A Report on Well Testing Result of Public and Private Wells Within the Linn Sanitary District Between 2017-2021.

Prepared by Geneva Lake Environmental Agency, January 2022

The following document includes the results of the 2021 well testing program and is a summary of five years of private well testing. Both programs includes the sampling of thirteen selected drinking wells in the Linn Sanitary District, Linn Township, Walworth County WI. It was conducted as a joint effort of the Geneva Lake Environmental Agency and the Linn Sanitary District. It was conducted to evaluate the groundwater quality in the Geneva Lake area.

The testing includes analysis of It includes total coliform bacteria, E-coli bacteria, and nitrate-nitrogen. In addition to the private wells tested, it also includes the annual test results for bacteria and nitrate-nitrogen on eighteen selected public water supplies including municipal wells and public restaurants, bars, churches, schools, and subdivision wells.

Although this report includes the test results of 2021 and a summary of the five-year testing, an initial report was prepared after the first year of the testing program. Subsequent reports were prepared after annual testing and are referred to as addendums. In the final year, 2021, a final report was prepared to discuss the cumulative results of the five years of sampling and test results. Below is a listing of the annual results of this well testing program. Copies of each annual report are available by contacting the Linn Sanitary District.

Title

Results of the First Year's testing, 2017
Addendum 1 – 2018
Addendum 2 – 2019
Addendum 3 – 2020
Addendum 4 – 2021 with assessment of all five years (this report).

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Geneva Lake Environmental Agency
Village of Fontana • City of Lake Geneva
Town of Linn • Town of Walworth
Village of Williams Bay

An Evaluation of the 2021 and Five-Year Selected Private and Public Well Testing Results, Geneva Lake Environmental Agency - Linn Sanitary District.

Matt Messer, Theodore W. Peters, Geneva Lake Environmental Agency, November 2021

This is the fourth and last addendum (#4,2021) to the report on the groundwater testing program conducted jointly by the Linn Sanitary District and the Geneva Lake Environmental Agency. The initial report is titled "Results of the First Year's Testing of Groundwater in the Joint Geneva Lake Environmental Agency – Linn Sanitary District Long-Term Well Testing Program" and was originally drafted by Hayden King and Theodore W. Peters, GLEA, January 8, 2018.

INTRODUCTION:

During the summer of 2021, eleven private wells within the Geneva Lake watershed, located in the Linn Sanitary District, Linn Township, Walworth County WI were tested for total bacteria, E-coli bacteria and nitrate-nitrogen (nitrate-n). This 2021 testing was the last year of the five-year well testing program that included the testing of the same 13 private well for five consecutive years. Two wells that were included in the previous four years were not tested in 2021. One owner did not want the well tested in 2021 and the other sampling could not be scheduled despite several attempts. The object of the program was to document groundwater quality and the potability of the wells based upon bacteria and nitrate test results. This groundwater analysis also included well test results from public water supplies in the area. Public water supply data was retrieved from the Wisconsin Department of Natural Resource's web page at https://prodoasext.dnr.wi.gov/inter1/pws2$.startup, where annual result can be viewed.

Wisconsin bacterial drinking water standard is negative for the presence of coliform bacteria, including E-Coli bacteria. The drinking water standard for nitrate-n is 10.0 mg/l.

2021 RESULTS:

None of the wells tested in 2021 tested positive for total coliform or E-coli bacteria (table 1, addendum 4). Although four of the wells tested in 2021 had detectable levels of nitrate-n, none

of the 11 private wells tested exceeded the nitrate-n drinking water standard of 10 mg/l. Wells with test results below the limits of detection were recorded as not detected, ND. The 2021 test results for detectable nitrate-n ranged from a high of 2.47 mg/l to 0.12 mg/l.

Table 1, Appendix 4.

Long Term (2017-2021) Well Testing Results 2021. Linn Sanitary District, Walworth CO, WI					
		2021			
		Bacteria (MPN/100 ml.)		Nitrates	Well depth
#	Tax #	Total coliform	E-coli	mg/l	ft.
1	IAV 0017	absent	absent	ND	84
2	ILGH 00080	absent	absent	0.12	NA
3	ILGT 00005A2	absent	absent	ND	90
4	IBA 00001A	absent	absent	0.317	199
5	IMH 00111	NT	NT	NT	224
6	ICI 00075	absent	absent	2.47	62
7	IMA 00001	absent	absent	ND	804
8	ILGB 00011	absent	absent	ND	ND
9	IL 1700012M3	absent	absent	ND	NA
10	IL 800002A2	NT	NT	NT	NA
11	IA 1190003	absent	absent	ND	180
12	IBB 00003C1	absent	absent	0.156	220
13	IW 00027	absent	absent	ND	208
NA = Not Available, ND=Below detection limits. NT=Not tested.					
mg/l=milligrams per liter. MPN/100 ml= most probable number per 100 ml of sample.					
Standard for drinking water: No bacteria, Nitrate-N, 10.0 mg/l.					
Source: Walworth County Public Health , Linn Sanitary District and Geneva Lake Environmental Agency					

Municipal public water supplies and public establishments that offers drinking water or serves the public drinks or food, are required by state code to test their water supply annually. Bacteria and nitrate-n are two of the items required to be tested. Annual tests results from several local establishments are listed in table 2 addendum 4. These wells were not sampled or tested by the authors but retrieved from Wisconsin Department of Natural Resource's web page at https://prodoasext.dnr.wi.gov/inter1/pws2$.startup. Well depths at these establishments vary (1500 ft. to 86 ft.). Waters drawn from these wells are from both the shallow sand and gravel aquifer and several deep consolidated aquifers.

None of the local establishments shown tested positive for total or fecal coliform bacteria. None of them exceeded the nitrate-n drinking water standard. Of the eighteen well test results

listed in table 2, addendum 4, nine wells had 2021 test results with detectable levels of nitrate-n. Nitrate-n values ranged from 4.87 mg/l to non-detectable at nine wells. As noted in past

Table 2, addendum 4.

Table 2 . Public Water Supply Systems Used in the Long-Term Groundwater Inventory, 2017- 2021,							
	Test result for Samples Collected Durng the Summer of 2021.						
NUMBER	Location	date	Total Coliform, MPN	Fecal Coliform, MPN	Nitrates, mg/l	Sample date for Nitrates,	depth(ft)
PW1	Big Foot County Club	6/22/21	n	n	2.416	6/24/21	na
PW2	Kikkoman Foods #1	7/21/21	n	n	4.87	7/22/21	86
PW3	Lake Geneva Club #3	4/13/21	n	n	ND	4/14/21	680
PW4	Lake Geneva County Club	7/20/21	n	n	0.046	7/28/21	na
PW5	Lake Geneva Highlands	7/1/21	n	n	0.103	7/1/21	na
PW6	Linn Presbyterian Church #2	10/18/21	n	n	ND	10/19/21	116
PW7	The Owl	6/23/21	n	n	ND	6/25/21	na
PW8	Reek School #2	9/21/21	n	n	ND	9/24/21	201
PW9	Shore Haven Lake Assoc.	5/3/21	n	n	0.022	5/5/21	720
PW10	Lazy Cloud Inn	7/19/21	n	n	ND	7/21/21	na
PW11	South Shore Club	9/20/21	n	n	ND	9/22/21	1500
PW12	Sybil Lane	10/18/21	n	n	0.013	10/19/21	163
PW13	The Geneva Inn	9/9/21	n	n	ND	9/10/21	270
PW14	Traver School	3/23/21	n	n	ND	3/24/21	na
PW15	Zenda Tap	6/23/21	n	n	ND	6/25/21	157
PW16	Village of Fontana #1	9/15/21	n	n	4.4	9/21/21	na
PW17	Village of Walworth #5	7/26/21	n	n	2.7	8/4/21	91
PW18	Village of Williams Bay #1	10/11/21	n	n	0.13	10/18/21	257
MPN = most probable number, mg/l = milligram per litre, n = negative, na = not available.							
Source: WI DNR and GLEA							

reports and addendums, levels of nitrate-n in the public supply wells were highest in the western portion of the Geneva Lake groundwater shed. Historically nitrate-n levels in groundwater areas to the west of Geneva Lake have been noted as higher than areas to the east. (SEWRPC Community Assistance Planning Report # 60 1St edition 1985.)

Using the data from the 13 private wells and 18 public water supply wells located at various locations and depths and drawing from different aquifers within the Geneva Lake groundwater shed, offers an insight into the ground water quality in the Geneva Lake area during the study period 2017-2021. Although the groundwater regime is complex and may vary from the west

end to the east end, these 31 data points indicate the quality of groundwater in the areas of these tested wells and entering Geneva Lake does not exceed bacteria or nitrate-n drinking water standards.

Five Year Evaluation: Bacteria.

Private Wells. Over the study period of five years, 63 samples were collected from 13 private wells. All well samples were evaluated for coliform bacteria. If total coliform was found a follow up test for E-coli bacteria, a fecal coliform bacterium, test was conducted. Over the five years of the study, 2017-2021, five test results were positive for total coliform (8%). None of the private wells tested positive for E-coli bacteria.

These wells are located at different locations around the lake. They draw water from different aquifers. Approximately 175-200 ft. of sand and gravel overlay the deep consolidated aquifers of dolomite or sandstone. Known well depths for the private wells ranged from 804 ft. in the deep consolidated sandstone aquifer to 62 ft. in the sand and gravel aquifer. The average well depth sampled was 230 ft. with a median well depth of 84 ft. The average depth value is skewed by a single well depth of 804 ft.

Five of the 63 tests conducted on the 13 private wells over the five years tested positive for total coliform. Four of these positive results were from the same well over four years. With no E-coli bacteria or nitrate-n issues associated with this study's test results for this well, it is unlikely that the bacterial contamination is from a fecal source such as animal or human waste. A bad casing or cap or surface drainage may be more likely the cause of total coliform contamination. The water distribution system, from the well to the sampled faucet, may also be a source of total coliform contamination.

Public Wells. Over the study's five years, 18 private wells were annually inventoried totaling 90 results. All 90 results of the public water supplies tested over the five years of this study, tested

negative for total coliform bacteria.

This study found that bacteria contamination is presently not a groundwater problem in the area where these wells are located. With a maximum of only five samples per well, collected over five years, it is difficult to look for any long-term trends.

Five Year Evaluation: Nitrate-nitrogen.

Private Wells. Detectable limits of nitrate - n were found in 18 of the 63 private wells tests conducted over the five-year study. One well, had detectable levels all five years, ranging from 3.395 mg/l to 1.72 mg/l. and a five-year average of 2.437 mg/l. (table 3 appendix 4). The highest detectable nitrate-n levels found in the private wells was consistently the same shallow well of 62 ft. This well is in an area of small lots with high density homes served by private on-site wastewater treatment systems (POWTS). There is not an obvious trend in the level of nitrate-n over the five years of testing. It is worthy to note that it was the only well with detectable nitrate-n levels all five years. Those values were the highest of all 13 private wells tested. Table 3, Appendix 4.

NITIRATE-N VALUES FOR 13 PRIVATE WELLS, GENEVA LAKE WATERSHED, LINN TOWNSHIP, WALWORTH COUNTY WI. nitrate value mg/l,. One test per year.					
well number	2017	2018	2019	2020	2021
IAV 0017	ND	ND	ND	ND	ND
ILGH 00080	ND	0.237	ND	0.33	0.12
ILGT 00005A2	ND	ND	ND	0.036	ND
IBA 00001A	ND	ND	ND	0.426	0.317
IMH 00111	ND	ND	ND	0.0476	NT
ICI 00075	2.57	3.395	2.031	1.72	2.47
IMA 00001	ND	ND	ND	ND	ND
ILGB 00011	ND	ND	ND	0.009	ND
IL 1700012M3	ND	ND	ND	ND	ND
IL 800002A2	ND	ND	ND	0.018	NT
IA 1190003	ND	ND	ND	ND	ND
IBB 00003C1	0.368	ND	ND	0.141	0.156
IW 00027	ND	ND	ND	0.155	ND
SOURCE: Linn Sanitary District ,Geneva Lake Environmental Agency and Walworth County Public Health,				NT = not tested ND = not detected.	

Public Wells. A total of 90 public well test results were reviewed for this study. These results were from tests conducted over five years on selected public water systems (table 4, appendix 4).

Table 4, appendix 4.

NITRATE- NITROGEN VALUES FOUND IN SELECTED PUBLIC WATER SUPPLIES, GENEVA LAKE AREA, WALWORTH CO. WI SOURCE: WI DNR AND GLEA						
	2017	2018	2019	2020	2021	avg.
Big Foot County Club	2.97	3.051	3.947	3.32	2.416	3.141
Kikkoman Foods #1	4.9	5.99	3.5	8.35	4.87	5.522
Lake Geneva Club #3	ND	ND	ND	ND	ND	
Lake Geneva County Club	ND	ND	ND	ND	0.046	0.046
Lake Geneva Highlands	0.353	0.1570	ND	ND	0.103	0.204
Linn Presbyterian Church #2	ND	ND	ND	ND	ND	
The Owl	ND	ND	ND	ND	ND	
Reek School #2	ND	ND	ND	ND	ND	
Shore Haven Lake Assoc.	ND	ND	ND	ND	0.022	0.022
Lazy Cloud Inn	0.558	ND	ND	ND	ND	0.558
South Shore Club	ND	ND	ND	ND	ND	
Sybil Lane	ND	ND	ND	ND	0.013	0.013
The Geneva Inn	ND	ND	ND	ND	ND	
Traver School	ND	ND	ND	ND	ND	
Zenda Tap	ND	ND	ND	ND	ND	
Village of Fontana #1	NR	1.9	1.9	ND	4.4	2.733
Village of Walworth #5	NR	3.71	3.34	ND	2.7	3.250
Village of Williams Bay #1	NR	0.15	0.14	0.2	0.13	0.155

Twenty-seven of the 90 test had detectable levels of nitrate-n. Fourteen of the detectable levels came from three wells. Two wells, both located in the western portion of the Geneva Lake groundwater shed, had detectable levels of nitrate-n each of the five years. None of the samples exceeded the drinking water standard of 10 mg./l of nitrate-n. With only one sample per year per well over a five-year period, there isn't enough data to identify a trend.

Other public water supply wells located in the western portion of Geneva Lake's groundwater shed also had detectable levels of nitrate-n with relatively high average concentrations (table 5 appendix 4).

Table 5, appendix 4.

Top five year nitrate-ntrogen concentrations Public Water Supplies,Geneva Lake Area, Walworth CO. WI 2017-2021	
Well location	5 year average nitrate-n values
Kikkoman	5.522 mg/l
Village of Walworth #5	3.25 mg/l
Big Foot CC	3.141 mg/l
Village of Fontana #1	2.733 mg/l
Village of Williams Bay #1	0.155 mg/l
Source: GLEA and WI DNR at https://prodoasext.dnr.wi.gov/inter1/pws2$.startup.	

Kikkoman's nitrate-nitrogen values show variability with peaks of greater that 8 mg/l in 2013 and 2020. This well is located west of Geneva Lake in an area of heavy agriculture land use. Although the data isn't presented in this report, it can be retrieved from the Wisconsin Department of Natural Resource 's link shown in table 5, appendix 4.,

Summary and Recommendations.

- Total coliform bacteria tests results from 90 public water supply samples collected over five years found no presence of total coliform bacteria.

- E-coli bacterial test results on groundwater samples from 63 private wells and 90 public water supplies over a five-year period were found to be safe and meet the Wisconsin Drinking Water Standards of "not present".

- Five of the 63 private wells test results collected over five years, tested positive for total coliform bacteria. Four of those positive tests were from the same well. The final year testing of that well resulted in negative results for total coliform. The other well with a positive total coliform tested negative the following year.

- All 63 private and 90 public wells test results met the Wisconsin Drinking Water Standard for nitrate-n of 10 mg/l.

- Eighteen (29%) of the total 63 private well test results collected over the five years had detectable nitrate-n levels, yet all met the drinking water standard.

- Twenty-six (29%) of the 90 public wells test conducted over five years had detectable levels of nitrate-n yet met the drinking water standard.

- Although all wells tested met the drinking water standard for nitrate-n, some of the results, and where the wells are located warrant further investigating.

- One private well accounted for five of the detectable nitrate-N results, one for each of the five years tested. This well is located in an area of small lots, with a high density of homes all on Private On-site wastewater treatment systems (POWTS). Follow up testing for nitrate-n and bacteria should be conducted in this area to evaluate the overall groundwater quality.

- Several nitrate-n values from the public water supplies located in the western portion of the Geneva Lake groundwater shed were higher than other well test values in the Geneva Lake area. Intense agriculture land use in the area and areas to the west may be influencing groundwater quality. Areas to the west of Geneva Lake are major groundwater recharge areas important in Geneva Lake's groundwater hydrology.