A summary of Lower Yakima Valley Groundwater Management Area baseline data regarding nitrate pollution

2021 to the Present

Water Quality Is Getting Worse

Friends of Toppenish Creek

January 2026

Preface

Water quality in Lower Yakima Valley (LYV) groundwater is worsening according to data gathered by the WA State Dept. of Ecology (Ecology) over the past five years. This means that Washington taxpayers will continue to spend millions ensuring that LYV residents have safe drinking water.

Is there an end in sight? The Friends of Toppenish Creek offer this paper that summarizes what we know about LYV groundwater pollution based on Ecology gathered data. Our intent is to justify stronger actions to reduce pollution. Stronger actions are necessary to reverse the trend toward increasing levels of Nitrate N in LYV groundwater.

Background: In 2019, after thirty years of delay and uncertainty over rising Nitrate N levels in Lower Yakima Valley (LYV) groundwater, Ecology undertook data gathering to establish a baseline for comparison that would help the agency and the public determine whether water quality in this area is improving or worsening.[1] For two years from the summer of 2021 to the spring of 2023 Ecology took quarterly samples from 30 dedicated monitoring wells and 3 Port of Sunnyside monitoring wells and about 139 domestic wells to complete this endeavor.

In the Quality Assurance Project Plan (QAPP) for this research, Ecology promised annual reports to show changes following baseline establishment.[2] Ecology has since published several documents including, *Lower Yakima Valley Groundwater Management Progress Report Publication 25-10-074*[3], an ArcGIS story map entitled *Eyes Underground*[4], and a Nitrate Mapping Tool, *Lower Yakima Valley Groundwater Management Area – Generating Maps for Groundwater Level and Nitrate Concentrations.*[5]

Today: None of these publications met the needs of Friends of Toppenish Creek so we undertook our own analysis of the raw data that is available on Ecology's Environmental Information website.[6] First we transferred Ecology's data to excel spreadsheets to facilitate statistical analysis for Nitrate N and other relevant measurements. Then we calculated averages for 30 dedicated monitoring wells and for domestic wells in four sub areas. We looked for trends

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[1] Quality Assurance Project Plan Lower Yakima Valley Groundwater Management Area (GWMA), Ambient Groundwater Monitoring Network. QAPP: Lower Yakima Valley GWMA, Ambient GW Monitoring Network

[2] QAPP, Page 15

[3] Available at Lower Yakima Valley Ground Water Management Area annual report

[4] Available at Eyes Underground: Lower Yakima Valley

[5] Available at Lower Yakima Valley Groundwater Management Area – Generating Maps for Groundwater Level and Nitrate Concentrations

[6] WA Ecology. Environmental Information Management. Environmental Information Management database - Washington State Department of Ecology

for conductivity, dissolved oxygen, oxidation reduction potential, and pH. Our analysis clearly shows that LYV GWMA water quality is not improving.

We now share our findings with state and local leadership and the public in hopes of informing in depth discussion on how to stop the worsening trend. Just building the spreadsheets required days of tedious work on our part because data on Ecology's EIM site was not entered chronologically. It almost appeared that someone had shuffled the entries prior to posting. In any case, it would be a shame for others to have to repeat this work. FOTC will share our spreadsheets with anyone who asks. Just contact us at jeanrmendoza@icloud.com

Analyzing the data has required weeks of study and that analysis is ongoing. We ask readers to send critiques and suggestions our way to help improve this work.

Sincerely,

Friends of Toppenish Creek

Table of Contents

Introduction

Since 2008 when reporter Mary Beth Ward pulled back the blinders that hid hard facts of groundwater pollution in south Yakima County[7], people have debated the best ways to stop the pollution and to clean up Lower Yakima Valley (LYV) aquifers.

Between 2012 and 2019 citizens and officials came together monthly to analyze the problem and propose solutions as part of the Lower Yakima Valley Groundwater Management Area (LYV GWMA). The Dept. of Ecology (Ecology), our state's environmental science agency, stated that their experts could not determine whether water quality was improving or not without a baseline, a reference point. Without good data we are never sure whether we make a difference.

And so the GWMA advisory committee authorized the drilling of 30 dedicated monitoring wells, evenly spaced within the GWMA target area and the participation of community members who volunteered their domestic wells for testing. For two years from 2021 to 2023 Ecology tested the 30 dedicated monitoring wells and 142 other wells for Nitrate-N every three months.[8] Now Ecology tests the same wells once a year, every spring.

After two years of follow up, it appears that overall water quality is trending in the wrong direction. The Friends of Toppenish Creek have analyzed data posted on Ecology's Environmental Information Management System website.[9] We share the results of our work in this paper.

The average level of Nitrate-N in 30 dedicated monitoring wells has increased from a baseline average of 13.2 mg/L in 2023 to 14 mg/L in 2024 and 15.5 mg/L in 2025.

The average level of Nitrate-N in a convenience sample of domestic wells has increased slightly from a baseline average of 5.35 mg/L in 2023, to averages of 6.24 mg/L in 2024 and 5.66 mg/L in 2025.

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[7] "Hidden Wells, Dirty Water" was published in the Yakima Herald Republic in 2008. This three part report is available at GWMA MR Attachment 36 Hidden Wells Dirty Water.pdf

[8] There is no baseline for the years prior to 2022, just numerous studies with different criteria for inclusion. Many of those studies are listed in the LYV GWMA Final Report available at Lower Yakima Valley Groundwater Management Area - Washington State Department of Ecology under Program Documents, and in the FOTC Minority Report starting on page 28 available at GWMA MR Plan XV.pdf

[9] To access this data go to Ecology's Environmental Information System Data Base at EIM Search. Go to Groundwater and choose "Get Data". You will see a screen with lots of options. Scroll down to the bottom and the section that says "Study". Fill in the line that says, "Study ID" with "mred0005" and click on "Search Groundwater Data" at the bottom. This should lead you to four pages of data from the sampling of 172 wells. The first 30 listed wells are the dedicated monitoring wells. The sites that follow are organized around the various cities and towns in South Yakima County.

Nitrate N Levels at the Port of Sunnyside are the second highest in the GWMA target area, eclipsed only by readings from the "Dairy Cluster". We will provide more information on these two persistent problems beginning on pages 109 and 115 of this document.

Levels of Nitrate-N in domestic wells have increased around Grandview, Outlook and Zillah. Levels appeared to be steady around Granger, Mabton and Sunnyside.

Soil types and hydrogeology vary across the GWMA target area.[10] In prehistoric times tectonic forces created folds and faults on the slopes of the Rattlesnake Hills and the Horse Heaven Hills. Two wells half a mile apart may have very different well logs and readings. A network of 30 monitoring wells only delivers a rough approximation of groundwater pollution.

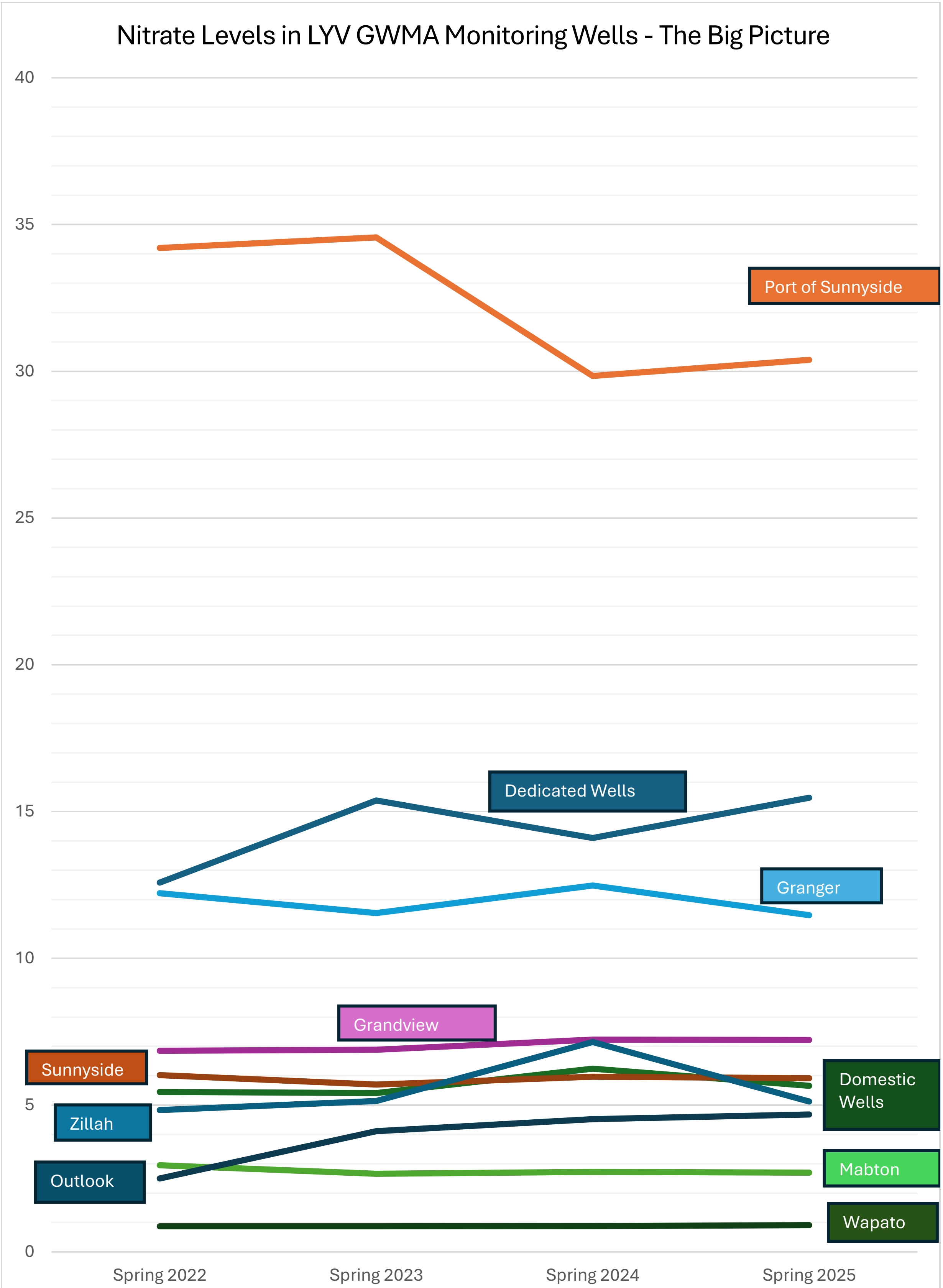
The domestic wells in this study belong to civic minded people who were willing to participate in the project. We can observe trends for each domestic well but these wells are not evenly distributed by location, well depth, proximity to the river, or many other variables. An average of readings from a convenience sample is not a true average.

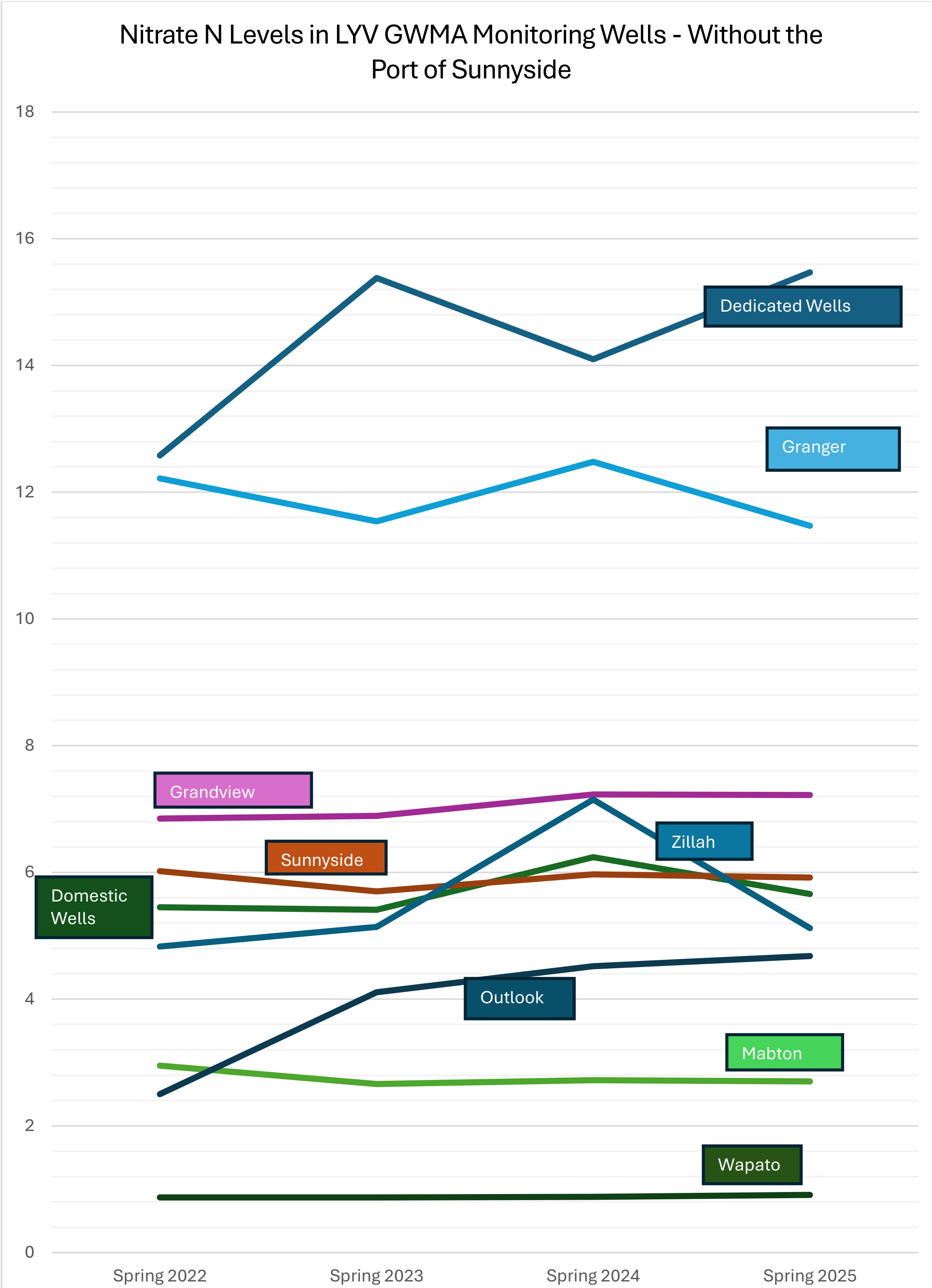
To understand this point consider: Average well depths for domestic wells in the network range from 106.75 ft in the Mabton area to 265.78 ft in the Zillah area. The two sub areas are different in terms of soils, underlying aquifers, agricultural practices and available wells for testing. Planning based on an average of the two areas does not address reality in either one.

In this paper we:

- Summarize results of testing from 30 dedicated monitoring wells.
- Summarize results of groundwater testing for Nitrate N by major zip codes in the area.
- Look at certain sub areas of interest – South Outlook, the area between Sunnyside and Grandview, North Mabton, and North Granger – in more depth.
- Add data from the "Dairy Cluster".
- Share data from court mandated research on a LYV dairy
- Share data collected at the Port of Sunnyside.
- Highlight most promising proposed solutions.

[10] See Attachment 3 with maps from the Lower Yakima Valley Groundwater Management Area


Nitrate Levels in LYV GWMA Monitoring Wells - The Big Picture
40
35
30
25
20
15
10
5
0
Port of Sunnyside
Dedicated Wells
Granger
Grandview
Sunnyside
Zillah
Outlook
Domestic Wells
Mabton
Wapato
Spring 2022
Spring 2023
Spring 2024
Spring 2025


Nitrate N Levels in LYV GWMA Monitoring Wells - Without the Port of Sunnyside
18
16
14
12
10
8
6
4
2
0
Dedicated Wells
Granger
Grandview
Zillah
Sunnyside
Domestic Wells
Outlook
Mabton
Wapato
Spring 2022
Spring 2023
Spring 2024
Spring 2025

Summary of Nitrate N Averages in Springtime in the LYV GWMA Target Area

	N	Ave Well Depth	Baseline Nitrate N	Spring 2022	Spring 2023	Spring 2024	Spring 2025
Dedicated Wells	30	71.3	13.19	12.58	15.38	14.1	15.47
Port of Sunnyside	3	22.5	38.2	34.2	34.56	29.84	30.39
Domestic Wells	139	198.7	5.35	5.45	5.41	6.24	5.66
Granger	11	132.9	11.61	12.22	11.54	12.48	11.47
Grandview	19	160.8	6.58	6.85	6.89	7.23	7.22
Mabton	16	106.8	2.72	2.95	2.66	2.72	2.7
Outlook	12	220.8	3.67	2.5	4.11	4.52	4.68
Sunnyside	37	190.8	5.72	6.02	5.7	5.97	5.92
Wapato	5	244.8	0.88	0.87	0.87	0.88	0.91
Zillah	36	265.8	4.86	4.83	5.14	7.15	5.12

Hopefully our work will stimulate further thought on how to achieve the overarching LYV GWMA goal:

> *The primary long-term goal of the GWMA is to reduce concentrations of nitrate in groundwater to below Washington State drinking water standards. Reductions in nitrogen loading will be demonstrated within 5 years.*[11]

Obviously the second part of the goal was not achieved. That is not a reason to give up. Water is too important.

[11] LYV GWMA Request for Identification. Microsoft Word - GWMA Petition Draft v8.doc

Special Concerns

LYV Dairy Cluster

Since early in our involvement with the Lower Yakima Valley Groundwater Management Area Advisory Committee (GWAC), FOTC has voiced concerns about the lack of attention to Nitrate N levels on what is commonly called the “dairy cluster” where the U.S. Environmental Protection Agency (EPA) has conducted research on the impact of groundwater pollution from five large dairies. Over our objections, the GWAC excluded the cluster area when choosing dedicated well sites. See the map below.

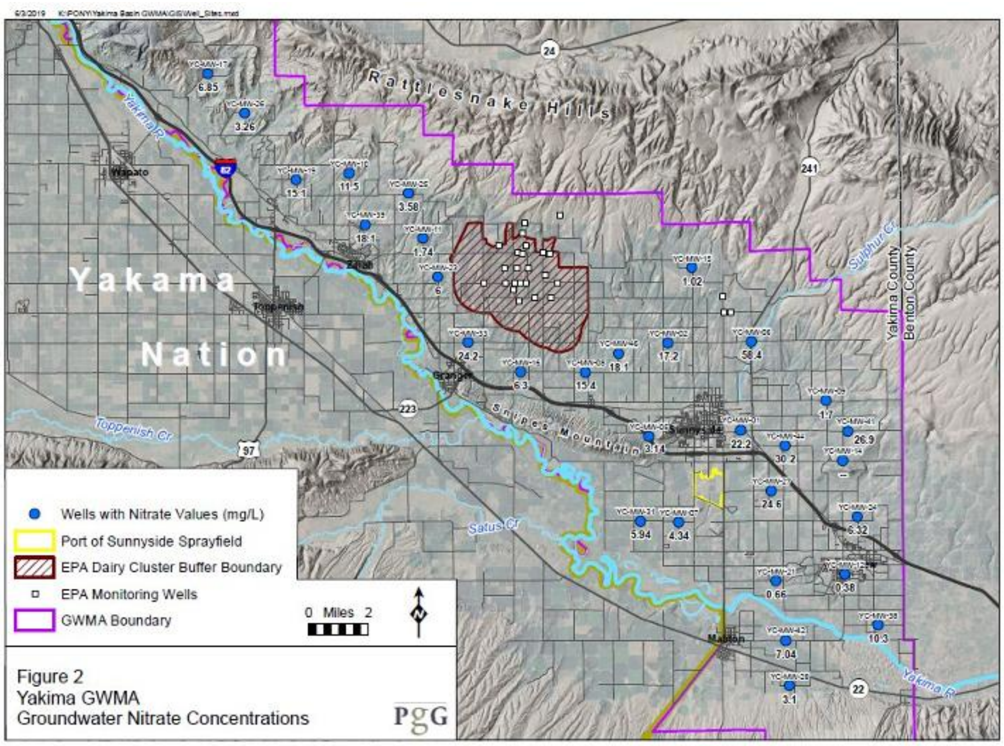


Figure 3. Locations of the monitoring wells installed by the GWMA and the respective nitrate concentrations (PGG, 2019).

The “dairy cluster” contains wells with some of the highest, if not the highest Nitrate N readings ever recorded in our state.[12] It seems unwise to exclude those readings when calculating average Nitrate N concentrations for the LYV GWMA.

Ecology promised to incorporate EPA data into their final reporting.[13] Unfortunately this did not happen. This is one of the reasons why FOTC has compiled this document. We have added

[12] U.S. Environmental Protection Agency. Lower Yakima Valley Groundwater Management Area. Lower Yakima Valley Groundwater | US EPA

[13] Quality Assurance Project Plan Lower Yakima Valley Groundwater Management Area (GWMA), Ambient Groundwater Monitoring Network. Page 24. QAPP: Lower Yakima Valley GWMA, Ambient GW Monitoring Network

data from the "dairy cluster" that shows little improvement in Nitrate N levels in downgradient wells and shows a continued threat to public health that includes a plume of nitrate contaminated groundwater moving toward the City of Granger.[14]

Aquitards and Preferential GW Flow

FOTC highlights another point on which we disagree with Ecology's methodology. It appears that Ecology has oversimplified the LYV GWMA target area and assumes that there is one unified aquifer beneath the surface. At least this is the description Ecology used in the agency's QAPP. In reality groundwater beneath the LYV GWMA moves according to complex hydrogeology. Over simplification eliminates the possibility of finding real solutions to pollution problems on a site by site basis.

WAC 173-100-100 Groundwater management program content says:

> *The program for each groundwater management area will be tailored to the specific conditions of the area. The following guidelines on program content are intended to serve as a general framework for the program, to be adapted to the particular needs of each area. Each program shall include, as appropriate, the following:*
>
> *(1) An area characterization section comprised of:*
>
> *(e) A description of the area's hydrogeology, including the delineation of aquifers, aquitards, hydrogeologic cross-sections, porosity and horizontal and vertical permeability estimates, direction and quantity of groundwater flow, water-table contour and potentiometric maps by aquifer, locations of wells, perennial streams and springs, the locations of aquifer recharge and discharge areas, and the distribution and quantity of natural and man-induced aquifer recharge and discharge;*

In 2021 when FOTC argued before the WA State Pollution Control Hearings Board that the LYV GWMA program failed to comply with WAC 173-100-100, we noted that the program failed to identify aquitards that direct and redirect groundwater flow in the area. Ecology argued that the agency has discretion to decide whether or not to do this work and the PCHB agreed.

Consequently such foundational work is missing from the LYV GWMA description of the area hydrogeology.[15] Consideration of groundwater flow is missing from Ecology's baseline and

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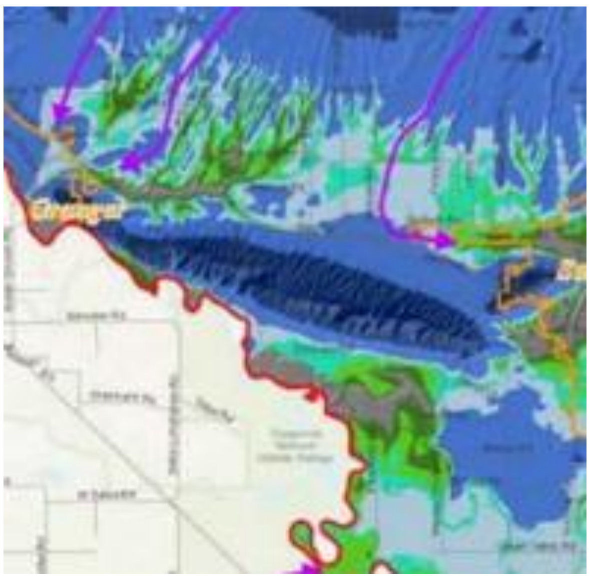
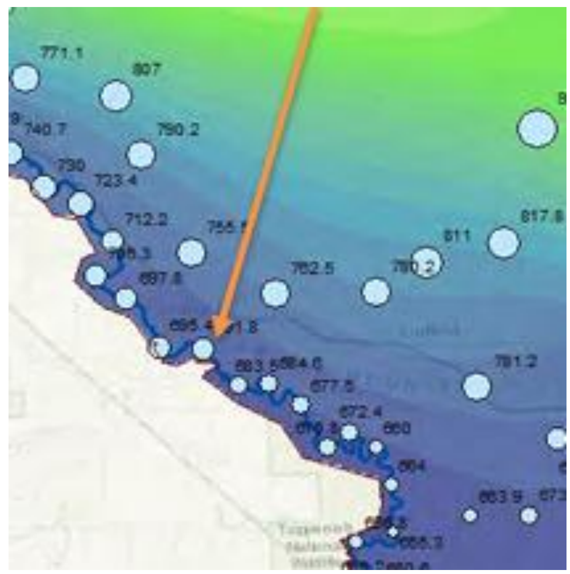
[14] Environmental Protection Agency, Region X. Lower Yakima Valley Groundwater Management Area. Lower Yakima Valley Groundwater | US EPA

[15] FOTC asserts that simply referencing the scientific work of the U.S. Geological Survey is not enough. A truly scientific work must show that the findings in the referenced work were incorporated into study conclusions.

trend analyses. There are big differences in monitoring well readings that could be explained by hydrogeology. This major factor has not been explored.

In a worst case example of over simplification, Ecology and the WA State Dept. of Health commissioned a study that erased a major anticline from the LYV map. In reality Snipes Mountain is a basalt outcropping that blocks groundwater flow from the Rattlesnake Hills to the Yakima River in an area near the middle of the GWMA. Snipes Mountain causes groundwater flow to make a right turn, either to the east or west and skirt the basalt. The Tetra Tech Study simply pretends that Snipes Mountain does not exist and shows groundwater flowing straight south to the river in this area.

Reality	**Oversimplification**
	
From LYV GWMA Final Report, Vol. 1, Page 52. Available at GWMA Volume I Purple arrows show groundwater flow	From Lower Yakima Valley Groundwater Management Area – Generating Maps for Groundwater Level and Nitrate Concentrations. Pages 12 – 15. Available at Lower Yakima Valley Groundwater Management Area – Generating Maps for Groundwater Level and Nitrate Concentrations

Sample Timing

Samples were taken as close to quarterly as possible, but the range of months for each quarter was large. A sample for what we consider winter could be taken any time from mid-December to the end of March. A sample for summer could be taken in June, July or August. Consequently data on water temperature and possibly other parameters lacks precision.

Objective

In this document FOTC presents simple calculations that show how groundwater quality is changing in different parts of the GWMA, along with supporting data to inform science based discussions.

One of the principles guiding study of nitrate contamination of groundwater is reliance on measurement of two major factors [16, 17] :

1. Nitrogen Input Factors

- High = high nitrogen loading or high population density
- Low = low nitrogen loading and low population density

2. Aquifer Vulnerability Factors

- High = well drained soil and low woodland to cropland ratio
- Low = poorly drained soil or high woodland to cropland ratio

FOTC keeps this principle in mind as we study data for the LYV. In general the LYV has few woodland areas. Our soils are highly variable with more well drained areas than poorly drained. The human population is not dense, while the bovine population is the most dense in Washington state. Ecology specifically ruled out identification of sources in the monitoring network.

Attention to groundwater pollution is important for the people of the LYV because it relates to our health and welfare. It is important for the people of Washington State because failure to restore the health of LYV aquifers and drinking water means unending provision of bottled water to LYV residents at a great expense to the entire state. How much more plastic can we absorb?

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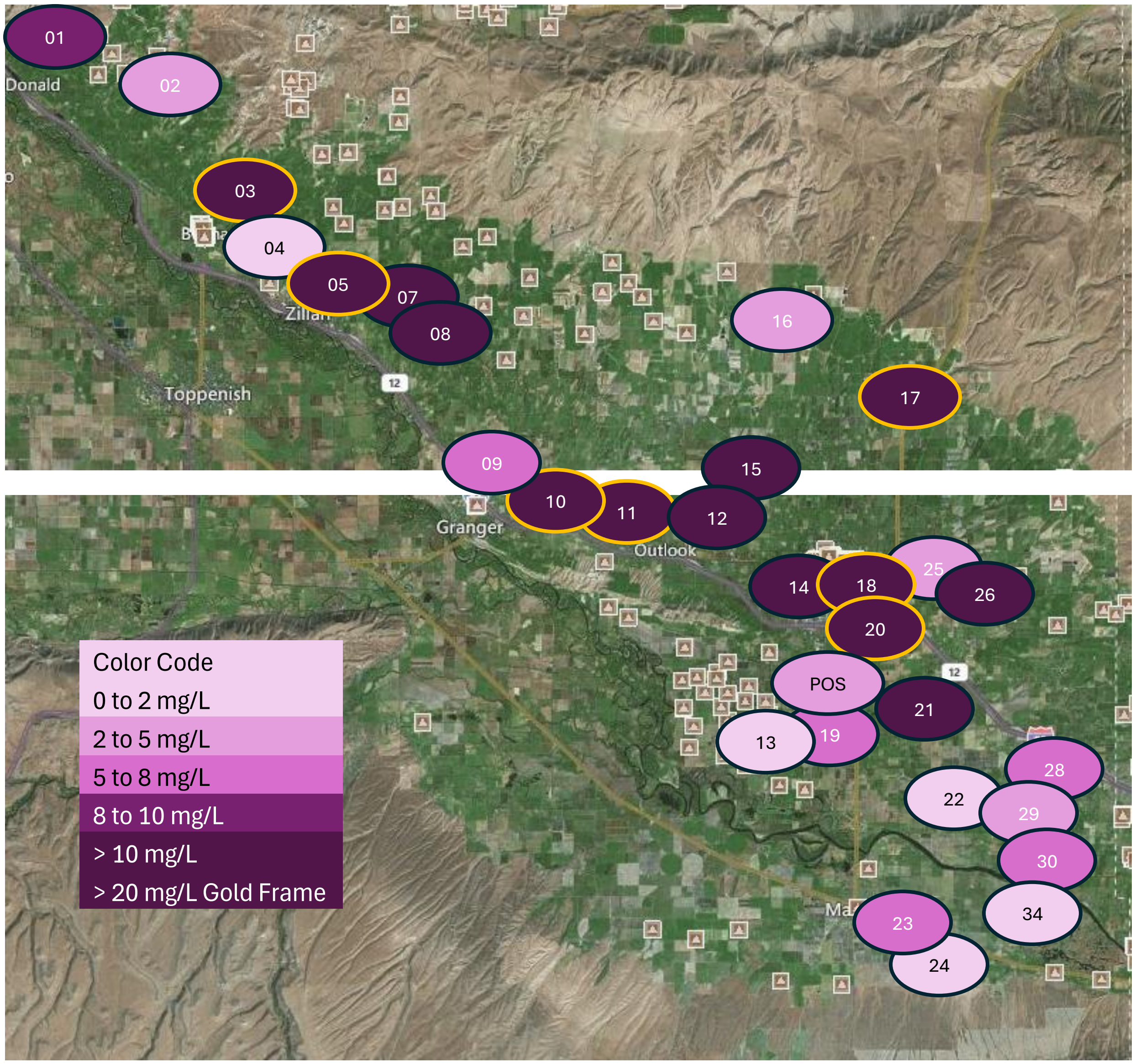
[16] Nolan, B. T., Ruddy, B. C., Hitt, K. J., & Helsel, D. R. (1997). Risk of Nitrate in groundwaters of the United States a national perspective. *Environmental science & technology*, *31*(8), 2229-2236. est_v31_no8.pdf

[17] WA Ecology. Nitrate Prioritization Project. Washington Nitrate Prioritization Report

Nitrate N Data for the LYV GWMA as a whole

Lower Yakima Valley Groundwater Dedicated Monitoring Wells – Spring 2025 Readings



This map describes the most recent readings for dedicated wells.[18]

This map shows the official numbering for the LYV GWMA Monitoring Wells. Numbers 6 and 27 are missing because they no longer pump water. Ecology has added a monitoring well

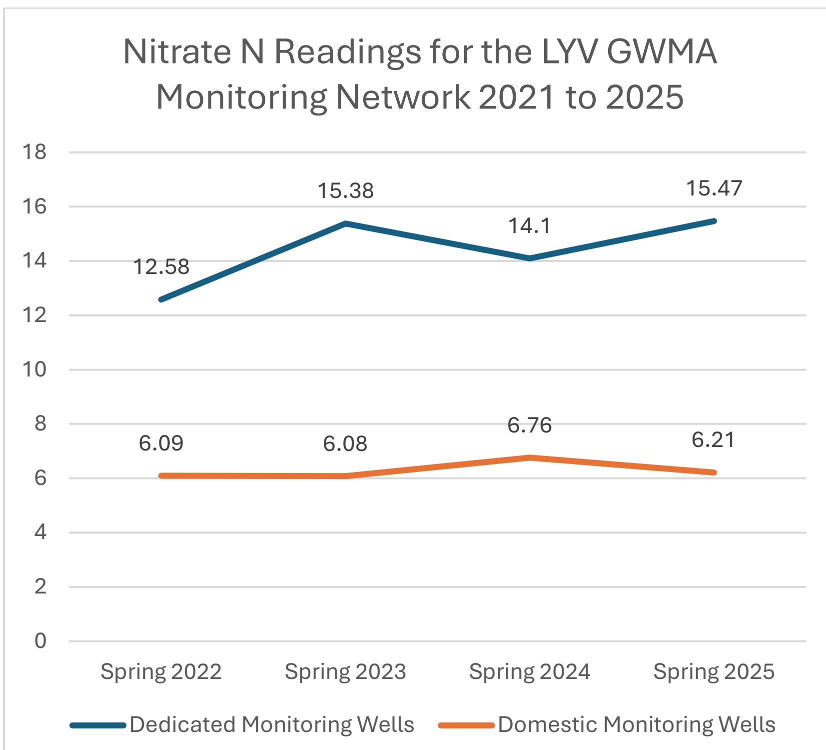
[18] For more in depth history and mapping, please visit Attachment LYV Dedicated Monitoring Wells III

from the Port of Sunnyside and a monitoring well from the old Grandview waste water treatment site, MW 34, to bring the total back to 30.

These wells tap "first waters", the top layers of the aquifers accessed when monitoring wells were drilled. The dedicated monitoring wells are generally more shallow than the domestic wells home owners use for drinking water and consequently yield higher readings. Ecology's rationale for monitoring " first waters" was stated in the QAPP for the project [19]:

> *Forty-five percent of the 30 randomly placed monitoring wells exceeded (did not meet) the safe drinking water standard for nitrate during the initial well sampling in the fall of 2018. Since the monitoring wells are screened across the water table, they intercept water impacted by surface activities as it first reaches groundwater. This upper zone is a good indicator of impacts from surface activities.*

The graph below depicts changes in spring Nitrate N readings over time for the entire GWMA target area.



[19] Quality Assurance Project Plan Lower Yakima Valley Groundwater Management Area (GWMA), Ambient Groundwater Monitoring Network. Page 10. Available at [QAPP: Lower Yakima Valley GWMA, Ambient GW Monitoring Network]

Groundwater Flow

Vertical GW Flow

In 2006 the USGS published a *Hydrogeologic Framework of Sedimentary Deposits in Six Structural Basins, Yakima River Basin, Washington*[20] that mapped the LYV into the Toppenish Sedimentary Basin and the Benton Sedimentary Basin. The dividing line runs northeast to southwest through the City of Granger.

10 Hydrogeologic Framework of Sedimentary Deposits in Six Structural Basins, Yakima River Basin, Washington

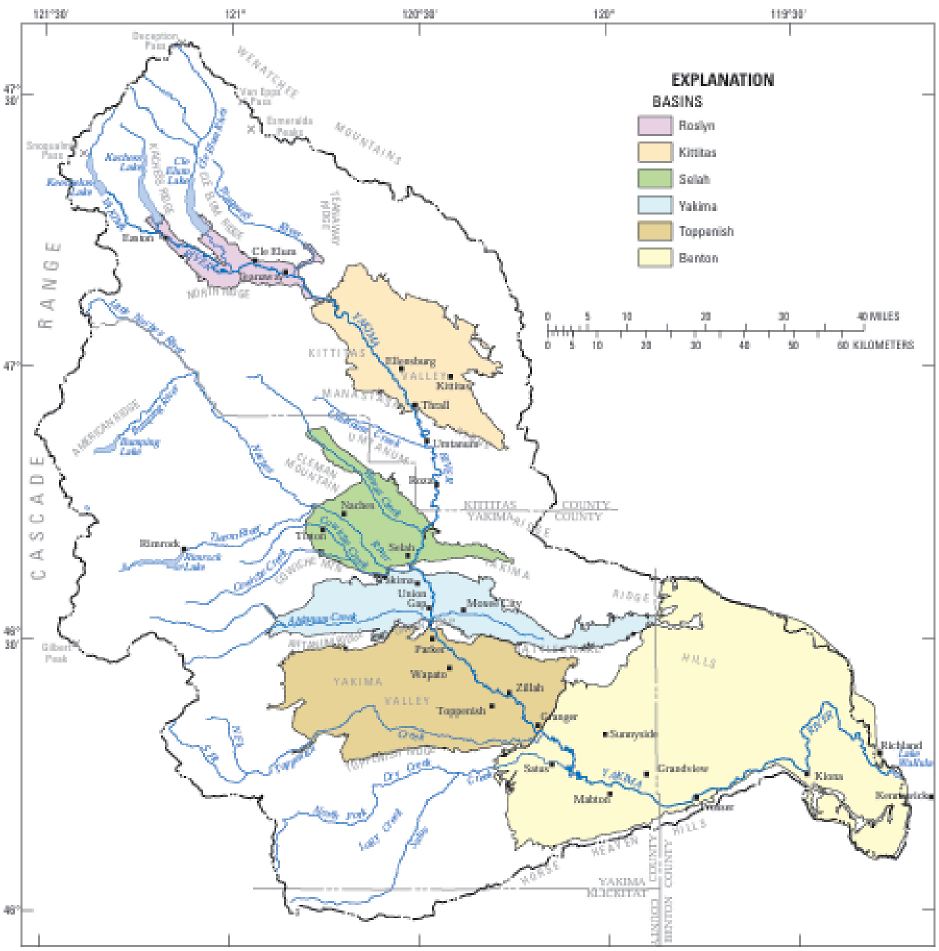


Figure 6. Location of six sedimentary basins, Yakima River Basin, Washington.

“The thickness of the basin-fill deposits in the Toppenish Basin is greatest in the central-southeastern part of the basin. The thickness of the basin-fill deposits ranges from 0 to 1,210 ft, with a mean and median thickness of 550 ft.”

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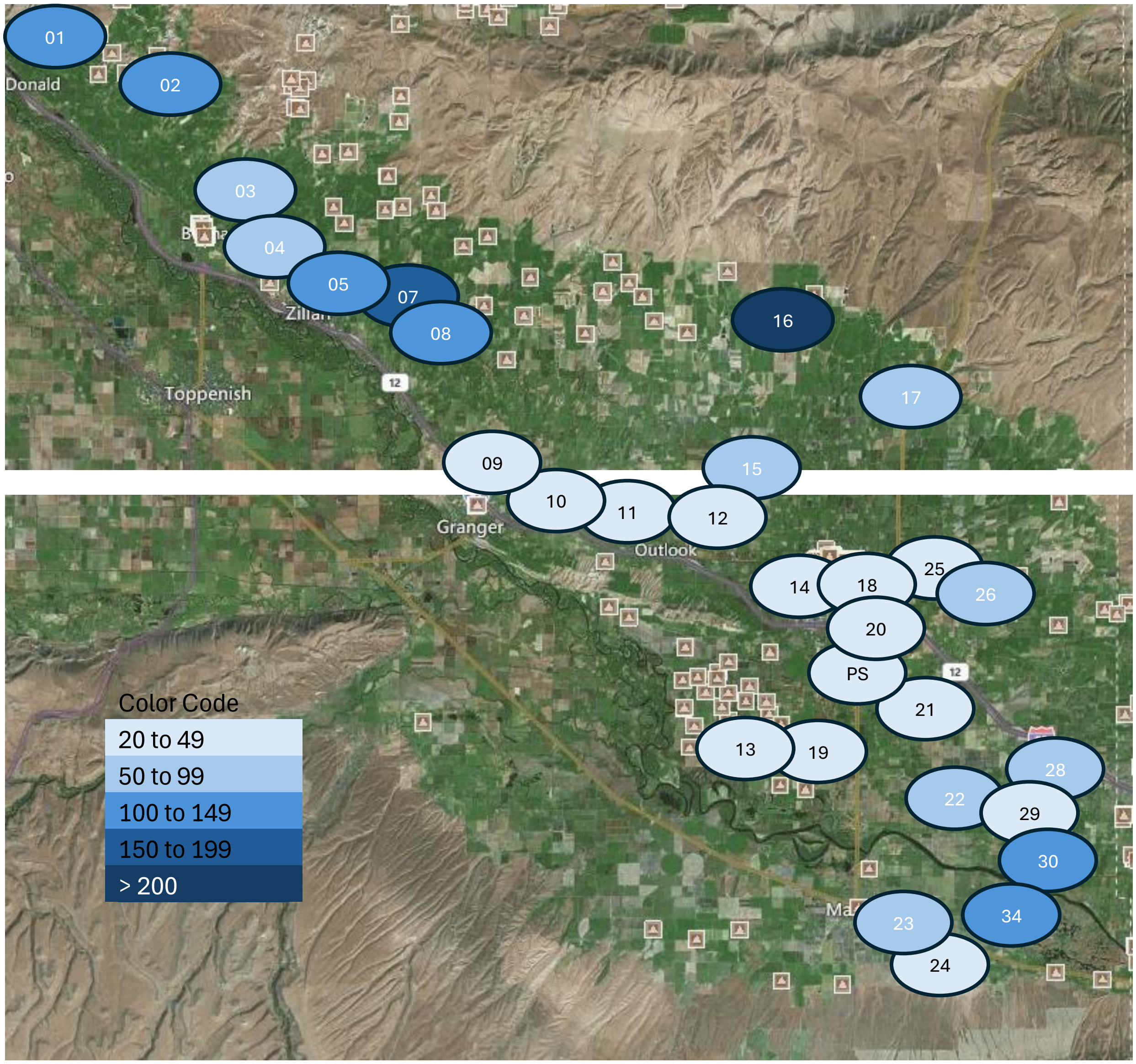
[20] Jones, M.A., Vaccaro, J.J., and Watkins, A.M., 2006, Hydrogeologic framework of sedimentary deposits in six structural basins, Yakima River Basin, Washington: U.S. Geological Survey Scientific Investigations Report 2006-5116, 24 p. sir20065116.pdf

"The thickness of the basin-fill deposits in the Benton Basin ranges from 0 to 870 ft, with a mean and median thickness of 120 and 60 ft, respectively."

Well Depths for LYV GWMA Dedicated Monitoring Wells



Generally speaking depth to groundwater is greater in the northern third of the GWMA target area. The underlying basalt is closer to the surface in the Benton Basin and reaches the surface in many parts of that basin. Drillers hit basalt at 20 ft when they drilled MW 26.[21]

[21] For more details see Attachment – Dedicated Well Logs

Lateral GW Flow

Groundwater moves slowly across the landscape following gravity and paths of least resistance. Rates vary significantly depending on geology.

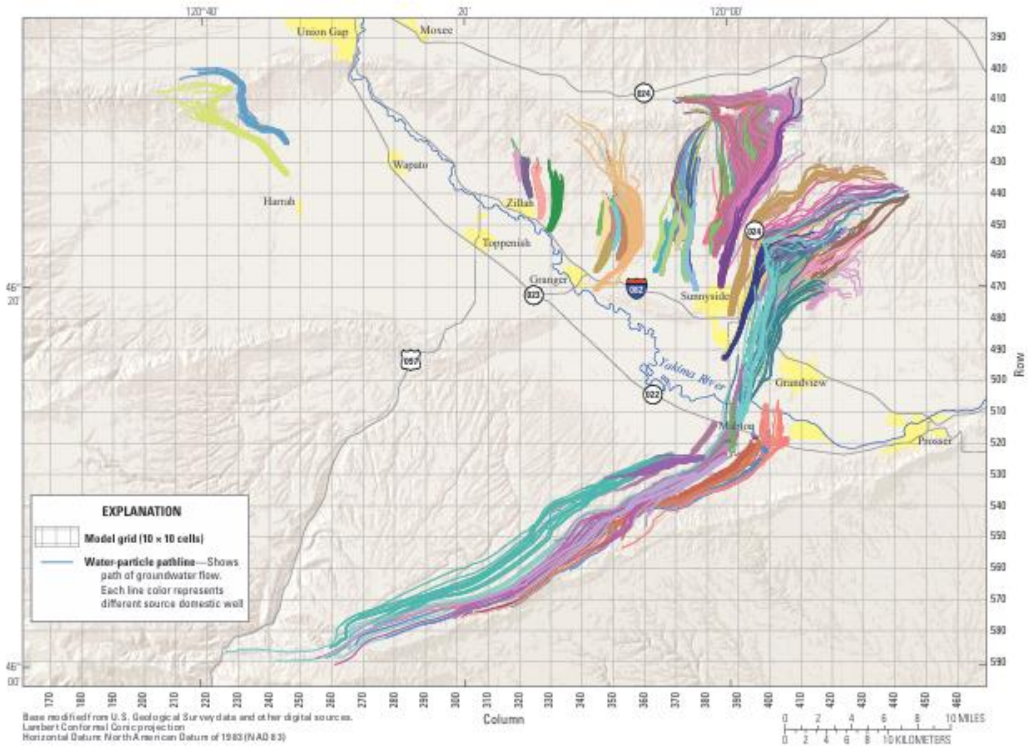


Figure 11. Simulated particle histories for particles that ended the 42-year simulation period at the location of model cells containing selected groundwater wells in the lower Yakima River Basin, Washington.

From Particle Tracking for Selected Groundwater Wells in the Lower Yakima River Basin, Washington, Page 27. Available at [body v 3.5.1]

In 2015 the USGS published research that maps groundwater movement from the Rattlesnake Hills and the Horse Heaven Hills towards the valley floor. [22] This study confirms work performed by the EPA that predicts movement of pollutants in groundwater from the "Dairy Cluster" toward the City of Granger. It also shows tortuous groundwater pathways around Sunnyside and Mabton.

Unfortunately there is no mapping of the area south of Snipes Mountain between Sunnyside and Mabton. Is it possible that the Snipes Mountain barrier protects this area from contamination? Could re-direction of the flow of groundwater from polluted farmland to the north account for high Nitrate N levels at the Port of Sunnyside

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[22] Bachmann, M.P., 2015, Particle tracking for selected groundwater wells in the lower Yakima River Basin, Washington: U.S. Geological Survey Scientific Investigations Report 2015-5149, 33 p., http://dx.doi.org/10.3133/sir20155149

LYV GWMA Dedicated Monitoring Well Data

FOTC has placed Nitrate N readings for dedicated monitoring wells along with basic sampling data into a spreadsheet that is available to others for your own use in analyzing LYV GWMA data. We have done this for some, but not all sub areas of domestic wells. We did not have the time and resources to do comprehensive data entry for all the domestic wells.

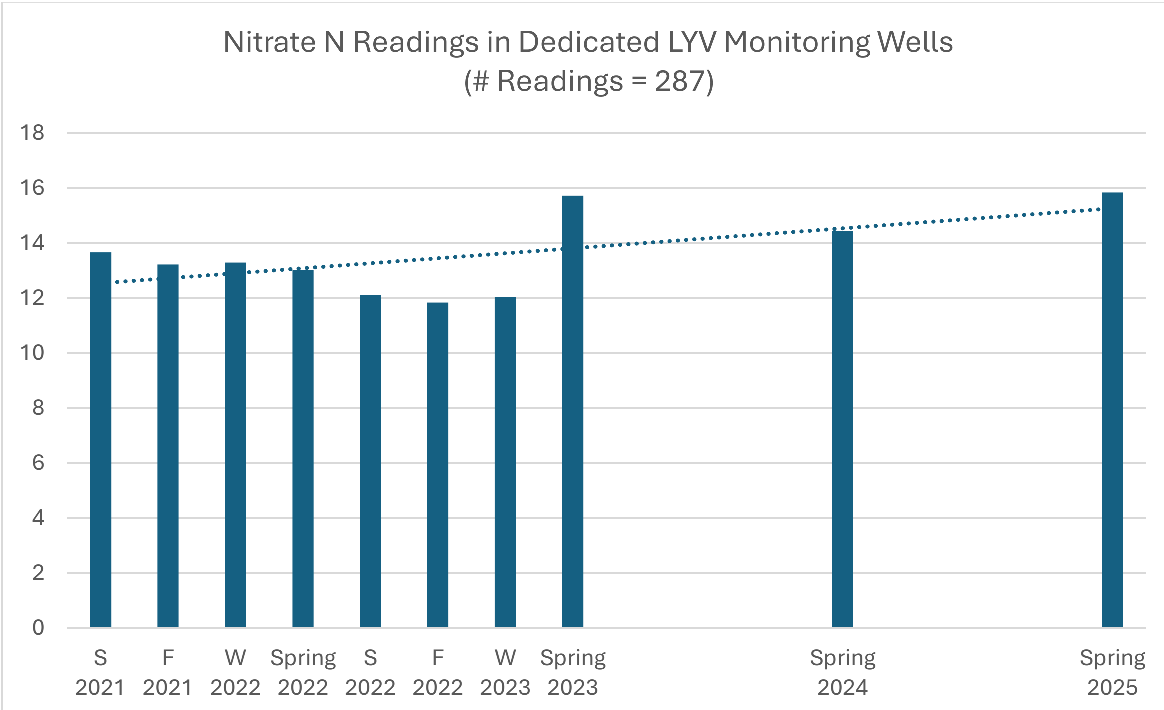
The table below shows that overall Nitrate N readings in dedicated monitoring wells are increasing. Conductivity readings, DO readings, REDOX potential readings and pH readings have all generally increased over the past 4 to 5 years. Those trends are graphed below.

Summary Statistics for Dedicated Monitoring Wells

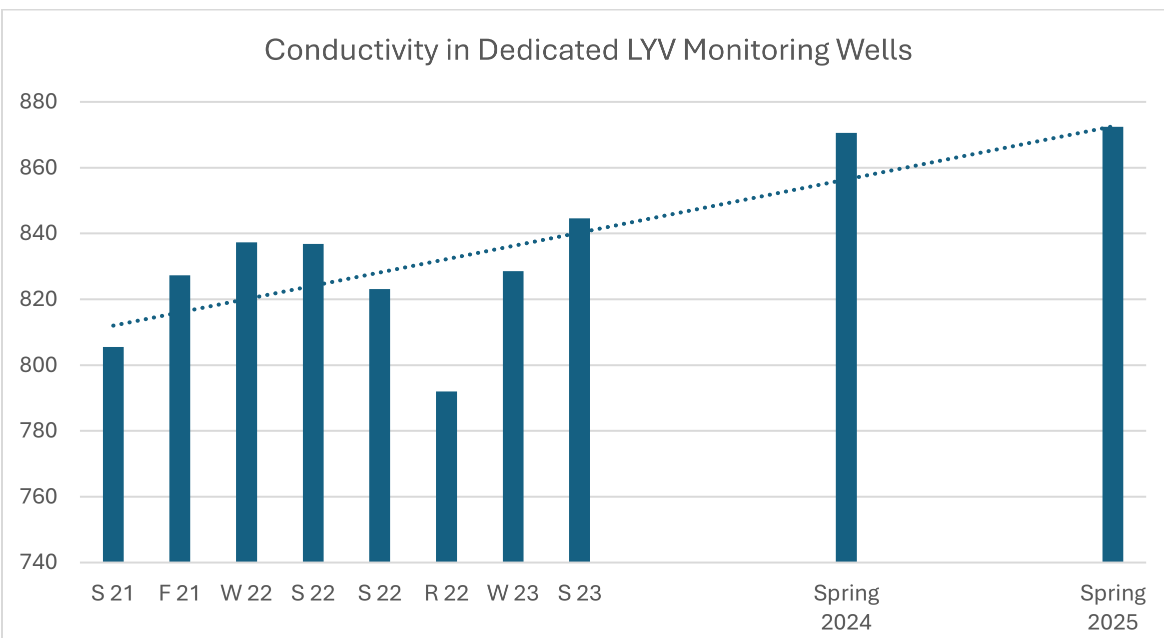
	Baseline		Spring 2022	Spring 2023	Spring 2024	Spring 2025
Nitrate N mg/L	13.19		13.02	15.72	14.45	15.84
Ammonia mg/L	0.024		0.0103	0.01	0.01	0.015
Conductivity µS/cm	821.83		836.78	844.62	870.57	872.39
Dissolved Oxygen mg/L	5.08		4.85	5.27	5.16	5.16
REDOX Potential mV	167.18		145.45	185	173.64	231.04
pH	7.32		7.39	7.38	7.43	7.48
Temperature	14.94		14.06	15.07	16.84	15.31

Graphing of Trends for Data from Dedicated Monitoring Wells

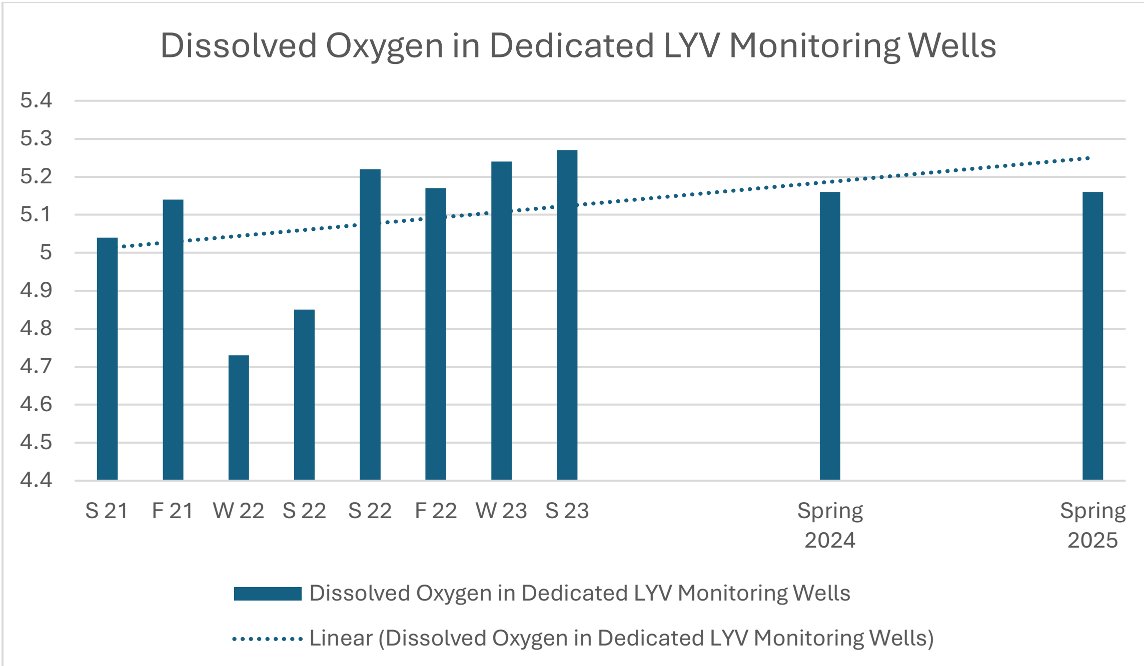
Nitrate N



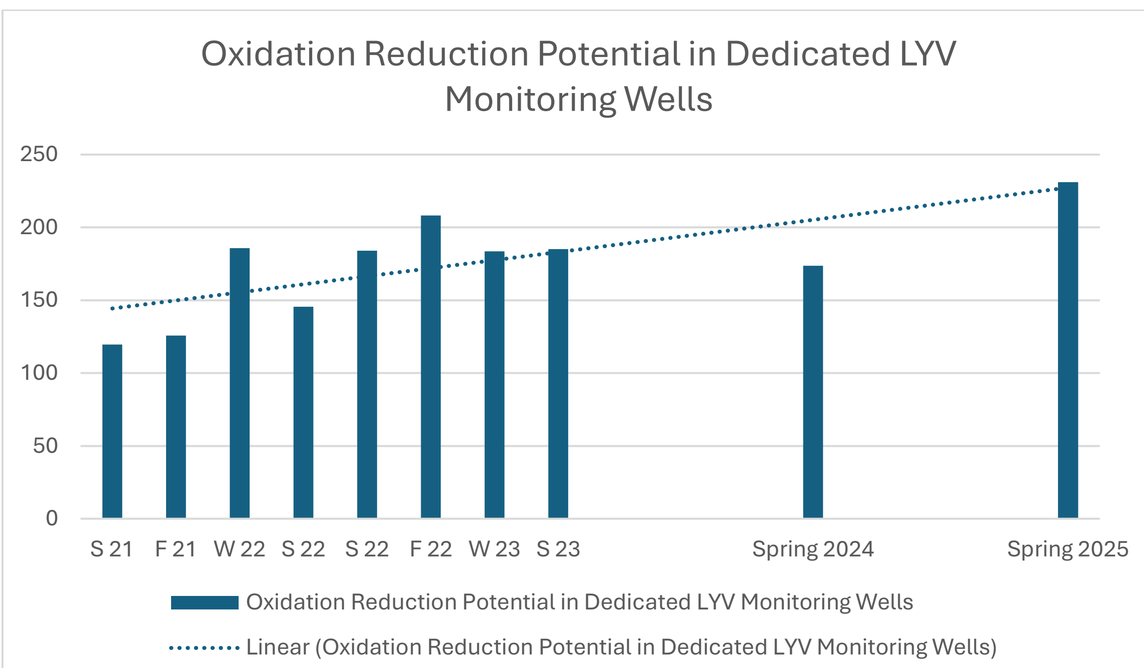
Conductivity



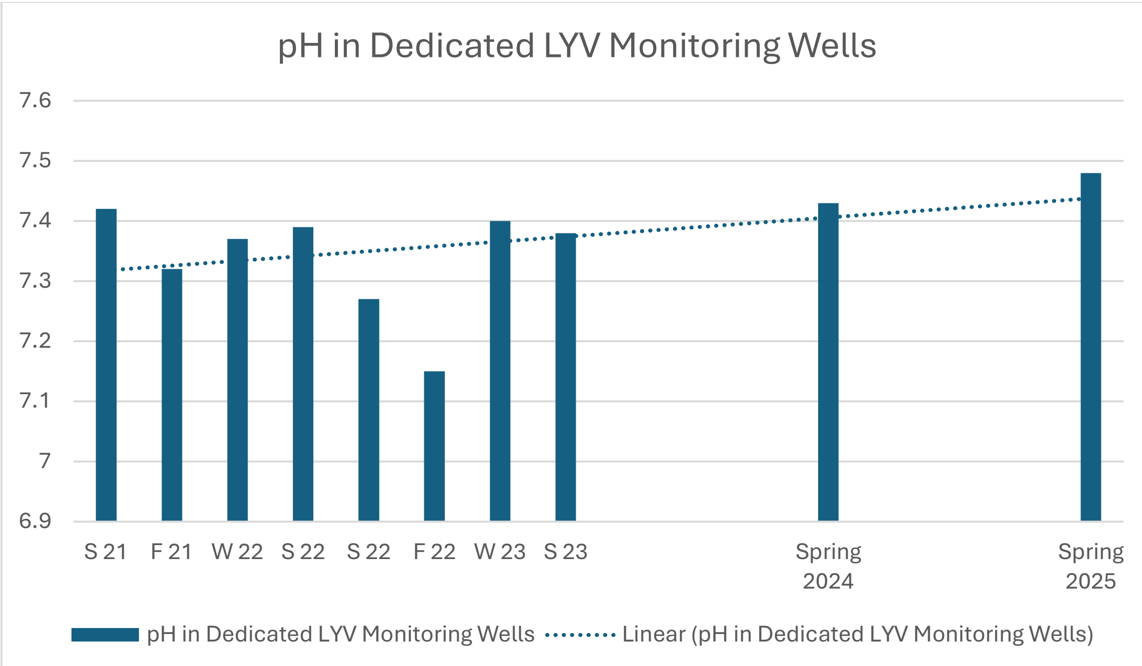
Dissolved Oxygen



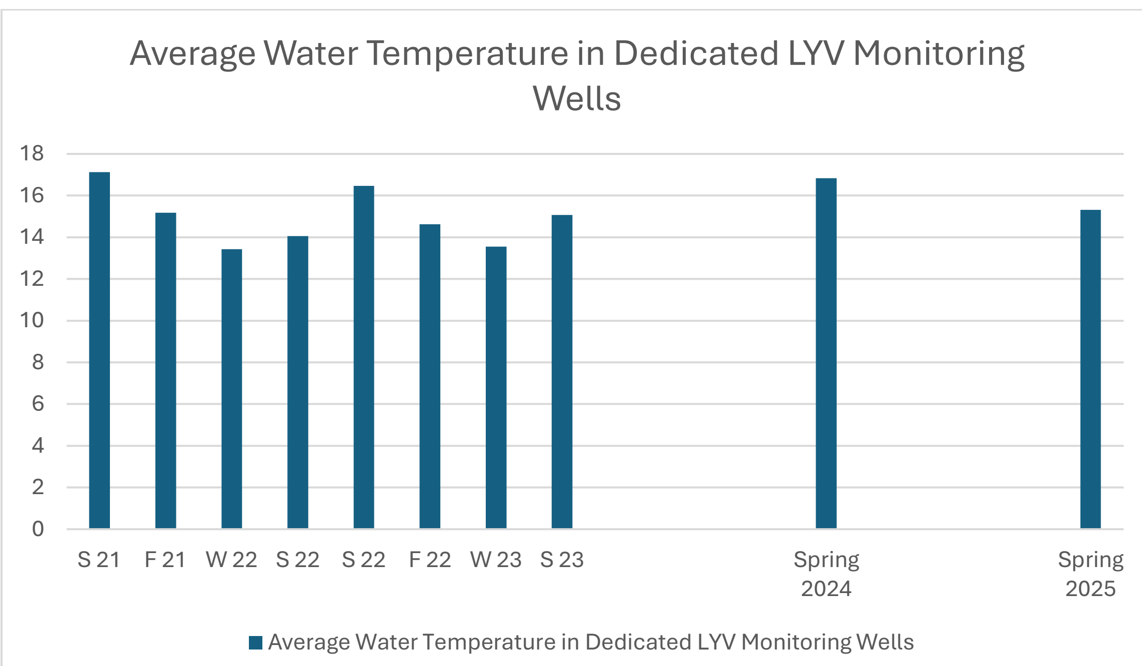
Oxidation Reduction Potential



pH



Water Temperature

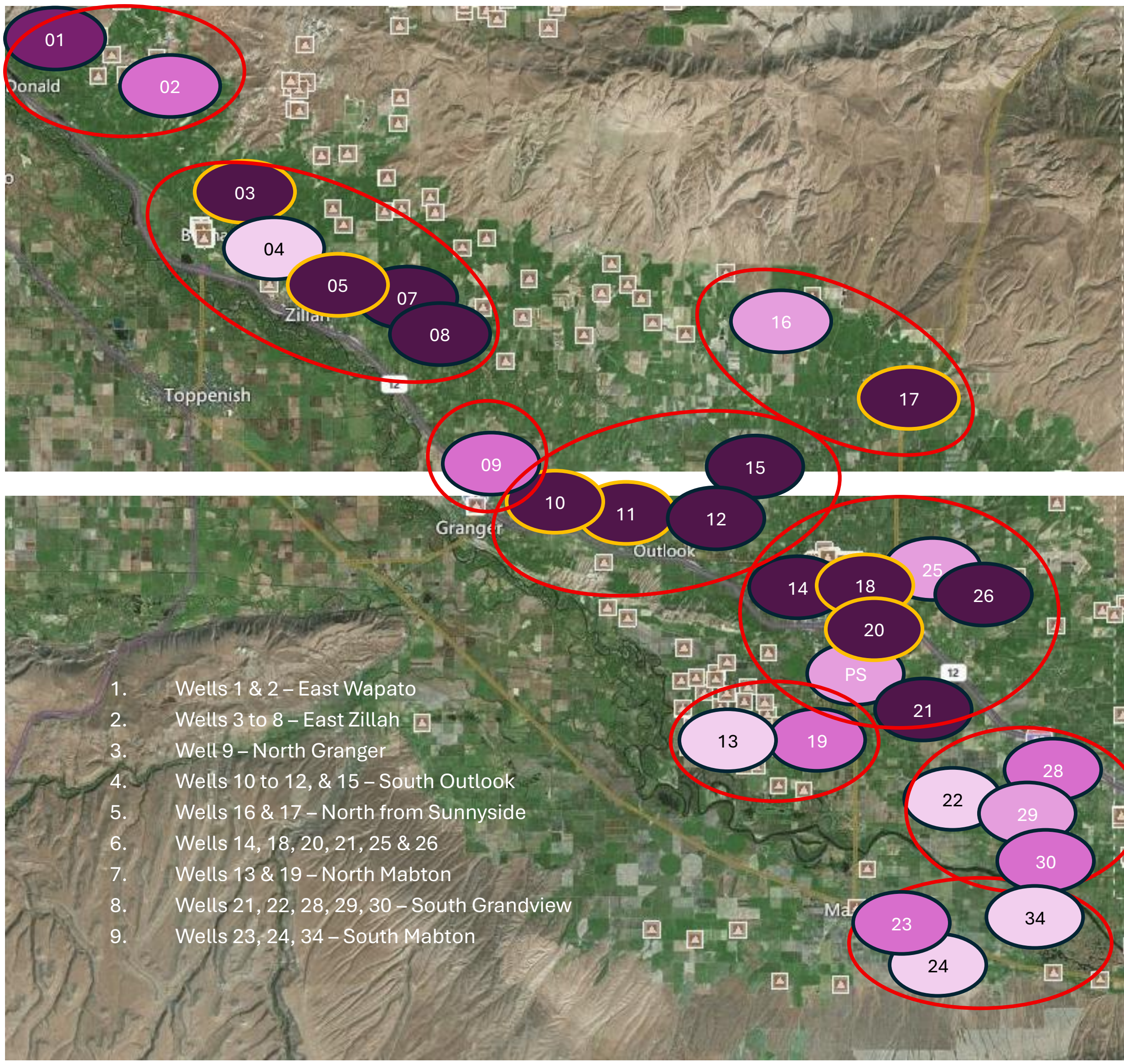


Dedicated Monitoring Well Analysis by Sub Area

One way to begin making sense of data from the LYV GWMA Ground Water Monitoring network is to divide the large target area into distinct sub areas and look for relationships between monitoring data and the underlying hydrogeology.

FOTC began our analysis by grouping Dedicated Monitoring Wells as shown in the map below.

LYV GWMA Dedicated Monitoring Wells – Spring 2025 Nitrate-N Readings



Wells 1 & 2 – Northwest Corner/East Wapato

Wells 1 & 2 – Northwest Corner/East Wapato

Historically this area had low levels of Nitrate N, although there are other drinking water contaminants present. The 2002 VIRE study found no wells with nitrates above 10 mg/L in the northern half of the Lower Yakima Valley (LYV).

Two dedicated monitoring wells in this sub area surprisingly yield ≈ 7 mg/L Nitrate N. Domestic wells in the area yield < 1 mg/L Nitrate N. Other parameters – conductivity, dissolved oxygen, REDOX potential, and pH are normal in this area. Soils are well drained with no clay reported in well logs for the dedicated wells.

Agriculture in this area is mostly comprised of orchards. The area has steeper slopes than other parts of the lower valley. The Cheyne Landfill lies in this sub area, east of the unincorporated community of Donald, and 3 miles east of MW 2.

In the past FOTC has reviewed reports from the monitoring wells at Cheyne Landfill. The landfill reported data from four monitoring wells with depths ranging from 338 to 494 feet. Two wells tap a sandy unit in the Ellensburg Formation and two tap an upper area of the Pomona Basalt. None of the wells showed signs of nitrate contamination, although there were exceedances for arsenic, iron, and magnesium. In 2015 groundwater flow was estimated to be between 0.58 ft per year and 127.8 ft per year for the sandy unit. Groundwater beneath the landfill tends to flow from north to south. See Attachment 2 – Cheyne Landfill Report

Dedicated Well Log Data for East Wapato

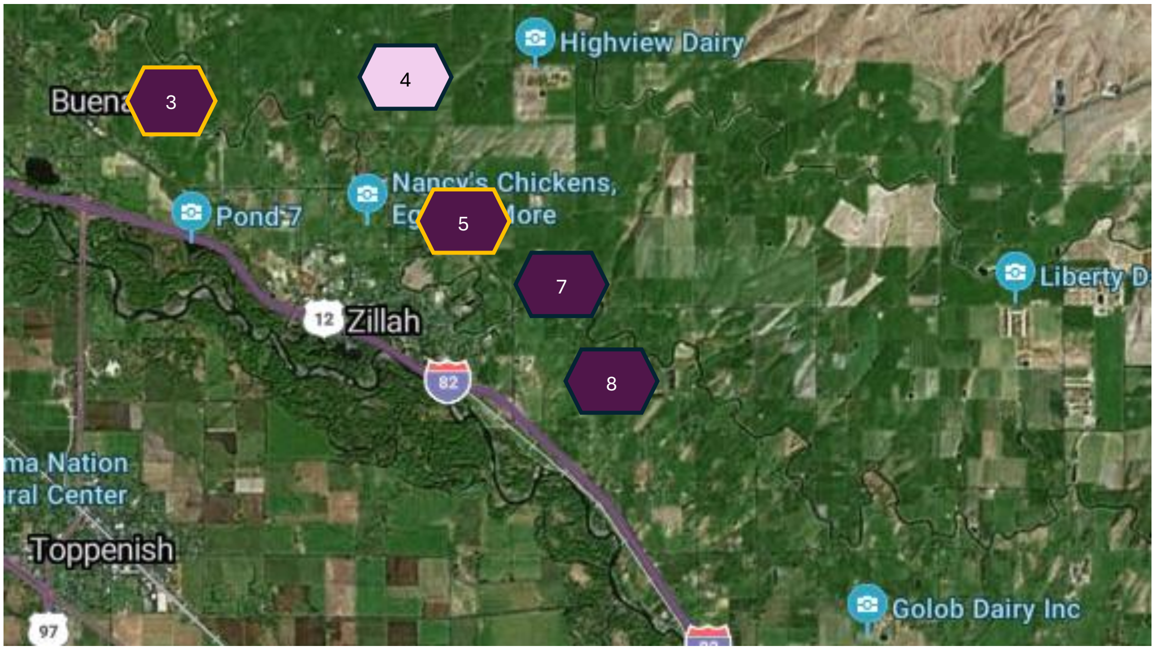
Depth	MW 1	MW 2
0 to 5	Sandy Silt	Silty Sand w/ Cobbles
5 to 10	Sandy Silt	Silty Sand w/ Cobbles
10 to 20	Sandy Silt	Silty Sand w/ Cobbles
20 to 30	Sandy Silt	Silty Sand w/ Cobbles
8 to 40	Sandy Silt	Silty Sand w/ Cobbles
40 to50	Sandy Silt	
50 to 60	Silty Sand	
60 to 70	Silty Sand	
70 to 80	Silty Sand	
80 to 90	Silty Sand	
90 to 100	Silty Sand	
100 to 110	Silty Sand	
110 to 120	Silty Sand	
120 to 130		

East Wapato						
Nitrate N Wapato	Spring 2022	Spring 2023	Spring 2024	Spring 2025		Averages
LYV-MW-001	8.16	7.24	8.50	8.89		7.10
LYV-MW-002	4.31	5.75	8.64	5.33		
Conductivity Wapato						
LYV-MW-001	974.7	947.9	989.9	941.9		965.15
LYV-MW-002	824.1	1119	1092.2	831.5		
DO Wapato						
LYV-MW-001	4.04	4.5	4.21	4.12		6.03
LYV-MW-002	8.35	7.33	7.93	7.73		
REDOX Wapato						
LYV-MW-001	335	200	179.1	221.2		208.76
LYV-MW-002	121	194	171.7	248.1		
pH Wapato						
LYV-MW-001	7.06	6.88	6.77	7.1		7.10
LYV-MW-002	7.34	7.09	7.08	7.47		

Comparing Dedicated Wells in the East Wapato Area to All LYV GWMA Dedicated Wells

Comparison		Nitrate N	Conductivity	Dissolved Oxygen	REDOX	pH
All Dedicated Wells		13.19	821.83	5.08	167.18	7.32
Wapato		7.1	965.15	6.03	208.76	7.1
		7.1	965.15	6.03	208.76	7.1
	Greater than Average				Below Average	

Wells 3 to 8 – East Zillah



Wells 3 to 8 – East Zillah

There are multiple hobby farms, orchards, vineyards, corn & hay fields, and one dairy in this area. The VIRE study did not find elevated nitrates near Zillah, but dedicated monitoring wells 3, 5, 7 and 8 now exceed 10mg/L.

Land in this area is irrigated and somewhat hilly. There are toxic cleanup sites at the unincorporated community of Buena which is served by a municipal water system that is operated by Yakima County. That system has two wells drilled to 473 and 477 feet. The most recent Nitrate N readings for the wells posted 2.88 mg/L.

Well logs that record clay and silty clay give rise to concerns about unidentified aquitards in this area. For the most part soils in this area are well drained.

Nitrate N levels for dedicated monitoring wells in East Zillah average 19.15 mg/L which is quite high. Conductivity and Nitrate N levels are high for wells 3 & 5. Oxygen levels are healthy for these wells and pH is relatively low.

Dedicated Well Log Data for East Zillah

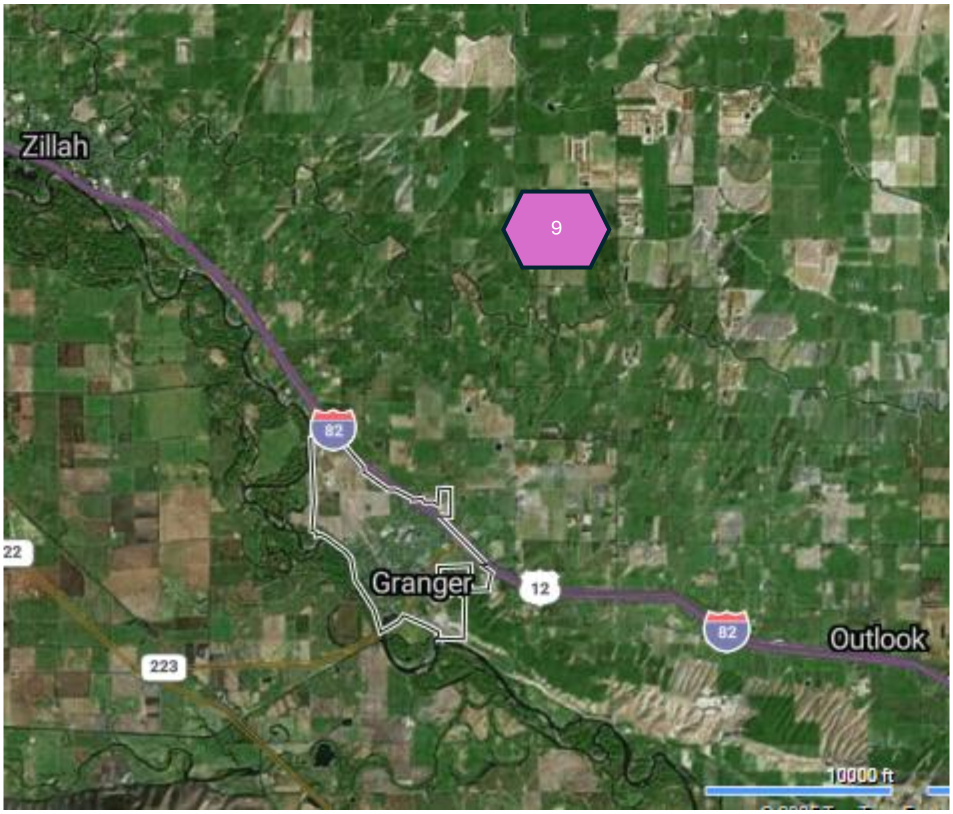
Depth	MW 3	MW 4	MW 5	MW 6	MW 7	MW 8
0 to 5	Sandy Silt	Silty Sand w/ Cobbles	Sandy Silt	Silty Sand & Gravels	Silty Sands w/ Gravels	Silty Sands
5 to 10	Sandy Silt	Silty Sand w/ Cobbles	Sandy Silt	Silty Sand & Gravels	Silty Sands w/ Gravels	Silty Sands
10 to 20	Sandy Silt	Silty Sand w/ Cobbles	Silty Clay	Clayey Silt	Silty Sands w/ Gravels	Silty Sands
20 to 30	Sandy Silt	Silty Sand w/ Gravels	Silty Clay	Clayey Silt	Silty Sands w/ Cobbles	Silty Sands
30 to 40	Sandy Silt	Silty Sand w/ Gravels	Silty Clay	Clayey Silt	Silty Sands w/ Cobbles	Silty Sands
40 to50	Sandy Silt	Silty Sand	Silty Clay	Clayey Silt	Silty Sands w/ Cobbles	Silty Sands
50 to 60	Sandy Silt	Silty Sand	Silty Clay	Clayey Silt	Silty Sands w/ Cobbles	Silty Sands
60 to 70		Silty Sand w/ Gravels	Silty Clay	Clayey Silt	Silty Sands w/ Cobbles	Clayey Silt
70 to 80			Silty Sand & Cobbles	Clayey Silt	Clayey Silt	Clayey Silt
80 to 90			Silty Sand & Cobbles	Clayey Silt	Clayey Silt	Clayey Silt
90 to 100			Silty Sand & Cobbles	Silty Gravels & Cobbles	Clayey Silt	Silty Sand
100 to 110			Silty Sand & Cobbles	Silty Gravels & Cobbles	Clayey Silt	Silty Sand
110 to 120			Silty Sand & Cobbles	Silty Gravels & Cobbles	Clayey Silt	Silty Sand
120 to 130				Silty Gravels & Cobbles	Gravely Cobbles	
130 to 140				Sandy Silt	Gravely Cobbles	
140 to 150				Sandy Silt	Gravely Cobbles	
150 to 160				Sandy Silt	Gravely Cobbles	
160 to 170				Sandy Silt	Gravely Cobbles	
170 to 180				Sandy Silt	Silty Sands w/ Gravels	
180 to 190				Sandy Silt		
190 to 200				Sandy Silt		
200 to 210				Sandy Silt		
210 to 220				Sandy Silt		
220 to 235				Gravely Silt		
235 to 273				Sandy Silt		

East Zillah					
Nitrate N East Zillah	Spring 2022	Spring 2023	Spring 2024	Spring 2025	Averages
LYV-MW-003	38.95	41.03	37.60	37.50	
LYV-MW-004	4.37	2.29	1.30	1.24	
LYV-MW-005	22.20	37.70	34.40	31.40	
LYV-MW-007	14.00	16.50	13.90	12.75	
LYV-MW-008	6.09	11.80	7.36	10.60	19.15
Conductivity East Zillah	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-003	1234	1296	1268.4	1199.6	
LYV-MW-004	832.7	794.1	804.7	813	
LYV-MW-005	1267	1430	1497.4	1324.2	
LYV-MW-007	758.8	755.3	762.2	731.1	
LYV-MW-008	782.8	794.7	798.3	820.8	998.26
DO East Zillah	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-003	6.98	7.08	7.28	7.17	
LYV-MW-004	8.8	8.33	8.41	8.48	
LYV-MW-005	6.69	6.88	6.56	6.7	
LYV-MW-007	8.69	9.22	8.58	8.7	
LYV-MW-008	8.35	8.43	7.99	8.02	7.87
REDOX East Zillah	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-003	141	201	161.8	261.5	
LYV-MW-004	180	200	234.6	296.4	
LYV-MW-005	155	193	163.8	279.2	
LYV-MW-007	194	198	210.7	277.7	
LYV-MW-008	199	203	176.4	228.3	207.72
pH East Zillah	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-003	7.28	7.15	7.15	7.38	
LYV-MW-004	7.34	7.23	7.42	7.43	
LYV-MW-005	7.05	6.99	7.15	7.22	
LYV-MW-007	7.32	7.23	7.38	7.41	
LYV-MW-008	7.45	7.34	7.42	7.45	7.29

Comparing wells in the East Zillah area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved Oxygen	REDOX	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
E Zillah	19.15	998.26	7.87	207.72	7.29
	19.15	998.26	7.87	207.72	7.29
	Greater than Average				Below Average

Well 9 – North Granger



Well 9 – North Granger

There are multiple hobby farms, orchards, vineyards, corn & hay fields, and 10 dairies in this area. The unincorporated community of Crewport is located in this area. Crewport is served by a water system operated by Yakima County with wells drilled to 155 ft and 240 ft. Nitrate N levels have increased in Crewport water in recent years and now exceed 5 mg/L. (See Attachment 6 Crewport)

Along the southern part of this subarea Granger Drain carries irrigation return flow to the Yakima River. In 2017 water samples collected from the Granger Drain by the U.S. Geological survey had Nitrate N levels between 2.47 and 7.66 mg/L.[23]

Cleanup of the Granger Drain has been ongoing for over twenty years.

There is only one dedicated monitoring well in this sub area. For this reason do not rely on averages for dedicated well(s) for the North Granger sub area. Nitrate N for this well averages

[23] *Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017* (No. 1084). US Geological Survey. Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017 — DS 1084

5.14 mg/L while Nitrate N readings for domestic wells in the area average 11.6mg/L. This is the reverse of what we see in other sub areas.

Conductivity, dissolved oxygen and REDOX potential are within normal parameters for this well, and pH is high. Domestic wells in this area are relatively shallow, while Granger municipal wells are deep.

Dedicated Well Log Data for North Granger

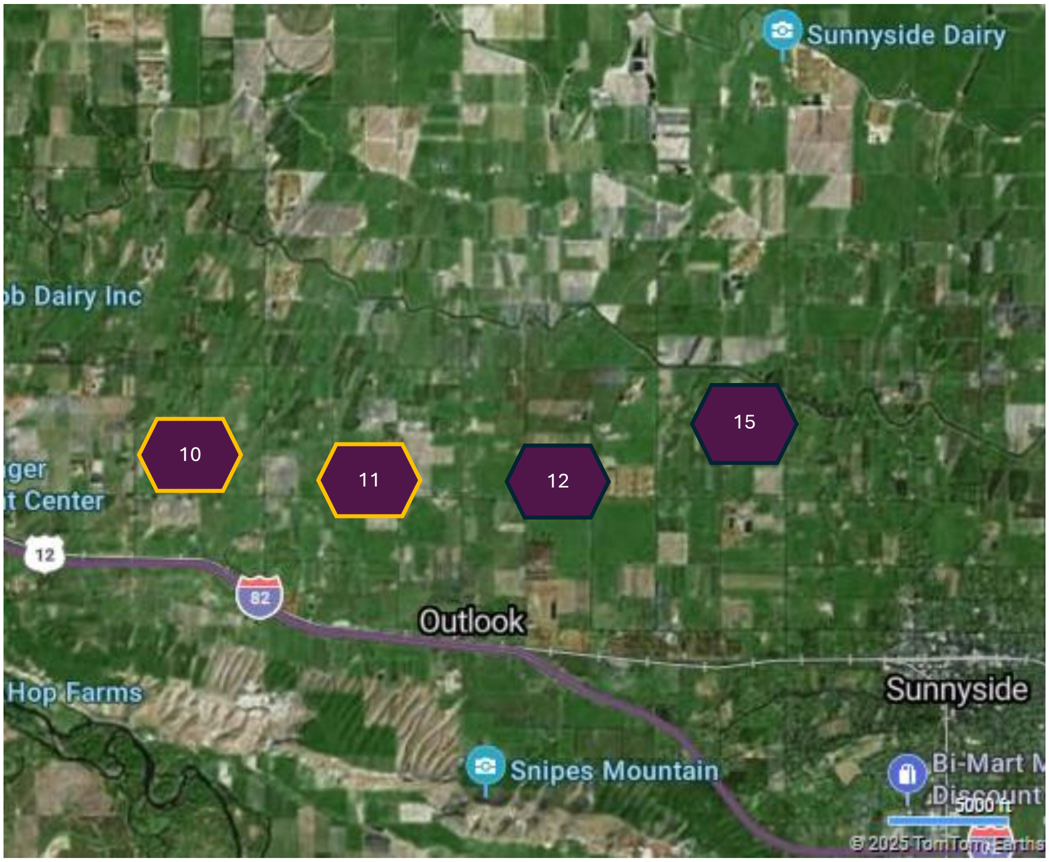
Depth	MW 9
0 to 5	Clayey Silt
5 to 10	Clayey Silt
10 to 20	Silty Sands & Gravels
20 to 30	Silty Sands & Gravels
30 to 40	

Nitrate N North Granger	Spring 2022	Spring 2023	Spring 2024	Spring 2025	Average
LYV-MW-009	4.83	5.28	5.17	5.29	5.14
Conductivity North Granger	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-009	745.2	743	760.1	740.8	747.28
DO North Granger	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-009	0.35	0.58	0.71	0.27	0.48
REDOX North Granger	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-009	128	193	153.7	168.7	160.85
pH North Granger	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-009	7.74	7.73	7.82	7.82	7.78

Comparing a Dedicated Well in the N Granger area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved Oxygen	REDOX	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
N Granger	5.14	747.28	0.48	160.85	7.78
	5.14	747.28	0.48	160.85	7.78
	Greater than Average				Below Average

Wells 10 to 12, & 15 – South Outlook



Wells 10, 11, 12, & 15 – South Outlook

This corridor alongside the Old Yakima Valley Highway, between Granger and Sunnyside, is somewhat unique due to the unusually low quality of groundwater in shallow wells.

Generally speaking groundwater flows from the Rattle Snake Hills south toward the Yakima River. However, a basalt anticline in the Yakima Fold Belt, Snipes Mountain, blocks the groundwater flow at Outlook. Water makes a nearly 90 degree turn to the east or the west. This might be described as underground congestion. A closer look at the data indicates that groundwater is flowing westward at wells 10 & 11, and eastward at well 12.

Shallow groundwater at Outlook has high levels of Nitrate N. The Outlook School has been forced to drill two new wells due to Nitrate N in the water. Most people who live in this area drill wells to deeper layers where the water is safer. FOTC asks whether there are aquitards in the Outlook area that protect water at the 200 foot level from contamination from the surface.

Dissolved oxygen is low in wells 10, 11 & 12, but not in well 15 which is a few miles further north. Due to low oxygen levels Ecology tested for ammonia and found elevations. Ideally oxygen in soils and water combines with ammonia to create nitrate. When there is insufficient oxygen available nitrogen from manure and fertilizer remains as ammonia in the water and soil.

Ecology water sampling shows higher than normal levels of ammonia along with low DO levels and higher than normal conductivity in this area. Wells 11 and 12 had ammonia levels of 0.03 mg/L and 0.02 mg/L at baseline. Four domestic wells with depths between 140 and 220 feet had baseline ammonia levels of 0.025, 0.038, 0.027, and 0.033.

But things get worse. In the section on "Ammonia at an Outlook Dairy" we share groundwater test results from a large dairy, located north of Outlook, that show even higher ammonia levels with averages in one well above 10 mg/L. The dairy is a likely source for many of the groundwater problems at Outlook.

Well Log Data for South Outlook

Depth	MW 10	MW 11	MW 12	MW 15
0 to 5	Sandy Silt	Sandy Silt	Clayey Silt	Silty Sand
5 to 10	Sandy Silt	Sandy Silt	Clayey Silt	Silty Sand
o 20	Sandy Silt	Sandy Silt	Clayey Silt	Silty Sand
20 to 30	Sandy Silt	Sandy Silt	Silty Sand	Clayey Silt
30 to 40	Sandy Silt	Sandy Silt		Clayey Silt
40 to50				Clayey Silt
50 to 60				Clayey Silt
60 to 70				Clayey Silt
70 to 80				

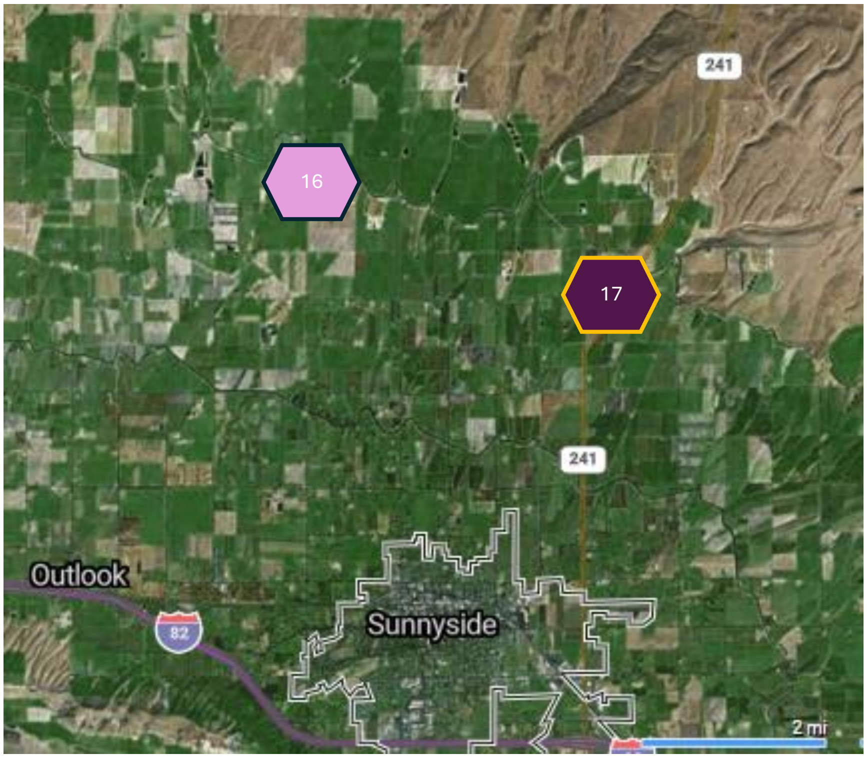
South Outlook					
Nitrate N South Outlook	Spring 2022	Spring 2023	Spring 2024	Spring 2025	Average
LYV-MW-010	26.50	33.55	60.70	70.50	
LYV-MW-011	17.80	19.70	15.60	59.20	
LYV-MW-012	23.00	22.90	24.70	19.60	
LYV-MW-015	15.20	16.30	15.10	15.60	28.50
Conductivity South Outlook	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-010	958	978.4	1381.7	1513.4	
LYV-MW-011	1035	1017	1032.4	1551.3	
LYV-MW-012	1271	1300	1324.2	1294.8	
LYV-MW-015	1037	1022	1022.4	982.9	1170.09
DO South Outlook	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-010	1.71	4.94	1.54	1.9	
LYV-MW-011	0	0.33	0.52	1.9	
LYV-MW-012	0	0.76	0.62	0.2	
LYV-MW-015	8.19	8.8	8.18	7.77	2.96

REDOX South Outlook	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-010	203	201	153	216.7		
LYV-MW-011	168	232	183.8	214.7		
LYV-MW-012	75	211	192.2	240.4		
LYV-MW-015	176	204	168.8	261		193.79
pH South Outlook	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-010	7.2	7.18	7.24	7.22		
LYV-MW-011	7.52	7.52	7.65	7.5		
LYV-MW-012	7.12	7.08	7.22	7.26		
LYV-MW-015	7.41	7.46	7.56	7.59		7.36

Comparing Dedicated Wells in the S Outlook area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved Oxygen	REDOX	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
S Outlook	28.5	1170.09	2.96	193.79	7.36
	28.5	1170.09	2.96	193.79	7.36
	Greater than Average				Below Average

Wells 16 & 17 – North from Sunnyside along the Rattlesnake Hills



Wells 16 & 17 – North from Sunnyside

These two wells near the northern edge of irrigated land are dissimilar and are grouped together as outliers. Note the wide range of values for Nitrate N – 2.29 mg/L and 21.8 mg/L in Spring 2025.

Since it was placed in 2019, Well 17 has shown some of the highest Nitrate N levels in the LYV dedicated set. This is difficult to explain given the well location at the northern edge of irrigated agriculture. The most likely answer is that Well 15 may lie along a preferential pathway for nitrogen that is discharged from a CAFO dairy that lies 1.9 miles upgradient.

There are two other large dairies in the area plus large tracts of apple orchards. Logs for these deeper wells help describe typical geology in the area.

Well Log Data for North Sunnyside

Depth	MW 16	MW 17
0 to 5	Clayey Silt	Clayey Silt
5 to 10	Clayey Silt	Clayey Silt
10 to 20	Clayey Silt	Clayey Silt
20 to 30	Clayey Silt	Clayey Silt
30 to 40	Clayey Silt	Clayey Silt

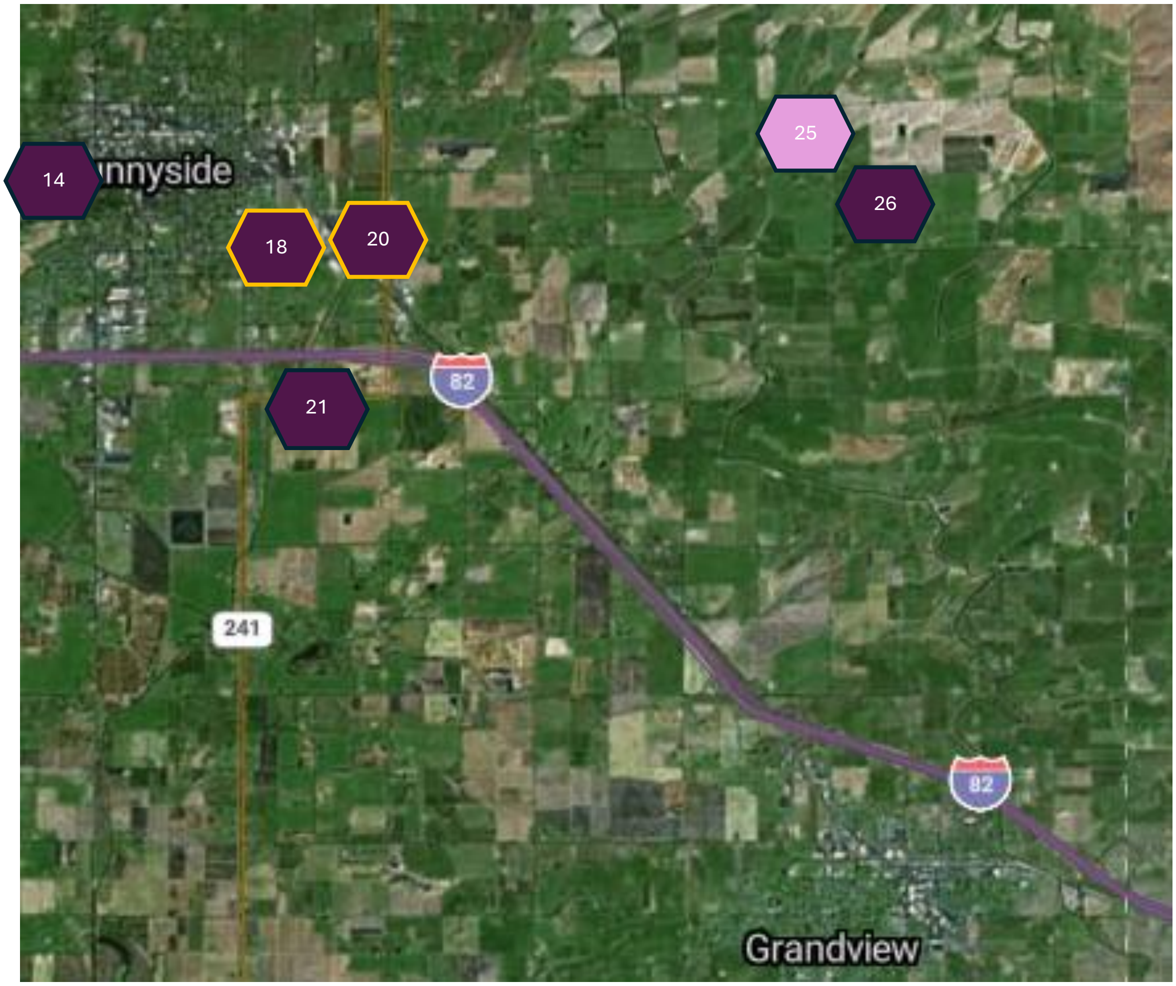
40 to50	Clayey Silt	Clayey Silt
50 to 60	Clayey Silt	Clayey Silt
60 to 70	Clayey Silt	Silty Sand
70 to 80	Clayey Silt	
80 to 90	Clayey Silt	
90 to 100	Clayey Silt	
100 to 110	Clayey Silt	
110 to 120	Clayey Silt	
120 to 130	Clayey Silt	
130 to 140	Clayey Silt	
140 to 150	Gravely Cobbles	
150 to 160	Cemented Cobbles w/ Gravel	
160 to 170	Cemented Cobbles w/ Gravel	
170 to 180	Cemented Cobbles w/ Gravel	
180 to 190	Cemented Cobbles w/ Gravel	
190 to 200	Cemented Cobbles w/ Gravel	
200 to 2010		

North Sunnyside					
Nitrate N North Sunnyside	Spring 2022	Spring 2023	Spring 2024	Spring 2025	Average
LYV-MW-016	1.34	1.59	2.17	2.29	
LYV-MW-017	36.50	49.30	29.40	21.80	18.05
Conductivity North Sunnyside	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-016	438.2	443.5	450.8	450.1	
LYV-MW-017	898	865.9	863.1	807.1	652.09
DO North Sunnyside	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-016	6.36	6.65	8.01	6.77	
LYV-MW-017	7.9	8.41	7.92	7.76	7.47
REDOX North Sunnyside	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-016	176	186	192.1	220.6	
LYV-MW-017	193	170	217.2	261.7	202.08
pH North Sunnyside	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-016	7.66	7.7	7.72	7.72	
LYV-MW-017	7.19	7.28	7.31	7.33	7.49

Comparing Dedicated Wells in the N Sunnyside area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved Oxygen	REDOX Potential	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
N Sunnyside	18.05	652.09	7.47	202.8	7.49
	18.05	652.09	7.47	202.8	7.49
	Greater than Average				Below Average

Wells 14, 18, 20, 21, 25, 26 – East of Sunnyside/North of Grandview



Wells 14, 18, 20, 21, 25 & 26 – East of Sunnyside/North of Grandview

There is a concentration of large dairies in the area between Sunnyside and Grandview. Dedicated monitoring wells have high nitrate levels, while levels in domestic wells are lower.

The Sulfur Creek Wasteway runs from north to south through the Sunnyside/Grandview sub area on its way to the Yakima River. Water sampling of the Sulfur Creek Wasteway at a site near Sunnyside by the U.S. Geological Survey in 2017 found Nitrate N levels between 2.4 and 9.2 mg/L. Some ancillary drains had much higher readings. [24]

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[24] *Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017* (No. 1084). US Geological Survey. Concentrations of Nitrate in Drinking Water in the Lower Yakima River Basin, Groundwater Management Area, Yakima County, Washington, 2017 — DS 1084

Moving eastward, basalt layers are closer to the land surface. Crops include corn, hops, grapes, and orchards. The eastern part of this subarea contains five more dairies along the Yakima/Benton County line.

Note: There is significant urban sprawl around the City of Sunnyside, the second largest city in Yakima County. Homes north of Sunnyside have a history of high nitrate levels in domestic wells, but there are no dedicated monitoring wells located in that area. Within Sunnyside there are over 40 toxic cleanup sites ranging from minor to major in scope.

The Port of Sunnyside covers over 700 acres south of the city. FOTC will address the Port of Sunnyside groundwater separately.

Well Log Data for Sunnyside/Grandview

Depth	MW 14	MW 18	MW 20	MW 21	MW 25	MW 26
0 to 5	Silty Sand	Clayey Silt	Clayey Silt	Silty Sand w/ Gravels	Silty Sand w/ Cobbles	Sandy Silt
5 to 10	Silty Sand	Clayey Silt	Clayey Silt	Silty Sand w/ Gravels	Silty Sand w/ Cobbles	Sandy Silt
10 to 20	Silty Sand	Silty Sand	Silty Sand & Gravels	Clayey Silt	Silty Sand w/ Cobbles	Sandy Silt
20 to 30	Silty Sand	Silty Sand		Clayey Silt	Silty Sand w/ Cobbles	Basalt
30 to 40	Silty Sand			Clayey Silt	Silty Sand w/ Cobbles	Basalt
40 to50						Basalt
50 to 60						Basalt
50 to 70						

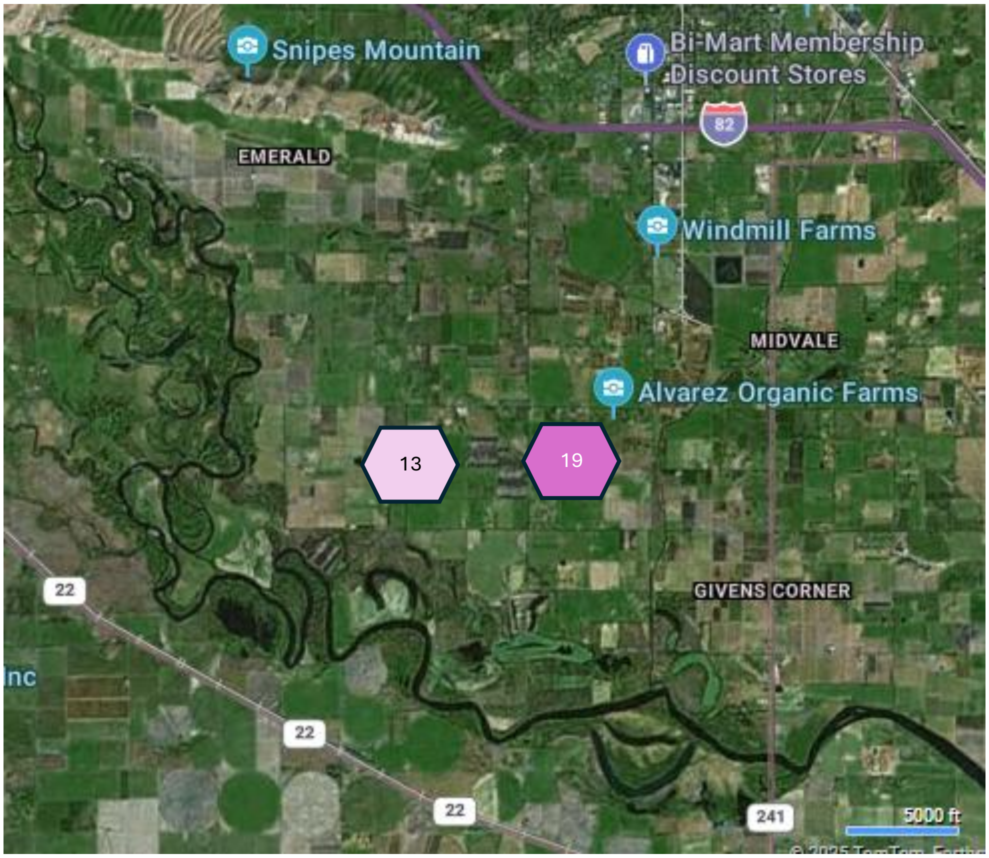
Sunnyside/Grandview					
Nitrate N Sunnyside/Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025	Average
LYV-MW-014	11.10	14.95	19.70	11.10	
LYV-MW-018	30.20	33.00	29.00	36.50	
LYV-MW-020	26.10	35.10	33.20	39.85	
LYV-MW-021	23.30	18.90	14.40	13.70	
LYV-MW-025	4.17	4.22	3.97	4.15	
LYV-MW-026	23.80	43.25	20.00	17.90	21.32
Conductivity Sunnyside/Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-014	1047	1146	1214.1	1134	
LYV-MW-018	2279	2308	2275.2	2493.6	
LYV-MW-020	838.5	910.7	973.1	1081.2	

LYV-MW-021	860.8	756.8	743.4	710.2		
LYV-MW-025	519.7	494.8	533.6	530.2		
LYV-MW-026	1157	1161	1078.8	1062		1137.86
DO Sunnyside/Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-014	0.09	1.04	0.9	1.01		
LYV-MW-018	0.41	0.38	0.72	1.36		
LYV-MW-020	1.99	2.85	3.1	3.52		
LYV-MW-021	0.92	0.95	0.65	0.49		
LYV-MW-025	6.78	7.33	6.18	7.83		
LYV-MW-026	6.97	7.01	6.92	6.35		3.16
REDOX Sunnyside/Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-014	81	214	163.7	245.6		
LYV-MW-018	52	207	199	208.1		
LYV-MW-020	77	206	204.4	230.6		
LYV-MW-021	62	171	188.7	202.7		
LYV-MW-025	153	188	188.4	260.3		
LYV-MW-026	190	188	208.2	247.1		180.66
pH Sunnyside/Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-014	7.56	7.43	7.47	7.56		
LYV-MW-018	7.38	7.36	7.48	7.46		
LYV-MW-020	7.11	7.06	7.18	7.17		
LYV-MW-021	7.73	7.82	7.83	7.85		
LYV-MW-025	7.42	7.4	7.42	7.35		
LYV-MW-026	7.21	7.29	7.33	7.29		7.42

Comparing Dedicated Wells in the Sunnyside/Grandview area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved Oxygen	REDOX Potential	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
SS/Grandview	21.32	1137.86	3.16	180.66	7.42
	21.32	1137.86	3.16	180.66	7.42
	Greater than Average				Below Average

Wells 13 & 19 – North Mabton



Wells 13 & 19 – North Mabton

In 1990 WA Ecology sampled wells in this area for agricultural chemicals and other pollutants. The study only found detectable nitrates in 7 of 27 wells.[25] Even today, despite intense farming, Nitrate N levels remain low. The 1990 study documented a large aquitard in the area.[26]

The southern edge of this lowland is part of the Yakima River flood plain, so we can infer significant interaction between groundwater and the river. The Agricultural Chemicals Pilot Study described this area as follows: "The physiography consists of two generally flat-lying terraces that gently slope to the south. The upper terrace occupies the northeastern one-third of the study area and stands about 25 feet above the lower terrace. The lower terrace represents the floodplain of the Yakima River prior to the river being dammed."

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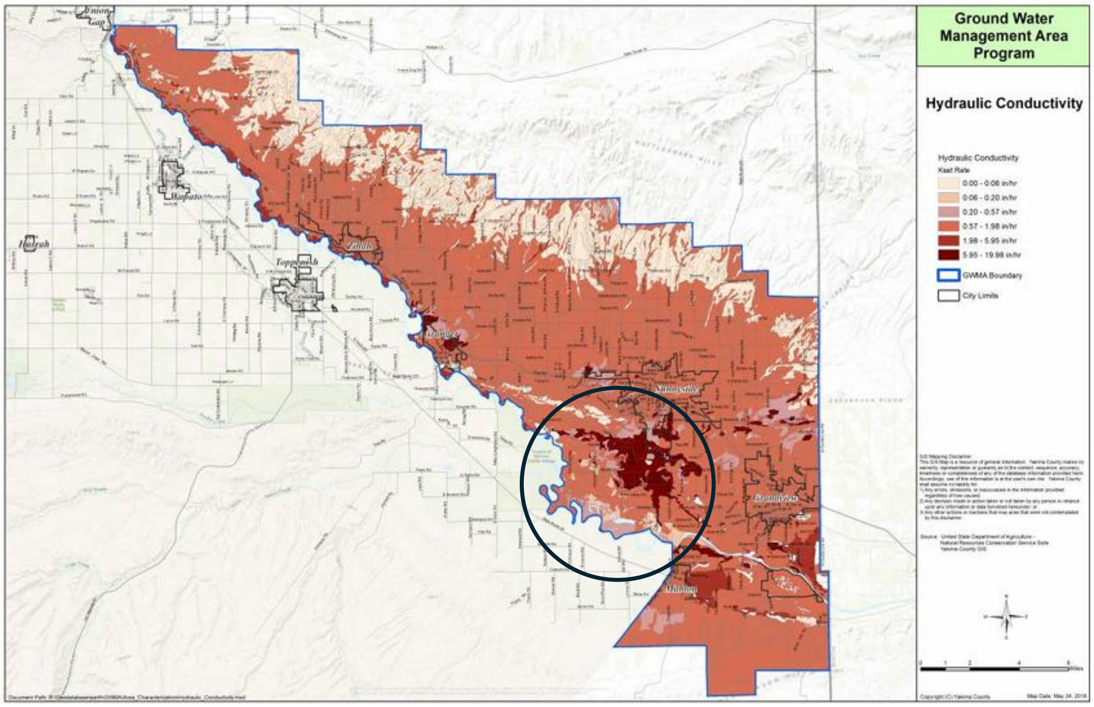
[25] WA Ecology Agricultural Chemicals Pilot Study. 9046.pdf

[26] WA Ecology Agricultural Chemicals Pilot Study, Page 44

Corn and hops are the main crops in North Mabton There are three dairies in the area. There are significant differences in soil characteristics for different parts of North Mabton.

For example, hydraulic conductivity ranges from very high in the northeast section to very low in the south section. See the map below from the LYV GWMA Final Report. [27]



Well Log Data for North Mabton

Depth	MW 13	MW 19
0 to 5	Clayey Silt	Silty Sand
5 to 10	Clayey Silt	Silty Sand
10 to 20	Silty Sand	Silty Sand
20 to 30	Silty Sand	Silty Sand
30 to 40	Silty Sand	Silty Sand
40 to50	Silty Sand	
50 to 60		

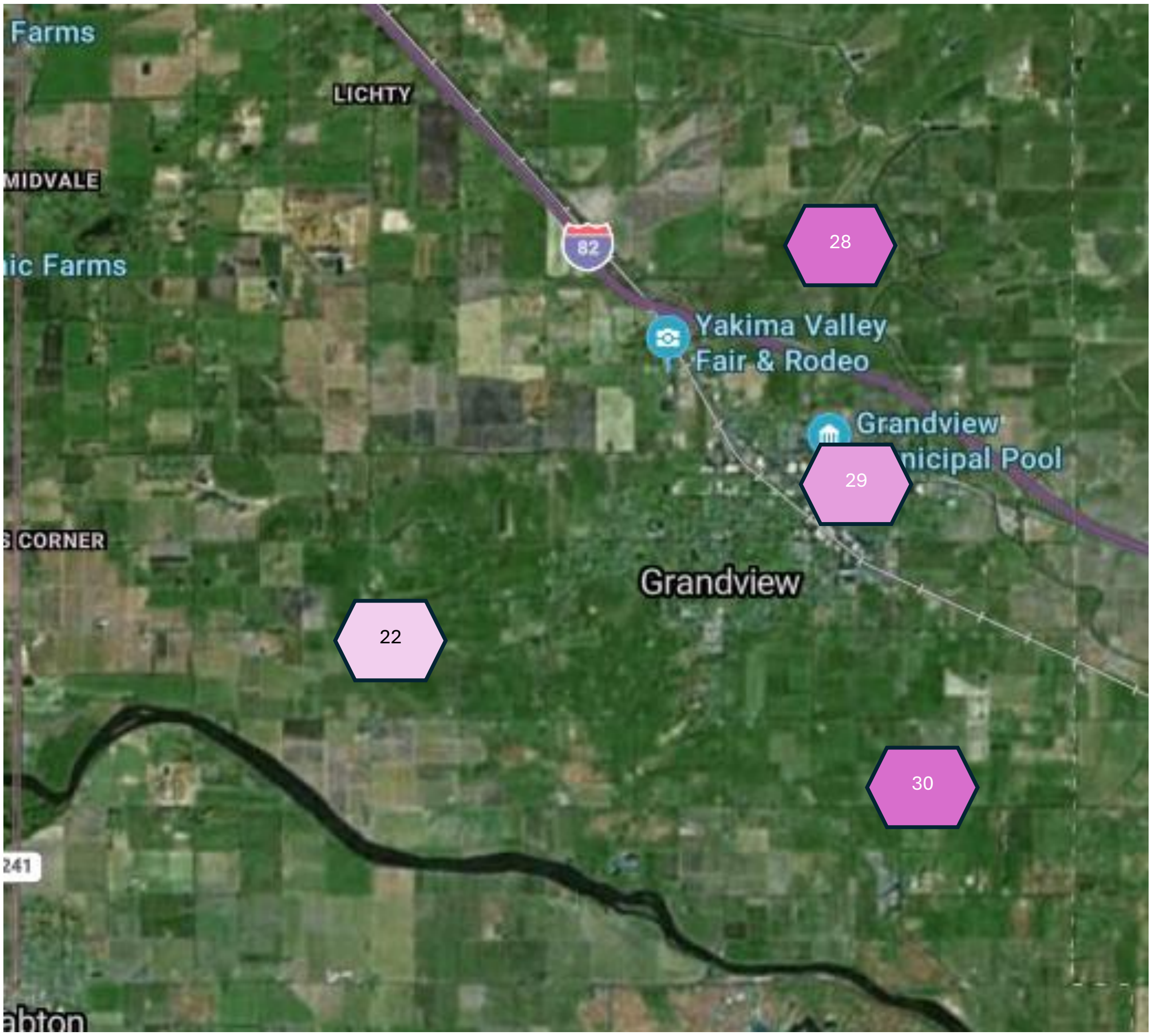
[27] Lower Yakima Valley Groundwater Management Area Final Report. Page 56, available at GWMA Volume I

North Mabton						
Nitrate N North Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025		Average
LYV-MW-013	1.92	1.90	1.16	0.81		
LYV-MW-019	6.19	4.93	4.80	7.76		3.68
Conductivity North Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-013	369.8	292.7	280.1	260.5		
LYV-MW-019	648.4	624.9	661.5	615.2		469.14
DO North Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-013	7.01	7.55	7.21	6.88		
LYV-MW-019	0.41	0.75	0.44	0.34		3.82
REDOX North Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-013	173	212	184.4	240		
LYV-MW-019	43	210	144.5	208.5		176.93
pH North Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-013	7.66	7.68	7.75	7.9		
LYV-MW-019	7.41	7.45	7.55	7.52		7.62

Comparing Dedicated Wells in the N Mabton area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved Oxygen	REDOX Potential	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
N Mabton	3.68	469.14	3.82	176.93	7.62
	3.68	469.14	3.82	176.93	7.62
	Greater than Average				Below Average

Wells 22, 28, 29, 30 – South Grandview



Wells 21, 22, 28, 29, 30 – South Grandview

The area between Grandview and the Yakima River is farmed in hops, grapes, and orchards. Nitrate N levels are relatively low in this area. Basalt layers are closer to the land surface. Conductivity, dissolved oxygen, REDOX potential, and pH are normal. If the rest of the GWMA target area had these values, the current discussion would be irrelevant.

Well Log Data for South Grandview

Depth	MW 22	MW 28	MW 29	MW 30
0 to 5	Clayey Silt	Sandy Silt	Sandy Silt	Clayey Silt
5 to 10	Clayey Silt	Sandy Silt	Sandy Silt	Clayey Silt
10 to 20	Clayey Silt	Clayey Silt	Clayey Silt	Silty Sand
20 to 30	Clayey Silt	Clayey Silt	Clayey Silt	Silty Sand
30 to 40	Clayey Silt	Clayey Silt	Clayey Silt	Silty Sand
40 to50	Clayey Silt	Clayey Silt		Silty Sand
50 to 60	Clayey Silt	Clayey Silt		
60 to 70				
70 to 80				

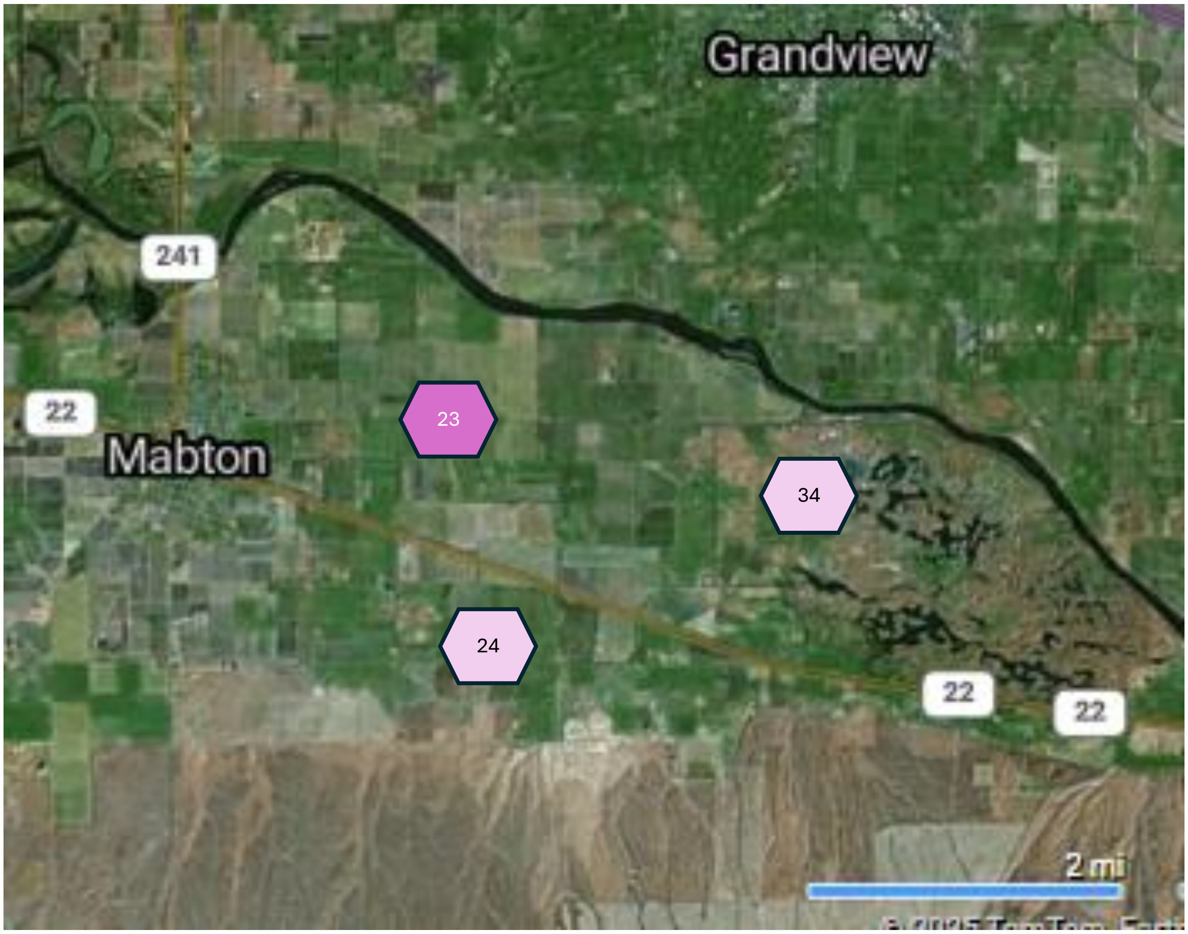
South Grandview					
Nitrate N South Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025	Average
LYV-MW-022	0.52	1.00	1.18	0.88	
LYV-MW-028	5.63	5.76	5.97	6.17	
LYV-MW-029	2.25	3.42	6.54	4.17	
LYV-MW-030	6.85	6.86	4.97	5.44	4.23
Conductivity South Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-022	543	519.8	523.8	486.8	
LYV-MW-028	564.7	534.2	571	551	
LYV-MW-029	331.3	339.8	420.5	427	
LYV-MW-030	693	601.3	572.4	624.4	519.00
DO South Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-022	5.75	6.74	7.6	8.05	
LYV-MW-028	6.8	7.14	6.48	6.16	
LYV-MW-029	6.53	6.08	7.44	7.5	
LYV-MW-030	6.26	6.98	7.4	8.48	6.96
REDOX South Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-022	183	187	155	250.3	
LYV-MW-028	199	182	204.1	260.7	
LYV-MW-029	179	169	186.5	272.6	
LYV-MW-030	130	190	192.3	252.8	199.58

pH South Grandview	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-022	7.41	7.63	7.55	7.57	
LYV-MW-028	7.38	7.49	7.49	7.48	
LYV-MW-029	7.85	7.94	7.83	7.82	
LYV-MW-030	7.11	7.18	7.32	7.31	7.52

Comparing Dedicated Wells in the South Grandview area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved O_2	REDOX	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
S Grandview	4.23	519	6.96	199.58	7.52
	4.23	519	6.96	199.58	7.52
	Greater than Average				Below Average

Wells 23, 24, 34 – South Mabton



Wells 23, 24, 34 – South Mabton

This area has been inadequately studied, despite the fact that the City of Mabton has suffered from drinking water problems for decades. A 2024 LYV GWMA study, the Tetra Tech Study, found insufficient data in the GWMA network database to map water levels south of the river.

Note the wide range of Nitrate N values for dedicated wells in South Mabton. Two wells in an area that is non-homogeneous is not enough, especially with a history of high Nitrate N in domestic and municipal wells.

Six concentrated animal feeding operations are located within three miles of Mabton, along with irrigated fields of alfalfa and corn.

An area near Byron Ponds where the City of Grandview processed municipal waste for decades is included in South Mabton as a special case. This is an area where basalt is close to the surface. Monitoring well 34 near Byron Ponds is an outlier with high levels of ammonia, low levels of Nitrate N, low levels of dissolved oxygen and negative REDOX potential.

Various studies indicate erratic groundwater flow in South Mabton and a patchwork of different soil types. The river makes abrupt twists and turns in the Mabton area.

Well Log Data for South Mabton

No well log for MW 34

Depth	MW 23	MW 24
0 to 5	Sands & Gravels	Sandy Silt
5 to 10	Sands & Gravels	Sandy Silt
10 to 20	Silty Sands w/ Gravels	Sandy Silt
20 to 30	Silty Sands w/ Gravels	Sandy Silt
30 to 40	Silty Sands w/ Gravels	Sandy Silt
40 to50	Silty Sands w/ Gravels	
50 to 60		

South Mabton					
Nitrate N South Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025	Average
LYV-MW-023	9.27	9.17	7.41	7.14	
LYV-MW-024	3.03	2.44	2.16	1.89	
LYV-MW-034	0.01	0.08	0.01	0.01	3.55
Conductivity South Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-023	644.1	602.6	626.2	624.7	
LYV-MW-024	259.9	237.2	254.9	242.6	
LYV-MW-034	453.9	457.3	470	453.3	443.89
DO South Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-023	7.76	8.12	8.16	8.02	
LYV-MW-024	6.42	6.63	6.11	6.08	
LYV-MW-034	0	1.02	1.81	0.09	5.02
REDOX South Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025	
LYV-MW-023	172	195	189.7	272.1	

LYV-MW-024	180	198	154.6	221.9		
LYV-MW-034	-100	-138	-86.7	-69.4		99.10
pH South Mabton	Spring 2022	Spring 2023	Spring 2024	Spring 2025		
LYV-MW-023	7.27	7.37	7.29	7.4		
LYV-MW-024	7.73	7.74	7.77	7.78		
LYV-MW-034	7.28	7.36	7.45	7.5		7.50

Comparing Dedicated Wells in the South Mabton area with all LYV GWMA Dedicated Wells

Comparison	Nitrate N	Conductivity	Dissolved O_2	REDOX	pH
All Dedicated	13.19	821.83	5.08	167.18	7.32
S Mabton	3.55	443.89	5.02	99.1	7.5
	3.55	443.89	5.02	99.1	7.5
	Greater than Average				Below Average

Data for Domestic Wells in Four Special Areas

Based on years of experience in the LYV we believe that four sub areas deserve special attention during analyses of groundwater nitrate pollution. FOTC has analyzed Ecology sampling for Nitrate N, conductivity, dissolved oxygen, REDOX potential and pH for both dedicated monitoring wells and domestic wells in South Outlook, Sunnyside/Grandview, North Mabton and North Granger.

When we look at readings from the four special areas a few points stand out:

- Nitrate N values for domestic wells in North Granger are well above average.
- Conductivity readings for dedicated wells in South Outlook are very high.
- REDOX potential readings for domestic wells in South Outlook and North Mabton are very low.
- Dissolved oxygen readings are low in domestic wells in North Mabton but higher in dedicated wells.
- pH readings for domestic wells in South Outlook are very high.

Domestic Wells in Special Areas - Spring 2025 Averages

	S. Outlook	SS/Grandview	North Mabton	North Granger	Baseline
Nitrate N in mg/L	2.96	6.7	1.71	11.47	6.06
Conductivity µS/cm	528.35	547.94	610.34	689.83	
DO in mg/L	2.94	1.45	0.266	3.87	
REDOX millivolts	-2.35	184.05	13.73	186.95	
pH	8.07	7.58	7.67	7.59	

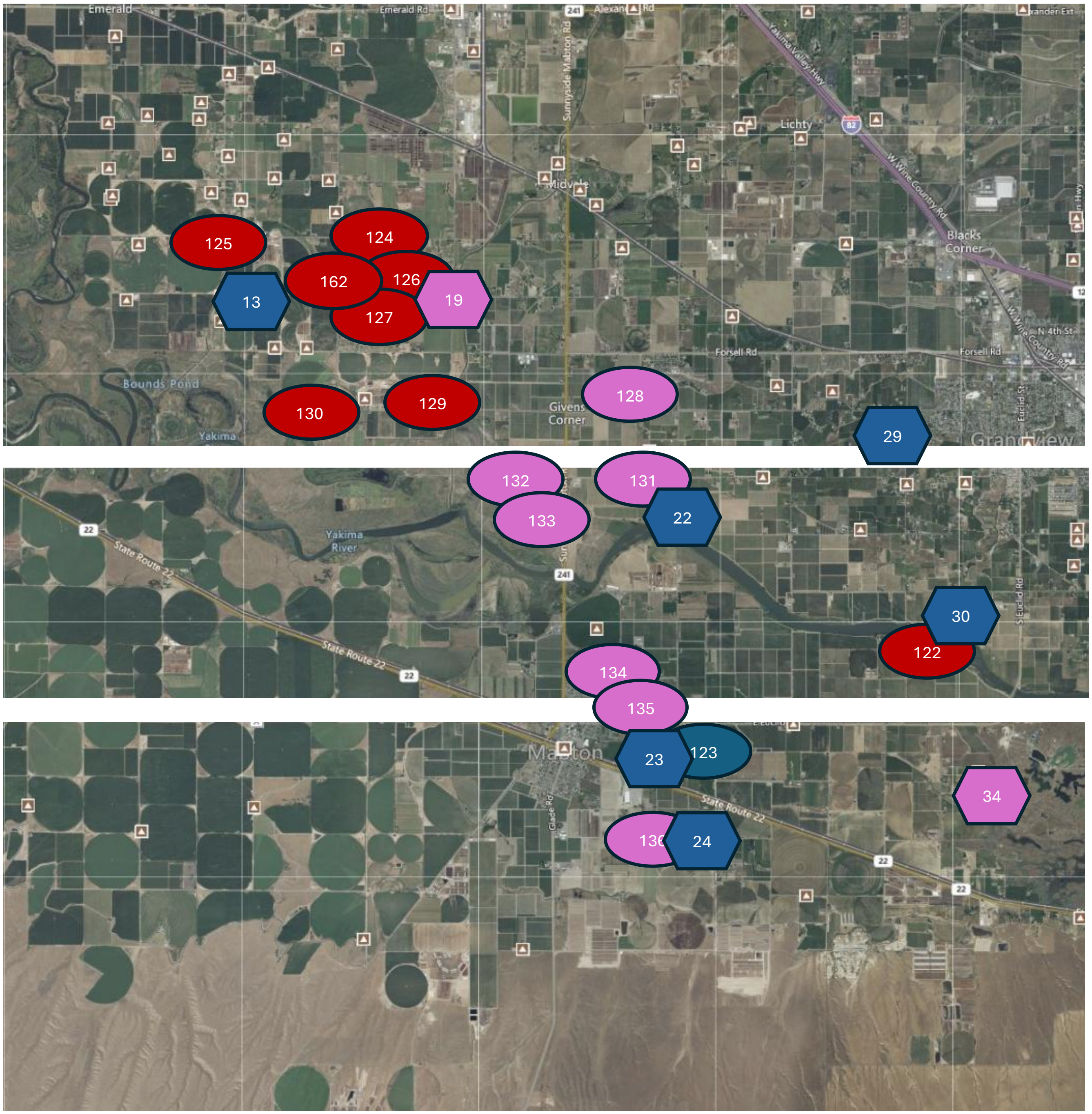
Dedicated Wells in Special Areas – Spring 2025 Averages

	S. Outlook	SS/Grandview	North Mabton	North Granger *	Baseline
Nitrate N in mg/L	41.23	15.55	4.29	5.29	13.19
Conductivity µS/cm	1335.6	723.35	437.85	740.8	821.83
DO in mg/L	1.23	3.1	3.61	0.27	5.08
REDOX milli volts	233.2	223.03	224.25	168.7	167.18
pH	7.39	7.53	7.71	7.82	7.32

*Only one well

Ammonia: Ecology has sampled some of the domestic wells in South Outlook and North Mabton for ammonia and found elevations. This correlates with low dissolved oxygen levels and low REDOX potentials in those areas.

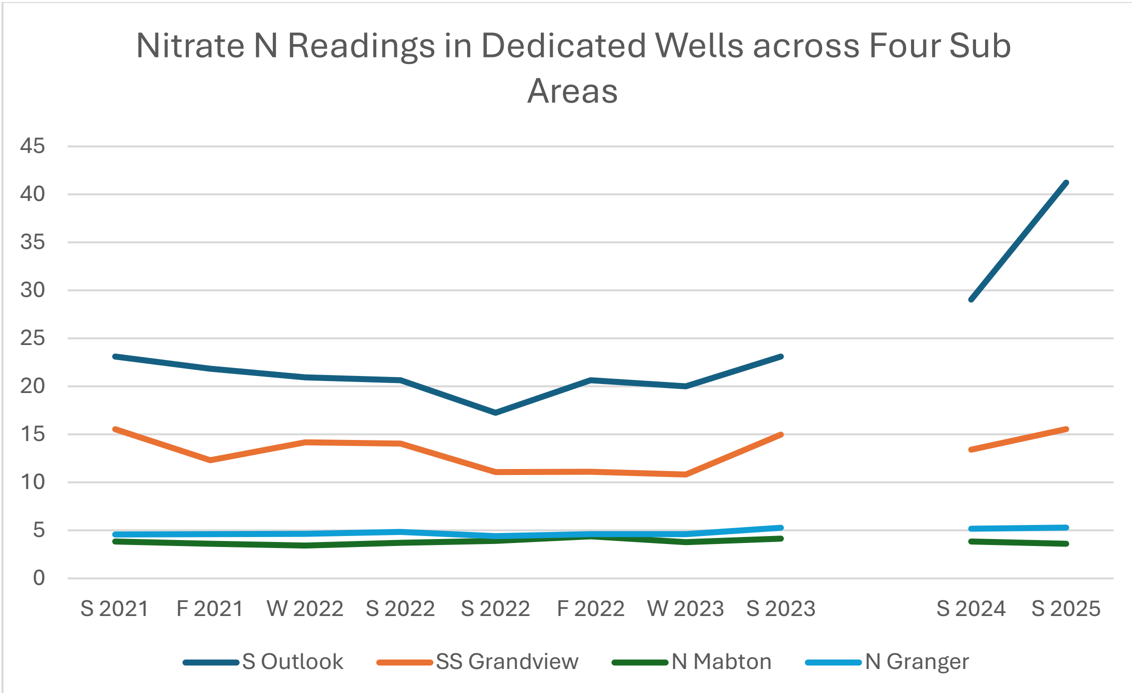
Mabton Groundwater Graphs – Average Ammonia Levels

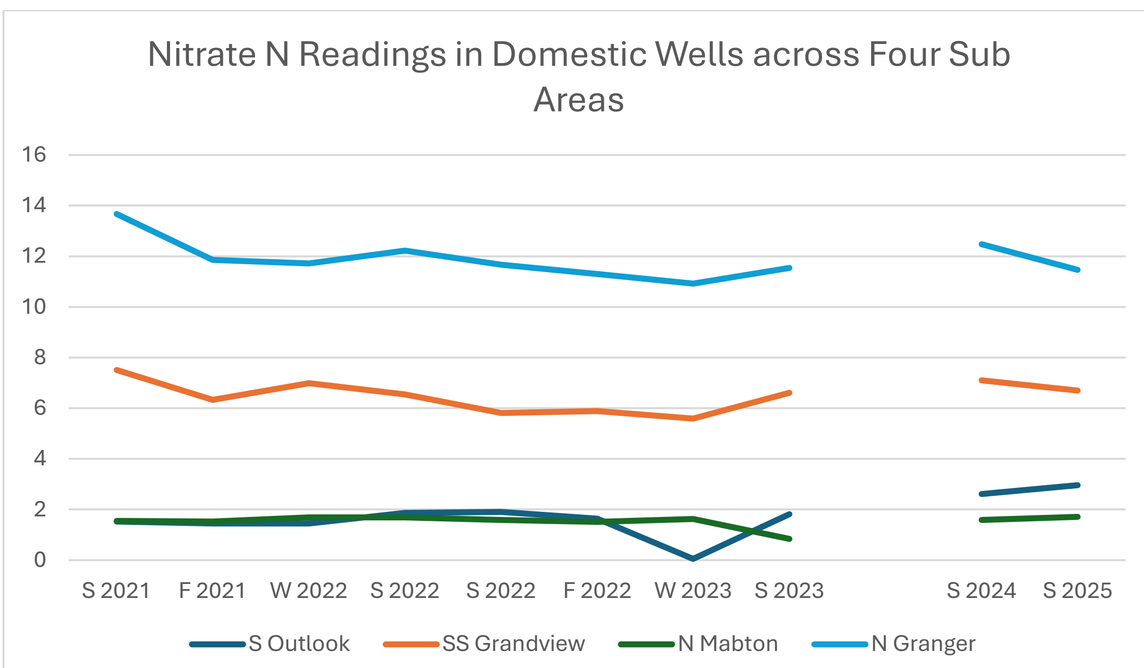


Ovals are domestic wells, Hexagons are dedicated monitoring wells

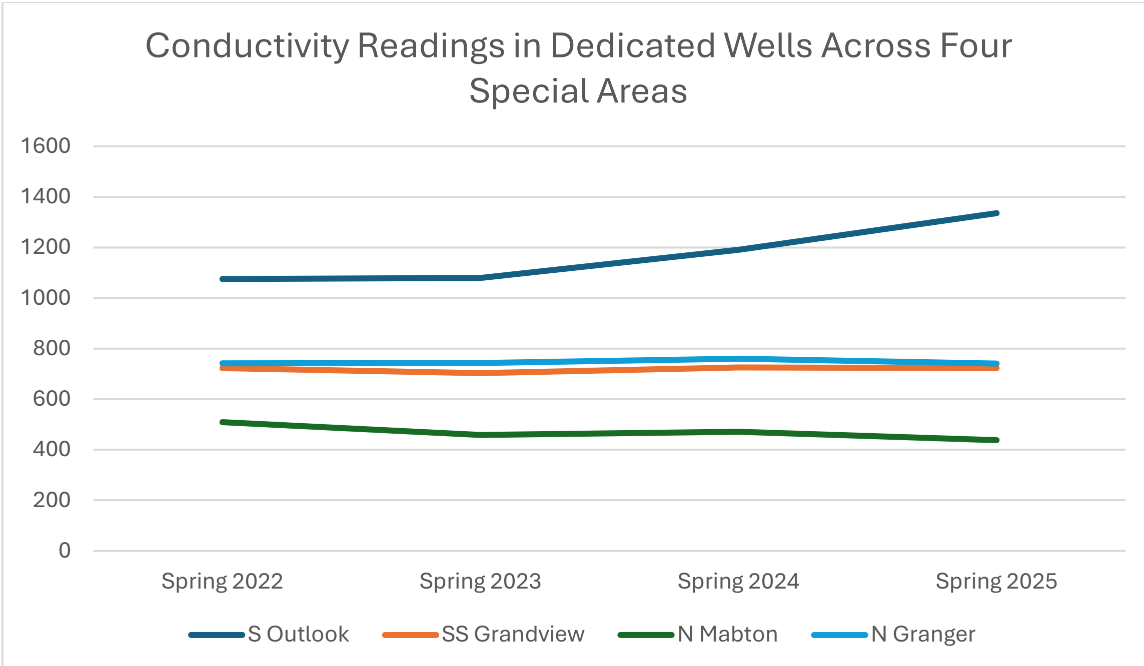
No testing = or Reading 0.01U to 0.05U = or Reading > 0.05 =

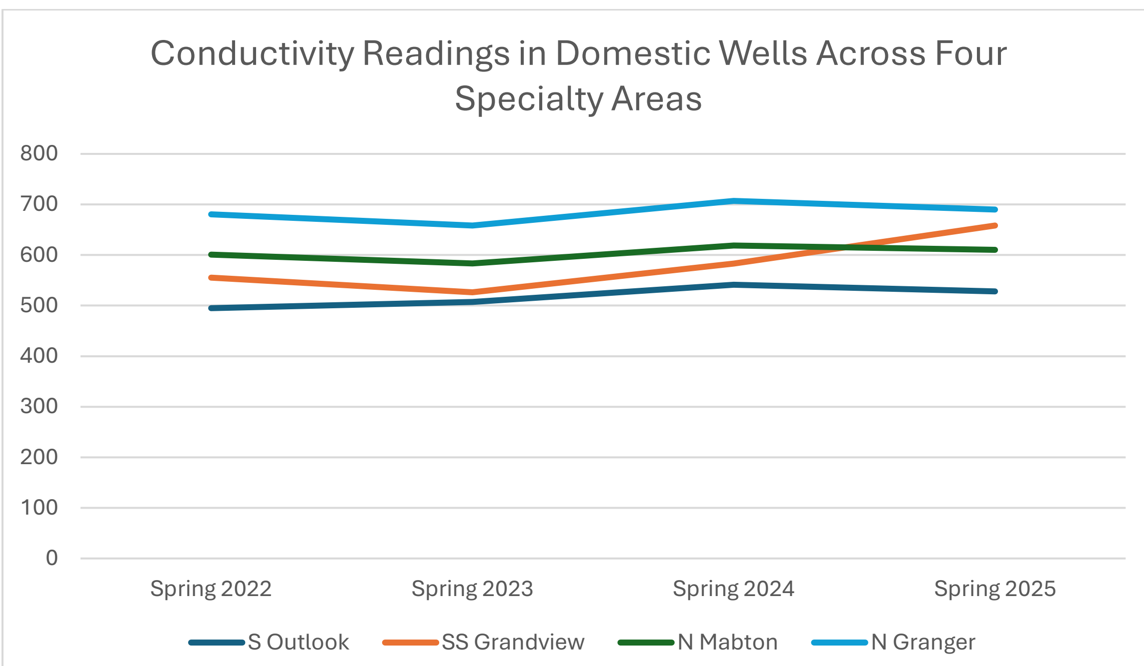
Comparing Nitrate N Readings across Sub Areas – See Attachment 7 for supporting data



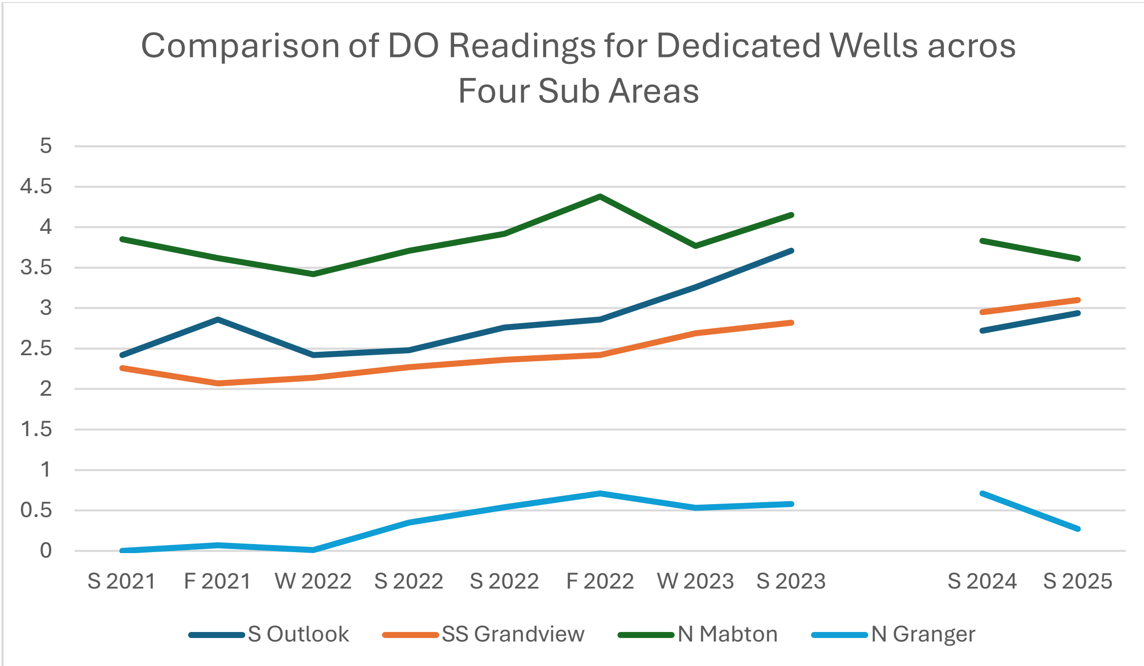


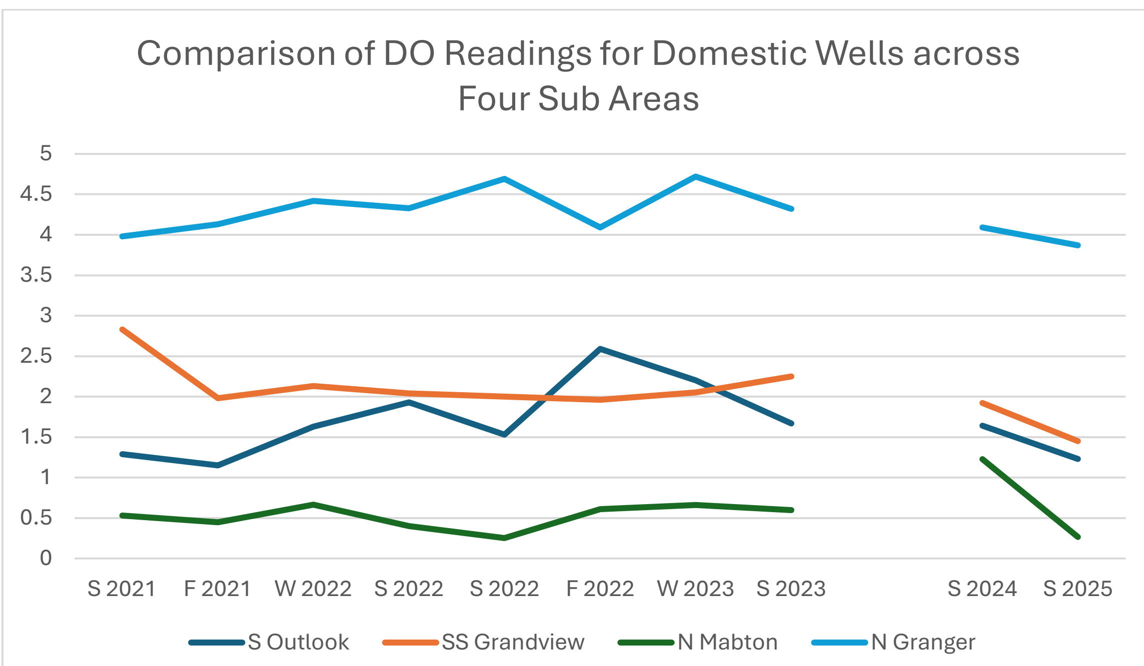
Comparing Conductivity across Sub Areas – See Attachment 7 for supporting data



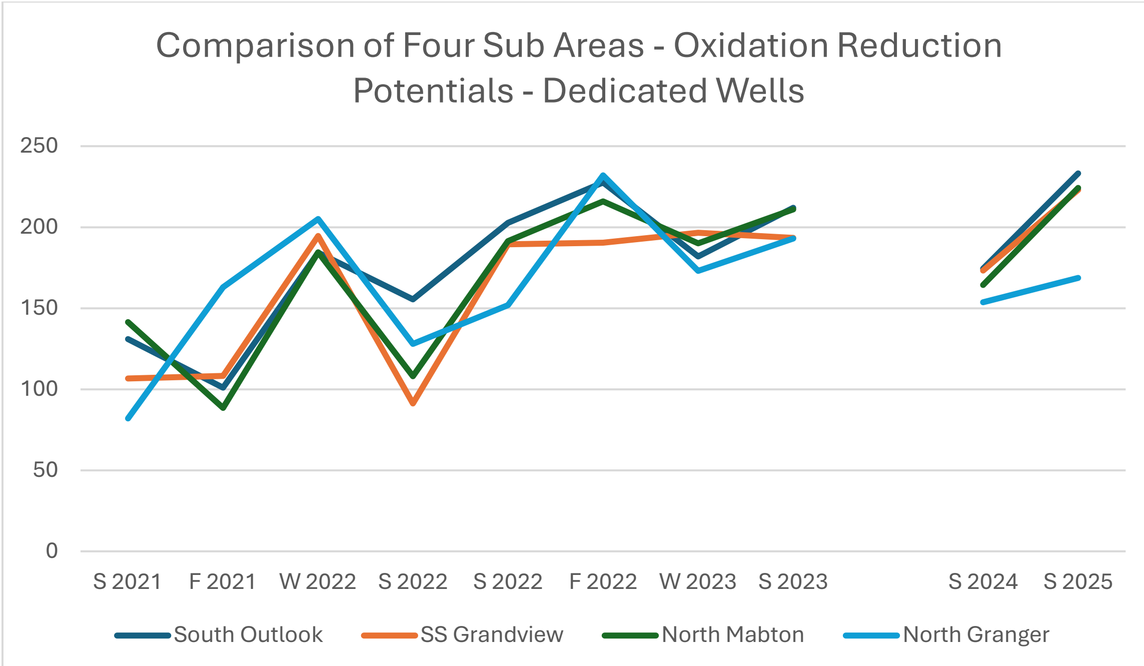


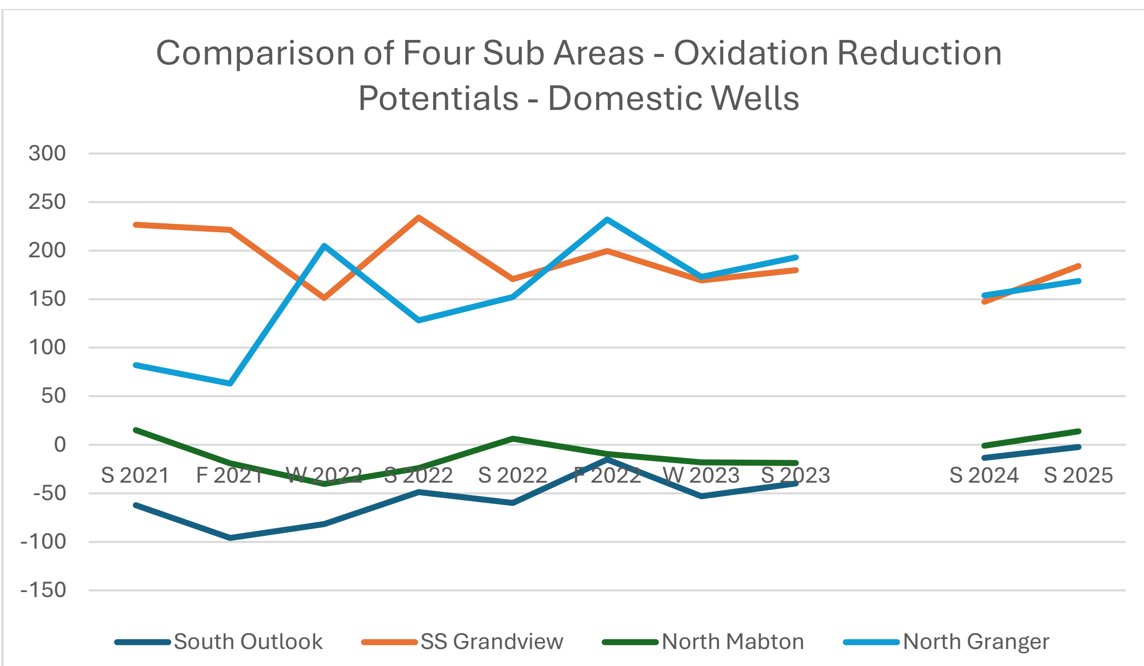
Comparing Dissolved Oxygen across Sub Area – See Attachment 7 for supporting data



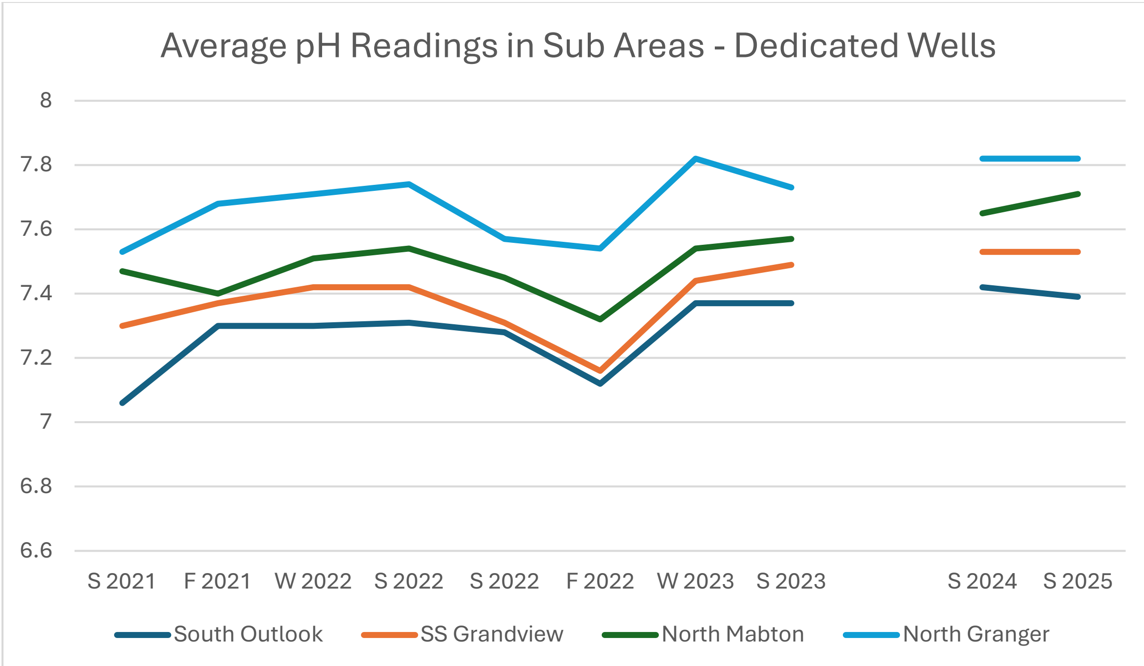


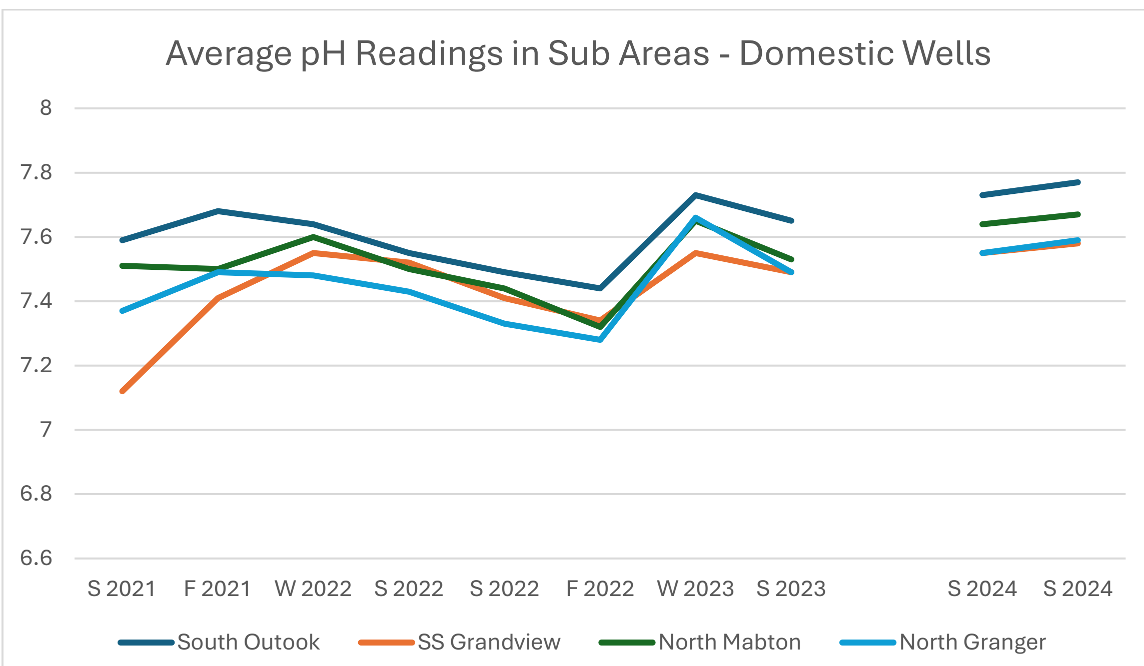
Comparing REDOX Potential Readings across Sub Areas – See Attachment 7 for supporting data





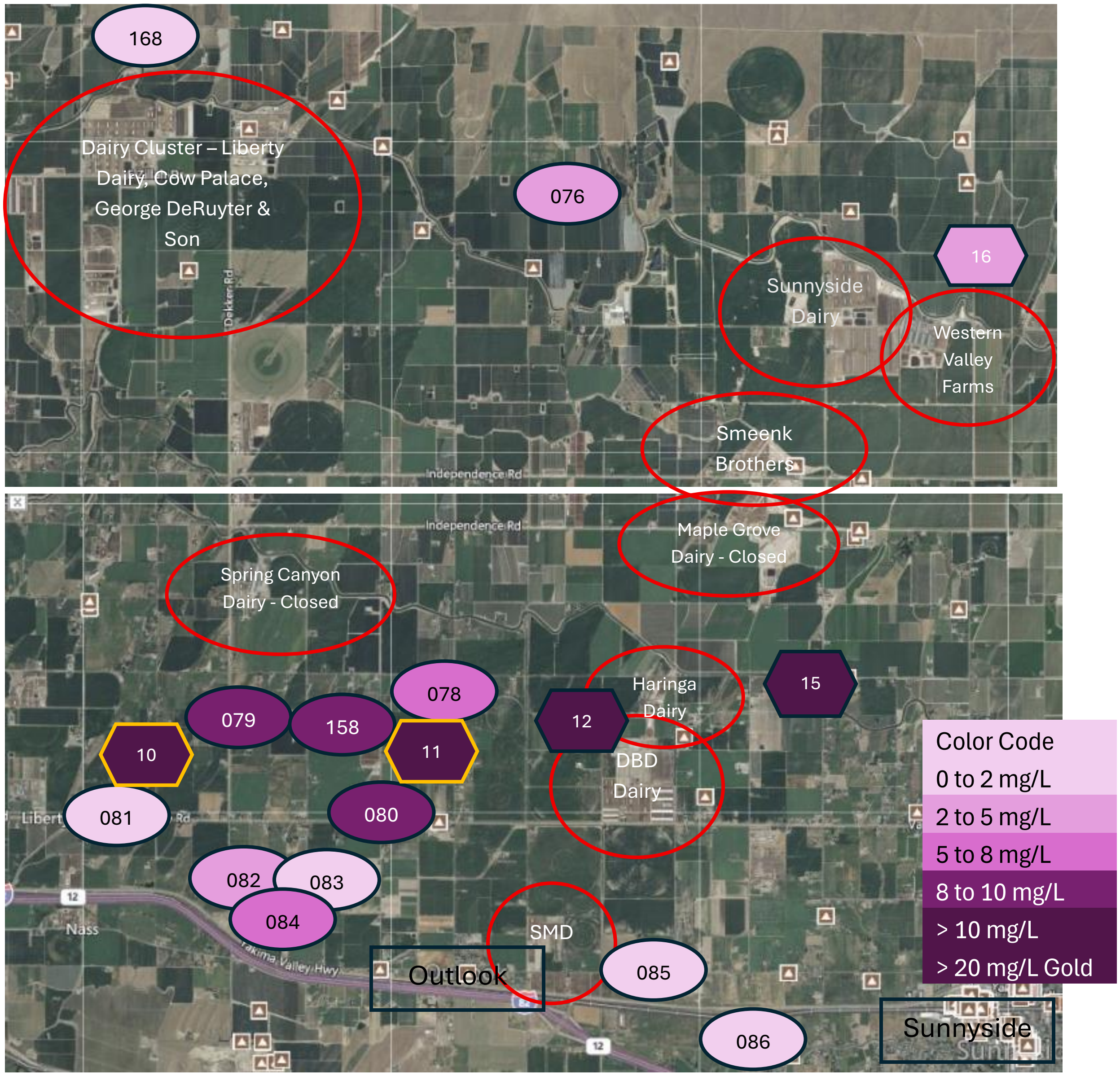
Comparing pH Readings across Sub Areas - – See Attachment 7 for supporting data





South Outlook

Outlook Monitoring Wells



Nitrate N readings are very high in dedicated wells in the Outlook area and often quite low in domestic wells. Other studies, over many years, have found high Nitrate N levels in the area around Van Belle, Fordyce, and Hudson Roads north of Outlook.

Data from Ecology's network of wells shows big differences in readings for dedicated wells with depths < 100 ft and for domestic wells with average depths > 140 ft and usually around 200 ft. We suspect different well sets tap two different aquifers.

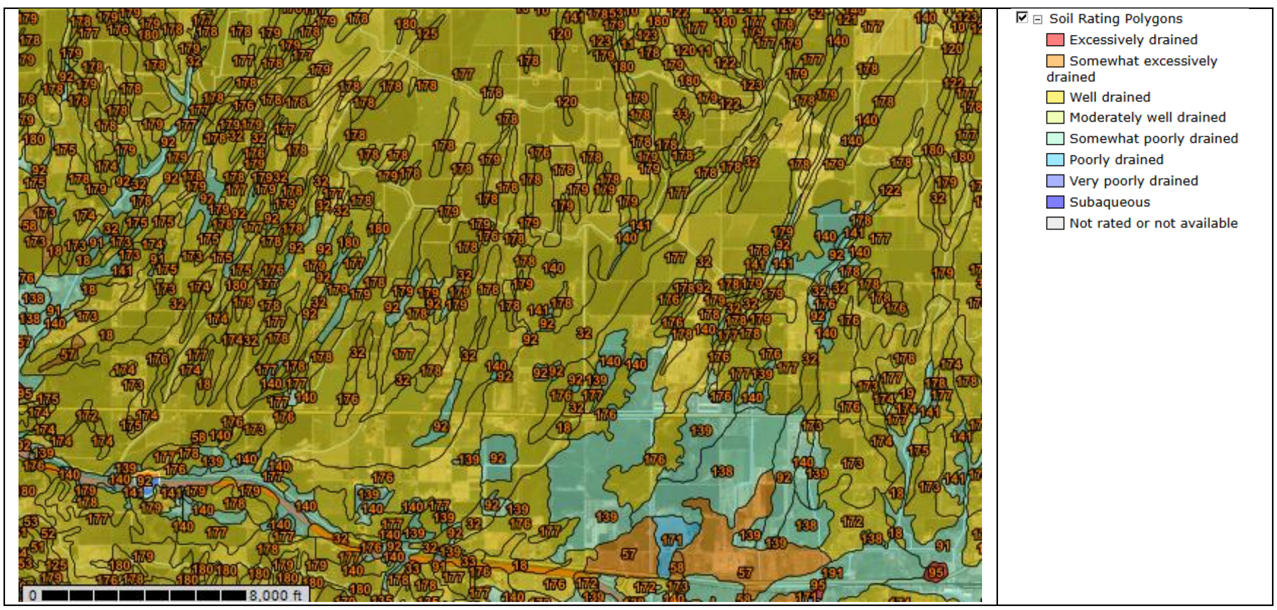
The dairies upgradient from Outlook have a history of non-compliance with Dairy Nutrient Management Plans.[28] Litigation records reveal massive over application of manure to cropland.[29]

George DeRuyter & Son, Sunnyside Dairy, Western Valley Farms, Maple Grove Dairy and DBD/SMD dairy all have NPDES permits. Soil testing for permitted dairies posted on Ecology's PARIS website shows years of over application of manure as fertilizer that results in leaching of nitrates to groundwater and phosphorous in runoff. [28]

The water table at Outlook is sometimes as shallow as five feet. This means that manure lagoons penetrate the water table and this creates conditions for direct discharge to the aquifer, not only of nitrogenous compounds but also of bacteria, viruses, veterinary pharmaceuticals and animal hormones.

For the most part soils in this area are well drained.

Soil Drainage Types in the South Outlook Area from the NRCS Web Soil Survey



Groundwater around Outlook flows north northeast to south southwest until it reaches the Snipes Mountain basalt outcropping where it diverts either to the east or west.

Conductivity is high to very high in dedicated wells and low in domestic wells. Dissolved oxygen is low for both types of wells which likely contributes to high ammonia levels in groundwater. Please read the section on Ammonia at an Outlook Dairy that begins on page 87.

[28] See data from Ecology's Permitting and Reporting Information Site at Paris - Permit Lookup

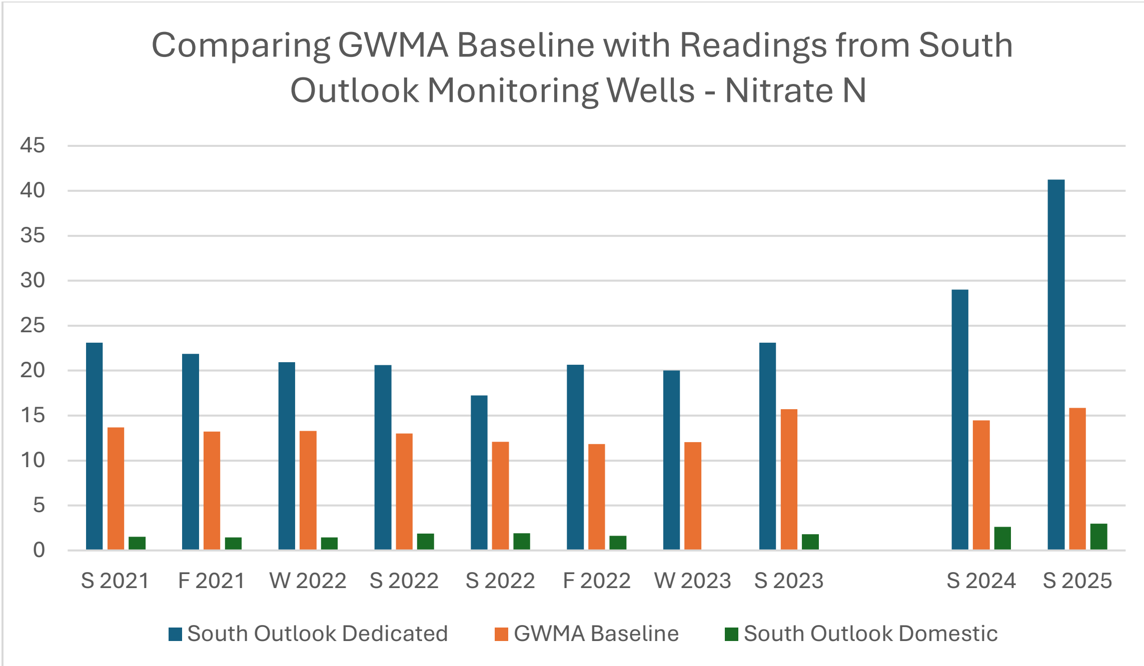
[29] Law Offices of Charlie Tebbutt Cases. Law Offices of Charlie Tebbutt - Highlighted Cases

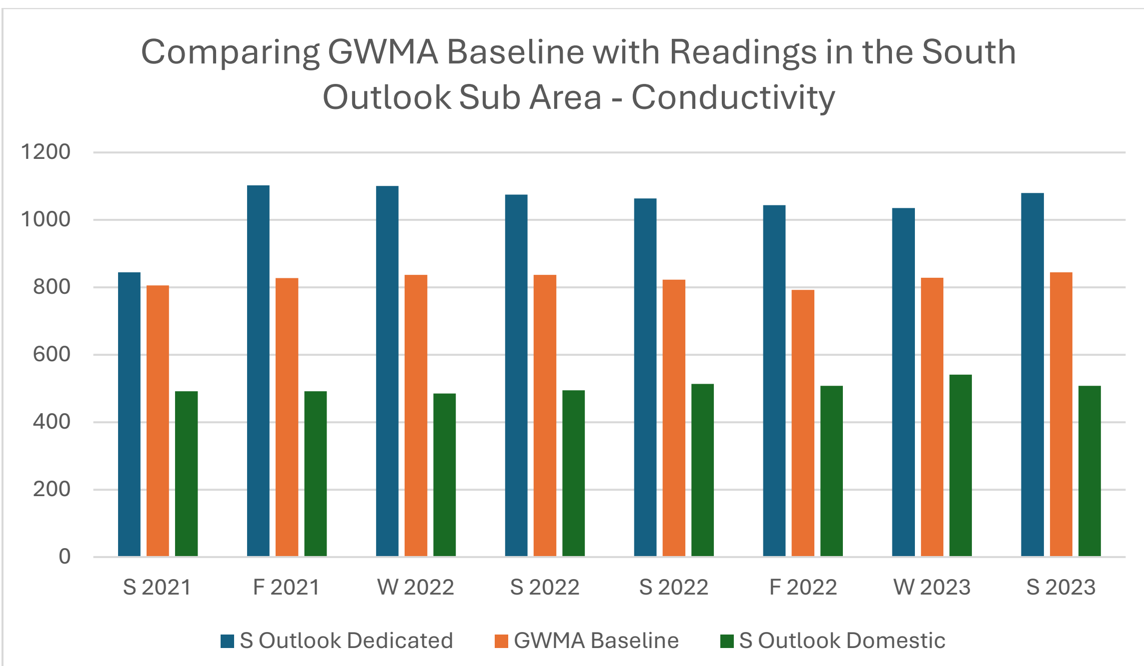
REDOX potential is high in dedicated wells and negative in most domestic wells. pH is 7.1 to 7.4 in dedicated wells and 7.4 to 8 in domestic wells which also impacts nitrification.

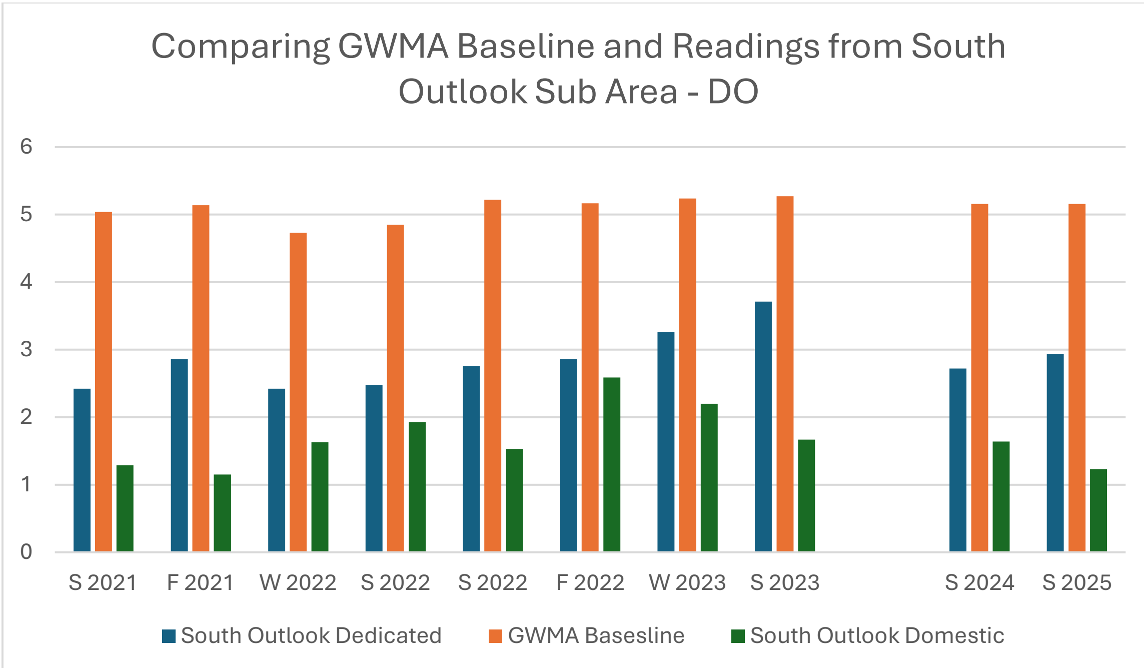
Nitrate N Readings for domestic monitoring wells in the Outlook area

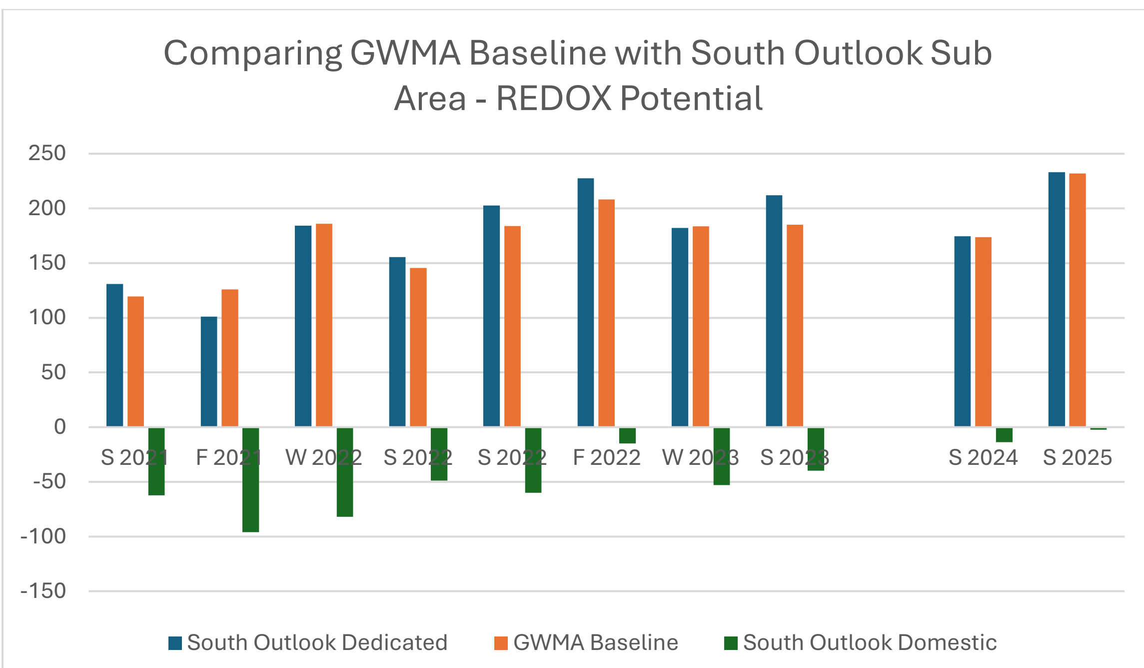
Outlook Nitrate N	Well Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
LYV-OL-084	140	6.08	6.5	5.965	6.15
LYV-OL-082	143	3.1	3.12	2.99	2.75
LYV-OL-078	156		8.86	9.25	7.35
LYV-OL-158	161		9.03	9.15	9.45
LYV-OL-080	162	6.7	7.21	10.08	8.43
LYV-OL-079	178		7.09	8.41	8.22
LYV-OL-081	221	0.222	0.05	0.01	0.058
LYV-OL-083	232	0.5	0.01	0.33	0.394
LYV-OL-085	243		0.013	0.01	
LYV-OL-168	256	0.61	0.618	0.674	0.665
LYV-OL-086	259	0.05			
LYV-OL-076	498	2.7	2.76	2.83	3.34
Average	220.75	2.5	4.11	4.58	4.68

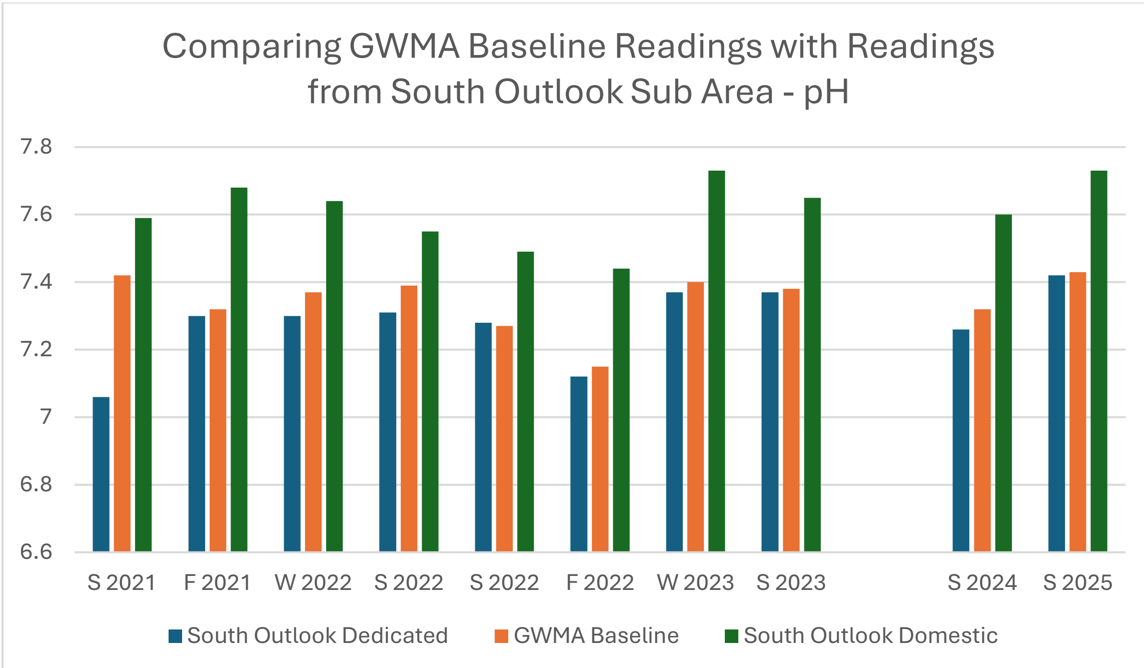
Nitrate N Dedicated Wells	Well Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
LYV-MW-010	23.2	26.50	33.55	60.70	70.50
LYV-MW-011	36.2	17.80	19.70	15.60	59.20
LYV-MW-012	33.18	23.00	22.90	24.70	19.60
LYV-MW-015	76	15.20	16.30	15.10	15.60
Average	42.15	20.63	23.11	29.03	41.23


Comparing GWMA Baseline with Readings from South Outlook Monitoring Wells - Nitrate N
45
40
35
30
25
20
15
10
5
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
South Outlook Dedicated
GWMA Baseline
South Outlook Domestic


Comparing GWMA Baseline with Readings in the South Outlook Sub Area - Conductivity
1200
1000
800
600
400
200
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S Outlook Dedicated
GWMA Baseline
S Outlook Domestic

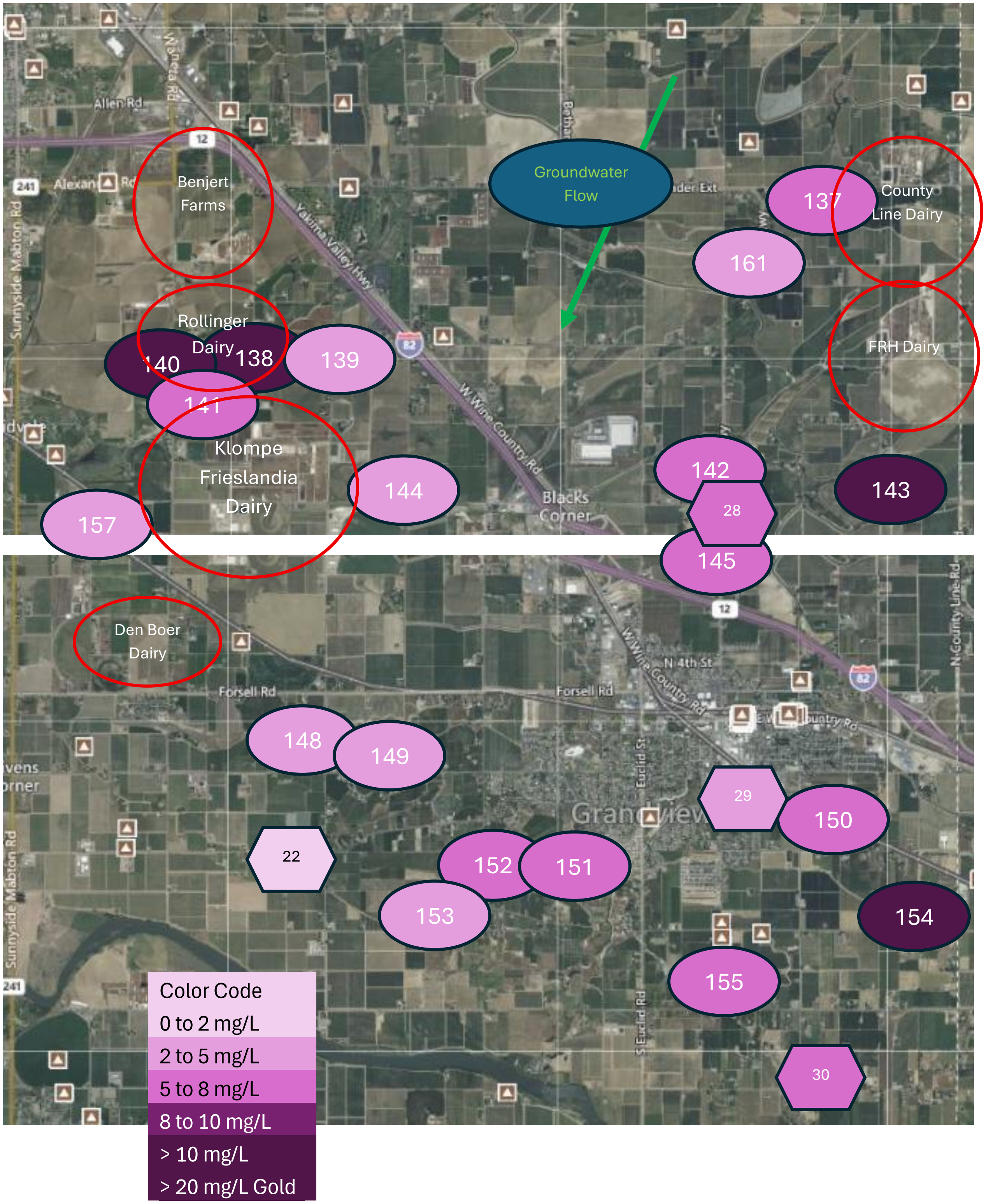

Comparing GWMA Baseline and Readings from South Outlook Sub Area - DO
6
5
4
3
2
1
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
South Outlook Dedicated
GWMA Baseline
South Outlook Domestic


Comparing GWMA Baseline with South Outlook Sub Area - REDOX Potential
250
200
150
100
50
0
-50
-100
-150
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
South Outlook Dedicated
GWMA Baseline
South Outlook Domestic


Comparing GWMA Baseline Readings with Readings from South Outlook Sub Area - pH
7.8
7.6
7.4
7.2
7
6.8
6.6
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
South Outlook Dedicated
GWMA Baseline
South Outlook Domestic

Sunnyside/Grandview

Grandview Monitoring Wells



The water table is fairly shallow in this area and soils are mostly well drained, interspersed with areas of poorly drained soils.

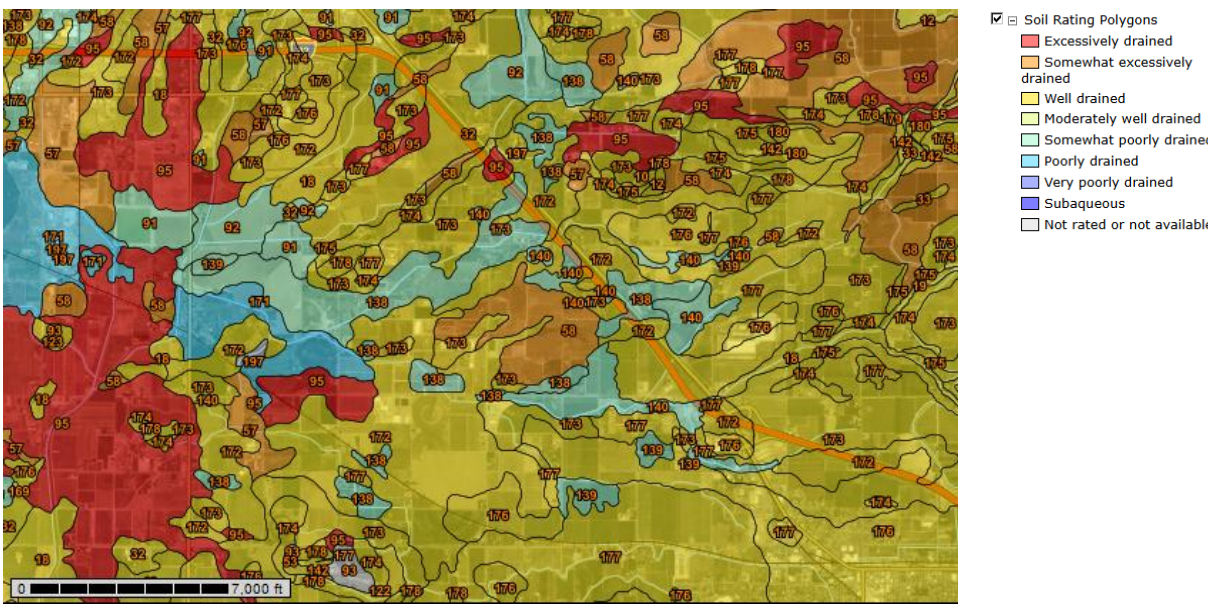
Over the years dairies in this area have grown in size and number of cows. Yet Nitrate N levels have not increased at the same rate. We wonder what happens to the nitrogen excreted by thousands of cows in this small area.

In 1992 Ecology performed the Hornby Lagoon study at what is now Klompe Frieslandia Dairy to better understand leakage from a newly constructed manure lagoon. After one year Ecology measured increased chloride levels in downgradient wells and estimated groundwater flow at 50 to 135 feet per year.[30] The water table was measured at 5 to 10 feet. The team stated:

"The westward flow of ground water in the study area probably conveys water from beneath the lagoons to an open irrigation ditch to the west and southwest. One domestic water supply well is downgradient of the main lagoon and eventually might become contaminated if leakage continues. However, this well taps the sand and gravel aquifer at a depth of 85 feet and a 15-foot-thick, fine grained layer may provide some natural protection."[31]

The research team recommended follow up over time, but that did not happen.

Soil Drainage Types in the Sunnyside/Grandview Area from the NRCS Web Soil Survey

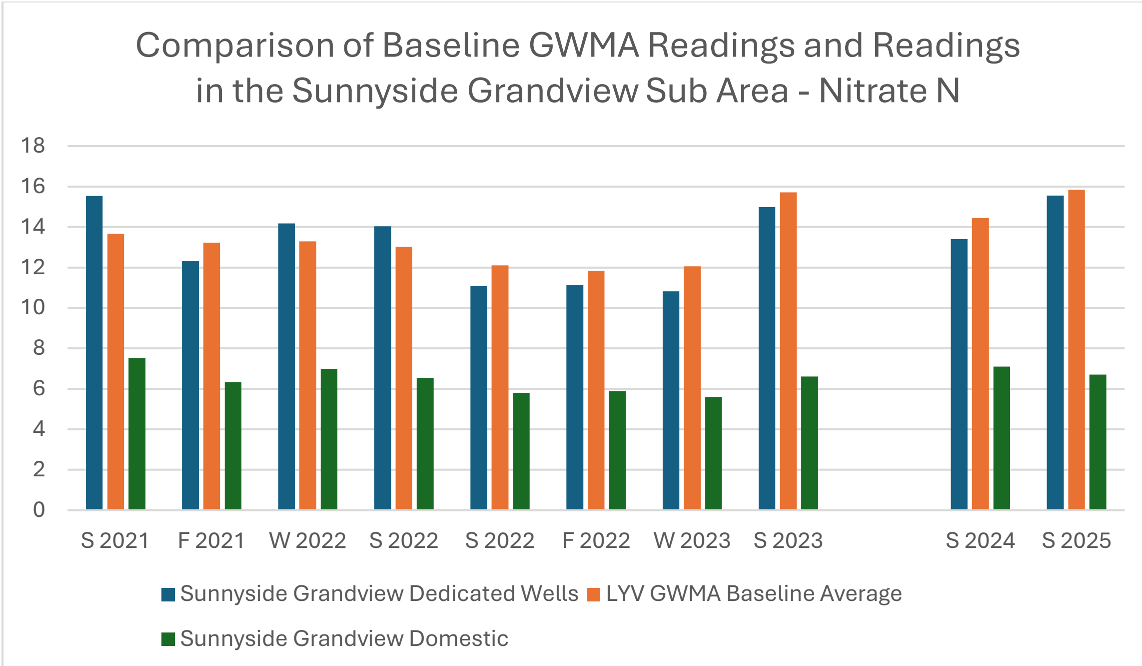


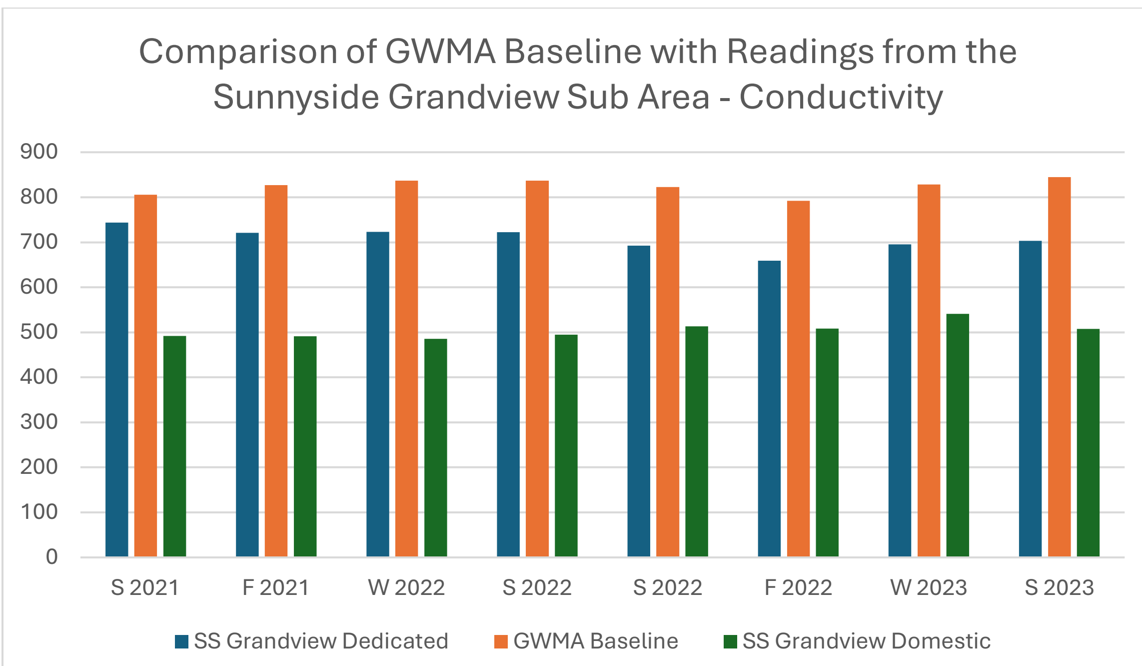
[30] Erickson, D. 1992, Ground Water Quality Assessment Hornby Dairy Lagoon Sunnyside, Washington. Page 12. [92e23.pdf](92e23.pdf)

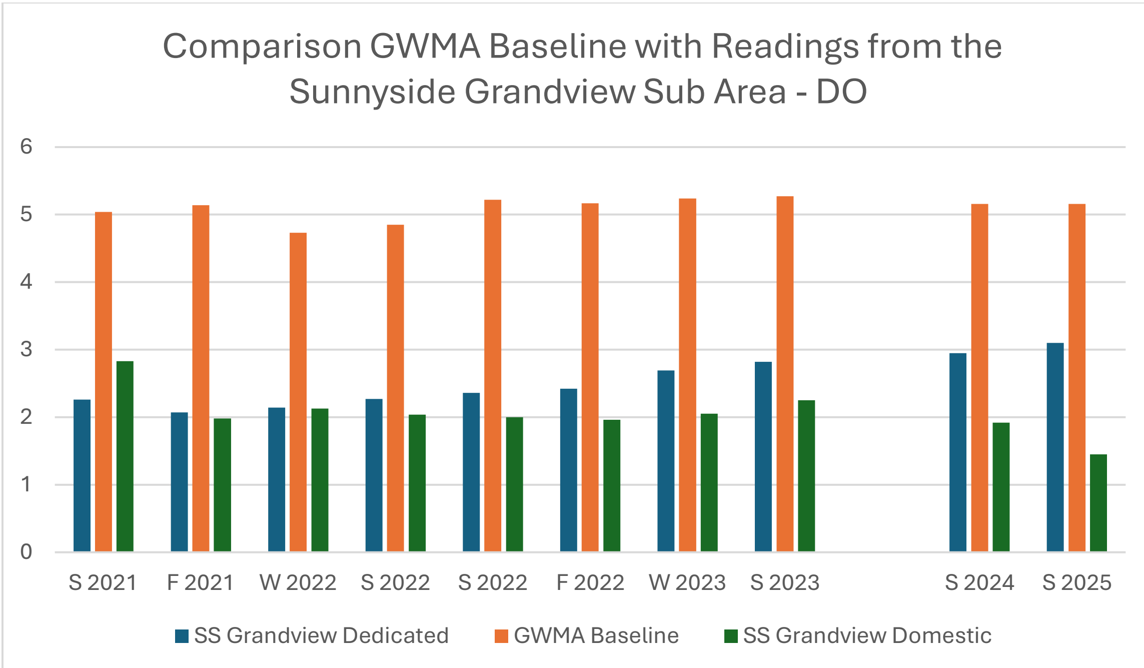
[31] Erickson, Page 19

Nitrate N Readings in domestic wells the Sunnyside/Grandview Area

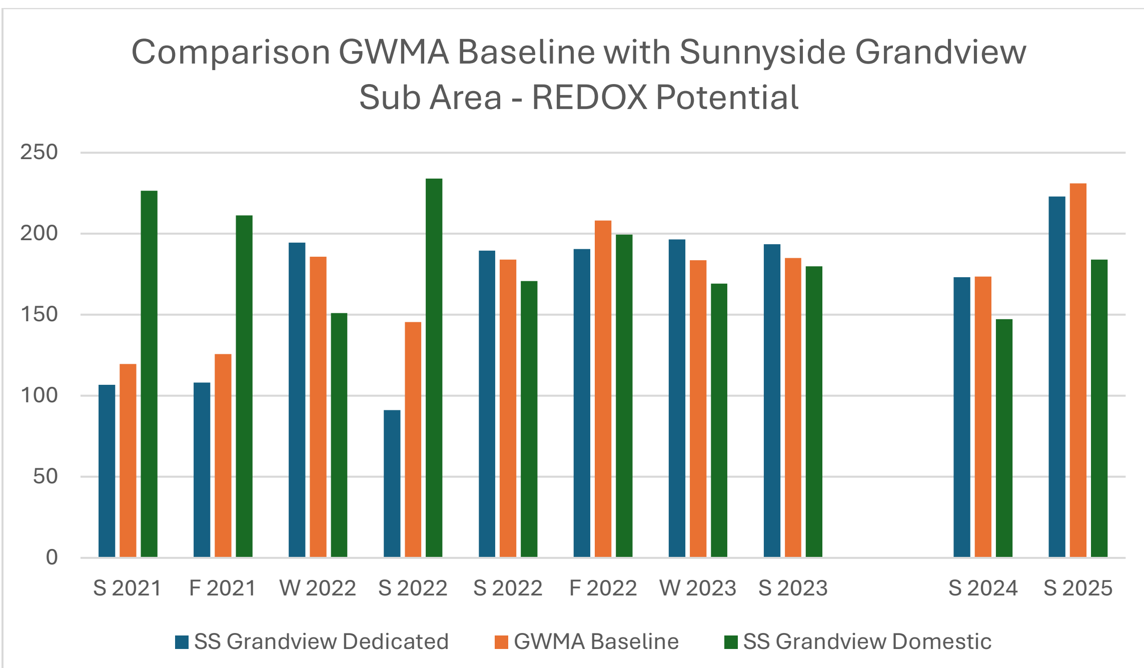
Grandview		Well Depth in Feet	Spring 2022	Spring 2023	Spring 2024	Spring 2025
LYV-GV-157		89	7.65	5.76	3.72	2.43
LYV-GV-143		90	18	20.1	21.2	21.9
LYV-GV-138		108	9.78	11	13.7	15.3
LYV-GV-137		120	3.86	3.67	3.72	3.94
LYV-GV-152		125	8.07	7.61	10.7	7.65
LYV-GV-141		135	6.55	6.36	6.96	7.04
LYV-GV-154		143	11.9	11.8	8.85	12.6
LYV-GV-142		144	7.07	7	8.13	7.54
LYV-GV-151		145	5.89	5.83	4.54	5.83
LYV-GV-161		145	4.17	4.15	4.25	4.24
LYV-GV-140		147	14.7	16.1	17.8	15.9
LYV-GV-139		160	3.32	3.35	4.73	3.78
LYV-GV-150		165	5.16	5.29	5.74	5.84
LYV-GV-153		179	2.69	2.56	2.59	2.66
LYV-GV-145		180	5.43	4.96	3.56	4.53
LYV-GV-148		180	2.8	3.03	3.88	3.77
LYV-GV-155		255	5.57	5	7.23	6.84
LYV-GV-144		270	2.43	2.36	2.42	2.38
LYV-GV-149		276	5.05	4.91	3.58	2.97
N = 19	Average	160.84	6.85	6.89	7.23	7.22
	Range	89 to 276				
	Median	145				


Comparison of Baseline GWMA Readings and Readings in the Sunnyside Grandview Sub Area - Nitrate N
18
16
14
12
10
8
6
4
2
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
Sunnyside Grandview Dedicated Wells
LYV GWMA Baseline Average
Sunnyside Grandview Domestic

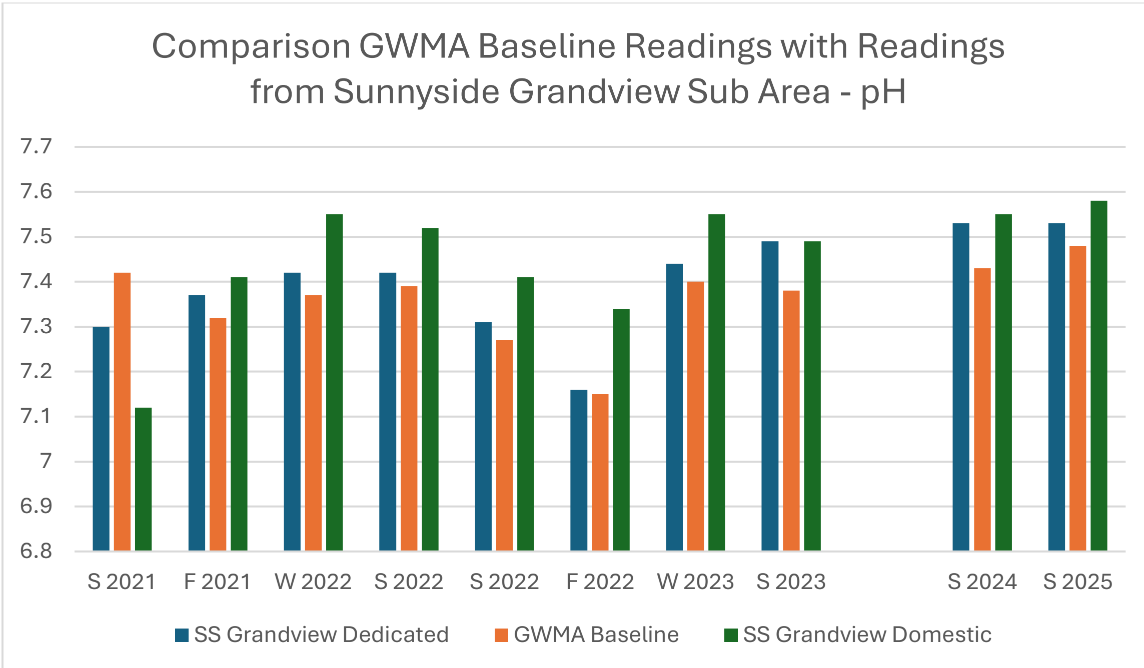

Comparison of GWMA Baseline with Readings from the Sunnyside Grandview Sub Area - Conductivity
900
800
700
600
500
400
300
200
100
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
SS Grandview Dedicated
GWMA Baseline
SS Grandview Domestic



Comparison GWMA Baseline with Readings from the Sunnyside Grandview Sub Area - DO
6
5
4
3
2
1
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
SS Grandview Dedicated
GWMA Baseline
SS Grandview Domestic

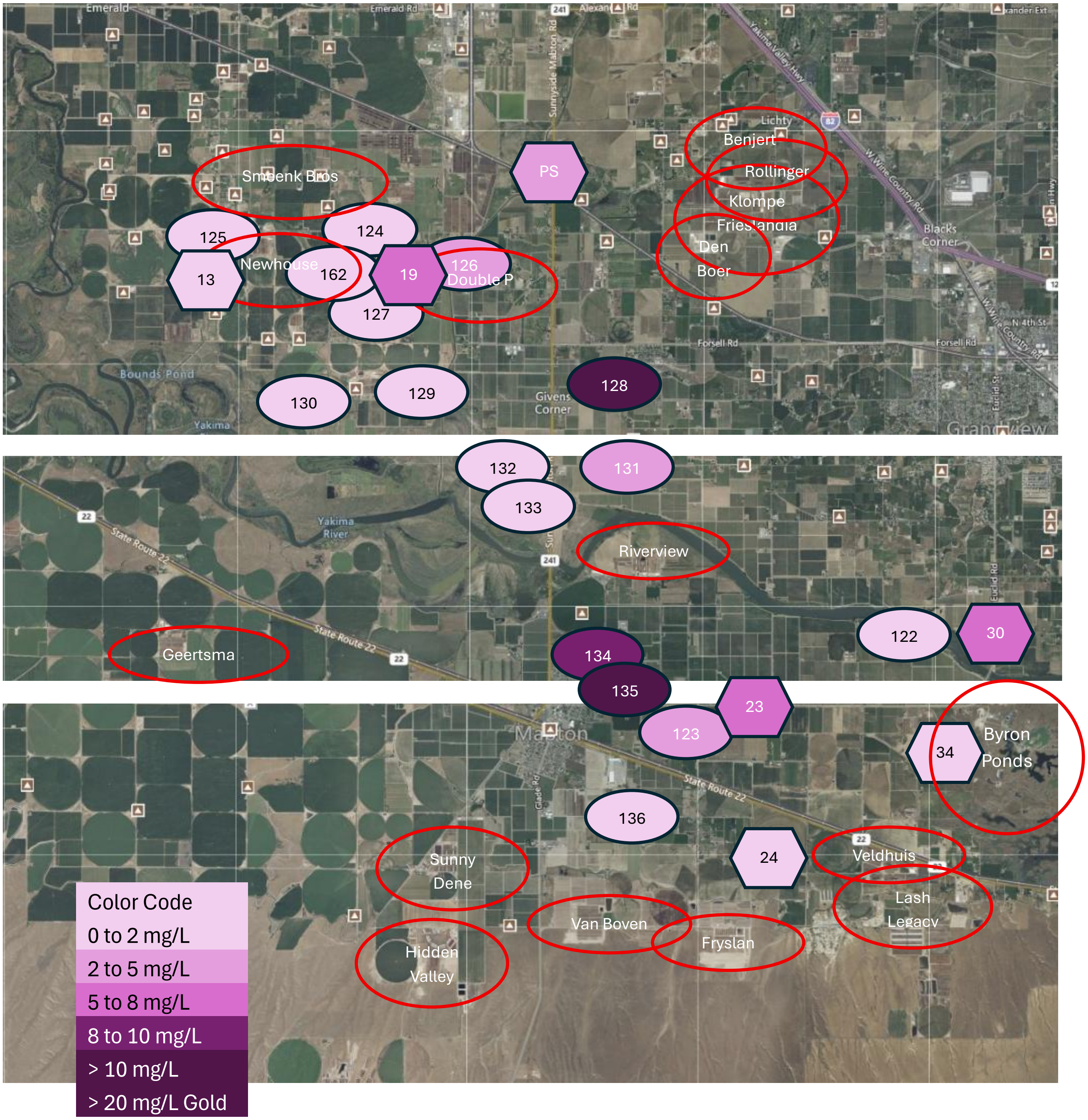


Comparison GWMA Baseline with Sunnyside Grandview Sub Area - REDOX Potential
250
200
150
100
50
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
SS Grandview Dedicated
GWMA Baseline
SS Grandview Domestic


Comparison GWMA Baseline Readings with Readings from Sunnyside Grandview Sub Area - pH
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7
6.9
6.8
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
SS Grandview Dedicated
GWMA Baseline
SS Grandview Domestic

North Mabton

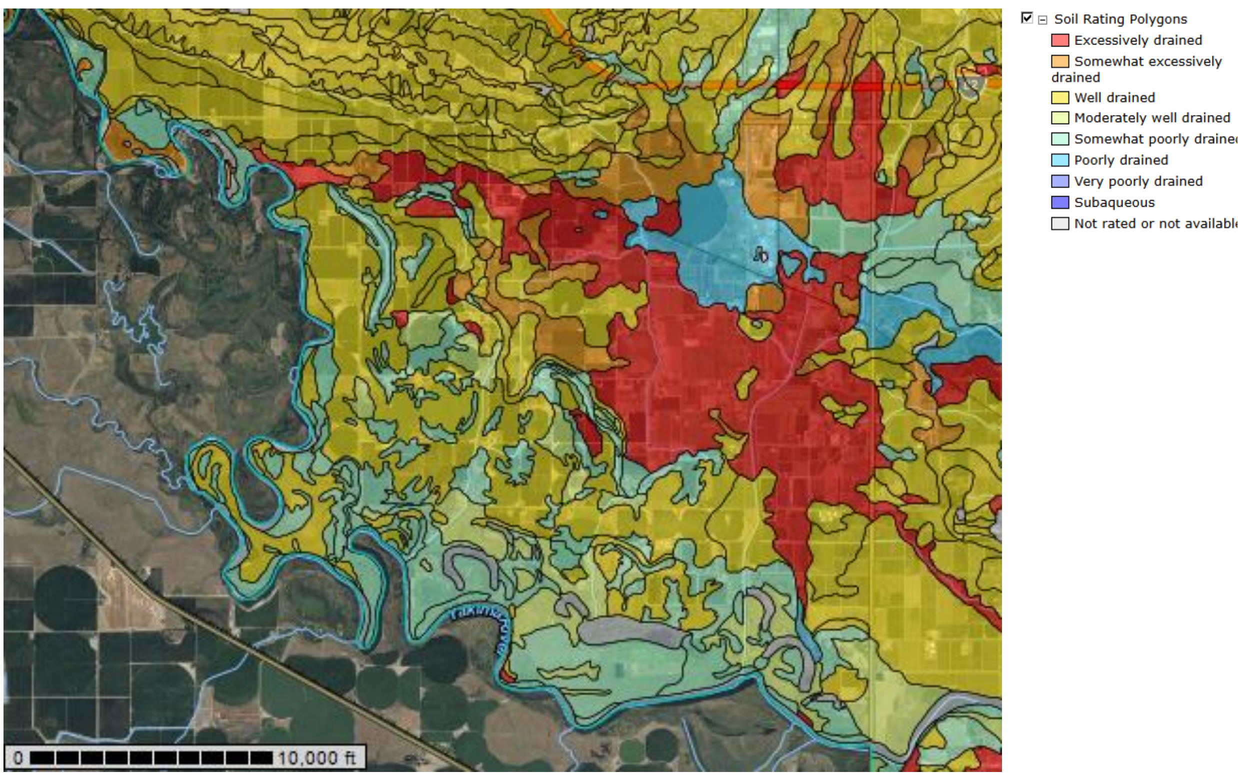
Mabton Groundwater Monitoring Wells – Spring 2025 – Nitrate N



The 1990 Agricultural Chemicals Pilot study [32] described the North Mabton area well, so we quote it here:

"Three hydrogeological units significant to the study have been identified beneath the study area based on published reports and well log reports. These units are an Upper Aquifer that consists of two hydraulically connected units, a sand unit which overlies a gravel unit, and an underlying silt-clay aquitard. . . . . . . The upper sand unit, which ranges in thickness from 50 to 70 feet, consists of alluvium and catastrophic flood slack-water sediments. The gravel unit ranges in thickness from 20 to 60 feet. Under most of the study area the two units appear to be hydraulically connected. . . . . . The silt-clay aquitard , probably the lower Ringold Formation, appears to be continuous beneath the study area."

Soil Drainage Types in the North Mabton Area from the NRCS Web Soil Survey



Nitrate N readings from domestic wells in the North Mabton sub area are low and ammonia readings are elevated which raises the question of what is happening in the underlying soils.

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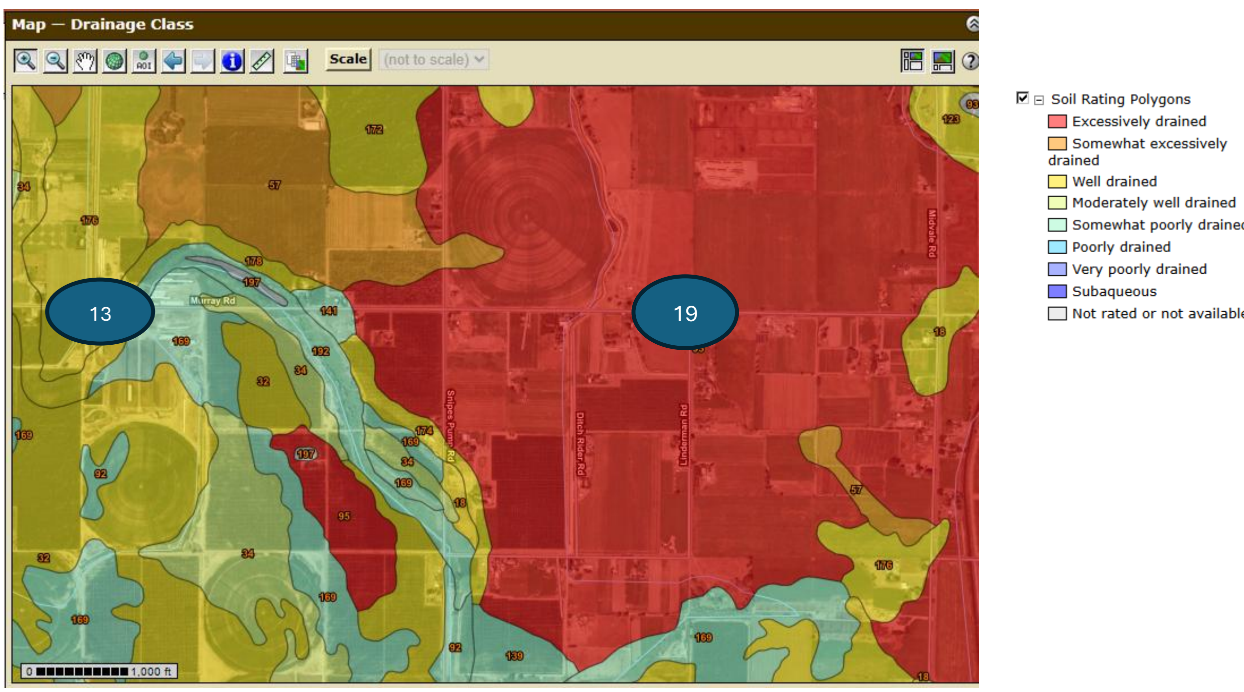
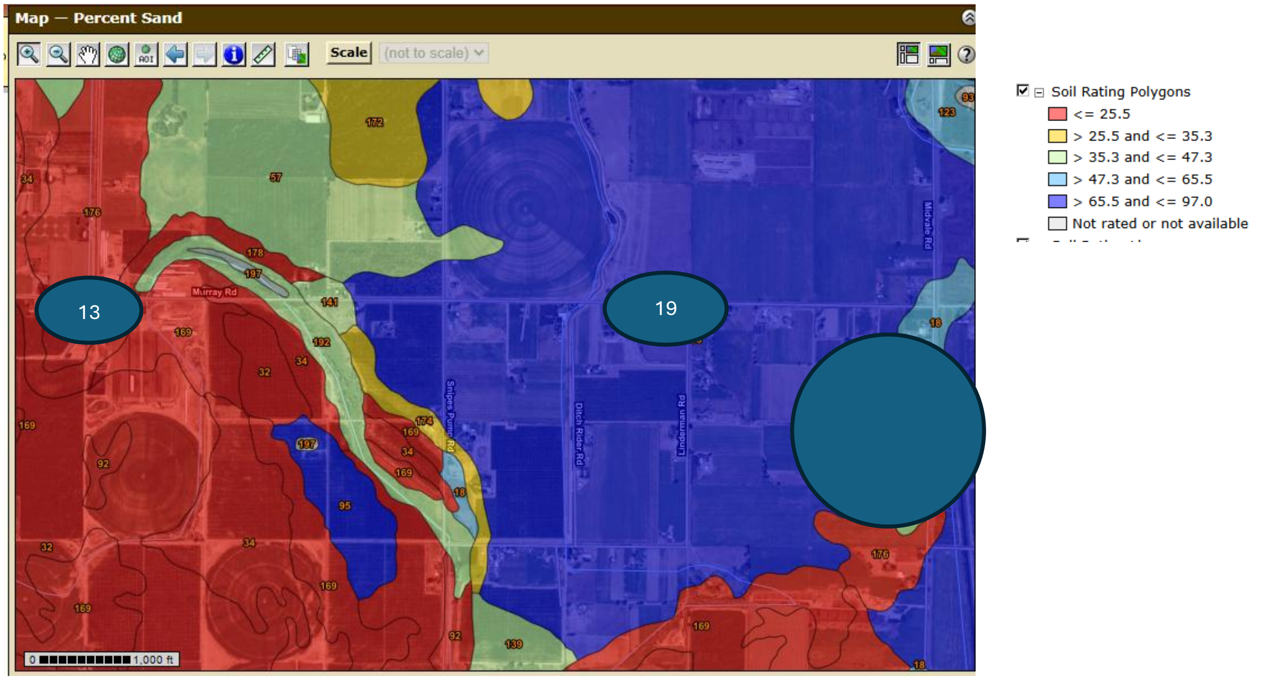
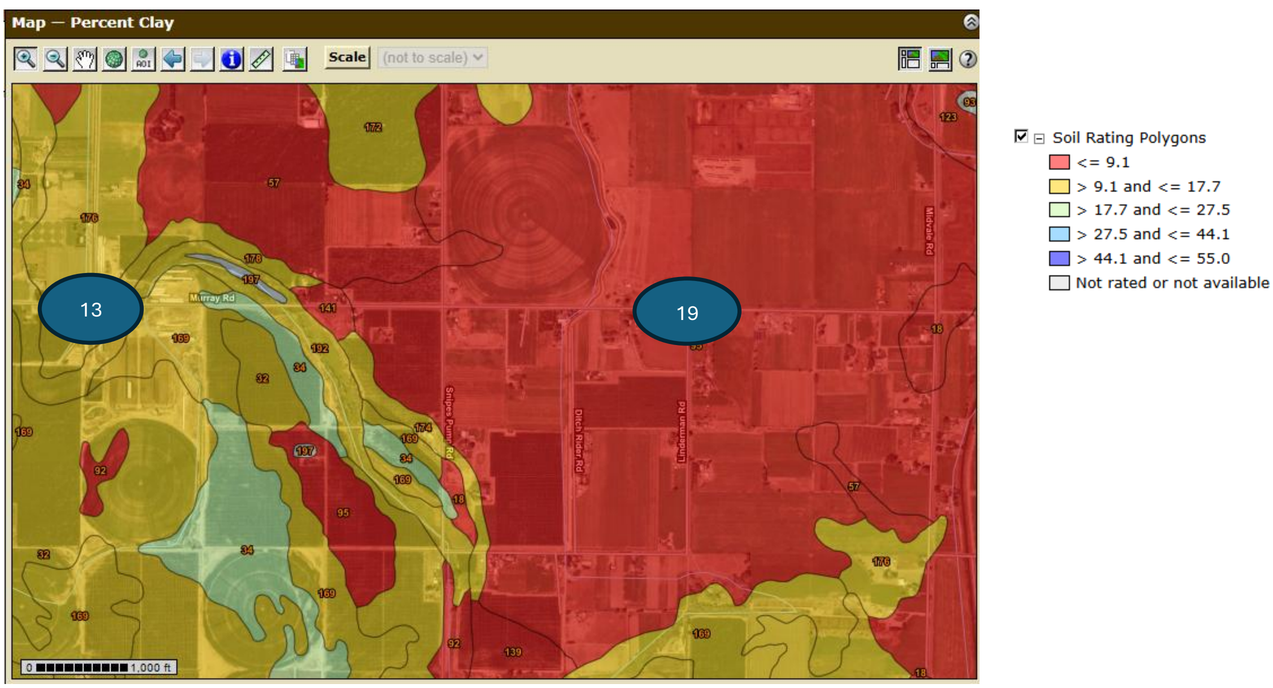
[32] WA Ecology Agricultural Chemicals Pilot Study. 9046.pdf

The two dedicated monitoring wells in North Mabton are 6,687 feet apart, but there are differences in the settings.







Moving along at Mabton, there are big differences in readings from domestic wells in North Mabton and South Mabton. The two areas should be addressed separately. Please review the chart below with readings from the two areas.

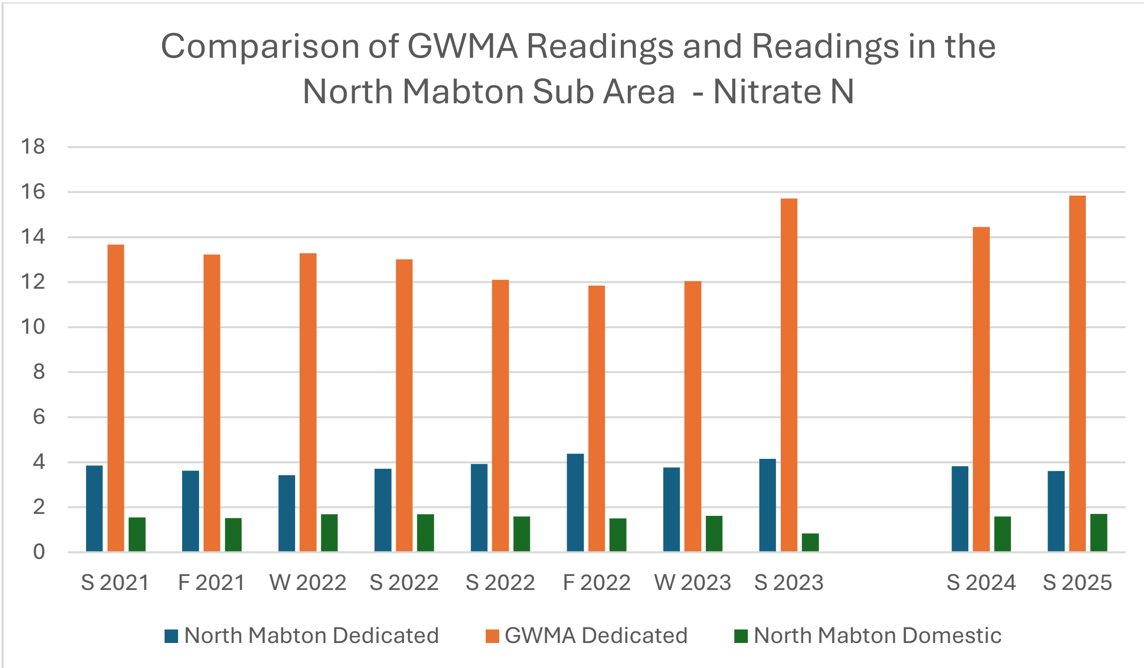
Comparing Water Samples from North and South Mabton

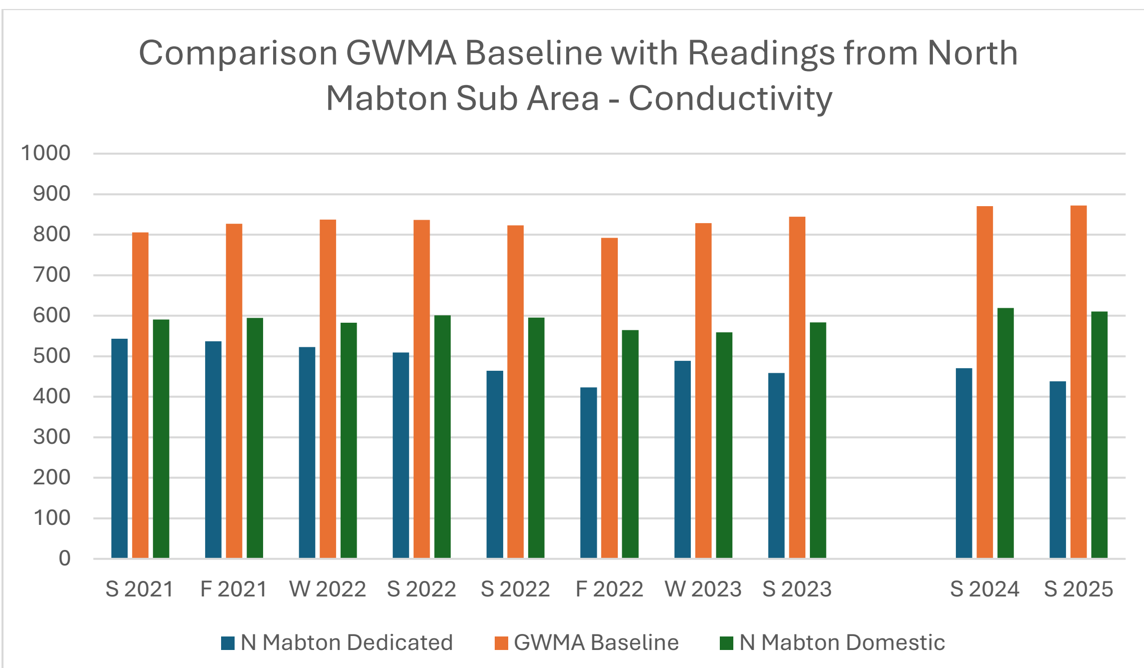
Domestic Wells	Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
Nitrate N Levels in mg/L					
LYV-MB-122	144	0.01	0.01	0.01	0.01
LYV-MB-123	110	4.55	4.65	6.31	4.72
LYV-MB-134	144	8.81	8.15	8.99	8.24
LYV-MB-135	146	14.8	12.2	10.3	11
LYV-MB-136	82	0.43	0.452	0.49	0.422
South Averages	127.83	5.72	5.09	5.22	4.88
LYV-MB-124	102	0.367	0.517	0.701	0.64
LYV-MB-125	85	0.01	0.01	0.01	0.01
LYV-MB-126	104	3.65	2.76	2.75	2.31
LYV-MB-127	98	0.01	0.01	0.01	0.195
LYV-MB-128	122	10.1	9,67	10.6	11.6
LYV-MB-129	85	0.01	0.009	0.01	0.01
LYV-MB-130	96	0.01	0.052	0.01	0.01
LYV-MB-131	123	2.74	2.59	2.84	3.13
LYV-MB-132	85	0.01	0.01	0.01	0.559
LYV-MB-133	82	1.63	1.42	0.505	0.373
LYV-MB-162	100	0.01	0.01	0.01	0.022
North Averages	98.36	1.69	0.84	1.59	1.71
Domestic Wells	Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
Mabton Ammonia Levels in mg/L					
LYV-MB-122 (Outlier)	144	0.324	0.215	0.271	0.278
LYV-MB-123	110	0.01	0.01	0.01	0.01
LYV-MB-134	144	0.01	0.01	0.01	0.01
LYV-MB-135	146	0.01	0.01	0.01	0.01
LYV-MB-136	82	0.01		0.01	
South Average		0.073	0.062	0.062	0.077

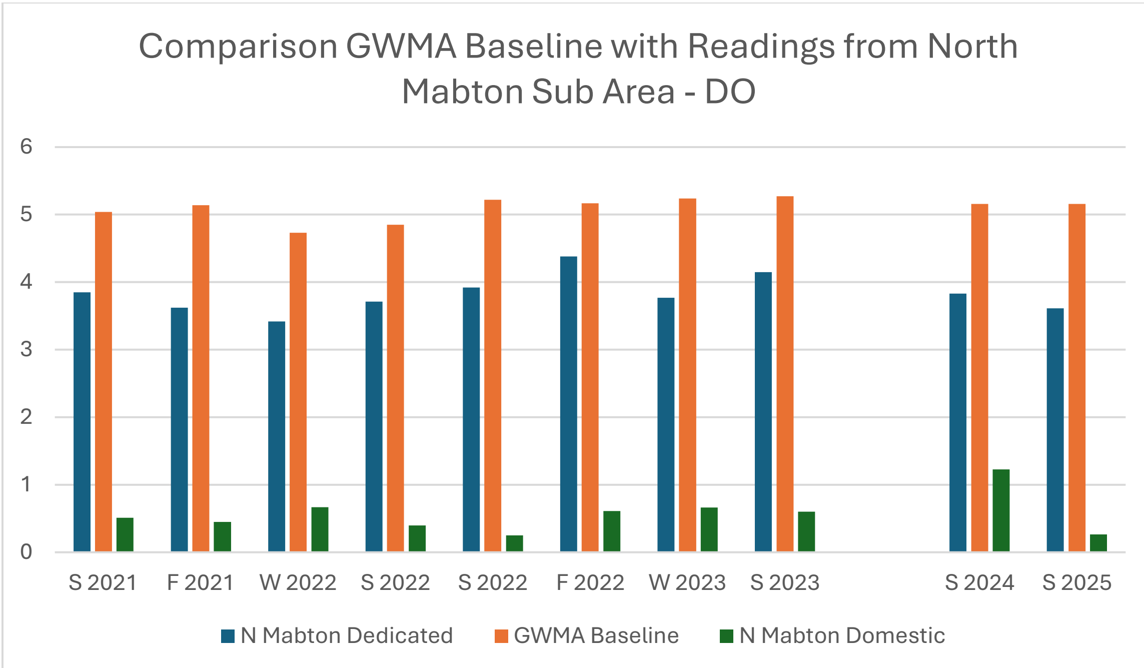
LYV-MB-124	102	0.01	0.01	0.013	0.01
LYV-MB-125	85	0.032	0.015	0.035	0.034
LYV-MB-126	104	0.01	0.01	0.01	0.01
LYV-MB-127	98	0.11	0.085	0.129	0.112
LYV-MB-128	122	0.01	0.01	0.01	0.01
LYV-MB-129	85	0.063	0.052	0.073	0.076
LYV-MB-130	96	0.071	0.053	0.047	0.077
LYV-MB-131	123	0.01			
LYV-MB-132	85	0.01	0.01	0.01	0.01
LYV-MB-133	82	0.01	0.01	0.01	0.01
LYV-MB-162	100	0.023	0.011	0.019	0.013
North Average		0.033	0.027	0.036	0.036
Domestic Wells	Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
Conductivity in µS/cm					
LYV-MB-122	144	687.3	695.9	723.2	668
LYV-MB-123	110	710.1	640.1	713	645.7
LYV-MB-134	144	789.3	790.2	798.6	750
LYV-MB-135	146	802.7	814.2	791.6	754
LYV-MB-136	82	272.7	260.2	281.1	275.5
South Average		652.42	640.12	661.5	618.64
LYV-MB-124	102	719.7	706.2	715.4	675.5
LYV-MB-125	85	390.6	380.9	413.8	403.9
LYV-MB-126	104	754.9	708.8	751.3	731.3
LYV-MB-127	98	710.1	693.4	754.8	771.2
LYV-MB-128	122	762.3	761.2	777.3	773
LYV-MB-129	85	585.7	610.7	621.4	600
LYV-MB-130	96	450	356.2	441.2	484.6
LYV-MB-131	123	481.8	488.9	507.8	511.4
LYV-MB-132	85	493.9	465.7	500.1	533.2
LYV-MB-133	82	621.5	604.3	659.7	608.6
LYV-MB-162	100	640.9	640.6	664.2	621
North Average		601.04	583.36	618.82	610.34

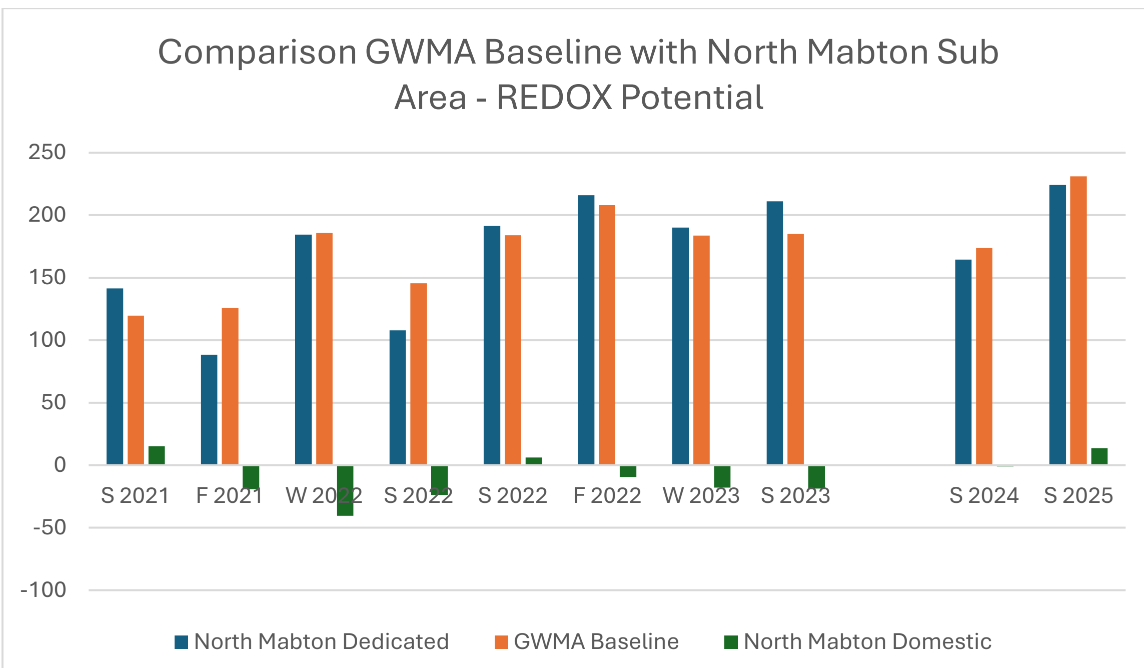
Domestic Wells		Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
Mabton Dissolved Oxygen in mg/L						
LYV-MB-122		144	0.15	0.29	0.14	0
LYV-MB-123		110	13.49	8.15	9.62	7.18
LYV-MB-134		144	0.21	0.27	0.33	0.01
LYV-MB-135		146	0	0.29	0.21	0.02
LYV-MB-136		82	1.11	1.05	1.14	0.75
South Average			2.992	2.01	2.288	1.592
LYV-MB-124		102	0.58	0.37	0.38	0
LYV-MB-125		85	0.47	0.4	0.23	0.05
LYV-MB-126		104	0.41	0.38	0.92	0.01
LYV-MB-127		98	0	0.39	0.2	0
LYV-MB-128		122	1.29	0.96	3.06	0.78
LYV-MB-129		85	0.31	0.36	1.9	0.03
LYV-MB-130		96	0.09	0.42	0.22	0.02
LYV-MB-131		123	1.18	2.03	1.94	1.93
LYV-MB-132		85	0.01	0.33	0.29	0
LYV-MB-133		82	0	0.3	0.23	0
LYV-MB-162		100	0.05	0.65	4.13	0.11
North Average DO Levels			0.399	0.599	1.227	0.266
Domestic Wells		Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
REDOX in mV						
LYV-MB-122		144	-146	-144	-99.2	-148.7
LYV-MB-123		110	124	103	176.1	185.9
LYV-MB-134		144	101	201	152.1	210
LYV-MB-135		146	172	231	92	212.9
LYV-MB-136		82	116	92	106.7	180.2
South Average REDOX			73.4	96.6	85.54	128.06

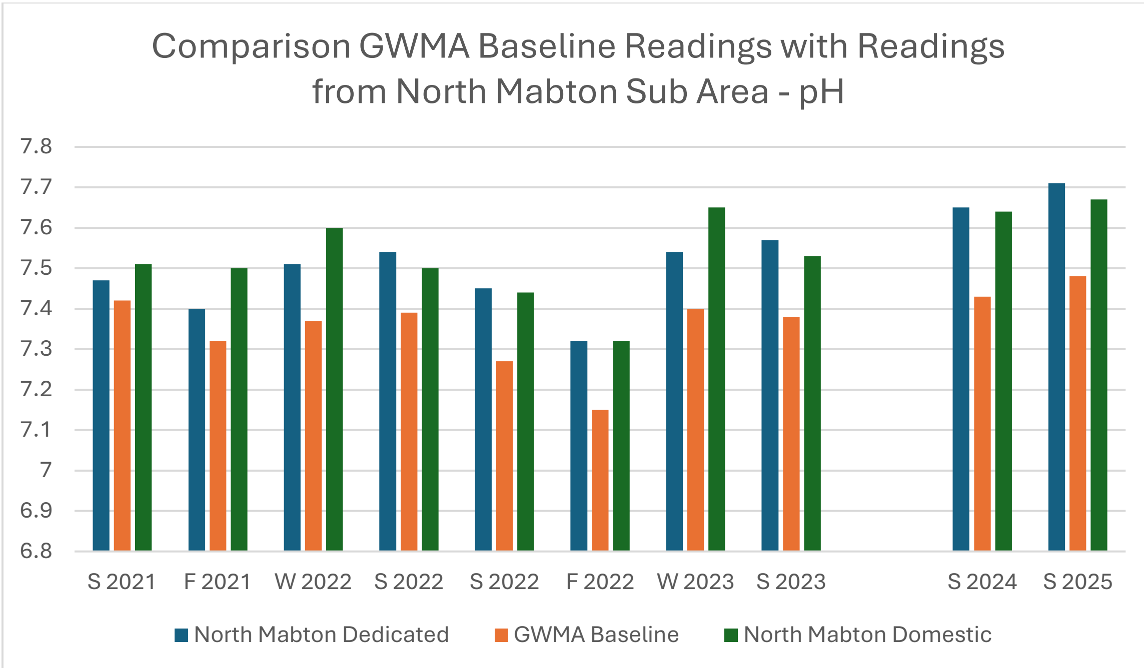
LYV-MB-124	102	-66	-69	2.8	-47.4
LYV-MB-125	85	-92	-119	-93.2	-83.4
LYV-MB-126	104	30	52	147.3	116.5
LYV-MB-127	98	-115	-118	-125.5	-98.4
LYV-MB-128	122	167	31	106.1	96.7
LYV-MB-129	85	-90	-77	-74.9	-93.3
LYV-MB-130	96	-133	-155	-138.4	-129.2
LYV-MB-131	123	50	172	109	190.8
LYV-MB-132	85	-47	-62	-42.6	108.9
LYV-MB-133	82	126	191	122.1	137.5
LYV-MB-162	100	-93	-51	-22.8	-47.7
North Average REDOX		-23.909	-18.636	-0.918	13.727
Domestic Wells	Depth in ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
Mabton pH					
LYV-MB-122	144	7.79	7.74	7.61	7.88
LYV-MB-123	110	7.04	7.08	7.23	7.26
LYV-MB-134	144	7.53	7.5	7.62	7.65
LYV-MB-135	146	7.35	7.26	7.41	7.44
LYV-MB-136	82	7.77	7.76	7.8	7.86
South Average pH		7.5	7.47	7.53	7.62
LYV-MB-124	102	7.6	7.58	7.64	7.68
LYV-MB-125	85	7.33	7.42	7.6	7.61
LYV-MB-126	104	7.42	7.48	7.64	7.66
LYV-MB-127	98	7.37	7.41	7.57	7.57
LYV-MB-128	122	7.38	7.41	7.52	7.57
LYV-MB-129	85	7.73	7.65	7.73	7.81
LYV-MB-130	96	7.57	7.64	7.68	7.58
LYV-MB-131	123	7.5	7.42	7.52	7.5
LYV-MB-132	85	7.54	7.6	7.74	7.79
LYV-MB-133	82	7.62	7.64	7.79	7.86
LYV-MB-162	100	7.46	7.62	7.66	7.75
North Average pH		7.5	7.53	7.64	7.67


Comparison of GWMA Readings and Readings in the North Mabton Sub Area - Nitrate N
18
16
14
12
10
8
6
4
2
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
North Mabton Dedicated
GWMA Dedicated
North Mabton Domestic


Comparison GWMA Baseline with Readings from North Mabton Sub Area - Conductivity
1000
900
800
700
600
500
400
300
200
100
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
N Mabton Dedicated
GWMA Baseline
N Mabton Domestic


Comparison GWMA Baseline with Readings from North Mabton Sub Area - DO
6
5
4
3
2
1
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
N Mabton Dedicated
GWMA Baseline
N Mabton Domestic

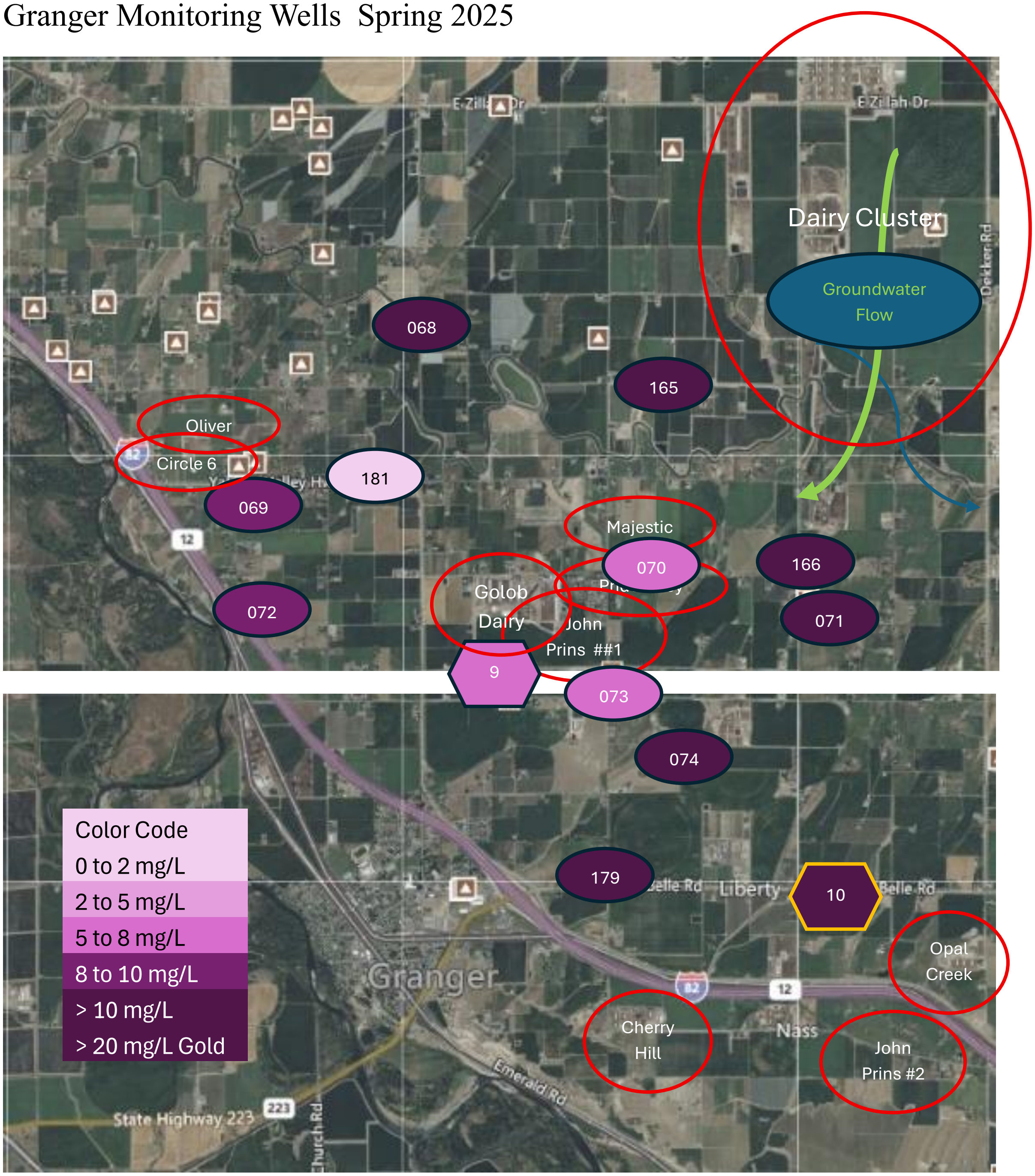

Comparison GWMA Baseline with North Mabton Sub Area - REDOX Potential
250
200
150
100
50
0
-50
-100
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
North Mabton Dedicated
GWMA Baseline
North Mabton Domestic



Comparison GWMA Baseline Readings with Readings from North Mabton Sub Area - pH
7.8
7.7
7.6
7.5
7.4
7.3
7.2
7.1
7
6.9
6.8
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
North Mabton Dedicated
GWMA Baseline
North Mabton Domestic

North Granger

Granger Monitoring Wells Spring 2025



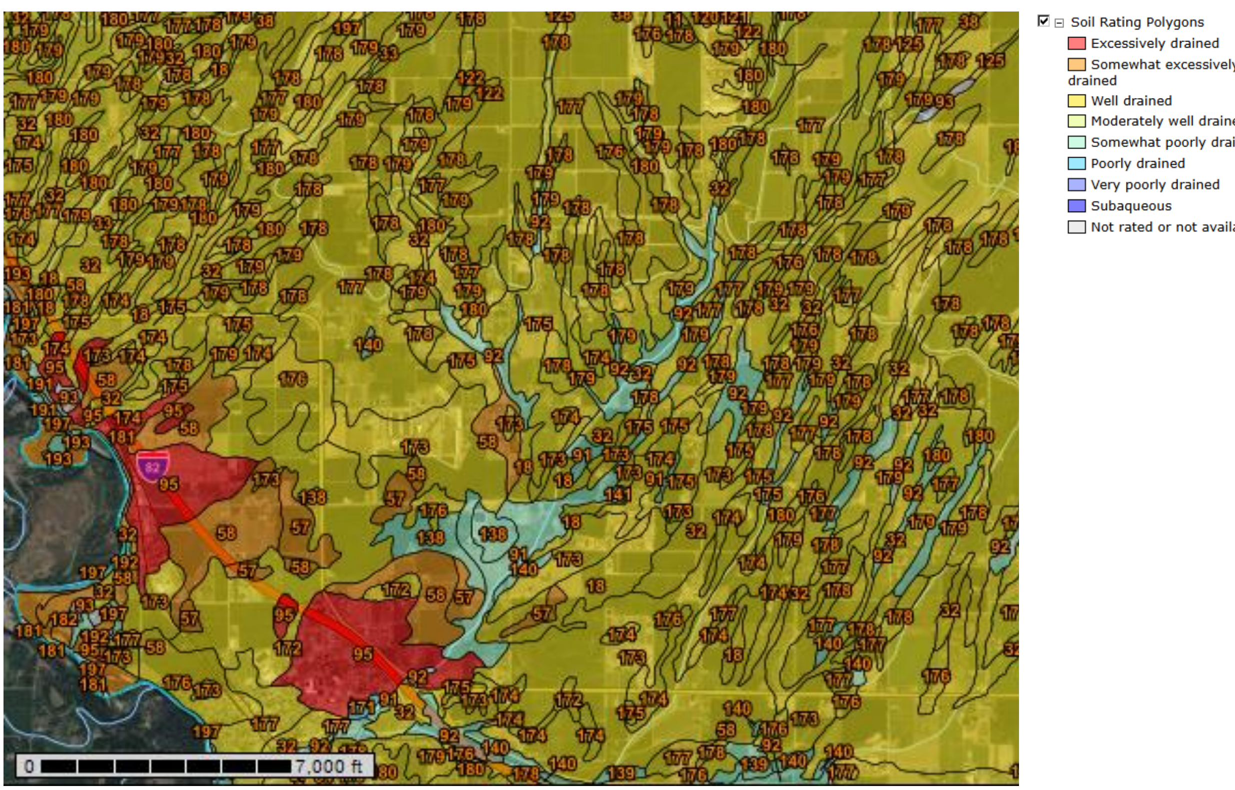
Granger has a number of risk factors that make this community prone to groundwater contamination. There are large and small dairies up gradient from Granger. Soils are well drained. There are legacy nitrates and other contaminants stored in the upgradient vadose zone that must flush toward the river sooner or later.

Granger already has the highest average levels of Nitrate N for any community in the LYV. This is a thriving small city that will feel the impact of nitrate pollution of the shallow aquifer continues.

It would be helpful to bring more dairies under permit, monitor applications of manure and fertilizer to cropland, and push dairies to line their manure lagoons with synthetic liners. Some soils are excessively well drained near Granger. The city lies next to the Yakima River and Granger drain flows through Granger before emptying into the river,

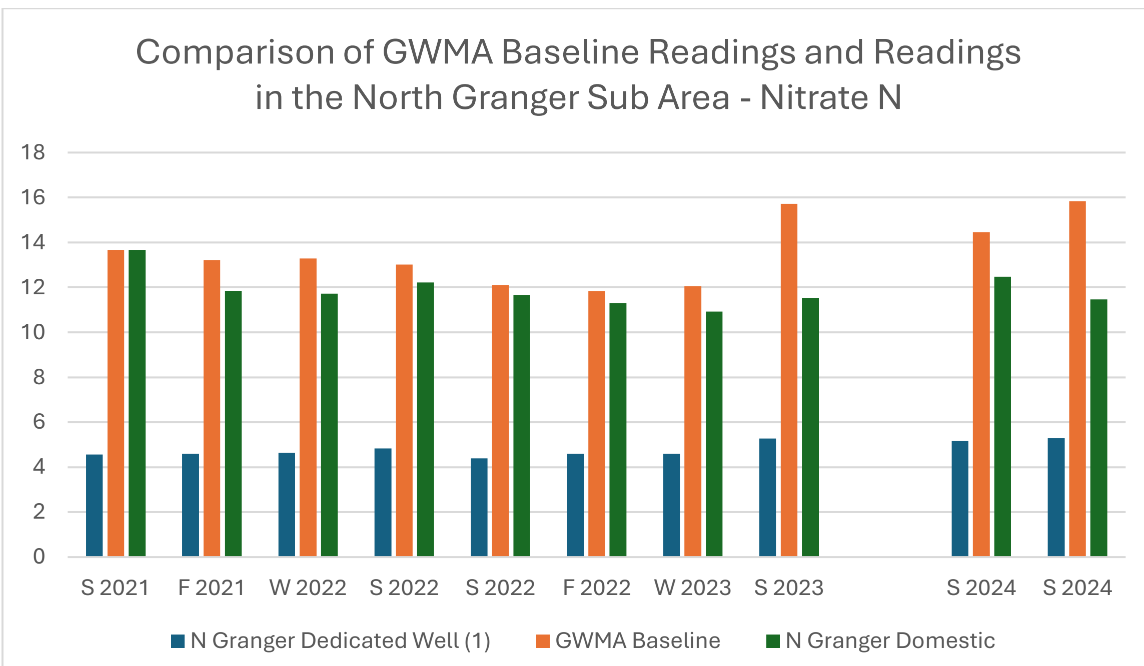
Adding more dedicated monitoring wells would provide for a more accurate evaluation of changes in groundwater quality in this area. With only one dedicated well in this area, the data provided for dedicated wells is highly questionable.

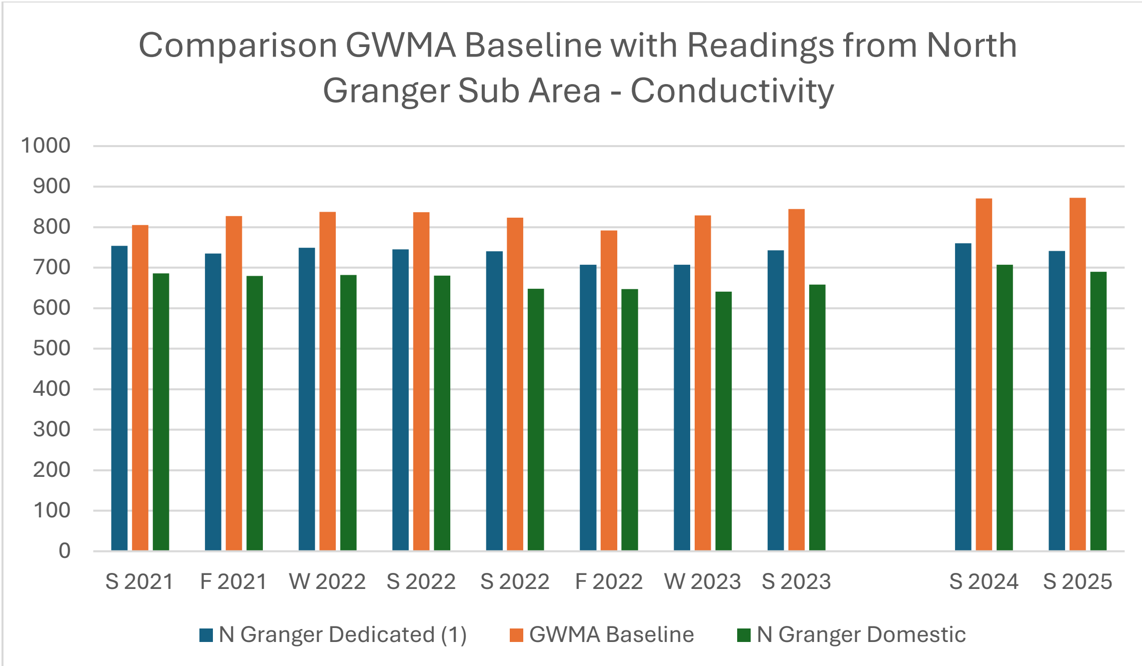
Soil Drainage Types in the North Granger Area from the NRCS Web Soil Survey



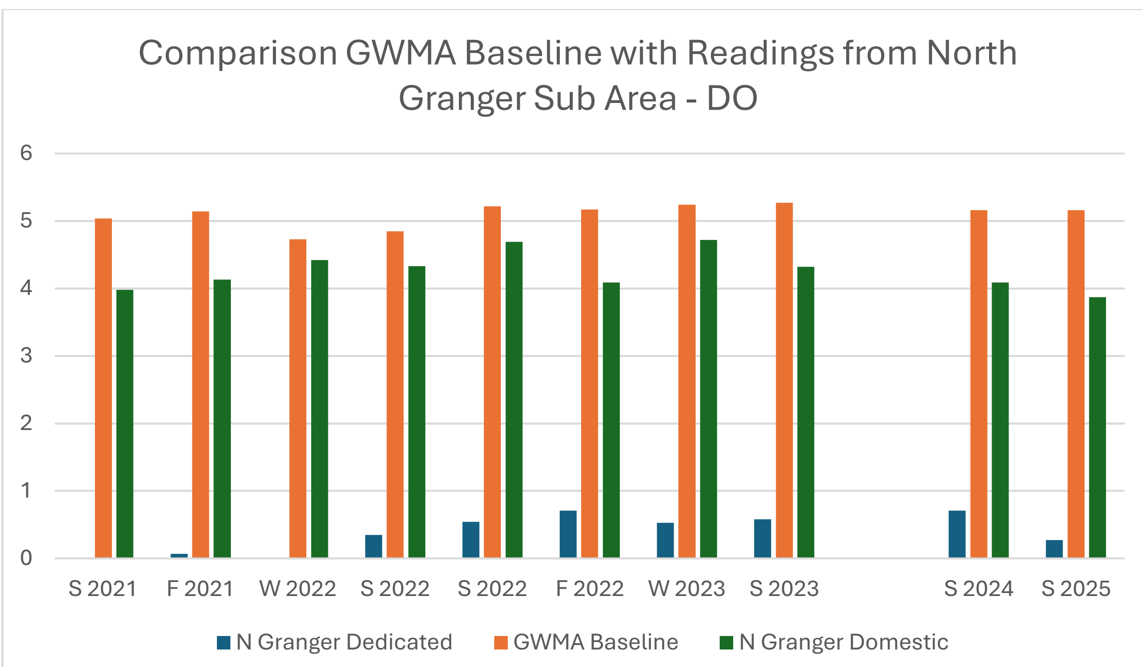
Granger Area Nitrate N Readings in Springtime

Granger		Well Depth - ft	Spring 2022	Spring 2023	Spring 2024	Spring 2025
LYV-GG-074		65	38	39.3	35.9	25.6
LYV-GG-073		94		6.85	7.28	6.82
LYV-GG-072		100	7.45	7.49	8.14	8.84
LYV-GG-181		100	1.5	1.5	1.84	1.73
LYV-GG-166		113	13.9		13.4	12.3
LYV-GG-071		115	11	10.6	12.2	10.5
LYV-GG-179		128	14.1	13	16.6	15.7
LYV-GG-069		178	7	6.64	8.05	8.4
LYV-GG-070		183	6.26	6.19	6.72	7.13
LYV-GG-165		185	9.9	10.6	11.7	12.7
LYV-GG-068		201	13.1	13.2	15.4	16.4
N = 11	Average	132.91	12.22	11.54	12.48	11.47
	Range	65 to 201				
	Median	115				

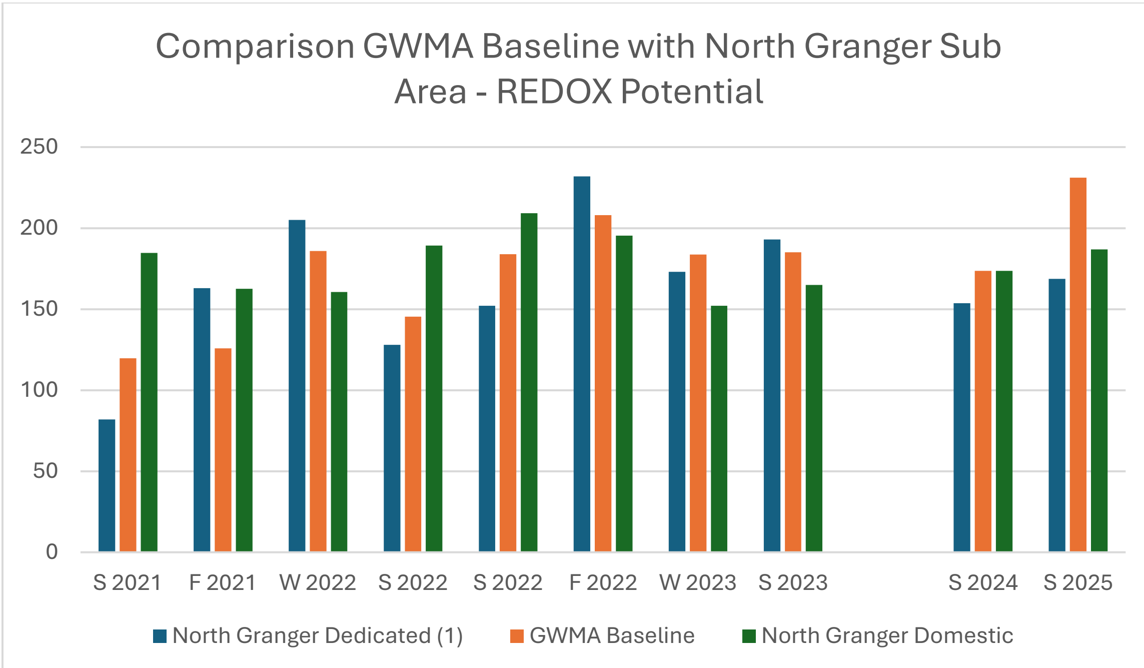




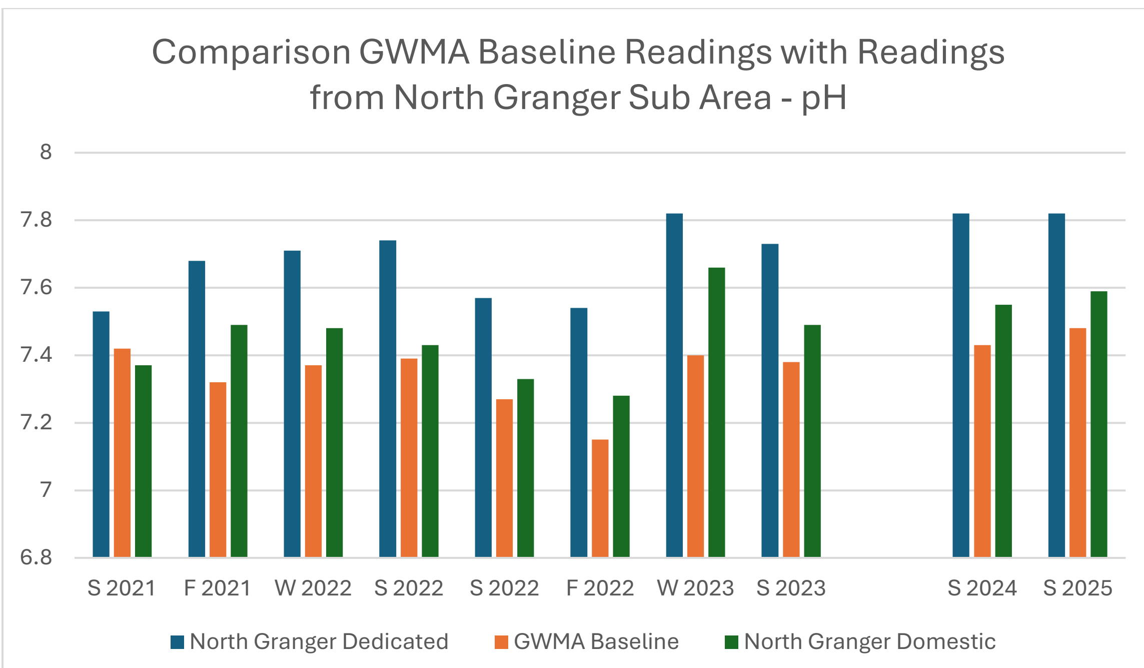
Comparison GWMA Baseline with Readings from North Granger Sub Area - Conductivity
1000
900
800
700
600
500
400
300
200
100
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
N Granger Dedicated (1)
GWMA Baseline
N Granger Domestic



Comparison GWMA Baseline with Readings from North Granger Sub Area - DO
6
5
4
3
2
1
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
N Granger Dedicated
GWMA Baseline
N Granger Domestic



Comparison GWMA Baseline with North Granger Sub Area - REDOX Potential
250
200
150
100
50
0
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
North Granger Dedicated (1)
GWMA Baseline
North Granger Domestic



Comparison GWMA Baseline Readings with Readings from North Granger Sub Area - pH
8
7.8
7.6
7.4
7.2
7
6.8
S 2021
F 2021
W 2022
S 2022
S 2022
F 2022
W 2023
S 2023
S 2024
S 2025
North Granger Dedicated
GWMA Baseline
North Granger Domestic

Well Logs for Domestic LYV GWMA Monitoring Wells

The most common layers throughout the GWMA are brown sand and clay. Mabton and Granger have lots of gravel. There is considerable basalt in the Grandview area.

Outlook has 10 wells with well logs. The Outlook area has much brown clay, sand and gravel. In a 267 ft well along the northern area basalt occurs at 165 ft and sandstone at 245 ft. In a 498 ft well along the northern area basalt begins at 205 ft and sandstone at 360 ft. Nitrate N levels of 3.34 mg/L were recently recorded for the 498 ft well which may speak to rate of downward groundwater flow.

In the southwestern area there is a cluster of three domestic wells, located within 1,000 ft of each other, with high, low and medium Nitrate N readings. There appears to be a sandstone layer in this area that begins at around 85 ft. beneath wells 81 and 82.

- Well 80 is 162 ft deep and had a Nitrate N reading of 8.43 mg/L in 2025
- Well 81 is 221 ft deep and had a Nitrate N reading of 0.058 mg/L in 2025
- Well 82 is 143 ft deep and had a Nitrate N reading of 2.75 mg/L in 2025

This speaks to the complexity of groundwater analysis, especially around Outlook, and the need for input from experts.

In the southeast area there are two artesian wells drilled through brown clay and sand. These wells have medium and high Nitrate N readings. They appear different from the wells to the west and are drilled to 243 and 259 ft.

Well depths for Outlook range from 143 to 498 ft.

Grandview has sixteen wells with well logs and we divide this area into three subgroups. There is much more basalt and much less clay and sand around Grandview. There seems to be an underlying sandstone layer. Well depths range from 89 to 276 ft.

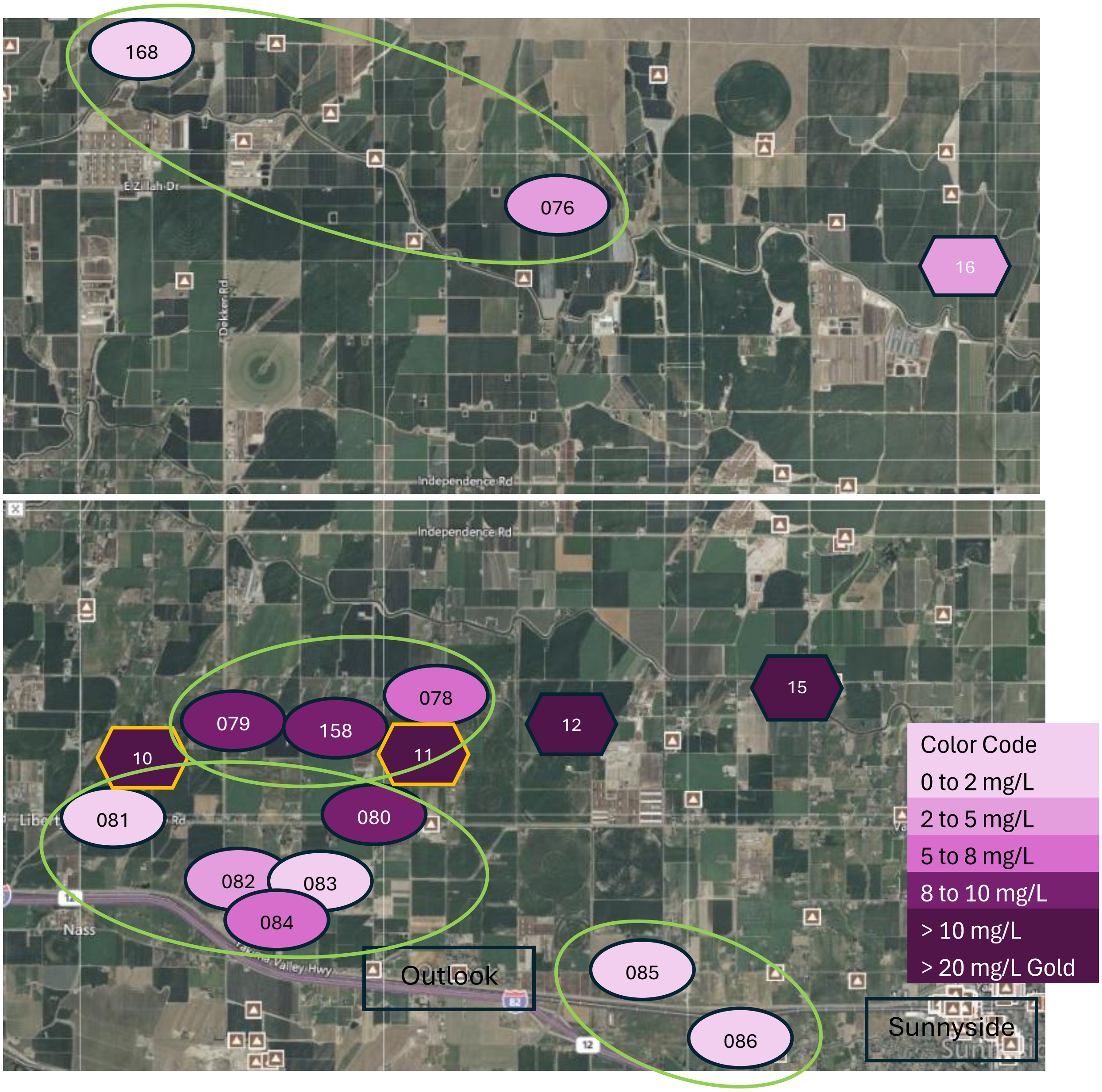
- The area between Sunnyside and Grandview contains many types of clay. Silt and sand are found above 90 ft in most wells. Basalt begins at 40-50 ft in two wells and 90 ft in a third well. Sandstone is found at 70 -80 ft in two wells and at 140 -150 ft in two more. All wells except one have low Nitrate N.
- In the North Grandview area basalt begins at 20 – 30 ft. We start seeing sandstone at 110 to 130 ft. Wells have medium and high Nitrate N.
- In the South Grandview area basalt begins early from 10 – 30 ft for most wells and by 80 ft for others. We start seeing sandstone between 80 and 100 ft. Nitrate N is mostly in the medium range.

Mabton has fourteen wells with well logs. There are two distinct Mabton sub areas located on opposites sides of the Yakima River. These areas differ significantly in geology and in geochemistry. See Attachment 8 Mabton Comparisons North & South

- Northern Mabton has much brown sand and clay with gravel. There are mostly low nitrate levels with one medium and one high. Shallow wells are mostly under 100 ft.
- Southern Mabton has brown clay, sand and gravel and a varied geology. One well in the midst of others is quite unique with basalt beginning at 80 ft. Nitrate N levels run from low to high.
  We include an outlier well in the South Mabton group. MW 122 is located next to the Yakima River and is drilled to 144 ft. This well has negligible Nitrate N, low dissolved oxygen and high ammonia readings. There is a sandstone layer at 50 ft.

Granger has eight wells with well logs. Layers are mostly clay and sand with slightly more gravel than seen in other areas. Sandstone occurs at 50, 70 and 110 ft in three wells. All wells except one have medium or high Nitrate N. There is iron water in one well. Well depths range from 94 to 201.

Outlook Monitoring Wells



Data from Well Logs – Outlook Area

Well Log	AFE 181 OL-168	AFH 903 OL-076	BIF 063 OL-079	AFH370 OL-078	ALF 092 OL-158
Depth	256 ft	498 ft	178 ft	156 ft	161 ft
Nitrate	Low	Medium	High	Medium	High
0 to 5 ft	Wh. Clay, Gravel	Soil, Boulders, Gravel	Silt	Topsoil	Top Soil
10	Tan Clay				
15					Br. Clay Br. Sand
20	Br. Clay, Gravel			Static Level	
30			Br. Clay Static Level		
35					Static Level
40					
45		Boulders, Gravel, Sand		Br. Clay Br. Sand Gravel	
50					
55				Br. Clay Br. Sand Water	
60					
65			Sand, Gravel	Br. Clay Br. Sand Water	Br. Clay Br. Sand Gravel
70					
75			Fine Sand		
80					
85			Sand, Gravel		
90					
95			Fine Sand	Br. Sand Water	
100	Tan Clay, Gravel				
105					Br. Clay, Br. Sand Water
110					
115			Sand, Gravel		
120					Br. Clay, Br. Sand, Gravel, Water

125					Br. Clay, Br. Sand, Water
130					
135			Br. Sand Gravel Water	Br. Sand Gravel Water	
140					
145	Tan Clay, Gravel	Sandy Clay			
150					
155					
160			Sand, Gravel	Well Depth	Br. Sand, Gravel, Water Well Depth
165	Black Basalt				
170	Static Level		Coarse Sand Gravel		
180			Well Depth		
185					
190					
195		Gravely Sand			
200					
205		Cemented Gravel & Sand			
210					
215					
220					
230					
235	Gray Basalt				
240					
245	S-stone Water				
250					
255					
260	Sand, Yellow, Water				
265	Well Depth				
270					
280					
290					
300					
305		Basalt			
310					
320					
330					
340					

345		Clay			
350					
360		Sandstone Clay Static Level			
370					
380					
390					
400					
410					
420					
430		Gravel, Sand			
435		Sandstone			
440					
450					
460					
470					
480					
485		Sand			
490		Sandstone			
500		Well Depth			

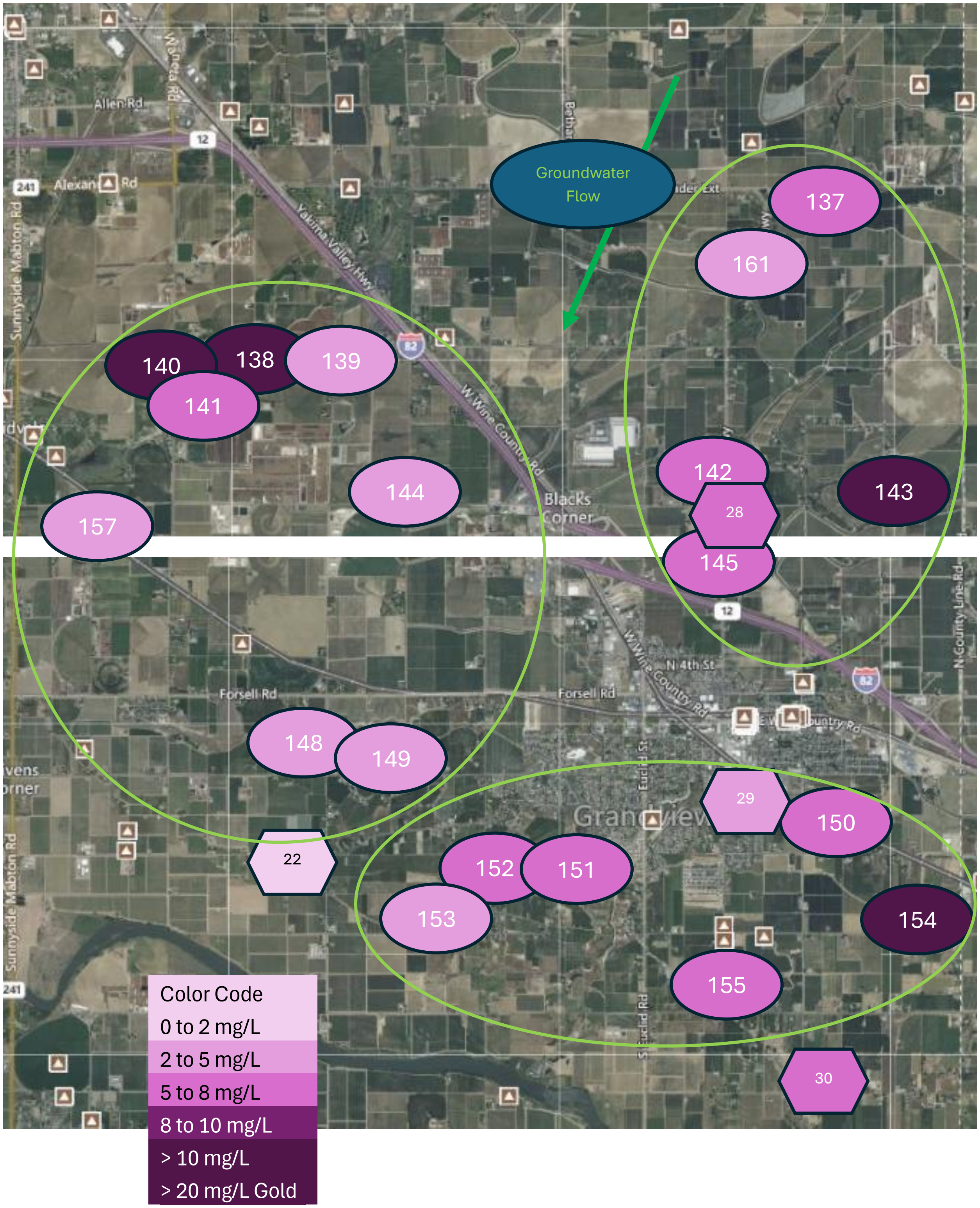
More Data from Well Logs – Outlook Area

Well Log	AKH 635 OL-081	ALE 039 OL-080	BBH 016 OL-082	ALE 040 OL-085	AKH 625 OL-086
Depth	221 ft	162 ft	143 ft	243 ft	259 ft
Nitrate	Low	High	Med Low	Low	Low
				Artesian	Artesian
0 to 5 ft	Top Soil	Top Soil Br. Clay Br. Sand	Soil Br. Clay, Sand	Top Soil Br. Clay, Sand	Top Soil, Br. Clay, Br. Sand
10					
15		Static Level	Br. Clay, Sand, H2O Static Level		
20	Br. Clay Br. Sand Static Level				
30					
35					
40					

45					
50					
55					
60					
65					Br. Sand, Br. Clay, Water
70				Br. Clay, Br. Sand, Gravel	
75		Br. Clay, Br. Sand, Gravel	Gray Clay, Sand		
80		Br. Clay, Br. Sand		Br. Clay, Br. Sand, Gravel, H2O	
85	Br. Sand Stone Br. Clay		Br. Sand Stone, Water		
90					
95					
100	Br. Sand Br. Clay			Br. Clay, Br. Sand, H2O	
105					
110	Br. Sand Br. Clay Water				
115		Br. Clay, Br. Sand, Gravel Water			Gray Sand, Water
120	Br. Sand Br. Clay H20, Iron				
125				Gray Clay	
130					Gray Clay, Gray Sand
135	Br. Sand Br. Clay				
140					Blue Gray Clay
145			Well Depth		
150					
155		Br. Sand Stone, H2O			
160	Br. Sand Water	Well Depth		Blue Gray Clay	
165					
170					
180					

185				Gray Clay, Gray Sand, Water	
190					
195					
200					Dk Gray Clay, Dk Gray Sand, Water
205					
210					Br. Sand, Br. Clay, Water
215	Gray Sand, Gravel Water				
220	Well Depth			Gray Sand, Gravel, H2O	
230					
235					
240				Well Depth	
245					
250					
255					Br. Sand, Gravel, Water
260					Well Depth

Data from Well Logs – Grandview Area



Grandview Well Logs

Area Between Sunnyside and Grandview

	ALC765	BAF731	BAF663	ALF051	AKA046	BAF687
	MW 138	MW 139	MW 144	MW 148	MW 149	MW 157
Nitrate N	High Nitrate	Low Nitrate	Low Nitrate	Low Nitrate	Low Nitrate	Low Nitrate
Well Depth	108 ft	160 ft	270 ft	180 ft	276 ft	89 ft
0 to 5	Topsoil to 2 ft deep	Soil	Topsoil	Topsoil	Soil	Topsoil to 1 ft deep Br. Clay & Br. Sand
5 to 10	Br. Clay & Br. Sand	Soil	Br. Clay & Br. Sand		Soil	Br. Clay & Br. Sand & Water
10 to 20		Soil, Silt, Sand		Br. Sand & Br. Clay	Soil	Br. Clay & Br. Sand
20 to 30					Silt Clay	
30 to 40						
40 to 50				Br. & Gray Basalt		
50 to 60		Silt, Sand	Gray Clay, Gray Sand & Water Porous Basalt Gravel, Br. Sand, Br. Clay & Water		Hard Clay Tan	Br. Clay, Br. Sand, Gravel & Water
60 to 70			Br. Clay, Br. Sand & Water			Hard Br. Clay and Br. Sand
70 to 80		Silt, Sand & Water	Br. Clay, Br. Sand & Br. Sandstone			
80 to 90	Br. Sandstone, Br. Clay, Gravel & Water		Greenish Gray Clay & Br. Clay			Br. Sand & Gravel & Water
90 to 100		Silt, Sand & Water		Br & Gray Basalt		
100 to 110	Br. Sandstone, Br. Clay, Gravel & Water		Dk Br. Clay and Lt Br. Clay		Broken Basalt	
110 to 120			Dk Br. Clay & Water			
120 to 130		Br. Clay	Gray & Br. Basalt & Br. Clay		Black Basalt	
130 to 140		Gray Clay	Gray & Br. Basalt			

			Hard Gray Basalt w/ Blue Seams			
140 to 150		Br. Clay & Sandstone		Br. Sandstone & Water		
150 to 160		Br. Clay, Silt, Sand & Water		Br. Clay	Brown Basalt	
160 to 170				Br. Clay	Black Basalt	
170 to 180			Porous Gray & Br. Basalt & Water	Blue Clay Soft Br. Sandstone & Water		
180 to 190			Med. Gray Basalt Br. Gray Basalt & Blue Shale & Water			
190 to 200						
200 to 210			Gray Basalt w. Blue Seams & Blue Shale		Sandstone	
210 to 220			Br. & Gray Basalt			
220 to 230			Br. & Gray Basalt & Hard Yellow Clay Hard Br. Clay & Water		Tan Clay	
230 to 240			Pink Clay		Hard Blue Clay & Hard Br. Clay	
240 to 250			Green Clay & Water			
250 to 260			Green Clay & Bluish Green Clay			
260 to 270			Br. Clay Br. Sandstone & Water		Hard Crumbly Blue & Br. Clay & Water	
270 to 280					Gray Clay	

North of Grandview

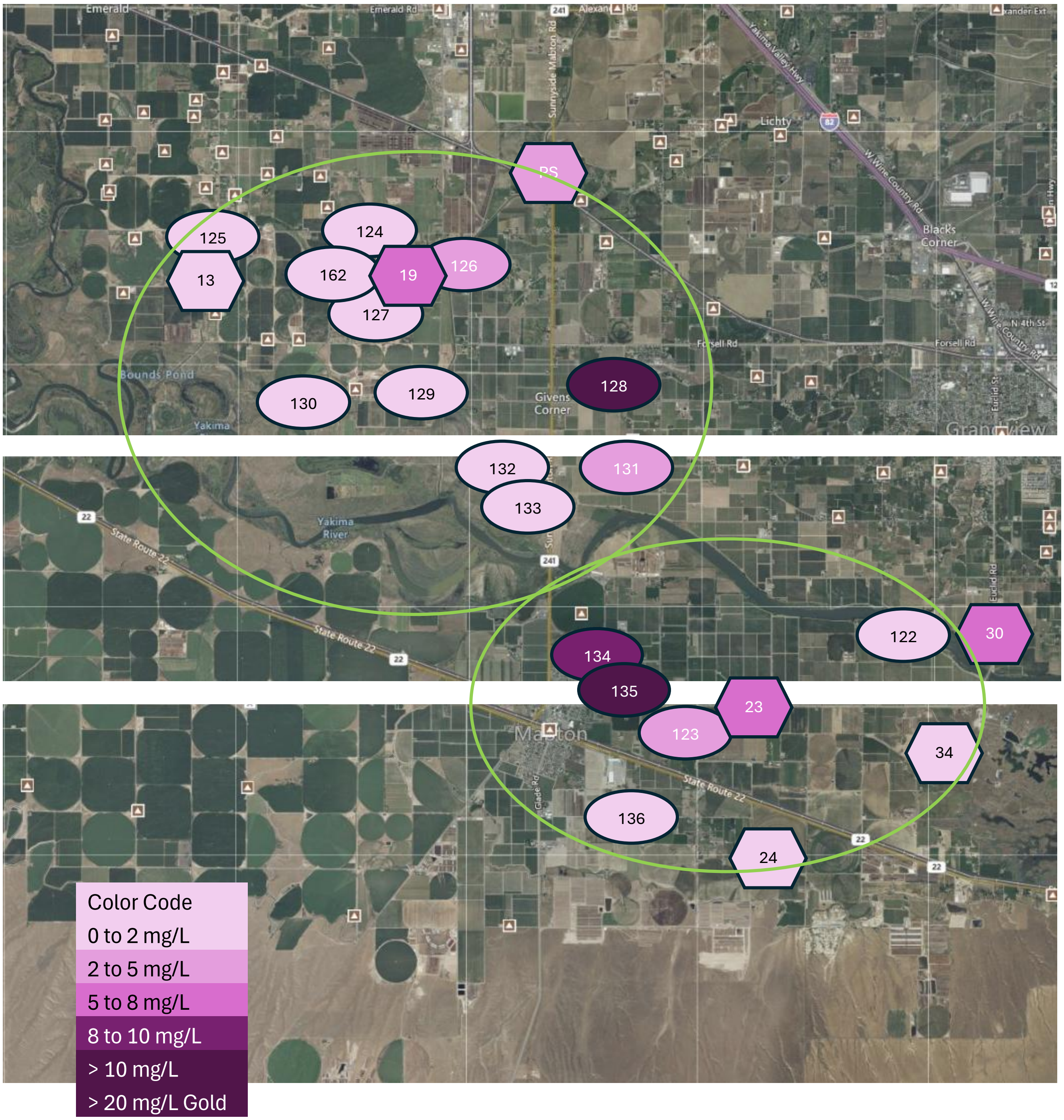
	APT867	AGB173	AEQ615	APT832
	MW 137	MW 143	MW 145	MW 161
Nitrate	Medium	High	Medium	Low
Well Depth	120	90	180	145
0 to 5 ft	Soil	Top Soil	Soil	Topsoil
5 to 10	Clay			Br Clay & Br Sand
10 to 20	Basalt Grey Brown	Brown soft Basalt		
20 to 30	Basalt Grey		Loam	Br Clay & Br Sand & Gray Clay & Gray Basalt
30 to 40			Basalt	Med. Br Basalt & Gray Basalt
40 to 50	Basalt Red	Hard Black Basalt		Hard Br Basalt & Gray Basalt
50 to 60				
60 to 70				Gray Basalt
70 to 80	Basalt	Porous Basalt & Water		
80 to 90		Hard Black Basalt		Br Basalt & Gray Basalt
90 to 100				Gray Basalt & Blue Shale
100 to 110				
110 to 120	Sandstone & Shale Clay			Gray Basalt
120 to 130				
130 to 140			Sandstone	Gray Basalt and Br Sandstone & Water
140 to 150			Shale Clay	
150 to 160				
160 to 170				
170 to 180			Sandstone & Sand	
180 to 190				
190 to 200				

South of Grandview

	BCF018 MW 150	APK172 MW 151	ALF052 MW 152	ALF094 MW 153	APK127 MW 154	AKH655 MW 155
Well Depth	165	145	125	179	143	255
Nitrate	Medium	Medium	Medium	Low	High	Medium
0 to 5 ft	Topsoil	Soil & Silt	Topsoil	Topsoil	Soil Gravel	Topsoil
5 to 10	Br Clay & Br Sand		Br Clay & Br Sand	Br & Gray Basalt		Br Clay & Gravel & Br Sand
10 to 20						
20 to 30	Porous broken Br and Gray Basalt & Br Clay				Black Basalt	
30 to 40	Br & Gray Basalt	Clay Mix Gravel				
40 to 50	Gray Basalt					Br Clay & Br Sand
50 to 60	Br & Gray Basalt	Tan Clay				Br Clay and Br Sand & Gravel
60 to 70	Gray Basalt					
70 to 80	Br & Gray Basalt					Br & Gray Basalt
80 to 90	Gray Basalt		Porous Br Basalt	Br Sandstone		
90 to 100			Br & Gray Basalt	Gray & Br Basalt	Br Basalt	
100 to 110		Hard Gray Basalt		Br Sandstone	Black Basalt	
110 to 120						
120 to 130	Br Sandstone & Br Clay & Water	Red Basalt Water	Porous Basalt & Water Gray Basalt	Br Clay		Med Gray Basalt
130 to 140					Sandstone & Water	
140 to 150		Black Basalt				
150 to 160	Br Sandstone & Br Clay			Br Sandstone & Br Clay		
160 to 170				Br Sandstone & Water		Br Sandstone
170 to 180				Br Clay		Br Clay & Br Sand & Water
180 to 190						

190 to 200						Br Clay
200 to 210						Br Sandstone & Br Clay & Water
210 to 220						Br Clay & Br Sandstone
220 to 230						Br Sandstone & Br Clay & Water
240 to 250						

Data from Well Logs – Mabton Area



North Mabton

	AFH380 MW 124	ALC798 MW 125	BCF213 MW 127	ALE498 MW 128	AFH206 MW 129	AEH966 MW 130	APT814 MW 131	ABX080 MW 132	BAF924 MW 133
Nitrate	Low	Low	Low	High	Low	Low	Medium	Low	Low
Well Depth	102	85	98	122	85	96	123	85	82
0 to 5 ft	Topsoil	Topsoil	Sandy Soil	Topsoil	Soil	Topsoil	Topsoil	Topsoil to 1 ft deep	Topsoil
5 to 10	Br. Sand & Br. Clay	Gray Sand	Sand	Gray Sand	Silt & Clay	Sandy Silts	Br. Sand	Br. Clay & Br. Sand	Soft Br. Clay and Br. Sand
10 to 20					Sand		Br. Sand & Small Gravel	Gray Sand & Water	Gray Coarse Sand & Fine Gravel
20 to 30				Gray Sand, Gray Clay & Gravel		Br. Clay			
30 to 40						Br. Sands & Water	Gray Clay & Gray Sand	Dk Gray Clay, Dk Gray Sand, & Water	
40 to 50	Gray Sand	Gray Sand, Gravel & Water					Gray Sand & Small Gravel	Dk Gray Sand, Gravel & Water	
50 to 60						Gray Clay, Gray Sands		Dk. Gray Sand, Dk. Gray Clay & Water	
60 to 70				Gray Sand					Gray Clay and Gray Sand

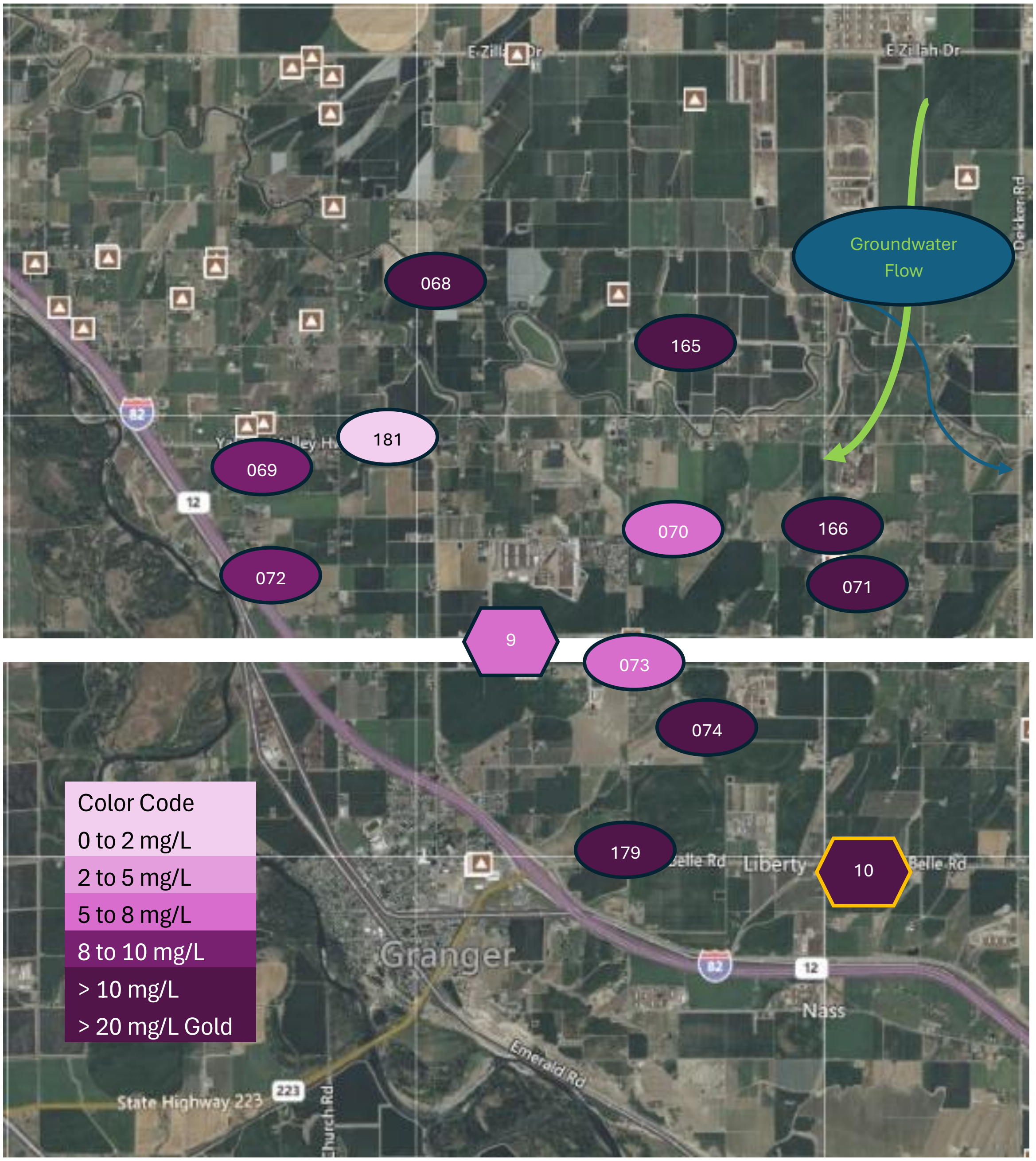
70 to 80		Br. Sand, Gravel & Water	Gravel & Sand		Sand & Gravel	Gray Silts, Gravel & Sandwater	Gray Sand & Water	Gray Sand, Gravel & Water	Br. Sand, Gravel & Water
80 to 90									
90 to 100	Gray Sand, Gravel & Water		Gravel & Sand	Gray Sand & Gray Clay		Gravels & Sandwater	Gray Sand, Gravel & Water		
100 to 110									
110 to 120				Br. Sand, Gravel & Water			Br. Sand, Multi Colored Gravel & Water		

South Mabton

	BAF690 MW 134	AGL711 MW 135	ALF671 MW 136	ACE738 MW 122	ALF095 MW 123
Nitrate N	High	High	Low	Low	Medium
Well Depth	144	146	82	144	110
0 to 10 ft	Top Soil to 4 ft deep Br. Clay, Br. Sand, Gravel beneath	Top Soil to 3 ft deep Br. Clay & Br. Sand beneath	Dirt to 2 ft deep. Loose gravels beneath	Top Soil to 10 ft deep	Top Soil to 2 ft deep Br. Clay, Br. Sand, Large & Small Gravel
10 to 20			Br. Silty Sands	Gravel & Sand	
20 to 30			Small Gravel, Br. Clay		
30 to 40		Br. Clay, Br. Sand & Gravel	Silty Sand		Br. Clay, Br. Sand, Large & Small Gravel & Water
40 to 50		Br. Clay & Br. Sand	Coarse Sand, Silty	Gray Clay	

50 to 60		Gray Sand & Gray Clay		Sandstone	
60 to 70	Gray Sand & Gravel				
70 to 80			Medium Sands & Water	Gravel & Sand (Sulfur Water)	
80 to 90		Br. Sand			Br & Gray Basalt & Water
90 to 100	Gray Sand				Medium Gray Basalt
100 to 110	Gray Sand, Gray Clay & Water			Gray Clay	
110 to 120		Gray Sand			Medium Gray Basalt
120 to 130		Br. Sand		Gravel & Sand (Sulfur Water)	
130 to 140	Br Sand & Gravel	Gray Sand		Gray Clay	
140 to 150	Br. Sand, Br. Clay, Gravel & Water	Br. Sand & Gravel & Water		Gravel & Coarse Sand & Water	
150 to 160					

Data from Well Logs – Granger Area



Granger Well Logs

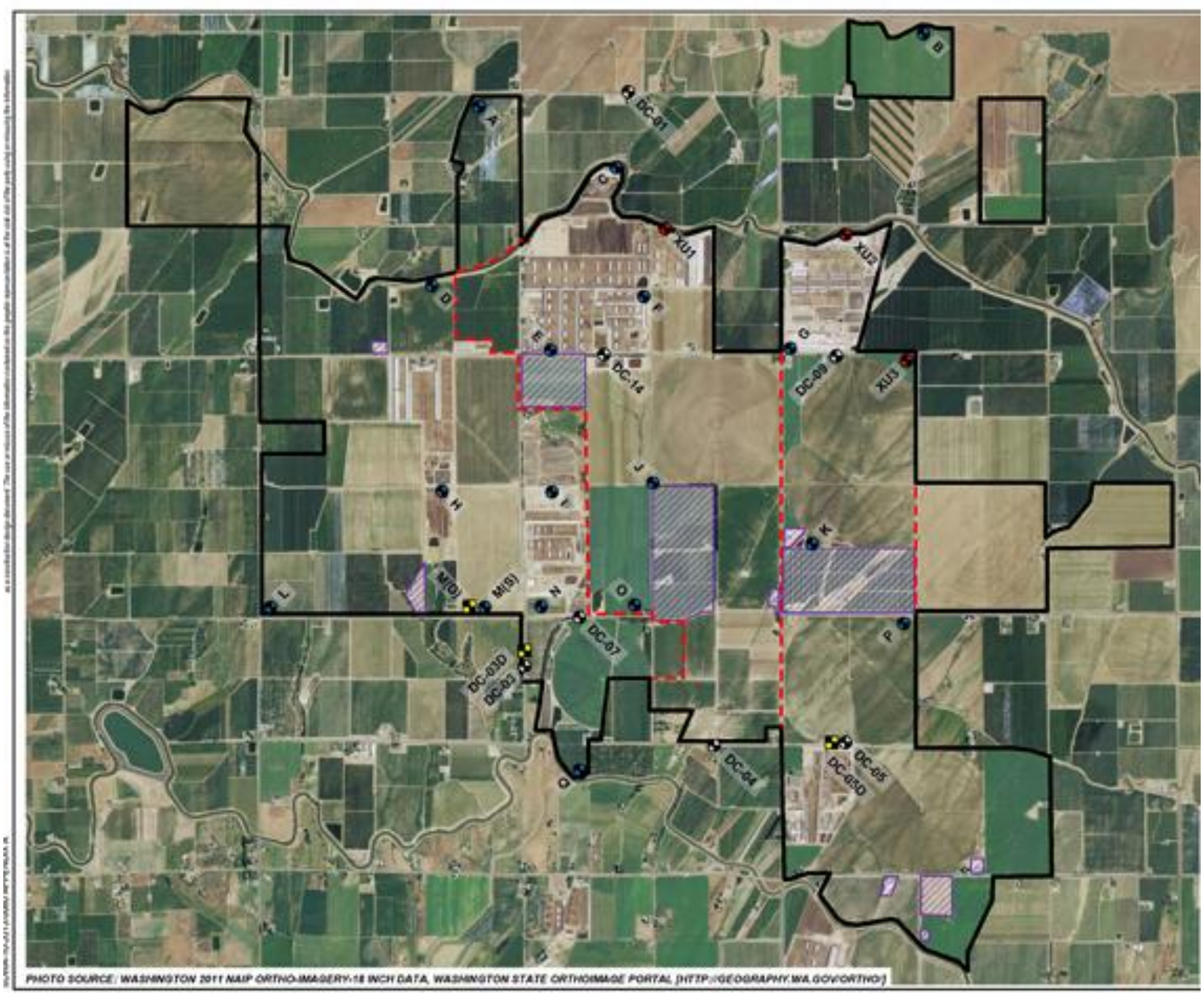
	ABL987	ALE053	ABL137	BIN967	AGM751	AKH607	AKH652	BIF380
	MW 73	MW 181	MW 166	MW 71	MW 69	MW 70	MW 165	MW 68
Nitrate	Med	Low	High	High	Med High	Medium	High	High
Well Depth	94	100	113	115	178	183	185	201
0 to 5 ft	Br. Clay Br. Sand	Silt & Clay	Soil to 3 ft deep,	Topsoil to 5 ft deep	Sandy Loam	Topsoil	Topsoil to 2 ft deep	Soil
5 to 10	Br. Clay Br. Sand		Br. Clay & Sand	Wet Brown Clay and Br. Sand		Br. Clay & Br. Sand	Br. Clay & Br. Sand	Sandy Soil
10 to 20	Br. Clay Br. Sand				Clay Sandy Conglomerate, Clay w/ Gravel			Sandy Clay
20 to 30	Br. Clay Br. Sand						Br. Clay, Br. Sand & Gravel	Gravel
30 to 40	Br. Clay Br. Sand	Gravel				Br. Clay, Br. Sand & Gravel	Br. Clay & Br. Sand	Clay
40 to 50	Br. Clay, Br. Sand, Gravel & Water	Clay				Br. Clay		
50 to 60		Clay & Sandstone Layers		Br. Clay, Br. Sand & Gravel	Clay, Sandy, Yellowish			
60 to 70	Tan Clay Sand, Gravel & Water		Br. Clay	Br. Clay			Br. Sand, Br. Clay & Gravel	
70 to 80	Hard Br. Clay w/ Br. Sandstone Layers					Br. Clay & Br. Sand		
80 to 90	Br. Sand & Water	Sand & Gravel						Sand, Sandy Clay
90 to 100	Hard Br. Clay, Sand & Water		Br. Sand & Water	Br. Clay & Br. Sand				
100 to 110			Gray Clay & Sand	Br. Clay, Br. Sand, Gravel & Water	Sand, Silt, Some Gravel	Br. Clay & Br. Sand		
110 to 120			Sand, Gravel & Water	Br. Sandstone, Br. Sand, Gravel & Water				
120 to 130						Br. Clay, Br. Sand, Gravel & Water		
130 to 140						Br. Sand & Iron & Water	Br. Clay & Br. Sand	

140 to 150							Br. Clay, Br. Sand & Gravel	
150 to 160					Sand, Silt	Br. Sand, Gravel, Iron & Water	Br. Clay & Br. Sand, Gravel & Water	Gravel & Sand
160 to 170								
179 to 180					Gravel, Sand	Br. Sand, Gravel & Water	Br. Clay & Br. Sand, Gravel & Water	
180 to 190								
190 to 200								Gravel & Sand

The “Dairy Cluster” & Dairy Cluster Monitoring Wells

In 2010 the U.S. Environmental Protection Agency came to the LYV under section 1431 of the Safe Drinking Water Act to investigate significant groundwater pollution in the area. In 2013 the EPA entered into an administrative order of consent with several large dairies located along the northern border of the LYV. That order provided for research to better understand the dynamics of the pollution and agree upon mitigation. [33]

EPA Maps – The LYV Dairy Cluster



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[33] Administrative Order on Consent. (2013) EPA Region 10 Administrative Order on Consent in the Matter of Yakima Valley Dairies

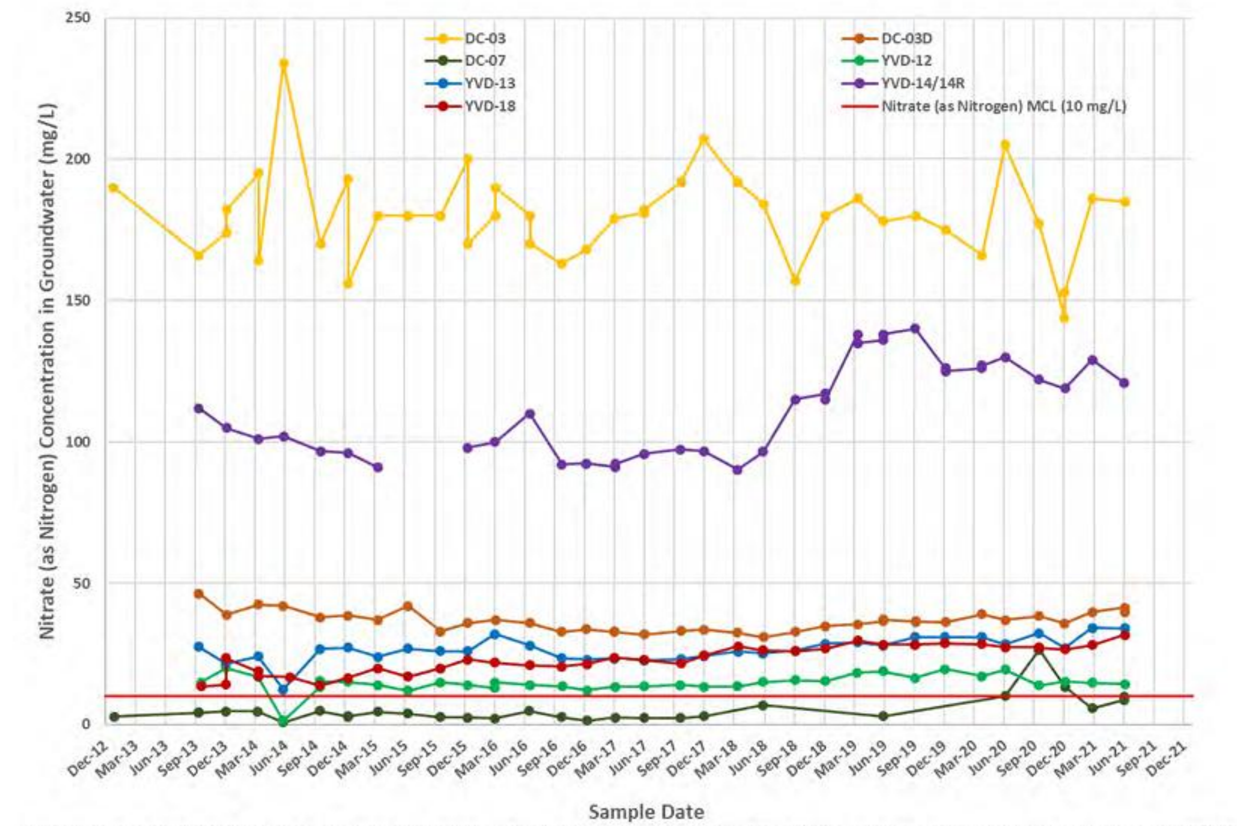
The dairies agreed to eight years of quarterly water sampling from 16 monitoring wells at the site. The data from those reports is public information available at Index of /region10/sites/yakima/Consent_Order_Deliverables/06__Groundwater

Here is an excerpt from a 2021 Monitoring Report [34] data sheet for one monitoring well that shows readings for a few of the targeted chemicals over an eight year time span.

		Analyte	Ammonia (as N)			Calcium			Chloride			Fluoride			Magnesium			Nitrate (as N)		
		Analytical Method	EPA 350.1			EPA 200.7			EPA 300			EPA 300.0			EPA 200.7			EPA 300.0		
Well ID	Sample Name	Sample Date	Result (mg/L)	Qualifier	Validation Code	Result (mg/L)	Qualifier	Validation Code	Result (mg/L)	Qualifier	Validation Code	Result (mg/L)	Qualifier	Validation Code	Result (mg/L)	Qualifier	Validation Code	Result (mg/L)	Qualifier	Validation Code
YVD-08	YVD-090919-02	9/9/2019	-	-	-	139	-	-	89.8	-	-	0.15	-	-	45.70	-	-	62.0	-	-
YVD-08	YVD-120919-02	12/9/2019	-	-	-	132	-	-	95.6	-	-	0.16	-	-	44.60	-	-	61.8	-	-
YVD-08	YVD-120919-04	12/9/2019	-	-	-	130	-	-	94.3	-	-	0.15	-	-	44.50	-	-	61.6	-	-
YVD-08	YVD-033120-17	3/31/2020	-	-	-	132	-	-	96.5	-	-	0.18	--	--	45.65	-	-	68.0	-	-
YVD-08	YVD-060920-23	6/9/2020	-	-	-	132	--	--	96.1	--	--	0.19	--	--	44.75	--	--	66.6	--	--
YVD-08	YVD-092120-11	9/21/2020	-	-	-	134	--	--	96.2	--	--	0.16	--	--	45.80	--	--	66.0	--	--
YVD-08	YVD-120720-11	12/7/2020	-	-	-	132	--	--	107	--	--	0.20	--	--	45.85	--	--	62.2	--	--
YVD-08	YVD-030121-07	3/1/2021	-	-	-	135	--	--	92.9	--	--	0.20	--	--	45.80	--	--	68.8	--	--
YVD-08	YVD-060821-28	6/8/2021	-	-	-	130	--	--	94.2	--	--	0.17	--	--	44.90	--	--	62.0	--	--
YVD-09	YVD-09-130919	09/19/2013	0.1	U	-	107	-	-	96.3	-	-	5	U	-	39.3	-	-	74.7	-	-
YVD-09	YVD-09-131212	12/12/2013	0.02	U	-	109	-	-	87.2	-	-	5	U	-	42.0	-	-	64.4	-	-
YVD-09	YVD-09-140319	03/19/2014	0.1	U	-	109	-	-	104	-	-	5.5		-	40.8	-	-	62.4	-	-
YVD-09	YVD-09-140603	06/03/2014	0.1	U	-	113	-	-	89.8	-	-	5	U	-	44.5	-	-	57.1	-	-
YVD-09	YVD-09-140924	09/24/2014	0.1	U	-	118	-	-	68.2	-	-	5	U	-	41.7	-	-	48	-	-
YVD-09	YVD-09-141217	12/17/2014	0.1	U	-	130	-	-	85	-	-	5	U	-	56.3	-	-	53.9	-	-
YVD-09	YVD-09-150318	03/18/2015	0.14	-	-	110	-	-	74	-	-	5	U	-	46.0	-	-	47	-	-
YVD-09	YVD-09-150617	06/17/2015	0.14	-	-	110	-	-	89	-	-	5	U	-	43.0	-	-	54	-	-
YVD-09	YVD-09-150923	09/23/2015	0.21	J	MSD	110	-	-	78	-	-	0.5	U	-	46.0	-	-	56	J+	MSD
YVD-09	YVD-09-151215	12/15/2015	-	R	MSD	110	-	-	77	-	-	5	U	-	42.0	-	-	52	-	-
YVD-09	YVD-09-160310	03/10/2016	0.12	-	-	110	-	-	72	-	-	5	U	-	42.0	-	-	48	-	-
YVD-09	YVD-09-160622	6/22/2016	0.1	UJ	MSD	100	-	-	76	-	-	5	U	-	42.0	-	-	49	-	-
YVD-09	YVD-09-160929	9/29/2016	0.050	U	MBK	103	-	-	66.7	-	-	0.34	-	-	41.2	-	-	43.2	-	-
YVD-09	YVD-09-161213	12/13/2016	0.050	U	-	107	-	-	59.8	-	-	0.40	-	-	38.1	-	-	42.8	J	HTQ
YVD-09	YVD-D2-161213	12/13/2016	0.050	U	-	108	-	-	61.4	-	-	0.40	-	-	37.1	-	-	43.3	J	HTQ
YVD-09	YVD-031317-35	3/13/2017	0.050	U	-	108	-	-	63.9	-	-	0.37	-	-	39.2	-	-	44.3	-	-
YVD-09	YVD-060517-08	6/5/2017	0.050	U	-	110	-	-	62.6	-	-	0.39	-	-	39.4	-	-	44.6	-	-
YVD-09	YVD-092617-29	9/26/2017	0.050	U	-	109	-	-	61.0	-	-	0.38	-	-	37.2	-	-	44.1	J	HTQ
YVD-09	YVD-092617-30	9/26/2017	0.050	U	-	109	-	-	61.1	-	-	0.38	-	-	37.4	-	-	44.1	J	HTQ
YVD-09	YVD-120517-21	12/5/2017	0.050	U	-	108	-	-	63.0	-	-	0.38	-	-	35.9	-	-	46.9	-	-
YVD-09	YVD-031918-18	3/19/2018	-	-	-	108	-	-	69.2	-	-	0.34	-	-	35.90	-	-	48.5	-	-
YVD-09	YVD-060318-13	6/3/2018	-	-	-	107	-	-	63.4	-	-	0.36	-	-	37.75	-	-	50.6	-	-
YVD-09	YVD-090918-06	9/9/2018	-	-	-	108	-	-	71.0	-	-	0.35	-	-	35.90	-	-	51.4	-	-
YVD-09	YVD-121118-15	12/11/2018	-	-	-	102	-	-	65.6	-	-	0.34	-	-	34.25	-	-	52.8	-	-
YVD-09	YVD-121118-17	12/11/2018	-	-	-	103	-	-	68.0	-	-	0.33	-	-	34.55	-	-	54.6	-	-
YVD-09	YVD-031719-05	3/17/2019	-	-	-	104	-	-	67.4	-	-	0.31	U	FBK	35.75	-	-	56.0	-	-
YVD-09	YVD-060319-15	6/3/2019	-	-	-	104	-	-	43.4	-	-	0.36	-	-	35.65	-	-	53.3	-	-
YVD-09	YVD-090919-04	9/9/2019	-	-	-	110	-	-	64.7	-	-	0.33	-	-	36.45	-	-	58.2	-	-
YVD-09	YVD-120919-06	12/9/2019	-	-	-	106	-	-	69.1	-	-	0.37	-	-	35.75	-	-	57.0	-	-
YVD-09	YVD-033020-05	3/30/2020	-	-	-	102	-	-	71.4	-	-	0.37	--	--	35.15	-	-	55.2	-	-
YVD-09	YVD-060920-24	6/9/2020	-	-	-	102	--	--	68.8	--	--	0.31	--	--	35.35	--	--	55.2	--	--
YVD-09	YVD-092120-16	9/21/2020	-	-	-	101	--	--	72.5	--	--	0.10	U	--	35.05	--	--	56.2	--	--
YVD-09	YVD-120720-13	12/7/2020	-	-	-	101	--	--	69.4	--	--	0.26	--	--	35.65	--	--	54.0	--	--
YVD-09	YVD-030121-05	3/1/2021	-	-	-	104	--	--	68.8	--	--	0.35	--	--	36.30	--	--	57.4	--	--
YVD-09	YVD-060721-18	6/7/2021	-	-	-	102	--	--	75.9	--	--	0.32	--	--	35.50	--	--	54.4	--	--

[34] Page 6/125. Available at Second Quarter 2021 Groundwater Monitoring Data Report, Yakima Valley Dairies, SDWA-10-2013-0080. This study was comprehensive with testing for alkalinity, ammonia, calcium, chloride, fluoride, magnesium, nitrate, nitrite, total Kjeldahl Nitrogen, phosphorous, potassium, sodium and sulfate.

Here is a graph from the 2021 Monitoring Report showing changes in readings for Nitrate N for seven of the "Dairy Cluster" monitoring wells over the eight year time span.



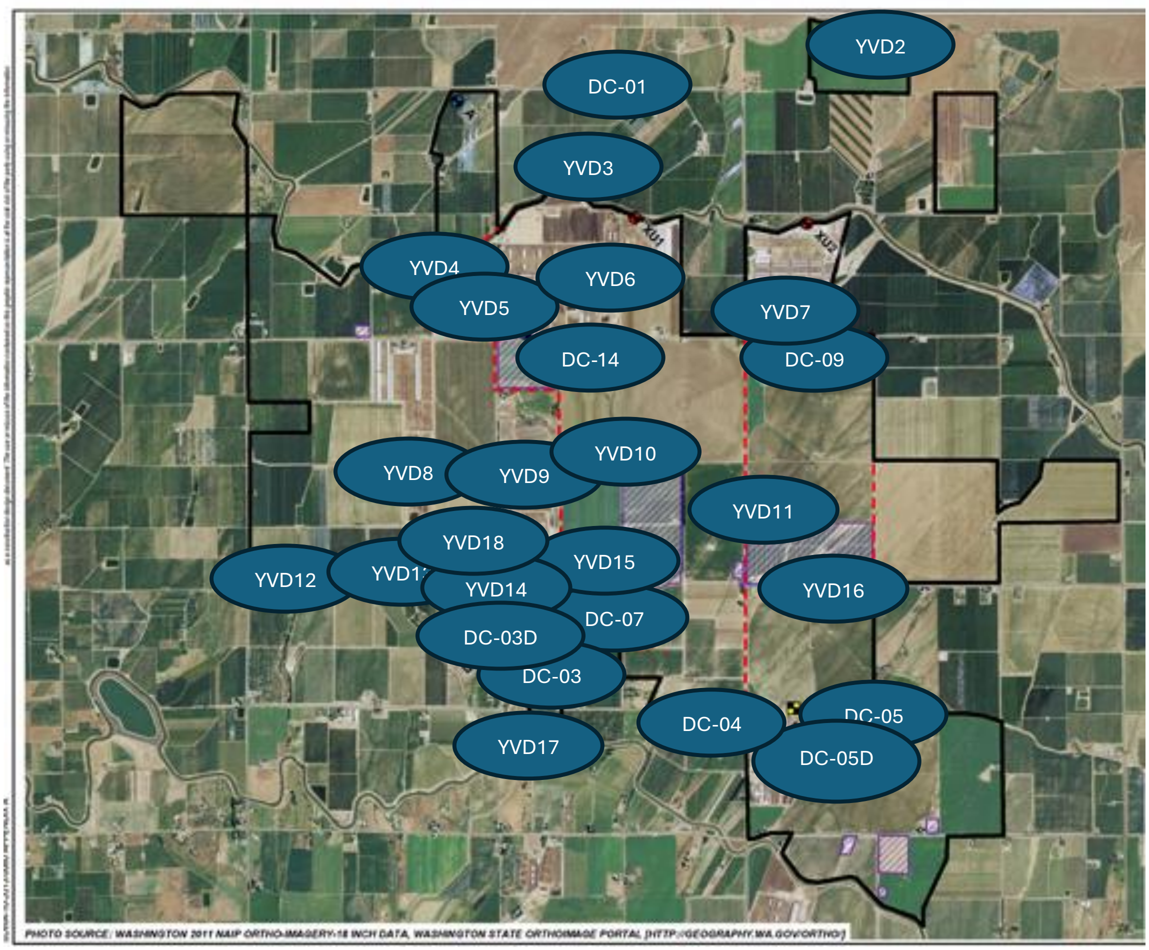
Note: In December 2015, YVD-14R was installed approximately 20 feet to the west of YVD-14, which was decommissioned. Beginning in Third Quarter 2020, quarterly sampling was resumed at well DC-07 due to elevated nitrate concentrations detected in Second Quarter 2020.

Nitrate N levels did not decline as anticipated. The most likely reason is that nitrate and other pollutants have leached into the vadose zone between the land surface and the water table and will likely remain there until they are slowly flushed downward into the aquifer.

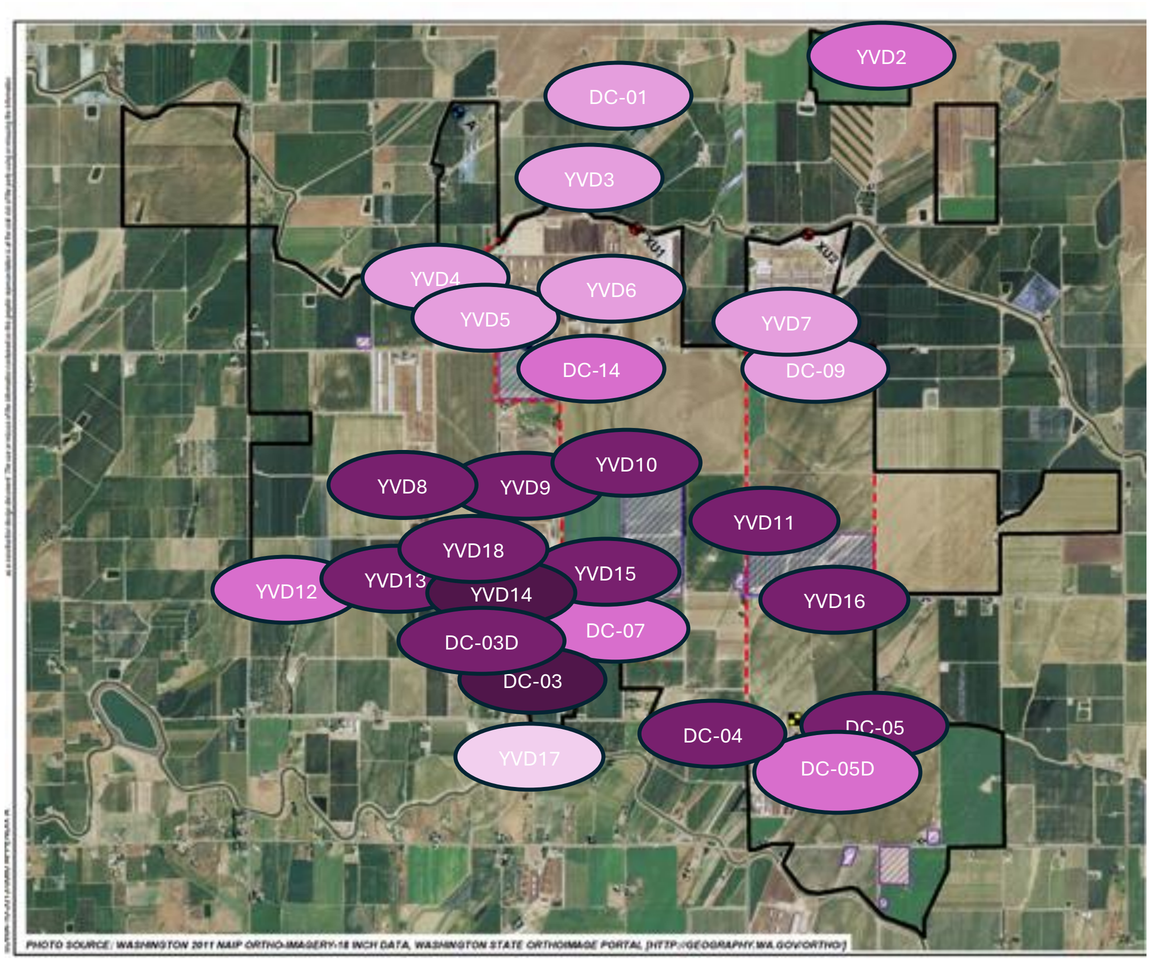
In 2024 the EPA projected that a plume of contaminants in the groundwater is headed toward the City of Granger. Municipal wells for Granger may not be impacted since they are drilled to 1,000 feet. However, most domestic wells around Granger are quite shallow. Because Nitrate N readings in Granger domestic wells are already significantly higher than other domestic wells in the GWMA, it is likely that this area already feels the impact.

Some of the cluster readings are quite high as you can see in the maps below. FOTC strongly believes that this data should be incorporated into the baseline for LYV GWMA groundwater trending.

Monitoring Wells



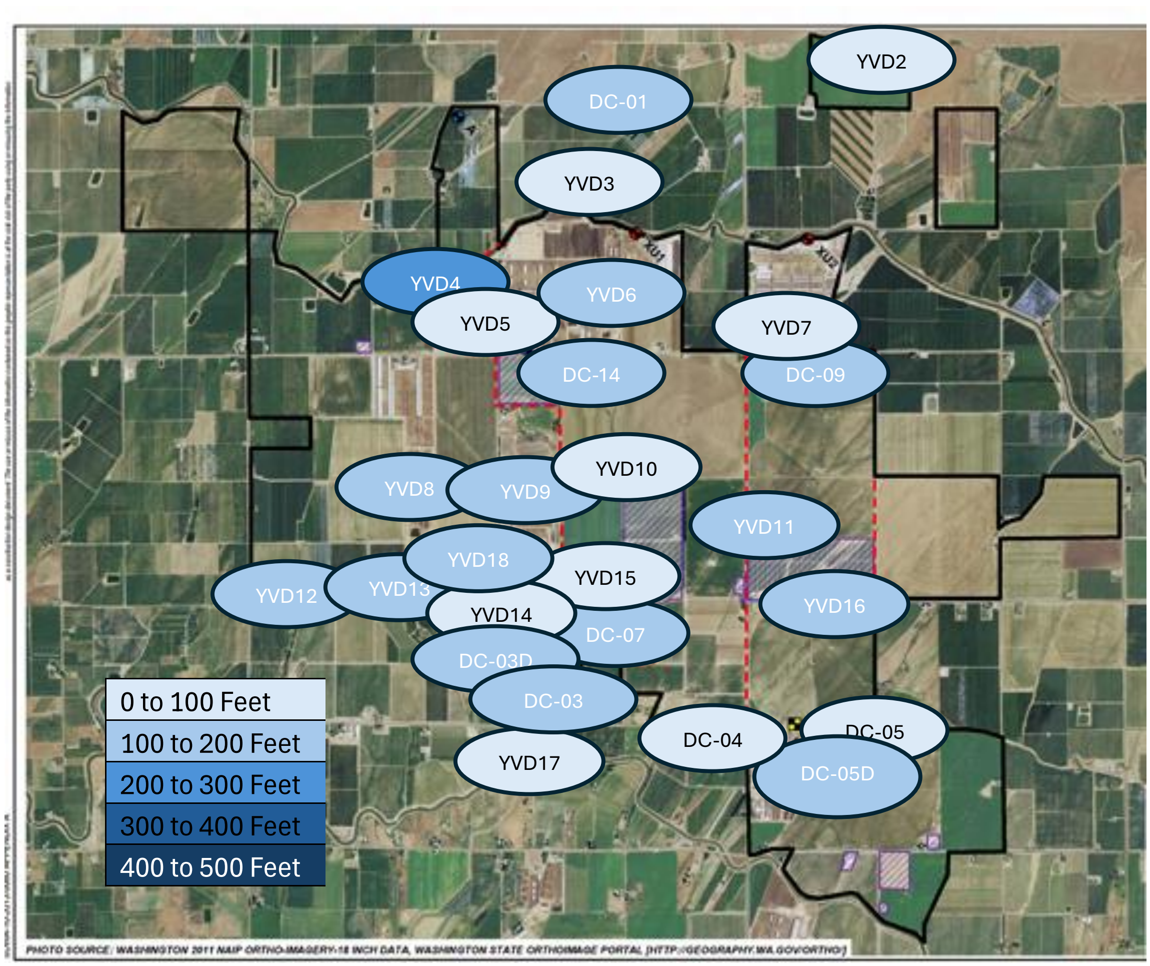
Nitrate N Levels 2021 Second Quarter



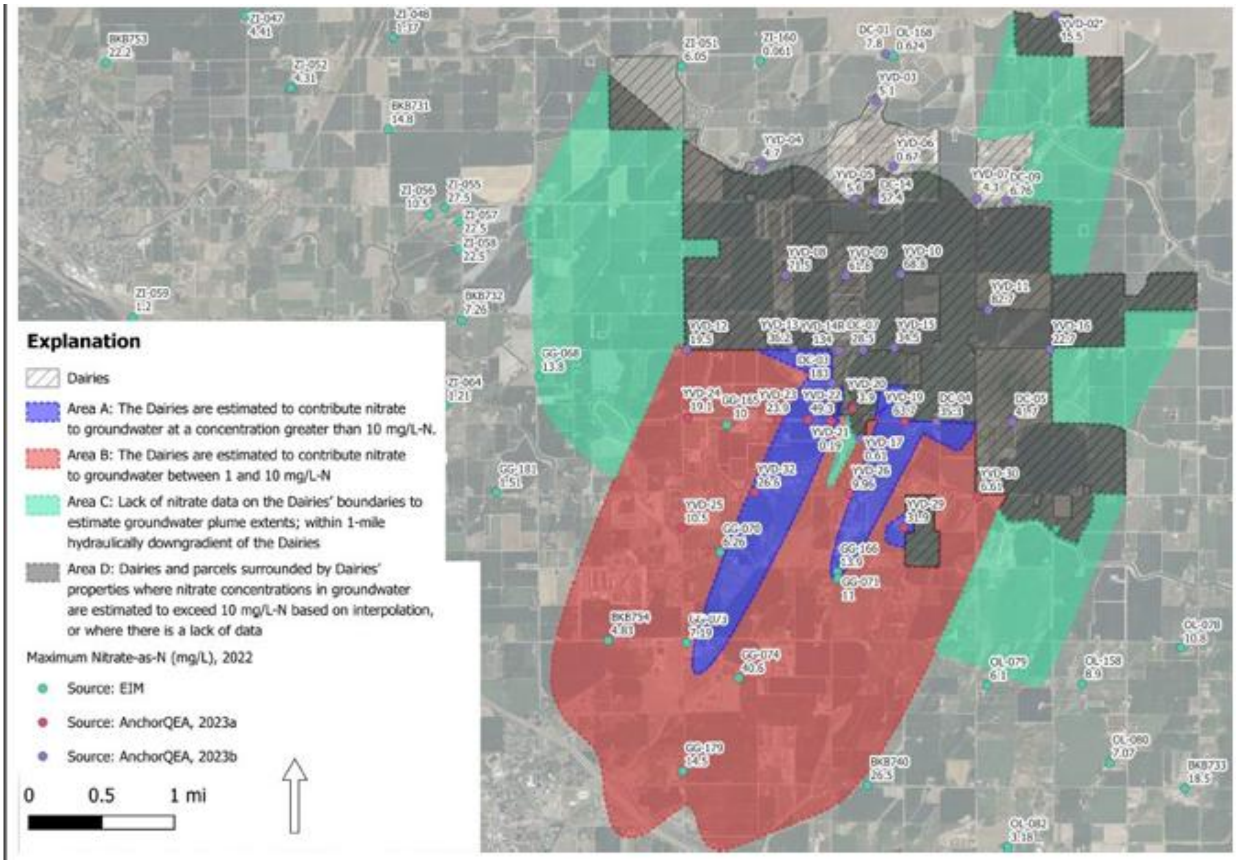
Dairy Cluster Monitoring Wells					
	Well Depth		2021 Q2		
DC-01	150		7.6		Color Code
YVD - 02	38		15.5		0 to 5 mg/L
YVD - 03	190		5.2		5 to 10 mg/L
YVD - 04	235		4.1		10 to 20mg/L
DC - 03	73		205		20 to 100 mg/L
DC - 03D	116		37		> 100mg/L
DC - 04	40		30.9		
DC - 05	74		24		0 to 100 Feet
DC - 05D	126.8		14.4		100 to 200 Feet
DC - 07	49		10.1		200 to 300 Feet
DC - 09	184		5.6		300 to 400 Feet
DC - 14	139		11.5		400 to 500 Feet

YVD - 05	172		3.88		
YVD - 06	159		0.7		
YVD - 07	158		4.86		
YVD - 08	172		66.6		
YVD - 09	112		55.2		
YVD - 10	93		82.6		
YVD - 11	107		24.9		
YVD - 12	141		19.5		
YVD - 13	131		28.5		
YVD - 14	81		130		
YVD - 15	95		21		
YVD - 16	112		21.8		
YVD - 17	38		0.7		
YVD - 18	175		27.4		

Well Depths



Map Showing Nitrate Plume Heading Towards Granger



From EPA Region X at [Lower Yakima Valley Groundwater | US EPA]

Pollution from over application of manure as fertilizer means more than just excessive Nitrate N in groundwater. There are other pollutants that can make water unpalatable or even contribute to health problems.

Washington law, WAC 246-290-310, states, "The EPA has also established a recommended level of 20 mg/L for sodium as a level of concern for those consumers that may be restricted for daily sodium intake in their diets." WAC 246-290-310 also establishes secondary MCLs of 700 µS/cm for specific conductivity and 500 mg/L for Total Dissolved Solids (TDS) in public water systems.

As this plume travels toward Granger it carries additional contaminants that may impact private wells. The table below is adapted from the Second Quarter of Dairy Cluster Reporting for 2021 that is published on the EPA Region X website. [35]

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[35] Environmental Protection Agency, Region X. Lower Yakima Valley Groundwater Management Area. Lower Yakima Valley Groundwater | US EPA

Well Water Analysis on the LYV Dairy Cluster – Quarter 2, 2021

	Alkalinity ($CaCO_3$)	Ca	Cl	Fl	Mg	NO_3	K	Na	SO_4
Up Gradient									
DC 01	140	72.5	32.4	0.32	25.15	8	5.3	36.4	136
YVD 02*	237	59.5	11.7	0.55	25.4	20.6	6.25	75	96.6
YVD 03	182	42.2	8.09	0.37	17.75	3.23	6.85	37.6	33
Average	**186.33**	**58.07**	**17.4**	**0.41**	**22.77**	**10.61**	**6.13**	**49.67**	**88.53**
Upper Cluster									
DC 09	129	34.4	14.8	0.38	7.35	6.2	2.13	37.4	14.8
DC 14	563	196	93.4	0.14	47.05	40.2	6.35	57	27.9
YVD 04	182	35.4	12.5	0.16	10.65	3.73	4.32	47.4	29.5
YVD 05	198	39.6	11	0.68	17.3	4.5	3.94	47.7	61.1
YVD 06	160	34	4.95	0.25	5.9	0.67	2.28	16.2	6.8
YVD 07	142	33.1	7.68	0.22	13.45	3.34	4.28	37.6	40.8
Average	**229**	**62.08**	**24.06**	**0.31**	**16.95**	**9.77**	**3.88**	**40.55**	**30.15**
Lower Cluster									
DC 03	406	280	150		69.5	185	3.07	160	162
DC 03D	455	174	66.7		38.35	39.9	2.98	62.5	81
DC 04	438	195	39.6		34.75	30.9	4.22	33.2	109
DC 05	360	129	34.9	0.17	46.45	38.5	3.26	52	102
DC 05D	212	78	27.2	0.22	26.85	13	4.11	36.9	106
DC 07	490	150	23.2		23.4	9.9	0.97	48.1	37.8
YVD 08	218	130	94.2	0.17	44.9	62	5.45	102	179
YVD 09	352	102	75.9	0.32	35.5	54.4	8.15	157	135
YVD 10	710	320	85.3	0.49	68	53.1	2.8	106	219
YVD 11	414	170	85.4	0.11	41.9	41.7	2.8	35.6	36
YVD 12	180	102	100	0.25	36.95	14.4	2.41	60	176
YVD 13	142	92.5	82.8	0.31	25.45	34	3.96	100	195
YVD 14R	558	262	131	0.14	68	121	4.71	146	114
YVD 15	428	94.5	21.8	0.29	41.65	21.6	3.32	86.5	72
YVD 16	299	88.5	37.5	0.16	31.85	21.8	5.03	77.5	111
YVD 17	144	33.5	2.99	0.24	14.7	0.47		5.75	5.31
YVD 18	120	71	75.8	0.31	22.75	31.8	4.02	85.5	161
Average	**348.59**	**145.41**	**66.72**	**0.24**	**39.47**	**45.5**	**3.83**	**79.68**	**117.71**

Ammonia Levels in Groundwater at a LYV Dairy

Under most conditions organic nitrogen in urine and feces is slowly converted to ammonia by micro-organisms. Other micro-organisms use oxygen to convert ammonia to nitrite which is then converted to nitrate under aerobic conditions.

There are areas in the LYV GWMA where water tables are close to the land surface and oxygen is less abundant. When the microbial system is not healthy or overwhelmed, the rates of conversion of ammonia to nitrite and nitrate is delayed. There may be problems with groundwater that are not identified just by sampling for Nitrate N.

One of the big problems faced by dairymen is how to dispose of the large amounts of manure that high quality milk cows produce. An average cow produces 120 pounds of manure and urine a day. In some instances dairies have over-applied manure to cropland as fertilizer. This leads to accumulation of nitrogen, phosphorous, sodium and other elements in the soil.

One such scenario has played out near the unincorporated town of Outlook in the LYV where overapplication of manure in an area with a high water table has resulted in high levels of both Nitrate N and Ammonia in groundwater. The table below summarizes groundwater testing at 13 monitoring wells on that site in 2023 and 2024. See Attachments 9 & 10 - DBD Groundwater Monitoring for more in depth data.

Well #	Depth to Ground Water in ft	Average Ammonia in mg/L, 2023-24	Average Nitrate N in mg/L, 2023-24
MW-01	14.28	10.16	29.14
MW-02	13.52	3.14	134.13
MW-03	9.15	0.28	57.57
MW-04	5.38	0.61	38.38
MW-05	7.65	0.17	5.5
MW-06	7.83	0.94	9.42
MW-07	8.4	0.68	83.36
MW-08	16.25	0.53	36.75
MW-09	7.92	3.03	42.56
MW-10	11.65	0.43	22.92
MW-11	10	0.42	10.8
MW-12	9.39	0.43	91.95
MW-13	6.79	0.61	18.2
Average	9.86	1.86	34.79
Median	9.15	0.61	16.58
Range	5.38 to 14.28	0.17 to 10.16	5.5 to 134.13

Ammonia levels at this dairy are much higher than levels obtained for dedicated monitoring wells and domestic wells in the Outlook area. The dairy is the most likely source for downgradient ammonia.

Ammonia in South Outlook			
	Well Depth		Baseline NH_3 Average
Dedicated Monitoring Wells			
LYV-MW-011	36.2		0.03
LYV-MW-012	33.18		0.02
Domestic Wells			
LYV-OL-081	221		0.025
LYV-OL-083	232		0.038
LYV-OL-085	243		0.027
LYV-OL-086	259		0.033

We add this information to highlight the causes for some abnormal results in groundwater testing in the LYV. We note that Ecology has anticipated this problem and tested for ammonia in the Outlook area, the area between Sunnyside and Grandview that has a high water table and a high concentration of dairies, and the North Mabton area where there is a long history of intense farming but low levels of Nitrate N.

FOTC asks whether it would be worthwhile for regulatory agencies to expand groundwater testing and also investigate the health of the soil microbial population in certain at risk areas. We suggest adding the following tests to the LYV testing program.

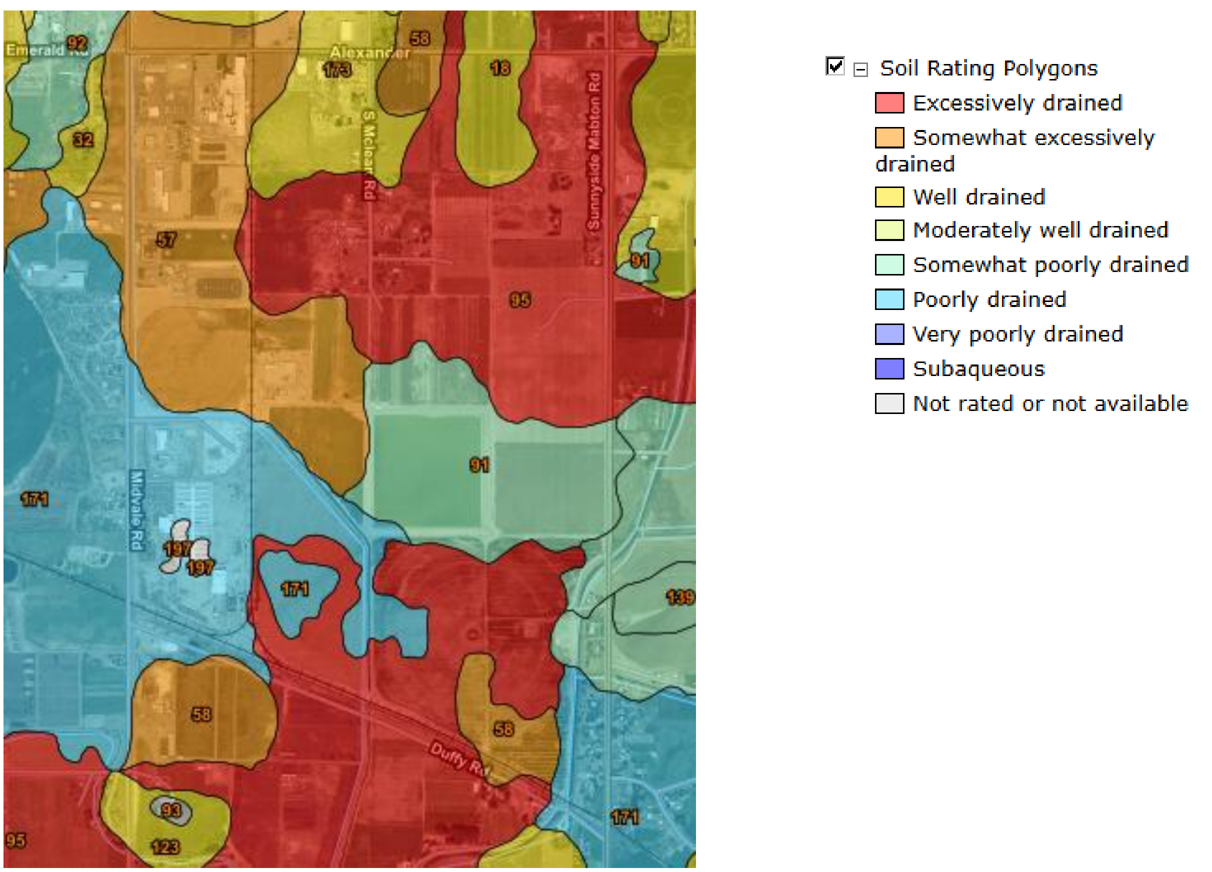
i. Nitrate (as nitrogen) by EPA Method 300.0
ii. Nitrite (as nitrogen) by EPA Method 300.0
iii. Ammonia by EPA Method 350.1
iv. Total phosphorus by EPA Method 365.3
v. Total Kjeldahl nitrogen (TKN) by EPA Method 351.2
vi. Inorganic anions (chloride, fluoride, sulfate) by EPA Method 300.0
vii. Metals (calcium, potassium, magnesium, sodium) by EPA Method 200.7
viii. Alkalinity (total and bicarbonate) by Standard Method 2320B.

Monitoring Wells at Port of Sunnyside, WA

In 2019 when the Friends of Toppenish Creek challenged Ecology certification of the Lower Yakima Valley Groundwater Management Area Final Plan, an Ecology official stated in a sworn statement, “Municipal and industrial wastewater discharges, which are regulated by NPDES permits that require compliance with water quality standards, were not considered a significant source.”[36]

In 2019 we were naïve. We trusted Ecology to bring relevant data to the table. We trusted Ecology to enforce permit conditions and protect groundwater. Since then we have learned that Nitrate N levels at the Port of Sunnyside are among the highest in the GWMA target area. Ecology has not issued a new NPDES permit for the Port of Sunnyside in ten years. Ecology simply rolled over the 2014 permit in 2019 and again in 2024.

Soil Drainage Classes at the Port of Sunnyside – From the Natural Resources Conservation Service Web Soil Survey

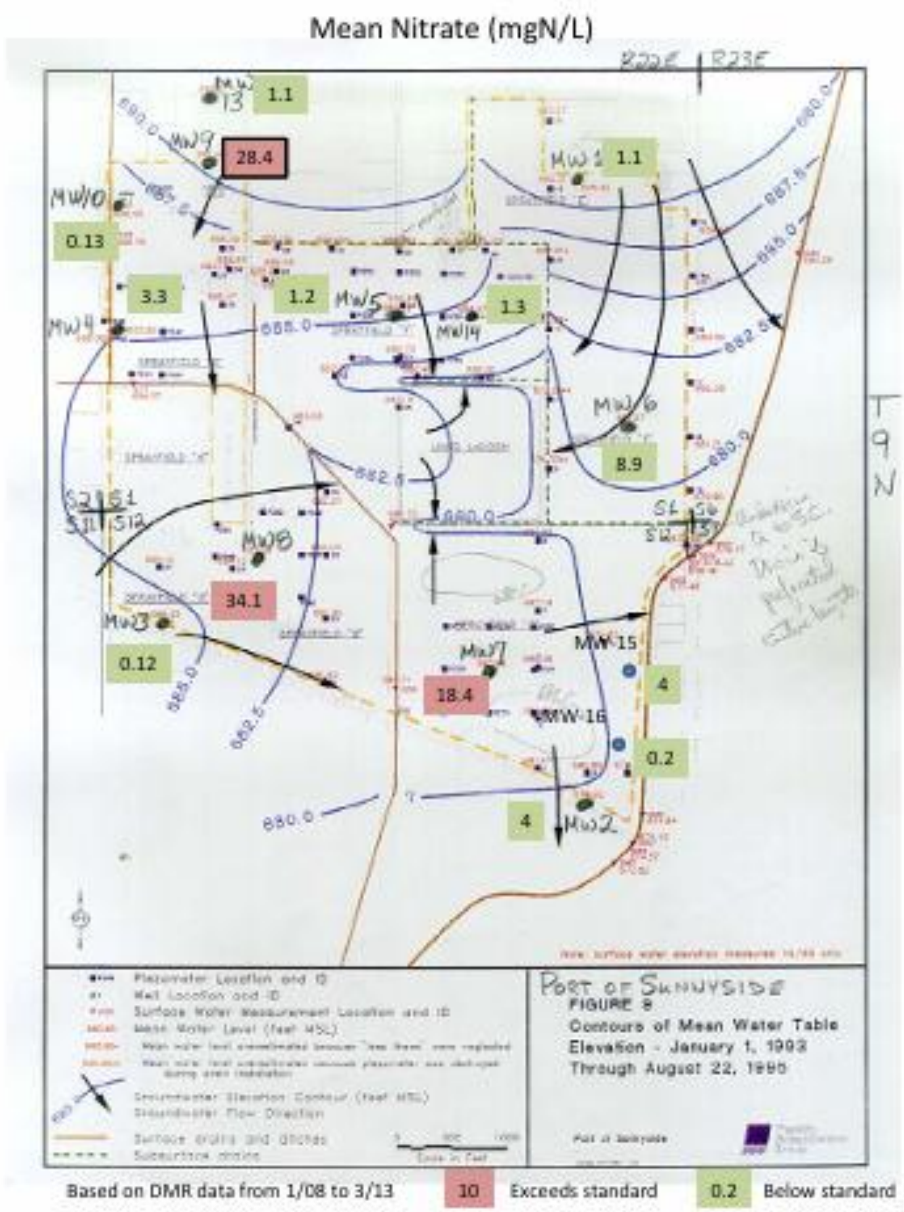


[36] See Attachment 11 David Bowen Statement

The erratic movements of groundwater at the port are documented in this map from the 2014 Port of Sunnyside permit that also shows locations of 16 monitoring wells.

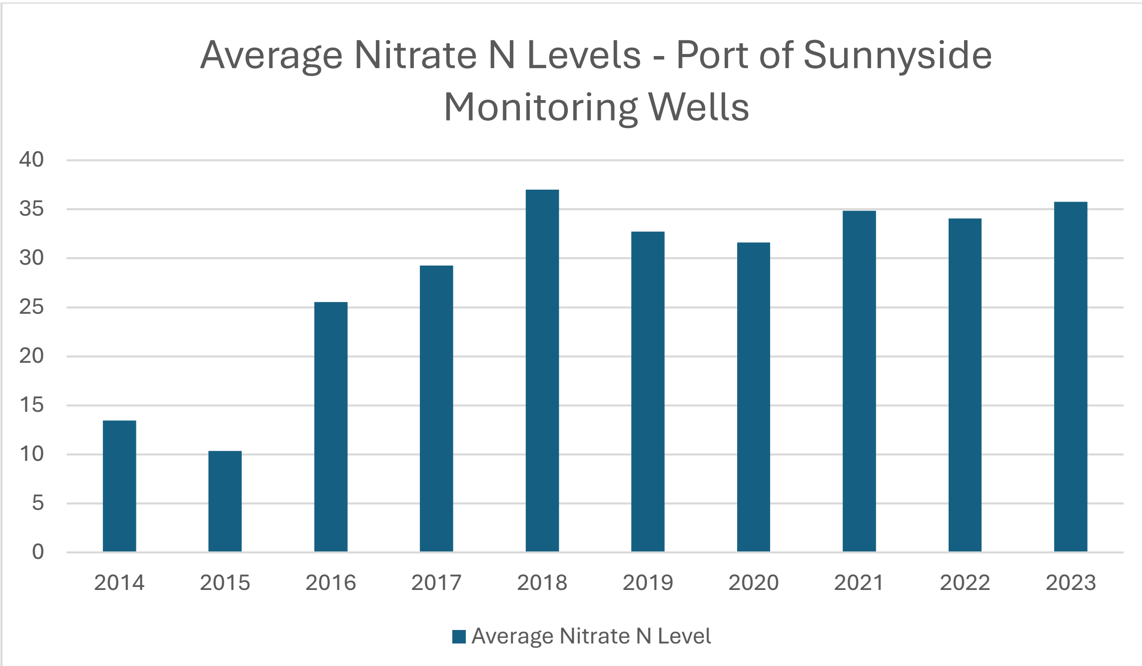
Fact Sheet for NPDES Permit No. WA0052426
PORT OF SUNNYSIDE
INDUSTRIAL WASTEWATER TREATMENT FACILITY (IWWTF)
Page 54 of 69

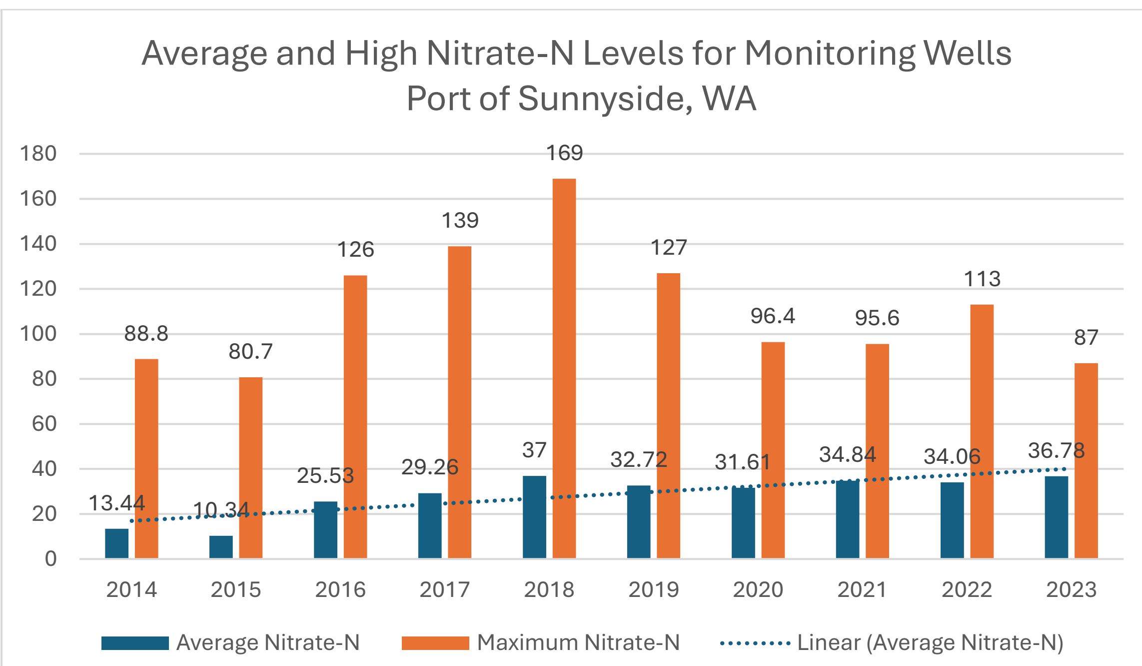
Mean nitrate concentration in monitor wells

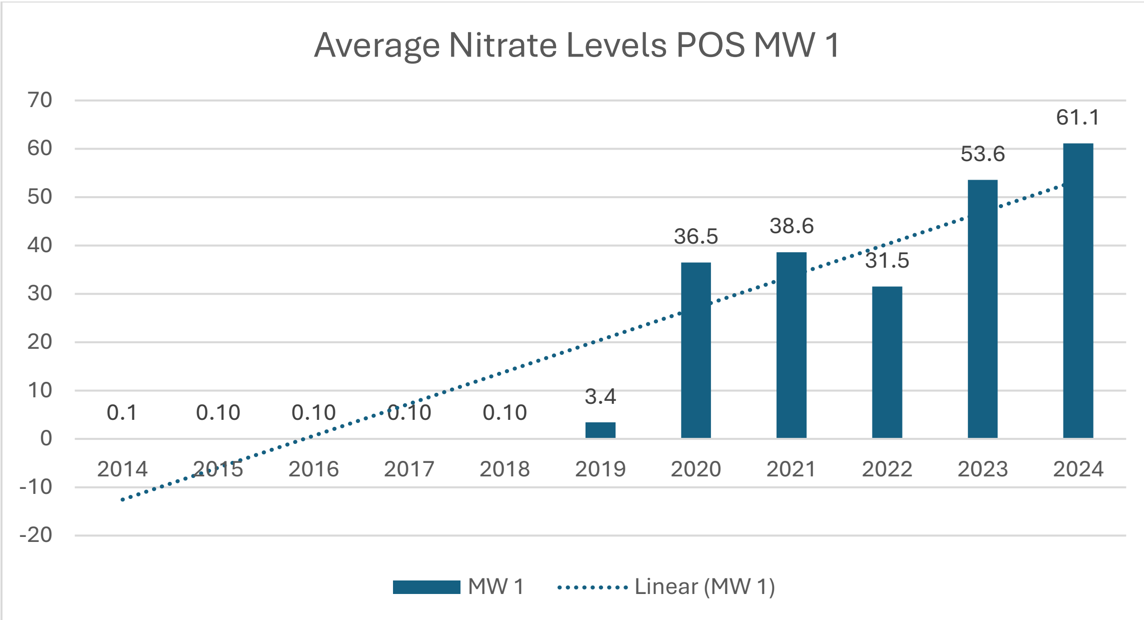


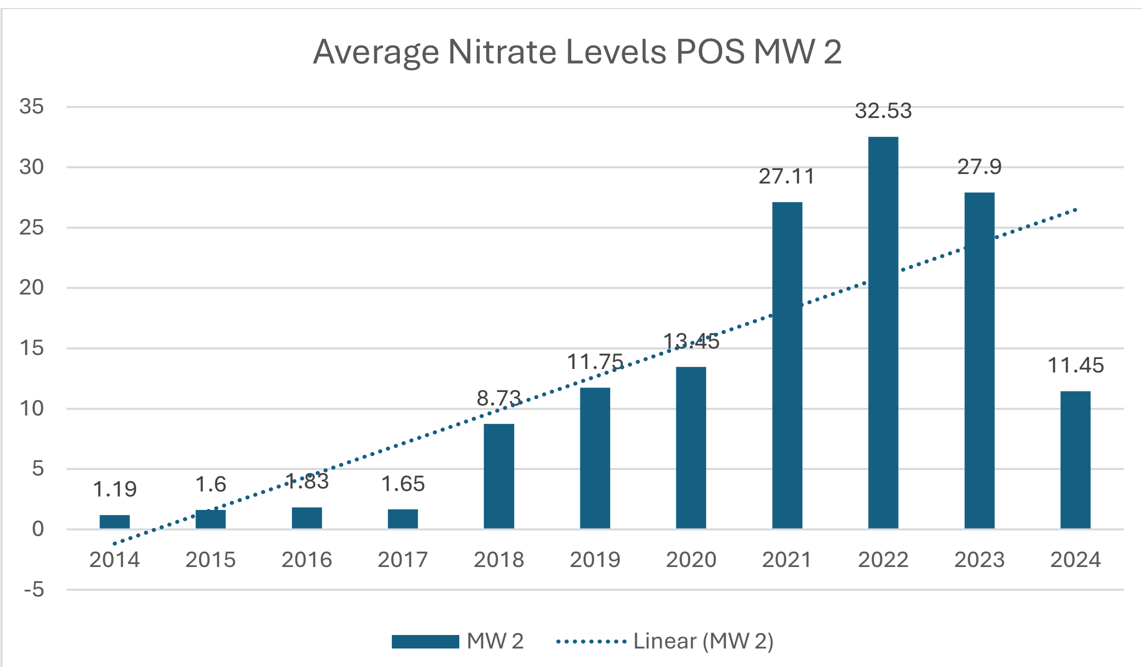
Available at Paris - Facility Summary

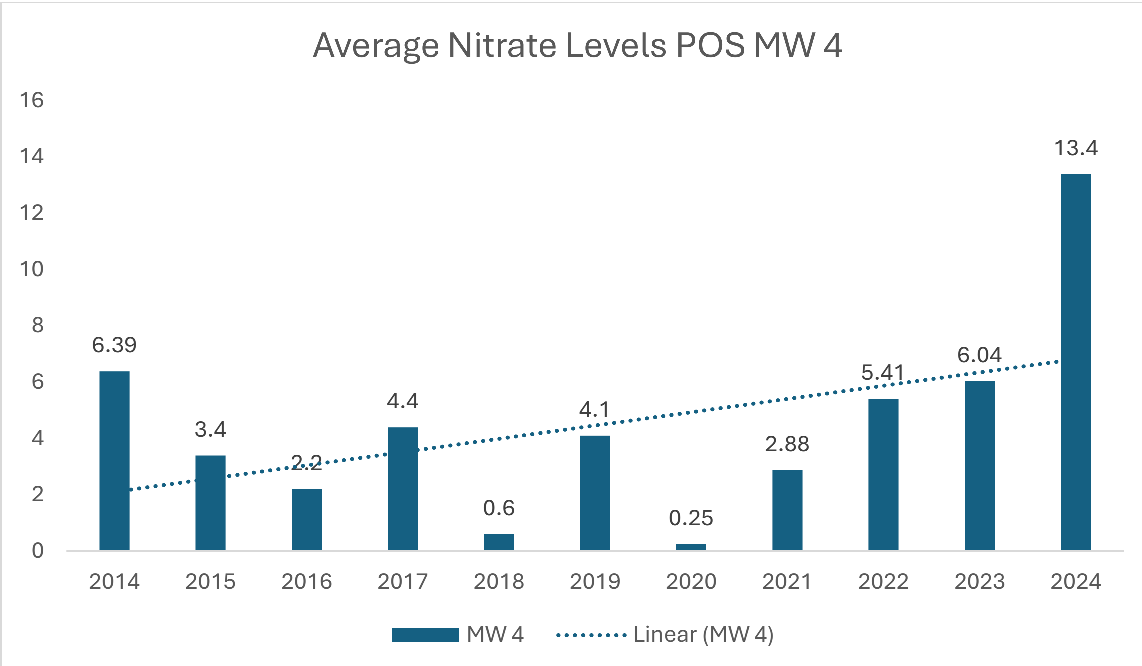
Please look at the graphs that follow, which are based on raw data obtained through a public records request. Leaching of Nitrate N to underlying aquifers is a big problem at the Port of Sunnyside.

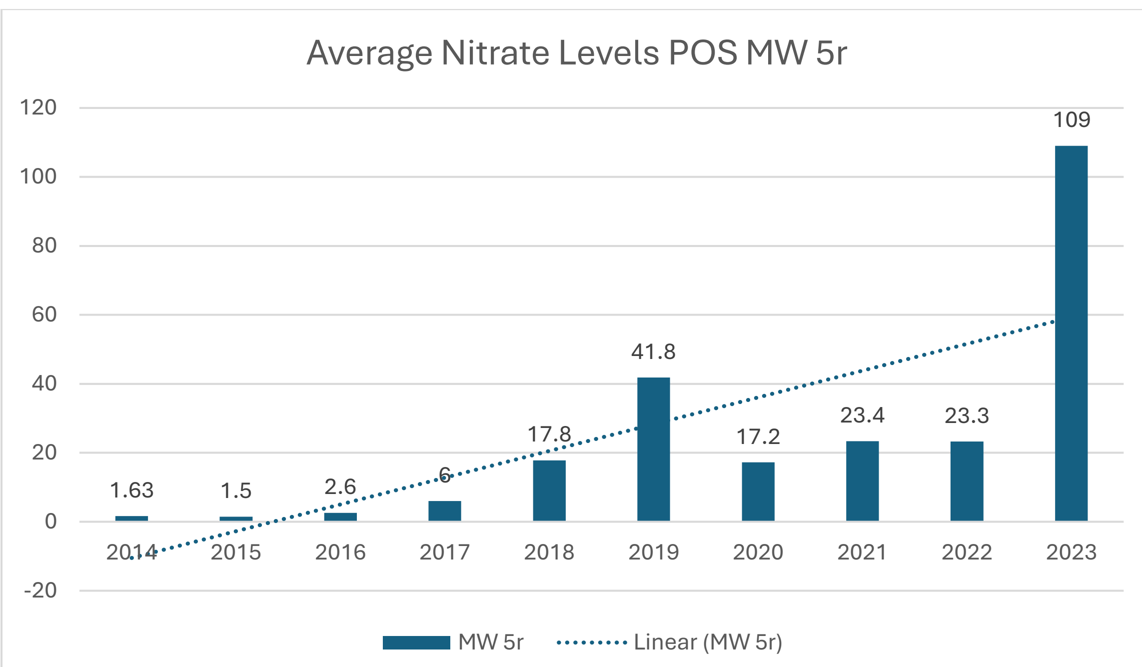


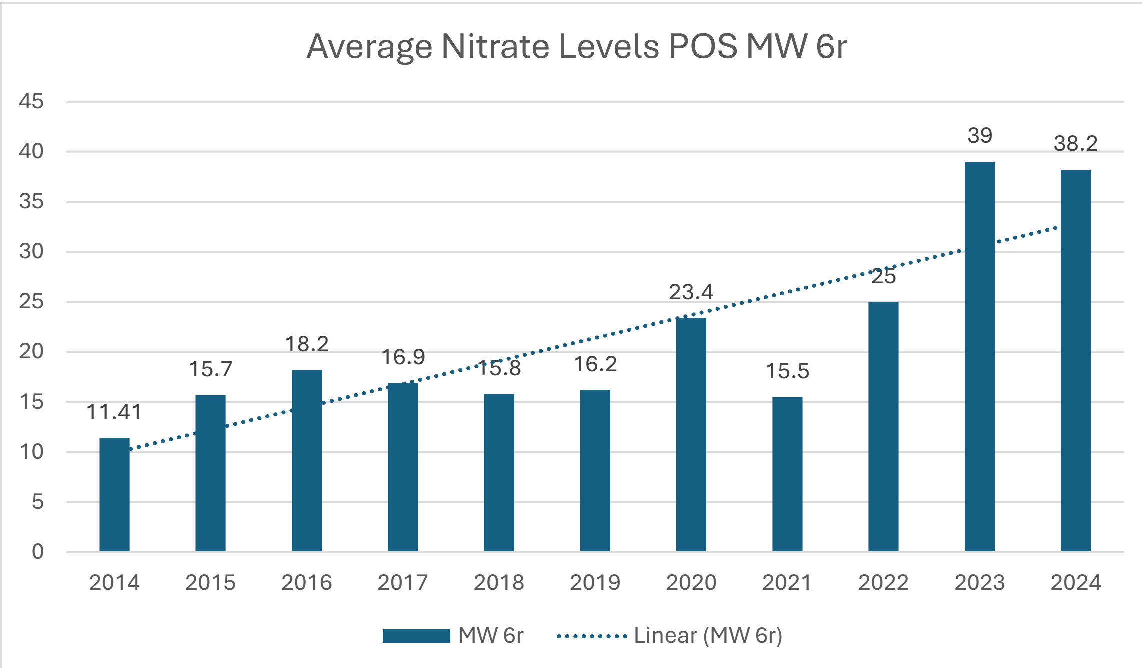


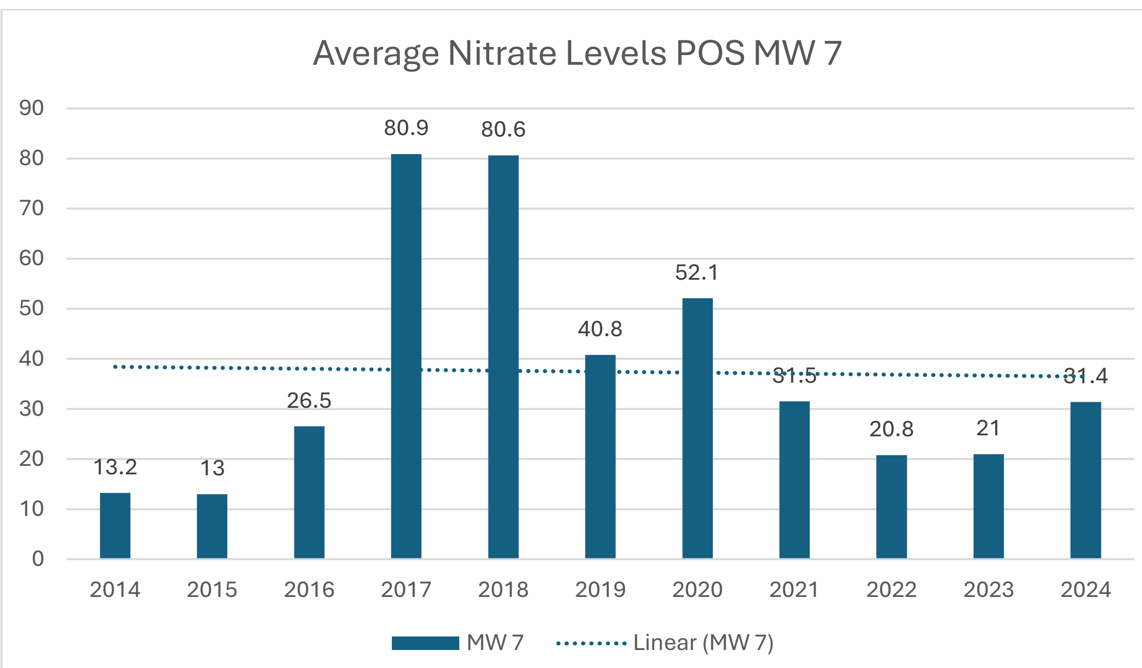

Average Nitrate Levels POS MW 1
70
60
50
40
30
20
10
0
-10
-20
0.1
0.10
0.10
0.10
0.10
3.4
36.5
38.6
31.5
53.6
61.1
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 1
Linear (MW 1)

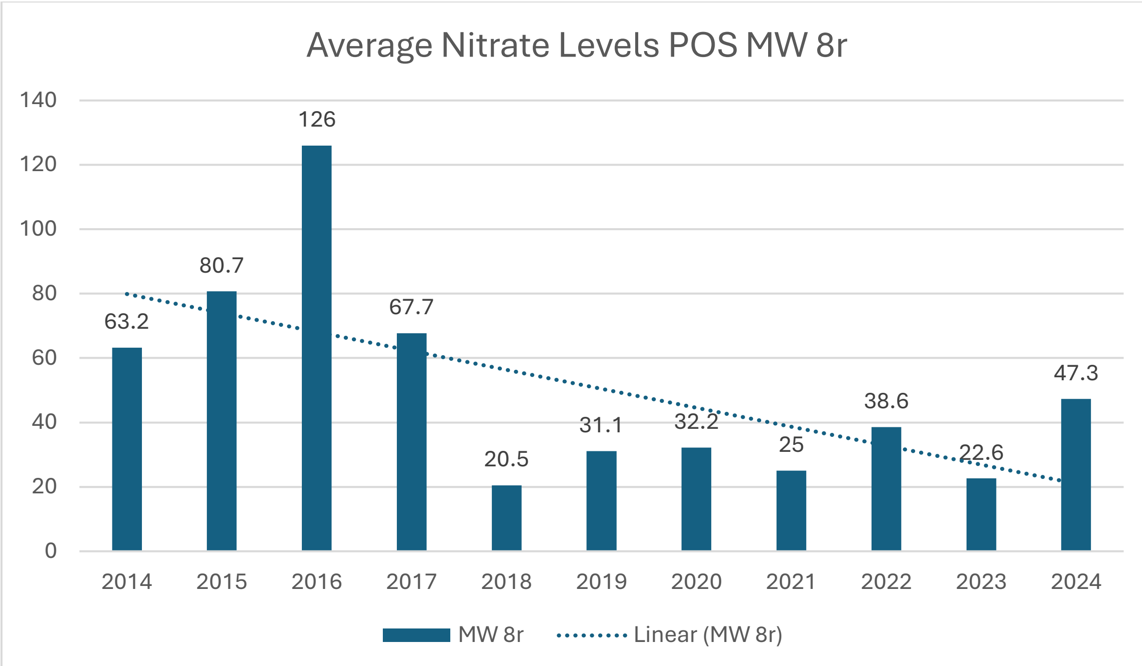

Average Nitrate Levels POS MW 2
35
30
25
20
15
10
5
0
-5
1.19
1.6
1.83
1.65
8.73
11.75
13.45
27.11
32.53
27.9
11.45
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 2
Linear (MW 2)

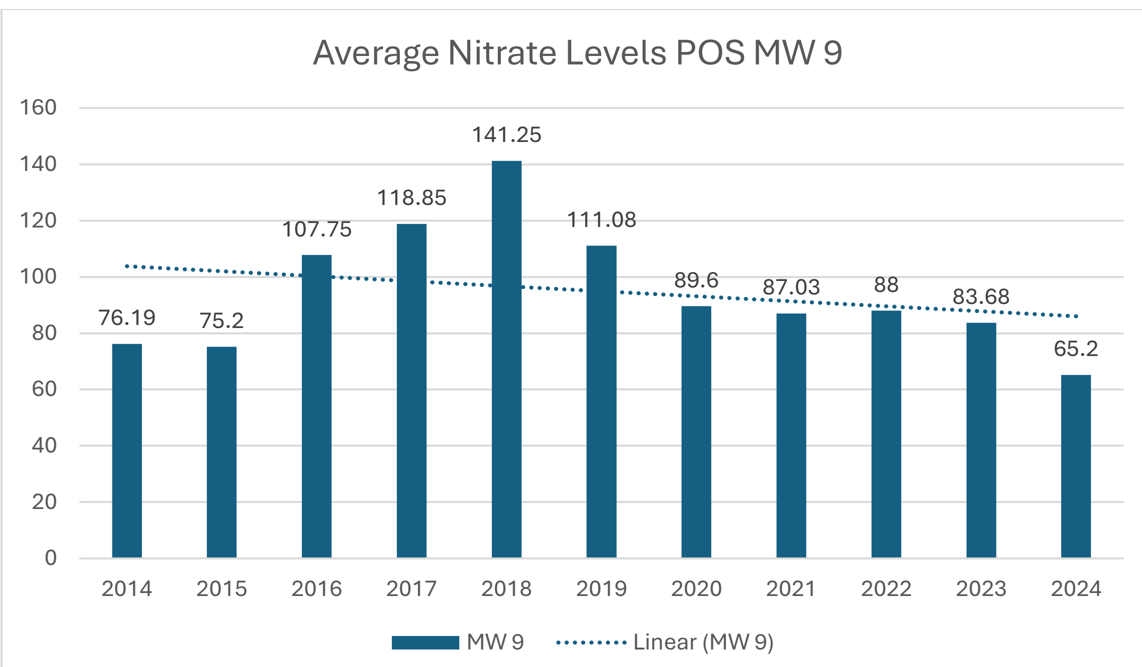

Average Nitrate Levels POS MW 4
16
14
12
10
8
6
4
2
0
6.39
3.4
2.2
4.4
0.6
4.1
0.25
2.88
5.41
6.04
13.4
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 4
Linear (MW 4)

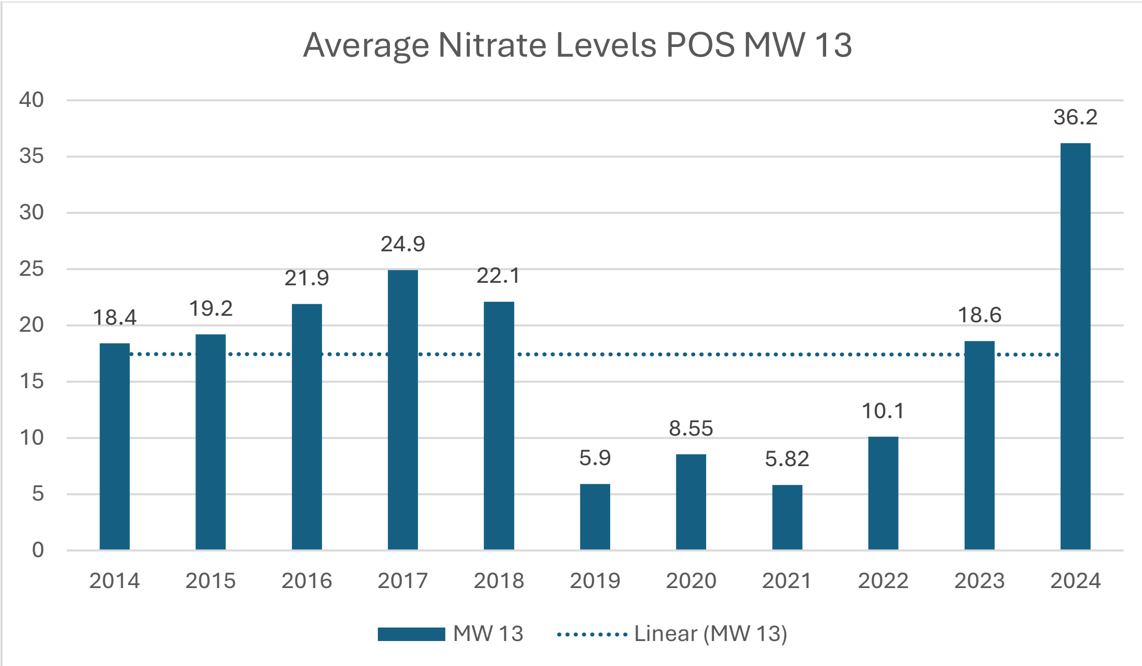

Average Nitrate Levels POS MW 5r
120
100
80
60
40
20
0
-20
1.63
1.5
2.6
6
17.8
41.8
17.2
23.4
23.3
109
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
MW 5r
Linear (MW 5r)

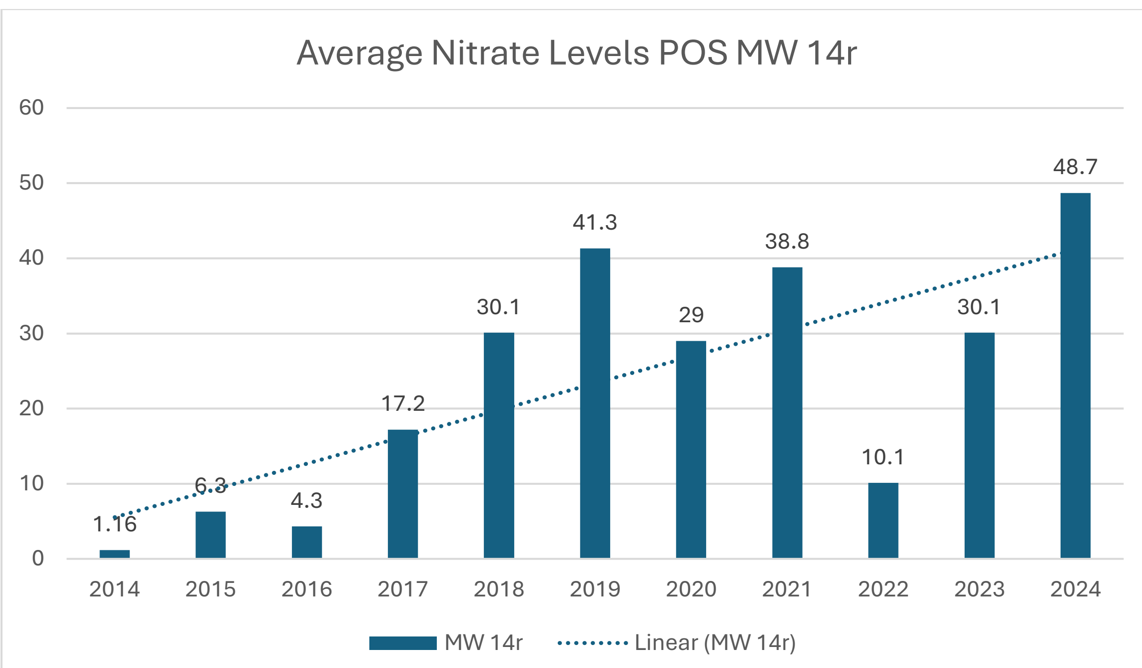

Average Nitrate Levels POS MW 6r
45
40
35
30
25
20
15
10
5
0
11.41
15.7
18.2
16.9
15.8
16.2
23.4
15.5
25
39
38.2
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 6r
Linear (MW 6r)

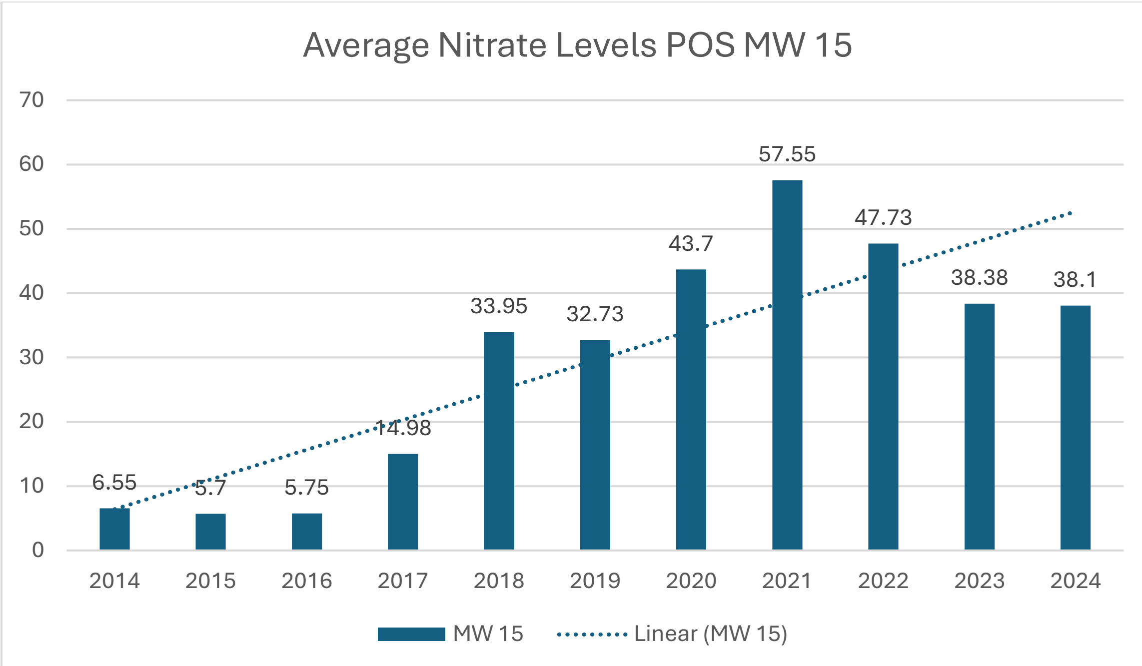

Average Nitrate Levels POS MW 7
90
80
70
60
50
40
30
20
10
0
13.2
13
26.5
80.9
80.6
40.8
52.1
31.5
20.8
21
31.4
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 7
Linear (MW 7)

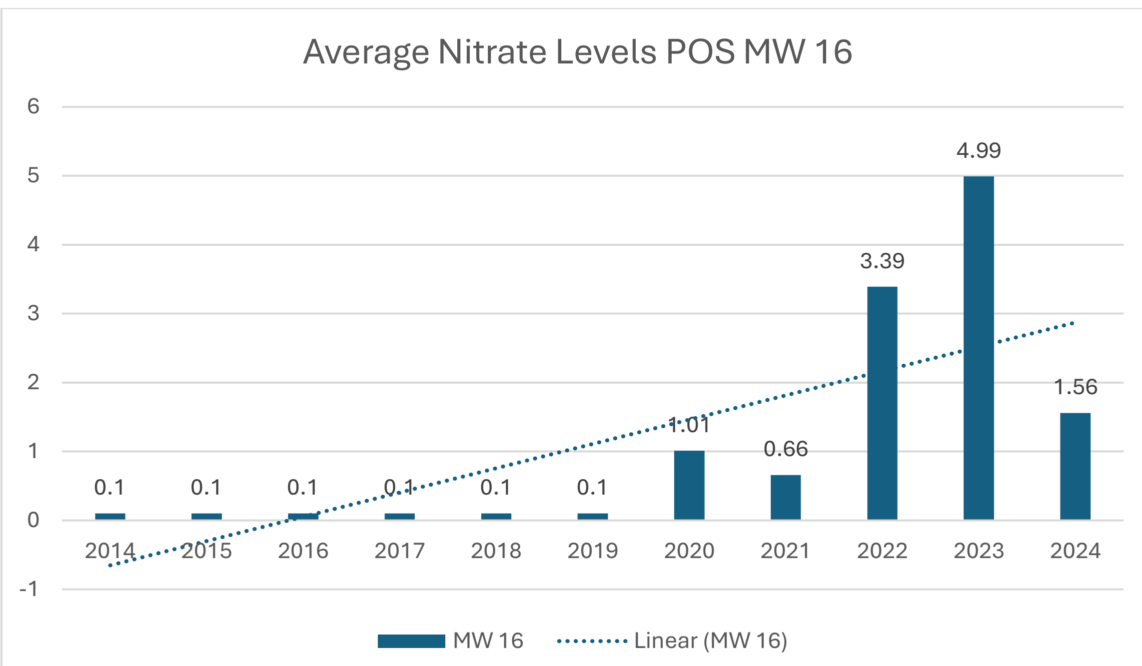

Average Nitrate Levels POS MW 8r
140
120
100
80
60
40
20
0
126
80.7
63.2
67.7
20.5
31.1
32.2
25
38.6
22.6
47.3
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 8r
Linear (MW 8r)


Average Nitrate Levels POS MW 9
160
140
120
100
80
60
40
20
0
141.25
118.85
107.75
111.08
76.19
75.2
89.6
87.03
88
83.68
65.2
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 9
Linear (MW 9)


Average Nitrate Levels POS MW 13
40
35
30
25
20
15
10
5
0
18.4
19.2
21.9
24.9
22.1
5.9
8.55
5.82
10.1
18.6
36.2
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 13
Linear (MW 13)


Average Nitrate Levels POS MW 14r
60
50
40
30
20
10
0
1.16
6.3
4.3
17.2
30.1
41.3
29
38.8
10.1
30.1
48.7
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 14r
Linear (MW 14r)


Average Nitrate Levels POS MW 15
70
60
50
40
30
20
10
0
6.55
5.7
5.75
14.98
33.95
32.73
43.7
57.55
47.73
38.38
38.1
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 15
Linear (MW 15)


Average Nitrate Levels POS MW 16
6
5
4
3
2
1
0
-1
0.1
0.1
0.1
0.1
0.1
0.1
1.01
0.66
3.39
4.99
1.56
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
MW 16
Linear (MW 16)

Suggested Helpful Actions

- Expand mandated soil testing on LYV farms to include non-dairy properties. It is certainly possible that non-dairymen over apply manure and fertilizer to the land and that this overapplication contributes significantly to groundwater pollution. No one is monitoring that source.
- Study the health of the soil microbiome in the LYV and evaluate the impact on conductivity, dissolved oxygen, REDOX potential, pH and nitrogen levels from application of manure, fertilizers, and agricultural chemicals. A healthy biome is essential for cleaning the water of contaminants.
- Pass legislation that requires dairies to comply with their Nutrient Management Plans [37] and gives WSDA and Ecology enforcement authority.
- Complete the assessment protocols for manure lagoons that were promised when WSDA and Ecology abandoned use of Tech Note 23 lagoon assessments. This protocol has not yet been completed. See Ground Water Management Progress Report September 2025 [38], page 41.
- Consider rescinding the Memorandum of Understanding between Ecology and WSDA that gives WSDA excessive control over enforcement of environmental laws on dairies. Under this MOU the WSDA investigates complaints of discharge to water of the state. Due to WSDA's mandate to work with and support dairies, these investigations usually result in informal correction agreements and no requirements to obtain NPDES permits.
- Map LYV groundwater flow using the methodology developed in *Particle tracking for selected groundwater wells in the lower Yakima River Basin, Washington*.[39] See Ground Water Management Progress Report September 2025, page 18. Goal #48 is to contract with USGS to do particle tracking model study to indicate where groundwater moves faster in certain areas compared to others. The report says this is a long term goal, which means it is unlikely to be completed.
- Increase the number of wells in South Mabton that are tested annually so that this underserved and under mapped area receives adequate attention. As noted above there is high

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[37] In Washington dairies are required to have Dairy Nutrient Management Plans but there is no authorization for WSDA to ensure that the dairies follow those plans. See Implementation of Nutrient Management Training Program for Farmers and Manure Management Program Review. GetPDF

For example, many dairies over apply phosphorous to cropland and there are no consequences. See Elevated Nitrate N and Phosphorus in Soils that Receive Dairy Manure in Washington State May 10, 2023 - Analysis of Dairy Inspections III.pdf

[38] Ground Water Management Progress Report September 2025. Lower Yakima Valley Ground Water Management Area annual report

[39] Bachmann, M.P., 2015, Particle tracking for selected groundwater wells in the lower Yakima River Basin, Washington: U.S. Geological Survey Scientific Investigations Report 2015-5149, 33 p., http://dx.doi.org/10.3133/sir20155149

variability in measurements from wells in this area. The Tetra Tech study said there are not enough monitoring wells to map depth to groundwater.

- Expand the number of dairies with NPDES permits in Yakima and in the state. There are over 250 concentrated animal feeding operations in Washington State. Only 16 CAFO dairies have NPDES permits and 4 of the permitted dairies are no longer in the dairy business. This means that, although officials boast about regulation of dairy water pollution, it is not taking place.
- Re-write NPDES permits for dairies as required by the courts, in ways that protect groundwater. The GWMA Implementation Team pretends that this has been completed. See Ground Water Management Progress Report September 2025, page 39. In fact environmentalists have challenged Ecology's updated NPDES permit for CAFOs and Ecology is in the process of another re-write that has not yet been released. We have been waiting for an adequate NPDES permit for CAFOs since 2011.[40]
- Re-write the NPDES permit for the Port of Sunnyside and reduce groundwater pollution from that source.
- Convene a task force that includes people from the community to consider what will happen if groundwater pollution in the LYV continues to increase.
- Open up the meetings of the LYV GWMA Implementation Team to the public. At present the only non-agency representatives on the GWMA Implementation Team are representatives from the Yakima Dairy Federation. They have the opportunity to support funding that subsidizes the dairy industry and to oppose funding for research that documents and explores dairy violations.
- Invite representatives from LYV cities to attend meetings of the LYV GWMA Implementation Team. On page 31 the Ground Water Management Progress Report September 2025, says that Yakima County has "issued letters to the Lower Valley cities notifying them that they are accountable to demonstrate adequate service levels before changes to UGAs will be considered under the 2026 Comprehensive Plan updates." The cities should have a voice in regulations that impact them.
- Investigate the impact of composting manure on over 500 acres of LYV farmland. Any regulations that require monitoring, inspection and measures to prevent leaching to groundwater are inadequate. See Ground Water Management Progress Report September 2025 and the most recent iteration of Ecology's NPDES General Permit for CAFOs.

[40] WA Agency Again Ordered to Rewrite Mega-Dairy Permits to Safeguard Public Health, Clean Water. 2025. [WA Agency Again Ordered to Rewrite Mega-Dairy Permits to Safeguard Public Health, Clean Water | Food & Water Watch]

Conclusion

The Friends of Toppenish Creek share this document with the best intentions. We hope the facts and thoughts in these few pages have provided readers with tools for problem solving, for finding ways to restore LYV aquifers to health.

Sincerely,

Friends of Toppenish Creek

Key Terms

Ammonia

Ammonia (NH_3) is a common toxicant derived from wastes, fertilizers and natural processes. Ammonia nitrogen includes both the ionized form (ammonium, NH_4^+) and the unionized form (ammonia, NH_3). An increase in pH favors formation of the more toxic unionized form (NH_3), while a decrease favors the ionized (NH_4^+) form. Temperature also affects the toxicity of ammonia to aquatic life.

Sources and Activities

- *Impoundments*
- *Municipal waste treatment outfalls*
- *Septic seepage*
- *Industrial point sources*
- *Agricultural and urban runoff (fertilizer)*
- *Manure application*
- *Concentrated animal feeding operations*
- *Aquaculture*
- *Landfill leachate*
- *Atmospheric sources*
- *Riparian devegetation*

Site Evidence

- *Slow-moving or stagnant water*
- *Presence of organic waste*
- *Foul odor*
- *Presence of organic suspended solids or floc*
- *Alkaline, anoxic or warm water*
- *High plant production (e.g., algal blooms)*

U.S. Environmental Protection Agency Ammonia | US EPA

Aquitard

An aquitard is characterized by its low hydraulic conductivity, which means water moves through it at a very slow rate. These layers are typically composed of fine-grained materials such as clay, shale, or silt. The small size of the pores within these materials, and their poor interconnectedness, create significant resistance to water flow. While an aquitard contains water, often with high porosity, its low permeability prevents it from yielding water freely to wells.

Despite slowing water considerably, an aquitard does not completely block its passage. Water can still seep through an aquitard over time, though the rate is substantially reduced compared to more permeable layers. This partial impedance distinguishes aquitards from other geological formations.

Aquitards play a significant role in groundwater systems by acting as confining layers for aquifers. They separate different water-bearing formations, often creating confined aquifers where water is held under pressure. This confinement helps maintain the pressure within the underlying aquifer, influencing how water can be extracted.

These low-permeability layers also protect aquifers from surface contamination. By significantly slowing the downward movement of contaminants, aquitards provide time for natural attenuation processes to occur. This allows pollutants to degrade or dilute before reaching deeper, cleaner water sources.

Aquitards also influence groundwater pressure and flow paths. They can cause a distinct change in hydraulic head across the layer, indicating a zone of lower hydraulic conductivity. This can lead to vertical flow components, even if the primary flow in adjacent aquifers is horizontal.

What Is an Aquitard and Its Role in Groundwater? Available at What Is an Aquitard and Its Role in Groundwater? - Biology Insights

Conductivity

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. For this reason, conductivity is reported as conductivity at 25 degrees Celsius (25 C).

U.S. Environmental Protection Agency 5.9 Conductivity | Monitoring & Assessment | US EPA

Denitrification

Denitrification is a series of reactions performed by bacteria and some archaea. These microorganisms utilize nitrogen oxides as alternative electron acceptors when oxygen is scarce, a process known as anaerobic respiration. It begins with nitrate (NO_3^-) reducing to nitrite (NO_2^-) by nitrate reductase.

Nitrite then transforms into nitric oxide (NO) by nitrite reductase. Nitric oxide reduces to nitrous oxide (N_2O) via nitric oxide reductase. Finally, nitrous oxide reductase converts nitrous oxide into dinitrogen gas (N_2), released into the atmosphere. An external electron donor, often organic carbon compounds like glucose or acetate, fuels these reactions.

From Biology Insights at [What Is Denitrification and Why Is It Important? - Biology Insights]

Dissolved Oxygen

Dissolved oxygen (DO) plays a crucial role in groundwater quality. It supports bacteria that break down pollutants and minimizes harmful substances like iron and manganese. High levels of dissolved oxygen help maintain low contaminant levels, leading to cleaner, safer water. Conversely, low dissolved oxygen can lead to the accumulation of toxins, impacting both drinking water and surrounding ecosystems.

Dissolved oxygen levels vary significantly across different aquifers, revealing insights about groundwater conditions. These variations, typically ranging from 0-10 mg/L, impact biological and chemical processes in the subsurface environment.

Typically measured in milligrams per liter (mg/L) or as a percentage of saturation, healthy groundwater contains between 0-10 mg/L of dissolved oxygen, depending on local conditions.

Several factors can influence the amount of dissolved oxygen in groundwater:

- Temperature: Cooler water can hold more dissolved oxygen, while warmer water retains less.
- Pressure: Higher pressures enhance oxygen solubility, allowing more oxygen to dissolve.
- Salinity: Freshwater holds more oxygen than saltwater; thus, salinity affects dissolved oxygen levels.
- The physical traits of an aquifer: Include permeability and flow rate, which influence how oxygen is distributed. Flowing groundwater generally, has higher dissolved oxygen due to increased aeration, while stagnant areas tend to show lower levels, particularly if rich in organic material.

From Atlas Scientific [The Critical Role Of Dissolved Oxygen In Groundwater Water Quality | Atlas Scientific]

Mineralization

Mineralization is a continuous process in ecosystems, acting as a natural recycling system for nutrients. It involves the breakdown of complex organic matter, such as dead plants, animals, and waste products, into simpler inorganic mineral forms. Microorganisms like bacteria and fungi are the primary agents driving this decomposition.

During this process, decomposers release essential nutrients, including nitrogen, phosphorus, and sulfur, back into the soil and water. These inorganic forms are then readily available for uptake by plants and other organisms, completing nutrient cycles. This replenishment of available nutrients through mineralization is important for maintaining soil fertility, supporting plant growth, and ensuring ecosystem health.

From Biology Insights at What is Mineralisation in Biology and Nature? - Biology Insights

Nitrate

The risk of ground-water contamination by nitrate depends both on the nitrogen input to the land surface and the degree to which an aquifer is vulnerable to nitrate leaching and accumulation.

Aquifer vulnerability depends on soil-drainage characteristics--the ease with which water and chemicals can seep to ground water--and the extent of cropland versus woodland in agricultural areas. Denitrification and plant uptake can occur beneath forests bordering streams near cropland, and precipitation seeping through forest soils to ground water contains less nitrogen than seepage beneath an agricultural field. Areas with a high risk of ground-water contamination by nitrate generally have high nitrogen loading or high population density, well-drained soils, and less extensive woodland relative to cropland.

U.S. Geological Survey. National look at nitrate contamination of Ground Water

Nitrite & Nitrate

Nitrate (NO_3^-) and nitrite (NO_2^-) are nitrogen-oxygen anions with distinct chemical behaviors. Nitrate consists of one nitrogen atom covalently bonded to three oxygen atoms in a trigonal planar arrangement, making it highly stable in aqueous environments. This stability arises from electron delocalization across the oxygen atoms, reducing its tendency to participate in redox reactions. In contrast, nitrite has two oxygen atoms bonded to nitrogen in a bent molecular geometry, making it more reactive.

The oxidation state of nitrogen further distinguishes these compounds. In nitrate, nitrogen is in its highest oxidation state (+5), making it relatively inert unless enzymatically or chemically reduced. Nitrite, with nitrogen in the +3 oxidation state, acts as an intermediate in redox reactions. It can be reduced to nitric oxide (NO) or oxidized back to nitrate, influencing its physiological significance.

Nitrate, due to its stability, is less likely to engage in direct chemical reactions unless enzymatically reduced. It is highly soluble in water and readily transported through biological systems. Nitrite, however, is more chemically active, interacting with metals, proteins, and biomolecules. For example, nitrite reacts with hemoglobin to form methemoglobin, which can impair oxygen transport at high levels. Additionally, in the stomach's acidic environment, nitrite can form reactive nitrogen species with both beneficial and potentially harmful effects.

From Biology Insights at Nitrate vs Nitrite: Key Differences and Their Biological Roles - Biology Insights

Nitrification

Nitrification is the biological oxidation of ammonia into nitrite, which is then further oxidized into nitrate. It is a key component of the global nitrogen cycle, moving nitrogen through the atmosphere, soil, and living organisms. Microorganisms facilitate these changes, converting nitrogen into forms readily used by plants and other organisms. The process requires oxygen, making it an aerobic transformation typically occurring in well-aerated environments such as soils and aquatic systems.

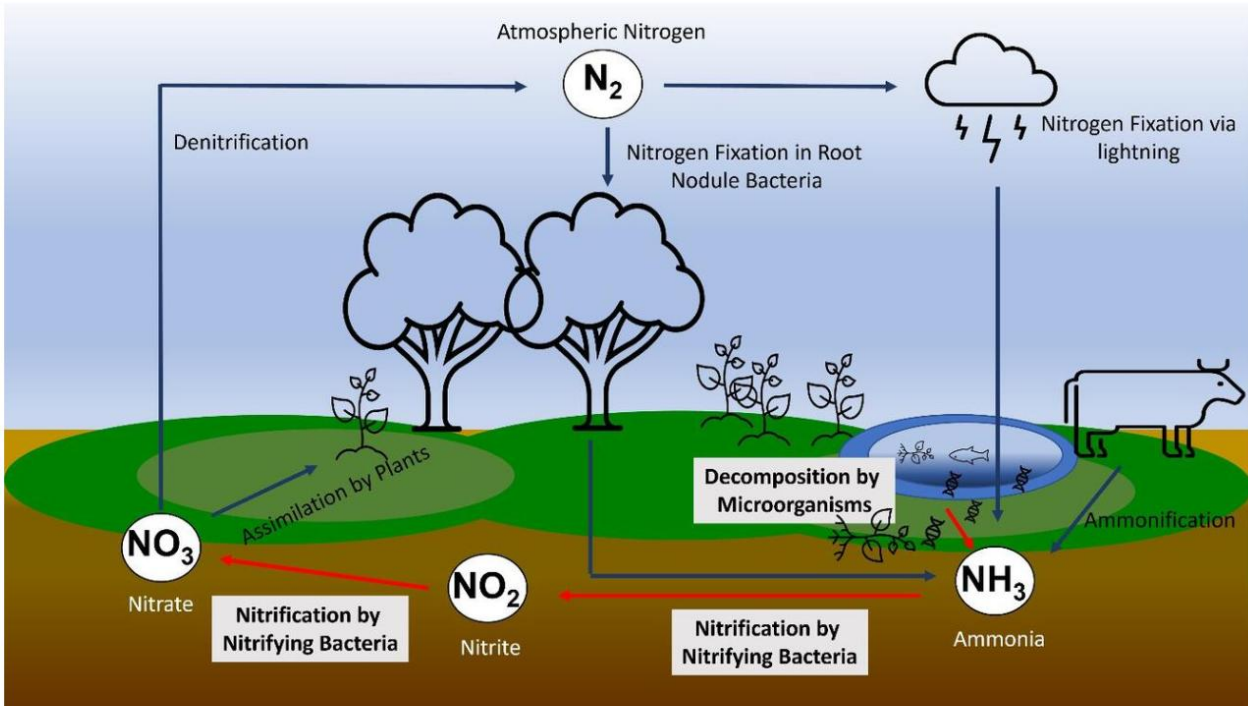
The overall reaction represents a gain of oxygen atoms by the nitrogen compound, indicating an oxidative process. This transformation is important because while ammonia can be toxic in higher concentrations, nitrate is a preferred and more easily absorbed form of nitrogen for most plants. Specialized groups of autotrophic bacteria and archaea gain energy from these reactions, making them central to this important part of nutrient cycling. Their metabolic activity underpins efficient nitrogen recycling.

From Biology Insights at What Is Nitrification? A Definition of the Process - Biology Insights

Nitrogen Cycle

Basic overview of the nitrogen cycle

By Columbia Environmental Research Center 2021 (approx.)



U.S. Geological Survey at Basic overview of the nitrogen cycle | U.S. Geological Survey

Oxidation Reduction Potential (Redox)

Oxidation-Reduction Potential (ORP) measures a water sample's ability to either donate or accept electrons during chemical reactions. This electrochemical property is expressed in millivolts (mV). A positive ORP value indicates an oxidizing environment, which is essential for disinfection and microbial control. Conversely, a negative ORP value suggests a reducing environment, which limits oxidation processes, and microbial growth may flourish.

From Alpha at ORP Drinking Water Standard: Redox Potential Impact on Quality - AlpHa Measure

Perched Water

A perched water table refers to a localized zone of water saturation that forms above the main, regional water table. This occurs when water accumulates in an upper soil layer, becoming fully saturated. It essentially creates a smaller, isolated body of groundwater that is separated from the deeper, larger groundwater system by a layer of unsaturated soil or rock.

This saturated zone is typically found within the vadose zone, which is the area above the main water table where air and water coexist in the soil pores. The water in a perched water table is unable to drain downwards due to an underlying restrictive layer. This means that while the ground below the perched water might appear dry or unsaturated, the area above the barrier remains waterlogged.

From Biology Insights at What Is a Perched Water Table and How Does It Form? - Biology Insights

pH

pH is an expression of hydrogen ion concentration in water. Specifically, pH is the negative logarithm of hydrogen ion (H^+) concentration (mol/L) in an aqueous solution:

$pH = -\log_{10}(H^+)$

The term is used to indicate basicity or acidity of a solution on a scale of 0 to 14, with pH 7 being neutral. As the concentration of H^+ ions in solution increases, acidity increases and pH gets lower, below 7 (see Figure 1). When pH is above 7, the solution is basic.

Consider listing low pH as a candidate cause when the following sources and activities, site evidence and biological effects are present:

Sources and Activities

- Mine wastes
- Historic mine sites
- Acid-generating rocks/soils
- Power plants and other sources of acidic gases
- Coal pile runoff
- Industrial effluents
- Landfill leachate
- Confined animal feeding operations, dairy runoff
- Instream oxidation or reduction processes
- Recent draining of naturally inundated wetlands or floodplains

Consider listing high pH as a candidate cause when the following sources and activities, site evidence, and biological effects are present:

Sources and Activities

- Industrial discharges
- Alkaline geology and soils
- Asphalt production or disposal
- Agricultural lime
- Oil and gas brines
- Industrial landfills
- Cement manufacturing
- Soap manufacturing
- Limestone gravel roads

From the U.S. Environmental Protection Agency at pH | US EPA

Water Temperature

At any given temperature, there is a specific concentration of a dissolved mineral's constituents in the groundwater that is in contact with that mineral. The actual concentration is temperature dependent, e.g., at higher temperatures, groundwater can dissolve more of the mineral. Even changes in groundwater temperature of only 5 to 10 o C can cause detectable changes in TDS. To some individuals, an increase in the temperature of their drinking water alone can be perceived as a different, and generally less palatable, taste.

For groundwater deeper than 50 to 75 feet, seasonal changes are generally less than one degree and temperature variations do not play a significant role in groundwater composition. For shallow groundwater, larger seasonal variations, related to warming of or cooling at the surface are common, and may be on the order of 5 to 10 degrees or more. Another source of temperature change in shallow groundwater, and occasionally deeper water, is the introduction of water from the surface during high-recharge time periods. For shallow groundwater, seasonal temperature-driven fluctuations in groundwater TDS may occur.

Natural Variations in the Composition of Groundwater at Natural Variations in the Composition of Groundwater

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