Draft Analysis of 2017 USGS Survey of Domestic Wells & Drains in the Lower Yakima Valley Groundwater Management Area

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Executive Summary

This document is a very preliminary effort to make sense of data from 901 well samples and 167 drain samples that were collected in 2017 by the United States Geological Survey for the Lower Yakima Valley Groundwater Management Area.

Data was gathered from the web site https://maps.waterdata.usgs.gov/mapper/index.html Readings were copied onto Excel spreadsheets and analyzed using Excel. The summaries that follow are my impressions from several weeks of study. There is much more work to be done.

At this point in time it appears that nitrate levels are higher in wells near the middle and southern portions of the GWMA. There is no statistical correlation between well depth and nitrate levels or ground surface elevation and nitrate levels. There were wells with low nitrate levels close to wells with high nitrate levels. There were a few wells with wide fluctuations in nitrate levels.

Wells near the Yakima River had much lower nitrate levels than those farther from the river. There is an area east of the Toppenish Wildlife Refuge with surprisingly low nitrate levels.

Drains likewise showed wide ranges in values from zero nitrates to as high as 20 mg/L nitrates. Drains showed major seasonal fluctuations.

This study requires a large time commitment and my knowledge of soils, hydrogeology and local farming practices is limited. I will continue to refine this very rough draft and welcome input from other members of the GWMA.

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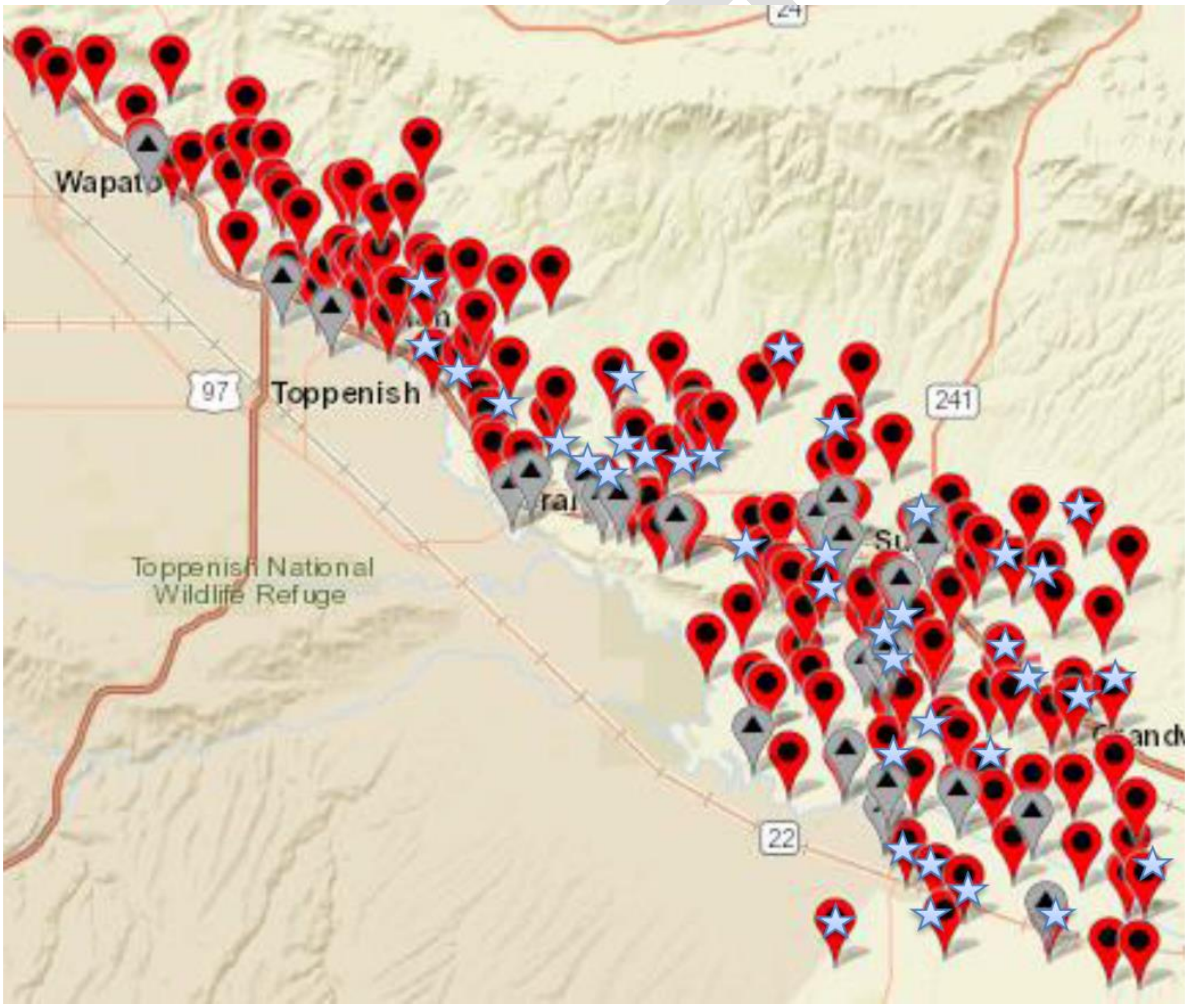
Introduction

Between April 3 and December 8, 2017 the United States Geological Survey (USGS) sampled 156 domestic wells and 24 drains in the Lower Yakima Valley (LYV) on behalf of the LYV Groundwater Management Area (GWMA). USGS sampled over 90% of the wells six times or approximately every two months. The study resulted in 901 well water samples and 167 drain samples. The purpose of the research was to describe nitrate levels across the GWMA target area at this point in time and to look for seasonal trends.

Here is a map that shows locations for the sampled wells and drains with stars next to wells that had nitrate levels > 10 mg/L.



Data was made available to the LYV Groundwater Advisory Committee (GWAC) at their April 5, 2018 meeting but there were no provisions for data analysis. The committee was essentially told, ‘Here is the data. If you want to understand, analyze it yourselves.’ This paper is an effort on the part of Friends of Toppenish Creek to begin that analysis and share the results with other members of the GWAC.

Overview of Well Sampling

133 (15%) of the samples had non-detectable levels of nitrate + nitrite that were reported at < 0.040 mg/L. A surprising finding was that 6 of the wells with no detectable nitrate were in the 50 to 100 foot well depth range.

180 (20%) of the samples had readings > 10 mg/L, the EPA designated safety level for drinking water.

The low number of wells at depths greater than 400 feet makes conclusions in this range less reliable.

Well depths ranged from 52 ft to 795 ft. No well depths (ND) were reported for six wells.

Well Depth	# Samples	# Sites	WD Average	WD Median	N Average	N Median	N Range
0 - 100 ft	183	31	83.4 ft	90 ft	7.12 mg/L	7.97 mg/L	0 - 22.3 mg/L
100.1 - 200	434	75	150.33	145	7.34	5.5	0 - 45.2
200.1 - 300	179	31	239.7	238	3.84	3.14	0 - 17.7
300.1 - 400	41	6	357.71	354	3.03	2.51	0.078 - 7.05
400.1 - 500	17	3	415.12	405	0.22	0	0 - 0.773
500.1 - 600	0	0	NA	NA	NA	NA	NA
600.1 - 700	6	1	663	663	0	0	0
> 700 ft	6	1	795	795	2.18	2.18	1.98 – 2.32
ND	35	6			5.51	2.82	0 – 18.9

Land surface elevations ranged from 657 ft to 1241 ft.

Elevation	# Samples	# Sites	Elev. Ave	Elev. Median	Nitrate Ave	N Median	N Range
600 – 700 ft	78	14	679.88	674	1.7	0	0 – 11.3
700.1 – 800 ft	338	58	751-33	750	6.22	4.68	0 – 22.3
800.1 – 900 ft	257	44	848.59	851	7.92	6.57	0.961 – 43.1
900.1 – 1000	107	18	934.06	928	6.35	5.48	0 – 17.7
1000.1 – 1100	80	14	1040.7	1043	5.95	2.32	0 – 45.2
> 1100 ft	41	7	1175.78	1155	2.05	2.27	0 – 5.74

Most of the samples, 721 out of 901, were under the safe level of 10 mg/L for nitrates.

Grouping	WD Average	Elevation Average	Nitrate Average	Nitrate Median	# Samples
0 – 10 mg/L	192 ft	846 ft	3.72 mg/L	3.21 mg/L	721
10.1 – 20 mg/L	120	803	13.35	12.4	159
20.1 – 30 mg/L	94	801	21.71	21.65	8
30.1 – 40 mg/L	151	850	36.15	NA	2
> 40 mg/L	112	949	43.16	43.1	11

Analysis by Well Depth

With 901 samples it is possible to look for a correlation between well depth and nitrate levels. We did this using calculation of a Pearson r correlation coefficient. The formula is:

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\frac{\left(x_i - \bar{x}\right)}{s_x}\frac{\left(y_i - \bar{y}\right)}{s_y}$$

The first step in the calculation is to create a scatter plot in order to visualize a possible relationship. Here is the portion of scatter plot for N values to 25 mg/L. (See Attachment 1)

24.1-25		x						
23.1-24								
22.1-23	x							
21.1-22	xxx							
20.1-21	xx	x						
19.1-20	xx	xxxx						
18.1-19		x						
17.1-18	xxxxxxx	xx	xxxxxx					
16.1-17	xx	xxxx						
15.1-16	xxxxx	Xxxxxxxxx						
14.1-15	xxxx	xxxx						
13.1-14	x	xx						
12.1-13	Xxxxxxxxxxxx	xxxxxxxx						
11.1-12	xxxxxx	Xxxxxxxxxxxxxxxxx						
10.1-11	Xxxxxxxxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx						
9.1-10	XxxxxxxxXxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxx						
8.1-9	Xxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	Xxxxxxxx					
7.1-8	Xxxxxxxxxxx	Xxxxxxxxxxxxxxxxx	Xxxxxxxxxx					
6.1-7		Xxxxxxxxxxxxxxxxxxx	xxxxxx	xxxxxx				
5.1-6		Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxx	Xxxxxxxxx	xxx				
4.1-5	xxxx	XxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxXxxx xxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	x				
3.1-4	Xxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxx	xxxxxx				
2.1-3	Xxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxx	Xxxxxxxxxxxx				xxxxx
1.1-2	xxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxx	xxxxxxxxx	xxxxxxx				x
0.1-1		Xxxxxxxxxx	xxxxxx	xxxxx	xxxxx			
0 mg/L	Xxxxxxxxxxxxxxxxxxxxxxxxxxxx xxxxxxxxxxxxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	x	Xxxxxxxxxxxx		xxxxxx	
	0-100 ft	101-200 ft	201-300	301-400	401-500	501-600	601-700	701-800

The first impression is that there is little overall correlation between well depth and nitrate levels. This is borne out by calculation of the Pearson r correlation coefficient = negative 0.281. Generally speaking there is poor correlation if $|r| < 0.60$. (Excel Calculations are available in Attachment 2)

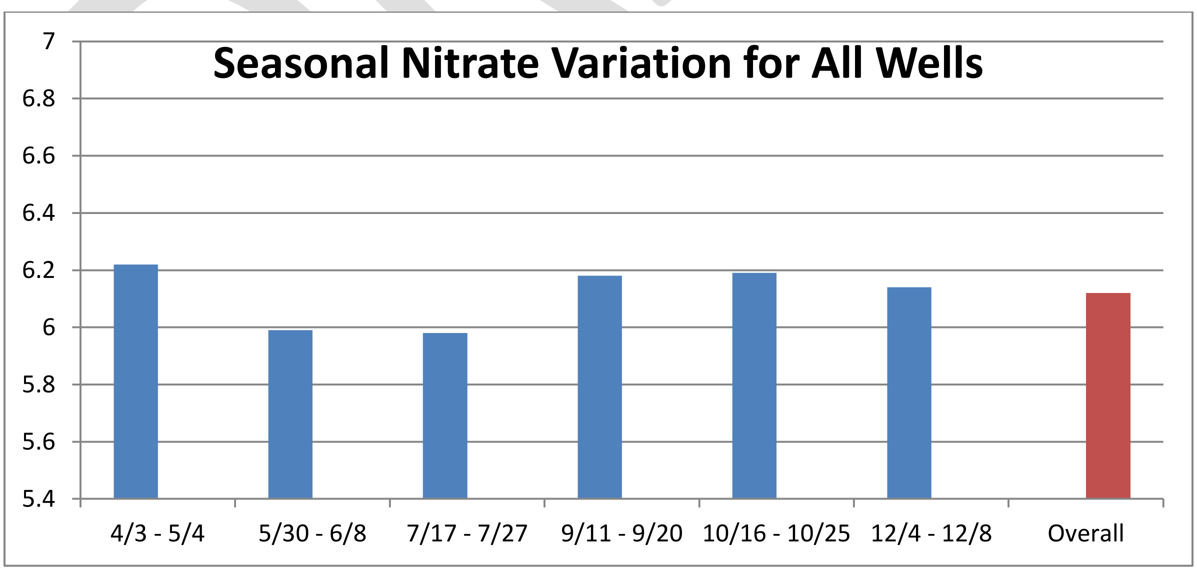
Analysis by Ground Surface Elevation

Based on a similar calculation of the Pearson r correlation coefficient regarding elevation and nitrate levels, r = negative 0.018. There is little relationship between elevation and nitrate levels. (See Attachment 2). This issue will be addressed more completely in the section on nitrate levels and distance from the Yakima River.

Seasonal Analysis

It is well known that nitrate levels in the LYV fluctuate with the seasons. Here are the seasonal results from this study.

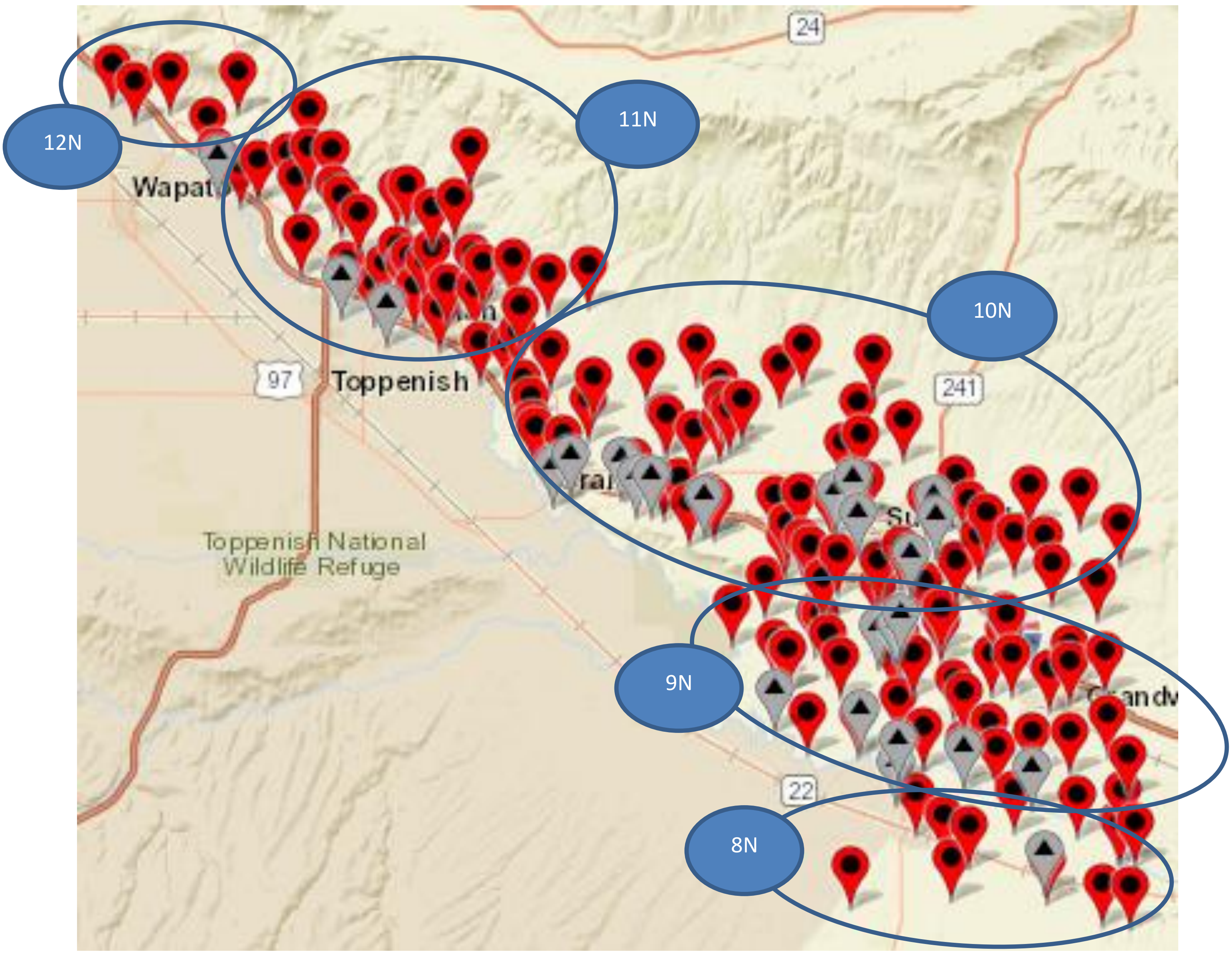
Sampling Period	N	WD Ave	El. Ave	Nitrate Ave
4/3 - 5/4	149	175.79	836.66	6.22
5/30 - 6/8	151	178.08	839.04	5.99
7/17 - 7/27	154	178.26	839.83	5.98
9/11 - 9/20	154	178.26	839.83	6.18
10/16 - 10/25	152	178.66	841.36	6.19
12/4 - 12/8	141	177.04	840.87	6.14
Overall	901	177.69	839.59	6.12



USGS Groupings

USGS uses five major categories for well classification in the GWMA Target Area. The categories begin with 8N, 9N, 10N, 11N, and 12 N.

Here is a map that shows where wells in each grouping are located:



This table describes the number of wells in each grouping with depths and average nitrate levels:

Grouping	N Samples	N Sites	Well Depth Average	Elevation Average	Ave. Nitrate Level	
All Sites	901 ft	156 ft	177.79 ft	839.59 ft	6.12 mg/L	
N12	29	5	276.48	1013.48	0.50	
N11	218	38	243.71	959.66	4.00	
N10	344	58	166.30	841.00	8.62	
N9	260	45	133.63	739.27	5.11	
N8	54	10	130.15	728.15	6.45	

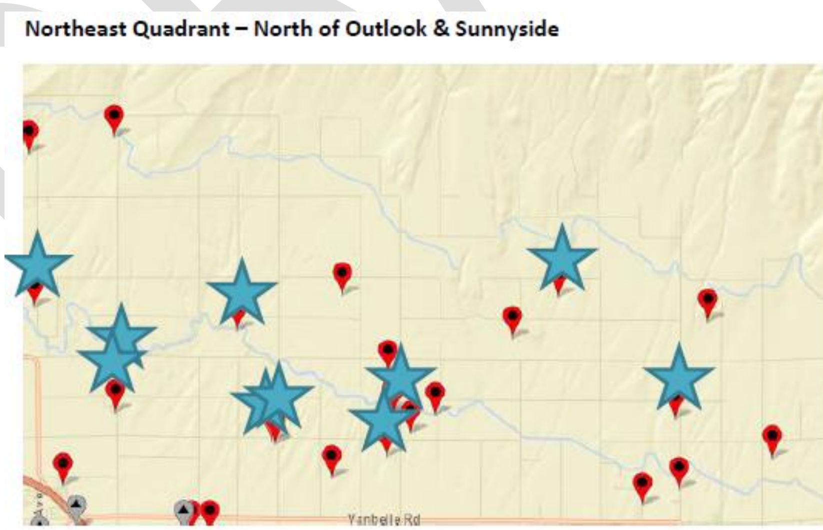
The northern wells are at a higher elevation, are deeper and have lower nitrate levels. Within the middle and southern groups a higher elevation and deeper well depth is associated with higher nitrate levels. My conclusion is that there are other factors involved besides well depth.

High Risk Wells & Low Risk Wells

Here is a mapping of high and low risk wells

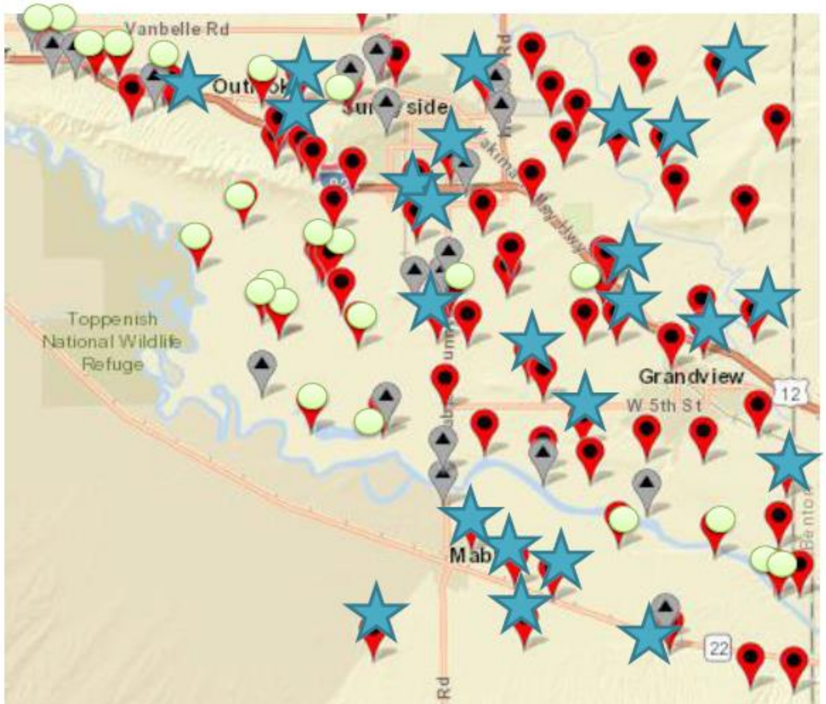
Wells with > 10 mg/L nitrate at least once are covered with a star =

Wells with < 1 mg/L nitrate are covered with a sphere =



Northwest Quadrant

Southeast Quadrant



There are multiple wells with very low nitrate levels near the Yakima River. There are also interesting pockets of low nitrate wells: 1. the area directly east of the Toppenish Wildlife Refuge, 2. the area north of Snipes Mountain and south of Van Belle Road.

Special Cases

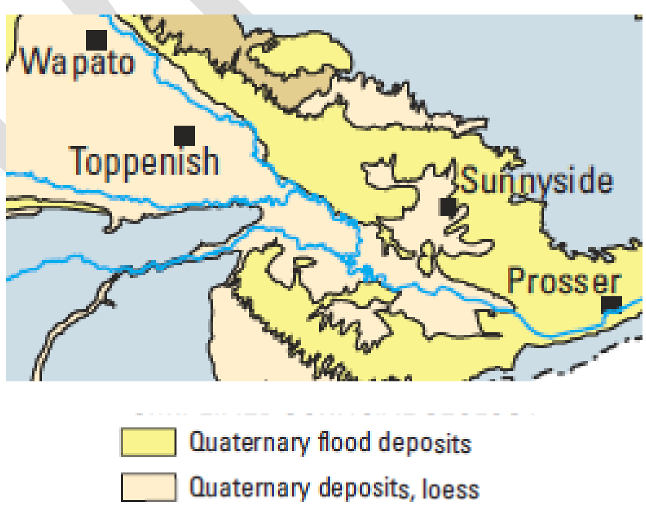
We have assumed that shallower wells are more vulnerable to nitrate pollution. After looking at the data it appears that other important factors are involved.

Near the Yakima River - I divided the data set into wells within 2 miles of the Yakima River and wells > 2 miles from the Yakima River. The results show shallower well depths and lower elevation nearer the river which is no surprise. The results also show lower nitrate levels on parcels within 2 miles of the river. (See Attachment 3)

Distance from the River	Well Depth	Hole Depth	Elevation	Average Nitrate Level
< 2 Miles	159 ft	160 ft	800 ft	4.34 mg/L
> 2 Miles	190 ft	191 ft	867 ft	7.32 mg/L

This deserves analysis by people who know more about hydrogeology than I do.

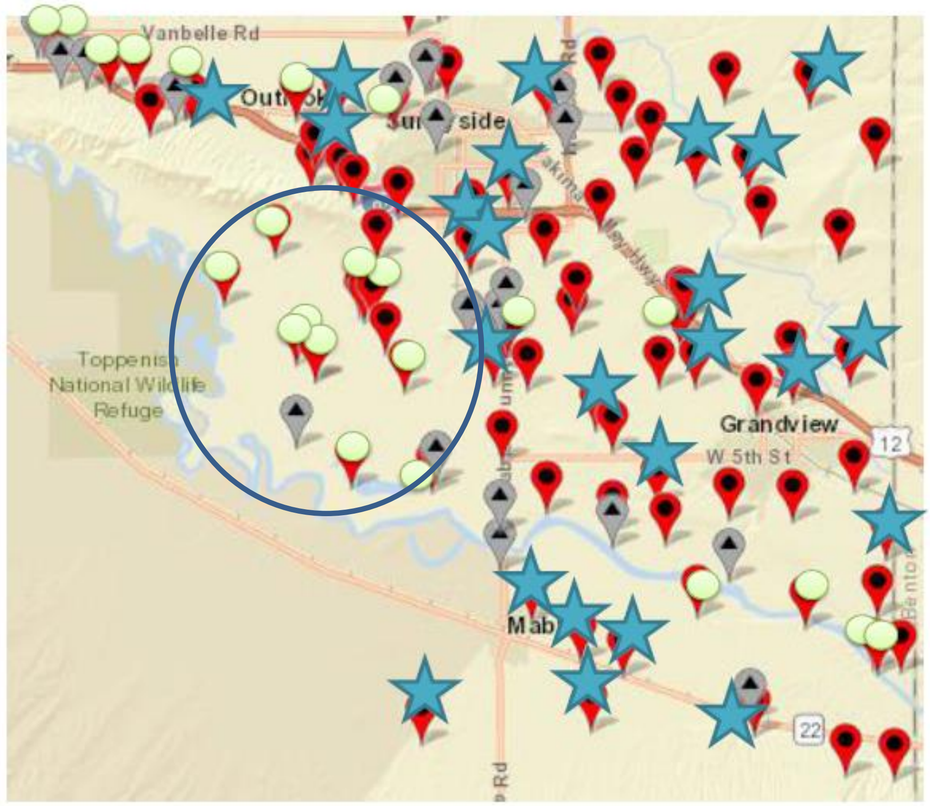
Let me point out that the 2006 USGS study *Hydrogeologic Framework of Sedimentary Deposits in Six Structural Basins, Yakima River Basin, Washington*, available at https://pubs.usgs.gov/sir/2006/5116/pdf/sir20065116.pdf lists two major soil types for this area. They are quaternary flood deposits and quaternary loess as shown in this excerpt from the map on page 7 of that document.



1990 Agricultural Chemicals Pilot Study

In 1990 Ecology released a document entitled the *Washington State Agricultural Chemicals Pilot Study.* Available at https://fortress.wa.gov/ecy/publications/documents/9046.pdf

Southeast Quadrant



The study found. "Eight wells of the 27 wells (30%) sampled in the Yakima County study area showed detectable concentrations of nitrate/nitrite-N. The concentrations ranged from less than 0.01 to 6.2 mg/L with a mean concentration of 0.7 mg/L. No wells exceeded the MCL of 10 mg1L." This correlates with our 2017 USGS sampling of domestic wells in the area that shows most wells with < 1 mg/L nitrate.

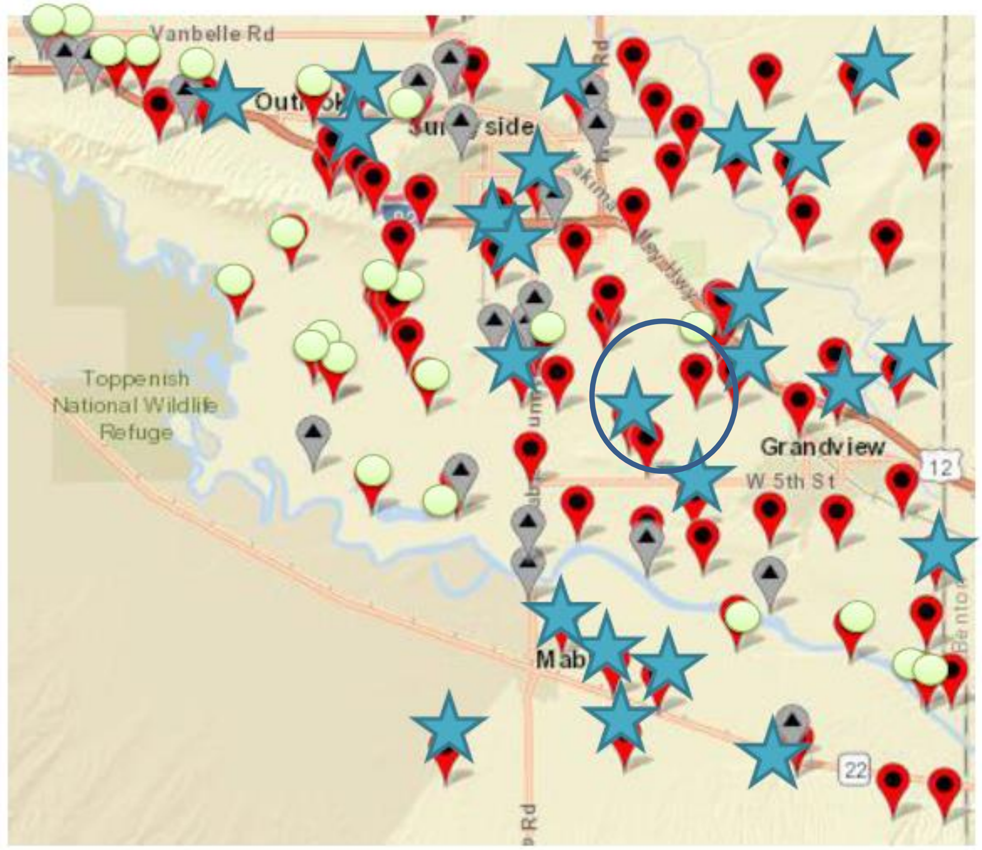
This suggests different patterns of groundwater flow compared to other parts of the GWMA.

1992 Hornby Lagoon Study

In 1992 Ecology published the *Groundwater Quality Assessment, Hornby Dairy Lagoon, Sunnyside Washington.* https://fortress.wa.gov/ecy/publications/documents/92e23.pdf

The purpose was to study water quality down gradient from a new two stage dairy lagoon. After one year only chloride was elevated in the monitoring wells and Ecology recommended further observations for long term effects. It appears that long term monitoring was not done.

Southeast Quadrant

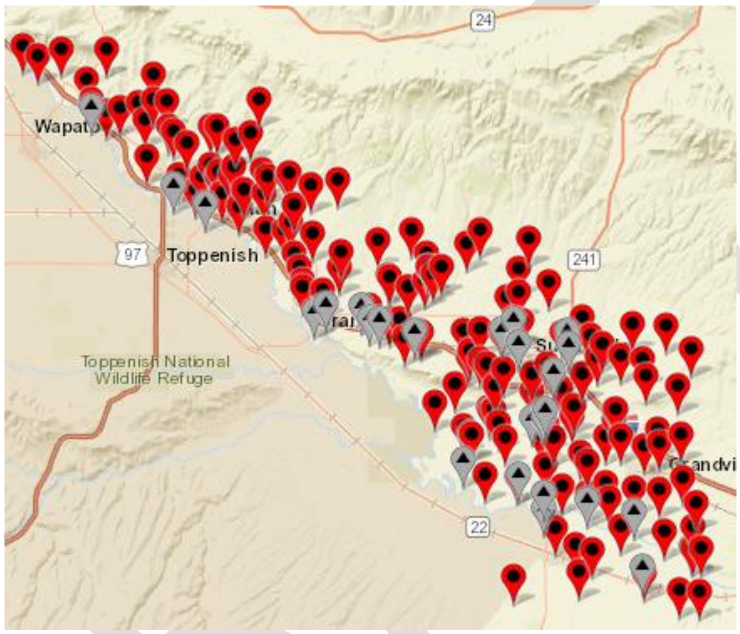


There are two wells in our study that are 0.8 miles and 1.5 miles downgradient from the Hornby Lagoon study. The nearest well had nitrate levels that ranged from 19.2 to 20.7 mg/L. The other had nitrate levels that ranged from 1.69 to 1.89 mg/L.

Lower Valley Drains

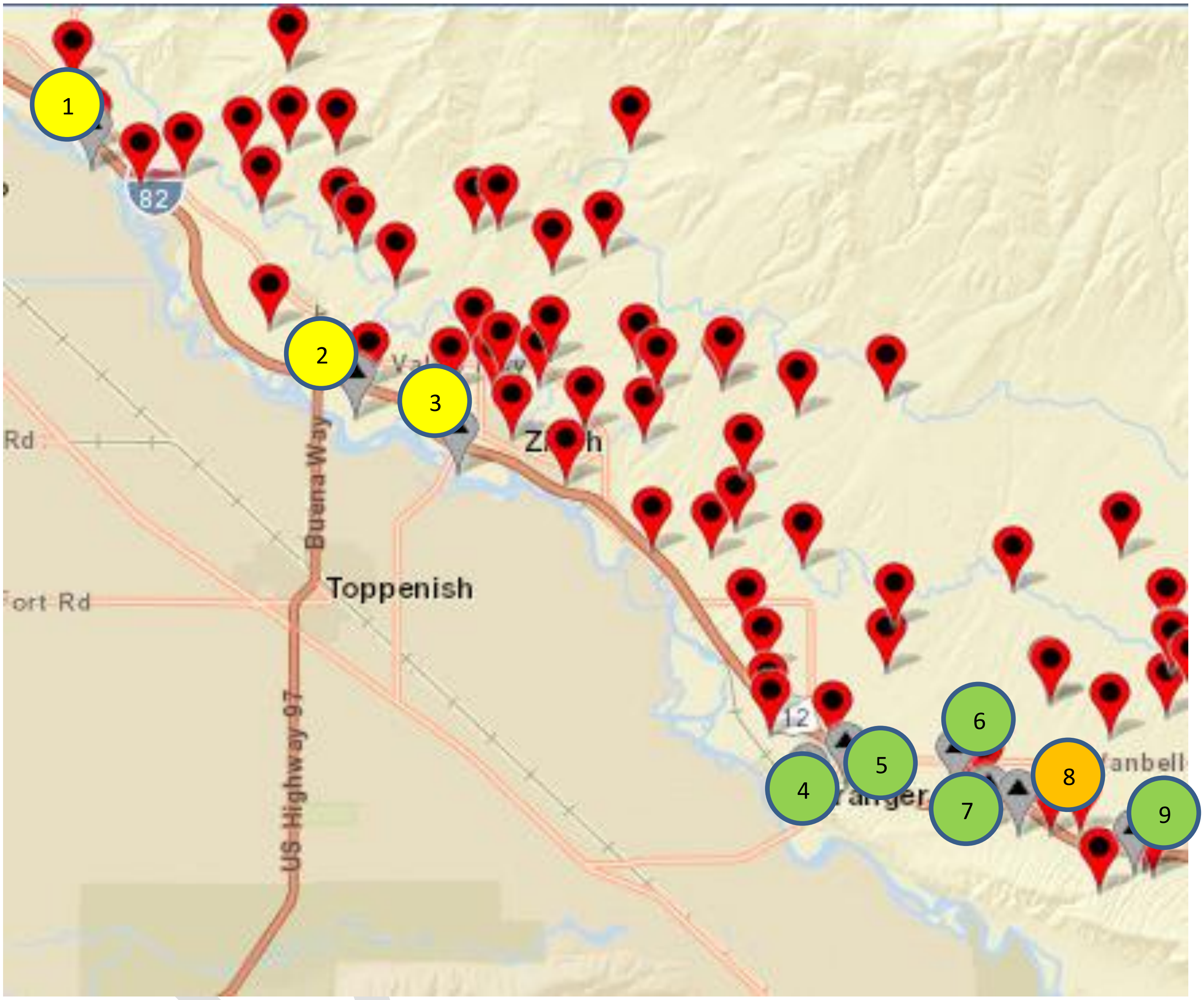
Variations in Bi-Monthly Nitrate Levels - Drain Testing Lower Yakima Valley 2017

In 2017, from April through December, the United States Geological Survey sampled 24 drains in the Lower Yakima Valley on behalf of the LYV Groundwater Management Area. USGS tested for nitrates and other variables. Most drains were sampled about seven times. The readings varied by season. The USGS map below identifies test sites. Domestic wells are coded in red and drains are coded in gray.

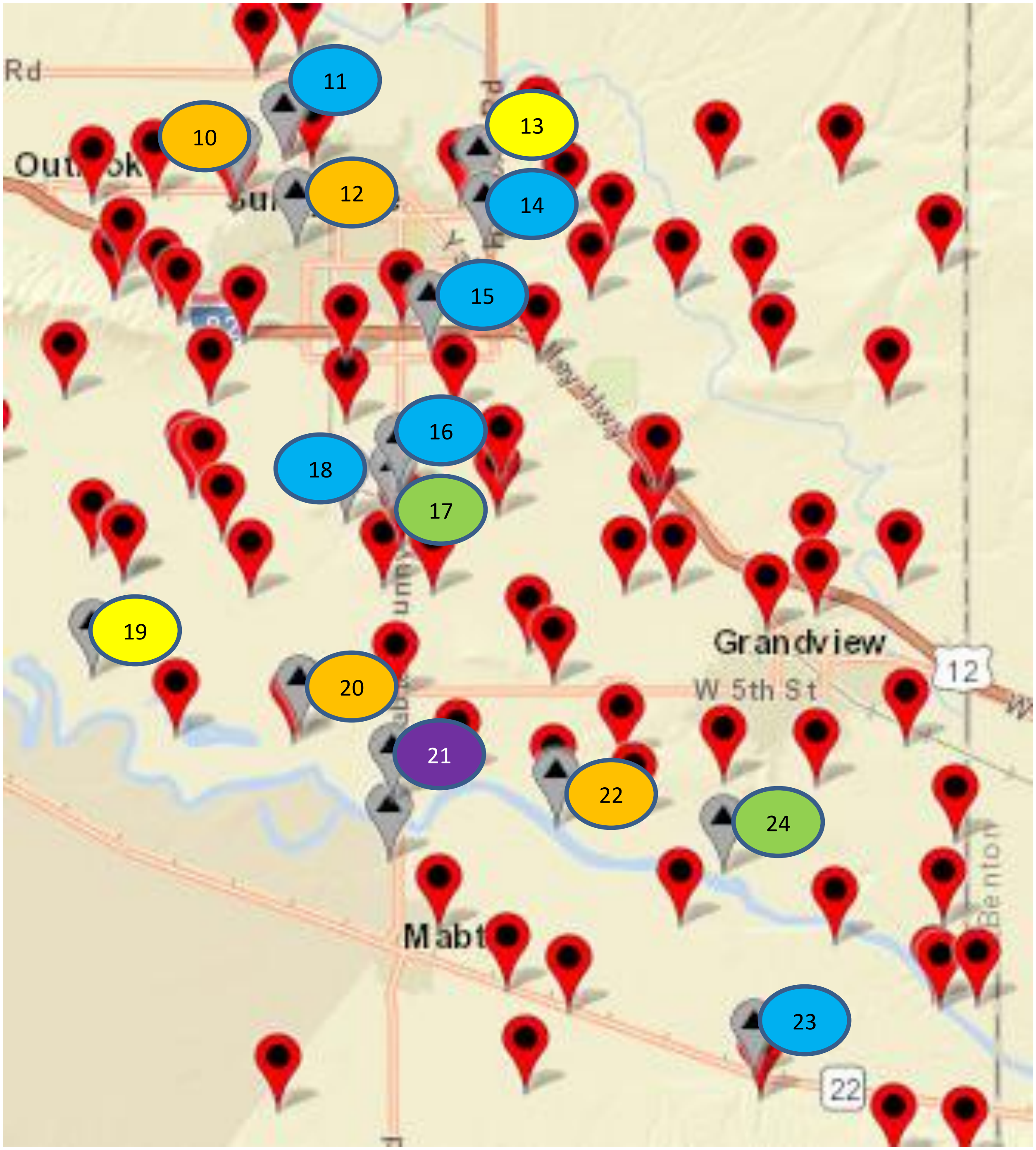


There were wide ranges in values for the various drains. For clarity the average readings are color coded on larger maps on the following pages. There is a map for the northern section of the GWMA and a map for the southern section.

	< 2.5 mg/L nitrate
	2.5 - 5 mg/L nitrate
	5 - 7.5 mg/L nitrate
	7.5 - 10 mg/L nitrate
	> 10 mg/L nitrate



1 = Roza Wasteway	6 = Joint Drain at Van Belle Road
2 = Buena Drain	7 = Joint Drain 28 near Granger
3 = Joint Drain at Chevron Station, Zillah	8 = Drain 2 NEET Site Number 3
4 = Granger Drain at Granger	9 = Joint Drain 32 at Outlook
5 = Joint Drain, Yakima Valley Hwy at Granger	



10 = Joint Drain from Rougk Land near Sunnyside	18 = DID Drain 3 near Sunnyside
11 = Joint Drain 34.2 at Woodin Road	19 = DID 7 near Mabton
12 = Joint Drain near S. First St. in Sunnyside	20 = Sulfur Creek Wasteway near Sunnyside
13 = Sulfur Creek Wasteway at Scheller Road	21 = Drain 31 at West Charvet Road
14 = DID Drain 18 at Sunnyside	22 = Drain 35 off Charvet Road
15 = Washout Drain at Sunnyside	23 = Joint Drain 1 at Bus Road
16 = Joint Drain 40.2 near Tear Road	24 = Grandview Drain at Chase Road
17 = Joint Drain 43.9 at Mabton	

Summary of Average and Median Nitrates for the 24 Lower Yakima Valley Drains

Number	Name	N Average	N Median	N Range
1	Roza Wasteway	0.01	0	0 - 0.072
2	Buena Drain	1.12	0.83	0.177 – 2.61
3	Joint Drain at Chevron Station, Zillah	0.31	0.09	0 – 1.29
4	Granger Drain at Granger	5.21	3.58	2.8 – 8.39
5	Joint Drain, Yakima Valley Hwy at Granger	6.82	5.46	3.49 – 10.9
6	Joint Drain at Van Belle Road	5.24	3.56	3.1 – 9.85
7	Joint Drain 28 near Granger	6.84	5.96	4.06 – 9.98
8	Drain 2 NEET Site Number 3	4.92	4.82	1.27 – 7.97
9	Joint Drain 32 at Outlook	7	4.33	2.33 – 14.3
10	Joint Drain from Rougk Land near Sunnyside	4.58	4.09	1.35 – 9.06
11	Joint Drain 34.2 at Woodin Road	8.95	5.88	4.03 – 16.5
12	Joint Drain near S. First St. in Sunnyside	4.98	4.74	1.97 – 7.78
13	Sulfur Creek Wasteway at Scheller Road	0.11	0.08	0 – 0.242
14	DID Drain 18 at Sunnyside	7.5	6.41	5.57 – 9.87
15	Washout Drain at Sunnyside	8.17	8.3	5.7 - 11
16	Joint Drain 40.2 near Tear Road	9.69	8.32	7.58 – 13.9
17	Joint Drain 43.9 at Mabton	5.36	4.58	3.68 – 8.22
18	DID Drain 3 near Sunnyside	7.99	8.22	3.07 – 12.3
19	DID 7 near Mabton	0.7	0.65	0 – 0.995
20	Sulfur Creek Wasteway near Sunnyside	4.81	3.91	2.4 – 9.2
21	Drain 31 at West Charvet Road	13.07	6.86	4.64 – 25.2
22	Drain 35 off Charvet Road	3.87	3.42	2.41 – 5.49
23	Joint Drain 1 at Bus Road	9.81	7.13	4.35 – 18.6
24	Grandview Drain at Chase Road	5.76	6.24	3.94 – 6.98

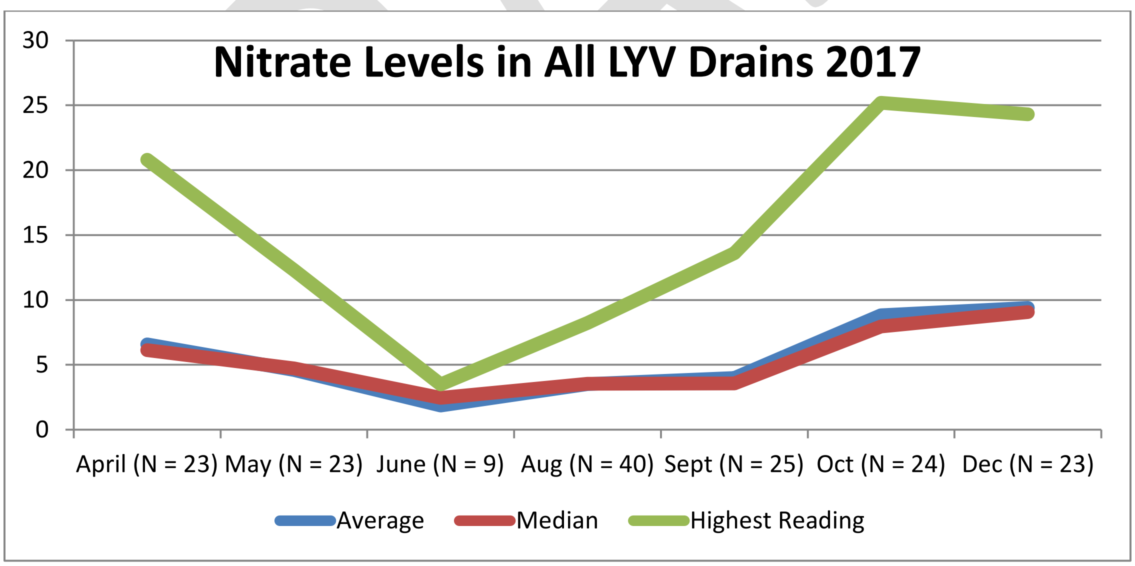
Ron Cowin from the Sunnyside Valley Irrigation District kindly provided this description of the different drains:

Wasteways are earthen ditches or concrete flumes designed to take excess water from RID's & SVID's main canals so the canal doesn't over top its banks. We can also use the wasteways to dump large volumes of water in an emergency situation such as a canal break. The Sulphur Creek Wasteway takes excess water or waste water (thus the name wasteway) from both RID & SVID. The Sulphur Creek Wasteway also has many large and small drains that flow into it making it the largest drain/wasteway in the GWMA. The Granger drain on the other hand is not a wasteway, it is strictly a drain. Neither RID or SVID spill or waste water directly into the Granger drain from our main canals.

The drains were all built with the purpose of collecting ground water and to provide irrigators with a place to spill unused water and/or tailwater. SVID also spills tailwater from open laterals into the drains. Open laterals aren't piped solid and can't back the water up into the main canal so we will spill the excess water to the drains. The drains vary in size which is usually due to the quantity of acres that they receive water from. The more acres you have in a drainage basin the more water it produces and that creates the need for a larger drain.

Drainage Improvement Districts (DID's) are drains which are paid for through county assessments to landowners in the DID and maintained by local landowners. I believe the County is just the treasurer who collects the assessments and pays the bills but doesn't do the work. There are still a few DID's operating within the SVID but most of them have been handed over to us. We eventually renamed the ones we now maintain from DID's to DR's since this made more sense. It's really a matter of ownership. They're both drains with DID's being maintained by landowners and DR's being maintained by the District. There are also about 30 Joint Drains (JD's) which don't just serve SVID like the DR's do, but both SVID and RID and so the cost of maintaining them is borne by both entities.

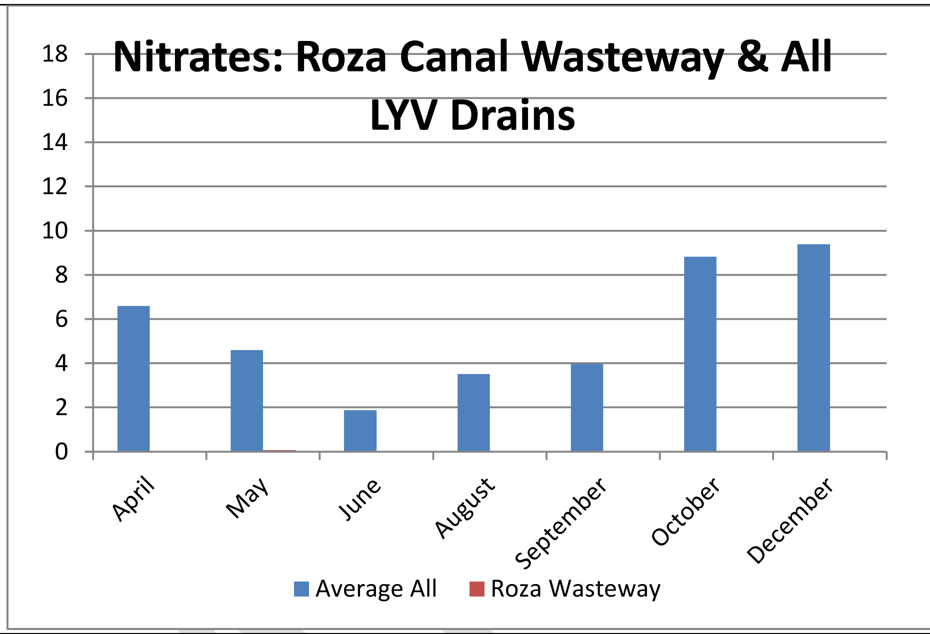
Hopefully this is helpful.

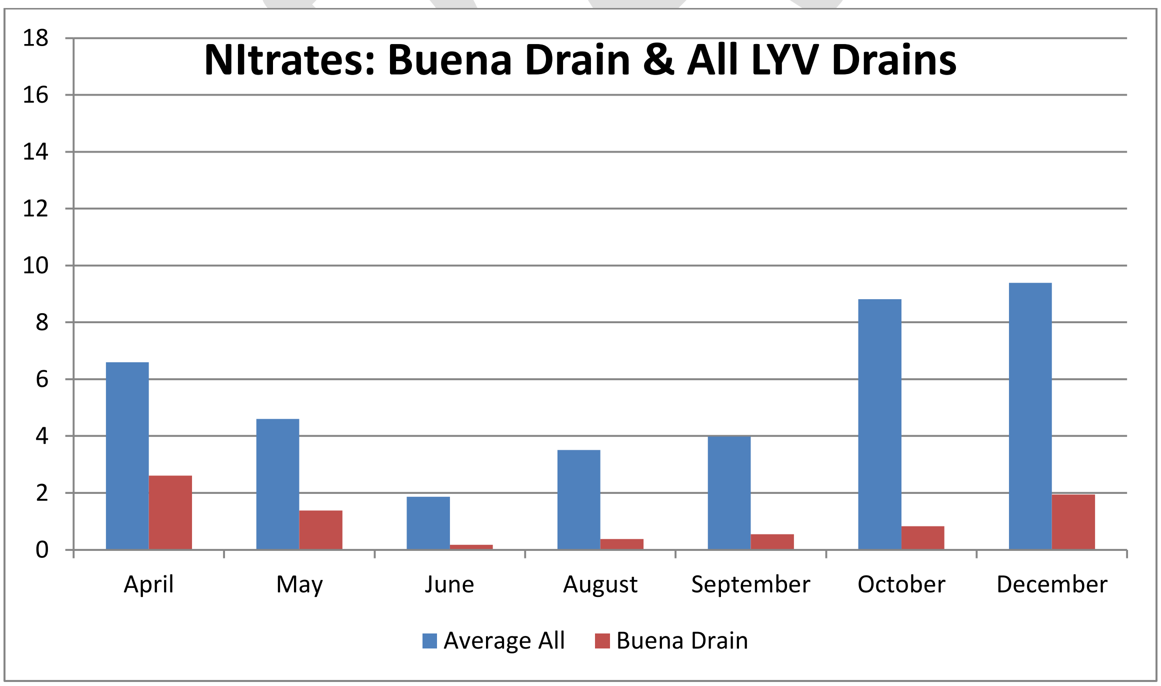


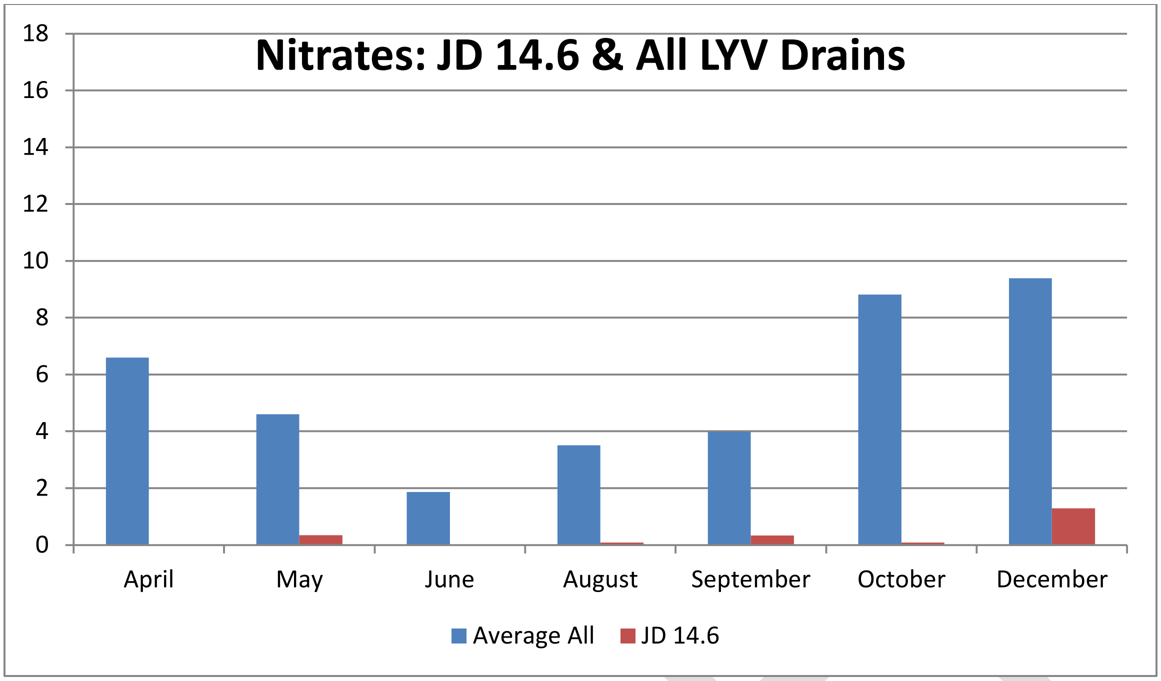
The graphs on the following pages compare readings for each drain with the overall average readings for all drains during the study period. Please note that only 9 drains were sampled in June, 2017, so the June numbers are less reliable.

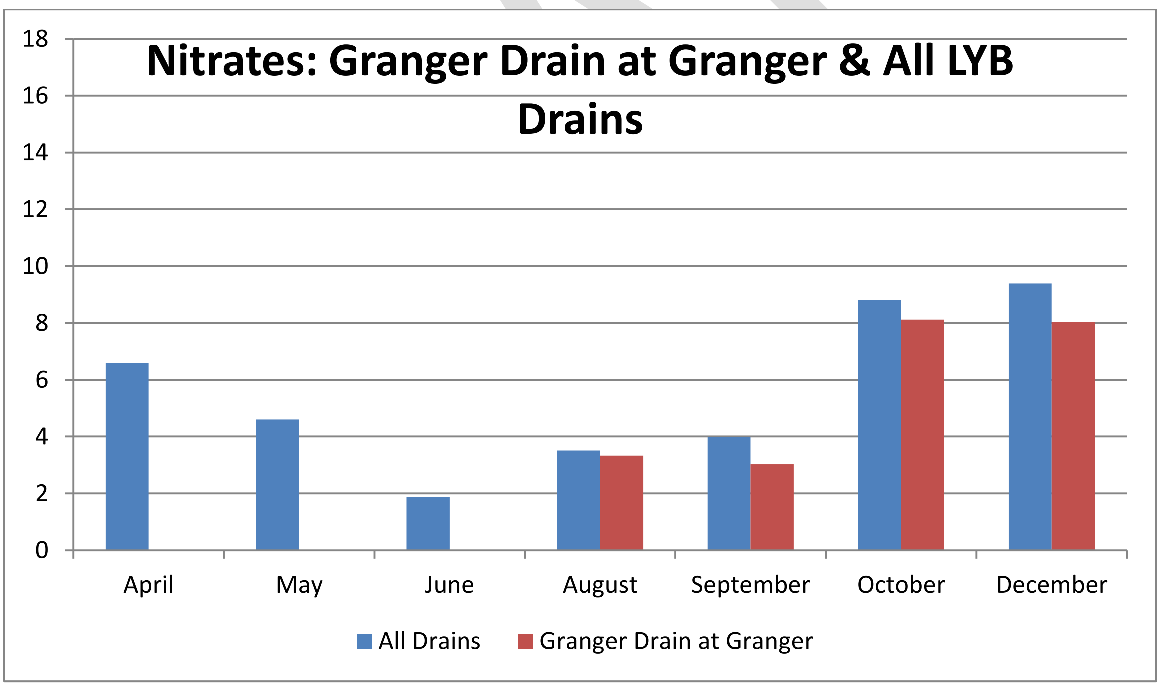
Roza Canal Wasteway had essentially zero nitrates in the 2017 sampling

Month	Roza
April	0
May	0.072
June	0
August	0
September	0
October	NA
December	NA

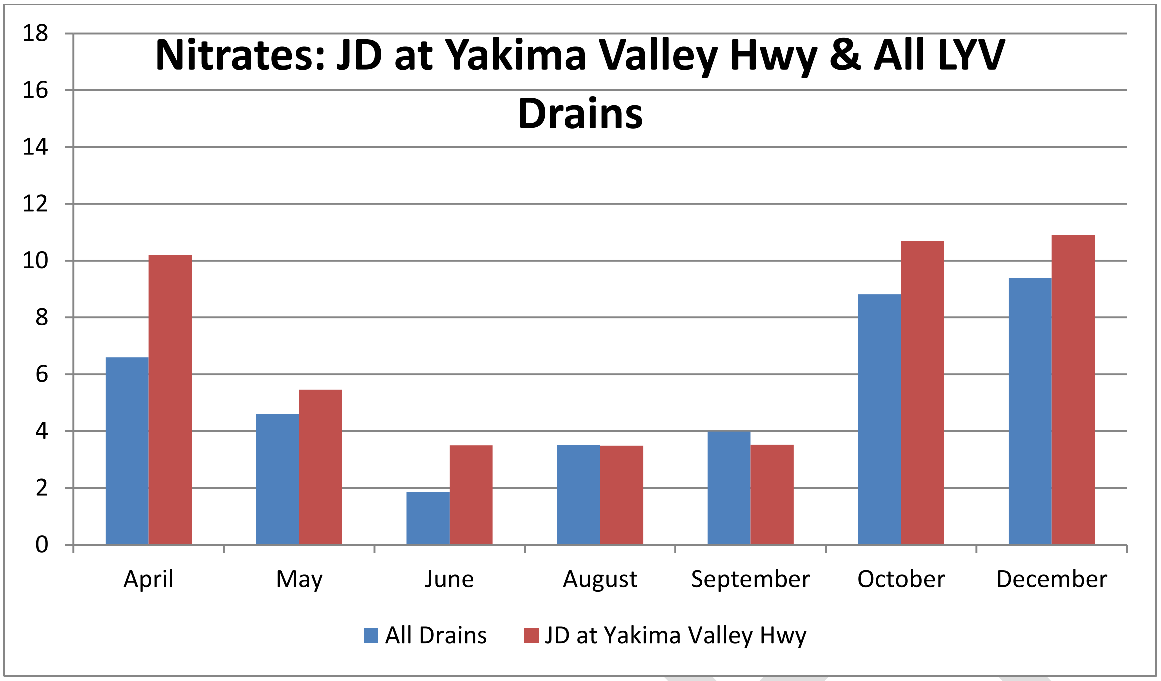


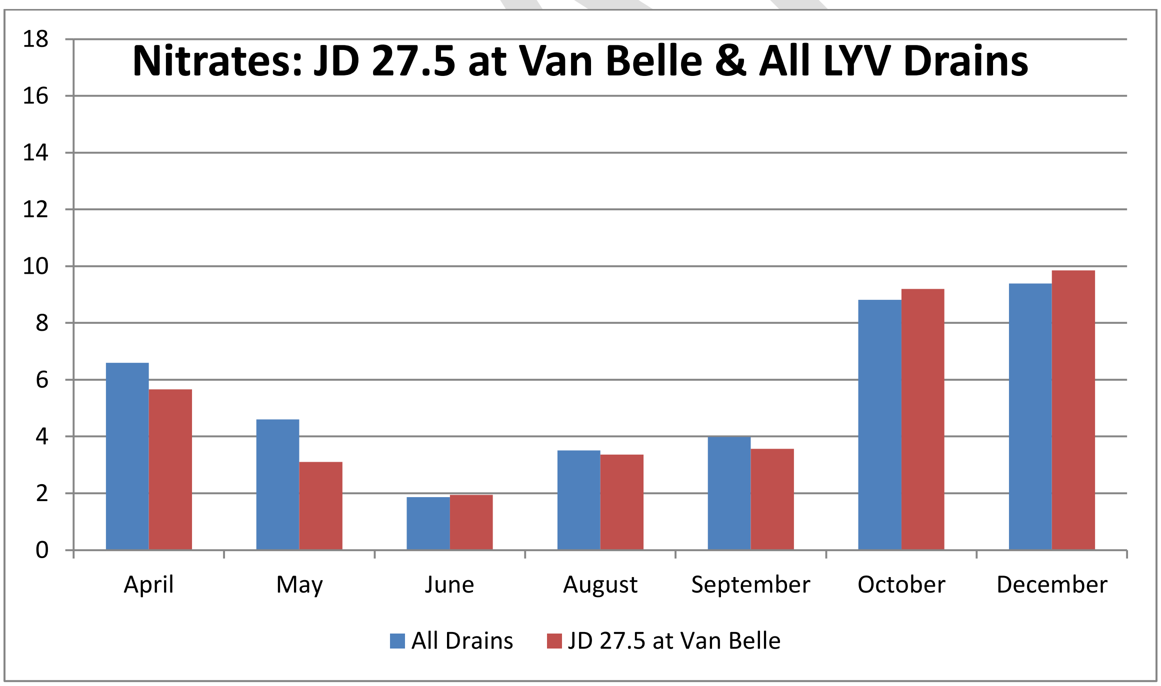






(There was no sampling of the Granger Drain at Granger in April, May & June)


Nitrates: JD at Yakima Valley Hwy & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
JD at Yakima Valley Hwy


Nitrates: JD 27.5 at Van Belle & All LYV Drains
18
16
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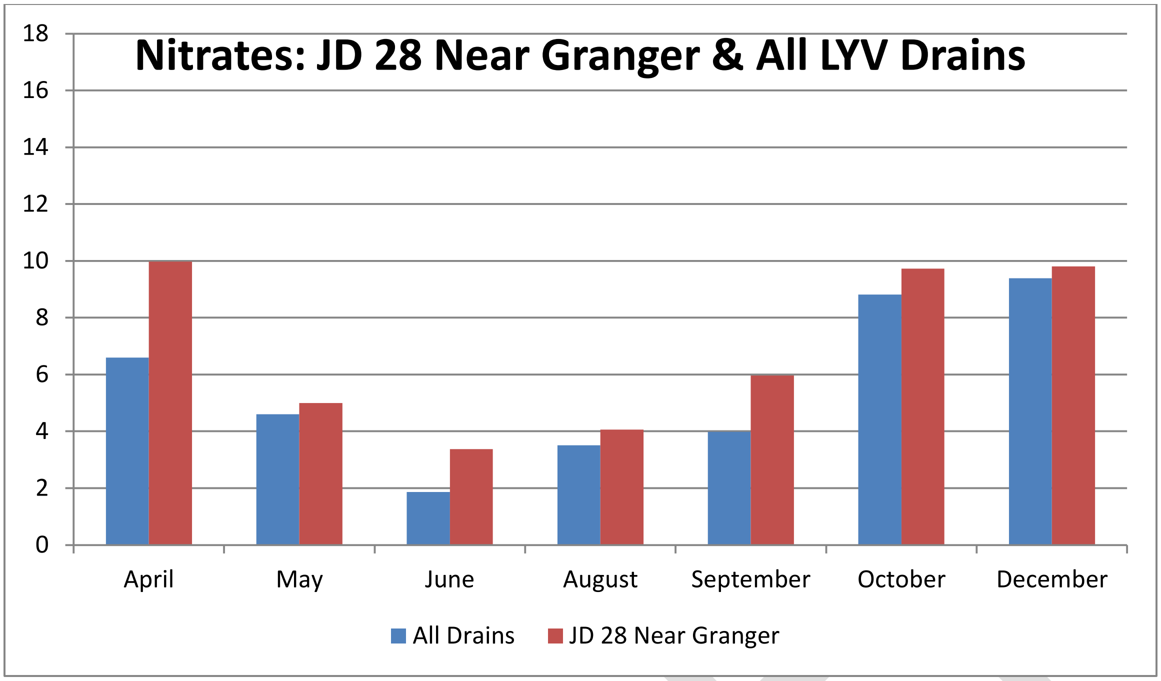
April
May
June
August
September
October
December
All Drains
JD 27.5 at Van Belle


Nitrates: JD 28 Near Granger & All LYV Drains
18
16
14
12
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8
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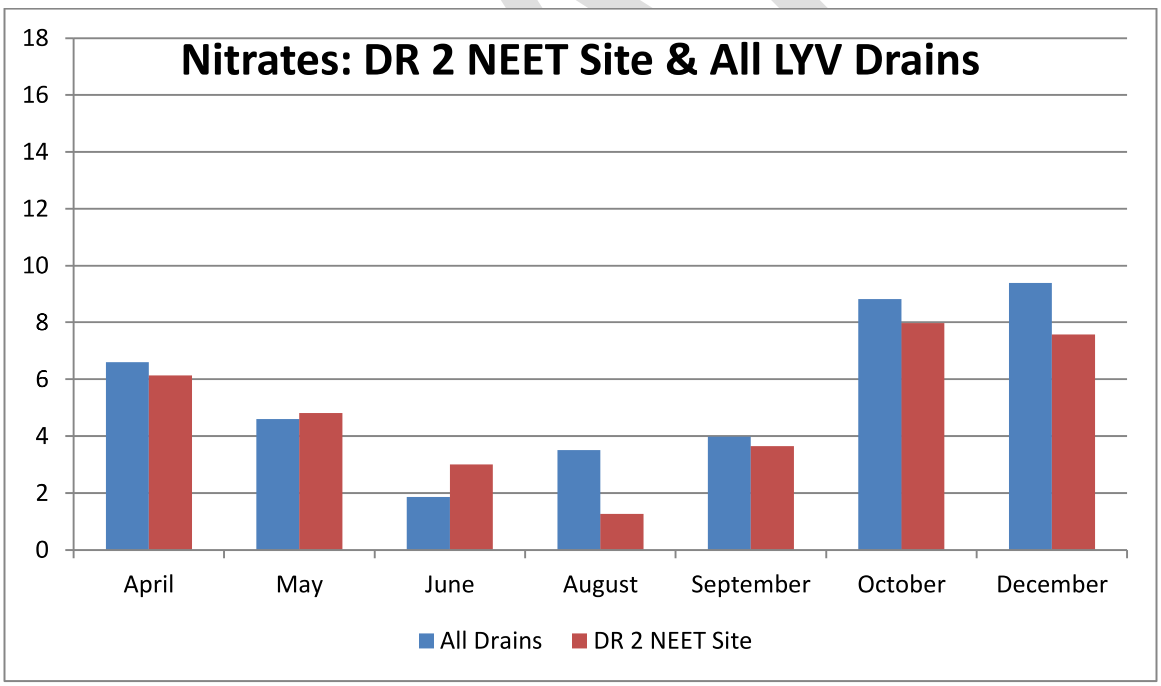
April
May
June
August
September
October
December
All Drains
JD 28 Near Granger


Nitrates: DR 2 NEET Site & All LYV Drains
18
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April
May
June
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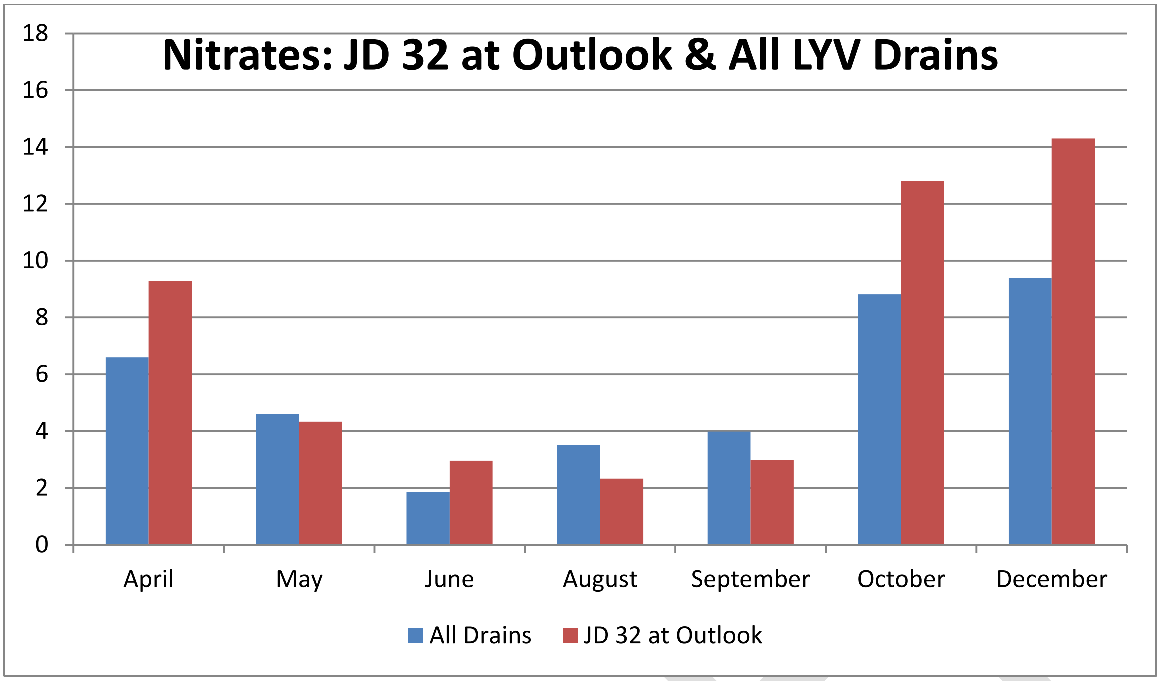
September
October
December
All Drains
DR 2 NEET Site



Nitrates: JD 32 at Outlook & All LYV Drains
18
16
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8
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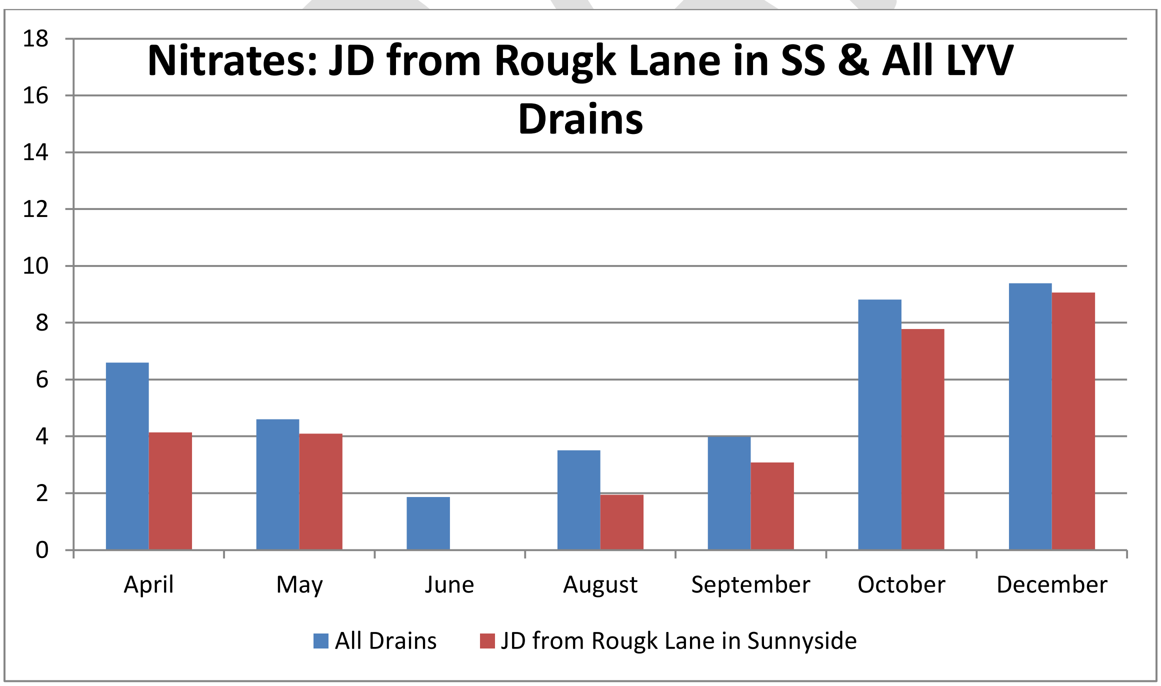
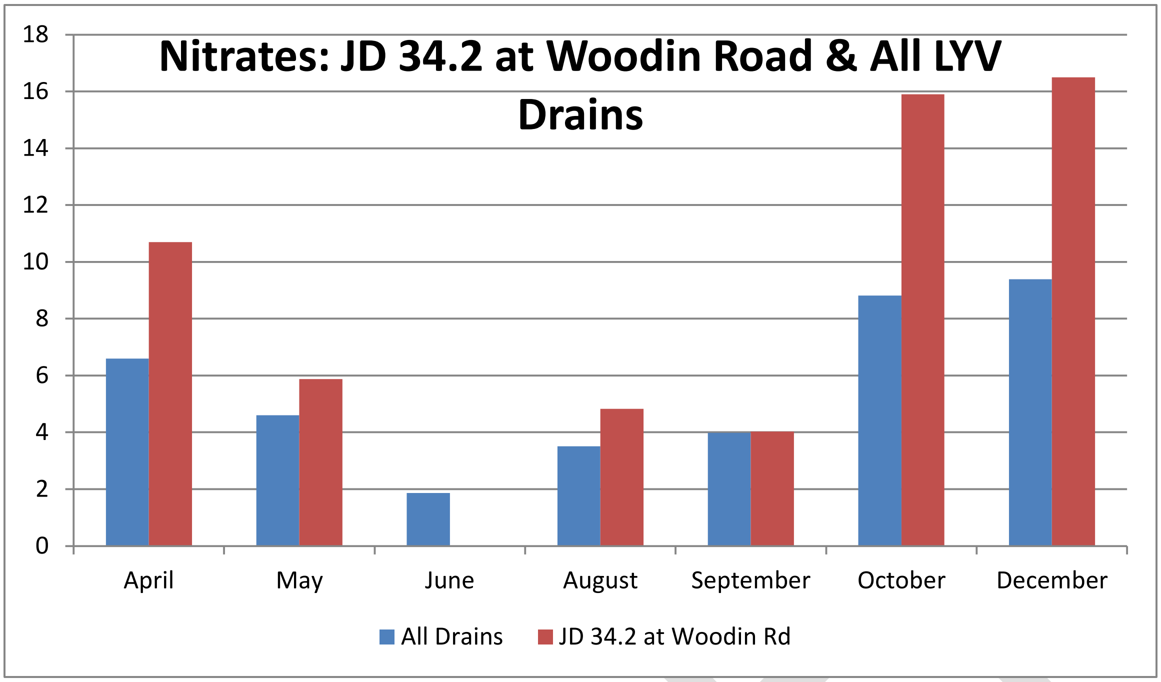
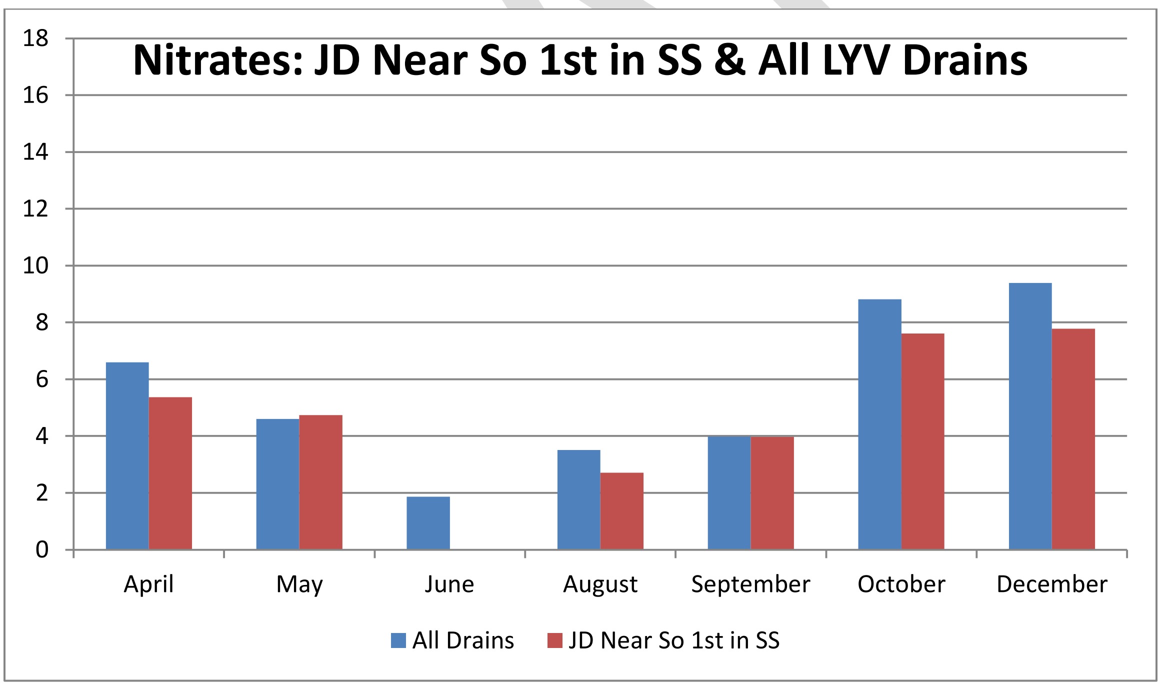
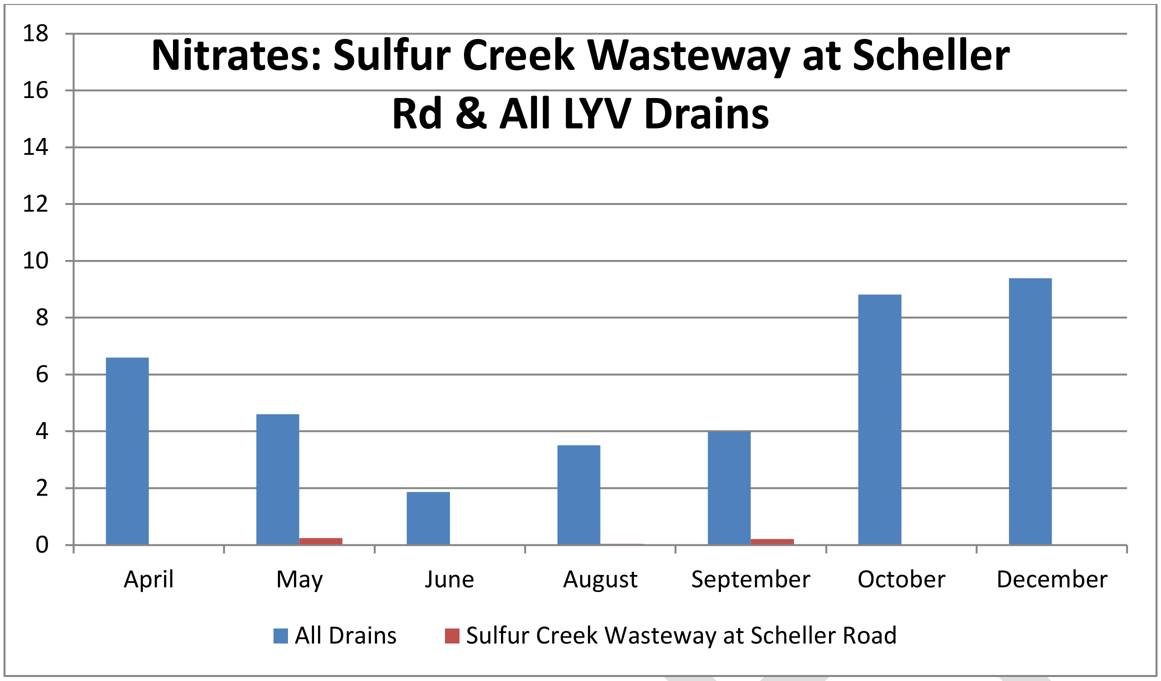
April
May
June
August
September
October
December
All Drains
JD 32 at Outlook

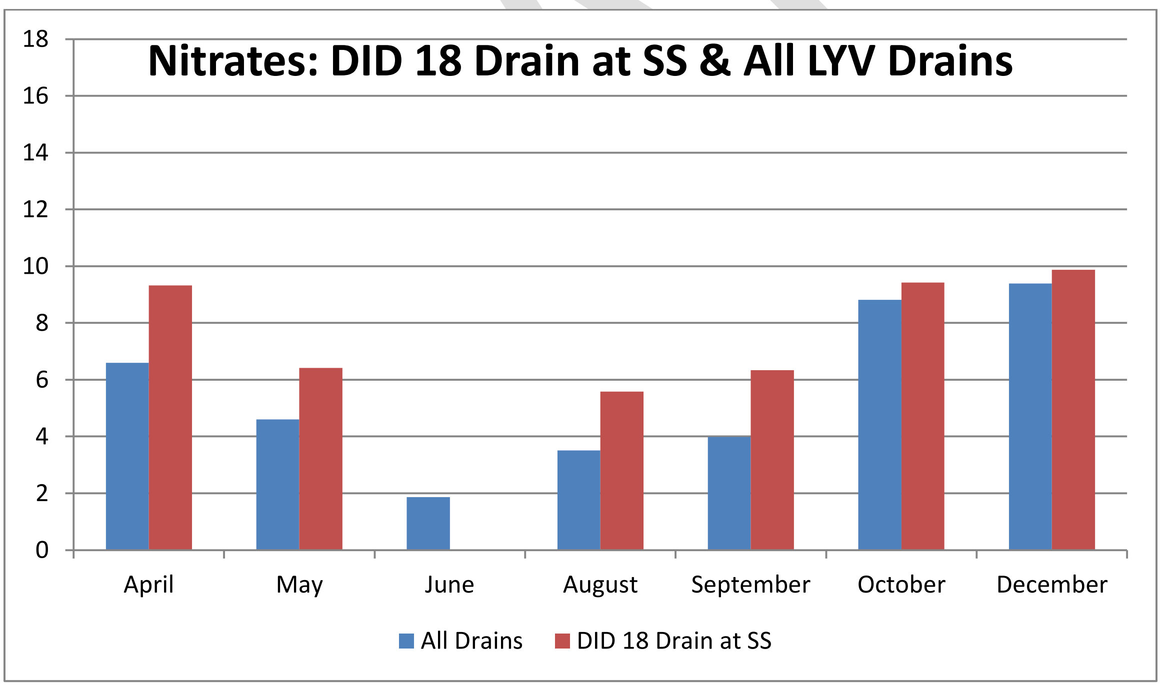


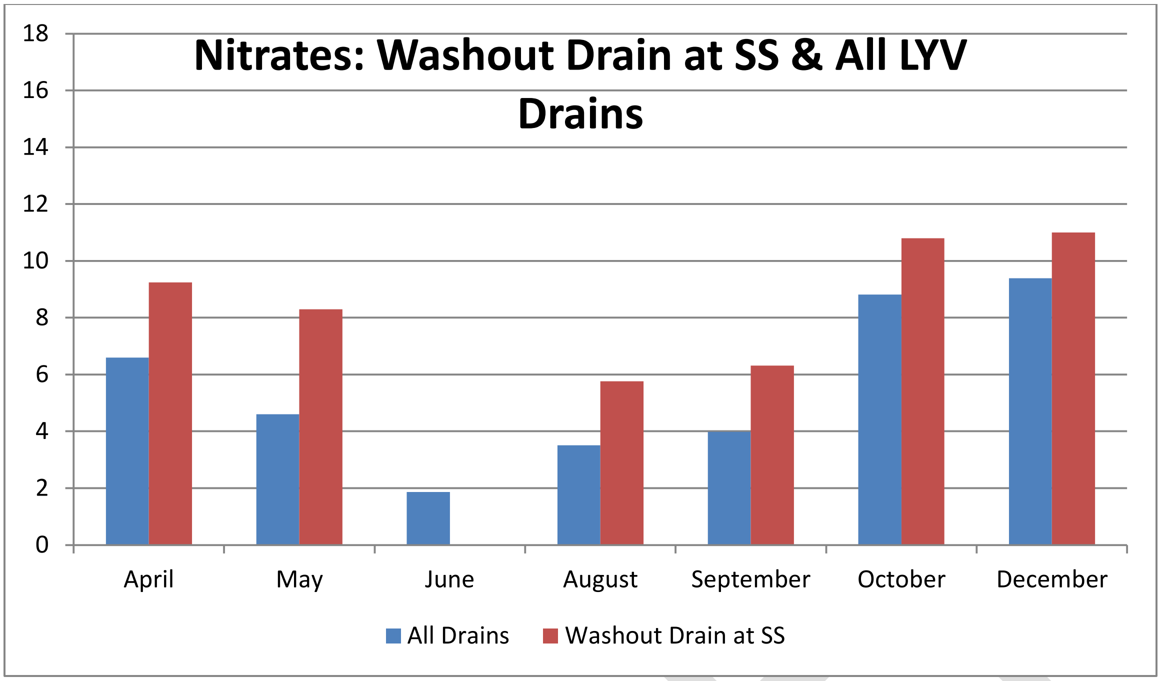
Nitrates: JD from Rougk Lane in SS & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
JD from Rougk Lane in Sunnyside


Nitrates: JD 34.2 at Woodin Road & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
JD 34.2 at Woodin Rd

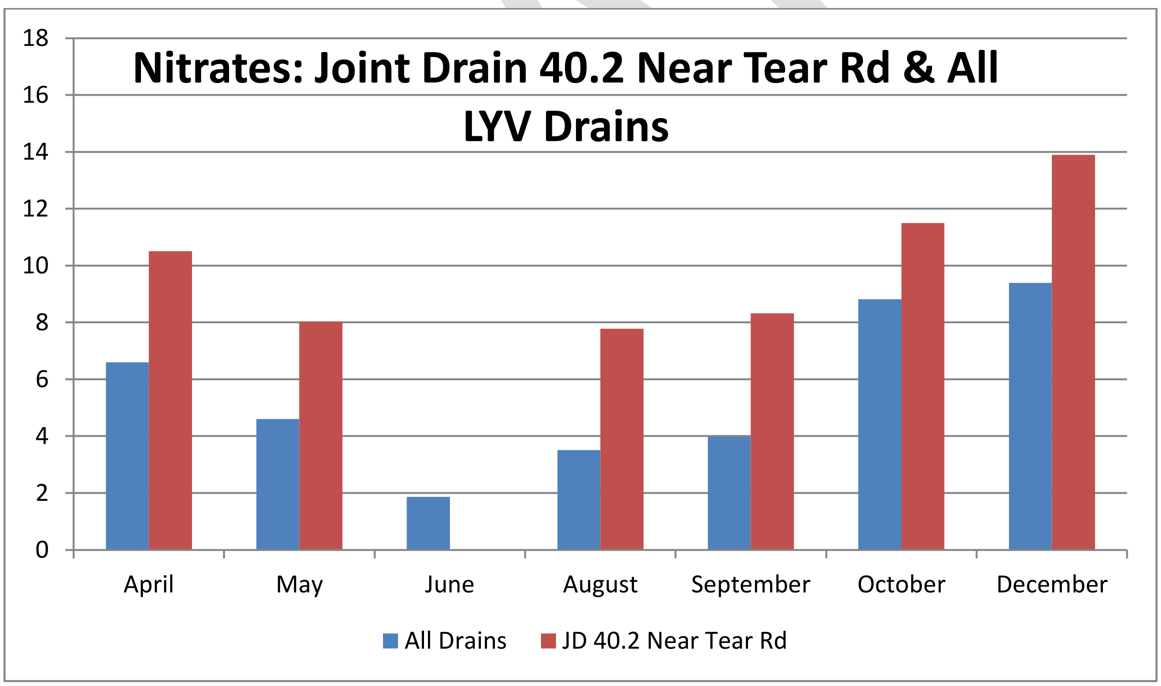

Nitrates: JD Near So 1st in SS & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
JD Near So 1st in SS


Nitrates: Sulfur Creek Wasteway at Scheller Rd & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
Sulfur Creek Wasteway at Scheller Road

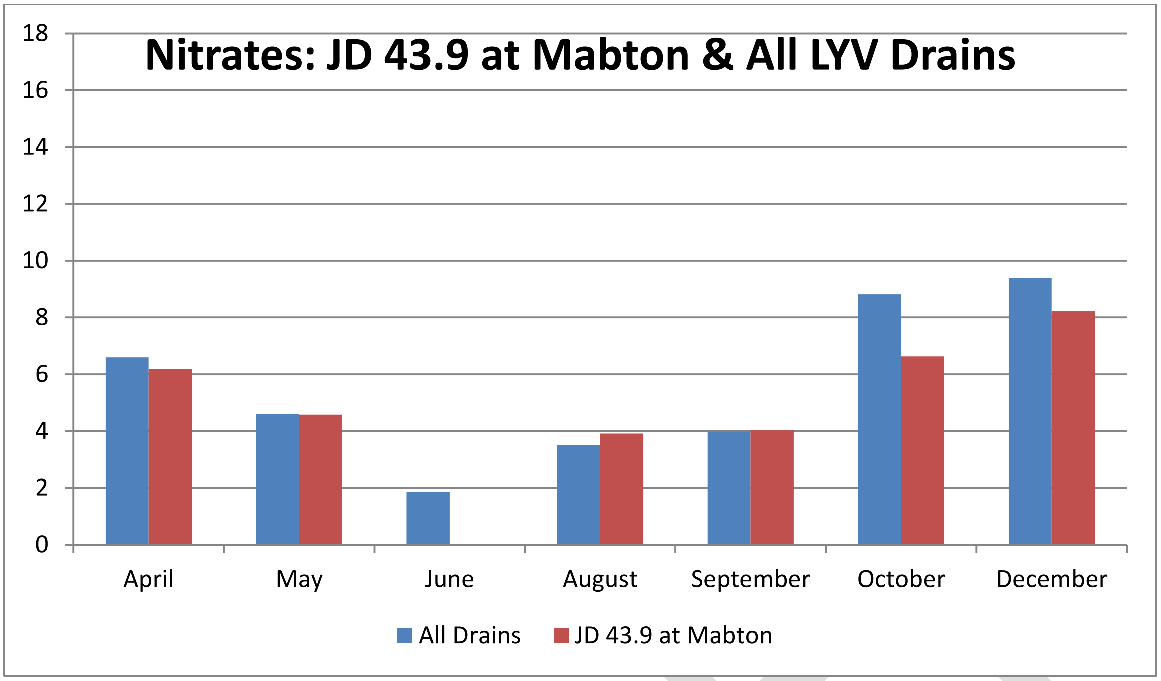

Nitrates: DID 18 Drain at SS & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
DID 18 Drain at SS

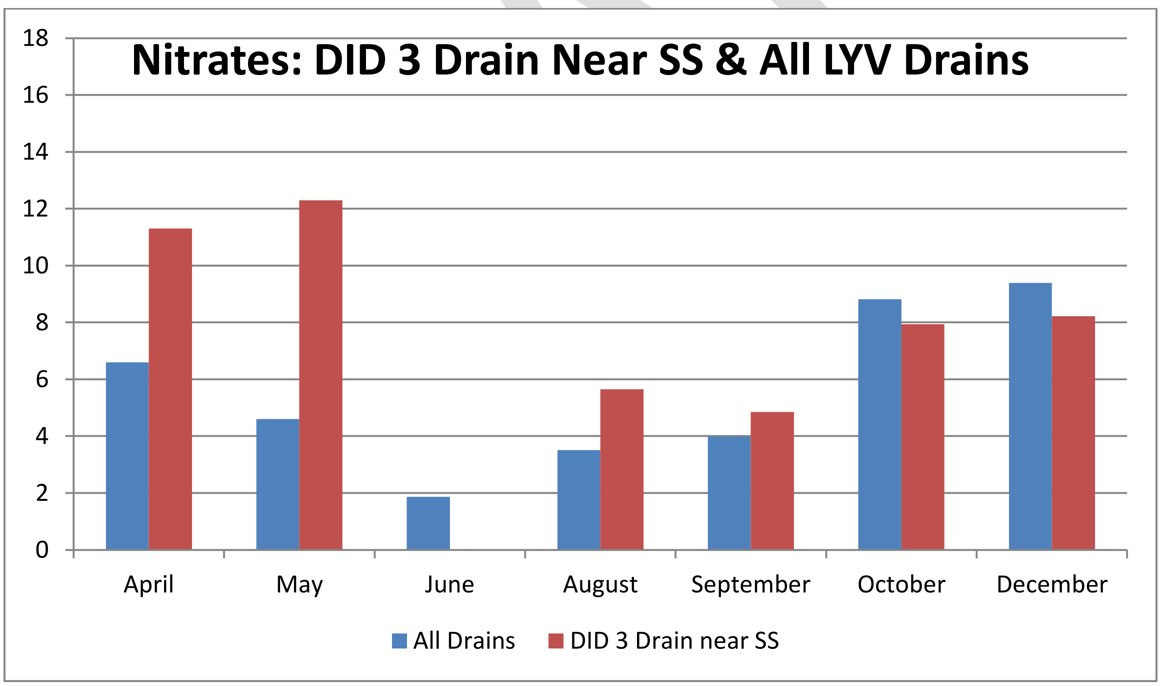


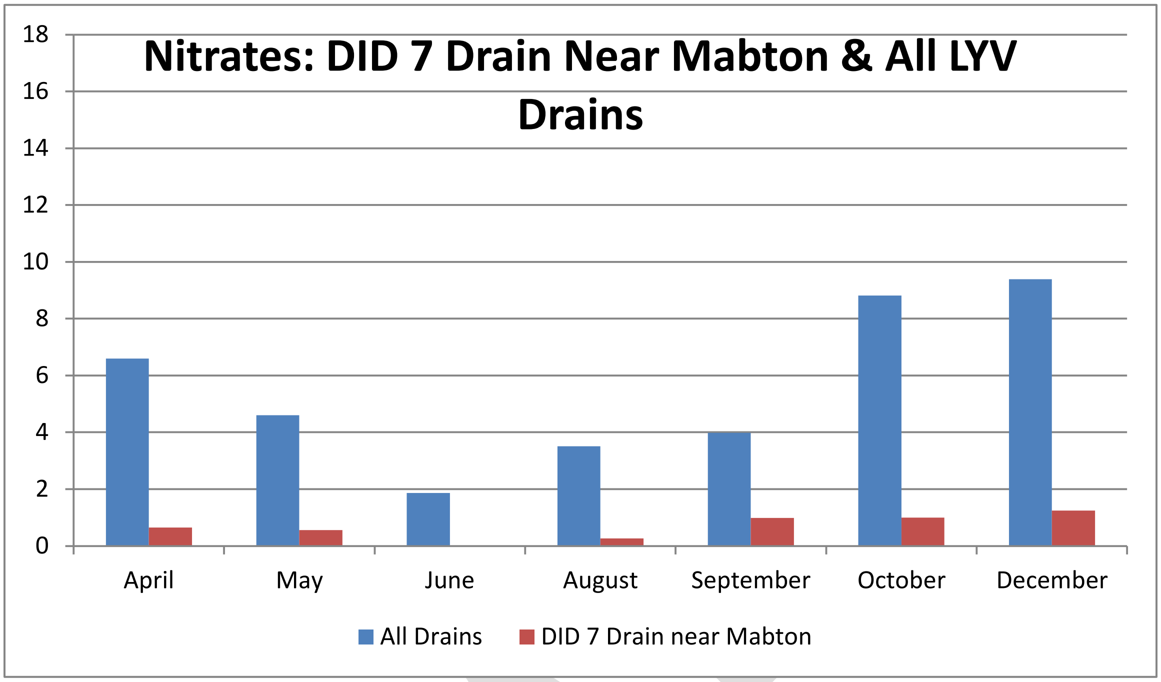
Nitrates: Washout Drain at SS & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
Washout Drain at SS

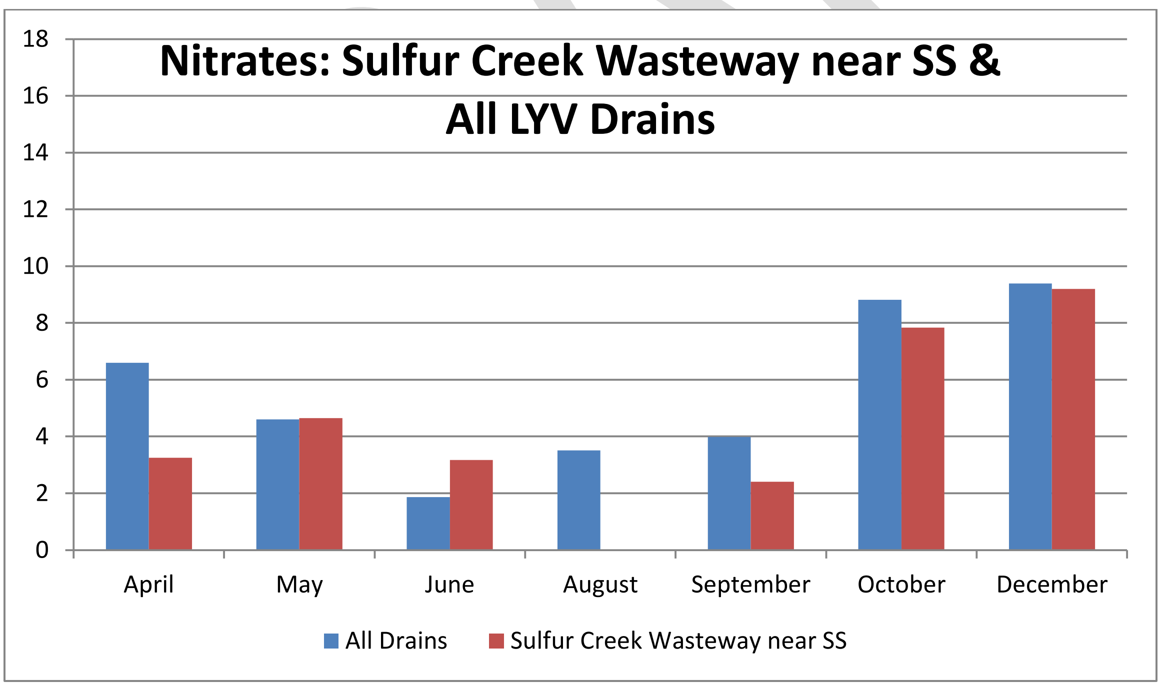


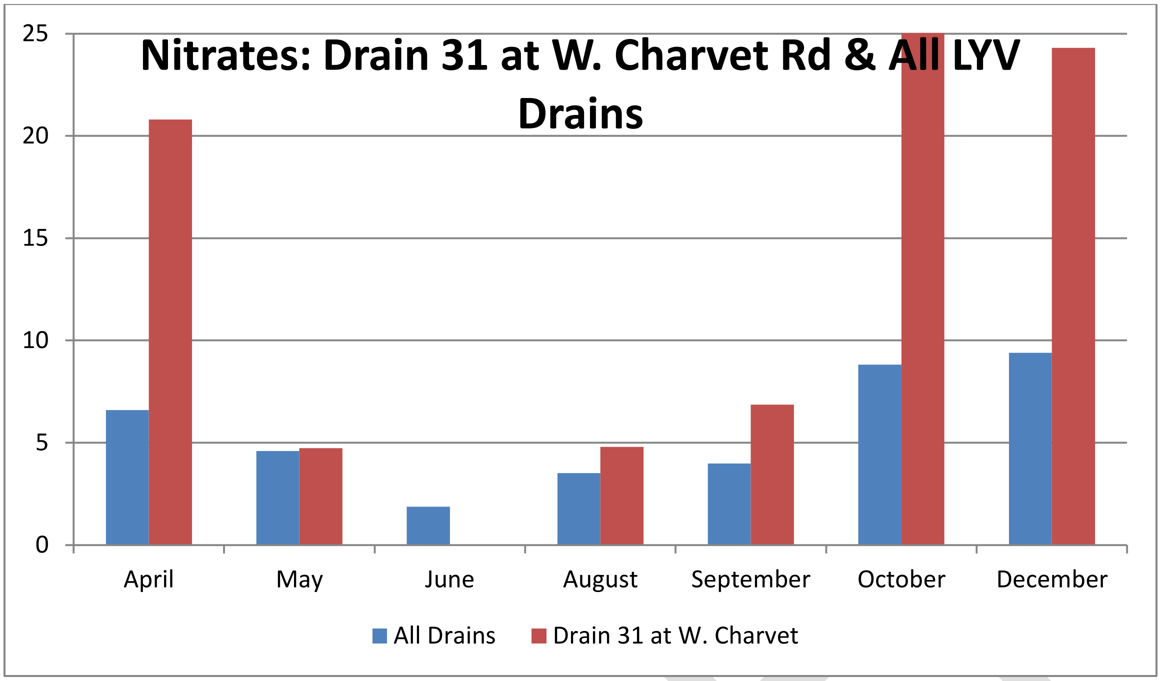
Nitrates: Joint Drain 40.2 Near Tear Rd & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
JD 40.2 Near Tear Rd


Nitrates: JD 43.9 at Mabton & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
JD 43.9 at Mabton

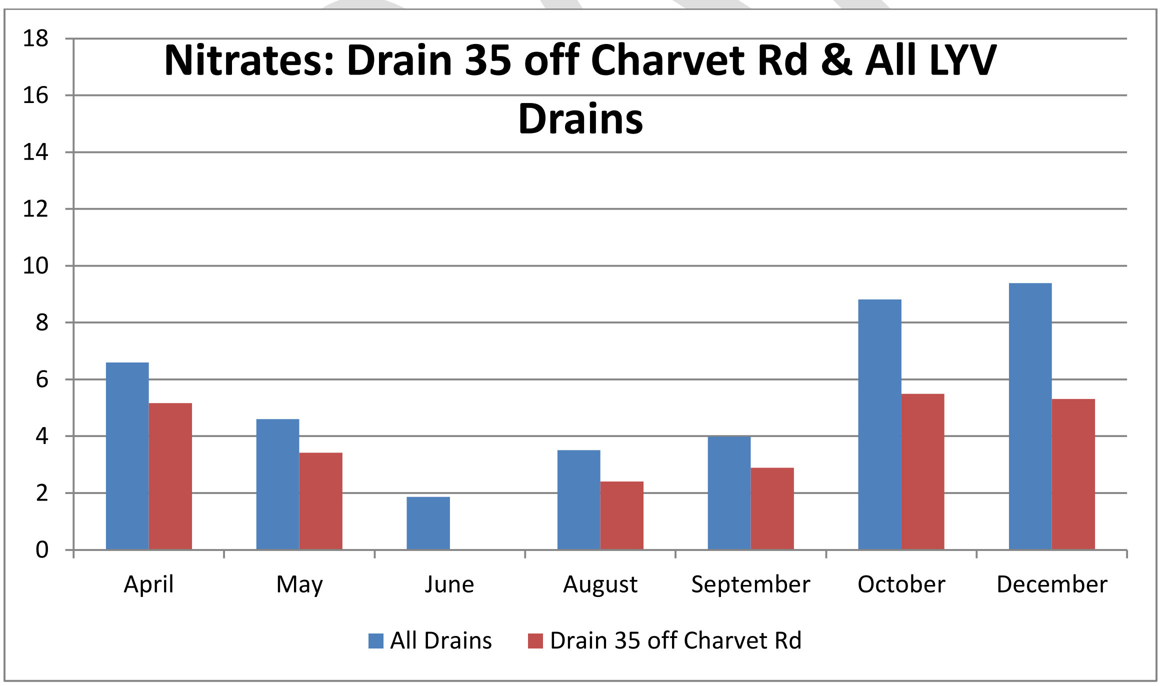

Nitrates: DID 3 Drain Near SS & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
DID 3 Drain near SS

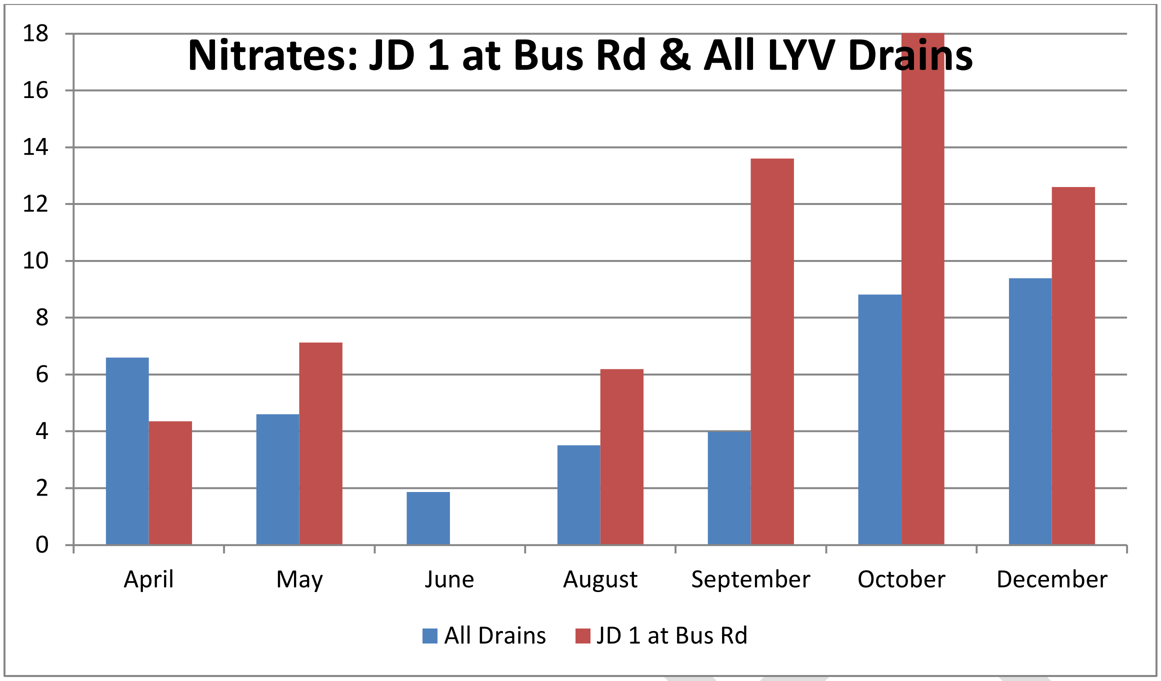

Nitrates: DID 7 Drain Near Mabton & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
DID 7 Drain near Mabton

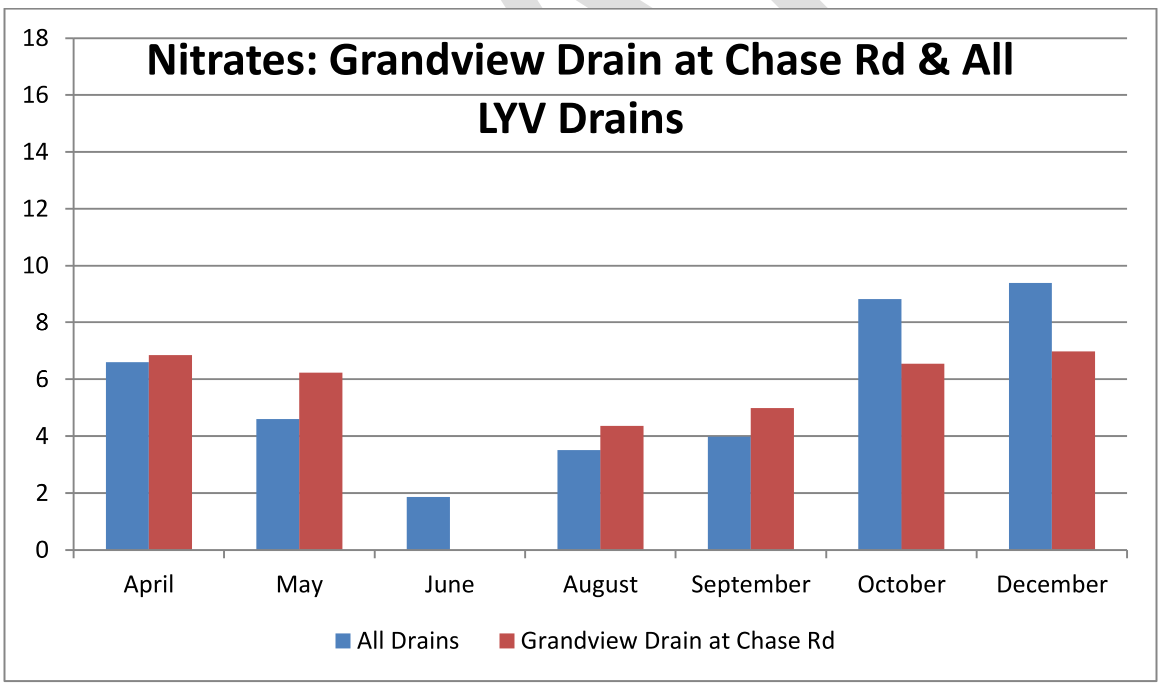

Nitrates: Sulfur Creek Wasteway near SS & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
Sulfur Creek Wasteway near SS



(Note change in Scale)




Nitrates: JD 1 at Bus Rd & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
JD 1 at Bus Rd


Nitrates: Grandview Drain at Chase Rd & All LYV Drains
18
16
14
12
10
8
6
4
2
0
April
May
June
August
September
October
December
All Drains
Grandview Drain at Chase Rd

Conclusions

Average nitrate levels for five well groupings are:

- North of Wapato – 0.50 mg/L
- Wapato to Toppenish – 4.00 mg/L
- Granger to Sunnyside – 8.62 mg/L
- Sunnyside to Mabton – 5.11 mg/L
- South of Mabton – 6.45 mg/L

Wells near the Yakima River had lower nitrate levels than those farther from the river

Wells in the area studied by the WA Agricultural Chemicals Pilot Project continue to have low nitrate levels

There was no overall correlation between well depth and nitrate levels

Drains in the northern study area had low nitrate levels

The highest drain nitrate levels were found in the area between Sunnyside and Mabton

Average nitrate levels in drains ranged from 0.01 mg/L to 13.07 mg/L

Last Updated on July 4, 2018