compliance well, MWC-10, was installed in 2008. Monitor wells MW-4 and MW-7 were renamed as background wells in the 2010 permit.

Former Levy County Dairy monitor well MW-3 was never included in groundwater monitoring of the Southpoint Dairy, and no historical analytical data is available for the well.

The current groundwater monitoring network at Southpoint Dairy consists of eight wells screened in the Upper Floridan Aquifer:

- Three Background wells – MWB-1, MWB-6 and MWB-7
- One Intermediate well – MWI-2
- Four Compliance wells – MWC-6, MWC-8, MWC-9 and MWC-10

All the monitor wells are 30 feet deep (except MWC-10 which is 33 feet deep) and completed with 20-foot-long screens. Two wells where bedrock was encountered deeper (24 feet in MWC-8 and 16 feet in MWC-10) are partially screened in overlying clay and sand which may affect the accuracy of water level elevations and analytical data. The current monitor well locations are shown in Figure L-1.

Sampling of monitor well MWI-5 was omitted in the 2019 permit and sampling was discontinued in mid-2020 when NOx-N levels were increasing to above 15 mg-N/L (Table L-1).

Monitor well MWC-9, installed adjacent to MWI-5, had elevated concentrations of NOx-N similar to those detected in MWI-5 prior to its monitoring being discontinued.

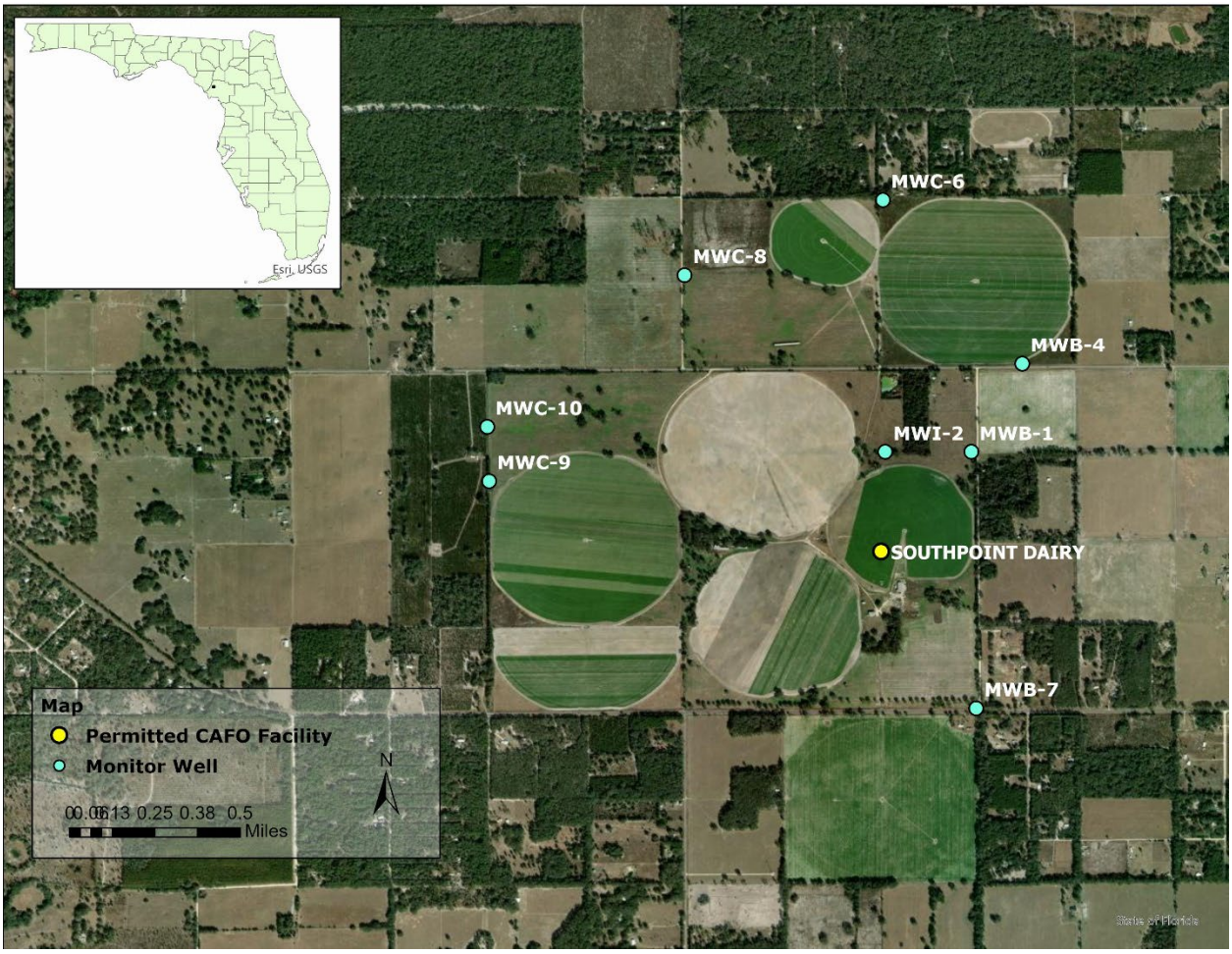

Figure L-1. Locations of Monitor Wells, Southpoint Dairy.

A potentiometric surface map of the Upper Floridan Aquifer in September 2021 near Southpoint Dairy (Figure L-2) indicates that the flow direction at Southpoint Dairy is to the west toward the Suwanee River. Groundwater elevation contours for the Upper Floridan Aquifer in September 2017 also demonstrate a westward flow direction. Based on the groundwater elevation contours, the three background wells at Southpoint Dairy are sited upgradient of the dairy and pivot fields. Intermediate well MWI-2 may be sited too close to the background wells to be accurately representative of conditions downgradient from the site and within the zone-of-discharge. The compliance wells are correctly sited at the downgradient zone of discharge.

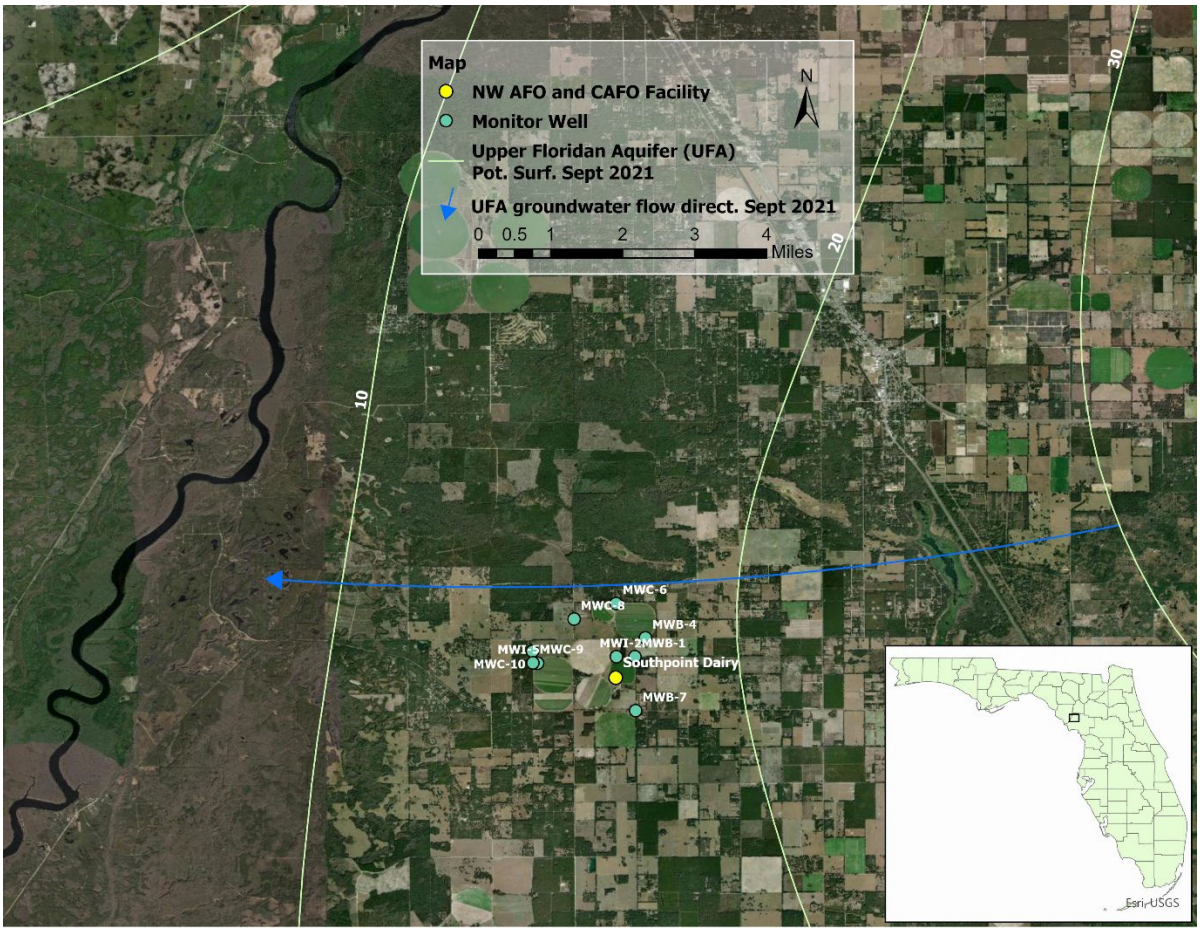

Figure L-2 Groundwater Contour Map of Upper Floridan Aquifer Potentiometric Surface at Southpoint Dairy, September 2021.

Groundwater General Water Quality

Table L-1 presents a summary of reported groundwater monitoring data for the period-of-record from September 2001 through September 2016. Background well data indicate relatively low nitrate and typical pH levels. Nitrogen concentrations are elevated at the intermediate wells and progressively lower in the compliance wells. pH is very high in the downgradient compliance wells, possibly indicating release of unidentified basic chemicals in the groundwater flow path. Water levels relative to NGVD indicate that the background wells are upgradient of other wells and the compliance wells are downgradient of other wells.

Table L-1. Southpoint Dairy Floridan Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	2.4	1.0	10.0	1.8	0.0	4.0	2.2	1.0	16.0
Nitrite plus Nitrate, Total (as N)	mg/L	2.27	0.01	14.60	9.34	0.20	51.00	6.42	0.20	25.00
pH	s.u.	7.64	6.12	11.06	7.55	6.43	8.40	10.16	7.92	12.27
Phosphate, Ortho (as P)	mg/L	0.015	0.000	0.090	0.014	0.002	0.040	0.020	0.000	0.240
Water Level Relative to NGVD	ft-NGVD	12.98	1.77	22.18	12.80	6.76	21.06	12.33	5.93	20.88

Groundwater Nitrate Concentration and Trends

Sampling of intermediate monitor well MWI-5 was discontinued in 2020 after NOx-N exceedances. The MWI-5 nitrate results were 20 mg-N/L, 14 mg-N/L and 18 mg-N/L, respectively during the last three quarters. The location of MWI-5 indicates that it should have been a compliance well.

All the current compliance monitor wells are sited at the property boundaries in downgradient locations. An additional compliance well is recommended in the southwest corner of the dairy property.

Consent Order (CO) 10-1986 issued on October 28, 2010, specified that the previous wastewater permit for the Southpoint Dairy issued in 2005 had expired in June 2010 and needed to be reissued. The dairy was fined for the lapse in permitting. A renewed permit was issued in November 2010.

CO 20-1140 issued on December 22, 2020, specified an interim compliance limit for NOx-N of 20 mg-N/L in monitor wells MWC-9 and MWC-10. The CO required that a compliance plan be submitted within 90 days of the CO that would detail the steps necessary to achieve compliance. Implementation of the plan was required within 30 days of plan approval. A compliance plan was submitted to FDEP on January 7, 2021 which included five proposed actions in an attempt to bring the wells into compliance.

Table L-2. Annual Average FAS Groundwater Nitrate (NOx-N) Concentrations at the Southpoint Dairy, Levy County.

Southpoint Dairy									
Year	MWB-1	MWB-4	MWB-7	MWC-6	MWC-8	MWC-9	MWI-2	MWI-5	MWC-10
2009	4.53	4.58	3.6	5.88	8.5	6.91	4.74	21.55	1.62
2010	0.5	2.29	3.48	8.1	7.07	4.55	6.9	14.1	2.62
2011	0.2	2.74	1.91	5.74	10.47	6.08	5.71	12.28	2.92
2012	1.74	1.84	1.82	3.93	3.73	5.74	2.71	7.95	3.13
2013	1.18	3.25	4.28	4.9	5.43	4.18	15.88	8	4.33
2014	0.42	1.62	3.58	4.83	3.63	4.75	18.25	5.3	2.72
2015	0.21	2.18	2.5	5.83	4.1	5.79	23.93	5.19	4.33
2016	0.13	2.7	1.53	7.59	4.18	6.01	14.59	6.11	8.01
2017	0.92	1.8	1.88	6.59	3.88	6.25	25.25	6.93	11.1
2018	3.82	3.08	1.66	8.78	1.51	9.75	5.85	7.03	11.15
2019	0.86	2.03	1.67	8.13	1.1	5.8	3.98	12.83	10.09
2020	1.07	3.68	0.7	6.78	0.83	14.74	3.03	16	11.97
2021	0.95	3	4.22	4.3	1.96	10.24	5.61		9.92
2022	0.28	3.19	4.3	5.6	2.36	8.3	2.54		6.21
2023	0.33	6.62	2.98	5.48	1.19	13.37	0.58		12.67
AVERAGE	1.142667	2.973333	2.674	6.164	3.996	7.497333	9.303333	10.2725	6.852667

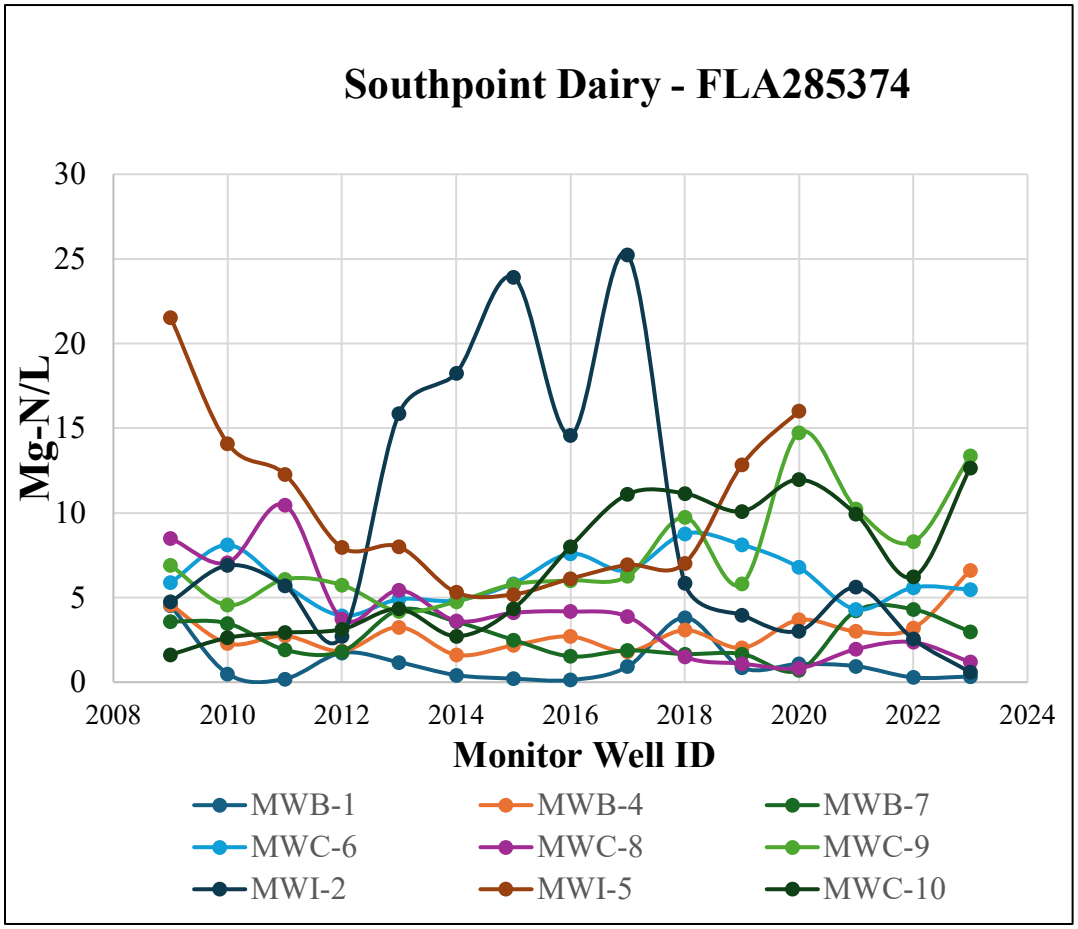

Figure L-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Southpoint Dairy.

Groundwater Consumption

The Southpoint Dairy in Levy County has 17 permitted FAS wells. The total permitted withdrawal is 1.511 MGD with 0.859 MGD to irrigate 754 ac of crops and 0.651 MGD to water 2,468 dairy cows.

Adjacent Potable Water Wells

Figure L-4 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the Southpoint Dairy. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

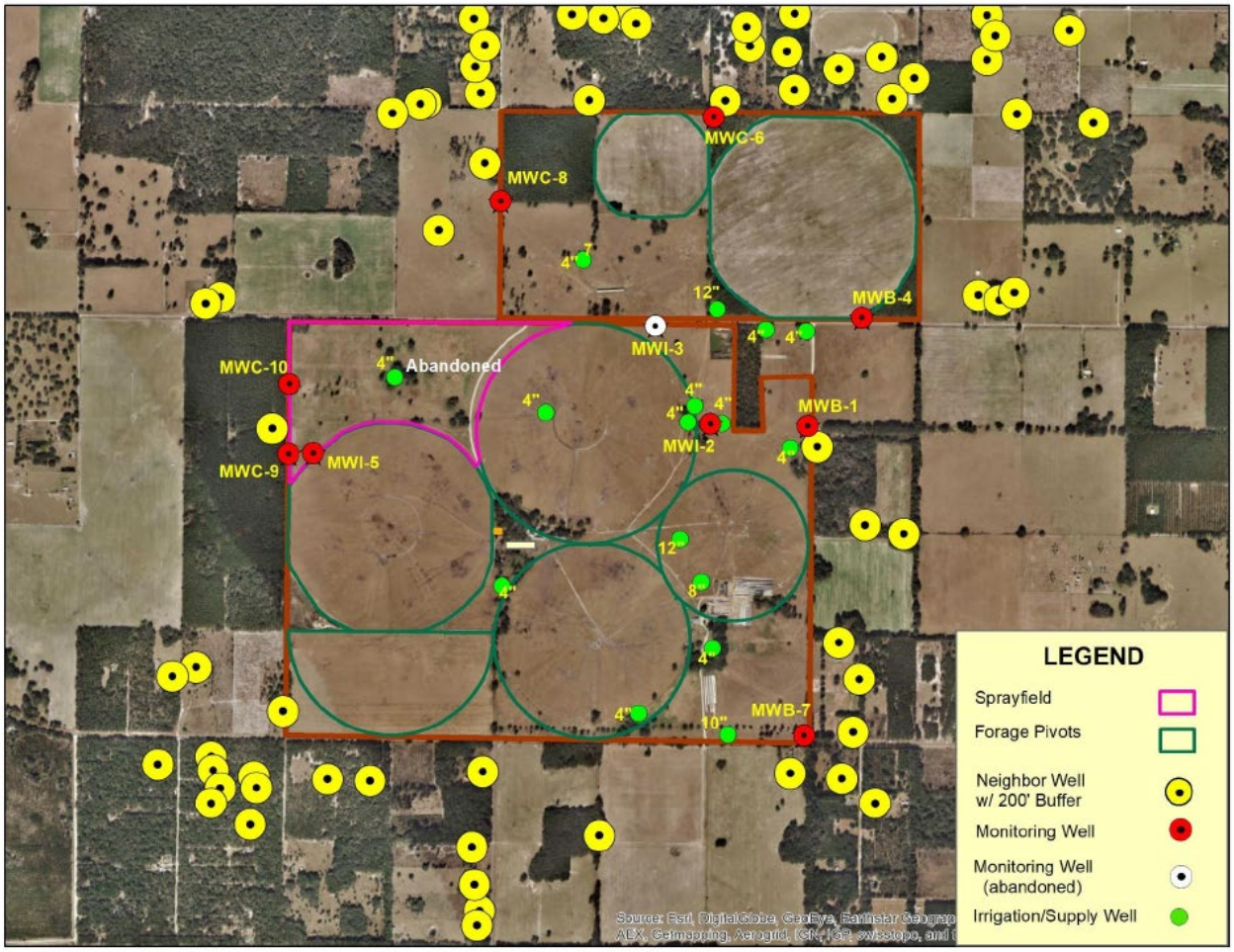

Figure L-4. Domestic Self-Supply Potable Wells in the Vicinity of the Southpoint Dairy, Levy County.

Appendix M: Walker and Sons Farms 1 FLA275026, Jefferson County

Description

Walker and Sons Farms 1 is located approximately 4 miles southwest of Monticello, Florida in the Tallahassee Hills geomorphologic province of north Florida. A former dairy was in operation in that location from the 1960s to 1988 when the Walkers bought the property. Walker and Sons Farms 1 was not permitted until 2009 after the definition of a confined animal feeding operation (CAFO) was changed to include any dairy with over 700 mature cattle (annual average).

The facility is currently an existing dairy farm operating as a rotationally grazed dairy with a current herd size of 1,250 mature dairy cows (maximum annual average), including 200 dry cows. The lactating cows are divided into seven herds: five healthy herds, a fresh herd, and a pot herd. The dry cows are divided into two herds. All milking herds are pastured about 70% of the time and the dry herds are pastured all the time. The production area consists of the waste storage pond, wastewater ditch and travel lane, milking barn, feed barn, cooling ponds and a covered commodities area. The products and materials stored in the commodities area have no contact with stormwater. Since the herds spend most of the time grazing on pastureland, most of the manure is deposited in pasture areas and only approximately 29% enters the waste management system.

A Nutrient Management Plan (NMP), based on agronomic rates for nitrogen, was developed for this facility. The design is based on an average total process wastewater volume of 32,252 gallons per day, a 10.5-acre production area, a 5.2-acre waste storage pond and a 79-acre spray irrigation area. The waste management system is designed to contain a 25-year, 24-hour storm event. Waste is flushed from the milking barn and feed barn and the wastewater gravity flows into a static pit separator; then via a clay lined ditch to the wastewater storage pond. Wastewater is pumped from the wastewater storage pond to the sprayfield for crop uptake. Clean water from roof run-off from the milking barn is guttered into the barn and flows into the wastewater management system; roof run-off from the commodities area is diverted onto surrounding grassland and away from the waste collection system.

Groundwater Monitoring

The current groundwater monitoring network at Walker and Sons Farms 1 consists of three wells screened in the Surficial Aquifer:

- One Background well – MWB-1
- One Intermediate well – MWI-2
- One Compliance well – MWC-3

The monitor well locations are shown in Figure M-1. Depths of the monitor wells ranged from 128 to 157 feet below the ground surface, however boring logs for the monitor wells were not available to confirm lithologies and corresponding hydrogeologic zones of the screened intervals. Permits for the dairy indicate that the monitor wells are screened in the Surficial Aquifer.

The top of the Floridan Aquifer system at the dairy is approximately at sea level (Williams and Kuniansky, 2016); the monitor wells are screened approximately 35 feet above sea level in the Surficial Aquifer.

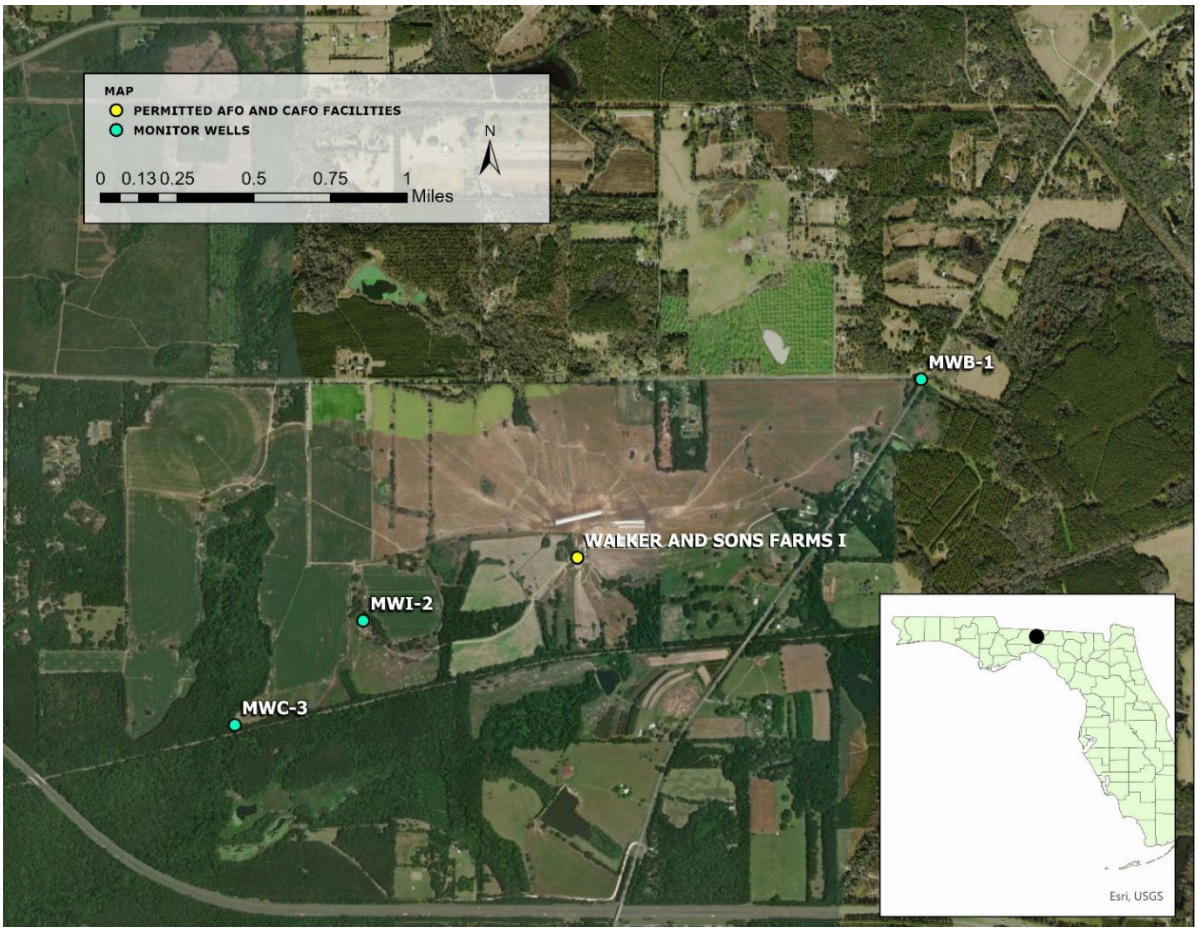

Figure M-1. Locations of Monitor Wells, Walker and Sons Farms 1, Jefferson County.

Potentiometric surface contours of the Floridan Aquifer in September 2021 are shown in Figure M-2. The groundwater flow direction in the Floridan Aquifer is to the southwest, toward the Gulf of Mexico. Potentiometric contours of the Floridan Aquifer in September 2017 confirm this flow direction. The flow direction in the Surficial Aquifer based on groundwater elevation data collected at the diary in December 2021 suggests a

southwest flow direction however the 3 monitor wells were installed in nearly a straight line, so an accurate triangulation of water level data is not possible.

Assuming a southwest flow direction in the Surficial Aquifer, monitor well MWB-1 is upgradient of the dairy. Monitor wells MWI-2 and MWC-3 are also appropriately sited downgradient of the furthest west spray field and at the western edge of the property respectively.

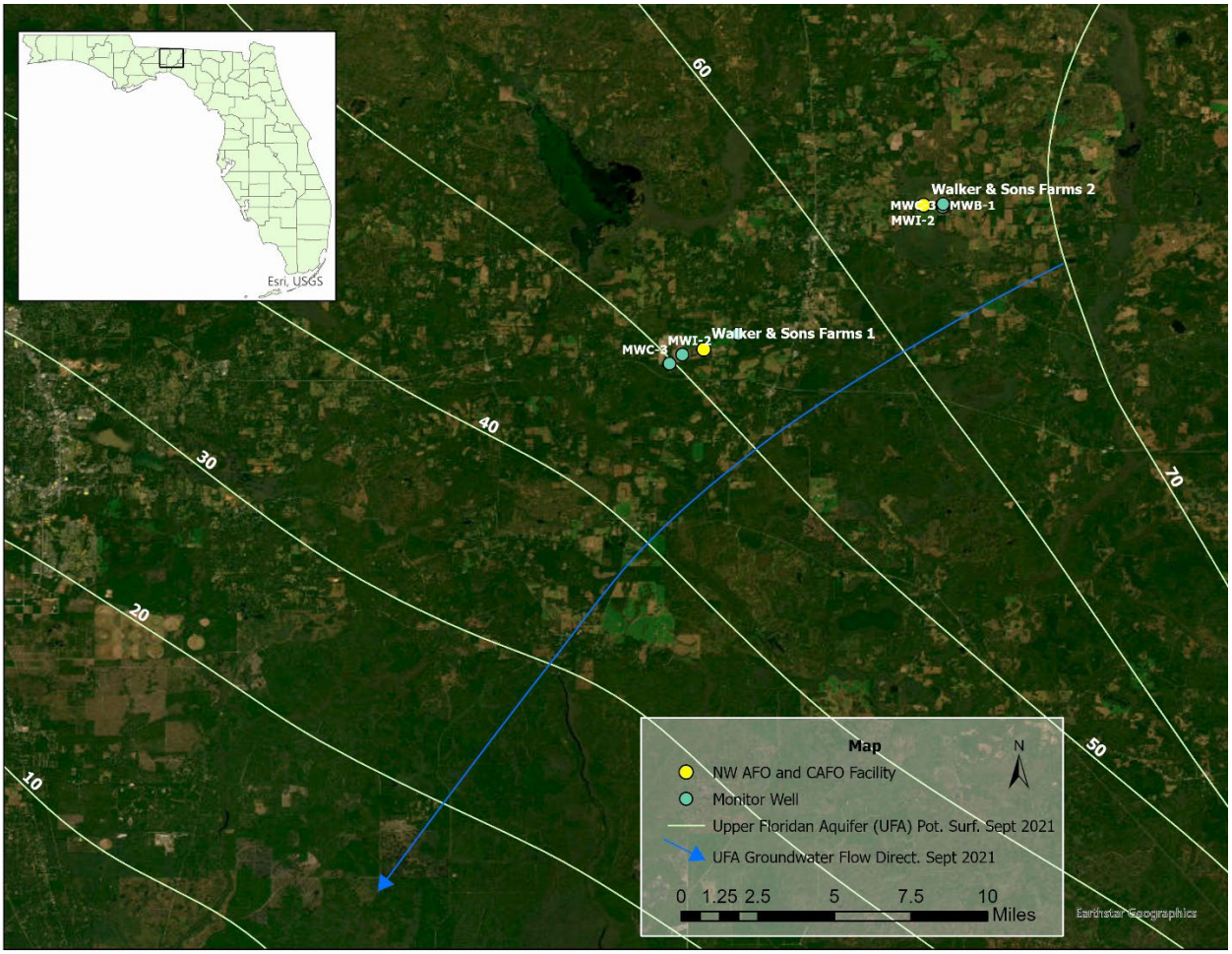

Figure M-2. Potentiometric Surface of the Floridan Aquifer, September 2021, Walkers and Sons Farms 1.

Groundwater General Water Quality

Table M-1 presents a summary of reported groundwater monitoring data for the period-of-record from June 2006 through December 2023. Average nitrate concentrations are not elevated in any of these wells. pH is elevated in the downgradient well, possibly indicating a pollution source other than manure.

Table M-1. Walker and Sons No. 1 Dairy Floridan Aquifer monitoring well general water quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	1.6	0.0	4.0	3.0	0.0	12.0	1.3	0.0	2.0
Nitrite plus Nitrate, Total (as N)	mg/L	0.26	0.00	0.90	0.24	0.00	0.90	0.44	0.00	4.12
pH	s.u.	7.52	6.32	8.64	7.92	6.08	11.42	10.45	7.95	12.94
Phosphate, Ortho (as P)	mg/L	0.127	0.006	1.100	0.012	0.002	0.070	0.041	0.000	0.082
Phosphorus, Total (as P)	mg/L	0.342	0.093	1.080	0.087	0.013	0.267	0.167	0.090	0.360
Specific Conductance	umhos/cm	436	88	645	452	112	3111	403	150	910
Temperature (F), Water	Deg F	70.2	64.8	75.4	68.4	60.6	79.0	68.1	64.9	71.2
Water Level Relative to NGVD	ft	43.76	40.65	55.90	43.94	32.44	83.12	41.79	36.56	46.68

Groundwater Nitrate Concentration and Trends

All groundwater sampling data for the period of record has indicated NOx-N concentrations below 10 mg-N/L in all the wells. At least one additional well is recommended so that triangulation of water levels will be possible to determine the groundwater flow direction in the Surficial Aquifer. This is needed to confirm that all the wells are sufficiently sited to correctly monitor groundwater at the facility.

Table M-2. Annual average FAS groundwater nitrate (NOx-N) concentrations at the Walker and Sons Farms 1.

Year	MWB-1	MWC-3	MWI-2
2006	5.15	0.91	1.63
2009	0.03		0.02
2012	0.04	0.05	0.21
2013	0.03	0.02	0.05
2014	0.06	0.11	0.09
2015	0.02	0.04	0.15
2016	0.03	0.05	0.04
2017	0.2	0.09	0.04
2018	0.02	0.07	0.04
2019	0.9	0.9	0.9
2020	0.69	0.69	0.88
2021	0.49	2.16	0.35
2022	0.2	0.27	0.2
2023	0.2	0.2	0.2
AVERAGE	0.575714	0.427692	0.342857

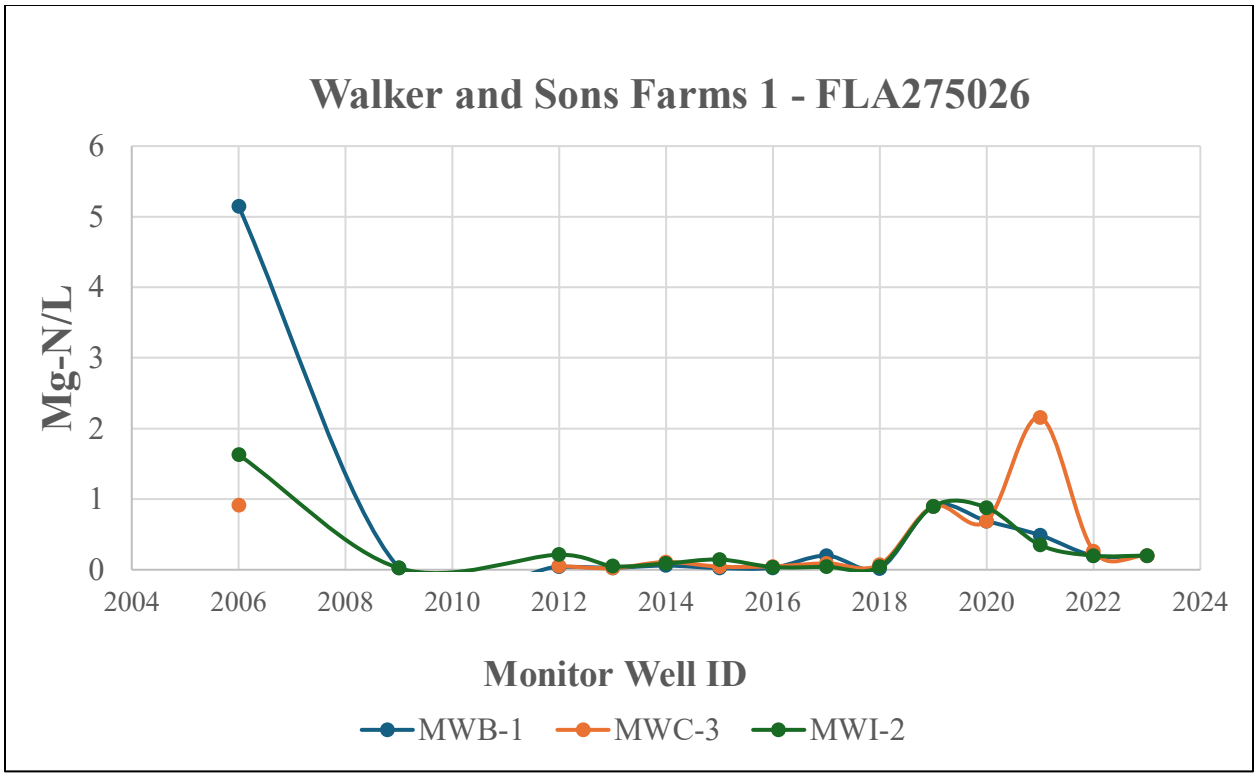

Figure M-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Walker and Sons Farms 1.

Groundwater Consumption

The Walker & Sons Farms 1 in Jefferson County has six permitted FAS wells. The total permitted withdrawal is 1.76 MGD to irrigate 100 ac of crops and to water 1,400 dairy cows.

Adjacent Potable Water Wells

A total of 4 potable self-supply wells are located within the Walker and Sons Farms 1 property boundary in Jefferson County. The NMP identifies 91 domestic self-supply wells within one quarter of a mile from the dairy boundary. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

Appendix N: Walker and Sons Farms 2 FLA165352, Jefferson County

Description

Walker and Sons Farms 2 is located at 2349 Ashville Highway in Monticello in Jefferson County Florida. Walker and Sons Farms 2 is approximately 2.9 miles northeast of Monticello on County Road 146.

The facility is an existing dairy farm operation that operates as a Confined Animal Feeding Operation (CAFO), with a herd size of 1,380 mature dairy cows consisting of 1,200 lactating and 180 dry cows. The 1,200 lactating cows are divided into seven herds: herds one through six are housed in three free-stall barns, herd seven is on pasture to the north and west of the free-stall barns and cows in the sick cow area. The dry cows are pastured to the east of the CAFO production area.

The 58-acre CAFO production area includes the holding barns; feed barn; milking parlor; sick cow area; three free-stall barns; exercise lots (high intensity area [HIA]) with dedicated storm water retention pond; waste reception sump; static screen separator and solids (manure) storage area; wastewater treatment lagoon; detention lagoon; dead cow area; and commodities area.

The CAFO facilities convey approximately 108,000 gallons per day annual average of generated process wastewater and storm water runoff to the wastewater treatment system. The agricultural wastewater treatment/detention system consists of a 10.5-acre anaerobic wastewater treatment lagoon and an 18.0-acre detention lagoon. The facility is designed to contain the generated process wastewater and storm water runoff from the CAFO production areas for up to a 25-year, 24-hr storm. A 138-acre spray irrigation area is located south of the CAFO production area, across C.R. 146; wastewater is disposed of by land application on the irrigation area. Residuals (manure/biosolids) generated by the treatment of agricultural wastewaters by this facility are land applied at on-site locations under the control of the permittee and at off-site locations that are not under the control of the permittee. The sites are specified in the nutrient management plan for the land application of residuals/manure.

A Nutrient Management Plan (NMP) has been developed for this facility. The majority of the area around the milking facilities and holding barns is paved and wastewater and storm water runoff flows directly into the reception sump or into the wastewater treatment lagoon. Wastewater from the milking parlor, feed barns and holding barns gravity flows via curbed concrete alleyways into the reception sump. The free-stall barns are flush-cleaned at least once per day with reused wastewater from the detention lagoon and this wastewater gravity flows into the reception sump. Storm water runoff from the barn roofs is collected by a gutter system and is routed to a storm water ditch that removes clean storm water from the dairy complex. The HIA is bermed to direct

storm water runoff into a dedicated storm water retention basin; storm water is pumped out of the basin after each rain event into the alleyways and the water gravity flows into the reception sump. Wastewater is pumped from the reception sump to an Ag-Pro Static Screen Solids Separator and distribution auger. Recovered residuals/manure are stored for reuse in land application and recovered wastewater flows into the wastewater treatment lagoon. Recovered process wastewater and storm water are stored in the wastewater treatment lagoon and the detention lagoon. Wastewater flows from the treatment lagoon into the detention lagoon via a metal drop culvert. Water is pumped from the lagoons for reuse in flush-cleaning the facilities and for spray irrigation. Specified water levels are maintained in each lagoon by pumping to ensure adequate storage capacity to retain the runoff from a 25-year, 24-hr storm event.

Groundwater Monitoring

Walker and Sons Farms 2 is located in the Tallahassee Hills geomorphologic province. Wolf Creek located immediately west of the facility flows to the south. The current groundwater monitoring network at Walker and Sons Farms 2 consists of three wells screened in the Surficial aquifer:

- One Background well – MWB-1
- One Intermediate well – MWI-2
- One Compliance well – MWC-3

The monitoring well locations are shown in Figure N-1. The monitor wells range in depth from 20 to 33 feet.

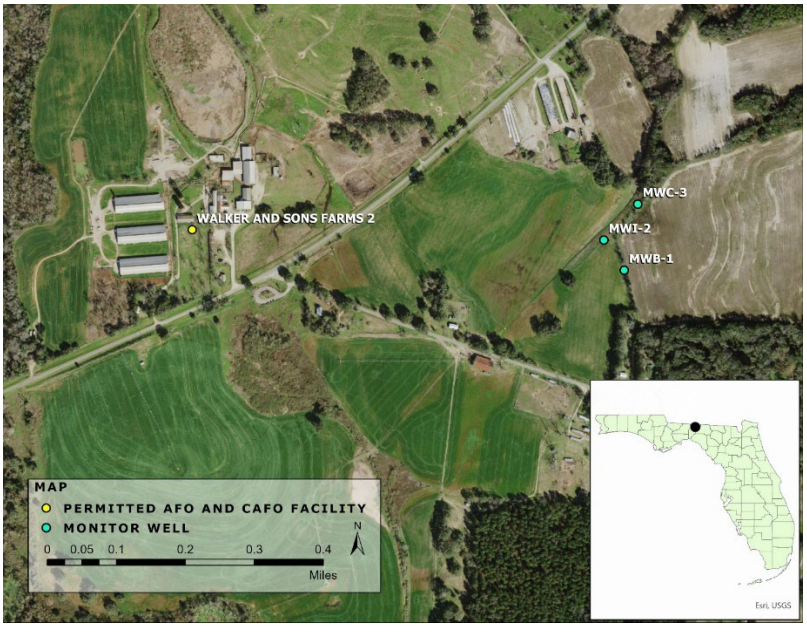

Figure N-1. Locations of Monitor Wells, Walker and Sons Farms 2.

Potentiometric surface contours of the Floridan Aquifer in September 2021 are shown in Figure N-2. The groundwater flow direction in the Floridan aquifer is to the southwest, toward the Gulf of Mexico. Potentiometric contours of the Floridan aquifer measured in September 2017 confirm this flow direction. The flow direction in the Surficial aquifer based on groundwater elevation data collected at the dairy in December 2021 also indicates a southwest flow direction.

Monitor well MWB-1 is correctly sited as a background well however neither intermediate monitor well MWI-2 nor compliance monitor well MWC-3 is correctly sited downgradient of the facility. Additional monitor wells are recommended to complete the monitor well network.

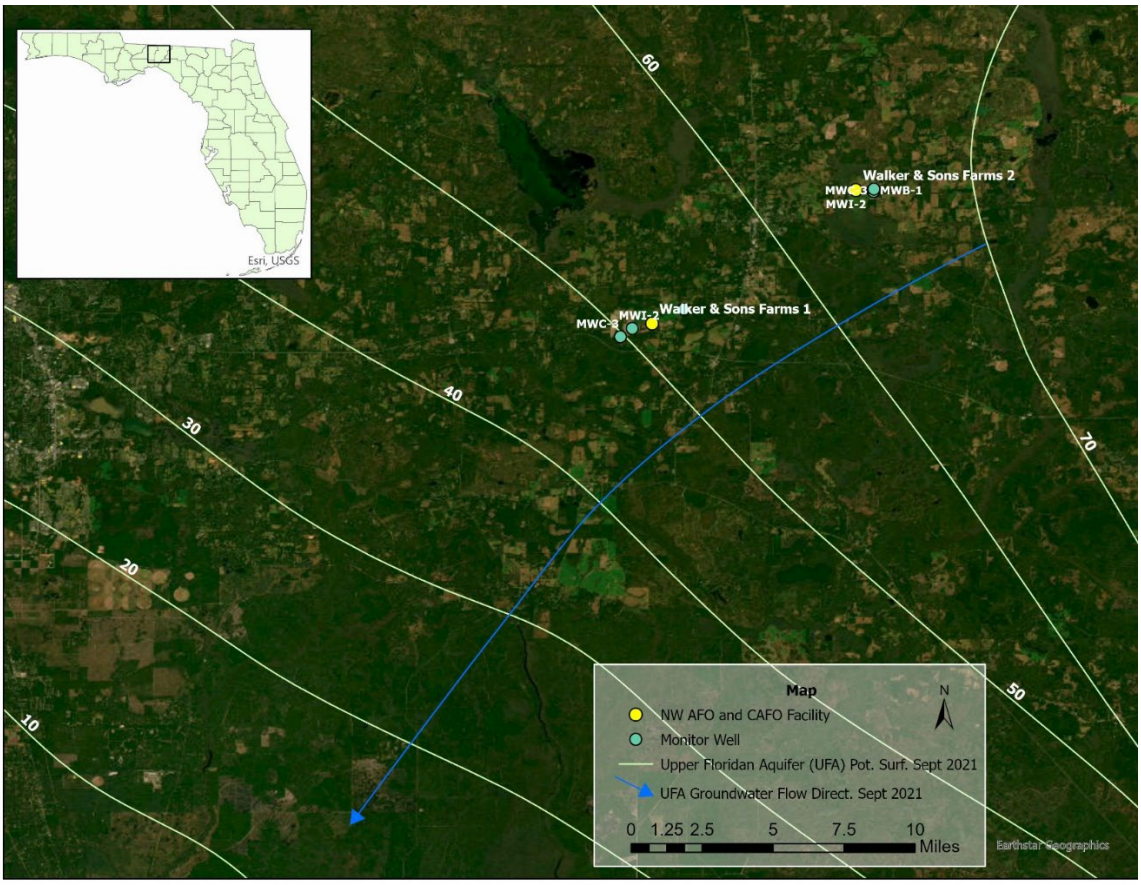

Figure N-2. Potentiometric Surface and Groundwater Flow Direction of the Upper Floridan Aquifer, Walker and Sons Farms 2, September 2021.

Groundwater General Water Quality

Table N-1 presents a summary of reported groundwater monitoring data for the period-of-record from December 2005 through June 2023. Background well data indicate relatively low nitrate. Nitrate levels increase in the intermediate wells and are reduced in

the compliance wells. Based on examination of minimum values in Table N-1, there are sampling/analytical errors included for pH and for specific conductance.

Table N-1. Walker and Sons No. 2 Dairy Surficial Aquifer Monitoring Wells General Water Quality.

		Background Wells			Intermediate Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	2.3	1.0	4.0	3.3	1.0	28.0	2.4	0.0	8.0
Nitrite plus Nitrate, Total (as N)	mg/L	1.22	0.00	11.00	7.26	0.50	12.00	2.88	0.50	6.18
pH	s.u.	6.76	5.79	8.20	6.38	4.34	8.90	6.25	0.00	8.67
Phosphate, Ortho (as P)	mg/L	0.332	0.332	0.332	0.002	0.002	0.002	0.009	0.009	0.009
Specific Conductance	umhos/cm	409	237	840	201	57	291	114	0	445
Temperature (F), Water	Deg F	70.9	64.4	74.1	71.6	59.3	75.7	70.2	67.5	72.7
Water Level Relative to NGVD	ft	99.02	84.80	113.00	99.02	87.83	120.73	97.54	86.92	101.83

Groundwater Nitrate Concentration and Trends

Nitrate (NOx-N) concentrations in groundwater at Walker and Sons Farms 2 are shown in Table N-2 and time series in Figure N-3. The only exceedance was at background well MWB-1 in 2005. All other detections in the period of record were below 10 mg-N/L.

Table N-2. Annual Average FAS Groundwater Nitrate (NOx-N) Concentrations at Walker and Sons 2 Dairy.

Walker and Sons Farms 2			
Year	**MWB-1**	**MWC-3**	**MWI-2**
2003	8.45	1.14	0.79
2005	11	1.9	
2006	7.67	2.53	2.92
2007	10		
2012	1.42	0.18	3.05
2013	0.01	0.93	7.88
2014	0.04	1.34	8.28
2015	0.02	2.4	5.88
2016	0.01	2.55	7.53
2017	0.07	3.43	6.87
2018	0.24	4.1	8
2019	5.95	4.6	7.35
2020	1.85	3.45	0.5
2021	3.01	2.54	9.1
2022	2.94	4.76	2.95
2023	4.65	2.38	8.17
AVERAGE	3.583125	2.548667	5.662143

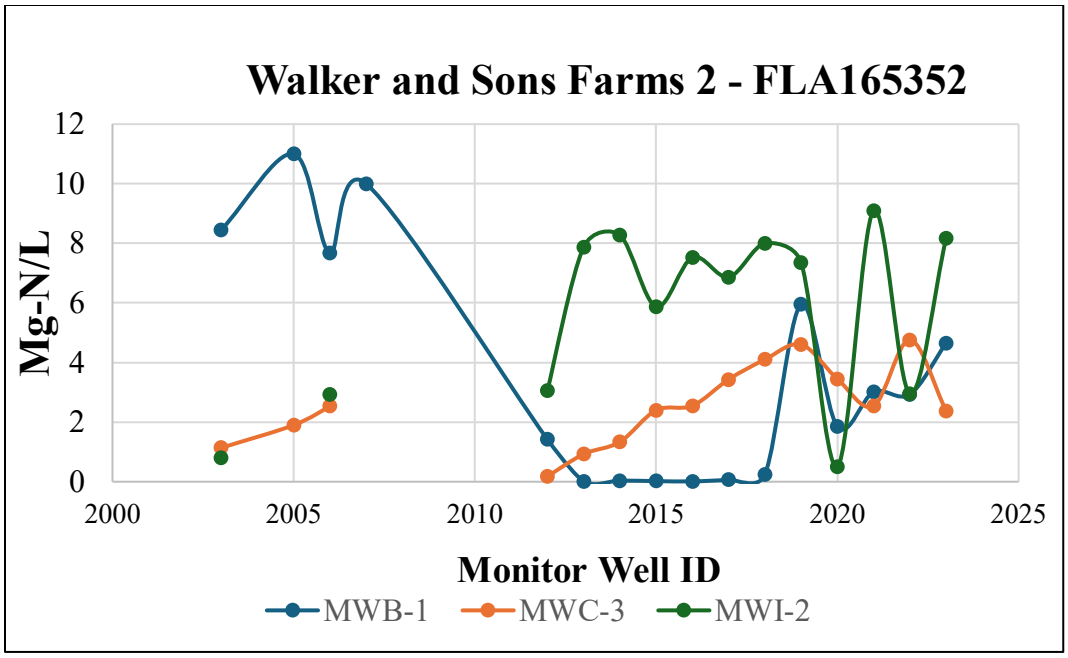

Figure N-3. Groundwater Nitrate (NOx-N) Concentration Time Series, Walker and Sons Farms 2.

Groundwater Consumption

The Walker & Sons Farm 2 in Jefferson County has six permitted FAS wells. The total permitted withdrawal is 0.486 MGD to water 1,660 dairy cows.

Appendix O: White Oak Dairy – FLAB07376, Lafayette County

Detailed Description

White Oak Dairy, Inc. is an existing dairy facility located at 6951 SE CR 534 in Mayo, Lafayette County, Florida, which stayed under 700 cows (CAFO threshold) beginning in 2002. In 2016 the farm started expanding and the dairy applied for a CAFO wastewater permit on November 19, 2016. Permit number FLA967149 was issued by FDEP on March 31, 2017, authorizing construction and operation of the approved NMP.

The original permit expired on March 20, 2022. The dairy expanded 1,850 lactating cows and 250 dry cows and a renewal permit FLAB07376 was issued on May 21, 2025.

The White Oak Dairy is located on Lafayette County parcel number 23-04-10-0000-0000-00500 which is 82.41 acres in size. The facility is approximately at latitude 30° 07’ 28" N, longitude 83° 17' 53" W, Lafayette County.

The White Oak Dairy currently has four free stall barns, with construction of one additional barn currently planned. As part of planned upgrades, the dairy has built a new sand lane for better sand separation, added a new screen for improved solids separation, and built a new waste storage pond to better manage the dairy’s wastewater. Another screen is planned to be added in the future but is not required by permit. The dairy has four existing wastewater pivots and is connecting two more pivots to the wastewater pipeline on land that is being leased-to-own. The two solids application freshwater pivots will continue to be used. Solids may also be spread at the corners of all the pivots. The dairy will also continue to have additional dry cows and heifers on pasture (not confined). Calves are also raised in hutches on the site, either in the open or under barns.

Wastewater pivots irrigate a total of over 383 acres of land that, at maximum cow numbers, will all be triple cropped. The treated effluent is land applied at agronomic rates to animal crops with no discharge to surface waters. A Nutrient Management Plan (NMP) has been developed for this facility.

Once this expansion is complete the facility will contain a new state-of-the-art milking center and four new (or partially new) free stall barns along with an existing free stall barn for dry cows. The barns and current waste management system will handle 1,275 lactating cows and 128 dry cows for a total of 1,403 mature cows in confinement.

All roof water is directed to clean water retention areas. No roof water is added to the waste management system. Two supply wells are just west of the milking center that supply water to the milking center and the rest of the farm. A well just north of the milking center will need to be abandoned when the new free stall barn is built.

Wastewater from the separation pit is pumped over the screen and solids fall into the old cell and wastewater flows through the screen into a PVC pipe and into the reinforced concrete Waste Storage Pond (WSP). The WSP contains over 845,000 gallons of storage and is sized to hold 6.5 days of process wastewater once all the expansion plans are complete. There is a pump at the WSP, capable of pumping approximately 1,200 gpm at 120 psi. Irrigation wells also are tied into the pipeline allowing freshwater irrigation during dry times. The WSP is designed to provide actual storage for greater than the 100-year, 10-day storm event before the pond would overtop.

Groundwater Monitoring

Monitoring Wells

The facility is located in the Tallahassee Hill geomorphologic province of north Florida. The current groundwater monitoring network at White Oak Dairy currently consists of seven wells screened in the Floridan Aquifer:

- Two Background wells – MWB-1 and MWB-6
- Five Compliance wells – MWC-2, MWC-3 MWC-4, MWC-5 and MWC-6

The existing monitor well locations are shown in Figure O-1.

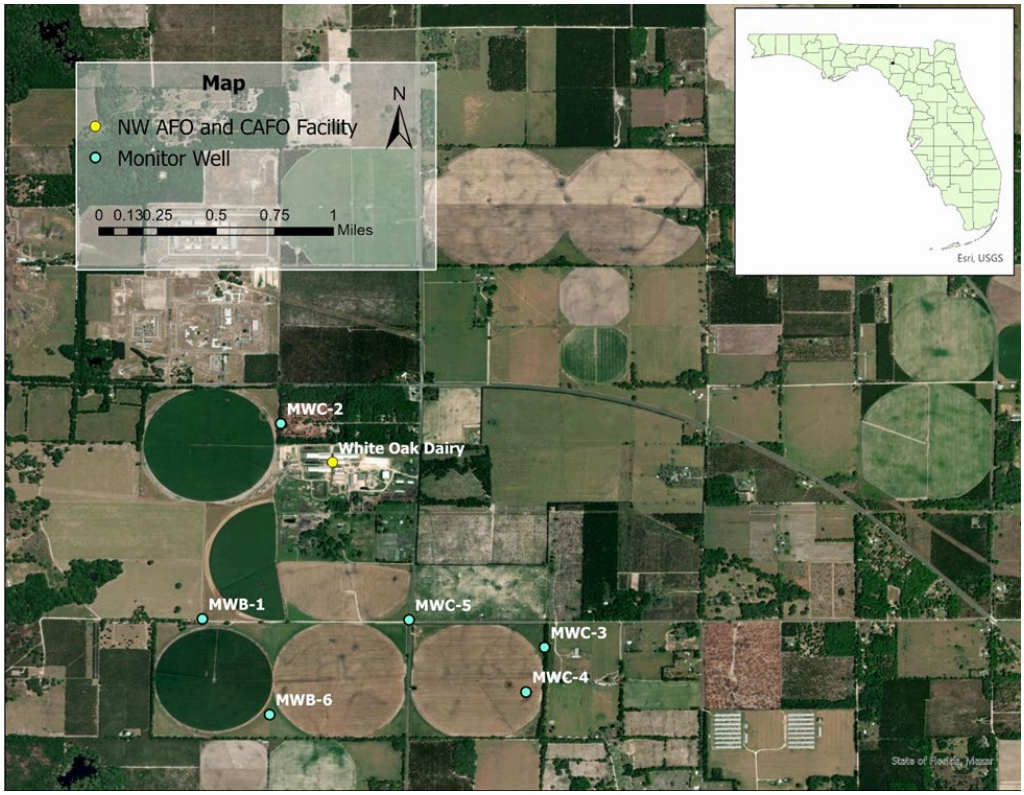

Figure O-1. Locations of Monitor Wells, White Oak Dairy.

Groundwater Flow Direction

Based on potentiometric surface contours of the Floridan aquifer in September 2021, the groundwater flow direction is to the east/northeast towards the Suwannee River (Figure O-2). This flow direction is consistent with contours generated with groundwater elevation data collected in September 2017.

Groundwater levels measured in the seven monitor wells on the property in December 2023 also indicated an east/northeast flow direction.

The potentiometric surface contours in Figure O-2 indicate that background monitor wells MWB-1 and MWB-6 are both upgradient of wastewater pivots however, MWB-6 is downgradient of a portion of the Edward 2 wastewater pivot and may be impacted. The remaining compliance monitor wells are all directly downgradient of wastewater pivots. Because the monitor wells are partially screened in unconsolidated materials above bedrock, it is more likely that they would be impacted by wastewater introduced at the land surface. MWC-3 is directly downgradient and adjacent to the Prine wastewater pivot and has had elevated NOx-N levels since 2018.

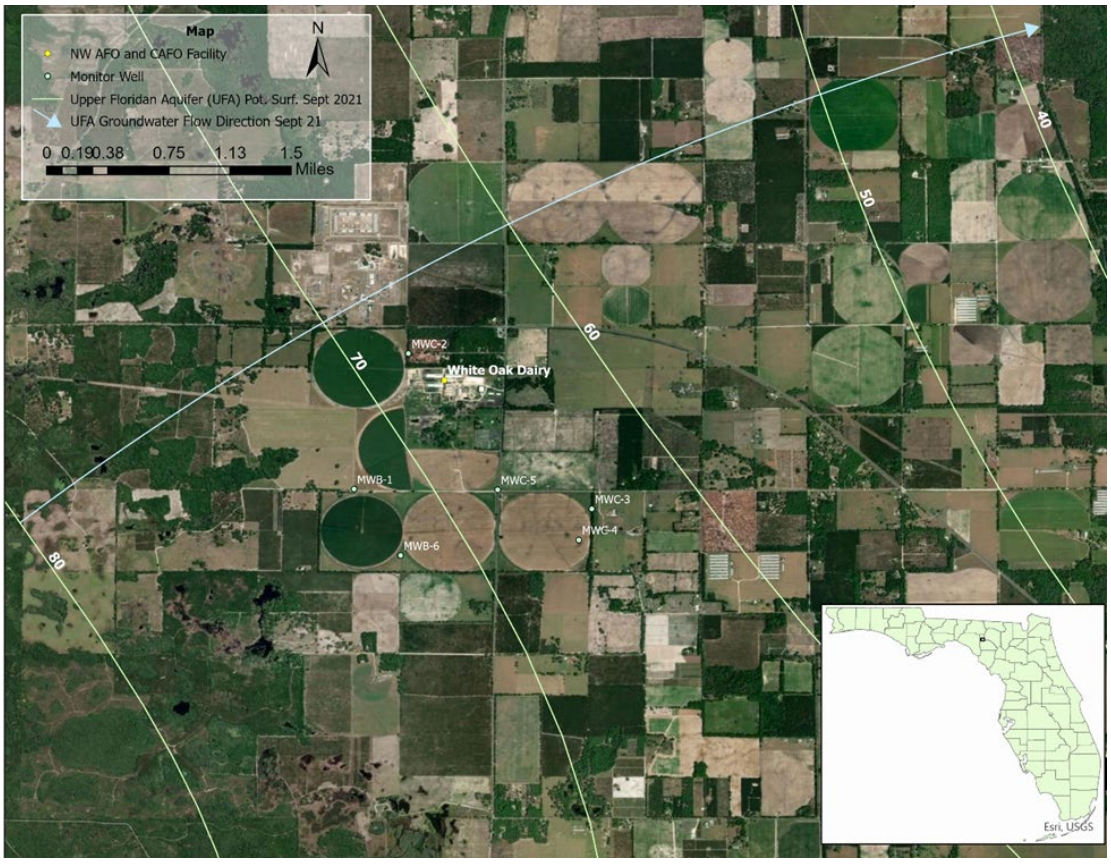

Figure O-2. Potentiometric Surface Contours of the Upper Floridan Aquifer, White Oak Dairy, September 2021.

Groundwater General Water Quality

Table O-1 presents a summary of reported groundwater monitoring data for the period-of-record from June 2017 through September 2023. Background well data indicate elevated average nitrate nitrogen concentrations, either from the dairy or some upgradient source of pollution. No background data were reported for specific conductance. Ortho phosphorus in background wells average 0.045 mg-N/L, and fecal coliforms averaged 1.2 col/100mL, both typical of unpolluted aquifer conditions.

Table O-1. White Oak Dairy Monitoring Wells General Water Quality.

		Background Wells			Compliance Wells		
Parameter	Units	Avg	Min	Max	Avg	Min	Max
Coliform, Fecal	#/100mL	1.2	1.0	4.0	1.0	1.0	1.0
Nitrite plus Nitrate, Total (as N)	mg/L	4.26	0.14	12.00	20.77	0.01	43.00
pH	s.u.	7.50	6.68	7.83			
Phosphate, Ortho (as P)	mg/L	0.045	0.015	0.100	0.191	0.031	1.000
Water Level Relative to NGVD	ft	49.26	4.44	65.45	42.89	12.07	60.94

Groundwater Nitrate Concentration and Trends

The initial sampling of monitor wells MWB-1, MWC-2 and MWC-3 in October and November 2016, prior to permit issuance, revealed elevated nitrite plus nitrate (NOx-N) levels in monitor well MWC-3 at 44 mg-N/L and 42 mg-N/L, respectively. Therefore, the facility did not meet the groundwater quality standard of 10 mg-N/L for NOx-N in monitor well MWC-3. These values may have been due to previous agricultural operations on the Prine Pivot property that was acquired by the White Oak Dairy. No due diligence information is available to corroborate this assumption. Based on water level elevation data collected during quarterly monitoring, monitor well MWC-3 is located downgradient of the Prine Pivot property.

As a result of the above exceedances, the initial permit issued on 3/31/17 included an Administrative Order (AO-189-NE) with interim NOx-N limits of 18 mg-N/L for MWC-2 and 45 mg-N/L for MWC-3. The interim limits and Administrative Order (AO) expired on 3/30/22. The dairy's permitted operation did not reduce the NOx-N levels in compliance wells MWC-2 and MWC-3 over the allowed four-year period in the AO to meet the state limit for groundwater of 10 mg-N/L.

Part III of the renewal permit requires quarterly groundwater monitoring for three typical dairy parameters at three existing monitor wells, and three new monitor wells that have been installed with one semi-annual dairy parameter, and one annual dairy parameter at these same wells which monitor the Floridan aquifer around the dairy's wastewater sprayfield irrigation sites.

Since this facility has numerous discharge sites and solids spreading sites, a zone of NOx-N discharge greater than 10 mg-N/L to the property lines was allowed.

The three original monitor wells were constructed with 20-foot long well screens with up to less than half of the of the screen actually penetrating the limestone bedrock; the remainder screening the unconsolidated materials (sand and clay) above bedrock i.e. these wells are partially screened in the upper confining unit or the Surficial aquifer. Screening across more than one water-bearing unit may negatively affect accurate determination of the groundwater flow direction as well as analytical data.

Three additional monitor wells (Compliance wells MWC-4 and MWC-5 and background well MWB-6) were installed and sampled in October 2023 (see Figure O-1). No information on the as-built specifications of these new monitor wells is currently available but will be submitted to FDEP after the draft permit is issued.

The renewal permit (FLAB07376) includes a 2024 Consent Order (CO) that specifies an interim NOx-N limit of 40 mg-N/L for new monitor wells MWC-4 and MWC-5.

Analytical Data Analysis

Data for this analysis was obtained by requesting a download from FDEP in 2023. The download contained analytical data from June 2017 through June 2022 and is presented in Table O-2 and Figure O-3.

Table O-2 Annual Average Concentrations of Nitrite+Nitrate Nitrogen (mg-N/L) at the White Oak Dairy.

White Oak Dairy			
Year	MWB-1	MWC-2	MWC-3
2017	0.49	9.1	39.33
2018	0.87	6.9	39.65
2019	3.2	0.22	35.55
2020	3.75	4.55	31.93
2021	7.14	7.56	32.33
2022	5.57	9.07	29.85
2023	11.5	21	30.5
AVERAGE	4.65	8.34	34.16

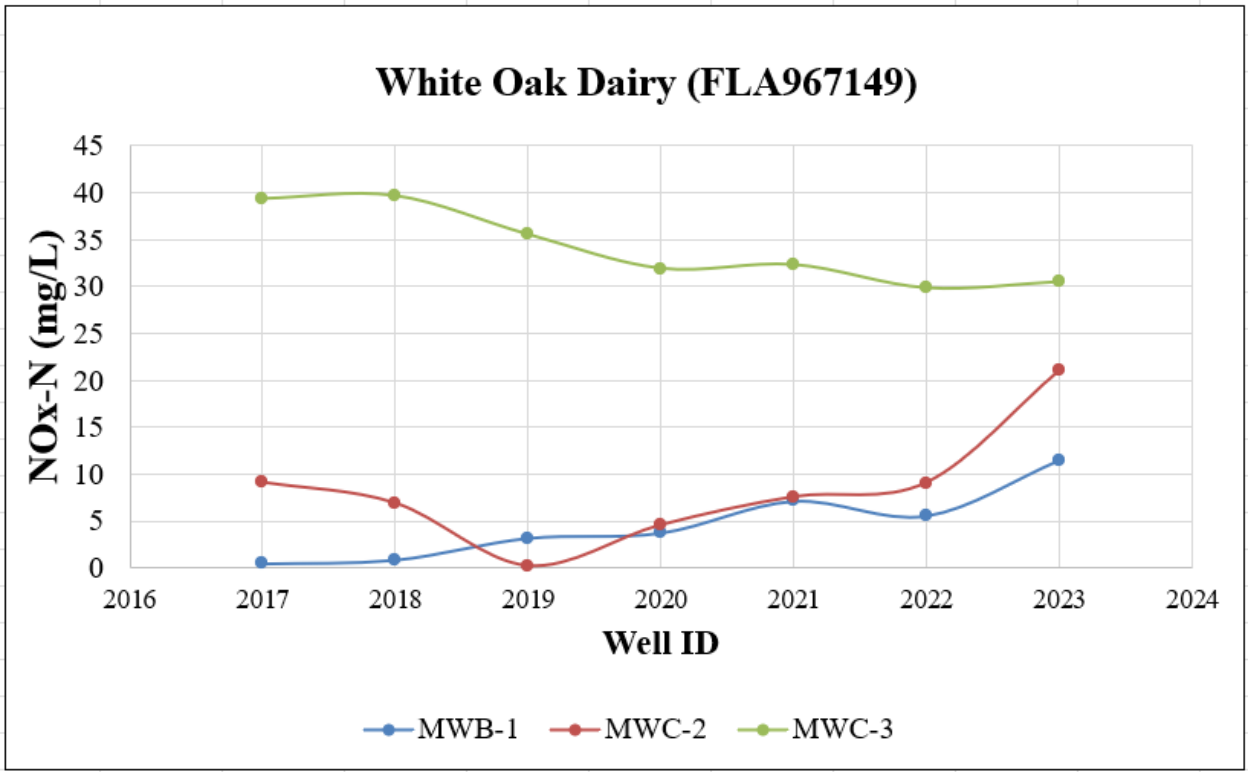

Figure O-3. White Oak Dairy NOx-N Concentrations Over Time in the 3 Original Monitor Wells.

NOx-N levels in background well MWB-1 rose steadily over the period of record which ended with an exceedance in 2023. NOx-N levels in monitor well MWC-2 have been rising since 2019 and averaged over 20 mg-N/L in 2023. NOx-N levels in monitor well MWC-3 have consistently been above the compliance level ranging from 27.6 to 43 mg-N/L during the monitoring period.

FDEP stipulated in a request for additional information (RAI) dated October 20, 2021, that #AO-189-NE would not be continued for MWC-2 and this well will need to meet the state NOx-N limit of 10 mg-N/L for issuance of the renewal permit. The RAI also stated that continued quarterly monitoring of MWC-3 will be needed until NOx-N levels drop below 10 mg-N/L.

Figure O-4 is a 5-year trend analysis from the CAFO Annual Report for 2023 and includes recent data from newly installed monitor wells MWC-4, MWC-5 and MWB-6. The new background monitor well, MWB-6, has been sampled twice. The initial result was NOx-N over twice the compliance level, then dropping to below the compliance level in the second round. Recent sampling of the two new compliance monitor wells, MWC-4 and MWC-5 in September 2023 found MWC-4 had nearly twice the 10 mg-N/L compliance level but then decreased to below 10 mg-N/L in December 2023. Monitor

well MWC-5 contained low concentrations of NOx-N in both these rounds. NOx-N concentrations in all the wells fell to 10 mg-N/L or below in the last quarter or 2023.

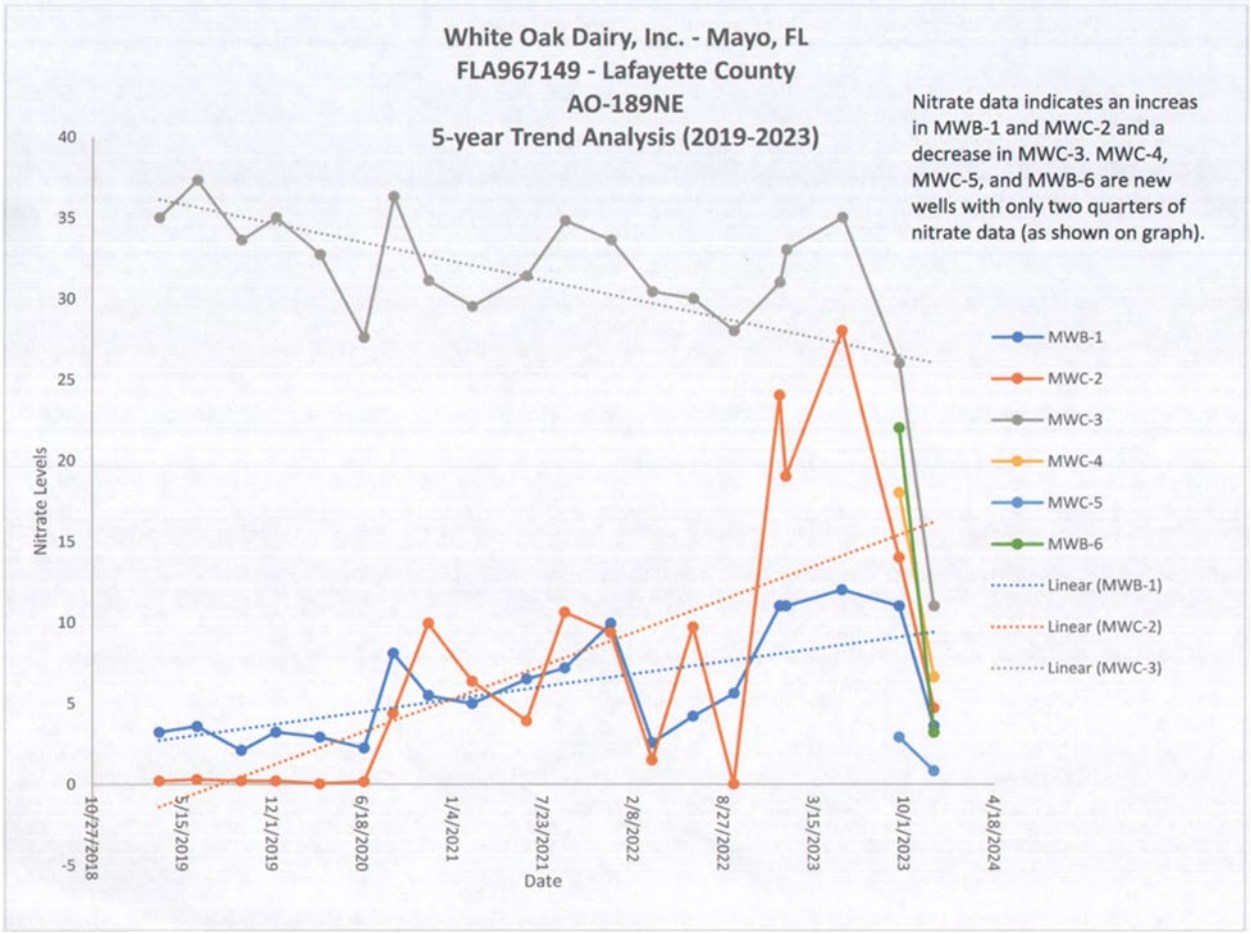

Figure O-4. NOx-N in Groundwater (mg-N/L), White Oak Dairy (Source: CAFO Annual Report 2023).

Groundwater Consumption

The White Oak Dairy in Lafayette County has 13 permitted FAS wells. The total permitted withdrawal is 1.32 MGD with 1.126 MGD to irrigate 692 ac of crops and 0.194 MGD to water 1,425 dairy cows.

Adjacent Potable Water Wells

Figure O-5 illustrates the likely locations of private potable water supply wells in the immediate vicinity of the White Oak Dairy in Lafayette County. The Florida Department of Health should periodically sample a selection of these wells to avoid health risks to local residents from elevated nitrate-N.

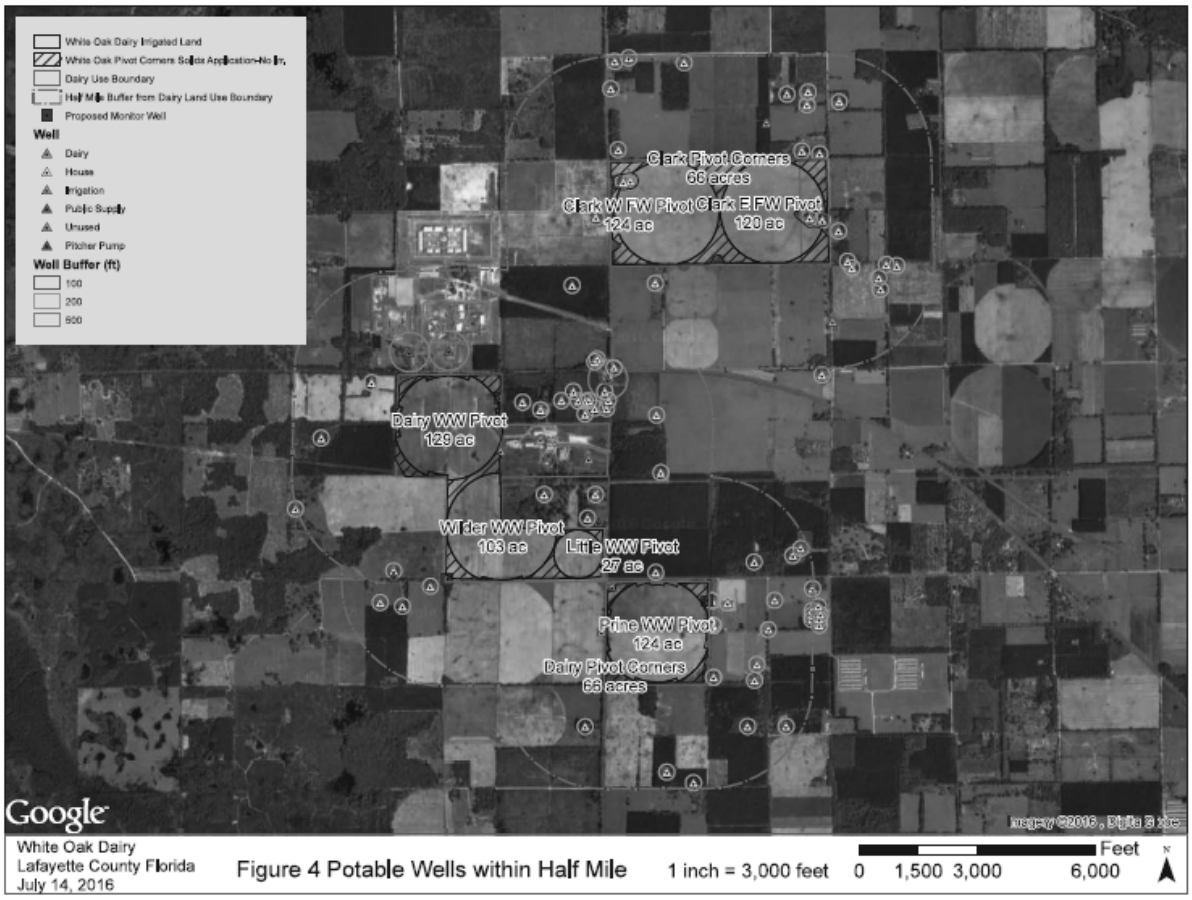

Figure O-5. Domestic Self-Supply Potable Wells Within the Vicinity (one-half mile) of the Southpoint Dairy, Levy County.